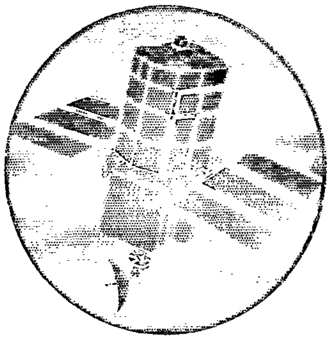
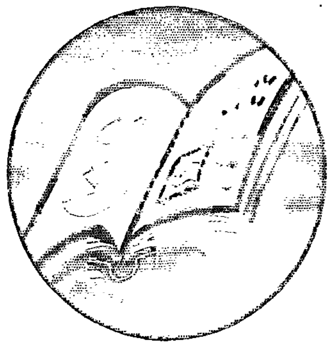
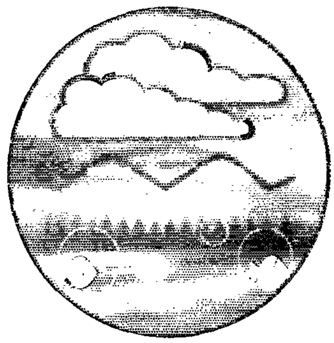
Recommendations for the Processing and Presentation of Groundwater Quality Data







Research and Development

Project Record
P2/088/01

ENVIRONMENT AGENCY

Recommendations for the Processing and Presentation of Groundwater Quality Data

R&D Project Record P2/088/1

Research Contractor:

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Commissioning Organisation:
Environment Agency
Rio House
Waterside Drive
Aztec West
Almondsbury
Bristol BS32 4UD

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This Project Record supplements R&D Technical Report P241 'Recommendations for the Processing and Presentation of Groundwater Quality Data' which examines the Environment Agency's requirements for the processing and presentation of groundwater data.

Research contractor
This document was produced under R&D Project P2-088 by:

Gibb Ltd
Gibb House
London Road
Reading
Berkshire
RG6 1BL

Tel: 0118 963 5000 Fax: 0118 963 5290

Environment Agency's Project Manager
The Environment Agency's Project Manager for R&D Project P2-088 was:
Rob Ward - National Groundwater and Contaminated Land Centre

CONTENTS

EXECUTIVE SUMMARY OF R&D REPORT P241

The Environment Agency is responsible for monitoring, assessing and reporting groundwater quality nationally, regionally, and locally around point sources of pollution. There is at present no standardisation for data processing and presentation, for which each region has developed its own system. Much of the software used is out of date and unsuitable for integration into the Agency's 'harmonised desktop' initiative, and users feel hampered by software inadequate to meet their needs. As European legislation brings in further statutory requirements for groundwater characterisation and monitoring, there is a pressing need for a standardised and integrated data storage, processing and presentation system.

The aim of the project reported in this document has been to develop a methodology to standardise the processing and presentation of groundwater quality data across the regions, largely by recommending a standard suite of software to be implemented throughout the Agency.

A National Strategy for Groundwater Monitoring is in the process of being developed by the Environment Agency. This strategy is required to meet internal objectives and to fulfil statutory requirements of the UK Government and the European Union, in particular the European Environment Agency. The National Strategy is based on proposals put forward by the BGS in 1994 (Chilton and Milne, 1994) modified to align with current Environment Agency strategy and updated to fulfil statutory requirements from more recent legislation, in particular the European Draft Water Framework Directive.

The Environment Agency has developed Codes of Practice for data handling to ensure a consistent approach to the handling of values below detection limits, estimation of percentiles and presentation of summary statistics. These Codes of Practice do not appear to have been widely adopted because of the difficulty of implementation without appropriate software to automate the procedures.

In this study the regulatory and other requirements for the processing and presentation of groundwater quality within the Environment Agency have been reviewed, and a standard reporting framework for groundwater quality assessment has been outlined. The key tasks for groundwater quality data handling and assessment can be broken down into data storage and archiving, data retrieval, and data processing and presentation. Data processing and presentation tasks include:

- graphical presentation of results from both individual monitoring points and sample groups, including time series and specialist geochemical diagrams
- mapping and contouring on local and regional scales
- reporting including comparison with standards
- statistics summarising results from groups of samples such as groundwater bodies, and from individual monitoring points

A search was undertaken for software suitable to complete the identified tasks and compatible with the Environment Agency's IT convergence strategy. Software already adopted as standard by the Agency was assessed, and the additional features required for the project and

not covered by the available software were identified. A fuller evaluation of software with the capabilities of meeting these requirements was then carried out.

The Agency has already specified that the **WIMS** database, which is in the process of being implemented, should be the primary archive for water quality data, including groundwater quality data. WIMS will hold all the groundwater quality measurements and some sampling point information. WIMS will require minor modification to allow sample depth data to be stored. Additional sampling point information will be required for data assessment, and it would be appropriate to store this data on the same database as that used to hold similar information for quantitative groundwater monitoring points, which will probably be **Hydrolog3**. If Hydrolog3 is used some additional tables would be useful to hold information regarding sampling point location, for example land use or proximity to pollution sources, urban areas or the sea.

It is recommended that Microsoft **Access** is used for groundwater quality data retrieval from WIMS and Hydrolog3. Some expert programming will be required to set up appropriate queries, search routines and reports in Access, but the package is sufficiently flexible and easy to use that non-expert users should be able to retrieve the permutation of data they require.

There is no single package that can carry out all the data processing and presentation tasks required for water quality data assessment. For graphical presentation, including general time series and geochemical diagrams, **Aquachem** is recommended. Microsoft **Excel** may also be used for general data plotting and manipulation. Although not essential for everyday use, it is also recommended that all users should have access to **Aardvark**, for sophisticated but simple trend analysis. The desktop GIS system **ArcView** is recommended for mapping purposes, and it is likely that it will also be used for integration with other data held by the Agency. ArcView by itself does not have the capability for contouring, and it is recommended that the extension **3D Analyst** be purchased for this purpose. Statistical analysis is required for the assessment of the effects of different sampling point types on groundwater quality parameters, and the software package **Minitab** is recommended for this purpose.

Some development will be required to set up the links between the individual elements of the software suite to allow automation of routine tasks and to ensure a consistent approach to data handling. Once this recommended suite of software is implemented across the Environment Agency Regions, with the required developments to allow additional capabilities, then those responsible for water quality data processing and presentation will have available a powerful suite of software. The integration of this software with other packages already recommended as standard within other disciplines of the Agency will encourage the release of the full potential of groundwater quality data assessment.

1. AGENCY QUESTIONNAIRES

1.1 Summary of Responses to Questionnaires

1.2 Example Questionnaire

1.3 Responses to Questionnaire

1.1 Summary of Responses to Questionnaires

Table 1.1 Responses received to the questionnaire

Region	Name	Response
Anglian	Paul Hart	✓
Anglian	Robert Heath	✓
Anglian	Alison Frogley	✓
Anglian	Russell Woollat	✓
Anglian (eastern area)	Richard Walter	✓
Anglian (eastern area)	Simon Wood	✓
Anglian	Clare Blacklodge	✓
Anglian	Andrew Brewster	✓
Anglian	Dave Chandler	✓
Southern (HQ)	Felicity Standley	✓
Southern (Hampshire and Isle of Wight Area)	Bob Barnes	✓
Thames	Ian Davey	✓
Thames	Sheena Engineer	✓
Thames	Carla Healey	✓
Thames	M J Hoare	✓
Welsh (HQ)	Wayne Davies / Phil Russell	x
North West (HQ)	Edward Wrathmell	✓
Midlands (HQ)	Andrew Pearson	✓
South West (HQ)	Nigel Crane	Verbal
NE Region (Dales Area)	Alex Garden	✓
NE Region (Dales Area)	Mark Morton	✓
NE Region (Ridings Area)	John Aldrick	✓
NE Region (Northumbria Area)	Martin Kershaw / Paul Butler	x

Table 1.2 Sources of groundwater quality data - public water supply and observation boreholes

		REGION												
		Anglian (HQ)	Anglian (Eastern)	Anglian (Northern)	Southen (HQ)	Southern (Hants)	Thames	Welsh (HQ)	NW (HQ)	NE (Dales)	NE (Ridings)	NE (Northumbria)	Midlands	SW (HQ)
No.PWS Wells	0													
	1 to 99			54+4		42					21			
	100 to 199		100+						123	111				
	200 to 299				278		290							
	300+	3-400											320	
	not-specified					x								x
Frequency	monthly/quarterly	x			x		x						x	
	bi-annually/annually	x							x		x			
	variable	x	x	x	x					x			x	x
Determinand suite		TON & nitrate / suite Q3	DWS		SS+	-	G2 & G4 suites		suite 537	SS	suite 801		suite 162/163	BGS
No.Observation Boreholes	0				x				x					x
	1 to 99													
	100 to 199			126			187			~90			180	
	200 to 299										2-300			
	300+	~600 ?	377											
Frequency	monthly/quarterly	x	x										x	
	bi-annually/annually	x	x							x				
	variable			x			x				x		x	
	not specified					x								x
Determinand suite		basic GW suite	suite Q4	Suite C2/C3	-	-	-		-	suite 801/805	suite 802 & 808		suite 162/163	BGS

Table 1.3 Sources of groundwater quality data - springs

		REGION												
		Anglian (HQ)	Anglian (Eastern)	Anglian (Northern)	Southen (HQ)	Southern (Hants)	Thames	Welsh (HQ)	NW (HQ)	NE (Dales)	NE (Ridings)	NE (Northumbria)	Midlands	SW (HQ)
No.Springs	0					x								
	1 to 99			19	17		67		50	~30	10-15		50	
	100 to 199	~123												
	200 to 299													
	300+		hundreds											
	not specified													x
Frequency	monthly/quarterly	x			x		x							
	bi-annually/annually	x							x	x				
	variable		x	x							x		x	x
Determinand suite		TON & nitrate/ basis GW suite	suite Q4	major ions	SS+	-	G2/G4/ NSA		suite 573	suite 801/805	suite 802 & 808		suite 162/163	BGS

Table 1.4 Sources of groundwater quality data - other monitoring locations

		Anglian (HQ)	Anglian (Eastern)	Anglian (Northern)	Southen (HQ)	Southern (Hants)	Thames	Welsh (HQ)	NW (HQ)	NE (Dales)	NE (Ridings)	NE (Northumbria)	Midlands	SW (HQ)
No.other monitoring locations	0													
	1 to 99				8	8					60-100			
	100 to 199								177	110				
	200 to 299													
	300+	3-400					350++							
	not specified		x	x		x							x	x
Type	Landfill sites	x	x				x			x	x		x	x
	Project specific	x								x	x		x	
	Private boreholes			x	x		x		x					
	River	x												
	Other	x		x			x		x	x				
Frequency	monthly/quarterly	x					x			x				
	bi-annually/annually	x			x	x	x		x	x				
	variable	x	x	x						x	x		x	
	not specified													x
Determinand suite		basic GW suite/ suite Q3	suite Q4	Cl & Cond. / WMP4/ suite C2/C3	SS+	list AA	G2/G4/ NSA/ WMP4		suite 537 & 538	suite 801 & WMP4	WMP4 / SS		site specific	BGS

Table 1.5 Sources of groundwater quality data - footnotes

Cl = chloride
Cond. = conductivity
WMP4 = Waste Management Paper 4
BGS = BGS Strategy
SS = site specific
DWS = Drinking Water Standard
SS+ = Site specific (one of @220 parameters)
TON = Total Oxidised Nitrogen

801 - major anions and cation plus pH, temp and conductivity (17 parameters in total)
805 - comprehensive list of @ 120 anions, cations, organic and physical parameters
Suite 537 - major anions and cations and physical parameters (31 in total)
Suite 538 - major anions and cations and physical parameters plus some organic parameters
Suite B - Ph, conductivity, DO, Cl, COD and ammoniacal nitrogen (6 paramters)
Suite Q4 - major anions and cations plus physical parameters
802 - anions and cations and some organic parameters (71 in total)
808 - anions & cations, organic parameters (including benzenes, phenols, chlorinated hydrocarbons - 94 in total)
Basic GW suite - major anions and cations and physical parameters (16 in total)
Suite Q3 - specific suite including analysis for radium, uranium, tritium, strontium, caesium and gross alpha and beta
G2/G4 suite - anions and cations, organic parmeters (including benzenes, phenols, chlorinated hydrocarbons, pesticides) (103 in total: G2 = 26, G4 = 77)
Suite 162- physical parameters and major anions and cations (16 in total)
Suite 163 - physical parameters, anions and cations, pesticides and organic parameters)
list AA - physical parameters, anions, cations, pesticides, organic parameters including oil and chlorinated solvents (80 in total)
Suite C2/C3 - major anions and cations and physical parameters (no. of parameters dependant on nature of site)

Table 1.6 Data collection by region

Region	Source of GW quality data	Name of external sources	Additional comment fields	Other environmental data	QA/QC procedures
Anglian (HQ)	Internal and external	Water Companies, Landfill operators and developers' consultants	Sometimes	Weather, flow, water level, surface water monitoring data	Lab is NAMAS/UCAS approved. Ionic balances calculated and historical comparisons made. Visual checking.
Anglian (eastern)	Internal and external	Essex and Suffolk and Anglian Water Companies, Landfill operators.	Yes - surface water pumping rates and qualitative descriptions	Water levels, gas and leachate concentrations	Time series and calculation of ionic balances. Audit sampling and analysis.
Anglian (northern)	Internal and external	Water Companies, Industrial Users Association, District Councils, Waste Disposal site operators	Occasionally	Landfill gas concentrations, groundwater levels, weather conditions, temperatures	Data on AQUA LIMS is validated, Internal Agency protocols followed. Use of NAMAS approved laboratories.
Southern (HQ)	Internal and external	Water companies	None	None	None

Table 1.6 Data collection by region

Region	Source of GW quality data	Name of external sources	Additional comment fields	Other environmental data	QA/QC procedures
Southern (Hants)	Internal and external	Water Companies and Waste Management Licensed Sites.		Gas monitoring undertaken at Waste Management Licensed Sites.	NAMAS accredited laboratories and accredited environmental companies.
Thames	Internal and external	Thames Water, other water companies, landfill site operators	Yes eg equipment used, general comments, location.	Rest water levels recorded at NSA sites. Other parameters include landfill gas, dust, asbestos fibres, noise, leachate quality, leachate levels and groundwater levels.	Lab is NAMAS accredited. Audit sampling by consultants employed by the Agency and Agency staff sometimes accompany consultants working for the landfill site operators when monitoring.
Welsh (HQ)					
Midlands	Internal and external	Water companies (Severn Trent, South Staffs, Yorkshire and Anglian)	Yes - but generally not used.	Weather conditions	Sample results are based on the 95 percentile rule.

Table 1.6 Data collection by region

Region	Source of GW quality data	Name of external sources	Additional comment fields	Other environmental data	QA/QC procedures
North West (HQ)	Internal and external	North West Water	Yes - general comments field	None	Standard Agency QA procedures.
North East (Dales)	Internally	N/A	No	Precipitation and temperature	LAB is NAMAS approved, but no other QA/QC.
North East (Ridings)	Internally and externally	Contaminated land sites and landfills	None	Water levels, field parameters, site name, NGR, source type, aquifer type, licence number.	Lab is NAMAS approved. Ionic balance is calculated.
North East (Northumbria)					
South West (HQ)	Very little data in general	Water Companies	No	None	None

Table 1.7 Storage of groundwater chemistry data by Region

Region	Single database or different software packages	Knowledge of other databases	Location of databases and personnel responsible
Anglian (HQ)	Several database packages	AQUA-LIMS, POLLEASE, ENTEC pollution incident database, NVZ database, Pesticide database.	Selina Randal , Alison Frogley, are responsible for database management.
Anglian (eastern)	Several different packages (LIMS, EXCEL, MONIT and HYDRODAT)	None	Different locations, including Kettering (D Chandler)
Anglian (northern)	Different packages (AQUA LIMS and DBASE3)	ACCESS database of landfill data.	ACCESS database located in Lincoln, under responsibility of Andrew Brewster.
Southern (HQ)	Three different database packages	None	Databases located in Worthing. Responsibility of Martin Jerome, Felicity Standley and Keith Jury
Southern (Hants)	Different databases.	MONITOR, WIMS and Water Compnay ARCHIVE system database.	Databases located in Winchester (protection and monitoring) and at regional office.
Thames	Data stored on Archive and then downloaded and manipulated using different packages. Data also stored on EXCEL and LOTUS spreadsheets and on ACCESS.	Databases held by District Council Environmental Health departments and WIMS.	Databases at regional and area offices eg at Highway House in Surrey under the responsibility of Scientific Support Team (M Hoare and Dr K Mason); at Wallingford office under responsibility of Sally Coble
Welsh (HQ)			
North West (HQ)	Single mainframe archive	None known	Kathy Greenall, Data Resource

Table 1.7 Storage of groundwater chemistry data by Region

Region	Single database or different software packages	Knowledge of other databases	Location of databases and personnel responsible
North East (Dales)	Different databases	Contaminated land /groundwater pollution database held by ENTEC.	
North East (Ridings)	Different databases.	None	N/A
North East (Northumbria)			
Midlands	Currently use Water company database (QUIS) to store both Water Company and Agency data. However, this arrangement will cease with the introduction of WIMS.	Very little additional groundwater quality data held on databases - majority held in paper form or on microfiche.	Area Scientific Support teams are responsible for landfill databases. All others are accessible via Regional Office.
South West (HQ)	Different databases	WIMS for surface water quality data. Database exists for Contaminated Land sites.	Jane Driver is responsible for database management in SW region

Table 1.8 Assessment and interpretation of groundwater chemistry data by Region

Region	Is data routinely manipulated, interpreted and displayed?	On what scale?	What level of interpretation is performed?	Are data used by other departments in EA or external bodies?	In what format is this data provided?
Anglian (HQ)	Yes	Individual boreholes or regional basis	Trend analysis and comparison with quality standards	Data provided to public, national groundwater centre, waste regulation authorities.	Paper and electronic
Anglian (eastern)	Yes	By area or site or LEAP area.	Trend analysis, Piper, Durov, Schoelder	Yes	Hard copy or via EXCEL
Anglian (northern)	Yes	Site specific	Trend analysis and comparison with quality standards	Data provided to general public/consultants via public register.	Hard copy printout from AQUA LIMS or on disk.
Southern (HQ)	No	N/A	N/A	No	N/A
Southern (Hants)	No	Individual sources	Interpretation by comparison and recently trend analysis.	Data provided to the public when requested.	Paper

Table 1.8 Assessment and interpretation of groundwater chemistry data by Region

Region	Is data routinely manipulated, interpreted and displayed?	On what scale?	What level of interpretation is performed?	Are data used by other departments in EA or external bodies?	In what format is this data provided?
Thames	Yes	By catchment for major aquifers (this will be extended to minor aquifers). Also on a site (landfill) basis.	Pollution trends for solvents, nitrates, pesticides, and a review of data for an aquifer over a networked area. Also for landfill sites: time series graphs, comparison with background quality and comparison of EA and site operators data.	Data provided to the public and to landfill operators.	Hard copy (paper) reports on groundwater quality, solvents, nitrates and pesticides. Raw data available as computer printouts from Customer Services Department. Some landfill data in Excel and Lotus provided on disk.
Welsh (HQ)					

Table 1.8 Assessment and interpretation of groundwater chemistry data by Region

Region	Is data routinely manipulated, interpreted and displayed?	On what scale?	What level of interpretation is performed?	Are data used by other departments in EA or external bodies?	In what format is this data provided?
Midlands	Historically (pre 1990) yes. Currently very little but likely to increase from 1998 onwards.	Generalised regional data plus some specific sub-catchment reports.	General interpretation, with nitrate (ANTEATER) trend analysis, assessment of pollution data against quality standards, general summary information on likely groundwater quality in aquifer outcrop areas.	Data is provided to industry, consultants, pressure groups and the general public via the register.	Usually hard copy (ASCII file extract). Internally it can be put into Visual Dbase, EXCEL or LOTUS 123.
North west (HQ)	Yes	Individual or small groups of samples	Trend analysis	Data available to industry and the general public	Hard copy
North East (Dales)	Routinely interpreted against Drinking Water quality standards	On an aquifer basis	Data compared to Drinking Water standards	Yes - to other EA departments, industry and the public	Hard copy

Table 1.8 Assessment and interpretation of groundwater chemistry data by Region

Region	Is data routinely manipulated, interpreted and displayed?	On what scale?	What level of interpretation is performed?	Are data used by other departments in EA or external bodies?	In what format is this data provided?
North East (Ridings)	No - as no suitable software.	Generally site specific basis - but also on aquifer basis.	Comparison with other monitoring stations and existing water quality standards.	Yes	Hard copy
North East (Northumbria)					
South West (HQ)	No	-	-	-	-

Table 1.9 Software used in each region

	Oracle	Access	Hydrodat	Surfer	WIMS	Geo-base	Lotus 123	Main Frame	ICL	Mapinfo	C-VAX	EXCEL	DBASE 3	EASY MAP	LIMS	MONIT
Anglian (HQ)		x								x		x			x	
Anglian (Eastern)		x		x								x			x	x
Anglian (Northern)							x						x	x	x	
Southern (HQ)	x	x	x	x	x											
Southern (Hants)																
Thames		x	x	x			x	x		x		x				
Welsh (HQ)																
North West (HQ)						x	x									
North East (Dales)		x					x	x	x		x					
North East (Ridings)							x	x								
North East (Northumbria)																
Midlands		x					x					x				
South West (HQ)	x				x		x									

Table 1.10 Software used in the Agency Regions by category

Software	Storage	Statistics	Tables	Graphs	Contours	Mapping	Other	Comments
ORACLE	x							Not user friendly
ACCESS	x	x	x					Graph package poorly integrated. Sometimes difficult to construct/use graphs from queries in database.
HYDRODAT	x	x		x			x	DOS based, crashes frequently. Cannot import data directly. No technical support.
SURFER				x	x			
WIMS	x							More training required.
QUIS	x							
GEOBASE		x		x				
LOTUS 123	x	x	x	x				No mapping/contour features, no searching possible, data must be input manually.
MAIN FRAME DATABASE	x	x	x	x				Manipulation of data is difficult. Searching is hit and miss. No graphing ability. No quick easy access to data.
ICL	x							Cannot graph data or compare the quality of different samples. Output quality is poor. Difficult package to learn.
FREELANCE							x	
ARCHIVE	x							
MAPINFO	x	x	x	x	x	x		
CVAX	x							Not user friendly. Stores data for only a short period of time.

Table 1.10 Software used in the Agency Regions by category

Software	Storage	Statistics	Tables	Graphs	Contours	Mapping	Other	Comments
EXCEL	x	x	x	x				Slow input of data. Individual spreadsheets can become slow to use as amount of data increases. Poor technical support. Data entry problems, for example Excel will not accept < or >. Excel will often allow access to data but will protect if from alternation and/or deletion. Generally no problems but need to work out macros to get data from MONITOR database, produce automatic updates and easily produce graphs from lots of data.
LIMS	x	x	x					Difficult graphing - not a windows package. Need system for regular interrogation of trends, as opposed to on a needs basis.
EASMAP						x		
MONITOR	x							
DBASE 3	x	x		x				Poor support
MONIT		x	x	x				Not a windows compatible package. Slow data input. Poor tabulated data output.

Table 1.11 Additional software features required by the regions

Region	Feature
Anglian (HQ)	Data archive and storage and graphic presentation capabilities, 3D visualisation of subsurface distribution, Piper, Durov and Ternary plots, Stiff diagrams, representation of biological parameters and interface with flow and CT models.
Anglian (eastern)	Ability to plot time-series graphs for many locations and parameters. Ability to do statistics and ionic balance calculaions. Ability to link to G.I.S to produce 3D plots. Ability to undertake multivariate analysis. Combination of AQUACHEM with GIS/ARC INFO.
Anglian (Northern)	Sample graphing and mapping package.
Southern (HQ)	Windows based package for interpretation and graphing of data exported from ACCESS database. Must have flexible import routines.
Southern (Hants)	A software feature which allows you to link between all the existing software packages.
Thames	An OS based GIS system over which groundwater protection zones, vulnerability zones, NSA, NVZ, network points and pollution sources can be overlaid for risk assessment purposes. Software features which allow the better more efficient storage of data, contouring, data plotting capability onto landfill site plans, automatic reporting facility which produces standardised reports for regular data reviews and also highlights areas of concern. Software package that are capable of piper diagrams, 3D plume monitoring and cross-sectional diagrams of geology.
Welsh (HQ)	
North West (HQ)	Ability to plot Durov, Stiff, Shroeder (?Schoeller) and histograms. Also ability to use such a package in conjunction with GIS, WIMS and other Agency software.
North East (Dales)	Automatic comparison (ie to compare with drinking water standards. Graphical capabilities, contour plots and statistics. Piper diagrams, cumulative percentage graphs, graphs showing comparisons with water quality standards, trend analysis and OPM's.

Table 1.11 Additional software features required by the regions

Region	Feature
North East (Ridings)	Ability to perform radial searches of database by NGR and aquifer type. Ability to draw graphs comparing water quality standards with analytical results. Ability to plot time-series data from the same point and graph individual determinands from separate boreholes.
North East (Northumbria)	
Midlands	ArcInfo to aid site location and data searches and increase efficiency to the customer. Improved statistical analysis/routines may also be helpful.
South West (HQ)	Straightforward access to data and simplicity for production of routine reports. Ability to monitor pollution of controlled waters over time, with intelligent (ie aquifer specific) contouring capabilities and easy-to-understand graphical illustrations.

Table 1.12 Other potentially suitable software known to the regions

Software	Comment
WIMS	In WIMS, data is entered against a site reference. It is not set up for accessing data by aquifer and borehole, but rather by water course and catchment. Some manipulation would therefore be required for use of WIMS with groundwater data.
AQUACHEM	Welsh region have just purchased a copy but have not started using it yet.
VISUAL GROUNDWATER	-
GIS based package	-
"Monitor-Pro"	Package has the ability to interface with current ACCESS databases and possible Agency's chosen GIS package ARCview, and maybe also Mapinfo.
USEPA "GRITS-STATS"	Statistic capabilities for calculations on upstream and downstream borehole water quality comparisons (incorporated into Chemstat).
MINITAB	-

1.2 Example Questionnaire

GIBB Environmental
LAWGIBB Group Member

QUESTIONNAIRE: Groundwater Quality Data Software

GIBB Ltd. have been contracted by the Agency to assess the Agency's requirements regarding the storage and display of groundwater quality data. This questionnaire forms part of our assessment and we will be grateful for your responses to the questions outlined below.

If you have any queries please contact Mark Vanstone or Tim Morgan at GIBB Ltd. on 0118-9635000, or by Email at mvanston@gibb.co.uk or tmorgan@gibb.co.uk.

The following questions are to obtain general details.

Q1.

Please provide the following reference details.			
Name:			
Position:		**Region:**	
Tel No.:		**Fax No.:**	
E-mail:			

Q2.

Please provide details of other Agency staff who may be able to provide input to this project.			
Name:			
Position:		**Region:**	
Tel No.:		**Fax No.:**	
E-mail:			
Name:			
Position:		**Region:**	
Tel No.:		**Fax No.:**	
Position:			
E-mail:			

The following questions are to establish how much groundwater quality monitoring data your office typically handles annually:

Q3. Public Water Supply Wells

No. of public water supply wells:	
What is the frequency of the data receipt and review process for public water supply wells and how was this determined ?	
Please identify the determinands for public water supply wells (or attach a list):	

Q4. Observation Boreholes

No. of observation boreholes:	
What is the frequency of the data receipt and review process for observation boreholes and how was this determined ?	
Please identify the determinands for observation boreholes (or attach a list):	

Q5. Springs

No. of springs:	
What is the frequency of the data receipt and review process for springs and how was this determined ?	
Please identify the determinands for springs (or attach a list):	

Q6. Other Monitoring Locations

No. of other monitoring locations:	
What is the frequency of the data receipt and review process for these monitoring points and how was this determined ?	
Please identify the determinands for these monitoring points (or attach a list):	

The following questions are to obtain information regarding the data collection, storage and use.

Q7. Data Collection

Is the groundwater quality data obtained internally or externally ?	
What and where are the external sources ?	
Does the determinand data collected have additional comment fields and what are these ?	
What other environmental data are collected in parallel with groundwater quality data ?	
What QA/QC procedures are used to assess the quality of the groundwater monitoring data ?	

Q8. Data Storage

Are groundwater quality data on a single database or are a number of software packages used ?	
What other databases are you aware of for other data ? E.g. contaminated land, landfill, mineral water, private supplies.	
Where are these databases located and who has responsibility ? Please provide name, address and telephone number.	

Q9. Data Use

Are groundwater quality data routinely manipulated, interpreted and displayed ?	
On what scale is this done ? E.g. sub catchment, catchment or other.	
What level of interpretation is performed ? E.g. trend analysis, comparison with quality standards etc.	
Are the data used by other departments in the Agency or provided to industry / the public ?	
In what format is this data provided ?	

The following questions relate to the software you use.

Q10.

What software do you currently use to store, analyse and present the data ? e.g. Excel, Lotus, Access, Approach, Oracle, Grapher, Statistica, SPSS, Surfer, Arcview, Arcinfo, Mapinfo, WIMS.

Program	Version	Main Uses						
		Storage	Statistics	Tables	Graphs	Contours	Mapping	Other please describe

Q11.

Is the software you have listed sufficient and suitable for your purposes, if not what are the problems ? e.g. difficult graphing, training required, poor technical support.	
Program	

Q12.

What additional software features would you like ? e.g. specific graphs or statistical capabilities.

Q13.

Are you aware of any other software that would satisfy your requirements ?

Q14.

Have you tested any software other than that you currently use and what was your conclusion ?

Thank you for completing this questionnaire. Please return the completed document by post or by fax to Mark Vanstone at GIBB Ltd.

GIBB Ltd,
Environmental Division,
GIBB House,
London Road,
Reading,
Berkshire RG6 1BL

Fax 0118 963 5290
Tel 0118 963 5000

APPENDIX A

AGENCY QUESTIONNAIRES

A.3 Responses to Questionnaire

1.3 Responses to Questionnaire

Processing and Presentation of Groundwater Quality Data

Questionnaire Responses - Environment Agency, Anglian Region

D Chandler : Environmental Protection Officer

Russell Woollat :

Robert Heath : Data Scientist

Paul Hart : Groundwater Quality

Alison Frogley : Water Quality Officer

Clare Blackledge : Team Leader Scientific Support

Andrew Brewster : Scientific Support

Dr S.J.Wood : Team Leader, Scientific Support

Richard Walter, Scientific Officer

GIBB Environmental
LAWGIBB Group Member

QUESTIONNAIRE: Groundwater Quality Data Software

GIBB Ltd. have been contracted by the Agency to assess the Agency's requirements regarding the storage and display of groundwater quality data. This questionnaire forms part of our assessment and we will be grateful for your responses to the questions outlined below.

If you have any queries please contact Mark Vanstone or Tim Morgan at GIBB Ltd. on 0118-9635000, or by Email at mvanston@gibb.co.uk or tmorgan@gibb.co.uk.

The following questions are to obtain general details.

Q1.

Please provide the following reference details.			
Name:	D. CHANDLER		
Position:	E.P.O	**Region:**	ANGLIAN
Tel No.:	01536 481124	**Fax No.:**	01536 482705
E-mail:			

Northampton office in Dance

Q2.

Please provide details of other Agency staff who may be able to provide input to this project.			
Name:	M. DENNIS		
Position:	EPO	**Region:**	ANGLIAN
Tel No.:	01536 481124	**Fax No.:**	01536 482705
E-mail:			
Name:			
Position:		**Region:**	
Tel No.:		**Fax No.:**	
Position:			
E-mail:			

The following questions are to establish how much groundwater quality monitoring data your office typically handles annually.

Q3. Public Water Supply Wells

No. of public water supply wells:	
What is the frequency of the data receipt and review process for public water supply wells and how was this determined ?	
Please identify the determinands for public water supply wells (or attach a list):	

Q4. Observation Boreholes

No. of observation boreholes:	APPROX 120
What is the frequency of the data receipt and review process for observation boreholes and how was this determined ?	MONTHLY & QUARTERLY DETERMINED BY WMP Nº 4 & OPERATORS MONITORING REGIME.
Please identify the determinands for observation boreholes (or attach a list):	SEE ATTACHED LIST.

Q5. Springs

No. of springs:	/
What is the frequency of the data receipt and review process for springs and how was this determined ?	
Please identify the determinands for springs (or attach a list):	

Q6. Other Monitoring Locations

No. of other monitoring locations:	SURFACE WATER POINTS 25
What is the frequency of the data receipt and review process for these monitoring points and how was this determined ?	MONTHLY / QUARTERLY AS DETERMINED BY WMP No 4 & OPERATORS MONITORING REGIME.
Please identify the determinands for these monitoring points (or attach a list):	SEE LIST. (ATTACHED)

The following questions are to obtain information regarding the data collection, storage and use.

Q7. Data Collection

Is the groundwater quality data obtained internally or externally ?	INTERNAL & EXTERNAL
What and where are the external sources ?	LANDFILL OPERATORS MONITORING REGIMES.
Does the determinand data collected have additional comment fields and what are these ?	YES, i- DRY, BLOCKED, LOST, UNABLE TO MONITOR & REASONS.
What other environmental data are collected in parallel with groundwater quality data ?	LOCAL METEOROLOGICAL DATA.
What QA/QC procedures are used to assess the quality of the groundwater monitoring data ?	LANDFILL OPERATORS WORKING PRACTICE

Q8. Data Storage

Are groundwater quality data on a single database or are a number of software packages used ?	A NUMBER ARE USED.
What other databases are you aware of for other data ? E.g. contaminated land, landfill, mineral water, private supplies.	CONTAMINATED LAND / LANDFILLS LANDSPREADING SAMPLE POINT LOCATIONS
Where are these databases located and who has responsibility ? Please provide name, address and telephone number.	KETTERING PLACE. D. CHANDLER.

Q9. Data Use

Are groundwater quality data routinely manipulated, interpreted and displayed ?	YES. USING EXCEL MAPINFO DBASE.
On what scale is this done ? E.g. sub catchment, catchment or other.	USUALLY THE LOCALITY OF LANDFILL
What level of interpretation is performed ? E.g. trend analysis, comparison with quality standards etc.	TREND ANALYSIS COMPARISON WITH QUALITY STANDARDS LIMITED STATISTICAL ANALYSIS.
Are the data used by other departments in the Agency or provided to industry / the public ?	PUBLIC REGISTER. REGIONAL SCIENTIFIC TEAM.
In what format is this data provided ?	HARD COPY FLOPPY.

The following questions relate to the software you use.

Q10.

What software do you currently use to store, analyse and present the data ? e.g. Excel, Lotus, Access, Approach, Oracle, Grapher, Statistica, SPSS, Surfer, Arcview, Arcinfo, Mapinfo, WIMS.

Program	Version	Main Uses						
		Storage	Statistics	Tables	Graphs	Contours	Mapping	Other please describe
MAPINFO	4	✓	✓	✓	✓	✓	✓	
DBASE	3	✓	✓		✓			
ACCESS		✓	✓	✓				
EXCEL		✓	✓	✓	✓			

Q11.

Is the software you have listed sufficient and suitable for your purposes, if not what are the problems ? e.g. difficult graphing, training required, poor technical support.	
Program	LIMITED STATISTICAL ANALYSIS.
DBAHE.	POOR SUPPORT.

Q12.

What additional software features would you like ? e.g. specific graphs or statistical capabilities.
STATISTICAL PACKAGES FOR FURTHER ANALYSES.

Q13.

Are you aware of any other software that would satisfy your requirements ?

Q14.

Have you tested any software other than that you currently use and what was your conclusion ?

Thank you for completing this questionnaire. Please return the completed document by post or by fax to Mark Vanstone at GIBB Ltd.

GIBB Ltd,
Environmental Division,
GIBB House,
London Road,
Reading,
Berkshire RG6 1BL

Fax 0118 963 5290
Tel 0118 963 5000

TABLE C.2

Determinands and Monitoring Frequencies for Surface Waters, Groundwaters & Background Gas Levels at Site Preparation Phase

surface water where necessary	**Monthly** will depend on type of water body and its flow rate.	pH, temperature (Temp), electrical conductivity (EC), dissolved oxygen (DO), ammoniacal nitrogen (NH_4-N), chlorides (Cl), chemical oxygen demand (COD).
	Quarterly	as monthly plus: sulphates (SO_4), total alkalinity as $CaCO_3$ at pH 4.5 (Alk), total oxidised nitrogen (TON), total organic carbon (TOC), Na, K, Ca, Mg, Fe, Mn, Cd, Cr, Cu, Ni, Pb, Zn.
Groundwater where necessary	**monthly**	water level, pH, Temp, EC, DO, NH_4-N, Cl - weekly for 4 weeks then monthly.
	Quarterly	as monthly plus: SO_4, Alk, TON, TOC, Na, K, Ca, Mg, Fe, Mn, Cd, Cr, Cu, Ni, Pb, Zn.
Background gas levels	**as WMP27 (1991)**[1]	methane (CH_4), carbon dioxide (CO_2), oxygen (O_2), atmospheric pressure (AP), other meteorological data (OMD).

[1] a minimum of twelve data sets, collected within a minimum of a three month period.

Note: In cases where wastes are known to contain specific elements or compounds, particularly list I and II substances, then those substances should be added to the appropriate list of determinands.

TABLE C.3

Determinands and Monitoring Frequencies for Surface Waters, Groundwaters, Leachates & Landfill Gas at Site Operation Phase

Surface Water if necessary.	**Monthly** will depend on water body and flow rate.	pH, Temp, EC, DO, NH_4-N, Cl, COD.
Groundwater where necessary.	**Monthly**	water level, pH, EC, Temp, DO, NH_4-N, Cl.
	Quarterly (may be reduced to 6 monthly if there is evidence of stable conditions).	as monthly plus: SO_4, Alk, TON, TOC, Na, K, Ca, Mg, Fe, Mn, Cd, Cr, Cu, Ni, Pb, Zn.
Leachate at Discharge Points	**Weekly**	discharge volume, pH, Temp, EC.
	Monthly (reduce to quarterly if stable conditions prevail).	as weekly plus: NH_4-N, Cl, biochemical oxygen demand (BOD), COD.
	Quarterly	as monthly plus: SO_4, Alk, TON, TOC, Na, K, Ca, Mg.
	Six-monthly (reduce to annually if stable conditions prevail).	as quarterly plus: Fe, Mn, Cd, Cr, Cu, Ni, Pb, Zn.
Leachate at monitoring points [1]	**Monthly**	leachate level, pH, Temp, EC.
	Quarterly (may be reduced to annually if there is evidence of stable conditions).	as monthly plus: Cl, NH_4- N, SO_4, Alk, COD, BOD, TON, TOC, Na, K, Ca, Mg.
	Annually	as quarterly plus: Fe, Mn, Cd, Cr, Cu, Ni, Pb, Zn.
Landfill Gas	**As WMP 27 (1991)**[2]	CH_4, CO_2, O_2, AP, OMD, Temp.
Other parameters	**Annually**	void utilisation, settlement.

[1] sump from which leachate is removed from the cell/site.
[2] generally weekly to six-monthly depending site-specific factors.

Note: In cases where wastes are known to contain specific elements or compounds, particularly list I and II substances, then those substances should be added to the appropriate list of determinands.

GIBB Environmental
LAWGIBB Group Member

QUESTIONNAIRE: Groundwater Quality Data Software

GIBB Ltd. have been contracted by the Agency to assess the Agency's requirements regarding the storage and display of groundwater quality data. This questionnaire forms part of our assessment and we will be grateful for your responses to the questions outlined below.

If you have any queries please contact Mark Vanstone or Tim Morgan at GIBB Ltd. on 0118-9635000, or by Email at mvanston@gibb.co.uk or tmorgan@gibb.co.uk.

The following questions are to obtain general details.

Q1.

Please provide the following reference details.			
Name:	RUSSELL WOOLLAT		
Position:	RBR/AIR INSPECTOR.	**Region:**	ANGLIAN
Tel No.:	(01733) 464416 7 50 4416	**Fax No.:**	(01733) 464472
E-mail:			

Q2.

Please provide details of other Agency staff who may be able to provide input to this project.			
Name:	JOEL ORMONDE		
Position:		**Region:**	NW
Tel No.:		**Fax No.:**	
E-mail:			
Name:			
Position:		**Region:**	
Tel No.:		**Fax No.:**	
Position:			
E-mail:			

The following questions are to establish how much groundwater quality monitoring data your office typically handles annually.

Q3. Public Water Supply Wells

No. of public water supply wells:	1
What is the frequency of the data receipt and review process for public water supply wells and how was this determined ?	Quarterly. – HARD COPY NO ELECTRONIC MANIPULATION OF DATA.
Please identify the determinands for public water supply wells (or attach a list):	TRITIUM K^{40} Sr^{90} I^{125} Cs^{134} Cs^{137} Po^{210} Ra^{226} U^{234} U^{235} U^{238} K, Ca, Sr. GROSS ALPHA GROSS BETA.

Q4. Observation Boreholes

No. of observation boreholes:	NONE.
What is the frequency of the data receipt and review process for observation boreholes and how was this determined ?	
Please identify the determinands for observation boreholes (or attach a list):	

Q5. Springs

No. of springs:	NONE.
What is the frequency of the data receipt and review process for springs and how was this determined ?	
Please identify the determinands for springs (or attach a list):	

Q6. Other Monitoring Locations

No. of other monitoring locations:	LANDFILL/ RESERVOIR/RIVER/LAKES.
What is the frequency of the data receipt and review process for these monitoring points and how was this determined ?	QUARTERLY
Please identify the determinands for these monitoring points (or attach a list):	As For Q.3.

The following questions are to obtain information regarding the data collection, storage and use.

Q7. Data Collection

Is the groundwater quality data obtained internally or externally ?	AGENCY MONITORING - ANALYSIS BY CONTRACTOR.
What and where are the external sources ?	ANALYSIS BY AEA TECHNOLOGY
Does the determinand data collected have additional comment fields and what are these ?	NO.
What other environmental data are collected in parallel with groundwater quality data ?	NONE.
What QA/QC procedures are used to assess the quality of the groundwater monitoring data ?	AEA - NAMAS / UCAS APPROVED.

Q8. Data Storage

Are groundwater quality data on a single database or are a number of software packages used ?	ORMONDE JOEL (NW)
What other databases are you aware of for other data ? E.g. contaminated land, landfill, mineral water, private supplies.	NONE.
Where are these databases located and who has responsibility ? Please provide name, address and telephone number.	ORMONDE JOEL / DETR JOHN TIPPING.

Q9. Data Use

Are groundwater quality data routinely manipulated, interpreted and displayed ?	NOR.
On what scale is this done ? E.g. sub catchment, catchment or other.	/
What level of interpretation is performed ? E.g. trend analysis, comparison with quality standards etc.	/
Are the data used by other departments in the Agency or provided to industry / the public ?	PUBLIC + INDUSTRY.
In what format is this data provided ?	PAPER COPY.

The following questions relate to the software you use.

Q10.

What software do you currently use to store, analyse and present the data ? e.g. Excel, Lotus, Access, Approach, Oracle, Grapher, Statistica, SPSS, Surfer, Arcview, Arcinfo, Mapinfo, WIMS.

Program	Version	Main Uses						
		Storage	Statistics	Tables	Graphs	Contours	Mapping	Other please describe

Q11.

Is the software you have listed sufficient and suitable for your purposes, if not what are the problems ? e.g. difficult graphing, training required, poor technical support.

Program	

Q12.

What additional software features would you like ? e.g. specific graphs or statistical capabilities.

Q13.

Are you aware of any other software that would satisfy your requirements ?

Q14.

Have you tested any software other than that you currently use and what was your conclusion ?

Thank you for completing this questionnaire. Please return the completed document by post or by fax to Mark Vanstone at GIBB Ltd.

GIBB Ltd,
Environmental Division,
GIBB House,
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Berkshire RG6 1BL

Fax 0118 963 5290
Tel 0118 963 5000

GIBB Environmental
LAWGIBB Group Member

QUESTIONNAIRE: Groundwater Quality Data Software

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If you have any queries please contact Mark Vanstone or Tim Morgan at GIBB Ltd. on 0118-9635000, or by Email at mvanston@gibb.co.uk or tmorgan@gibb.co.uk.

The following questions are to obtain general details.

Q1.

Please provide the following reference details.			
Name:	ROBERT HEATH.		
Position:	DATA SCIENTIST	**Region:**	ANGLIAN
Tel No.:	01733 464366	**Fax No.:**	01733 464364
E-mail:			

Q2.

Please provide details of other Agency staff who may be able to provide input to this project.			
Name:			
Position:		**Region:**	
Tel No.:		**Fax No.:**	
E-mail:			
Name:			
Position:		**Region:**	
Tel No.:		**Fax No.:**	
Position:			
E-mail:			

The following questions are to establish how much groundwater quality monitoring data your office typically handles annually.

Q3. Public Water Supply Wells

No. of public water supply wells:	NONE.
What is the frequency of the data receipt and review process for public water supply wells and how was this determined ?	
Please identify the determinands for public water supply wells (or attach a list):	

Q4. Observation Boreholes

No. of observation boreholes:	200.
What is the frequency of the data receipt and review process for observation boreholes and how was this determined ?	MONTHLY / YEARLY
Please identify the determinands for observation boreholes (or attach a list):	SEE ATTACHMENT.

Q5. Springs

No. of springs:	83.
What is the frequency of the data receipt and review process for springs and how was this determined ?	MONTHLY / YEARLY.
Please identify the determinands for springs (or attach a list):	SEE ATTACHMENT

Q6. Other Monitoring Locations

No. of other monitoring locations:	LANDFILLS / POLLUTION INVESTIGATIONS 300-400.
What is the frequency of the data receipt and review process for these monitoring points and how was this determined ?	MONTHLY / YEARLY
Please identify the determinands for these monitoring points (or attach a list):	SEE ATTACHMENTS

The following questions are to obtain information regarding the data collection, storage and use.

Q7. Data Collection

Is the groundwater quality data obtained internally or externally ?	INTERNAL - NLS.
What and where are the external sources ?	
Does the determinand data collected have additional comment fields and what are these ?	YES - COMMENT FIELD. WEATHER, FLOWS ETC.
What other environmental data are collected in parallel with groundwater quality data ?	SEE ABOVE.
What QA/QC procedures are used to assess the quality of the groundwater monitoring data ?	IONIC BALANCES HISTORICAL COMPARISONS.

Q8. Data Storage

Are groundwater quality data on a single database or are a number of software packages used ?	AQUA-LIMS
What other databases are you aware of for other data ? E.g. contaminated land, landfill, mineral water, private supplies.	See ALISON FROGLEY QUESTIONAIRE - POLLBASE - ENTEL POLLUTION INCIDENT D.B.
Where are these databases located and who has responsibility ? Please provide name, address and telephone number.	ANGLIAN WQ. Alison Frogley.

Q9. Data Use

Are groundwater quality data routinely manipulated, interpreted and displayed ?	QA/QC PURPOSES ONLY.
On what scale is this done ? E.g. sub catchment, catchment or other.	REGIONAL.
What level of interpretation is performed ? E.g. trend analysis, comparison with quality standards etc.	NONE.
Are the data used by other departments in the Agency or provided to industry / the public ?	WASTE REGS WATER RESOURCES WATER QUALITY. F.E.R. + PUBLIC REGISTER.
In what format is this data provided ?	HARD COPY/ ELECTRONIC.

The following questions relate to the software you use.

Q10.

What software do you currently use to store, analyse and present the data ? e.g. Excel, Lotus, Access, Approach, Oracle, Grapher, Statistica, SPSS, Surfer, Arcview, Arcinfo, Mapinfo, WIMS.

Program	Version	Main Uses						
		Storage	Statistics	Tables	Graphs	Contours	Mapping	Other please describe
AQUA LIMS	36.0	✓	✓	✓				

Q11.

Is the software you have listed sufficient and suitable for your purposes, if not what are the problems ? e.g. difficult graphing, training required, poor technical support.	
Program	
AQUA LIMS	SUITABLE FOR ALL USES.

Q12.

What additional software features would you like ? e.g. specific graphs or statistical capabilities.
AQUA-LIMS - DATA ARCHIVE + STORAGE
NO GRAPHIC PRESENTATION CAPABILITY

Q13.

Are you aware of any other software that would satisfy your requirements ?
WIMS

Q14.

Have you tested any software other than that you currently use and what was your conclusion ?
NO.

Thank you for completing this questionnaire. Please return the completed document by post or by fax to Mark Vanstone at GIBB Ltd.

GIBB Ltd,
Environmental Division,
GIBB House,
London Road,
Reading,
Berkshire RG6 1BL

Fax 0118 963 5290
Tel 0118 963 5000

ROUTINE ANALYSIS SUITES

GB - GROUNDWATER FERRUGINOUS (O/S FC)

CODE	DETERMINAND NAME	UNITS	BOTL
00613	pH	pH UNITS	A
00772	CONDUCTIVITY AT 25 DEG C	uS/cm	A
00994	CARBON ORGANIC TOTAL (ACID SPARGED) mg/l	mg/l C	O
01113	AMMONIA AS NITROGEN mg/l	mg/l N	A
01165	NITROGEN TOTAL OXIDISED AS NITROGEN mg/l	mg/l N	A
01622	ALKALINITY TOTAL AS CaCO3 mg/l	mg/l CaCO3	A
01724	CHLORIDE mg/l	mg/l Cl	A
01774	FLUORIDE mg/l	mg/l F	AB
01806	PHOSPHORUS SOLUBLE REACTIVE mg/l	mg/l P	A
01833	SULFATE mg/l	mg/l SO4	I
02073	SODIUM TOTAL mg/l	mg/l Na	I
02113	POTASSIUM TOTAL mg/l	mg/l K	I
02374	MAGNESIUM TOTAL mg/l	mg/l Mg	I
02414	CALCIUM TOTAL mg/l	mg/l Ca	I
04035	MANGANESE TOTAL mg/l	mg/l Mn	I
04217	IRON TOTAL mg/l	mg/l Fe	I

ttles:A AB I O

BASIC G/W SUITE

ROUTINE ANALYSIS SUITES

GW - WASTE REGS. BASIC G/W SUITE

CODE	DETERMINAND NAME	UNITS	BOTL
00613	pH	pH UNITS	A
00772	CONDUCTIVITY AT 25 DEG C	uS/cm	A
00922	CHEMICAL OXYGEN DEMAND mg/l	mg/l O	A
01113	AMMONIA AS NITROGEN mg/l	mg/l N	A
01724	CHLORIDE mg/l	mg/l Cl	A

Bottles:A

ROUTINE ANALYSIS SUITES

GX - WASTE REGS. EXTENDED G/W SUITE

CODE	DETERMINAND NAME	UNITS	BOTL
00613	pH	pH UNITS	A
00772	CONDUCTIVITY AT 25 DEG C	uS/cm	A
00922	CHEMICAL OXYGEN DEMAND mg/l	mg/l O	A
00994	CARBON ORGANIC TOTAL (ACID SPARGED) mg/l	mg/l C	O
01113	AMMONIA AS NITROGEN mg/l	mg/l N	A
01165	NITROGEN TOTAL OXIDISED AS NITROGEN mg/l	mg/l N	A
01622	ALKALINITY TOTAL AS CaCO3 mg/l	mg/l CaCO3	A
01724	CHLORIDE mg/l	mg/l Cl	A
01835	SULFATE mg/l	mg/l SO4	A
02353	MAGNESIUM 0.45um MEMBRANE FILTERED mg/l	mg/l Mg	Y
02393	CALCIUM 0.45um MEMBRANE FILTERED mg/l	mg/l Ca	Y
04015	MANGANESE 0.45um MEMBRANE FILTERED mg/l	mg/l Mn	Y
04197	IRON 0.45um MEMBRANE FILTERED mg/l	mg/l Fe	Y
74841	SODIUM 0.45um MEMBRANE FILTERED mg/l	mg/l	Y
74851	POTASSIUM 0.45um MEMBRANE FILTERED mg/l	mg/l	Y
92645	CADMIUM 0.45um MEMBRANE FILTERED ug/l	ug/l Cd	Y
98884	CHROMIUM 0.45um MEMBRANE FILTERED ug/l	ug/l Cr	Y
98904	COPPER 0.45um MEMBRANE FILTERED ug/l	ug/l Cu	Y
98925	LEAD 0.45um MEMBRANE FILTERED ug/l	ug/l Pb	Y
98944	NICKEL 0.45um MEMBRANE FILTERED ug/l	ug/l Ni	Y
98964	ZINC 0.45um MEMBRANE FILTERED ug/l	ug/l Zn	Y

Bottles:A O Y

ROUTINE ANALYSIS SUITES

GY - WASTE REGS. EXT G/W SUITE (TOTAL METALS)

CODE	DETERMINAND NAME	UNITS	BOTL
00613	pH	pH UNITS	A
00772	CONDUCTIVITY AT 25 DEG C	uS/cm	A
00922	CHEMICAL OXYGEN DEMAND mg/l	mg/l O	A
00994	CARBON ORGANIC TOTAL (ACID SPARGED) mg/l	mg/l C	O
01113	AMMONIA AS NITROGEN mg/l	mg/l N	A
01165	NITROGEN TOTAL OXIDISED AS NITROGEN mg/l	mg/l N	A
01622	ALKALINITY TOTAL AS CaCO3 mg/l	mg/l CaCO3	A
01724	CHLORIDE mg/l	mg/l Cl	A
01835	SULFATE mg/l	mg/l SO4	A
02073	SODIUM TOTAL mg/l	mg/l Na	I
02113	POTASSIUM TOTAL mg/l	mg/l K	I
02374	MAGNESIUM TOTAL mg/l	mg/l Mg	I
02414	CALCIUM TOTAL mg/l	mg/l Ca	I
04035	MANGANESE TOTAL mg/l	mg/l Mn	I
04217	IRON TOTAL mg/l	mg/l Fe	I
92655	CADMIUM TOTAL ug/l	ug/l Cd	I
98874	CHROMIUM TOTAL ug/l	ug/l Cr	I
98894	COPPER TOTAL ug/l	ug/l Cu	I
98914	LEAD TOTAL ug/l	ug/l Pb	I
98934	NICKEL TOTAL ug/l	ug/l Ni	I
98954	ZINC TOTAL ug/l	ug/l Zn	I

Bottles:A I O

→ Dean

GIBB Environmental
LAWGIBB Group Member

QUESTIONNAIRE: Groundwater Quality Data Software

GIBB Ltd. have been contracted by the Agency to assess the Agency's requirements regarding the storage and display of groundwater quality data. This questionnaire forms part of our assessment and we will be grateful for your responses to the questions outlined below.

If you have any queries please contact Mark Vanstone or Tim Morgan at GIBB Ltd. on 0118-9635000, or by Email at mvanston@gibb.co.uk or tmorgan@gibb.co.uk.

The following questions are to obtain general details.

Q1.

Please provide the following reference details.			
Name:	Paul Hart		
Position:	G/W QUALITY	**Region:**	ANGLIAN.
Tel No.:	KFH	**Fax No.:**	
E-mail:			

Q2.

Please provide details of other Agency staff who may be able to provide input to this project.			
Name:			
Position:		**Region:**	
Tel No.:		**Fax No.:**	
E-mail:			
Name:			
Position:		**Region:**	
Tel No.:		**Fax No.:**	
Position:			
E-mail:			

The following questions are to establish how much groundwater quality monitoring data your office typically handles annually.

Q3. Public Water Supply Wells

No. of public water supply wells:	234 ~~00~~
What is the frequency of the data receipt and review process for public water supply wells and how was this determined ?	At RHO Nitrate + Pesticide data received every 3 months or. Other data, no formal arrangement. Statutory driver – review of nitrate data.
Please identify the determinands for public water supply wells (or attach a list):	(Dean, see LIMS if necessary, for range of Agency dets) (Water Cos will supply these) – varies from Co. to Co.)

Q4. Observation Boreholes — I assume this refers to non-pws sampling sites!

No. of observation boreholes:	283 (not including operational sites)
What is the frequency of the data receipt and review process for observation boreholes and how was this determined ?	Monthly to quarterly. Review related to nitrate Directive – every 4 years
Please identify the determinands for observation boreholes (or attach a list):	Basic suite only being monitored (– Rob Heath will supply)

Q5. Springs

No. of springs:	circa 50.
What is the frequency of the data receipt and review process for springs and how was this determined ?	Same as above - Q4
Please identify the determinands for springs (or attach a list):	Same as above - Q.4

Q6. Other Monitoring Locations — does this mean operational or Special investigations - ask Area staff.

No. of other monitoring locations:	
What is the frequency of the data receipt and review process for these monitoring points and how was this determined ?	Specific to investigation.. "
Please identify the determinands for these monitoring points (or attach a list):	Will depend on reason for investigation - pollution specific.

The following questions are to obtain information regarding the data collection, storage and use.

Q7. Data Collection

Is the groundwater quality data obtained internally or externally ?	Both
What and where are the external sources ?	Water Cos Landfill operators Developers' consultants
Does the determinand data collected have additional comment fields and what are these ?	Sometimes
What other environmental data are collected in parallel with groundwater quality data ?	Surface water quality Water level monitoring data
What QA/QC procedures are used to assess the quality of the groundwater monitoring data ?	NLS procedure (NAMAS) Mike Healy – Analytical Chemist

Q8. Data Storage

Are groundwater quality data on a single database or are a number of software packages used ?	Several.
What other databases are you aware of for other data ? E.g. contaminated land, landfill, mineral water, private supplies.	NVZ database ~~Groundwater Poole~~ Pesticide database
Where are these databases located and who has responsibility ? Please provide name, address and telephone number.	RHO Alison Frogley

Q9. Data Use

Are groundwater quality data routinely manipulated, interpreted and displayed ?	Only for Nitrates & Pesticide
On what scale is this done ? E.g. sub catchment, catchment or other.	Catchment – regional
What level of interpretation is performed ? E.g. trend analysis, comparison with quality standards etc.	Trend analysis Comparison with DWS
Are the data used by other departments in the Agency or provided to industry / the public ?	Yes.
In what format is this data provided ?	Graphs, bar/pie charts Thematic maps. Tables – summaries

The following questions relate to the software you use.

Q10.

What software do you currently use to store, analyse and present the data ? e.g. Excel, Lotus, Access, Approach, Oracle, Grapher, Statistica, SPSS, Surfer, Arcview, Arcinfo, Mapinfo, WIMS.

Program	Version	Main Uses						
		Storage	Statistics	Tables	Graphs	Contours	Mapping	Other please describe
Excel	?	✓	✓		✓			
MapInfo	?					✓	✓	
Access	?	✓						
Lims		✓	✓	✓				

Q11.

Is the software you have listed sufficient and suitable for your purposes, if not what are the problems ? e.g. difficult graphing, training required, poor technical support.	
Program	Yes! Need dedicated software/systems
	like Visual Groundwater, ~~Vis~~ Aquachem
	(but there are others too!)

Q12.

What additional software features would you like ? e.g. specific graphs or statistical capabilities.
3D visualisation of subsurface distribution
Piper, Durov & Ternary plots
Stiff diagrams
Interface with flow & CT models
important
Representation of biological parameters

Q13.

Are you aware of any other software that would satisfy your requirements ?
See Answer to Q11

Q14.

Have you tested any software other than that you currently use and what was your conclusion ?
No.

Thank you for completing this questionnaire. Please return the completed document by post or by fax to Mark Vanstone at GIBB Ltd.

GIBB Ltd,
Environmental Division,
GIBB House,
London Road,
Reading,
Berkshire RG6 1BL

Fax 0118 963 5290
Tel 0118 963 5000

GIBB Environmental
LAWGIBB Group Member

QUESTIONNAIRE: Groundwater Quality Data Software

GIBB Ltd. have been contracted by the Agency to assess the Agency's requirements regarding the storage and display of groundwater quality data. This questionnaire forms part of our assessment and we will be grateful for your responses to the questions outlined below.

If you have any queries please contact Mark Vanstone or Tim Morgan at GIBB Ltd. on 0118-9635000, or by Email at mvanston@gibb.co.uk or tmorgan@gibb.co.uk.

The following questions are to obtain general details.

Q1.

Please provide the following reference details.			
Name:	ALISON FROGLEY.		
Position:	WQ OFFICER	**Region:**	ANGLIAN
Tel No.:	01733 464414	**Fax No.:**	01733 464472
E-mail:			

Q2.

Please provide details of other Agency staff who may be able to provide input to this project.			
Name:			
Position:		**Region:**	
Tel No.:		**Fax No.:**	
E-mail:			
Name:			
Position:		**Region:**	
Tel No.:		**Fax No.:**	
Position:			
E-mail:			

The following questions are to establish how much groundwater quality monitoring data your office typically handles annually.

Q3. Public Water Supply Wells

No. of public water supply wells:	3 - 400.
What is the frequency of the data receipt and review process for public water supply wells and how was this determined ?	~~B~~ TWICE YEARLY.
Please identify the determinands for public water supply wells (or attach a list):	TON NITRATE. (PESTICIDE DATA COLLECTED + PASSED TO EHS WALLINGFORD)

Q4. Observation Boreholes

No. of observation boreholes:	NONE.
What is the frequency of the data receipt and review process for observation boreholes and how was this determined ?	
Please identify the determinands for observation boreholes (or attach a list):	

Q5. Springs

No. of springs:	N/A
What is the frequency of the data receipt and review process for springs and how was this determined ?	
Please identify the determinands for springs (or attach a list):	

Q6. Other Monitoring Locations

No. of other monitoring locations:	RIVER c. 50.
What is the frequency of the data receipt and review process for these monitoring points and how was this determined ?	TWICE YEARLY.
Please identify the determinands for these monitoring points (or attach a list):	TON NO_3

The following questions are to obtain information regarding the data collection, storage and use.

Q7. Data Collection

Is the groundwater quality data obtained internally or externally ?	EXTERNAL
What and where are the external sources ?	WATER COMPANIES.
Does the determinand data collected have additional comment fields and what are these ?	YES
What other environmental data are collected in parallel with groundwater quality data ?	NONE.
What QA/QC procedures are used to assess the quality of the groundwater monitoring data ?	VISUAL CHECKING.

Q8. Data Storage

Are groundwater quality data on a single database or are a number of software packages used ?	2 × ACCESS DATABASE.
What other databases are you aware of for other data ? E.g. contaminated land, landfill, mineral water, private supplies.	POLLBASE – POLLN INCIDENTS
Where are these databases located and who has responsibility ? Please provide name, address and telephone number.	WQ ANGLIAN – SELINA RANDAL.

Q9. Data Use

Are groundwater quality data routinely manipulated, interpreted and displayed ?	FORTNIGHTLY - MONTHLY BASIS
On what scale is this done ? E.g. sub catchment, catchment or other.	INDIVIDUAL BOREHOLES
What level of interpretation is performed ? E.g. trend analysis, comparison with quality standards etc.	TREND ANALYSIS COMPARISON W/ QUALITY STANDARDS
Are the data used by other departments in the Agency or provided to industry / the public ?	PUBLIC REQUESTS NATIONAL GWC.
In what format is this data provided ?	PAPER / ELECTRONIC

The following questions relate to the software you use.

Q10.

What software do you currently use to store, analyse and present the data ? e.g. Excel, Lotus, Access, Approach, Oracle, Grapher, Statistica, SPSS, Surfer, Arcview, Arcinfo, Mapinfo, WIMS.

Program	Version	Main Uses						
		Storage	Statistics	Tables	Graphs	Contours	Mapping	Other please describe
Access	2.0	✓						
Excel	5.0		✓	✓	✓			

Q11.

Is the software you have listed sufficient and suitable for your purposes, if not what are the problems ? e.g. difficult graphing, training required, poor technical support.	
Program ACCESS	OK
EXCEL	OK

Q12.

What additional software features would you like ? e.g. specific graphs or statistical capabilities.
EXCEL PROVIDES FULL FLEXIBILITY
REQUIRED.

Q13.

Are you aware of any other software that would satisfy your requirements ?
AWARE OF NO OTHER SYSTEM.

Q14.

Have you tested any software other than that you currently use and what was your conclusion ?
NO.

Thank you for completing this questionnaire. Please return the completed document by post or by fax to Mark Vanstone at GIBB Ltd.

GIBB Ltd,
Environmental Division,
GIBB House,
London Road,
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Berkshire RG6 1BL

Fax 0118 963 5290
Tel 0118 963 5000

Item 35

ites Within Avon (Hamp. Upper) Catchment

RN	Name	Material	NGR	Reasons for Sampling	Visits					
3055000	BOREHOLE AT AVON SPRINGS FISH FARM		SU175 617	GRN	8	W043	8			CRETACEOUS UPPER GREENSAND

ites Within Wylye Catchment

RN	Name	Material	NGR	Reasons for Sampling	Visits					
3054000	BOREHOLE AT HILL DEVERILL WATERCRESS BEDS		ST868 403	GRN	8	W043	8			CRETACEOUS UPPER GREENSAND

ites Within Ebble Catchment

RN	Name	Material	NGR	Reasons for Sampling	Visits					
0252000	CVTF BOREHOLE		SU025 236	GRN	12	W001	12	W024	12	CRETACEOUS LOWER CHALK
3050000	SPRINGS AT BISHOPSTONE CRESS BEDS		SU071 257	GRN	8	W043	8			VALLEY GRAVEL OVER CRETACEOUS CHALK
3053000	BOREHOLE AT BOWERCHALKE FISH FARM		SU025 236	GRN	8	W043	8			CRETACEOUS LOWER CHALK

ites Within Ashford / Allen Catchment

RN	Name	Material	NGR	Reasons for Sampling	Visits					
3051000	SPRINGS AT CRYSTAL SPRINGS FISH FARM, DAMERHAM		SU110 149	GRN	8	W043	8			PALAEOCENE READING BEDS

ites Within Stour (upper) Catchment

RN	Name	Material	NGR	Reasons for Sampling	Visits					
0320000	ZEALS FISH FM SPRING		ST789 314	GRN	12	W001	12	W024	12	JURASSIC KIMMERIDGE CLAY OVER CALCAREOUS GRIT
0321000	ZEALS FISH FARM BOREHOLE		ST789 314	GRN	12	W001	12	W024	12	— AS ABOVE —

ites Within Stour (middle) Catchment

RN	Name	Material	NGR	Reasons for Sampling	Visits					
0414000	BAILEY GATE FISH FM BOREHOLE		SY9520 9900	GRN	12	W001	12	W024	12	QUATERNARY RIVER TERRACE DEPOSITS SURROUNDED BY CRETACEOUS UPPER CHALK / PALAEOCENE SAND.
0469000	IWERNE MINSTER FISH FARM BOREHOLE		ST865 142	GRN	12	W001	12	W024	12	CRETACEOUS CHALK.

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Sites Within Stour (middle) Catchment

URN	Name	Material	NGR	Reasons for Sampling	Visits					
33140000	BOREHOLE AT DORSET SPRINGS FISH FARM		SY9510 9890	GRN	8	W043	8			QUATERNARY RIVER TERRACE DEPOSITS SURROUNDED BY PALAEOCENE SAND AND CRETACEOUS UPPER CHALK
33148000	SYLVASPRINGS WATERCRESS BED		ST9030 0290	GRN	8	W043	8			CRETACEOUS UPPER CHALK
33230000	SOURCE AT WINTERBOURNE HOUGHTON FISH FARM		SY8230 0450	GRN	8	W043	8			CRETACEOUS MIDDLE CHALK.
33234000	PIMPERNE COMPENSATION WATER BLANDFORD		ST906 091	GRN	8	W043	8			CRETACEOUS UPPER CHALK
33469000	IWERNE SPRINGS FISH FARM BOREHOLE FEED WATER		SY8650 1420	GRN	8	W043	8			CRETACEOUS CHALK

Sites Within Allen Catchment

URN	Name	Material	NGR	Reasons for Sampling	Visits					
30486000	BOREHOLE AT WINTERBORNE HOUGHTON FISH FARM		ST823 045	GRN	12	W001	12	W024	12	CRETACEOUS MIDDLE CHALK
33056000	BOREHOLE AT ALLENBROOK FISH FARM		SU019 108	GRN	8	W043	8			CRETACEOUS UPPER CHALK

Sites Within Moors Catchment

URN	Name	Material	NGR	Reasons for Sampling	Visits			
33052000	ARTESIAN WELL AT CRANBORNE WATERCRESS		SU062 130	GRN	8	W043	8	CRETACEOUS UPPER CHALK.

Sites Within Stour (lower) Catchment

URN	Name	Material	NGR	Reasons for Sampling	Visits			
33565000	SYLVASPRINGS WATERCRESS BERE REGIS WATERCRESS BED INLET		SY8470 9460	GRN	8	W043	8	CRETACEOUS UPPER CHALK.

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ites Within Bere Catchment

IRN	Name	Material	NGR	Reasons for Sampling	Visits			
3239000	ALTON PANCRAS SPRING (GROUNDWATER)		ST696 024	GRN	8	W043	8	CRETACEOUS MIDDLE CHALK
3244000	FBA SITE LOWER WATERSTON PUDDLETOWN		SY740 953	GRN	8	W043	8	CRETACEOUS UPPER CHALK
3566000	SYLVASPRINGS WATERCRESS		SY851 938	GRN	8	W043	8	— AS ABOVE —
3567000	ROKE WATERCRESS BEDS BERE REGIS INLET TO BEDS		SY836 958	GRN	8	W043	8	— " —
3568000	SPRING SOURCE WATERCRESS BEDS BROCKHILL CECILY BRIDGE BERE REGIS		SY835 928	GRN	8	W043	8	PALAEOCENE / EOCENE LONDON CLAY & READING BEDS.

ites Within Cattistock Catchment

IRN	Name	Material	NGR	Reasons for Sampling	Visits			
3509000	RAMPISHAM SPRING (GROUNDWATER SAMPLE)		ST563 022	GRN	8	W043	8	CRETACEOUS LOWER CHALK

ites Within Frome (Dors Cerne) Catchment

IRN	Name	Material	NGR	Reasons for Sampling	Visits			
3571000	ISLINGTON WATERCRESS BEDS INLET TINCLETON DORCHESTER		SY7540 9190	GRN	8	W043	8	PALAEOCENE / EOCENE READING BEDS
3573000	WADDOCKCROSS WATERCRESS BEDS WADDOCK CROSS DORCHESTER DORSET		SY795 909	GRN	8	W043	8	PALAEOCENE / EOCENE BAGSHOT BEDS
3608000	SPRINGS AT NETHER CERNE FISH FARM		SY668 991	GRN	8	W043	8	CRETACEOUS LOWER CHALK
3609000	LOWER MAGISTON SYDLING ST NICHOLAS WATERCRESS BEDS INLET		SY6340 9610	GRN	8	W043	8	CRETACEOUS MIDDLE CHALK.

ites Within Frome (Dors Middle) Catchment

IRN	Name	Material	NGR	Reasons for Sampling	Visits			
3414000	WARMWELL (GOLDEN SPRINGS) WATERCRESS BEDS SPRING BOREHOLE		SY746 875	GRN	8	W043	8	PALAEOCENE / EOCENE READING BEDS OVER CRETACEOUS UPPER CHALK.

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Sites Within Tadnoll Bk Catchment

URN	Name	Material	NGR	Reasons for Sampling	Visits			
33413000	WATERGATES FISH FARM INLET BOREHOLES, WATERGATES LANE BROADMAYNE		SY739 870	GRN	8	W043	8	PALAEOCENE/EOCENE READING BEDS OVER CRETACEOUS UPPER CHALK

Sites Within Frome (Dors Lower) Catchment

URN	Name	Material	NGR	Reasons for Sampling	Visits			
33319000	WOOL WATERCRESS BEDS SPRING SUPPLY		SY8450 8630	GRN	8	W043	8	— AS ABOVE —

Sites Within Wey Catchment

URN	Name	Material	NGR	Reasons for Sampling	Visits			
33404000	UPWEY - WISHING WELL SOURCE		SY661 852	GRN	8	W043	8	JURASSIC MIDDLE PURBECK

Sites Within Bride Catchment

URN	Name	Material	NGR	Reasons for Sampling	Visits			
33520000	SPRING HEADING LITTON CHENEY		SY550 908	GRN	8	W043	8	UPPER CRETACEOUS CHALK

Sites Within Brit Catchment

URN	Name	Material	NGR	Reasons for Sampling	Visits			
33508000	STOKE ABBOT VILLAGE SPRING		ST4540 0080	GRN	8	W043	8	JURASSIC UPPER LIAS BRIDPORT & YEOVIL SANDS.

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TOTAL 9

tes Within Yeo Catchment

RN	Name	Material	NGR	Reasons for Sampling	Visits			
210039	WESTLANDS HELICOPTERS GROUNDWATER		ST542 153	GRN	12	S001	12	MIDDLE JURASSIC UPPER LIAS YEOVIL SANDS

tes Within Sedgemoor West Catchment

RN	Name	Material	NGR	Reasons for Sampling	Visits			
000100	R AXE SOURCE 15-2-95		ST531 480	GRN	12	S001	12	TRIASSIC MERCIA MUDSTONE

tes Within ~~Parrett Estuary (r Bank) Catchment~~

RN	Name IS THIS A SPRING?	Material	NGR	Reasons for Sampling	Visits			
130100	TRIB CONGRESBURY YEO - RICKFORD		ST487 593	GRN	12	S001	12	TRIASSIC MERCIA MUDSTONE

tes Within River Sheppey/Hartlake Catchment

RN	Name IS THIS PUCKLY GWCK	Material	NGR	Reasons for Sampling	Visits			
290850	WELLS MOAT STREAM AT BISHOPS PALACE		ST551 457	GRN	12	S001	12	TRIASSIC MERCIA MUDSTONE

tes Within By Catchment

RN	Name	Material	NGR	Reasons for Sampling	Visits			
170238	GAULTERS MILL GROUNDWATER		ST832 791	GRN	6	W043	6	JURASSIC GREAT OOLITE LIMESTONE

tes Within Avon (Sherston) Catchment

RN	Name	Material	NGR	Reasons for Sampling	Visits			
012836	FARLEAZE FARM GROUNDWATER		ST869 833	GRN	6	W043	6	JURASSIC GREAT OOLITE FOREST MARBLE
012924	CROW DOWN SPRINGS DOWNSTREAM EAST		ST839 863	GRN 15-2-96	6	W043	6	AS ABOVE

tes Within Mells Catchment

RN	Name	Material	NGR	Reasons for Sampling	Visits			
260169	SPRING AT FARLEIGH HUNGERFORD FISH FARM INTAKE		ST802 577	GRN	6	W043	6	JURASSIC GREAT OOLITE LIMESTONE

09.05.96

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Sites Within Severn (Berkeley) Catchment

URN	Name	Material	NGR	Reasons for Sampling	Visits			
23170613	LASBOROUGH SPRINGS GROUNDWATER MONITORING		ST822 944	GRN	6	W043	6	Jurassic Great Oolite Fuller's Earth.

Last sample 09-05-96

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TOTAL 12

ites Within Lim Catchment

RN	Name	Material	NGR	Reasons for Sampling	Visits			
SY39/100	PINHAY - RAW WATER INLET INSIDE BUILDING.		SY3102 9050	GRN	4	S001	4	CRETACEOUS UPPER GREENSAND

ites Within Lower Axe Catchment

RN	Name	Material	NGR	Reasons for Sampling	Visits			
SY28/100	BOVEY LANE BOREHOLE		SY2282 8983	GRN	4	S001	4	CRETACEOUS MIDDLE CHALK

tes Within Middle Axe Catchment

RN	Name	Material	NGR	Reasons for Sampling	Visits			
ST20/100	WILMINGTON 1 - SPRING ADJACENT TO BUILDING		ST2139 0033	GRN	4	S001	4	CRETACEOUS UPPER GREENSAND

tes Within Upper Axe Catchment

RN	Name	Material	NGR	Reasons for Sampling	Visits			
ST30/101	COTLEY SPRING ON LEFT SIDE OF ROAD FROM CHARDSTOCK - FROM MANHOLE AMONGST BUSHES.		ST3098 0551	GRN	4	S001	4	CRETACEOUS UPPER GREENSAND

tes Within Lower Otter Catchment

RN	Name	Material	NGR	Reasons for Sampling	Visits			
SY08/110	OTTERTON 4. - RIGHT SIDE OF ROAD TO SOUTH FARM - TAP IN BOX BY BOREHOLE.		SY0780 8464	GRN	4	G002	4	TRIAS/PERMIAN UPPER SANDSTONE

tes Within Otter Catchment

RN	Name	Material	NGR	Reasons for Sampling	Visits			
SY08/101	COLATON RALEIGH 2 - LEFT HAND SIDE OF KINGSTON ROAD		SY0705 8775	GRN	4	G002	4	TRIAS/PERMIAN UPPER SANDSTONE

S = Dangerous Substances, ESQ= Estuary Quality, EX= Exchange of Information, FF = Freshwater Fisheries, GQA= General Quality Assessment, GQM = GQA + Zn & Cu, HM = Harmonized Monitoring, GRN - Groundwater Monitoring, NN = National Network Sites, IP = National Marine Plan, RLP = Red List/Parcom, SF + Shellfish Waters, SW = Surface Water Abstraction, UW = Urban Waste Water Treatment Directive

Sites Within Otter Catchment

URN	Name	Material	NGR	Reasons for Sampling	Visits			
GSY08/103	DOTTON 1 - ADJACENT TO BUILDING IN WORKS - TAP BY BOREHOLE CHAMBER.		SY0830 8826	GRN	4	G003	4	TRIAS/PERMIAN UPPER SANDSTONE.
GSY09/100	HARPFORD 6 - BOREHOLE NEAREST PUMP HOUSE - TAP BY BOREHOLE CHAMBER.		SY0912 9078	GRN	4	G003	4	TRIAS/PERMIAN UPPER SANDSTONE.
GSY19/100	GREATWELL 1 - RIGHT SIDE OF B3174		SY1101 9550	GRN	4	G002	4	— AS ABOVE —
GSY19/103	GREATWELL 4B - RIGHT SIDE OF B3174 FURTHEST AWAY FROM OTTERY.		SY1146 9559	GRN	4	G002	4	UPPER (KEUPER) MARL.

Sites Within Tidal Exe Catchment

URN	Name	Material	NGR	Reasons for Sampling	Visits			
GSX98/100	DUCKALLER - BOREHOLE IN FIELD AT BACK OF MOWLISH FARM - TAP BY BOREHOLE CHAMBER.		SX9549 8086	GRN	4	S001	4	PERMIAN DAWLISH SANDSTONE

Sites Within Yeo & Dalch Catchment

URN	Name	Material	NGR	Reasons for Sampling	Visits			
GSS70/129	CLANNABOROUGH ADIT, BOW (SWWS)		SS736 014	GRN	4	S001	4	PERMIAN KNOWLE SANDSTONE

DGS = Dangerous Substances, ESQ= Estuary Quality, EX= Exchange of Information, FF = Freshwater Fisheries, GQA= General Quality Assessment, GQM = GQA + Zn & Cu, HM = Harmonized Monitoring, GRN - Groundwater Monitoring, NN = National Network Sites, NMP = National Marine Plan, RLP = Red List/Parcom, SF + Shellfish Waters, SW = Surface Water Abstraction, UW = Urban Waste Water Treatment Directive

TOTAL 3

Sites Within Red River, Portreath & Perranwell Streams Catchment

URN	Name	Material	NGR	Reasons for Sampling	Visits			
SW63/101	CARGENWYN SPRING INFLOW TO CARGENWYN RESERVOIRS.		SW6559 ~~6520~~ 3520 ?	GRN	4	S001	4	IGNEOUS GRANITE
SW63/103	COPPERHILL ADIT- 8" PVC PIPE ON LEFT LOOKING UPSTREAM FROM BOSWYN RESERVOIR		SW659 363	GRN	4	S001	4	IGNEOUS GRANITE
SW63/104	BOSWYN ADIT BELOW MANHOLE COVER BY ADIT ENTRANCE		SW6605 3628	GRN	4	S001	4	IGNEOUS GRANITE

DS = Dangerous Substances, ESQ= Estuary Quality, EX= Exchange of Information, FF = Freshwater Fisheries, GQA= General Quality Assessment, GQM = GQA + Zn & Cu, HM = Harmonized Monitoring, GRN - Groundwater Monitoring, NN = National Network Sites, MP = National Marine Plan, RLP = Red List/Parcom, SF + Shellfish Waters, SW = Surface Water Abstraction, UW = Urban Waste Water Treatment Directive

GIBB Environmental
LAWGIBB Group Member

QUESTIONNAIRE: Groundwater Quality Data Software

GIBB Ltd. have been contracted by the Agency to assess the Agency's requirements regarding the storage and display of groundwater quality data. This questionnaire forms part of our assessment and we will be grateful for your responses to the questions outlined below.

If you have any queries please contact Mark Vanstone or Tim Morgan at GIBB Ltd. on 0118-9635000, or by Email at mvanston@gibb.co.uk or tmorgan@gibb.co.uk.

The following questions are to obtain general details.

Q1.

Please provide the following reference details.			
Name:	Clare Blackledge		
Position:	Team Leader Scientific Support	**Region:**	Anglian
Tel No.:	01522 513100	**Fax No.:**	01522 512927
E-mail:			

Q2.

Please provide details of other Agency staff who may be able to provide input to this project.			
Name:	also see questionnaires completed by		
Position:	Andrew Brewster	**Region:**	
Tel No.:	+ Dave Chandler	**Fax No.:**	
E-mail:			
Name:			
Position:		**Region:**	
Tel No.:		**Fax No.:**	
Position:			
E-mail:			

GIBB Environmental
LAWGIBB Group Member

The following questions are to establish how much groundwater quality monitoring data your office typically handles annually.

Q3. Public Water Supply Wells

No. of public water supply wells:	54 + 4 (not used at moment)
What is the frequency of the data receipt and review process for public water supply wells and how was this determined ?	No regular receipt of data at Area. Tends to be ad hoc in relation to a particular problem. This is very unsatisfactory.
Please identify the determinands for public water supply wells (or attach a list):	Raw water is not analysed very often. Don't know dets. – contact regional Water Quality

Q4. Observation Boreholes

No. of observation boreholes:	126 current ~~170 current boreholes (+40 boreholes not currently monitored)~~
What is the frequency of the data receipt and review process for observation boreholes and how was this determined ?	"Receipt" is dependent on how often Aqua-Lims is interrogated and reports generated. – no pattern at present.
Please identify the determinands for observation boreholes (or attach a list):	Major ions only Some for monitoring Nitrate Sensitive areas & salinity specifically

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GIBB Environmental
LAWGIBB Group Member

Q5. Springs

No. of springs:	~~[illegible]~~ 19
What is the frequency of the data receipt and review process for springs and how was this determined ?	As for Observation groundwater quality boreholes
Please identify the determinands for springs (or attach a list):	"

Q6. Other Monitoring Locations Licensed Boreholes where saline controls exists

No. of other monitoring locations:	Industrial Users Association (LUA) approx. 6 companies in Grimsby Area
What is the frequency of the data receipt and review process for these monitoring points and how was this determined ?	When LUA remembers to send saline monitoring
Please identify the determinands for these monitoring points (or attach a list):	Chloride Conductivity Data manually transferred from Aqua-LIMS to Lotus for graphical presentation of trends. Trends will determine decision making on abstractions

control. This is done by Water Resources section.

The following questions are to obtain information regarding the data collection, storage and use.

Q7. Data Collection

Is the groundwater quality data obtained internally or externally ?	Internal + external
What and where are the external sources ? Waste Disposal site operators	PWS - region HQ. Industrial Users Association - Grimsby area. District Councils private supplies - no regular receipt of data at moment
Does the determinand data collected have additional comment fields and what are these ?	not clear what you mean.
What other environmental data are collected in parallel with groundwater quality data ?	Groundwater levels if borehole coincides with GW level monitoring network
What QA/QC procedures are used to assess the quality of the groundwater monitoring data ?	Data on Aqua-LIMS is validated. EA sampling should follow procedures

Q8. Data Storage

Are groundwater quality data on a single database or are a number of software packages used ?	EA data on Aqua-LIMS. No system for other data. Information about ~~other~~ sampling locations on DBASE 3
What other databases are you aware of for other data ? E.g. contaminated land, landfill, mineral water, private supplies.	DBase 3 databases hold information on ~~#~~ non-licensed supplies (private), contaminated land sites } SITE INFORMATION ONLY Clare Blackledge Lincoln. ~~Excel spreadsheet~~ ACCESS database } Landfill data
Where are these databases located and who has responsibility ? Please provide name, address and telephone number.	landfill data - Andrew Brewster, Lincoln (ACCESS)

GIBB Environmental
LAWGIBB Group Member

Q9. Data Use

Are groundwater quality data routinely manipulated, interpreted and displayed ?	No, not routinely. No simple graphics package for easy presentation of data exists
On what scale is this done ? E.g. sub catchment, catchment or other.	On a needs basis – very unsatisfactory. and special investigations for GW pollutions, data is transferred to Lotus ~~and~~ from Aqua Lims & displayed graphically.
What level of interpretation is performed ? E.g. trend analysis, comparison with quality standards etc.	gut feeling for routine sites on GW network for special investigations & some landfill sites trend analyses, comparison with drinking water standards
Are the data used by other departments in the Agency or provided to industry / the public ?	A great deal of data is passed to the public / consultants via the public register. No interpretations accompanies the data.
In what format is this data provided ?	report outputs from Aqua-LIMS

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LAWGIBB Group Member

The following questions relate to the software you use.

Q10.

What software do you currently use to store, analyse and present the data ? e.g. Excel, Lotus, Access, Approach, Oracle, Grapher, Statistica, SPSS, Surfer, Arcview, Arcinfo, Mapinfo, WIMS.

Program	Version	Main Uses						
		Storage & retrieval	Statistics	Tables	Graphs	Contours	Mapping	Other please describe
LIMS		✓		✓				
LOTUS					✓			
DBase 3		✓						
EASYMAP							✓	

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LAWGIBB Group Member

Q11.

Is the software you have listed sufficient and suitable for your purposes, if not what are the problems ? e.g. difficult graphing, training required, poor technical support.	
Program LIMS	no graphing. Need system for regular interrogation of trends not on needs basis
DBase 3	to be superseded in harmonisation programme?
Easymap	" ?
	CIS do not provide good technical support for software. Tend to use local contacts.

Q12.

What additional software features would you like ? e.g. specific graphs or statistical capabilities.
Simple graphing package
mapping package to identify sites. Easymap is
excellent but will be superseded (I understand)
transfer of DBase 3 data into supported package

GIBB Environmental
LAWGIBB Group Member

Q13.

Are you aware of any other software that would satisfy your requirements ?
Need to introduce a GIS culture where we
share data. Staff remain responsible for their
datasets and others have 'read only' access.
Too much information is dispersed when there
would be major benefits in integrating datasets

Q14.

Have you tested any software other than that you currently use and what was your conclusion ?
No

Thank you for completing this questionnaire. Please return the completed document by post or by fax to Mark Vanstone at GIBB Ltd.

GIBB Ltd,
Environmental Division,
GIBB House,
London Road,
Reading,
Berkshire RG6 1BL

Fax 0118 963 5290
Tel 0118 963 5000

GIBB Environmental
LAWGIBB Group Member

QUESTIONNAIRE: Groundwater Quality Data Software

GIBB Ltd. have been contracted by the Agency to assess the Agency's requirements regarding the storage and display of groundwater quality data. This questionnaire forms part of our assessment and we will be grateful for your responses to the questions outlined below.

If you have any queries please contact Mark Vanstone or Tim Morgan at GIBB Ltd. on 0118-9635000, or by Email at mvanston@gibb.co.uk or tmorgan@gibb.co.uk.

The following questions are to obtain general details.

Q1.

Please provide the following reference details.			
Name:	ANDREW BREWSTER		
Position:	SCIENTIFIC SUPPORT	**Region:**	ANGLIAN
Tel No.:	01522 895965	**Fax No.:**	01522 895989
E-mail:	—		

Q2.

Please provide details of other Agency staff who may be able to provide input to this project.			
Name:			
Position:		**Region:**	
Tel No.:		**Fax No.:**	
E-mail:			
Name:			
Position:		**Region:**	
Tel No.:		**Fax No.:**	
Position:			
E-mail:			

GIBB Environmental
LAWGIBB Group Member

The following questions are to establish how much groundwater quality monitoring data your office typically handles annually.

Q3. Public Water Supply Wells

No. of public water supply wells:	
What is the frequency of the data receipt and review process for public water supply wells and how was this determined ?	
Please identify the determinands for public water supply wells (or attach a list):	

Q4. Observation Boreholes

No. of observation boreholes:	
What is the frequency of the data receipt and review process for observation boreholes and how was this determined ?	
Please identify the determinands for observation boreholes (or attach a list):	

GIBB Environmental
LAWGIBB Group Member

Q5. Springs

No. of springs:	—
What is the frequency of the data receipt and review process for springs and how was this determined ?	—
Please identify the determinands for springs (or attach a list):	—

Q6. Other Monitoring Locations

No. of other monitoring locations:	Landfill Sites
What is the frequency of the data receipt and review process for these monitoring points and how was this determined ?	Ranging from weekly to quarterly, set in site working Plans or Waste Management Licence conditions. Some require annual review
Please identify the determinands for these monitoring points (or attach a list):	Usually as per Waste Management Paper No 4 App C or WMP 26D (Draft)

The following questions are to obtain information regarding the data collection, storage and use.

Q7. Data Collection

Is the groundwater quality data obtained internally or externally ?	Both
What and where are the external sources ?	Landfill sites operators/licencees or their contractors
Does the determinand data collected have additional comment fields and what are these ?	Some do for field data or field instrument measurements.
What other environmental data are collected in parallel with groundwater quality data ?	Landfill gas, ground & weather conditions, temperatures
What QA/QC procedures are used to assess the quality of the groundwater monitoring data ?	Set out in sampling/storage protocols, use of NAMAS accredited laboratories for analysis.

Q8. Data Storage

Are groundwater quality data on a single database or are a number of software packages used ?	Access database
What other databases are you aware of for other data ? E.g. contaminated land, landfill, mineral water, private supplies.	landfill - as above
Where are these databases located and who has responsibility ? Please provide name, address and telephone number.	

Q9. Data Use

Are groundwater quality data routinely manipulated, interpreted and displayed ?	Not routinely, occasionally for particular sites or problems.
On what scale is this done ? E.g. sub catchment, catchment or other.	Individual landfill sites
What level of interpretation is performed ? E.g. trend analysis, comparison with quality standards etc.	trend analysis
Are the data used by other departments in the Agency or provided to industry / the public ?	Not currently Occasional public register enquiry for monitoring data
In what format is this data provided ?	Paper or disk

The following questions relate to the software you use.

Q10.

What software do you currently use to store, analyse and present the data ? e.g. Excel, Lotus, Access, Approach, Oracle, Grapher, Statistica, SPSS, Surfer, Arcview, Arcinfo, Mapinfo, WIMS.

Program	Version	Main Uses						
		Storage	Statistics	Tables	Graphs	Contours	Mapping	Other please describe
ACCESS	2	✓		✓				
EXCEL	4/5		✓		✓			
MAPINFO						✓	✓	

GIBB Environmental
LAWGIBB Group Member

Q11.

Is the software you have listed sufficient and suitable for your purposes, if not what are the problems ? e.g. difficult graphing, training required, poor technical support.

Program	
ACCESS	Microsoft Graph 5 comes with ACCESS but is poorly integrated in some ways & is not easy to use/construct graphs from queries in the database

Q12.

What additional software features would you like ? e.g. specific graphs or statistical capabilities.

Guidance as to appropriate features is within WMP 260 for
statistical purposes.

Q13.

Are you aware of any other software that would satisfy your requirements ?
Geo Services International "Monitor Pro"
USEPA "GRITS-STATS" has some in built stats capability
and although designed to help with a different regulatory
regime would do statistically valid calculations on upstream
& downstream borehole water quality comparisons.

Q14.

Have you tested any software other than that you currently use and what was your conclusion ?
Brief tests of the above 2 programs - MonitorPro looks
like it would do everything we currently need & would interface
with current ACCESS databases and possibly the Agency's
chosen GIS program ARCView plus legacy systems such as
MapInfo.

Thank you for completing this questionnaire. Please return the completed document by post or by fax to Mark Vanstone at GIBB Ltd.

GIBB Ltd,
Environmental Division,
GIBB House,
London Road,
Reading,
Berkshire RG6 1BL

Fax 0118 963 5290
Tel 0118 963 5000

GIBB Environmental
LAWGIBB Group Member

QUESTIONNAIRE: Groundwater Quality Data Software

GIBB Ltd. have been contracted by the Agency to assess the Agency's requirements regarding the storage and display of groundwater quality data. This questionnaire forms part of our assessment and we will be grateful for your responses to the questions outlined below.

If you have any queries please contact Mark Vanstone or Tim Morgan at GIBB Ltd. on 0118-9635000, or by Email at mvanston@gibb.co.uk or tmorgan@gibb.co.uk.

The following questions are to obtain general details.

Q1.

Please provide the following reference details.			
Name:	DR. S. J. WOOD		
Position:	TEAM LEADER SCIENTIFIC SUPPORT	**Region:**	EASTERN AREA ANGLIAN REGION
Tel No.:	01473 - 727712	**Fax No.:**	01473-724265
E-mail:	(PROXY) cath.tomlin@environment-agency.gov.uk		

Q2.

Please provide details of other Agency staff who may be able to provide input to this project.			
Name:	RICHARD WALTER		
Position:	SCIENTIFIC OFFICER	**Region:**	As above.
Tel No.:		**Fax No.:**	
E-mail:			
Name:	CATH TOMLIN		
Position:	SCIENTIFIC OFFICER	**Region:**	As above.
Tel No.:		**Fax No.:**	
Position:			
E-mail:			

The following questions are to establish how much groundwater quality monitoring data your office typically handles annually.

Q3. Public Water Supply Wells

No. of public water supply wells:	100+
What is the frequency of the data receipt and review process for public water supply wells and how was this determined ?	Only AWS water results are obtained routinely. Raw water results for last year were received from Essex & Suffolk Water
Please identify the determinands for public water supply wells (or attach a list):	Standard drinking water inspectorate

Q4. Observation Boreholes

No. of observation boreholes:	Anglian groundwater network 66
What is the frequency of the data receipt and review process for observation boreholes and how was this determined ?	1 sample per 6 months for most. Data is pulled of LIMS automatically and fed into a spreadsheet for ion ratio/ion balance assessment.
Please identify the determinands for observation boreholes (or attach a list):	Ferruginous groundwater suite Ca, Mg, K, Na, Cl, Alk, NO3, SO4 Iron pH, Cond, PO4, TOC

Data examined on basis of hydrochemical knowledge

Q5. Springs

No. of springs:	Hundreds
What is the frequency of the data receipt and review process for springs and how was this determined ?	Sampled intermittently No systematic review. Cost constraint
Please identify the determinands for springs (or attach a list):	As Q4 or a reduced suite with Cl, Cond, NO_3, TOC,

Q6. Other Monitoring Locations

No. of other monitoring locations:	Landfill sites
What is the frequency of the data receipt and review process for these monitoring points and how was this determined ?	6 bores per site 1 per year. Landfill suite (GB + metals) Points chosen on basis of risk assessment and borehole data. – National audit target.
Please identify the determinands for these monitoring points (or attach a list):	GB + metals ie (Q4 + metals)

The following questions are to obtain information regarding the data collection, storage and use.

Q7. Data Collection

Is the groundwater quality data obtained internally or externally ?	Both.
What and where are the external sources ?	Water Companies - Essex & Suffolk Water - Anglian Water. Environmental Health Departments Landfill operators Contaminated land investigators
Does the determinand data collected have additional comment fields and what are these ?	EA data does this may include S.W.L pumping rates qualitative descriptions
What other environmental data are collected in parallel with groundwater quality data ?	Water levels gas concentrations
What QA/QC procedures are used to assess the quality of the groundwater monitoring data ?	Time series and anion cation balances - Hydrochemical knowledge.

Q8. Data Storage

Are groundwater quality data on a single database or are a number of software packages used ?	A number. LIMS & EXCEL - MONIT HYDRODAT
What other databases are you aware of for other data ? E.g. contaminated land, landfill, mineral water, private supplies.	None
Where are these databases located and who has responsibility ? Please provide name, address and telephone number.	Many places - there is insufficient resource to maintain them all.

Q9. Data Use

Are groundwater quality data routinely manipulated, interpreted and displayed ?	No –
On what scale is this done ? E.g. sub catchment, catchment or other.	Depends on issue. Ideally we would like to do all. LEAPS areas are used.
What level of interpretation is performed ? E.g. trend analysis, comparison with quality standards etc.	Depends – visual check to full trend / ratio / Piper etc. ✓ Durov Schoeller
Are the data used by other departments in the Agency or provided to industry / the public ?	Yes on occasions.
In what format is this data provided ?	EXCEL or tabular hard copy

The following questions relate to the software you use.

Q10.

What software do you currently use to store, analyse and present the data ? e.g. Excel, Lotus, Access, Approach, Oracle, Grapher, Statistica, SPSS, Surfer, Arcview, Arcinfo, Mapinfo, WIMS.

Program	Version	Main Uses						
		Storage	Statistics	Tables	Graphs	Contours	Mapping	Other please describe
EXCEL	5.2	✓	✓	✓	✓			
SURFER						✓		
ACCESS								

Q11.

Is the software you have listed sufficient and suitable for your purposes, if not what are the problems ? e.g. difficult graphing, training required, poor technical support.	
Program	NO – Software to plot hydrochemical data is essential. – We don't have enough cash or resources to do useful things with ArcInfo.
	I would like MINITAB and AQUACHEM for example

Q12.

What additional software features would you like ? e.g. specific graphs or statistical capabilities.
AQUACHEM with GIS / ARC INFO. MULTIVARIATE ANALYSIS

Q13.

Are you aware of any other software that would satisfy your requirements ?
AQUACHEM & MINITAB

Q14.

Have you tested any software other than that you currently use and what was your conclusion ?
NO

Thank you for completing this questionnaire. Please return the completed document by post or by fax to Mark Vanstone at GIBB Ltd.

MARK VANSTONE
GIBB Ltd,
Environmental Division,
GIBB House,
London Road,
Reading,
Berkshire RG6 1BL

Fax 0118 963 5290
Tel 0118 963 5000

GIBB Environmental
LAWGIBB Group Member

QUESTIONNAIRE: Groundwater Quality Data Software

GIBB Ltd. have been contracted by the Agency to assess the Agency's requirements regarding the storage and display of groundwater quality data. This questionnaire forms part of our assessment and we will be grateful for your responses to the questions outlined below.

If you have any queries please contact Mark Vanstone or Tim Morgan at GIBB Ltd. on 0118-9635000, or by Email at mvanston@gibb.co.uk or tmorgan@gibb.co.uk.

The following questions are to obtain general details:

* NB: MAIN RESPONSE BY SIMON WOOD.

Q1. THIS RESPONSE COVERS LANDFILL SITE MONITORING ONLY.

Please provide the following reference details.			
Name:	RICHARD WALTER		
Position:	SCIENTIFIC OFFICER	**Region:**	ANGLIAN
Tel No.:	01473 727712 x4712	**Fax No.:**	01473 724205
E-mail:	CATH. TOMLIN @ ENVIRONMENT-AGENCY. GOV. UK		

Q2.

Please provide details of other Agency staff who may be able to provide input to this project.			
Name:			
Position:		**Region:**	
Tel No.:		**Fax No.:**	
E-mail:			
Name:			
Position:		**Region:**	
Tel No.:		**Fax No.:**	
Position:			
E-mail:			

The following questions are to establish how much groundwater quality monitoring data your office typically handles annually.

Q3. Public Water Supply Wells

No. of public water supply wells:	
What is the frequency of the data receipt and review process for public water supply wells and how was this determined ?	
Please identify the determinands for public water supply wells (or attach a list):	

Q4. Observation Boreholes

No. of observation boreholes:	A 95 B 216
What is the frequency of the data receipt and review process for observation boreholes and how was this determined ?	A MONTHLY B THREE-MONTHLY (DOE GUIDANCE IN WASTE MANAGEMENT PAPER No. 4)
Please identify the determinands for observation boreholes (or attach a list):	SEE ATTACHED + WATER TEMP & WATER LEVELS

Q5. Springs

No. of springs:	
What is the frequency of the data receipt and review process for springs and how was this determined ?	
Please identify the determinands for springs (or attach a list):	

Q6. Other Monitoring Locations

No. of other monitoring locations:	
What is the frequency of the data receipt and review process for these monitoring points and how was this determined ?	
Please identify the determinands for these monitoring points (or attach a list):	

The following questions are to obtain information regarding the data collection, storage and use.

Q7. Data Collection

Is the groundwater quality data obtained internally or externally ?	BOTH
What and where are the external sources ?	LANDFILL OPERATORS / ANALYTICAL LABS.
Does the determinand data collected have additional comment fields and what are these ?	?
What other environmental data are collected in parallel with groundwater quality data ?	LEACHATE & LANDFILL GAS MONITORING DATA *
What QA/QC procedures are used to assess the quality of the groundwater monitoring data ?	AUDIT SAMPLING & ANALYSIS IONIC BALANCE CHECK.

Q8. Data Storage

Are groundwater quality data on a single database or are a number of software packages used ?	MOSTLY ON PAPER RECORDS. SOME ON LIMS, SOME INPUT TO MONIT (ASPINWALL & CO)
What other databases are you aware of for other data ? E.g. contaminated land, landfill, mineral water, private supplies.	—
Where are these databases located and who has responsibility ? Please provide name, address and telephone number.	—

* THERE IS A SIGNIFICANT AMOUNT OF LEACHATE / LANDFILL GAS MONITORING DATA TO BE RECEIVED & MANIPULATED

Q9. Data Use

Are groundwater quality data routinely manipulated, interpreted and displayed ?	YES
On what scale is this done ? E.g. sub catchment, catchment or other.	AREA - BY SITE
What level of interpretation is performed ? E.g. trend analysis, comparison with quality standards etc.	TREND ANALYSIS
Are the data used by other departments in the Agency or provided to industry / the public ?	YES
In what format is this data provided ?	PAPER TABULATED DATA PRINTOUT.

The following questions relate to the software you use.

Q10.

What software do you currently use to store, analyse and present the data ? e.g. Excel, Lotus, Access, Approach, Oracle, Grapher, Statistica, SPSS, Surfer, Arcview, Arcinfo, Mapinfo, WIMS.

Program	Version	Main Uses						
		Storage	Statistics	Tables	Graphs	Contours	Mapping	Other please describe
LIMS		✓		✓				
MONIT		✓	✓	✓	✓			
EXCEL			✓	✓	✓			

Q11.

Is the software you have listed sufficient and suitable for your purposes, if not what are the problems ? e.g. difficult graphing, training required, poor technical support.	
Program	
MONIT	NOT A WINDOWS COMPATIBLE PACKAGE - SLOW DATA INPUT. - POOR TABULATED DATA OUTPUT
LIMS	DIFFICULT GRAPHING — NOT A WINDOWS PACKAGE
EXCEL	POOR INPUT RATE /SLOW — NO TRAINING IN SET UP TO RECEIVE DATA

Q12.

What additional software features would you like ? e.g. specific graphs or statistical capabilities.
TIME SERIES GRAPHS - MANY LOCATIONS VS
MANY PARAMETERS
STATISTICS + IONIC BALANCE CALCULATIONS
LINK TO G.I.S. - 3D PLOTS

Q13.

Are you aware of any other software that would satisfy your requirements ?
No

Q14.

Have you tested any software other than that you currently use and what was your conclusion ?
No.

Thank you for completing this questionnaire. Please return the completed document by post or by fax to Mark Vanstone at GIBB Ltd.

GIBB Ltd,
Environmental Division,
GIBB House,
London Road,
Reading,
Berkshire RG6 1BL

Fax 0118 963 5290
Tel 0118 963 5000

ENVIRONMENTAL MONITORING - GROUNDWATER

Monthly/Three Monthly (Basic Suite-B) "GW"

Code	Determinand	Units	Bottle Type
00613	pH	pH units	A
00772	Electrical Conductivity (EC)	uS/cm	A
00823	Dissolved Oxygen (DO)	mg/l O	C
01113	Ammoniacal Nitrogen (NH_4-N)	mg/l N	A
01724	Chloride (Cl)	mg/l Cl	A
00922	Chemical Oxygen Demand (COD)	mg/l O	A

6 Monthly (Extended Suite-E) "GX" - Filtered Metals

Code	Determinand	Units	Bottle Type
00613	pH	pH units	A
00772	Electrical Conductivity (EC)	uS/cm	A
00823	Dissolved Oxygen (DO)	mg/l O	C
01113	Ammoniacal Nitrogen (NH_4-N)	mg/l N	A
01724	Chloride (Cl)	mg/l Cl	A
00922	Chemical Oxygen Demand (COD)	mg/l O	A
01833	Sulphate (SO4)	mg/l SO_4	A
01622	Alkalinity (as $CaCO_3$ at pH 4.5)	mg/l Ca CO_3	A
01165	Total Oxidised Nitrogen (TON)	mg/l N	A
00994	Total Organic Carbon (TOC)	mg/l C	O
74841	Sodium (Na)	mg/l Na	Y
74851	Potassium (K)	mg/l K	Y
02393	Calcium (Ca)	mg/l Ca	Y
02353	Magnesium (Mg)	mg/l Mg	Y
04197	Iron (Fe)	mg/l Fe	Y
04015	Manganese (Mn)	mg/l Mn	Y
92645	Cadmium (Cd)	ug/l Cd	Y
98884	Chromium (Cr)	ug/l Cr	Y
98904	Copper (Cu)	ug/l Cu	Y
98944	Nickel (Ni)	ug/l Ni	Y
98925	Lead (Pb)	ug/l Pb	Y
98964	Zinc (Zn)	ug/l Zn	Y

Other parameters such as Chlorinated Solvents as and when required.

PLEASE NOTE:

The figures given for the number of boreholes and the monitoring suites used can only be an approximation as there are many landfill sites with different monitoring requirements. Generally speaking taking an average approach there are two main groups of site. Firstly, those sites with a **monthly** monitoring requirement for a simple **basic suite of analyses** and a **6 - monthly** requirement for the **extended suite of analyses.** Secondly those sites with a **3 - monthly** monitoring requirement for the **basic suite of analyses** and a **6- monthly** requirement for the **extended suite.**

Processing and Presentation of Groundwater Quality Data

Questionnaire Responses - Environment Agency, Midlands Region

Andrew Pearson : Senior Hydrogeologist

QUESTIONNAIRE: Groundwater Quality Data Software

GIBB Ltd. have been contracted by the Agency to assess the Agency's requirements regarding the storage and display of groundwater quality data. This questionnaire forms part of our assessment and we will be grateful for your responses to the questions outlined below.

If you have any queries please contact Mark Vanstone or Tim Morgan at GIBB Ltd. on 0118-9635000, or by Email at mvanston@gibb.co.uk or tmorgan@gibb.co.uk.

The following questions are to obtain general details.

Q1.

Please provide the following reference details:			
Name:	Andrew Pearson		
Position:	Senior Hydrogeologist	**Region:**	Midlands
Tel No.:	0121 711 5840	**Fax No.:**	0121 711 5830
E-mail:			

Q2.

Please provide details of other Agency staff who may be able to provide input to this project.			
Name:	Phil Humble		
Position:	Assistant Hydrogeologist	**Region:**	Midlands
Tel No.:	0121 711 2324 Ext 4643	**Fax No.:**	0121 711 5830
E-mail:			
Name:	Dean Roden		
Position:	Scientific Officer	**Region:**	Midlands
Tel No.:	0121 711 2324 Ext 4654	**Fax No.:**	0121 711 5830
Position:			
E-mail:			

The following questions are to establish how much groundwater quality monitoring data your office typically handles annually.

Q3. Public Water Supply Wells

No. of public water supply wells:	@ 320 Sources
What is the frequency of the data receipt and review process for public water supply wells and how was this determined ?	Ranges from 1 to 170 times per yr, usually between 1 to 12 time per yr.
Please identify the determinands for public water supply wells (or attach a list):	See attached lists (Not all determinands may be tested for, Very dependant on the PWS Location and licence type. Bulk of information is supplied by Water Companies. The parameters analysed for are to be revised over the next 12 months. To date the Agency has not had as much control as it could like concerning Water Company Monitoring.

Q4. Observation Boreholes

No. of observation boreholes:	@ 180 Sites in the present Network.
What is the frequency of the data receipt and review process for observation boreholes and how was this determined ?	Generally between 1 to 4 times per yr. Can range up to 54 times per yr. for certain determinands.
Please identify the determinands for observation boreholes (or attach a list):	See attached lists of Gwtr suites (162 & 163). For most sites at least one suite 163 taken per year.

Q5. Springs

No. of springs:	@ 50 (previous counted in Q3/Q4)
What is the frequency of the data receipt and review process for springs and how was this determined ?	See Q3/Q4 - dependant on the licence type.
Please identify the determinands for springs (or attach a list):	See before

Q6. Other Monitoring Locations

No. of other monitoring locations:	Variety of locations, generally landfills, pollution incidents & some site specific groundwater quality anomalies.
What is the frequency of the data receipt and review process for these monitoring points and how was this determined ?	Depends on site requirements - can be one off analyses, other sites may have several years worth of data.
Please identify the determinands for these monitoring points (or attach a list):	Tend to be site specific - most likely to be metals or organics.

The following questions are to obtain information regarding the data collection, storage and use.

Q7. Data Collection

Is the groundwater quality data obtained internally or externally ?	70% Water Companies 30% Agency.
What and where are the external sources ?	External Water Companies (ie Severn Trent Water, South Staffs, Yorkshire, Anglian).
Does the determinand data collected have additional comment fields and what are these ?	Yes. However, not often used.
What other environmental data are collected in parallel with groundwater quality data ?	None at time of sampling borehole. (Short records of weather may be noted in comment fields).
What QA/QC procedures are used to assess the quality of the groundwater monitoring data ?	Sample results are based on the 95th percentile rule.

Q8. Data Storage

Are groundwater quality data on a single database or are a number of software packages used ?	Currently use Water Company database (QUIS) to store both W/C & Agency data. This arrangement will cease with the introduction of WIMS.
What other databases are you aware of for other data ? E.g. contaminated land, landfill, mineral water, private supplies.	Very little additional gwtG information is held on computer databases (Some landfill data) but significant quantities are held in paper form for both contaminated land & landfills. Some Historical public water supply data is held on Microfiche.
Where are these databases located and who has responsibility ? Please provide name, address and telephone number.	Varied and numerous. Landfill - Area Scientific Support team all other accessiable via Regional Office (See Q1/Q2)

Q9. Data Use

Are groundwater quality data routinely manipulated, interpreted and displayed ?	Historically yes (pre 1990), little in early/mid 1990's. This will form greater prominence in workload, 1998 onwards. Some analysis in M.Sc. reports.
On what scale is this done ? E.g. sub catchment, catchment or other.	Providing generalised regional data. Plus some subcatchment specific reports.
What level of interpretation is performed ? E.g. trend analysis, comparison with quality standards etc.	General. - nitrate (ANTEATER) Trend analysis - assessment of pollution data against quality standards - general summary information on likely gwtr quality in aquifer outcrop areas.
Are the data used by other departments in the Agency or provided to industry / the public ?	Data is provided internally in the Agency and to all below:- - industry - Public Register enquires. - Pressure Groups - Consultants etc.
In what format is this data provided ?	Hardcopy; ASC II file extract. Internally it can be put into Visual D Base, Excel or Lotus 1-2-3.

The following questions relate to the software you use.

Q10.

What software do you currently use to store, analyse and present the data ? e.g. Excel, Lotus, Access, Approach, Oracle, Grapher, Statistica, SPSS, Surfer, Arcview, Arcinfo, Mapinfo, WIMS.

Program	Version	Main Uses						
		Storage	Statistics	Tables	Graphs	Contours	Mapping	Other please describe
Lotus	Release 4-?		✓	✓	✓			
Excel	Excel 97		✓	✓	✓			
Access	Access 97	Some Storage	✓	✓				Query facility
Visual D Base		manuplation .						
WIMS								To be implimented soon .

Note

All data is pulled off QUIS as a query as required.
The data is only manpulated & sent out to the customer.
QUIS Query → ASC II → Visual DBase ↗ Excel → Access
↘ Lotus ↗

Q11.

Is the software you have listed sufficient and suitable for your purposes, if not what are the problems ? e.g. difficult graphing, training required, poor technical support.	
Program	
QUIS	O.k. at present - but will be replaced by WIMS due to standardisation.

Q12.

What additional software features would you like ? e.g. specific graphs or statistical capabilities.
Arcinfo - to aid site location and data searches, to increase
efficiency to the customers.
Improved statistical analysis/routines maybe helpful.

Q13.

Are you aware of any other software that would satisfy your requirements ?
Not at present.

Q14.

Have you tested any software other than that you currently use and what was your conclusion ?
No.

Thank you for completing this questionnaire. Please return the completed document by post or by fax to Mark Vanstone at GIBB Ltd.

16/6/98

GIBB Ltd,
Environmental Division,
GIBB House,
London Road,
Reading,
Berkshire RG6 1BL

Fax 0118 963 5290
Tel 0118 963 5000

GROUNDWATERS

There are two mandatory groundwater suites which are called 'Basic' and 'Extended'

BASIC (GW1) SUITE 162

pH
Electrical Conductivity
Filtered Total Organic Carbon
Ammonia
Total Oxidised Nitrogen
Chloride
Sulphate
Alkalinity
Sodium
Potassium
Calcium
Magnesium
Filtered Iron
Filtered Manganese

Field Dets
Temperature
Dissolved Oxygen

EXTENDED (GW2) SUITE 163

pH
Electrical Conductivity
Filtered Total Organic Carbon
Ammonia
Total Oxidised Nitrogen
Chloride
Sulphate
Alkalinity
Sodium
Potassium
Calcium
Magnesium
Filtered Iron
Filtered Manganese

Field Dets
Temperature
Dissolved Oxygen

Silica
Aluminium
Boron
Cadmium
Chromium
Copper
Lead
Nickel
Zinc
Orthophosphate
Barium
Silver
Arsenic
Beryllium
Mercury
Antimony
Selenium
Vanadium
Total Hardness
Nitrite
Fluoride
Cobalt

Cyanide
Chlorinated Pesticides (15)
Phosphorous Pesticides (16)
PAH's
NVM
Oil (IR)
Phenols (16)
Pentachlorophenol

Processing and Presentation of Groundwater Quality Data

Questionnaire Responses - Environment Agency, North West Region

Edward Wrathmell : Assistant Hydrogeologist

QUESTIONNAIRE: Groundwater Quality Data Software

GIBB Ltd. have been contracted by the Agency to assess the Agency's requirements regarding the storage and display of groundwater quality data. This questionnaire forms part of our assessment and we will be grateful for your responses to the questions outlined below.

If you have any queries please contact Mark Vanstone or Tim Morgan at GIBB Ltd. on 0118-9635000, or by Email at mvanston@gibb.co.uk or tmorgan@gibb.co.uk.

The following questions are to obtain general details.

Q1.

Please provide the following reference details.			
Name:	EDWARD WRATHMELL		
Position:	ASSIST. HYDROGEOLOGIST	**Region:**	NORTH WEST
Tel No.:	(01925) 653 999 ext 2027	**Fax No.:**	(01925) 415 961
E-mail:			

Q2.

Please provide details of other Agency staff who may be able to provide input to this project.			
Name:	John Ingram		
Position:	Hydrogeologist	**Region:**	North West
Tel No.:	(01925) 653999 ext	**Fax No.:**	As Above
E-mail:			
Name:			
Position:		**Region:**	
Tel No.:		**Fax No.:**	
Position:			
E-mail:			

The following questions are to establish how much groundwater quality monitoring data your office typically handles annually.

Q3. Public Water Supply Wells

No. of public water supply wells:	~~100 BOREHOLE SOURCES~~ 18 SPRING SOURCES 3 MINE ADIT SOURCES (GRAVITY) 2 MINE WORKINGS SOURCES (PUMPED)
What is the frequency of the data receipt and review process for public water supply wells and how was this determined ?	SAMPLED TWICE PER YEAR BY EA/CONTRACT STAFF
Please identify the determinands for public water supply wells (or attach a list):	SEE ATTACHED SUITE 537.

Q4. Observation Boreholes

No. of observation boreholes:	OBSERVATION BH's NOT ROUTINELY MONITORED
What is the frequency of the data receipt and review process for observation boreholes and how was this determined ?	—
Please identify the determinands for observation boreholes (or attach a list):	—

?

?

Q5: Springs

No. of springs:	50 (PRIVATE) APROX.
What is the frequency of the data receipt and review process for springs and how was this determined ?	SAMPLED TWICE PER YEAR BY EA / CONTRACT STAFF
Please identify the determinands for springs (or attach a list):	SEE ATTACHED SUITE 537

Q6. Other Monitoring Locations

No. of other monitoring locations:	BOREHOLES 175 (PRIVATE) APROX + 2 MINE WORKINGS
What is the frequency of the data receipt and review process for these monitoring points and how was this determined ?	SAMPLED TWICE PER YEAR BY EA / CONTRACT STAFF
Please identify the determinands for these monitoring points (or attach a list):	SEE ATTACHED. SUITE 537 & 538.

The following questions are to obtain information regarding the data collection, storage and use.

Q7. Data Collection

Is the groundwater quality data obtained internally or externally ?	MAINLY INTERNAL
What and where are the external sources ?	North-West-Water — NITRATE DATA FROM SOME BOREHOLE SOURCES.
Does the determinand data collected have additional comment fields and what are these ?	GENERAL COMMENTS BOX (20 CHARACTER).
What other environmental data are collected in parallel with groundwater quality data ?	NO.
What QA/QC procedures are used to assess the quality of the groundwater monitoring data ?	Stnd Agency Lab QA ?

Q8. Data Storage

Are groundwater quality data on a single database or are a number of software packages used ?	Single Mainframe Archive.
What other databases are you aware of for other data ? E.g. contaminated land, landfill, mineral water, private supplies.	~~Contaminated Land~~
Where are these databases located and who has responsibility ? Please provide name, address and telephone number.	I.C.L. at Warwick. Kathy Greenall, Data Resource (EA, North West Region)

(01925) 653999 ext

Q9. Data Use

Are groundwater quality data routinely manipulated, interpreted and displayed ?	Yes.
On what scale is this done ? E.g. sub catchment, catchment or other.	Individual / small groups of samples
What level of interpretation is performed ? E.g. trend analysis, comparison with quality standards etc.	Trend Analysis. Hydrochem
Are the data used by other departments in the Agency or provided to industry / the public ?	Largely available to public and industry.
In what format is this data provided ?	Paper copy

The following questions relate to the software you use.

Q10.

What software do you currently use to store, analyse and present the data ? e.g. Excel, Lotus, Access, Approach, Oracle, Grapher, Statistica, SPSS, Surfer, Arcview, Arcinfo, Mapinfo, WIMS.

Program	Version	Main Uses						
		Storage	Statistics	Tables	Graphs	Contours	Mapping	Other please describe
GEOBASE	6		✓		✓			
LOTUS	5			✓	✓			

GIBB Environmental
LAWGIBB Group Member

Q11.

Is the software you have listed sufficient and suitable for your purposes, if not what are the problems ? e.g. difficult graphing, training required, poor technical support.	
Program	

Q12.

What additional software features would you like ? e.g. specific graphs or statistical capabilities.
Plot Durov, Stiff, Shroeder, Histograms
Plot Ranges, + Trends.
Be able to use this package ~~with it~~ in
~~conjun~~ conjunction with GIS, WIM's, and
other ~~relevant~~ ~~sof~~ Agency standard software.

Q13.

Are you aware of any other software that would satisfy your requirements ?
?

Q14.

Have you tested any software other than that you currently use and what was your conclusion ?

Thank you for completing this questionnaire. Please return the completed document by post or by fax to Mark Vanstone at GIBB Ltd.

GIBB Ltd,
Environmental Division,
GIBB House,
London Road,
Reading,
Berkshire RG6 1BL

Fax 0118 963 5290
Tel 0118 963 5000

* Suite No. 537 - NW STD GROUNDWATER (SGA)

0050 Pb (Tot) ug/l	0061 pH	0077 COND 25'C us/cm
0092 COD Micro mg/l	0108 Cd (Tot) ug/l	0111 Ammonia mg/l
0117 Nitrate mg/l	0118 Nitrite mg/l	0241 Calcium mg/l
0237 Magnesium mg/l	0158 Hard Tot mg/l	0162 Alkalin. mg/l
0172 Chloride mg/l	0180 Phosphate mg/l	0182 SiO2 Reac mg/l
0183 Sulphate mg/l	0207 Sodium mg/l	0211 Potassium mg/l
7421 Fe (Tot) ug/l	7375 Cr (Tot) ug/l	7215 Cu (Tot) ug/l
7429 Ni (Tot) ug/l	7245 Zn (Tot) ug/l	7403 Mn (Tot) ug/l
7760 Al (Tot) ug/l	0116 T.O.N. mg/l	0177 Fluoride mg/l
7356 As (Tot) ug/l	0171 Bromide mg/l	7763 B (Tot) ug/l
7770 Sr (Tot) ug/l		

* Suite No. 538 - NW STD GROUND + SOLV (SGAS)

0050 Pb (Tot) ug/l	0061 pH	0077 COND 25'C us/cm
0092 COD Micro mg/l	0108 Cd (Tot) ug/l	0111 Ammonia mg/l
0117 Nitrate mg/l	0118 Nitrite mg/l	0241 Calcium mg/l
0237 Magnesium mg/l	0207 Sodium mg/l	0211 Potassium mg/l
0158 Hard Tot mg/l	0162 Alkalin. mg/l	0172 Chloride mg/l
0180 Phosphate mg/l	0182 SiO2 Reac mg/l	0183 Sulphate mg/l
7421 Fe (Tot) ug/l	7375 Cr (Tot) ug/l	7215 Cu (Tot) ug/l
7429 Ni (Tot) ug/l	7245 Zn (Tot) ug/l	7403 Mn (Tot) ug/l
**** SOLVENTS ug/l	9168 3CL-ETHAN ug/l	9524 Chlorofrm ug/l
9643 4CHLMETH ug/l	9706 4CHLTHENE ug/l	9707 3Clethene ug/l
9712 12Dicleth ug/l	9811 112-TRICH ug/l	7760 Al (Tot) ug/l
0116 T.O.N. mg/l	~~9705 HCBD ug/l~~	~~9052 135-TCBEN ug/l~~
~~9051 124-TCBEN ug/l~~	~~9050 123-TCBEN ug/l~~	0915 METHANE mg/l
0177 Fluoride mg/l	7356 As (Tot) ug/l	0171 Bromide mg/l
7763 B (Tot) ug/l	7770 Sr (Tot) ug/l	

* PLUS FIELD DETERMINANDS : TEMPERATURE
PH
DISSOLVED OXYGEN.

* Suite No. 537 - NW STD GROUNDWATER (SGA)

0050 Pb (Tot) ug/l	0061 pH	0077 COND 25'C us/cm
0092 COD Micro mg/l	0108 Cd (Tot) ug/l	0111 Ammonia mg/l
0117 Nitrate mg/l	0118 Nitrite mg/l	0241 Calcium mg/l
0237 Maghesium mg/l	0158 Hard Tot mg/l	0162 Alkalin. mg/l
0172 Chloride mg/l	0180 Phosphate mg/l	0182 SiO2 Reac mg/l
0183 Sulphate mg/l	0207 Sodium mg/l	0211 Potassium mg/l
7421 Fe (Tot) ug/l	7375 Cr (Tot) ug/l	7215 Cu (Tot) ug/l
7429 Ni (Tot) ug/l	7245 Zn (Tot) ug/l	7403 Mn (Tot) ug/l
7760 Al (Tot) ug/l	0116 T.O.N. mg/l	0177 Fluoride mg/l
7356 As (Tot) ug/l	0171 Bromide mg/l	7763 B (Tot) ug/l
7770 Sr (Tot) ug/l		

* Suite No. 538 - NW STD GROUND + SOLV (SGAS)

0050 Pb (Tot) ug/l	0061 pH	0077 COND 25'C us/cm
0092 COD Micro mg/l	0108 Cd (Tot) ug/l	0111 Ammonia mg/l
0117 Nitrate mg/l	0118 Nitrite mg/l	0241 Calcium mg/l
0237 Magnesium mg/l	0207 Sodium mg/l	0211 Potassium mg/l
0158 Hard Tot mg/l	0162 Alkalin. mg/l	0172 Chloride mg/l
0180 Phosphate mg/l	0182 SiO2 Reac mg/l	0183 Sulphate mg/l
7421 Fe (Tot) ug/l	7375 Cr (Tot) ug/l	7215 Cu (Tot) ug/l
7429 Ni (Tot) ug/l	7245 Zn (Tot) ug/l	7403 Mn (Tot) ug/l
**** SOLVENTS ug/l	9168 3CL-ETHAN ug/l	9524 Chlorofrm ug/l
9643 4CHLMETH ug/l	9706 4CHLTHENE ug/l	9707 3Clethene ug/l
9712 12Dicleth ug/l	9811 112-TRICH ug/l	7760 Al (Tot) ug/l
0116 T.O.N. mg/l	~~9705 HCBD ug/l~~	~~9052 135 TCBEN ug/l~~
~~9051 124 TCBEN ug/l~~	~~9050 123 TCBEN ug/l~~	0915 METHANE mg/l
0177 Fluoride mg/l	7356 As (Tot) ug/l	0171 Bromide mg/l
7763 B (Tot) ug/l	7770 Sr (Tot) ug/l	

* PLUS FIELD DETERMINANDS : TEMPERATURE
PH
DISSOLVED OXYGEN.

Processing and Presentation of Groundwater Quality Data

Questionnaire Responses - Environment Agency,

North East Region

Jenny Hodgson : Groundwater Officer, Ridings Area

Mark Morton : Contaminant Hydrogeologist, Dales Area

Alex Garden : Hydrogeologist

GIBB Environmental
LAWGIBB Group Member

QUESTIONNAIRE: Groundwater Quality Data Software

GIBB Ltd. have been contracted by the Agency to assess the Agency's requirements regarding the storage and display of groundwater quality data. This questionnaire forms part of our assessment and we will be grateful for your responses to the questions outlined below.

If you have any queries please contact Mark Vanstone or Tim Morgan at GIBB Ltd. on 0118-9635000, or by Email at mvanston@gibb.co.uk or tmorgan@gibb.co.uk.

The following questions are to obtain general details.

Q1.

Please provide the following reference details.			
Name:	Jenny Hodgson		
Position:	Groundwater Officer	Region:	North East (Ridings)
Tel No.:	(0113) 213 4818	Fax No.:	(0113) 213 4609
E-mail:	n/a		

Q2.

Please provide details of other Agency staff who may be able to provide input to this project.			
Name:	Andrew Clark (Temporary)		
Position:	Groundwater Technician	Region:	North East (Ridings)
Tel No.:	(0113) 213 4827	Fax No.:	(0113) 213 4609
E-mail:			
Name:	John Aldrick.		
Position:	Water Resource Team Leader.	Region:	
Tel No.:	0113 2134814.	Fax No.:	
Position:			
E-mail:			

GIBB Environmental
LAWGIBB Group Member

The following questions are to establish how much groundwater quality monitoring data your office typically handles annually.

Q3. Public Water Supply Wells

No. of public water supply wells:	we recieve data for 9 sites comprising 21 boreholes.
What is the frequency of the data receipt and review process for public water supply wells and how was this determined ?	This data is sent by Yorkshire Water on a 6-monthly basis and is in the form of both a hard copy and a lotus file.
Please identify the determinands for public water supply wells (or attach a list):	The determinands tested for are Major Ions, Iron and Manganese which is giving a lab suite code of 801.
EA is seeking to obtain water quality data of Yorkshire Water boreholes and springs.	

Q4. Observation Boreholes

No. of observation boreholes:	Around 200 - 300 (Data from)
What is the frequency of the data receipt and review process for observation boreholes and how was this determined ?	So far each of these borehole has only been sampled once but ~~applying~~ the BGS Strategy. will be applied
Please identify the determinands for observation boreholes (or attach a list):	All boreholes will have been sampled under the 802 suite and occasionally the additional determinands of 808 are tested for. See Attached Lists.

Q5. Springs

No. of springs:	Data from 10-15 Springs.
What is the frequency of the data receipt and review process for springs and how was this determined ?	As with the observation boreholes
Please identify the determinands for springs (or attach a list):	As with the observation boreholes.

Q6. Other Monitoring Locations

No. of other monitoring locations:	Landfills, Contaminated lands (of which there are 60-100), One off projects i.e Chalk Spring Project, Sheep Dip Programme
What is the frequency of the data receipt and review process for these monitoring points and how was this determined ?	Landfills are as per WMP4. Con Land sites are variable but in the main a single round of sampling is carried out, but occasionally it may be monthly for many years.
Please identify the determinands for these monitoring points (or attach a list):	Landfills are analysed according to WMP4 Analysis for contaminated land sites is site specific.

The following questions are to obtain information regarding the data collection, storage and use.

Q7. Data Collection

Is the groundwater quality data obtained internally or externally ?	The Data is obtained both Internally and Externally
What and where are the external sources ?	External quality data is obtained from Public Supply - Boreholes, Contaminated Land sites and from Landfills.
Does the determinand data collected have additional comment fields and what are these ?	Yes, the lab attaches comments regarding analytical problems and result analysers
What other environmental data are collected in parallel with groundwater quality data ?	Water Levels, Field Parameters (ie pH) Site Name, Grid Reference, Source type Aquifer type, Licence Number, depth of sample some times.
What QA/QC procedures are used to assess the quality of the groundwater monitoring data ?	Most determinands have a NAMAS Accreditation for their analysis, the Lab has its own QA/QC and occasionally an ionic balance check is carried out.

Q8. Data Storage

Are groundwater quality data on a single database or are a number of software packages used ?	Data is archived on Labman, Hard copies of results are kept and these hard copies originate from Lotus files
What other databases are you aware of for other data ? E.g. contaminated land. landfill. mineral water. private supplies.	Not aware Large volume of data on paper sheets
Where are these databases located and who has responsibility ? Please provide name. address and telephone number.	n/a

Q9. Data Use

Are groundwater quality data routinely manipulated, interpreted and displayed ? (Not routinely at the moment) - as no software.	Would be very useful to be able to access electronically and especially if in a database to be able to perform searches
On what scale is this done ? E.g. sub catchment, catchment or other.	In the main this is carried out on a site specific basis but occasionally on a Aquifer type or well yield scale.
What level of interpretation is performed ? E.g. trend analysis, comparison with quality standards etc.	Comparison with other monitoring stations and with existing water quality standards. Trend analysis may be carried out where historical data is available
Are the data used by other departments in the Agency or provided to industry / the public ?	Yes
In what format is this data provided ?	Hard Copy

The following questions relate to the software you use.

Q10.

What software do you currently use to store, analyse and present the data ? e.g. Excel, Lotus, Access, Approach, Oracle, Grapher, Statistica, SPSS, Surfer, Arcview, Arcinfo, Mapinfo, WIMS.

Program	Version	Main Uses						
		Storage	Statistics	Tables	Graphs	Contours	Mapping	Other please describe
Main Frame Labman		✓						
Lotus	5.0	✓	✓	✓	✓			

Q11.

Is the software you have listed sufficient and suitable for your purposes, if not what are the problems ? e.g. difficult graphing, training required, poor technical support.	
Program	
YW Archive	No - manipulation of the data is difficult. Searching is very hit and miss. No graphing ability. No quick, easy access to data.
Lotus	No searching is possible, data must be inputted manually. No mapping/contour features, insufficient data is currently in format.
	Lack of suitable software has handicapped progress.

Q12.

What additional software features would you like ? e.g. specific graphs or statistical capabilities.
Ability to perform radial searches of database by
Grid Reference and Analyser type, ability to draw graphs
comparing quality results with water quality standards.
Graphs of seperate determinands from seperate boreholes.
Plot time series data from same point.

Q13.

Are you aware of any other software that would satisfy your requirements ?
Possibly Microsoft Access as a slight improvement
to Lotus.
other groundwater quality packages exist, but obtaining them is
difficult as no support from CIS. for specialist software.

Q14.

Have you tested any software other than that you currently use and what was your conclusion ?
No

Thank you for completing this questionnaire. Please return the completed document by post or by fax to Mark Vanstone at GIBB Ltd.

GIBB Ltd.
Environmental Division.
GIBB House,
London Road.
Reading.
Berkshire RG6 1BL

Fax 0118 963 5290
Tel 0118 963 5000

GIBB Environmental
LAWGIBB Group Member

QUESTIONNAIRE: Groundwater Quality Data Software

GIBB Ltd. have been contracted by the Agency to assess the Agency's requirements regarding the storage and display of groundwater quality data. This questionnaire forms part of our assessment and we will be grateful for your responses to the questions outlined below.

If you have any queries please contact Mark Vanstone or Tim Morgan at GIBB Ltd. on 0118-9635000, or by Email at mvanston@gibb.co.uk or tmorgan@gibb.co.uk.

The following questions are to obtain general details.

Q1.

Please provide the following reference details.			
Name:	MARK MORTON		
Position:	CONTAMINANT HYDROGEOLOGIST	**Region:**	NE (DALES AREA)
Tel No.:	01904 822507 (DL)	**Fax No.:**	01904 693748
E-mail:	mark.morton@environment-agency.gov.uk		

Q2.

Please provide details of other Agency staff who may be able to provide input to this project.			
Name:			
Position:		**Region:**	
Tel No.:		**Fax No.:**	
E-mail:			
Name:			
Position:		**Region:**	
Tel No.:		**Fax No.:**	
Position:			
E-mail:			

GIBB Environmental
LAWGIBB Group Member

The following questions are to establish how much groundwater quality monitoring data your office typically handles annually.

Q3. Public Water Supply Wells

No. of public water supply wells:	111 including springs.
What is the frequency of the data receipt and review process for public water supply wells and how was this determined ?	Ad Hoc.
Please identify the determinands for public water supply wells (or attach a list):	As required.

Q4. Observation Boreholes

No. of observation boreholes:	~~[illegible]~~ c90
What is the frequency of the data receipt and review process for observation boreholes and how was this determined ?	SAMPLED Bi ANNUALLY BGS STRATEGY
Please identify the determinands for observation boreholes (or attach a list):	805 suite - 1st 2 years then every 5years full sweep. 801 Suite - reduced sweep, replaces 805 when not used. LISTS ATTACHED FOR BOTH SUITES.

Q5. Springs

No. of springs:	30
What is the frequency of the data receipt and review process for springs and how was this determined ?	SAMPLED BI ANNUALLY BGS STRATEGY
Please identify the determinands for springs (or attach a list):	805 & 801 suites see Observation Boreholes

Q6. Other Monitoring Locations

No. of other monitoring locations:	LANDFILLS – 110 CONTAMINATED LAND – varible 10–30 per year.
What is the frequency of the data receipt and review process for these monitoring points and how was this determined ?	LANDFILLS – 60 – 2x year – 12x year 50 – as necessary CONTAMINATED LAND – VARIABLE range one offs to monthly
Please identify the determinands for these monitoring points (or attach a list):	WMP 4.

The following questions are to obtain information regarding the data collection, storage and use.

Q7. Data Collection

Is the groundwater quality data obtained internally or externally ?	INTERNALLY
What and where are the external sources ?	N/A
Does the determinand data collected have additional comment fields and what are these ?	No
What other environmental data are collected in parallel with groundwater quality data ?	LITTLE OR NONE
What QA/QC procedures are used to assess the quality of the groundwater monitoring data ?	LAB MANAGE NO OTHER.

Q8. Data Storage

Are groundwater quality data on a single database or are a number of software packages used ?	YW ARCHIVE LOTUS 123
What other databases are you aware of for other data ? E.g. contaminated land, landfill, mineral water, private supplies.	CONTAMINATED LAND / GW POLLUTION – ENTEC POINT SOURCE D/B – S/S FOR DATA COMPARISON WITH DUTCH GUIDELINES
Where are these databases located and who has responsibility ? Please provide name, address and telephone number.	DALES AREA J.M. LANCASTER

Q9. Data Use

Are groundwater quality data routinely manipulated, interpreted and displayed ?	No But would like to be able to (Hard copies filed)
On what scale is this done ? E.g. sub catchment, catchment or other.	N/A
What level of interpretation is performed ? E.g. trend analysis, comparison with quality standards etc.	Comparison
Are the data used by other departments in the Agency or provided to industry / the public ?	Yes
In what format is this data provided ?	Hard copy

The following questions relate to the software you use.

Q10.

What software do you currently use to store, analyse and present the data ? e.g. Excel, Lotus, Access, Approach, Oracle, Grapher, Statistica, SPSS, Surfer, Arcview, Arcinfo, Mapinfo, WIMS.

Program	Version	Main Uses						
		Storage	Statistics	Tables	Graphs	Contours	Mapping	Other please describe
MAIN FRAME DATABASE		✓						
ENTEC PS ACCESS	2.0	✓						
CLASP LOTUS 123 S/S	5.0	✓						Comparision with Dutch guidelines.
LOTUS 123 SS	5.0	✓						

✓

Q11.

Is the software you have listed sufficient and suitable for your purposes, if not what are the problems ? e.g. difficult graphing, training required, poor technical support.	
Program	
YW ARCHIVE	No – Only provides very limited functionallity. Basic searching and poor quality print outs. Ally usefull features. No graphics – stats functionallity.
WASTE SITE SAMPLING DATABASE	No – no

Q12.

What additional software features would you like ? e.g. specific graphs or statistical capabilities.
Piper diagrams, stiff diagrams, Cumulative % graphs,
Graphs showing comparison with standards eg
DWI, Dutch, US EPA etc.
Trend analysis, OPM's.

Q13.

Are you aware of any other software that would satisfy your requirements ?
No
Possibly – AquaChem by Waterloo Hydrologic
Looks like it could do all we want – You probably are
already aware of this but a free demo is downloadable
from their website – HTTP://WWW.FLOWPATH.COM.

Q14.

Have you tested any software other than that you currently use and what was your conclusion ?
No –
but we are looking at the Waterloo
demo now.

Thank you for completing this questionnaire. Please return the completed document by post or by fax to Mark Vanstone at GIBB Ltd.

GIBB Ltd,
Environmental Division,
GIBB House,
London Road,
Reading,
Berkshire RG6 1BL

Fax 0118 963 5290
Tel 0118 963 5000

NE REGION.

COMMONLY USED DETERMINAND GROUPS

108 BASIC SEWAGE — PI S

0001 DOCUMENT
0061 pH
0085 BOD TOTAL +ATU
0111 NITROGEN AMMONIAC
0135 SOLIDS PARTC 105C

109 EXTENDED SEWAGE — PI S

0001 DOCUMENT
0061 pH
0085 BOD TOTAL +ATU
0092 COD TOTAL
0111 NITROGEN AMMONIAC
0116 NITROGEN TOT OXID
0118 NITRITE
0135 SOLIDS PARTC 105C
0180 O-PHOSPHATE

110 STORM TANK ANALYSIS — PI S

0001 DOCUMENT
0061 pH
0085 BOD TOTAL +ATU
0092 COD TOTAL
0111 NITROGEN AMMONIAC
0135 SOLIDS PARTC 105C
3020 FLOW - RATE

142 RIVERS — PI S

0001 DOCUMENT
0061 pH
0076 TEMPERATURE
0077 CONDUCTIVITY 25C
0082 OXYGEN DISSOLVED
0085 BOD TOTAL +ATU
0111 NITROGEN AMMONIAC
0116 NITROGEN TOT OXID
0118 NITRITE
0135 SOLIDS PARTC 105C
0158 HARDNESS TOTAL
0162 ALKALINITY pH 4.5
0172 CHLORIDE
0180 O-PHOSPHATE
0241 CALCIUM total

180 A/B DESCR.CONSENT — PI S

0001 DOCUMENT
0061 pH
0076 TEMPERATURE
0082 OXYGEN DISSOLVED
0085 BOD TOTAL +ATU
0111 NITROGEN AMMONIAC
0135 SOLIDS PARTC 105C

178 SURFACE WATER TIP — PI S

0001 DOCUMENT
0061 pH
0076 TEMPERATURE
0085 BOD TOTAL +ATU
0092 COD TOTAL
0111 NITROGEN AMMONIAC
0116 NITROGEN TOT OXID
0118 NITRITE
0135 SOLIDS PARTC 105C
9265 CADMIUM total
9559 COPPER total
9561 ZINC total
9576 CHROMIUM total
9582 IRON total
9586 NICKEL total

179 TIP MONITORING BH — PI S

0001 DOCUMENT
0061 pH
0076 TEMPERATURE
0085 BOD TOTAL +ATU
0092 COD TOTAL
0111 NITROGEN AMMONIAC
0116 NITROGEN TOT OXID
0118 NITRITE
0135 SOLIDS PARTC 105C
9264 CADMIUM filtered
9560 COPPER filtered
9562 ZINC filtered
9577 CHROMIUM filtered
9583 IRON filtered
9587 NICKEL filtered

801 ~~181~~ WATER RESOURCES BH — 5IWS

0001 DOCUMENT
0061 pH
0076 TEMPERATURE
0077 CONDUCTIVITY 25C
0111 NITROGEN AMMONIAC
0116 NITROGEN TOT OXID
0118 NITRITE
0158 HARDNESS TOTAL
0162 ALKALINITY pH 4.5
0172 CHLORIDE
0183 SULPHATE
0207 SODIUM total
0211 POTASSIUM total
0241 CALCIUM total
9580 MANGANESE total
9581 MANGANESE filt
9582 IRON total
9583 IRON filtered

805 NE Region

AQUA-LIMS - NRA OLYMPIA HOUSE LAB NE REGION DATE: 09/02/98

SAMPLE DETAILS DETERMINAND SUITE 805

SAMPLE REFERENCE 97148670
SAMPLE POINT CODE 8611103
LAB REF 99
REASON FOR SAMPLE 15:2I:3W: :
SAMPLE INDICATOR
SAMPLING DEPT CC
SAMPLED BY C48
SAMPLING METHOD S
SAMPLE DATE (from) 03/12/97 @ 11:20
SOURCE ID OMR
COMMENTS
S.NAME E.BIRK RIGG FM. B.H.
LOC.REF 2180
OMS NUMBER
OS.NUMBER
SAMPLE REGISTERED 04/12/97 SR4
SAMPLE COMPLETED Y 31/12/97
SAMPLE VALIDATED Y 31/12/97 L00
DATA TRANSMITTED Y 31/12/97 LAB
SAMPLE AUTHORISED N

RESULT DETAIL:-

DET	RESULT	ANALYST	DATE	LAB	AQC	STATS	Spare	DEL	VALID	DUPL	XMITD	DT.ENT	DT.VAL	DT.XMT
00021 (Appear.)	1AA2	C48	03/12/97	01					*****		*****	04/12/97	09/12/97	12/12/97
00501 (Pb - T)	<1.	BM	27/12/97	05					*****		*****	27/12/97	27/12/97	27/12/97
00521 (Pb - F)	<1.	BM	27/12/97	05					*****		*****	27/12/97	27/12/97	27/12/97
00611 (pH)	7.91	np	04/12/97	05					*****		*****	04/12/97	12/12/97	12/12/97
00761 (TEMP)	8.6	C48	03/12/97	01					*****		*****	04/12/97	09/12/97	12/12/97
00771 (COND(25))	265	np	04/12/97	05					*****		*****	04/12/97	12/12/97	12/12/97
01051 (Hg - T)	<0.02	NLL	08/12/97	05		*****			*****		*****	08/12/97	08/12/97	12/12/97
01111 (AMM-N)	<0.03	MS	05/12/97	05					*****		*****	05/12/97	12/12/97	12/12/97
01161 (TON)	<0.2	MS	05/12/97	05					*****		*****	05/12/97	12/12/97	12/12/97
01181 (NITRITE)	<. 005	MS	05/12/97	05		*****			*****		*****	05/12/97	16/12/97	16/12/97
01581 (TOT HARD)	134	L57	08/12/97	00					*****		*****	08/12/97	08/12/97	12/12/97
01621 (ALK 4.5)	139	MS	05/12/97	05					*****		****	05/12/97	12/12/97	12/12/97
01721 (CHLORIDE)	5.55	MS	05/12/97	05					*****		*****	05/1 /97	12/12/97	12/12/97
01751 (CN-TOT)	<0.003	JHN	04/12/97	05					*****		*****	04/12/97	12/12/97	12/12/97
01771 (FLUOR DIS)	0.17	NP	10/12/97	05					*****		*****	10/12/97	12/12/97	12/12/97
01801 (O-PHOS)	<0.02	MS	05/12/97	05					*****		*****	05/12/97	12/12/97	12/12/97
01831 (SO4)	10.9	AH	05/12/97	05					*****		*****	05/12/97	12/12/97	12/12/97
02071 (Na - T)	8.41	TY	08/12/97	05					*****		*****	08/12/97	12/12/97	12/12/97
02111 (K - T)	1.06	TY	08/12/97	05					*****		*****	08/12/97	12/12/97	12/12/97
02371 (Mg - T)	6.93	JR	08/12/97	05					*****		*****	08/12/97	08/12/97	12/12/97
02411 (Ca - T)	42.3	JR	08/12/97	05					*****		*****	08/12/97	08/12/97	12/12/97
04991 (HCH-g)	<0.001	DRG	18/12/97	05					*****		*****	18/12/97	18/12/97	18/12/97
07231 (DIAZINON)	<0.005	ADC	11/12/97	05					*****		*****	11/12/97	12/12/97	12/12/97
08161 (C-FORM)	AE	DS	19/12/97	05					*****		*****	19/12/97	22/12/97	22/12/97
08171 (BDCM)	AE	DS	19/12/97	05					*****		*****	19/12/97	22/12/97	22/12/97
08181 (B-FORM)	AE	DS	19/12/97	05					*****		*****	19/12/97	22/12/97	22/12/97
08191 (DBCM)	AE	DS	19/12/97	05					*****		*****	19/12/97	22/12/97	22/12/97
10851 (PCP)	<0.1	SAJ	08/12/97	05					*****		*****	08/12/97	12/12/97	12/12/97
60981 (B-OXYNIL)	<0.04	ADC	11/12/97	05					*****		*****	11/12/97	12/12/97	12/12/97
61091 (TOLUENE)	AE	DS	19/12/97	05					*****		*****	19/12/97	22/12/97	22/12/97
61591 (CFENVINPHOS)	<0.005	ADC	11/12/97	05					*****		*****	11/12/97	12/12/97	12/12/97

SAMPLE RESULT DETAILS - CONTINUED - SAMPLE REFERENCE 97148670

DET	RESULT	ANALYST	DATE	LAB	AQC	STATS	Spare	DEL	VALID	DUPL	XMITD	DT.ENT	DT.VAL	DT.XMT
61631 (ETH GLYCOL)	<500	CH	11/12/97	05					*****		*****	11/12/97	12/12/97	12/12/97
62291 (25DMP)	<0.1	SAJ	08/12/97	05					*****		*****	08/12/97	12/12/97	12/12/97
64781 (MTBE)	AE	DS	19/12/97	05					*****		*****	19/12/97	22/12/97	22/12/97
66571 (BROMIDE)	<0.5	AH	10/12/97	05					*****		*****	10/12/97	12/12/97	12/12/97
66781 (GLYPHOSATE)	<0.1	NL	31/12/97	05					*****		*****	31/12/97	31/12/97	31/12/97
67001 (OIL (IR))	<0.1	VSM	05/12/97	05					*****		*****	05/12/97	12/12/97	12/12/97
67331 (m+p-XYL)	AE	DS	19/12/97	05					*****		*****	19/12/97	22/12/97	22/12/97
67341 (o-XYL)	AE	DS	19/12/97	05					*****		*****	19/12/97	22/12/97	22/12/97
67621 (TRICLOPYR)	<0.02	ADC	11/12/97	05					*****		*****	11/12/97	12/12/97	12/12/97
67631 (DICAMBA)	<0.04	ADC	11/12/97	05					*****		*****	11/12/97	12/12/97	12/12/97
73771 (Se - F)	<1	MB	15/12/97	05					*****		*****	15/12/97	15/12/97	15/12/97
73791 (Se - T)	<1	MB	15/12/97	05					*****		*****	15/12/97	15/12/97	15/12/97
90701 (DIURON)	<0.03	JA	16/12/97	05					*****		*****	16/12/97	16/12/97	16/12/97
92601 (As - F (P))	<1	MB	15/12/97	05					*****		*****	15/12/97	15/12/97	15/12/97
92611 (As - T (P))	1.05	MB	15/12/97	05		*****			*****		*****	15/12/97	16/12/97	16/12/97
92641 (Cd - F)	<0.1	BM	27/12/97	05					*****		*****	27/12/97	27/12/97	27/12/97
92651 (Cd - T)	<0.1	BM	27/12/97	05					*****		*****	27/12/97	27/12/97	27/12/97
92781 (ASULAM)	<0.04	CS	18/12/97	05					*****		*****	18/12/97	18/12/97	18/12/97
93221 (MCPP)	<0.04	ADC	11/12/97	05					*****		*****	11/12/97	12/12/97	12/12/97
93231 (MCPA)	<0.04	ADC	11/12/97	05					*****		*****	11/12/97	12/12/97	12/12/97
93241 (MCPB)	<0.04	ADC	11/12/97	05					*****		*****	11/12/97	12/12/97	12/12/97
93281 (246TCP)	<0.1	SAJ	08/12/97	05					*****		*****	08/12/97	12/12/97	12/12/97
93421 (2,4 D)	AE	ADC	11/12/97	05					*****		*****	11/12/97	12/12/97	12/12/97
93701 (FLUORANT)	<5	ADC	11/12/97	05					*****		*****	11/12/97	12/12/97	12/12/97
93711 (B[ghi]P)	<10	ADC	11/12/97	05					*****		*****	11/12/97	12/12/97	12/12/97
93721 (B[k]F)	<5	ADC	11/12/97	05					*****		*****	11/12/97	12/12/97	12/12/97
93731 (INDENO)	<10	ADC	11/12/97	05					*****		*****	11/12/97	12/12/97	12/12/97
93741 (B[b]F)	<5	ADC	11/12/97	05					*****		*****	11/12/97	12/12/97	12/12/97
93751 (B[a]P)	<5	ADC	11/12/97	05					*****		*****	11/12/97	12/12/97	12/12/97
93791 (SIMAZINE)	<0.02	ADC	11/12/97	05					*****		*****	11/12/97	12/12/97	12/12/97
93811 (TRIFLUR)	<0.010	DRG	18/12/97	05					*****		*****	18/12/97	18/12/97	18/12/97
93831 (ATRAZINE)	<0.02	ADC	11/12/97	05					*****		*****	11/12/97	12/12/97	12/12/97
93911 (PROPETAM)	<0.02	ADC	11/12/97	05		*****			*****		*****	11/12/97	16/12/97	16/12/97
93931 (CTOLURON)	<0.04	JA	16/12/97	05					*****		*****	16/12/97	16/12/97	16/12/97
93941 (IPURON)	<0.04	JA	16/12/97	05					*****		*****	16/12/97	16/12/97	16/12/97
93951 (LINURON)	<0.04	JA	16/12/97	05					*****		*****	16/12/97	16/12/97	16/12/97
94711 (PHENOL)	<0.1	SAJ	08/12/97	05					*****		*****	08/12/97	12/12/97	12/12/97
94721 (O-CRESOL)	<0.1	SAJ	08/12/97	05					*****		*****	08/12/97	12/12/97	12/12/97
94731 (M-CRESOL)	<0.1	SAJ	08/12/97	05					*****		*****	08/12/97	12/12/97	12/12/97
94741 (P-CRESOL)	<0.1	SAJ	08/12/97	05					*****		*****	08/12/97	12/12/97	12/12/97
94751 (2CP)	<0.1	SAJ	08/12/97	05					*****		*****	08/12/97	12/12/97	12/12/97
94761 (4CP)	<0.1	SAJ	08/12/97	05					*****		*****	08/12/97	12/12/97	12/12/97
94771 (24DCP)	<0.1	SAJ	08/12/97	05					*****		*****	08/12/97	12/12/97	12/12/97
94951 (3CP)	<0.1	SAJ	08/12/97	05					*****		*****	08/12/97	12/12/97	12/12/97
95191 (12DCE)	AE	DS	19/12/97	05					*****		*****	19/12/97	22/12/97	22/12/97
95421 (ETHBENZ)	AE	DS	19/12/97	05					*****		*****	19/12/97	22/12/97	22/12/97
95511 (B - T)	<100	TY	11/12/97	05					*****		*****	11/12/97	12/12/97	12/12/97
95521 (B - F)	<100	TY	11/12/97	05					*****		*****	11/12/97	12/12/97	12/12/97
95591 (Cu - T)	<1	BM	30/12/97	05					*****		*****	30/12/97	30/12/97	30/12/97
95601 (Cu - F)	<1	BM	30/12/97	05					*****		*****	30/12/97	30/12/97	30/12/97
95611 (Zn - T)	<5.0	JR	08/12/97	05					*****		*****	08/12/97	08/12/97	12/12/97
95621 (Zn - F)	<5.0	JR	08/12/97	05					*****		*****	08/12/97	08/12/97	12/12/97
95631 (Sr - T)	433	TY	05/12/97	05					*****		*****	05/12/97	08/12/97	12/12/97
95641 (Sr - F)	418	TY	05/12/97	05					*****		*****	05/12/97	08/12/97	12/12/97
95761 (Cr - T)	<1	BM	27/12/97	05					*****		*****	27/12/97	27/12/97	27/12/97
95771 (Cr - F)	<1	BM	27/12/97	05					*****		*****	27/12/97	27/12/97	27/12/97
95801 (Mn - T)	<10	TY	08/12/97	05					*****		*****	08/12/97	08/12/97	12/12/97

MPLE RESULT DETAILS - CONTINUED - SAMPLE REFERENCE 97148670 SOS NE Region

DET	RESULT	ANALYST	DATE	LAB	AQC	STATS	Spare	DEL	VALID	DUPL	XMITD	DT.ENT	DT.VAL	DT.XMT
95811 (Mn - F)	<10	TY	08/12/97	05					|*****|		|*****|	08/12/97	08/12/97	12/12/97
95821 (Fe - T)	<30.0	JR	08/12/97	05					|*****|		|*****|	08/12/97	08/12/97	12/12/97
95831 (Fe - F)	<30.0	JR	08/12/97	05					|*****|		|*****|	08/12/97	08/12/97	12/12/97
95861 (Ni - T)	<1	BM	27/12/97	05					|*****|		|*****|	27/12/97	27/12/97	27/12/97
95871 (Ni - F)	<1	BM	27/12/97	05					|*****|		|*****|	27/12/97	27/12/97	27/12/97
97731 (BENZENE)	AE	DS	19/12/97	05					|*****|		|*****|	19/12/97	22/12/97	22/12/97
98691 (CARB TET)	AE	DS	19/12/97	05					|*****|		|*****|	19/12/97	22/12/97	22/12/97
99171 (111TCANE)	AE	DS	19/12/97	05					|*****|		|*****|	19/12/97	22/12/97	22/12/97
99131 (4CHLETHENE)	AE	DS	19/12/97	05					|*****|		|*****|	19/12/97	22/12/97	22/12/97
99191 (3CHLETHENE)	AE	DS	19/12/97	05					|*****|		|*****|	19/12/97	22/12/97	22/12/97

QUESTIONNAIRE: Groundwater Quality Data Software

GIBB Ltd. have been contracted by the Agency to assess the Agency's requirements regarding the storage and display of groundwater quality data. This questionnaire forms part of our assessment and we will be grateful for your responses to the questions outlined below.

If you have any queries please contact Mark Vanstone or Tim Morgan at GIBB Ltd. on 0118-9635000, or by Email at mvanston@gibb.co.uk or tmorgan@gibb.co.uk.

The following questions are to obtain general details.

Q1.

Please provide the following reference details.			
Name:	Alex Garden.		
Position:	Hydrogeologist	**Region:**	North East
Tel No.:	01904 692296	**Fax No.:**	01904 693748
E-mail:	NE·YORK2(gardea)		

Q2.

Please provide details of other Agency staff who may be able to provide input to this project.			
Name:	Mark Morton		
Position:	Contaminant Hydrogeologist	**Region:**	North East
Tel No.:	01904 692296	**Fax No.:**	01904 693748
E-mail:	NE·YORK2(MortoM)		
Name:			
Position:		**Region:**	
Tel No.:		**Fax No.:**	
Position:			
E-mail:			

The following questions are to establish how much groundwater quality monitoring data your office typically handles annually.

Q3. Public Water Supply Wells

No. of public water supply wells:	None.
What is the frequency of the data receipt and review process for public water supply wells and how was this determined ?	
Please identify the determinands for public water supply wells (or attach a list):	

Q4. Observation Boreholes

No. of observation boreholes:	91
What is the frequency of the data receipt and review process for observation boreholes and how was this determined ?	frequency of data receipt - biannually reviewed - anually.
Please identify the determinands for observation boreholes (or attach a list):	801 & 805 determinand such as attached.

Q5. Springs

No. of springs:	24.
What is the frequency of the data receipt and review process for springs and how was this determined ?	frequency of data receipt - biannually. reviewed - annually.
Please identify the determinands for springs (or attach a list):	801 & 805 determinand suite.

Q6. Other Monitoring Locations

No. of other monitoring locations:	Water Quality data gained from test pumping samples Project Water Quality data.
What is the frequency of the data receipt and review process for these monitoring points and how was this determined ?	Test Pumping data taken as test pumping occurs.
Please identify the determinands for these monitoring points (or attach a list):	Usually 801 determinand suite.

The following questions are to obtain information regarding the data collection, storage and use.

Q7. Data Collection

Is the groundwater quality data obtained internally or externally ?	Internally
What and where are the external sources ?	N/A.
Does the determinand data collected have additional comment fields and what are these ?	The only other comment fields are units and a replacement for the determinand value if problems have occured e.g broken bottle.
What other environmental data are collected in parallel with groundwater quality data ?	Precipitation Temperature.
What QA/QC procedures are used to assess the quality of the groundwater monitoring data ?	None.

Q8. Data Storage

Are groundwater quality data on a single database or are a number of software packages used ?	Data can found found on 2 databases.
What other databases are you aware of for other data ? E.g. contaminated land, landfill, mineral water, private supplies.	contaminated land - access. Groundwater levels - hydrodat.
Where are these databases located and who has responsibility ? Please provide name, address and telephone number.	These databases are located on stand alone machines or on a specific group drive. Field data Services (Hydrodat) Olympia House, Leeds.

Q9. Data Use

Are groundwater quality data routinely manipulated, interpreted and displayed ?	We check the determinand values against drinking water quality standards. We would wish to do more interpretation but in its present form this would be very time consuming
On what scale is this done ? E.g. sub catchment, catchment or other.	On an aquifer basis.
What level of interpretation is performed ? E.g. trend analysis, comparison with quality standards etc.	We compare the data with drinking water quality standards. More analysis would be carried out if a more friendly system is in use.
Are the data used by other departments in the Agency or provided to industry / the public ?	We provide data to other departments, industry and the public.
In what format is this data provided ?	The data is usually sent as a hard copy.

The following questions relate to the software you use.

Q10.

What software do you currently use to store, analyse and present the data ? e.g. Excel, Lotus, Access, Approach, Oracle, Grapher, Statistica, SPSS, Surfer, Arcview, Arcinfo, Mapinfo, WIMS.

Program	Version	Main Uses						
		Storage	Statistics	Tables	Graphs	Contours	Mapping	Other please describe
ICL		✓						
CVAX		✓						

✓

Q11.

Is the software you have listed sufficient and suitable for your purposes, if not what are the problems ? e.g. difficult graphing, training required, poor technical support.	
Program ICL	Can not graph data or compare the quality of different samples. It is difficult to learn. The output quality is poor.
CVAX	Not user friendly. Stores data for only a short period.

Q12.

What additional software features would you like ? e.g. specific graphs or statistical capabilities.
Automatic comparison e.g to compare with drinking water standards.
Graphical capabilities
Contour plots
Statistics.

Q13.

Are you aware of any other software that would satisfy your requirements ?
No.

Q14.

Have you tested any software other than that you currently use and what was your conclusion ?
No.

Thank you for completing this questionnaire. Please return the completed document by post or by fax to Mark Vanstone at GIBB Ltd.

GIBB Ltd,
Environmental Division,
GIBB House,
London Road,
Reading,
Berkshire RG6 1BL

Fax 0118 963 5290
Tel 0118 963 5000

	A	B	C
58	802	67341	XYLENE ORTHO
59	802	73771	SELENIUM filt
60	802	73791	SELENIUM total
61	802	92601	ARSENIC filtered (PLASMA)
62	802	92611	ARSENIC total (PLASMA)
63	802	92641	CADMIUM filtered
64	802	92651	CADMIUM total
65	802	95191	1,2-DICHLOROETHANE
66	802	95381	1,1-DICHLOROETHENE
67	802	95421	ETHYLBENZENE
68	802	95511	BORON total
69	802	95521	BORON filtered
70	802	95591	COPPER total
71	802	95601	COPPER filtered
72	802	95611	ZINC total
73	802	95621	ZINC filtered
74	802	95631	STRONTIUM total
75	802	95641	STRONTIUM filtered
76	802	95771	CHROMIUM filtered
77	802	95801	MANGANESE total
78	802	95811	MANGANESE filtered
79	802	95821	IRON total
80	802	95831	IRON filtered
81	802	95861	NICKEL total
82	802	95871	NICKEL filtered
83	802	97731	BENZENE
84	802	97741	NAPHTHALENE
85	802	97751	1,1,2-TRICHLOROTRIFLUORETHANE
86	802	97781	1,4-DICHLOROBENZENE
87	802	98691	CARBON TETRACHLORIDE
88	802	99171	1,1,1-TRICHLOROETHANE
89	802	99181	TETRACHLOROETHYLENE
90	802	99191	TRICHLOROETHYLENE
91	805	00501	LEAD total
92	805	00521	LEAD filtered
93	805	00611	pH
94	805	00771	CONDUCTIVITY 25C
95	805	01051	MERCURY total
96	805	01111	NITROGEN AMMONIACAL
97	805	01161	NITROGEN TOTAL OXIDISED
98	805	01181	NITRITE
99	805	01621	ALKALINITY pH 4.5
100	805	01721	CHLORIDE
101	805	01751	CYANIDE TOTAL
102	805	01771	FLUORIDE DISS.
103	805	01801	O-PHOSPHATE
104	805	01831	SULPHATE
105	805	02071	SODIUM total
106	805	02111	POTASSIUM total
107	805	02371	MAGNESIUM total
108	805	02411	CALCIUM total
109	805	04991	HCH-g
110	805	07231	DIAZINON
111	805	08161	CHLOROFORM
112	805	08171	BROMODICHLOROMETH
113	805	08181	BROMOFORM
114	805	08191	DIBROMOCHLOROMETH

5 te

	A	B	C
115	805	10851	PENTACHLOROPHENOL
116	805	60981	BROMOXYNIL
117	805	61091	TOLUENE
118	805	61591	CHLORFENVINPHOS
119	805	61631	ETHYLENE GLYCOL
120	805	62291	2,5-DIMETHYLPHENOL
121	805	64781	METHYLtBUTYLETHER
122	805	66571	BROMIDE
123	805	66781	GLYPHOSATE
124	805	67001	OIL (IR)
125	805	67331	XYLENE (M+P)
126	805	67341	XYLENE ORTHO
127	805	67621	TRICLOPYR
128	805	67631	DICAMBA
129	805	73771	SELENIUM filt
130	805	73791	SELENIUM total
131	805	90701	DIURON
132	805	92601	ARSENIC filtered (PLASMA)
133	805	92611	ARSENIC total (PLASMA)
134	805	92641	CADMIUM filtered
135	805	92651	CADMIUM total
136	805	92781	ASULAM
137	805	93221	MCPP (MECOPROP)
138	805	93231	MCPA
139	805	93241	MCPB
140	805	93281	2,4,6-TRICHLOROPHENOL
141	805	93421	2,4-DICHLOROPHENOXYACETIC ACID
142	805	93701	FLUORANTHENE
143	805	93711	BENZ-[ghi]-PERYLENE
144	805	93721	BENZ-[k]-FLUORANTHENE
145	805	93731	INDENO-(1,2,3-cd)-PYRENE
146	805	93741	BENZ-[b]-FLUORANTHENE
147	805	93751	BENZ[a]PYRENE
148	805	93791	SIMAZINE
149	805	93811	TRIFLURALIN
150	805	93831	ATRAZINE
151	805	93911	PROPETAMPHOS
152	805	93931	CHLORTOLURON
153	805	93941	ISOPROTURON
154	805	93951	LINURON
155	805	94711	PHENOL GC
156	805	94721	oCRESOL
157	805	94731	mCRESOL
158	805	94741	pCRESOL
159	805	94751	2-CHLOROPHENOL
160	805	94761	4-CHLOROPHENOL
161	805	94771	2,4-DICHLOROPHENOL
162	805	94951	3-CHLOROPHENOL
163	805	95191	1,2-DICHLOROETHANE
164	805	95421	ETHYLBENZENE
165	805	95511	BORON total
166	805	95521	BORON filtered
167	805	95591	COPPER total
168	805	95601	COPPER filtered
169	805	95611	ZINC total
170	805	95621	ZINC filtered
171	805	95631	STRONTIUM total

	A	B	C
172	805	95641	STRONTIUM filtered
173	805	95761	CHROMIUM total
174	805	95771	CHROMIUM filtered
175	805	95801	MANGANESE total
176	805	95811	MANGANESE filtered
177	805	95821	IRON total
178	805	95831	IRON filtered
179	805	95861	NICKEL total
180	805	95871	NICKEL filtered
181	805	97731	BENZENE
182	805	98691	CARBON TETRACHLORIDE
183	805	99171	1,1,1-TRICHLOROETHANE
184	805	99181	TETRACHLOROETHYLENE
185	805	99191	TRICHLOROETHYLENE
186	808	00501	LEAD total
187	808	00521	LEAD filtered
188	808	00611	pH
189	808	00771	CONDUCTIVITY 25C
190	808	00911	COD SETTLED
191	808	00991	TOTAL ORGANIC CARBON
192	808	01111	NITROGEN AMMONIACAL
193	808	01161	NITROGEN TOTAL OXIDISED
194	808	01181	NITRITE
195	808	01351	SOLIDS PARTICULATE 105C
196	808	01621	ALKALINITY pH 4.5
197	808	01721	CHLORIDE
198	808	01771	FLUORIDE DISS.
199	808	01801	O-PHOSPHATE
200	808	01831	SULPHATE
201	808	02071	SODIUM total
202	808	02111	POTASSIUM total
203	808	02371	MAGNESIUM total
204	808	02411	CALCIUM total
205	808	04831	ALDRIN
206	808	04871	HCH-a
207	808	04911	HCH-BETA
208	808	04991	HCH-g
209	808	05071	DICHLORVOS
210	808	05111	DIELDRIN
211	808	05351	MALATHION
212	808	05391	DDT-OP
213	808	05511	DDE-PP
214	808	05551	DDT-PP
215	808	05591	TDE-PP
216	808	05611	2,4,5-TRICHLOROPHENOXYACETIC ACID
217	808	05621	ENDRIN
218	808	05761	HEXACHLOROBENZENE
219	808	07231	DIAZINON
220	808	08161	CHLOROFORM
221	808	08171	BROMODICHLOROMETH
222	808	08181	BROMOFORM
223	808	08191	DIBROMOCHLOROMETH
224	808	60941	2,4-DICHLOROPHENOXYBUTYRIC ACID
225	808	60971	4-CHLOROPHENOXYACETIC ACID
226	808	60981	BROMOXYNIL
227	808	61001	2,4-DICHLOROPHENOXYPROPIONIC ACID
228	808	61011	2,6-DINITROBUTYLPHENOL

801 SUITE

	A	B
1	Det	Name
2	00061	DEPTH (METRES)
3	00611	pH
4	00761	TEMPERATURE
5	00771	CONDUCTIVITY 25C
6	01111	NITROGEN AMMONIACAL
7	01161	NITROGEN TOTAL OXIDISED
8	01181	NITRITE
9	01621	ALKALINITY pH 4.5
10	01721	CHLORIDE
11	01831	SULPHATE
12	02071	SODIUM total
13	02111	POTASSIUM total
14	02371	MAGNESIUM total
15	02411	CALCIUM total
16	95801	MANGANESE total
17	95811	MANGANESE filtered
18	95821	IRON total
19	95831	IRON filtered

Processing and Presentation of Groundwater Quality Data

Questionnaire Responses - Environment Agency,

Thames Region

Sheena Engineer : Team Leader, Scientific Support - West Area

Carla Sealey : Team Leader, Scientific Support - North East Area

M.J. Hoare : Team Leader, Scientific Support - South East Area

Ian Davey : Regional Scientist, Groundwater Quality

VMW 2/7/98

GIBB Environmental
LAWGIBB Group Member

QUESTIONNAIRE: Groundwater Quality Data Software

GIBB Ltd. have been contracted by the Agency to assess the Agency's requirements regarding the storage and display of groundwater quality data. This questionnaire forms part of our assessment and we will be grateful for your responses to the questions outlined below.

If you have any queries please contact Mark Vanstone or Tim Morgan at GIBB Ltd. on 0118-9635000, or by Email at mvanston@gibb.co.uk or tmorgan@gibb.co.uk.

The following questions are to obtain general details.

Q1.

Please provide the following reference details.			
Name:	SHEENA ENGINEER		
Position:	TEAM LEADER SCIENTIFIC SUPPORT	**Region:**	THAMES REGION WEST AREA
Tel No.:	01491 828375	**Fax No.:**	
E-mail:			

Q2.

Please provide details of other Agency staff who may be able to provide input to this project.			
Name:	DAVE HYBERT		
Position:	SCIENTIFIC SUPPORT OFFICER	**Region:**	THAMES WEST AREA
Tel No.:	01491 82 8365	**Fax No.:**	
E-mail:			
Name:	SALLY COBLE		
Position:	TEAM LEADER SCIENTIFIC INVESTIGATIONS	**Region:**	THAMES. WEST AREA
Tel No.:	01491 828442	**Fax No.:**	01491 828439
Position:			
E-mail:	Sally Coble @ environment - agency . gov . UK		

The following questions are to establish how much groundwater quality monitoring data your office typically handles annually.

Q3. Public Water Supply Wells

No. of public water supply wells:	see Regional return
What is the frequency of the data receipt and review process for public water supply wells and how was this determined ?	
Please identify the determinands for public water supply wells (or attach a list):	

Q4. Observation Boreholes

No. of observation boreholes:	" "
What is the frequency of the data receipt and review process for observation boreholes and how was this determined ?	
Please identify the determinands for observation boreholes (or attach a list):	

Q5. Springs

No. of springs:	see Regional return
What is the frequency of the data receipt and review process for springs and how was this determined ?	
Please identify the determinands for springs (or attach a list):	

Q6. Other Monitoring Locations

No. of other monitoring locations:	approx 70 LFS Harwell
What is the frequency of the data receipt and review process for these monitoring points and how was this determined ?	operator supplied for LFS
Please identify the determinands for these monitoring points (or attach a list):	as required by WMP4. Harwell . TCA TCE PCE CT chloroform. bromoform

The following questions are to obtain information regarding the data collection, storage and use.

Q7. Data Collection

Is the groundwater quality data obtained internally or externally ?	internally (Harwell) externally (LFS operators)
What and where are the external sources ?	
Does the determinand data collected have additional comment fields and what are these ?	
What other environmental data are collected in parallel with groundwater quality data ?	LFS data, leachate quality & levels
What QA/QC procedures are used to assess the quality of the groundwater monitoring data ?	WMP4 requires accredited lab.

Q8. Data Storage

Are groundwater quality data on a single database or are a number of software packages used ?	No
What other databases are you aware of for other data ? E.g. contaminated land, landfill, mineral water, private supplies.	Thames - West area lf monitoring database
Where are these databases located and who has responsibility ? Please provide name, address and telephone number.	Wallingford Office contact Sally Coble

Q9. Data Use

Are groundwater quality data routinely manipulated, interpreted and displayed ?	yes
On what scale is this done ? E.g. sub catchment, catchment or other.	by lf site Harwell
What level of interpretation is performed ? E.g. trend analysis, comparison with quality standards etc.	trend analysis completion criteria
Are the data used by other departments in the Agency or provided to industry / the public ?	public access
In what format is this data provided ?	raw data graphs statistics

The following questions relate to the software you use.

Q10.

What software do you currently use to store, analyse and present the data ? e.g. Excel, Lotus, Access, Approach, Oracle, Grapher, Statistica, SPSS, Surfer, Arcview, Arcinfo, Mapinfo, WIMS.

Program	Version	Main Uses						
		Storage	Statistics	Tables	Graphs	Contours	Mapping	Other please describe
Access		✓						
MapInfo							✓	
Surfer						✓		
Excel					✓			

Q11.

Is the software you have listed sufficient and suitable for your purposes, if not what are the problems ? e.g. difficult graphing, training required, poor technical support.	
Program	
MapInfo Surfer	training required

Q12.

What additional software features would you like ? e.g. specific graphs or statistical capabilities.

Q13.

Are you aware of any other software that would satisfy your requirements ?

Q14.

Have you tested any software other than that you currently use and what was your conclusion ?

Thank you for completing this questionnaire. Please return the completed document by post or by fax to Mark Vanstone at GIBB Ltd.

GIBB Ltd,
Environmental Division,
GIBB House,
London Road,
Reading,
Berkshire RG6 1BL

Fax 0118 963 5290
Tel 0118 963 5000

/ WW 2/11/98

GIBB Environmental
LAWGIBB Group Member

QUESTIONNAIRE: Groundwater Quality Data Software

GIBB Ltd. have been contracted by the Agency to assess the Agency's requirements regarding the storage and display of groundwater quality data. This questionnaire forms part of our assessment and we will be grateful for your responses to the questions outlined below.

If you have any queries please contact Mark Vanstone or Tim Morgan at GIBB Ltd. on 0118-9635000, or by Email at mvanston@gibb.co.uk or tmorgan@gibb.co.uk.

The following questions are to obtain general details.

Q1.

Please provide the following reference details.			
Name:	CARLA SEALEY		
Position:	TEAM LEADER. SCIENTIFIC SUPPORT	**Region:**	THAMES REGION NORTH - EAST AREA
Tel No.:	01707 632450.	**Fax No.:**	
E-mail:			

Q2.

Please provide details of other Agency staff who may be able to provide input to this project.			
Name:	NICKY ~~[illegible]~~ INGREY		
Position:	TEAM LEADER. SCIENTIFIC INVESTIGATIONS	**Region:**	THAMES REGION NORTH - EAST AREA.
Tel No.:	01707 632436	**Fax No.:**	
E-mail:			
Name:			
Position:		**Region:**	
Tel No.:		**Fax No.:**	
Position:			
E-mail:			

The following questions are to establish how much groundwater quality monitoring data your office typically handles annually.

Q3. Public Water Supply Wells

No. of public water supply wells:	see Regional return
What is the frequency of the data receipt and review process for public water supply wells and how was this determined ?	
Please identify the determinands for public water supply wells (or attach a list):	

Q4. Observation Boreholes

No. of observation boreholes:	
What is the frequency of the data receipt and review process for observation boreholes and how was this determined ?	
Please identify the determinands for observation boreholes (or attach a list):	

Q5. Springs

No. of springs:	see Regional return
What is the frequency of the data receipt and review process for springs and how was this determined ?	
Please identify the determinands for springs (or attach a list):	

Q6. Other Monitoring Locations

No. of other monitoring locations:	250 - 280 landfill groundwater monitoring points.
What is the frequency of the data receipt and review process for these monitoring points and how was this determined ?	Supplied by operator in accordance with WMP4
Please identify the determinands for these monitoring points (or attach a list):	WMP4 requirements

The following questions are to obtain information regarding the data collection, storage and use.

Q7. Data Collection

Is the groundwater quality data obtained internally or externally ?	both, externally supplied internally collected
What and where are the external sources ?	landfill site operators contaminated land clean-up consultants & contractors.
Does the determinand data collected have additional comment fields and what are these ?	
What other environmental data are collected in parallel with groundwater quality data ?	
What QA/QC procedures are used to assess the quality of the groundwater monitoring data ?	

Q8. Data Storage

Are groundwater quality data on a single database or are a number of software packages used ?	data stored on Thames Archive or Access databases.
What other databases are you aware of for other data ? E.g. contaminated land, landfill, mineral water, private supplies.	
Where are these databases located and who has responsibility ? Please provide name, address and telephone number.	

The following questions relate to the software you use.

Q10.

What software do you currently use to store, analyse and present the data ? e.g. Excel, Lotus, Access, Approach, Oracle, Grapher, Statistica, SPSS, Surfer, Arcview, Arcinfo, Mapinfo, WIMS.

Program	Version	Main Uses						
		Storage	Statistics	Tables	Graphs	Contours	Mapping	Other please describe
Access		✓		✓				
Excel			✓	✓				
Surfer					✓			
MapInfo							✓	

Q9. Data Use

Are groundwater quality data routinely manipulated, interpreted and displayed ?	GWQ network - regional function. area function looks at site specific cont. land & LFS type issues.
On what scale is this done ? E.g. sub catchment, catchment or other.	by landfill or point source site
What level of interpretation is performed ? E.g. trend analysis, comparison with quality standards etc.	
Are the data used by other departments in the Agency or provided to industry / the public ?	
In what format is this data provided ?	

Q11.

Is the software you have listed sufficient and suitable for your purposes, if not what are the problems ? e.g. difficult graphing, training required, poor technical support.	
Program	Insufficient software for manipulating data in monitoring team. Would like a package like hydrodat for piper diagrams and a 3D/x-section type database.
surfer	no-one has been trained to use it properly, put to poor useage.

Q12.

What additional software features would you like ? e.g. specific graphs or statistical capabilities.
piper diagrams, geochemistry, 3D plume monitoring
x-sectional diagrams of geology

Q13.

Are you aware of any other software that would satisfy your requirements ?

Q14.

Have you tested any software other than that you currently use and what was your conclusion ?

Thank you for completing this questionnaire. Please return the completed document by post or by fax to Mark Vanstone at GIBB Ltd.

GIBB Ltd,
Environmental Division,
GIBB House,
London Road,
Reading,
Berkshire RG6 1BL

Fax 0118 963 5290
Tel 0118 963 5000

√ MW 2/7/98

GIBB Environmental
LAWGIBB Group Member

QUESTIONNAIRE: Groundwater Quality Data Software

GIBB Ltd. have been contracted by the Agency to assess the Agency's requirements regarding the storage and display of groundwater quality data. This questionnaire forms part of our assessment and we will be grateful for your responses to the questions outlined below.

If you have any queries please contact Mark Vanstone or Tim Morgan at GIBB Ltd. on 0118-9635000, or by Email at mvanston@gibb.co.uk or tmorgan@gibb.co.uk.

The following questions are to obtain general details.

Q1.

Please provide the following reference details.			
Name:	M. J. HOARE		
Position:	T. L. (SCIENTIFIC SUPPORT)	**Region:**	THAMES (S.E. AREA)
Tel No.:	0181 - 310 - 5500.	**Fax No.:**	0181 - 311 - 9778
E-mail:			

Q2.

Please provide details of other Agency staff who may be able to provide input to this project.			
Name:	KATHARINE MANSON.		
Position:	S. S. OFFICER.	**Region:**	THAMES (S.E. AREA).
Tel No.:		**Fax No.:**	
E-mail:			
Name:	ANDREA SZABADOS.		
Position:	S. S. OFFICER	**Region:**	THAMES (S.E. AREA).
Tel No.:	01483 577655.	**Fax No.:**	
Position:			
E-mail:			

The following questions are to establish how much groundwater quality monitoring data your office typically handles annually.

Q3. Public Water Supply Wells

No. of public water supply wells:	
What is the frequency of the data receipt and review process for public water supply wells and how was this determined ?	
Please identify the determinands for public water supply wells (or attach a list):	

Q4. Observation Boreholes

No. of observation boreholes:	THREE (HOGSBACK, SURREY)
What is the frequency of the data receipt and review process for observation boreholes and how was this determined ?	SIX MONTHLY; SAMPLES OBTAINED BY OUR OWN STAFF. DATA AUDITED ANNUALLY.
Please identify the determinands for observation boreholes (or attach a list):	pH, Cond, Toc, NH_3, TON, NO_2, Cl, SO_4, PO_4, Hardness, Alkalinity ($CaCO_3$), Anion (Cat. balance. Ca (diss); Mg (diss) Na (diss) K (diss), Mn (diss), Fe (diss), Fl; Boron.

Q5. Springs

No. of springs:	
What is the frequency of the data receipt and review process for springs and how was this determined ?	
Please identify the determinands for springs (or attach a list):	

Q6. Other Monitoring Locations

No. of other monitoring locations:	40 LANDFILLS, wide range in no of monitoring pts from 2 to 60
What is the frequency of the data receipt and review process for these monitoring points and how was this determined ?	Data received monthly, quarterly 6-monthly and yearly. Review process is ad hoc at present determined by problems on site or requirements of waste licensing team.
Please identify the determinands for these monitoring points (or attach a list):	See attached list but determinands vary from site to site. Attached list is collated from all the landfills and does not represent what each landfill site monitors for in groundwater.

The following questions are to obtain information regarding the data collection, storage and use.

Q7. Data Collection

Is the groundwater quality data obtained internally or externally ?	Both
What and where are the external sources ?	Landfill site operators.
Does the determinand data collected have additional comment fields and what are these ?	Yes eg - equipment used - general comments - location description - Laboratory - "Taken By"
What other environmental data are collected in parallel with groundwater quality data ?	1) Landfill Gas 2) Dust 3) Asbestos Fibres 4) Noise 5) Leachate Quality 6) Leachate Levels 7) Groundwater Levels
What QA/QC procedures are used to assess the quality of the groundwater monitoring data ?	1) Audit sampling by consultants employed by the Agency 2) Inspecting officers sometimes accompany an operators consultants when doing monitoring

Q8. Data Storage

Is Are groundwater quality data on a single database or are a number of software packages used ?	Excell 5 Spreadsheets. Lotus Spreadsheets
What other databases are you aware of for other data ? E.g. contaminated land, landfill, mineral water, private supplies.	WIMS
Where are these databases located and who has responsibility ? Please provide name, address and telephone number.	Highway House, 21. Chessington Road. W. Ewell, Surrey KT17 1TT Scientific Support Team. Mr. M. Hoare 0181-310-5500 Dr K Marsh 0181-786-7551

Q9. Data Use

Are groundwater quality data routinely manipulated, interpreted and displayed ?	Yes.
On what scale is this done ? E.g. sub catchment, catchment or other.	- usually only on a site (landfill) basis. but we have a series of landfills along the Hogsback (sub catchment) where we are beginning to look at the area as a whole.
What level of interpretation is performed ? E.g. trend analysis, comparison with quality standards etc.	- time series graphs to assess trends. - comparison with background quality - comparison of operators vs. Environment Agency Data.
Are the data used by other departments in the Agency or provided to industry / the public ?	Data has been provided to other operators and to members of the public. There has been no significant demand from other departments in the Agency apart from operational teams.
In what format is this data provided ?	- Paper - Disk — Excel 5 spreadsheet Lotus Spreadsheet

The following questions relate to the software you use.

Q10.

What software do you currently use to store, analyse and present the data ? e.g. Excel, Lotus, Access, Approach, Oracle, Grapher, Statistica, SPSS, Surfer, Arcview, Arcinfo, Mapinfo, WIMS.

Program	Version	Main Uses						
		Storage	Statistics	Tables	Graphs	Contours	Mapping	Other please describe
Excell	5	✓		✓	✓			
Lotus	3+4	✓		✓	✓			

Q11.

Is the software you have listed sufficient and suitable for your purposes, if not what are the problems ? e.g. difficult graphing, training required, poor technical support.	
Program Excell	1) Poor Technical Support 2) Individual spreadsheets can become slow to use as amount of data accumulates
Excell cartin	3) Allowing access to data but protecting data from alteration / deletion.
Excell cartin.	4) Insufficient training to use the more advanced features of this software
Excell cartin-	5) Excell will not accept "less than" e.g. < and "more than" > and still treat numbers as numbers. It treats nos prefixed by > & < as text

Q12.

What additional software features would you like ? e.g. specific graphs or statistical capabilities.
① Better more efficient storage for data (we have been looking at using MICROSOFT ACCESS)
② Contouring Package - for water levels etc.
③ Capability of plotting data onto Landfill site Plan
④ Automatic reporting facility whereby high gas conc. for example are highlighted and report generated to be sent to landfill operator or to operational teams.
⑤ Automatic procedures to produce regular reports for regular review of data

Q13.

Are you aware of any other software that would satisfy your requirements ?
"Monitor Pro" produced by Geo Services

Q14.

Have you tested any software other than that you currently use and what was your conclusion ?
We have one copy of 'MONITOR PRO' but it
has not been used sufficiently to give
any definite views on its suitability

Thank you for completing this questionnaire. Please return the completed document by post or by fax to Mark Vanstone at GIBB Ltd.

GIBB Ltd,
Environmental Division,
GIBB House,
London Road,
Reading,
Berkshire RG6 1BL

Fax 0118 963 5290
Tel 0118 963 5000

TempC		HCH-alpha
pH		HCH-beta
ECS/cm		HCH-gamma
SuspSolmg/l		Trifluralin
NH3-N		Endosulphanalpha
NH4N		Triallate
Cl		Tecnazene
SO4		1,2,4 Trichlorobenzene
TOTALK CaCO3		Malathion
Hardness CaC03		Fenitrothion
BOD		Dichlorvos
COD		Mevinphos
~~TOC~~		Azinphos-methyl
N02N		1,2 Dichloroethane
NO3N		1,2 Dichlorobenzene
TON	Most Frequent	Benzene
TOC		Chlorobenzene
Na	Determinands	1,4 Dichlorobenzene
K		Heptachlor-Epoxide
Ca		Chlordane Alpha
Mg		Chlordane gamma
Fe		Dichlobenil
Mn		Triphenyltin
As		Tributyltin
Cd		Triazophos
Cr		Phorate
Cu		Propetamphos
Ni		Pirimiphos-methyl
Pb		Fenthion
Zn		Dimethoate
Hg		Diazinon
ionic bal		Parathion-methyl
CN		Parathion-ethyl
phenol		Disulphoton
Toluene		Chlorfenvinphos
Xylene		Carbophenothion
1,2,4 Trimethylbenzene		Chloroethene
1,3,5 Trimethylbenzene		Chloroethane
o,p'DDT		1,1 Dichloroethene
p,pDDT		1,1 Dichloroethane
o,pDDE		cis 1,2 Dichloroethene
p,pDDE		Trichloroethene
o,pTDE		Trichloromethane
p,pTDE		Iso-butyric acid
Hexachlorobenzene		N-butyric acid
Hexachlorobutadiene		Iso-valeric acid
Aldrin		N-valeric acid
Dieldrin		Propionic acid
Endrin		Acetic acid
Isodrin		TVA

Done MW 2/7/98

GIBB Environmental
LAWGIBB Group Member

QUESTIONNAIRE: Groundwater Quality Data Software

GIBB Ltd. have been contracted by the Agency to assess the Agency's requirements regarding the storage and display of groundwater quality data. This questionnaire forms part of our assessment and we will be grateful for your responses to the questions outlined below.

If you have any queries please contact Mark Vanstone or Tim Morgan at GIBB Ltd. on 0118-9635000, or by Email at mvanston@gibb.co.uk or tmorgan@gibb.co.uk.

The following questions are to obtain general details.

Q1.

Please provide the following reference details.			
Name:	IAN DAVEY		
Position:	REGIONAL SCIENTIST GWQ.	**Region:**	THAMES REGION
Tel No.:	0118 953 5404	**Fax No.:**	0118 953 5106.
E-mail:			

Q2.

Please provide details of other Agency staff who may be able to provide input to this project.			
Name:	KATHLEEN MASON		
Position:	SENIOR SCIENTIST. GWQ	**Region:**	THAMES REGION
Tel No.:	0118 953 5430	**Fax No.:**	0118 953 5106.
E-mail:			
Name:			
Position:		**Region:**	
Tel No.:		**Fax No.:**	
Position:			
E-mail:			

The following questions are to establish how much groundwater quality monitoring data your office typically handles annually.

Q3. Public Water Supply Wells

No. of public water supply wells:	290 TWUL 147 3V 79 MS = 30 Wes = 1 SUTTON = 12 ES = 11 ESS = 5 NS = 5	total monitoring points.
What is the frequency of the data receipt and review process for public water supply wells and how was this determined ?	4 x p.a.	
Please identify the determinands for public water supply wells (or attach a list):	G2 G4 suites (copy attached)	

Q4. Observation Boreholes

No. of observation boreholes:	187 (identified as OBH on archive)
What is the frequency of the data receipt and review process for observation boreholes and how was this determined ?	ad hoc
Please identify the determinands for observation boreholes (or attach a list):	not specified

Q5. Springs

No. of springs:	67 (including network & NSA)
What is the frequency of the data receipt and review process for springs and how was this determined ?	4 x p.a.
Please identify the determinands for springs (or attach a list):	G2 G4 NSA = TON, Amm., Cl⁻

Q6. Other Monitoring Locations

No. of other monitoring locations:	169 privately owned network sites 11 NSA points (excluding springs)
What is the frequency of the data receipt and review process for these monitoring points and how was this determined ?	4 x p.a.
Please identify the determinands for these monitoring points (or attach a list):	G2 G4 NSA

The following questions are to obtain information regarding the data collection, storage and use.

Q7. Data Collection

Is the groundwater quality data obtained internally or externally ?	both, TWUL supply all. other WCs part supplied, part Agency samples. private all Agency samples
What and where are the external sources ?	Thames Water (TWUL)
Does the determinand data collected have additional comment fields and what are these ?	DWI format as standard has comments field, not generally used
What other environmental data are collected in parallel with groundwater quality data ?	NSA sites - rest water levels
What QA/QC procedures are used to assess the quality of the groundwater monitoring data ?	Nat. Lab Service TW - NAMAS accredited

Q8. Data Storage

Are groundwater quality data on a single database or are a number of software packages used ?	all data stored on Archive - downloaded manipulate using packages.
What other databases are you aware of for other data ? E.g. contaminated land, landfill, mineral water, private supplies.	private supplies held by DC' EHO's
Where are these databases located and who has responsibility ? Please provide name, address and telephone number.	

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Q9. Data Use

Are groundwater quality data routinely manipulated, interpreted and displayed ?	yes
On what scale is this done ? E.g. sub catchment, catchment or other.	major aquifers by catchment (will be extended to minor aquifers)
What level of interpretation is performed ? E.g. trend analysis, comparison with quality standards etc.	pollution trends for solvents, nitrates pesticides, data for NVZ & NSA review of data for aquifer over a networked area.
Are the data used by other departments in the Agency or provided to industry / the public ?	public data access.
In what format is this data provided ?	reports on GWQ solvents nitrates pesticides } paper data (raw available as print out from customer services)

The following questions relate to the software you use.

Q10.

What software do you currently use to store, analyse and present the data ? e.g. Excel, Lotus, Access, Approach, Oracle, Grapher, Statistica, SPSS, Surfer, Arcview, Arcinfo, Mapinfo, WIMS.

Program	Version	Main Uses						
		Storage	Statistics	Tables	Graphs	Contours	Mapping	Other please describe
Access		✓	✓	✓				
Hydrodat		✓			✓			piper diags.
Freelance							✓	
MapInfo							✓	
Lotus 123			✓	✓				
Boreholes, wells & Springs	DBase	✓						
Archive		✓						

Q11.

Is the software you have listed sufficient and suitable for your purposes, if not what are the problems ? e.g. difficult graphing, training required, poor technical support.	
Program Archive	Change to WIMS, not sure how this will affect data transfer to Hydrodat. Cumbersome programme for printing out data to send to network site owners.
Boreholes, Wells & Springs	DBase package may not be supported following harmonisation

Q12.

What additional software features would you like ? e.g. specific graphs or statistical capabilities.
An OS base GIS system over which GPZs, vulnerability zones
NSA, NVZ, network points, pollution sources (if controlled)
can be overlaid for risk assessment purposes.

Q13.

Are you aware of any other software that would satisfy your requirements ?

Q14.

Have you tested any software other than that you currently use and what was your conclusion ?

Thank you for completing this questionnaire. Please return the completed document by post or by fax to Mark Vanstone at GIBB Ltd.

GIBB Ltd,
Environmental Division,
GIBB House,
London Road,
Reading,
Berkshire RG6 1BL

Fax 0118 963 5290
Tel 0118 963 5000

G2/G4 suite for network 08/06/98

Drinking water inspectorate com

Determinand	Units	Agency	DWI c	Suite
Hardness (Total as CaCO3)	mg/l	26	N041	G2
Orthophosphate (as P)	mg/l	22	N019	G2
Nitrite (as N)	mg/l N	18	N042	G2
Nitrate (as N)	mg/l N	76	N043	G2
Manganese (total)	ug/l	7403	A023	G2
Manganese (dissolved)	ug/l	7401	N016	G2
Magnesium (dissolved)	mg/l	288	N015	G2
Iron (dissolved)	ug/l	7419	N013	G2
Potassium (dissolved)	mg/l	290	N020	G2
Hydrogen Ion (pH) (lab)		1	A006	G2
Iron (total)	ug/l	7421	A022	G2
Fluoride	ug/l	9177	A027	G2
Conductivity (lab)	us/cm	2	D001	G2
Chloride as Cl (lab)	mg/l	19	D002	G2
Cations	mequiv/l	151		G2
Calcium (dissolved)	mg/l	206	N006	G2
Boron (dissolved)	ug/l	9284	N004	G2
Anions	mequiv/l	150		G2
Ammoniacal nitrogen (as N)(lab)	mg/l	15	N039	G2
Alkalinity (as CaCO3)	mg/l	27	N001	G2
Ionic Balance	%	152		G2
Sodium (dissolved)	mg/l	289	N022	G2
Temperature (field)	'C	12	A005	G2
Total oxidised nitrogen (as N)	mg/l	17	N040	G2
Total Organic Carbon	mg/l C	11	A017	G2
Sulphate as SO4	mg/l SO4	20	A007	G2
Dibromochloromethane	ug/l	7057	D11C	G4
Tribromomethane (Bromoform)	ug/l	7009	D11D	G4
Copper (dissolved)	ug/l	7213	N009	G4
Copper (total)	ug/l	7215	A024	G4
Cyanazine	ug/l	9852	P092	G4
Chromium (total)	ug/l	7375	B004	G4
Diazinon	ug/l	7114	P024	G4
Chromium (dissolved)	ug/l	7373	N007	G4
Dicamba	ug/l	7910	P025	G4
Dichlorobromomethane (Bromodichloromet	ug/l	7010	D11B	G4
Dichlorprop	ug/l	9848	P026	G4
Dieldrin	ug/l	84	P028	G4
Dissolved Hydrocarbons (EnvAge method)	ug/l	9615	N035	G4
Isoproturon	ug/l	7950	P048	G4
Dissolved oxygen (field)	mg/l	13	N010	G4
Cyanide (total)	mg/l	54		G4
Trietazine	ug/l	9814	P132	G4
2,4-D	ug/l	7983	P020	G4
2,4-DB	ug/l	9851	P082	G4
Zinc (dissolved)	ug/l	7243	N024	G4
Xylene (total)	ug/l	7778	N034	G4
Trifluralin	ug/l	7103	P081	G4
Atrazine	ug/l	9801	P004	G4
Clopyralid	ug/l	9853	P018	G4
Benzene	ug/l	7780	N025	G4
Dissolved oxygen (field)	% sat.	14	N011	G4
Bromide	mg/l	60	N026	G4
Cadmium (dissolved)	ug/l	9106	N005	G4
Cadmium (total)	ug/l	9108	B002	G4
Triclopyr	ug/l	9816	P131	G4
Trichloromethane (Chloroform)	ug/l	7008	D11A	G4
Chlorfenvinphos	ug/l	7115	P013	G4
Trichloroethene	ug/l	9795	D009	G4
Chlorothalonil	ug/l	9857	P015	G4
Chlorotoluron	ug/l	7945	P014	G4
Bentazone	ug/l	9863	P006	G4
Permethrin-trans	ug/l	156	P121	G4
Methyl tertiary butyl ester (TBME/MTBE)	ug/l	164	Q018	G4
Diuron	ug/l	196	P032	G4

38
+65
103

P = pesticide

Determinand	Units	Agency	DWI c	Suite
Nickel (total)	ug/l	7429	B006	G4
Dissolved or Emulsified Hydrocarbons [WC]	ug/l	9616	A018	G4
Strontium (total)	mg/l	249	N030	G4
Mercury (total)	ug/l	45	B005	G4
Permethrin-cis	ug/l	155	P120	G4
Nickel (dissolved)	ug/l	7427	N018	G4
Phenols (total) (EnvAge method)	ug/l (calculati		N036	G4
Phenols (total) [WC]	ug/l	9979	A019	G4
Strontium (dissolved)	mg/l	43	N023	G4
Prometryn	ug/l	9804	P070	G4
Propazine	ug/l	9799	P066	G4
Propetamphos	ug/l	9898	P069	G4
Simazine	ug/l	9802	P073	G4
Permethrin	ug/l	130	P119	G4
Tetrachloromethane	ug/l	9049	D008	G4
Total Trihalomethanes [WC]	ug/l	7202	D011	G4
Fluroxypyr	ug/l	9839	P040	G4
Gamma-HCH (Lindane)	ug/l	82	P041	G4
Imazapyr	ug/l	9836	P160	G4
Tecnazene	ug/l	9806	P130	G4
1,1,1-trichlorethane	ug/l	7784	D100	G4
Mercury (dissolved)	ug/l	103	N017.	G4
Zinc (total)	ug/l	7245	A025	G4
Lead (dissolved)	ug/l	9052	N014	G4
Lead (total)	ug/l	9050	B007	G4
Linuron	ug/l	7965	P051	G4
Tetrachloroethene	ug/l	9793	D010	G4
Terbutryne	ug/l	129	P077	G4
MCPA	ug/l	7915	P054	G4
MCPB	ug/l	7920	P055	G4
MCPP (Mecoprop)	ug/l	7925	P053	G4
Toluene	ug/l	776	N033	G4
Phenol	ug/l	9988	Q001	G4*
O-Cresol	ug/l	9874	Q002	G4*
2-chlorophenol	ug/l	9092	Q004	G4*
2,5-dimethyl phenol	ug/l	7989	Q007	G4*
2,4-dichlorophenol	ug/l	7994	Q006	G4*
2,4,6-trichlorophenol	ug/l	7096	Q011	G4*

Processing and Presentation of Groundwater Quality Data

Questionnaire Responses - Environment Agency, Southern Region

Bob Barnes : Hampshire Groundwater Protection Officer

Felicity Standley : Groundwater Protection Officer

QUESTIONNAIRE: Groundwater Quality Data Software

GIBB Ltd. have been contracted by the Agency to assess the Agency's requirements regarding the storage and display of groundwater quality data. This questionnaire forms part of our assessment and we will be grateful for your responses to the questions outlined below.

If you have any queries please contact Mark Vanstone or Tim Morgan at GIBB Ltd. on 0118-9635000, or by Email at mvanston@gibb.co.uk or tmorgan@gibb.co.uk.

The following questions are to obtain general details.

Q1.

Please provide the following reference details.			
Name:	BOB BARNES		
Position:	HANTS GROUNDWATER PROTECTION OFFICER	**Region:**	SOUTHERN
Tel No.:	01962 860103	**Fax No.:**	01962 870216
E-mail:			

Q2.

Please provide details of other Agency staff who may be able to provide input to this project.			
Name:	MIKE NEIL		
Position:		**Region:**	AS ABOVE
Tel No.:	AS ABOVE	**Fax No.:**	AS ABOVE
E-mail:			
Name:	JOHN MILLIKEN		
Position:	TEAM LEADER ENVIRONMENTAL MONITORING	**Region:**	AS ABOVE
Tel No.:	AS ABOVE	**Fax No.:**	AS ABOVE
Position:			
E-mail:			

The following questions are to establish how much groundwater quality monitoring data your office typically handles annually.

Q3. Public Water Supply Wells

No. of public water supply wells:	30 HANTS 12 IOW.
What is the frequency of the data receipt and review process for public water supply wells and how was this determined ?	- ASK AT REGION (DICK FLAVIN)
Please identify the determinands for public water supply wells (or attach a list):	

Q4. Observation Boreholes - ASK MIKE NEIL (LANDFILL MONITORING)

No. of observation boreholes:	
What is the frequency of the data receipt and review process for observation boreholes and how was this determined ?	
Please identify the determinands for observation boreholes (or attach a list):	

Q5. Springs

No. of springs:	NOT MONITORED (BUT SEE BELOW)
What is the frequency of the data receipt and review process for springs and how was this determined ?	
Please identify the determinands for springs (or attach a list):	

Q6. Other Monitoring Locations

No. of other monitoring locations:	8 GROUNDWATER (1 SPRING)
What is the frequency of the data receipt and review process for these monitoring points and how was this determined ?	BI ANNUALLY.
Please identify the determinands for these monitoring points (or attach a list):	See locations list of determinands } attached

The following questions are to obtain information regarding the data collection, storage and use.

Q7. Data Collection

Is the groundwater quality data obtained internally or externally ?	BOTH
What and where are the external sources ?	WATER COS (a) WASTE MANAGEMENT LICENCED SITES (b)
Does the determinand data collected have additional comment fields and what are these ?	-TALK TO REGIONAL (a) -MIKE NEIL SHOULD KNOW (b)
What other environmental data are collected in parallel with groundwater quality data ?	GAS MONITORING AT WML SITES
What QA/QC procedures are used to assess the quality of the groundwater monitoring data ?	NAMAS + ACCREDITED ENVIRONMENTAL COMPANIES

Q8. Data Storage

Are groundwater quality data on a single database or are a number of software packages used ?	A NUMBER
What other databases are you aware of for other data ? E.g. contaminated land, landfill, mineral water, private supplies.	(1) MONITOR (2) WIMS (3) WATER CO ARCHIVE SYSTEM DATABASE
Where are these databases located and who has responsibility ? Please provide name, address and telephone number.	(1) WINCHESTER (PROTECTION-MONITORING) (2) SOUTHERN/ SOUTH WEST (TALK TO KEITH JURY AT GUILDBORNE HOUSE) (3) REGIONAL

Q9. Data Use

Are groundwater quality data routinely manipulated, interpreted and displayed ?	NO
On what scale is this done ? E.g. sub catchment, catchment or other.	INDIVIDUAL SOURCES
What level of interpretation is performed ? E.g. trend analysis, comparison with quality standards etc.	COMPARISON BEGINNING TO DO TREND ANALYSIS (LUCY ABBOTT - GW PROTECTION, WINCHESTER)
Are the data used by other departments in the Agency or provided to industry / the public ?	TO PUBLIC WHEN REQUESTED
In what format is this data provided ?	PAPER

The following questions relate to the software you use.

Q10.

What software do you currently use to store, analyse and present the data ? e.g. Excel, Lotus, Access, Approach, Oracle, Grapher, Statistica, SPSS, Surfer, Arcview, Arcinfo, Mapinfo, WIMS.

Program	Version	Main Uses						
		Storage	Statistics	Tables	Graphs	Contours	Mapping	Other please describe
WIMS		✓						
Excel	5.0	✓	✓		✓			
Monitor		✓						

Q11.

Is the software you have listed sufficient and suitable for your purposes, if not what are the problems ? e.g. difficult graphing, training required, poor technical support.	
Program	
WIMS	Training required / more experience
Excel	Fine - need to work out macros to get data from Monitor Database, automatic updates, easy graphing of latest data
	Limited statistical ability (may be my computer). (Lucy Abbott)

Q12.

What additional software features would you like ? e.g. specific graphs or statistical capabilities.
I'm looking at it currently - don't know the scope
of the work yet
All seems hard to link between too many
different packages. (Lucy Abbott)

Q13.

Are you aware of any other software that would satisfy your requirements ?
No

Q14.

Have you tested any software other than that you currently use and what was your conclusion ?
No.

Thank you for completing this questionnaire. Please return the completed document by post or by fax to Mark Vanstone at GIBB Ltd.

GIBB Ltd,
Environmental Division,
GIBB House,
London Road,
Reading,
Berkshire RG6 1BL

Fax 0118 963 5290
Tel 0118 963 5000

Summary of Samples between 01-jan-97 and 01-may-98

Sampling Point: 20003820 HOCKLEY HOUSE (GROUNDWATER)
Type: GROUNDWATER ABSTRACTION (GR) Grid Ref: SU5700027300

	Determinand	Unit	Maximum	Date of Max	Minimum	Date of Min	Mean	S.Dev	Count	<'s	Fail
0050	LEAD TOTAL	UG/L	2.00000	10-JUL-97 1015	2.00000	10-JUL-97 1015	1.00000	.00000	1	1	
0061	pH	PH UNITS	7.30000	10-JUL-97 1015	7.30000	10-JUL-97 1015	7.30000	.00000	1		
0062	CONDUCTIVITY	USIE/CM	527.00000	10-JUL-97 1015	527.00000	10-JUL-97 1015	527.00000	.00000	1		
0099	TOC	MG/L C	.50000	10-JUL-97 1015	.50000	10-JUL-97 1015	.25000	.00000	1	1	
0105	MERCURY	UG/L HG	.01000	10-JUL-97 1015	.01000	10-JUL-97 1015	.00500	.00000	1	1	
0108	CADMIUM	UG/L CD	.10000	10-JUL-97 1015	.10000	10-JUL-97 1015	.05000	.00000	1	1	
0111	AMMONIA - N	MG/L N	.03000	10-JUL-97 1015	.03000	10-JUL-97 1015	.01500	.00000	1	1	
0116	T.O.N	MG/L N	5.40000	10-JUL-97 1015	5.40000	10-JUL-97 1015	5.40000	.00000	1		
0117	NITRATE - N	MG/L N	5.40000	10-JUL-97 1015	5.40000	10-JUL-97 1015	5.40000	.00000	1		
0118	NITRITE - N	MG/L N	.00400	10-JUL-97 1015	.00400	10-JUL-97 1015	.00200	.00000	1	1	
0158	HARDNESS TOT	MG/L*	298.00000	10-JUL-97 1015	298.00000	10-JUL-97 1015	298.00000	.00000	1		
0162	ALK PH 4.5	MG/L*	268.00000	10-JUL-97 1015	268.00000	10-JUL-97 1015	268.00000	.00000	1		
0167	SULPHIDE	MG/L S	.01000	10-JUL-97 1015	.01000	10-JUL-97 1015	.00500	.00000	1	1	
0172	CHLORIDE	MG/L CL	15.00000	10-JUL-97 1015	15.00000	10-JUL-97 1015	15.00000	.00000	1		
0177	FLUORIDE	MG/L F	.06000	10-JUL-97 1015	.06000	10-JUL-97 1015	.06000	.00000	1		
0180	O-PHOSPHATE	MG/L P	.02000	10-JUL-97 1015	.02000	10-JUL-97 1015	.02000	.00000	1		
0182	SIO2 DISSOLV	MG/L*	9.90000	10-JUL-97 1015	9.90000	10-JUL-97 1015	9.90000	.00000	1		
0183	SULPHATE	MG/L SO4	10.00000	10-JUL-97 1015	10.00000	10-JUL-97 1015	5.00000	.00000	1	1	
0192	PO4 TOT INOR	MG/L P	.02000	10-JUL-97 1015	.02000	10-JUL-97 1015	.02000	.00000	1		
0207	SODIUM TOTAL	MG/L NA	8.00000	10-JUL-97 1015	8.00000	10-JUL-97 1015	8.00000	.00000	1		
0211	POTASSIUM TO	MG/L K	1.40000	10-JUL-97 1015	1.40000	10-JUL-97 1015	1.40000	.00000	1		
0237	MAGNESIUM TO	MG/L MG	1.90000	10-JUL-97 1015	1.90000	10-JUL-97 1015	1.90000	.00000	1		
0241	CALCIUM TOTA	MG/L CA	116.00000	10-JUL-97 1015	116.00000	10-JUL-97 1015	116.00000	.00000	1		
0283	BORON TOTAL	MG/L B	.10000	10-JUL-97 1015	.10000	10-JUL-97 1015	.05000	.00000	1	1	
0403	MANGANESE TO	MG/L MN	.01000	10-JUL-97 1015	.01000	10-JUL-97 1015	.00500	.00000	1	1	
0421	IRON TOTAL	MG/L FE	.05000	10-JUL-97 1015	.05000	10-JUL-97 1015	.02500	.00000	1	1	
0661	OIL BY IR	MG/L	.06000	10-JUL-97 1015	.06000	10-JUL-97 1015	.03000	.00000	1	1	
0816	CHLOROFORM	UG/L	.10000	10-JUL-97 1015	.10000	10-JUL-97 1015	.05000	.00000	1	1	
1002	ACTION TAKEN	NULL	10.00000	10-JUL-97 1015	10.00000	10-JUL-97 1015	10.00000	.00000	1		
6429	NICKEL TOTAL	UG/L	10.00000	10-JUL-97 1015	10.00000	10-JUL-97 1015	10.00000	.00000	1		
7215	COPPER TOTAL	UG/L	5.00000	10-JUL-97 1015	5.00000	10-JUL-97 1015	5.00000	.00000	1		
7245	ZINC TOTAL	UG/L	9.00000	10-JUL-97 1015	9.00000	10-JUL-97 1015	9.00000	.00000	1		
7356	ARSENIC TOTA	UG/L AS	1.00000	10-JUL-97 1015	1.00000	10-JUL-97 1015	.50000	.00000	1	1	
7375	CHROMIUM TOT	UG/L	1.00000	10-JUL-97 1015	1.00000	10-JUL-97 1015	.50000	.00000	1	1	
9109	HCH ALPHA	NG/L	2.70000	10-JUL-97 1015	2.70000	10-JUL-97 1015	1.35000	.00000	1	1	
9110	HCH GAMMA	NG/L	2.90000	10-JUL-97 1015	2.90000	10-JUL-97 1015	1.45000	.00000	1	1	
9112	ALDRIN	NG/L	3.20000	10-JUL-97 1015	3.20000	10-JUL-97 1015	1.60000	.00000	1	1	
9113	DDE PP	NG/L	4.80000	10-JUL-97 1015	4.80000	10-JUL-97 1015	2.40000	.00000	1	1	
9114	DIELDRIN	NG/L	5.20000	10-JUL-97 1015	5.20000	10-JUL-97 1015	2.60000	.00000	1	1	
9115	DDD PP	NG/L	4.50000	10-JUL-97 1015	4.50000	10-JUL-97 1015	2.25000	.00000	1	1	
9116	DDT PP	NG/L	3.50000	10-JUL-97 1015	3.50000	10-JUL-97 1015	1.75000	.00000	1	1	
9118	DRINS TOTAL	NG/L	6.90000	10-JUL-97 1015	6.90000	10-JUL-97 1015	6.90000	.00000	1		
9120	ENDRIN	NG/L	2.70000	10-JUL-97 1015	2.70000	10-JUL-97 1015	1.35000	.00000	1	1	
9125	CARBON TET	UG/L	.10000	10-JUL-97 1015	.10000	10-JUL-97 1015	.05000	.00000	1	1	
9127	ISODRIN	NG/L	2.70000	10-JUL-97 1015	2.70000	10-JUL-97 1015	1.35000	.00000	1	1	
9128	HCH EPSILON	NG/L	5.00000	10-JUL-97 1015	5.00000	10-JUL-97 1015	2.50000	.00000	1	1	
9131	HCB	NG/L	3.90000	10-JUL-97 1015	3.90000	10-JUL-97 1015	1.95000	.00000	1	1	

NB: RSelection criteria for report: Point 20003820, Type % Class %1422

LIST OF DETERMINANDS FOR GROUNDWATER MONITORING

Summary of Samples between 01-jan-97 and 01-may-98

Sampling Point: 20003820 HOCKLEY HOUSE (GROUNDWATER)
Type: GROUNDWATER ABSTRACTION (GR) Grid Ref: SU5700027300

	Determinand	Unit	Maximum	Date of Max	Minimum	Date of Min	Mean	S.Dev	Count	<'s	Fail
9132	HCBD	NG/L	2.80000	10-JUL-97 1015	2.80000	10-JUL-97 1015	1.40000	.00000	1	1	
9135	BARIUM TOTAL	UG/L	28.00000	10-JUL-97 1015	28.00000	10-JUL-97 1015	28.00000	.00000	1		
9143	HCH BETA	NG/L	2.80000	10-JUL-97 1015	2.80000	10-JUL-97 1015	1.40000	.00000	1	1	
9144	HCH DELTA	NG/L	4.00000	10-JUL-97 1015	4.00000	10-JUL-97 1015	2.00000	.00000	1	1	
9145	HCH TOTAL	NG/L	8.70000	10-JUL-97 1015	8.70000	10-JUL-97 1015	8.70000	.00000	1		
9146	DDT OP	NG/L	3.80000	10-JUL-97 1015	3.80000	10-JUL-97 1015	1.90000	.00000	1	1	
9148	DDT TOTAL	NG/L	8.30000	10-JUL-97 1015	8.30000	10-JUL-97 1015	8.30000	.00000	1		
9149	ATRAZINE	NG/L	30.00000	10-JUL-97 1015	30.00000	10-JUL-97 1015	15.00000	.00000	1	1	
9150	SIMAZINE	NG/L	30.00000	10-JUL-97 1015	30.00000	10-JUL-97 1015	15.00000	.00000	1	1	
9151	PROMETRYNE	NG/L	10.00000	10-JUL-97 1015	10.00000	10-JUL-97 1015	5.00000	.00000	1	1	
9152	PROPAZINE	NG/L	17.00000	10-JUL-97 1015	17.00000	10-JUL-97 1015	8.50000	.00000	1	1	
9154	HEPTEPOX TOT	NG/L	5.30000	10-JUL-97 1015	5.30000	10-JUL-97 1015	5.30000	.00000	1		
9157	CARBOPHENOTH	NG/L	19.00000	10-JUL-97 1015	19.00000	10-JUL-97 1015	9.50000	.00000	1	1	
9158	DIMETHOATE	NG/L	22.00000	10-JUL-97 1015	22.00000	10-JUL-97 1015	11.00000	.00000	1	1	
9159	MALATHION	NG/L	15.00000	10-JUL-97 1015	15.00000	10-JUL-97 1015	7.50000	.00000	1	1	
9178	DICHLOROETHA	UG/L	1.00000	10-JUL-97 1015	1.00000	10-JUL-97 1015	.50000	.00000	1	1	
9180	TRICHLOELENE	UG/L	.40000	10-JUL-97 1015	.40000	10-JUL-97 1015	.40000	.00000	1		
9182	TETCHLOELENE	UG/L	.10000	10-JUL-97 1015	.10000	10-JUL-97 1015	.05000	.00000	1	1	
9190	TCB TOTAL	NG/L	15.00000	10-JUL-97 1015	15.00000	10-JUL-97 1015	15.00000	.00000	1		
9221	CHLORTOLURON	NG/L	40.00000	10-JUL-97 1015	40.00000	10-JUL-97 1015	20.00000	.00000	1	1	
9222	ISOPROTURON	NG/L	40.00000	10-JUL-97 1015	40.00000	10-JUL-97 1015	20.00000	.00000	1	1	
9223	LINURON	NG/L	40.00000	10-JUL-97 1015	40.00000	10-JUL-97 1015	20.00000	.00000	1	1	
9233	MCPA	NG/L	50.00000	10-JUL-97 1015	50.00000	10-JUL-97 1015	25.00000	.00000	1	1	
9235	2,4,-D	NG/L	70.00000	10-JUL-97 1015	70.00000	10-JUL-97 1015	35.00000	.00000	1	1	
9236	MECOPROP	NG/L	50.00000	10-JUL-97 1015	50.00000	10-JUL-97 1015	25.00000	.00000	1	1	
9282	CARBENDAZIM	NG/L	900.00000	10-JUL-97 1015	900.00000	10-JUL-97 1015	450.00000	.00000	1	1	
9286	TRIALLATE	NG/L	7.30000	10-JUL-97 1015	7.30000	10-JUL-97 1015	3.65000	.00000	1	1	
9325	111TRICHLETH	UG/L	.10000	10-JUL-97 1015	.10000	10-JUL-97 1015	.05000	.00000	1	1	
9461	1,2,3-TCB	NG/L	10.00000	10-JUL-97 1015	10.00000	10-JUL-97 1015	5.00000	.00000	1	1	
9462	1,2,4 - TCB	NG/L	10.00000	10-JUL-97 1015	10.00000	10-JUL-97 1015	5.00000	.00000	1	1	
9463	1,3,5-TCB	NG/L	10.00000	10-JUL-97 1015	10.00000	10-JUL-97 1015	5.00000	.00000	1	1	
9605	HEPTACHL CIS	NG/L	5.30000	10-JUL-97 1015	5.30000	10-JUL-97 1015	2.65000	.00000	1	1	
9606	HEPTACHL TRA	NG/L	5.30000	10-JUL-97 1015	5.30000	10-JUL-97 1015	2.65000	.00000	1	1	

NB: RSelection criteria for report: Point 20003820, Type % Class %1422

Sampling Route Dictionary Report

oute Code : WC9 (Contd)

	HS0707	Bursledon STW	NE	E801	4S	
)	HT2505	Maritime Operations Centre (#)	NE	E808	5K	
30	HS0306	Peel Common STW Sea Outfall	NE	E801	4S	
10	HS0609	Eastney Outfall (Main P.S.)	NE	E801	4B	
20	HE1118	Shedfield Stream	NW	R831	2F	

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oute Code : WGND (GROUNDWATER:WINCHESTER)
esponsible Officer : WE40 (Winchester Office (RF))
ampling Officer : ( )

eq o.	Sampling Pt Id.	(Description)	Purp Code	Comp	ARG(s)	Matl Code	P
0	HE2307	Hockley House, Cheriton	NW		G850	3V	
0	HE2306	Manor Farm, Ropley	NW		G850	3V	
0	HE2305	Basingstoke Golf Course - Kemp	NW		G850	3V	
0	HE2309	Stoke Charity Cress Beds	NW		G850	3V	
0	HE2302	Sparsholt Agricultural College	NW		G850	3V	
)	HE2303	Georgia Farm, Amport	NW		G850	3V	
0	HE2301	New Manor Farm, Winterslow	NW		G850	3V	
0	HE2304	West Dean Farm, Whiteparish	NW		G850	3V	

GROUNDWATER MONITORING POINTS

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oute Code : WGNDS (Winch: Groundwater survey)
esponsible Officer : WE40 (Winchester Office (RF))
ampling Officer : ( )

eq o.	Sampling Pt Id.	(Description)	Purp Code	Comp	ARG(s)	Matl Code	P
0	HE1988	DUMP-Winch-Chalk Groundwater	AW		AH12	2E	
0	HE1988	DUMP-Winch-Chalk Groundwater	AW		AH12	2E	
0	HE1988	DUMP-Winch-Chalk Groundwater	AW		AH12	2E	
0	HE1988	DUMP-Winch-Chalk Groundwater	AW		AH12	2E	
0	HE1988	DUMP-Winch-Chalk Groundwater	AW		AH12	2E	
0	HE1988	DUMP-Winch-Chalk Groundwater	AW		AH12	2E	
0	HE1988	DUMP-Winch-Chalk Groundwater	AW		AH12	2E	
0	HE1988	DUMP-Winch-Chalk Groundwater	AW		AH12	2E	
0	HE1988	DUMP-Winch-Chalk Groundwater	AW		AH12	2E	
00	HE1988	DUMP-Winch-Chalk Groundwater	AW		AH12	2E	
10	HE1988	DUMP-Winch-Chalk Groundwater	AW		AH12	2E	
120	HE1988	DUMP-Winch-Chalk Groundwater	AW		AH12	2E	
30	HE1988	DUMP-Winch-Chalk Groundwater	AW		AH12	2E	
40	HE1988	DUMP-Winch-Chalk Groundwater	AW		AH12	2E	
50	HE1988	DUMP-Winch-Chalk Groundwater	AW		AH12	2E	

E0141	DUMP-INV Langstone Harbour sed	AS	I221	
E0141	DUMP-INV Langstone Harbour sed	AS	I221	
E0141	DUMP-INV Langstone Harbour sed	AS	I221	

GIBB Environmental
LAWGIBB Group Member

QUESTIONNAIRE: Groundwater Quality Data Software

GIBB Ltd. have been contracted by the Agency to assess the Agency's requirements regarding the storage and display of groundwater quality data. This questionnaire forms part of our assessment and we will be grateful for your responses to the questions outlined below.

If you have any queries please contact Mark Vanstone or Tim Morgan at GIBB Ltd. on 0118-9635000, or by Email at mvanston@gibb.co.uk or tmorgan@gibb.co.uk.

The following questions are to obtain general details.

Q1.

Please provide the following reference details.			
Name:	Felicity Standley		
Position:	Groundwater Protection Officer	**Region:**	Southern
Tel No.:	[redacted] 01903 - 832177	**Fax No.:**	01903 - 832229
E-mail:	felicity.standley@environment-agency.gov.uk		

Q2.

Please provide details of other Agency staff who may be able to provide input to this project.			
Name:	Martin Jerome		
Position:	Regional Environmental Registrar	**Region:**	Southern
Tel No.:	01903 - 832000	**Fax No.:**	01903 - 832229
E-mail:	—		
Name:	Bob Barnes		
Position:	Area Groundwater Protection Officer	**Region:**	Southern
Tel No.:	01962 - 860103	**Fax No.:**	01962 841573
Position:			
E-mail:	—		

The following questions are to establish how much groundwater quality monitoring data your office typically handles annually.

Q3. Public Water Supply Wells

No. of public water supply wells:	278 (9 water companies)
What is the frequency of the data receipt and review process for public water supply wells and how was this determined ?	1 Water Co. sends data quarterly. 1 Water Co. sends data via Thames Region on regular basis but not at any specified frequency. The other 7 companies do not send data yet.
Please identify the determinands for public water supply wells (or attach a list):	Two det. lists attached – one for each Wtr Co. that we currently receive data from. We don't necessarily receive data for all these dets though.

?

?

Q4. Observation Boreholes

No. of observation boreholes:	NONE
What is the frequency of the data receipt and review process for observation boreholes and how was this determined ?	
Please identify the determinands for observation boreholes (or attach a list):	

Q5. Springs

No. of springs:	17
What is the frequency of the data receipt and review process for springs and how was this determined ?	Data received from 1 Water Co. on quarterly basis.
Please identify the determinands for springs (or attach a list):	Det list ① attached. We don't necessarily receive data for all these dets.

Q6. Other Monitoring Locations

No. of other monitoring locations:	8 private boreholes.
What is the frequency of the data receipt and review process for these monitoring points and how was this determined ?	Six monthly
Please identify the determinands for these monitoring points (or attach a list):	Major anions & cations.

The following questions are to obtain information regarding the data collection, storage and use.

Q7. Data Collection

Is the groundwater quality data obtained internally or externally ?	Both (internal data for the 8 private b/h's).
What and where are the external sources ?	Water companies (nine).
Does the determinand data collected have additional comment fields and what are these ?	Don't think so.
What other environmental data are collected in parallel with groundwater quality data ?	None
What QA/QC procedures are used to assess the quality of the groundwater monitoring data ?	None at present.

Q8. Data Storage

Are groundwater quality data on a single database or are a number of software packages used ?	On ~~two~~ three databases at present – although only ~~one~~ two has data on it at present.
What other databases are you aware of for other data ? E.g. contaminated land, landfill, mineral water, private supplies.	None.
Where are these databases located and who has responsibility ? Please provide name, address and telephone number.	Oracle database – located at Worthing – responsibility of Martin Jerome – 01903-832000. Access database – located at Worthing. Responsibility of

Felicity Standley 01903-832177.
WIMS – located at Worthing – data from private b/h's stored on here – responsibility of Keith Jury 01903-832171.

Q9. Data Use

Are groundwater quality data routinely manipulated, interpreted and displayed ?	No,..
On what scale is this done ? E.g. sub catchment, catchment or other.	N/A
What level of interpretation is performed ? E.g. trend analysis, comparison with quality standards etc.	N/A
Are the data used by other departments in the Agency or provided to industry / the public ?	No
In what format is this data provided ?	N/A

The following questions relate to the software you use.

Q10.

What software do you currently use to store, analyse and present the data ? e.g. Excel, Lotus, Access, Approach, Oracle, Grapher, Statistica, SPSS, Surfer, Arcview, Arcinfo, Mapinfo, WIMS.

Program	Version	Main Uses						
		Storage	Statistics	Tables	Graphs	Contours	Mapping	Other please describe
ORACLE		✓						
ACCESS		✓						
HYDROCHAT			✓		✓			
SURFER						✓		
WIMS		✓						

Q11.

Is the software you have listed sufficient and suitable for your purposes, if not what are the problems ? e.g. difficult graphing, training required, poor technical support.	
Program Hydrodat	DOS based; crashes frequently. Cannot import data directly. No technical support.
ORACLE d/b	Not user friendly.

Q12.

What additional software features would you like ? e.g. specific graphs or statistical capabilities.
Windows based package for interpretation/graphing
of data exported from the ACCESS d/b. Must
~~be~~ have flexible import routines.

Q13.

Are you aware of any other software that would satisfy your requirements ?
Plotchem? I understand this is being trialled by the National Groundwater Centre and Welsh Region?? - but have not had any feedback on whether it provides the required functionality.

Q14.

Have you tested any software other than that you currently use and what was your conclusion ?
No.

Thank you for completing this questionnaire. Please return the completed document by post or by fax to Mark Vanstone at GIBB Ltd.

GIBB Ltd,
Environmental Division,
GIBB House,
London Road,
Reading,
Berkshire RG6 1BL

Fax 0118 963 5290
Tel 0118 963 5000

(1) DET CODES

t Id	Det Name	Det Unit
2	DAY OF THE WEEK	(1=MONDAY)
4	TIME OF HIGH TIDE	HH:MM
50	LEAD TOTAL	UG/L
61	PH	PH UNITS
62	CONDUCTIVITY 20C	USIE/CM
64	ODOUR QUANT. THRESHOLD NO	TON
68	TURBIDITY	FTU
69	COLOUR	HAZEN
72	COLOUR LIQUID FILTERED	HAZEN
76	TEMPERATURE WATER	CEL
77	CONDUCTIVITY 25C	USIE/CM
85	BOD 5 ATU	MG/L O
97	PV N/80 4 HOURS	MG/L O
99	CARBON ORGANIC TOTAL(TOC)	MG/L C
105	MERCURY	UG/L HG
108	CADMIUM	UG/L CD
111	NITROGEN AMMONIACAL	MG/L N
112	NITROGEN ALBUMINOID	MG/L N
114	NITROGEN KJELDAHL	MG/L N
116	NITROGEN TOTAL OXIDISED	MG/L
117	NITROGEN NITRATE	MG/L N
18	NITROGEN NITRITE	MG/L N
5	SOLIDS SUSPENDED 105C	MG/L
138	SOLIDS DISSOLVED 180C	MG/L
141	SOLIDS TOTAL 180C	MG/L
157	HARDNESS NON-CARBONATE	MG/L CACO3
158	HARDNESS TOTAL	MG/L CACO3
159	CARBON DIOXIDE FREE	MG/L CO2
162	ALKALINITY PH 4.5	MG/L CACO3
67	SULPHIDE	MG/L S
72	CHLORIDE	MG/L CL
74	CYANIDE FREE	MG/L CN
75	CYANIDE TOTAL	MG/L CN
77	FLUORIDE	MG/L F
30	ORTHOPHOSPHATE	MG/L P
32	SILICATE REACTIVE DISSOLVED	MG/L SIO2
33	SULPHATE	MG/L SO4
2	PHOSPHATE TOTAL	MG/L P
7	SODIUM TOTAL	MG/L NA
1	POTASSIUM TOTAL	MG/L K
5	COPPER TOTAL	MG/L CU
	SILVER TOTAL	MG/L AG
7	MAGNESIUM TOTAL AS MG	MG/L MG
1	CALCIUM TOTAL AS CA	MG/L CA
5	ZINC TOTAL	MG/L ZN
	CADMIUM TOTAL	MG/L CD
	MERCURY (DRY WEIGHT)	MG/KG
3	BORON TOTAL	MG/L B
	ALUMINIUM DISSOLVED	MG/L AL
	ALUMINIUM TOTAL	MG/L AL
	CARBON ORGANIC DISSOLVED	MG/L C
	LEAD TOTAL	MG/L PB
	MANGANESE DISSOLVED	MG/L MN
	MANGANESE TOTAL	MG/L MN
	IRON DISSOLVED	MG/L FE

Det Id	Det Name	Det Unit
421	IRON TOTAL	MG/L FE
461	DETERGENTS ANIONIC	MG/L M.OT
483	ALDRIN TOTAL	UG/L
487	HCH (BCH) ALPHA TOTAL	UG/L
491	HCH (BCH) BETA TOTAL	UG/L
499	HCH (BCH) GAMMA TOTAL	UG/L
511	DIELDRIN TOTAL	UG/L
527	HEPTACHLOR TOTAL	UG/L
531	HEPTACHLOR EPOXIDE TOTAL	UG/L
535	MALATHION TOTAL	UG/L
539	DDT OP TOTAL	UG/L
551	DDE PP TOTAL	UG/L
555	DDT PP TOTAL	UG/L
559	TDE PP TOTAL	UG/L
562	ENDRIN TOTAL	UG/L
625	TASTE QUAL. NATURE	CODE
626	TASTE QUAL. INTENSITY	CODE
729	CHLOROPHYLL A	UG/L
763	PHENOLS TOTAL	MG/L
797	ODOUR QUAL. INTENSITY	CODE
98	ODOUR QUAL. NATURE	CODE
16	CHLOROFORM	UG/L
817	BROMODICHLOROMETHANE	UG/L
818	BROMOFORM	UG/L
819	CHLORODIBROMOMETHANE	UG/L
911	CHLORINE FREE	MG/L CL2
912	CHLORINE TOTAL	MG/L CL2
932	COLONIES 3 DAYS AT 22C	NO/ML
933	COLONIES 1 DAY AT 37C	NO/ML
934	COLONIES 2 DAYS AT 37C	NO/ML
935	COLONIES 3 DAYS AT 37C	NO/ML
938	E.COLI	NO/100 ML
940	COLIFORMS TOTAL	NO/100 ML
948	ALGAE TOTAL CELL COUNT	NO/ML
950	PHAEOPHYTIN	UG/L
1001	SAMPLE DATA ON FILE FROM	DATE
1002	ACTION TAKEN UNDER COPA	
1085	PENTACHLOROPHENOL	NG/L
1166	PCBS AROCLOR 1254	UG/L
193	SALMONELLAE	PRES/ABS 1L
200	TRIHALOMETHANES	UG/L
2325	CLOSTRIDIUM PERFR. C-MF	NO/100ML
2329	COLIFORMS TOTAL PRES MF	NO/100ML
2331	COLIFORMS TOTAL CONF MF	NO/100ML
2346	COLIF FAECAL PRES MF	NO/100ML
2348	COLIFORMS FAECAL CONF MF	NO/100ML
2372	SALMONELLAE (POTABLE)	PRES/ABS 10L
6429	NICKEL TOTAL	UG/L
7215	COPPER TOTAL	UG/L
7219	SILVER TOTAL	UG/L
7245	ZINC TOTAL	UG/L
7356	ARSENIC TOTAL	UG/L AS
7375	CHROMIUM TOTAL	UG/L
7379	SELENIUM TOTAL	UG/L SE
8000	TRICHLOROBENZOIC ACID	NG/L

t Id	Det Name	Det Unit
3001	UNKNOWN1	UG/L
3002	UNKNOWN2	UG/L
3003	UNKNOWN3	TON
3004	UNKNOWN4	UG/L
3005	UNKNOWN5	MG/L
3006	UNKNOWN6	UG/L
3007	UNKNOWN7	CODE
3008	UNKNOWN8	CODE
9100	MERCURY TOTAL	UG/L HG
9102	FLUORANTHENE	NG/L
9103	BENZO(B)FLUORANTHENE	NG/L
9104	BENZO(K)FLUORANTHENE	NG/L
9105	BENZO(ALPHA)PYRENE	NG/L
9106	INDENO(123CD)PYRENE	NG/L
9107	BENZO(GHI)PERYLENE	NG/L
9109	HCH ALPHA TOTAL	NG/L
110	HCH GAMMA TOTAL	NG/L
111	HEPTACHLOR	NG/L
112	ALDRIN	NG/L
113	DDE PP	NG/L
114	DIELDRIN	NG/L
15	DDD PP (TDE PP)	NG/L
5	DDT PP	NG/L
117	TOTAL PESTICIDES	UG/L
118	DRINS TOTAL	NG/L
119	PCBS AROCLOR 1260	UG/L
20	ENDRIN	NG/L
25	CARBON TETRACHLORIDE	NG/L
127	ISODRIN	NG/L
28	HCH EPSILON	NG/L
29	DDD OP (TDE OP)	NG/L
30	DDE OP	NG/L
31	HEXACHLOROBENZENE (HCB)	NG/L
32	HEXACHLOROBUTADIENE(HCBD)	NG/L
33	BORON TOTAL	UG/L
35	BARIUM TOTAL	UG/L
37	ANTIMONY TOTAL	UG/L
43	HCH BETA	NG/L
44	HCH DELTA	NG/L
45	HCH TOTAL	NG/L
5	DDT OP	NG/L
	DDT TOTAL	NG/L
19	ATRAZINE	NG/L
50	SIMAZINE	NG/L
1	PROMETRYNE	NG/L
2	PROPAZINE	NG/L
3	TRIAZINES TOTAL	NG/L
4	HEPTACHLOR EPOXIDE	NG/L
5	ENDOSULPHAN	NG/L
5	PARATHION	NG/L
7	CARBOPHENOTHION	NG/L
3	DIMETHOATE	NG/L
9	MALATHION	NG/L
0	DALAPON	NG/L
1	AROCLOR 125A	NG/L

t Id	Det Name	Det Unit
9162	AROCLOR 1260	NG/L
9163	PCB'S TOTAL	NG/L
9166	HYDROCARBONS PERSISTENT	UG/L
9169	CHLORFENVINPHOS	NG/L
9170	PEST.ORGANOPHOS.TOTAL	NG/L
9172	PEST.ORGANOCHLOR.TOTAL	NG/L
9173	SOLVENTS HALOG. TOTAL	UG/L
9179	TRICHLOROETHANE	UG/L
9180	TRICHLOROETHYLENE	UG/L
9181	TETRACHLOROETHANE	UG/L
9182	TETRACHLOROETHYLENE	UG/L
9195	PAH TOTAL	NG/L
9198	STREPTOCOCCI FAECAL PRES	NO/100ML
9203	CLOSTRIDIUM SPP CONF.	NO/100ML
9205	PHENOLS NON PARA	MG/L
9221	CHLORTOLURON	NG/L
9222	ISOPROTURON	NG/L
9223	LINURON	NG/L
9224	PESTICIDES UREA	NG/L
9226	MECARBAM	NG/L
[illegible]	METHIDATHION	NG/L
[illegible]	AZINPHOS-METHYL	NG/L
229	FENITROTHION	NG/L
230	MEVINPHOS	NG/L
231	DICHLORVOS	NG/L
232	CHLORDANE	NG/L
233	MCPA	NG/L
234	MCPB	NG/L
235	2,4-D	NG/L
236	MECOPROP	NG/L
237	DICHLORPROP	NG/L
238	PHENOXY.ACID PESTICIDES	NG/L
239	BROMOXYNIL	NG/L
242	2,4,5-T	NG/L
243	TECNAZENE	NG/L
248	PCB 28	NG/L
249	PCB 52	NG/L
250	PCB 101	NG/L
252	PCB 138	NG/L
[illegible]	PCB 153	NG/L
[illegible]	PCB 180	NG/L
273	TRIFLURALIN	NG/L
274	PV 10 MIN BOIL	MG/L O
276	CLOPYRALID	NG/L
282	CARBENDAZIM	NG/L
283	CARBETAMIDE	NG/L
284	EPTC	NG/L
285	PROPYZAMIDE	NG/L
287	DICAMBA	NG/L
288	IOXYNIL	NG/L
289	TCA TRICHLORACETIC ACID	NG/L
290	GLYPHOSPHATE	NG/L
292	PARAQUAT	NG/L
297	TRIADIMEFON	NG/L
301	DIURON	NG/L

Id	Det Name	Det Unit
10	ATRAZINE	UG/L
11	SIMAZINE	UG/L
13	PROPAZINE	UG/L
15	ENDOSULPHAN-A	NG/L
16	ENDOSULPHAN-B	NG/L
18	AZINPHOS-METHYL	UG/L
19	FENITROTHION	UG/L
21	DICHLOROVOS	UG/L
33	TRIETAZINE	NG/L
37	DICHLORPROP	UG/L
47	DIAZINON	NG/L
48	DICHLOBENIL	NG/L
49	TERBUTRYNE	NG/L
01	METHABENZTHIAZURON	NG/L
02	DIFLUFENICAN	NG/L
3	PROPETAMPHOS	NG/L
9	UNKNOWN OR NEW	TBA
54	IMAZAPYR	NG/L

ows selected.

(2)

Hydrogen Ion (pH) (lab)		1	A006
Conductivity (lab)	us/cm	2	D001
Total Organic Carbon	mg/l C	11	A017
Temperature (field)	'C	12	A005
Ammoniacal nitrogen (as N)(lab)	mg/l	15	N039
Total oxidised nitrogen (as N)	mg/l	17	N040
Nitrite (as N)	mg/l N	18	N042
Chloride as Cl (lab)	mg/l	19	D002
Sulphate as SO4	mg/l SO4	20	A007
Hardness (Total as CaCO3)	mg/l	26	N041
Alkalinity (as CaCO3)	mg/l	27	N001
Calcium (total)	mg/l	28	D003
Magnesium (total)	mg/l	29	A008
Sodium (total)	mg/l	30	A009
Potassium (total)	mg/l	31	A010
Bromide	mg/l	60	N026
Nitrate (as N)	mg/l N	76	N043
Gamma-HCH (Lindane)	ug/l	82	P041
Aldrin	ug/l	83	P002
Dieldrin	ug/l	84	P028
Nitrate (as NO3)	mg/l NO3	117	A012
Nitrite (as NO2)	mg/l NO2	118	A013
Terbutryne	ug/l	129	P077
Permethrin	ug/l	130	P119
Anions	mequiv/l	150	150
Cations	mequiv/l	151	151
Ionic Balance	%	152	152
Diuron	ug/l	196	P032
Strontium (total)	mg/l	249	N030
Toluene	ug/l	776	N033
Trichloromethane (Chloroform)	ug/l	7008	D11A
Tribromomethane (Bromoform)	ug/l	7009	D11D
Dichlorobromomethane (Bromodi	ug/l	7010	D11B
Dibromochloromethane	ug/l	7057	D11C
Diazinon	ug/l	7114	P024
Chlorfenvinphos	ug/l	7115	P013
Cyanide (easily liberable/free)	ug/l	7175	B003
Total Trihalomethanes [WC]	ug/l	7202	D011
Copper (total)	ug/l	7215	A024
Zinc (total)	ug/l	7245	A025
Manganese (total)	ug/l	7403	A023
Iron (total)	ug/l	7421	A022
Nickel (total)	ug/l	7429	B006
Xylene (total)	ug/l	7778	N034
Benzene	ug/l	7780	N025
Trichloroethane	ug/l	7784	
1,1,1-trichlorethane	ug/l	7784	D100
MCPA	ug/l	7915	P054
MCPB	ug/l	7920	P055
MCPP (Mecoprop)	ug/l	7925	P053
Carbophenothion	ug/l	7940	P011
Chlorotoluron	ug/l	7945	P014
Isoproturon	ug/l	7950	P048

TCA	ug/l		7951	P075
Dalapon	ug/l		7952	P021
Linuron	ug/l		7965	P051
2,4-D	ug/l		7983	P020
Tetrachloromethane	ug/l		9049	D008
Lead (total)	ug/l		9050	B007
Cadmium (total)	ug/l		9108	B002
Fluoride	ug/l		9177	A027
Fenoprop	ug/l		9245	P105
Boron (total)	ug/l		9283	D005
Dissolved or Emulsified Hydrocar	ug/l		9616	A018
Tetrachloroethene	ug/l		9793	D010
Trichloroethene	ug/l		9795	D009
Atrazine	ug/l		9801	P004
Simazine	ug/l		9802	P073
Chlorthal	ug/l		9805	P175
Tecnazene	ug/l		9806	P130
Dichlobenil	ug/l		9850	P098
Phenols (total) [WC]	ug/l		9992	A019

Processing and Presentation of Groundwater Quality Data

Questionnaire Responses - Environment Agency,

South West Region

Nigel Crane : Principle Officer Groundwater Protection

From telephone conversation

GIBB Environmental
LAWGIBB Group Member

QUESTIONNAIRE: Groundwater Quality Data Software

GIBB Ltd. have been contracted by the Agency to assess the Agency's requirements regarding the storage and display of groundwater quality data. This questionnaire forms part of our assessment and we will be grateful for your responses to the questions outlined below.

If you have any queries please contact Mark Vanstone or Tim Morgan at GIBB Ltd. on 0118-9635000, or by Email at mvanston@gibb.co.uk or tmorgan@gibb.co.uk.

The following questions are to obtain general details.

Q1.

Please provide the following reference details.			
Name:	Nigel Crane		
Position:	Principle Officer Groundwater Protection	**Region:**	South West
Tel No.:	01392 444000	**Fax No.:**	01392 444238
E-mail:			

Q2.

Please provide details of other Agency staff who may be able to provide input to this project.			
Name:	Jane Driver		
Position:		**Region:**	South West
Tel No.:	01392 444000	**Fax No.:**	01392 444238
E-mail:			
Name:			
Position:		**Region:**	
Tel No.:		**Fax No.:**	
Position:			
E-mail:			

The following questions are to establish how much groundwater quality monitoring data your office typically handles annually.

Q3. Public Water Supply Wells

No. of public water supply wells:	lots
What is the frequency of the data receipt and review process for public water supply wells and how was this determined ?	Data is received on an adhoc basis. There is no systematic reporting and archiving of data.
Please identify the determinands for public water supply wells (or attach a list):	Determinands identified in BGS strategy.

Q4. Observation Boreholes

No. of observation boreholes:	SW groundwater monitoring is virtually zero
What is the frequency of the data receipt and review process for observation boreholes and how was this determined ?	A copy of the monitoring programme will be copied and sent in week beginning 18 May Used to monitor SW Water boreholes. No monitoring in Devon and Cornwall. Whole of Devon and cornwall is a minor aquifer.
Please identify the determinands for observation boreholes (or attach a list):	Determinands identified in BGS strategy.

Q5. Springs

No. of springs:	
What is the frequency of the data receipt and review process for springs and how was this determined ?	S Wessex, fish farms and cress beds on Chalk, used to sample springs, but not any more. N Wessex, limited spring sampling. Devon and Cornawall, none.
Please identify the determinands for springs (or attach a list):	Determinands identified in BGS strategy.

Q6. Other Monitoring Locations

No. of other monitoring locations:	Landfill sites, data held at local offices.
What is the frequency of the data receipt and review process for these monitoring points and how was this determined ?	
Please identify the determinands for these monitoring points (or attach a list):	Determinands identified in BGS strategy.

The following questions are to obtain information regarding the data collection, storage and use.

Q7. Data Collection

Is the groundwater quality data obtained internally or externally ?	Very little data in general
What and where are the external sources ?	Water companies
Does the determinand data collected have additional comment fields and what are these ?	No
What other environmental data are collected in parallel with groundwater quality data ?	None
What QA/QC procedures are used to assess the quality of the groundwater monitoring data ?	None

Q8. Data Storage

Are groundwater quality data on a single database or are a number of software packages used ?	Quality data is not stored on a single database. The water authority data is not stored.
What other databases are you aware of for other data ? E.g. contaminated land, landfill, mineral water, private supplies.	Surface water quality data is held on WIMS. WIMS is not well set up for groundwater quality data. Landfill data is held in the local offices. Contaminated land location database exists.
Where are these databases located and who has responsibility ? Please provide name, address and telephone number.	Jane Driver is responsible for databasing of SW region environmental data

Q9. Data Use

Are groundwater quality data routinely manipulated, interpreted and displayed ?	No
On what scale is this done ? E.g. sub catchment, catchment or other.	
What level of interpretation is performed ? E.g. trend analysis, comparison with quality standards etc.	
Are the data used by other departments in the Agency or provided to industry / the public ?	
In what format is this data provided ?	

The following questions relate to the software you use.

Q10.

What software do you currently use to store, analyse and present the data ? e.g. Excel, Lotus, Access, Approach, Oracle, Grapher, Statistica, SPSS, Surfer, Arcview, Arcinfo, Mapinfo, WIMS.

Program	Version	Main Uses						
		Storage	Statistics	Tables	Graphs	Contours	Mapping	Other please describe
Lotus 123		X						
ORACLE		X						WIMS
MS Office								New Agency standard

Q11.

Is the software you have listed sufficient and suitable for your purposes, if not what are the problems ? e.g. difficult graphing, training required, poor technical support.	
Program	
	No

Q12.

What additional software features would you like ? e.g. specific graphs or statistical capabilities.
Want straightforward access to the data
SIMPLICITY for the production of routine reports
Required to monitor pollution in controlled waters
- monitor over time
- contouring easily understood, needs to be intelligent (e.g. aquifer specific)
- reporting is generally not to groundwater specialists. Want easily understood graphical illustrations.

Q13.

Are you aware of any other software that would satisfy your requirements ?
In WIMS, data is entered against a site reference. Site references can be related to grid references or against general codes. WIMS is not set up for accessing data by aquifer and borehole, but rather by water course and catchment. Some manipulation would be required for use of WIMS with groundwater data.

Q14.

Have you tested any software other than that you currently use and what was your conclusion ?
No

Thank you for completing this questionnaire. Please return the completed document by post or by fax to Mark Vanstone at GIBB Ltd.

GIBB Ltd,
Environmental Division,
GIBB House,
London Road,
Reading,
Berkshire RG6 1BL

Fax 0118 963 5290
Tel 0118 963 5000

2. EUROPEAN REPORTING REQUIREMENTS

2.1 Eurowaternet - Groundwater: Draft Guidelines for a European Groundwater Monitoring Network Design

EUROWATERNET – GROUNDWATER

Guidelines for a European Groundwater Monitoring Network Design

Draft Proposal

1. Scope

The draft monitoring strategy outlined below has been developed based on
– the information needs of the EEA (objective, reliable and comparable data)
– the results which have been elaborated so far within the ETC/IW work programme (e.g. EEA Report 10/1996, Pilot study, Draft Groundwater Monograph, etc.) as well as on general principles of monitoring network design
– the spirit of the Draft Groundwater Action Programme (COM(96) 315 fin)
– the current discussion on Annex II, III and V of the draft Water Framework Directive
– and last but not least on the principles of efficiency and saving costs;

Representative data in this proposal are seen as data which provide an overview on the state of groundwater quality and quantity in the EEA-area. Delivered information should allow to identify the status of groundwater bodies ranging from nearly "natural" to "heavily impacted". Member Countries should therefore deliver representative data based on their existing national programmes.

2. Objective of the Monitoring

Objective of the Monitoring is to provide:

- objective, reliable and comparable information at the European level
- a survey about important groundwater bodies in the EEA area
- a description of the status of groundwater quantity and quality in the EEA area
- information about trends in groundwater quantity and quality status
- a long-term assessment about the impacts of measures

3. Which Aquifers are Covered?

Monitoring of **all important groundwater bodies** (groundwater in porous media, karst groundwater and others), both shallow and deep aquifers.

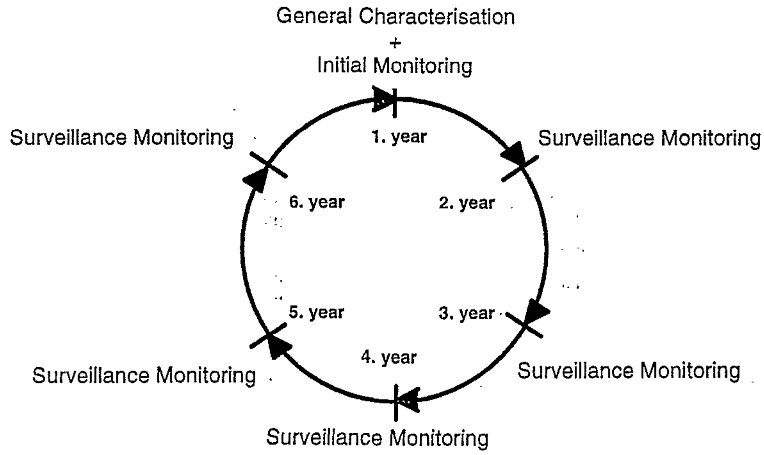
Important groundwater bodies:

At least one of the three requirements have to be met

- > 300 km²;
- of regional, socio-economic or environmental importance in terms of quantity and quality;
- exposed to severe or major impacts.

4. General Characteristics of the Monitoring Programme

The proposed monitoring programme is cyclic with a period of six years. The monitoring specifications are described as follows:



General Characterisation and Initial Monitoring should provide a more comprehensive description of the groundwater body. Based on the knowledge of this programme, extent and characteristics of the **Surveillance Monitoring** will be derived. Every six years the general characteristics should be updated (according to Tab 1) and the initial monitoring – based on the general characterisation – should be carried out. Monitoring results will then be the basis for the development of the new surveillance monitoring. This system should be a tool to adapt the monitoring strategy regularly in accordance with the change of conditions within the monitored region.

5. Characterisation of Groundwater Bodies

Two-step approach:

- A **General characterisation** should be carried out for **all important groundwater bodies.**
- The general characterisation of the groundwater body should be **proved and updated** (esp. the pressure situation) at least every six years.

The **general characterisation** of the groundwater body shall identify:

Tab.1: General characterisation

Groundwater Quantity	**Groundwater Quality**
• the location, area and boundaries of the groundwater body	
• geological characterisation of the groundwater body including: extent and type of geological units and the characterisation of the overlying strata in the catchment from which the groundwater body receives its recharge.	
• hydrogeological characterisation of the groundwater body and the surface layer	
• hydrological characterisation of the groundwater body including: climate (precipitation)	
• stratification characteristics of the groundwater within the groundwater body;	
• an inventory of associated surface systems including terrestrial ecosystems and surface water bodies, with which the groundwater body is dynamically linked;	

• land use in the catchment or catchment from which the groundwater body receives its natural and artificial recharge; land use information shall include the percentage of: agricultural, arable, pasture land, forest, urbanisation or any other impacts of human intervention	
• Assessment of the pressures to which each groundwater body is liable to be subject incl.: are there water abstractions or artificial recharges, associated aquatic or terrestrial ecosystems?	• Assessment of the pressures to which each groundwater body is liable to be subject incl.: are there diffuse sources or point sources of pollution, associated aquatic or terrestrial ecosystems?

6. Groundwater Quantity Monitoring

Two-step approach:

- Periodical **characterisation** of the groundwater body (according to chap. 4 and 5)
- **Initial** and continued **surveillance monitoring** of the groundwater quantity of all important groundwater bodies should be carried out.

6.1 Types of Monitoring Stations

- The monitoring network should be based on a balanced distribution of sampling sites in order to provide representative information on the quantitative aspects of a groundwater body.
- Monitoring stations should be located away fromabstraction or recharge stations..

6.2 Monitoring Station Density

The **density of** monitoring stations in a groundwater network shall depend on:

- The size of the groundwater body.
- The geological and hydro(geo)logical characteristic and complexity of the aquifer
- The intensity of impacts (e.g. land use, population density, abstraction and recharge).

Vulnerability mapping will provide additional basic information for the selection of sampling sites and monitoring station distribution within the monitored area.

6.3 Monitoring Frequency

Groundwater quantity shall be monitored according to the following monitoring programme which has been set up for a period of six years:

- In the first year of the monitoring period all important groundwater bodies have to run through an **initial monitoring** where groundwater bodies should be monitored **at least four times** in order to detect seasonal variations (depending on the hydrology and the dynamics of the aquifer system). More frequent monitoring may be necessary in more variable systems.
- In the following five years of the monitoring period all important groundwater bodies have to run through a **surveillance monitoring** where groundwater bodies shall be monitored **at least twice a year** in order to detect maximum and minimum groundwater levels (depending on their hydrology and dynamics).

6.4 Parameter

- Piezometric head of groundwater

No recommendation for karst aquifers can be made at this stage.

6.5 Interpretation and Presentation of Groundwater Quantitative Status

- Member Countries should provide a map of all important groundwater bodies including the location of sampling sites.
- For each important groundwater body Member Countries should provide information on the characterisation of the groundwater body (according to chapter 4 and 5).
- The results for one sampling site should be aggregated as an annual mean value or twice-yearly mean value if appropriate. For each groundwater body monitoring these data should be aggregated per year and be compared with or related to the data of a reference year, the mean values for a reference period or to average long term values (e.g. for a 30 years period). The aggregation of yearly data could be done as percentiles, mean values and extremes for the groundwater area. Wherever possible trends should be calculated. Overviews should be provided by tables, figures and maps (further details will be given at a later date subject to the findings of pilot studies carried out by ETC/IW partners).

The following table and figures show (by way of example) the difference of the mean groundwater levels of the current year to a reference year (mean value of a reference period).

Tab 2: Differences of the mean groundwater levels of the current year to a reference year (mean value of a reference period) in cm. (All measured values were derived from one groundwater body). Analysis of the frequencies.

1994	Summary frequency in % and extremes										
Groundwater body	mean	min	10	20	30	40	50	60	70	80	90	max
GW-1	0	-11	-9	-6	-5	-3	-2	-1	1	3	7	52
GW-2	6	-38	-12	-6	-2	2	6	8	12	16	20	74

Fig 1: Summary frequency

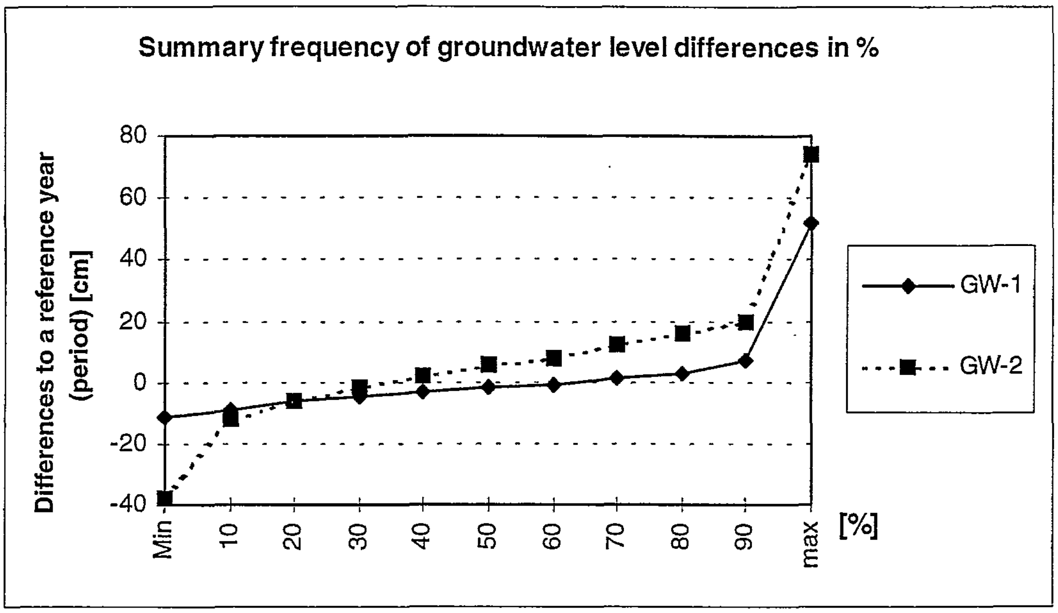
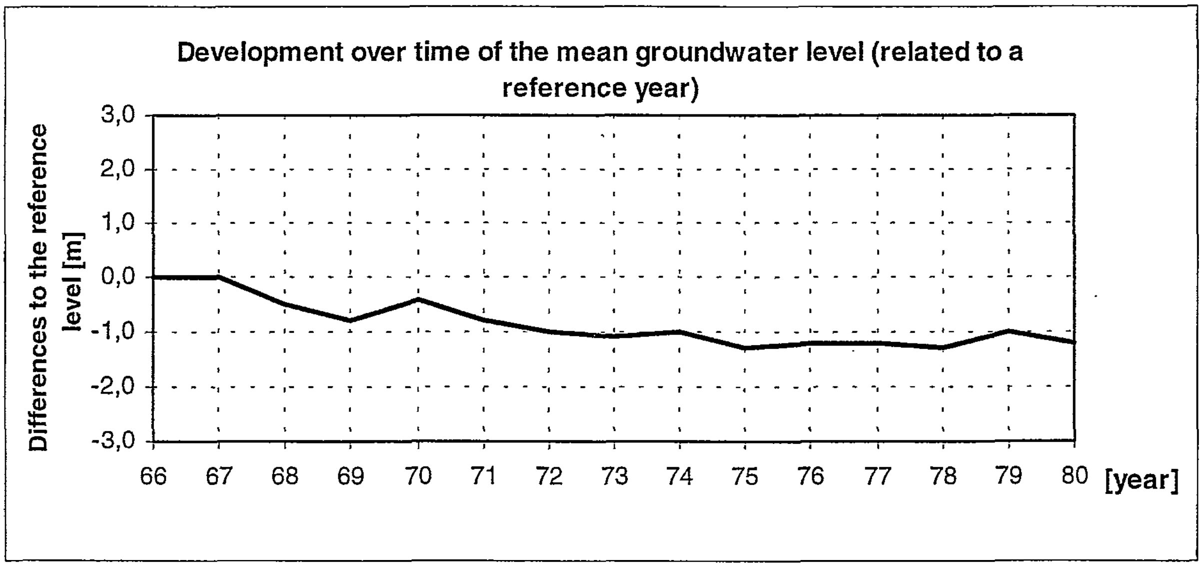


Fig 2: Development over time of the mean groundwater level for a groundwater body related to a reference year.



7. Groundwater Quality Monitoring

Two-step approach:

- Periodical **characterisation** of each important groundwater body (according to chap. 4 and 5)
- **Initial** and **surveillance monitoring** of the groundwater quality of each important groundwater body should be carried out.

7.1 Characteristics of Sampling Sites

The construction characteristics of the monitoring station must be provided when information is submitted (in particular the information on the aquifer (groundwater body being sampled or monitored). This is particularly important in multi-aqufer systems or where quality changes strongly with depth.

The monitoring network should be based on a balanced spatial distribution as well as a balanced mixture of different types of sampling sites in order to give representative information on the mean quality of a groundwater body. A monitoring network dominated by a specific type of sampling sites could provide results which are not representative for the region (e.g. drinking water wells are usually situated in unpolluted areas).

The purpose of a sampling site shall be indicated when information is submitted:

1. Drinking water well
2. Industrial
3. Other uses (irrigation,...)
4. Surveillance

7.2 Sampling Site Density

The **density of observation wells** should depend on:

- The size of the groundwater body.
- The geological and hydro(geo)logical characteristics and complexity of the aquifer
- Intensity of impacts (e.g. land use, population density, point and diffuse sources).

Comment: A pilot study in heavily impacted area suggested that a sampling density of about 25 km²/site would be appropriate for such an impacted area. For regional surveillance in less-- impacted areas a more appropriate sampling density could exceed 100 km²/sampling point. Further experience is essential.

For each important groundwater body for which **vulnerability mapping** exists monitoring density should be chosen also in accordance with the findings from the vulnerability mapping.

7.3 Monitoring frequency

Groundwater quality parameters should be monitored according to the following monitoring programme which has been set up for a period of six years:

- In the first year of the monitoring period all important groundwater bodies have to run through an **initial monitoring** where groundwater bodies should be monitored **at least**

twice. Seasonal variations and aquifer characteristics should be taken into account and might require higher monitoring frequency.

- during the following five years of the monitoring period all important groundwater bodies have to run through a **surveillance monitoring** where groundwater bodies should be monitored **at least once a year.** Seasonal variations and aquifer characteristics should be taken into account and might require higher monitoring frequency.
- All important groundwater bodies for which the general characterisation did not detect significant anthropogenic pressures **and** the initial monitoring did not detect *impacted groundwater quality,* do not have to run through the surveillance monitoring.
- After the completion of the monitoring programme it has to be **started again** with an initial monitoring. (according to chapter 4 and 5)

The sampling schedule should relate to the infiltration or recharge regime of the groundwater body and to seasonal variations in the use of pollutants (from land use) causing groundwater pollution.

7.4 Parameters

The **initial monitoring** should give a first overview and characterisation for all important groundwater bodies about the natural content of quality parameters and anthropogenically induced pollution. It shall contain at least bold marked determinants of Group 1 and all other determinants of group 1 and 2 which could be of relevance according to the anthropogenic pressures which were detected in the course of the general characterisation of the groundwater body.

Group		Determinants
1	Descriptive parameters	**pH, EC, DO** Temp.
	Major ions	**Ca, Mg, Na, K, Cl, NH_4, NO_3, NO_2, HCO_3, SO_4** PO_4, TOC
2	Heavy metals	As, Hg, Cd, Pb, Cr, Fe, Mn, Zn, Cu, Al, Ni, Choice depends partly on local pollution source as indicated by land-use framework
	Organic substances	Aromatic hydrocarbons, halogenated hydrocarbons, phenols, chlorophenols. Choice depends partly on local pollution source as indicated by land-use framework
	Pesticides	Choice depends in part on local usage, land-use framework and existing observed occurrences in groundwater.
	Additional parameters	Choice depends partly on results of pressure analysis (according to chapter 5)

The **surveillance monitoring** follows the initial monitoring and observes all group 1 determinants and all other determinants, where (significant) deviations from the natural background occur.

7.5 Interpretation and Presentation of Groundwater Chemical Status

- Member Countries should provide a **map** of all important groundwater bodies including the location of sampling sites.
- For each important groundwater body Member Countries should provide information on the **characterisation** of the groundwater body (according to chapter 4 and 5).

The results for one sampling site should be aggregated as an annual mean value. The results of individual monitoring points within a groundwater body should be aggregated for the groundwater body as a whole.

- Sampling sites:

- Number of sampling sites for each type of sampling site.

- Quality data:

- For each groundwater body monitoring data should be aggregated per year. The aggregation of yearly data could be in the form of percentiles (10, 25, 50, 75, 90), mean values and extremes for the groundwater area. Wherever possible trends should be calculated. Overviews could be provided by tables, figures and maps.

This information should allow an assessment of groundwater quality with regard to limit values (e.g. Drinking Water, ...), a comparison between unimpacted and impacted groundwater bodies and analysis of time series.

The information provided (maps, table, descriptions, statistical data) should allow the assessment about the status of the groundwater body and extent of the impacted areas.

The following tables and figures show examples for the presentation of quality data:

Tab 3: Summary frequency of nitrate (annual mean values in mg/l)

					percentile												
YEAR	sampl. sites	mean value		min	10	20	25	30	40	50	60	70	75	80	90	max
1991	85	27,16194118		0	3,12	9,54	11	12,51	15	17,65	22	28	31	35,04	66,35	137
1992	85	24,95014837		0	3,08	7,9	9,3	10,2	12,9	15,6	19,36	23,6	26,5	31,84	63,68	138
1993	84	26,18678679		0	3,5	7,7	9,6	11	13,36	16	19,42	27,4	30,15	38,02	64,62	142,4
1994	83	25,02109091		0	2,51	7,32	9	10,26	12,5	14,95	18,1	24,8	29,65	34,14	61,92	243
1995	81	28,06574074		0	2,85	7,5	10,425	12,15	14,8	17,3	23,1	30,6	32,9	37,8	68,7	144,9
1996	94	30,5079492		0	2,705	9,61	11,275	12,2	14,6	17,55	22,2	29,1	32,425	42,6	83,1	251

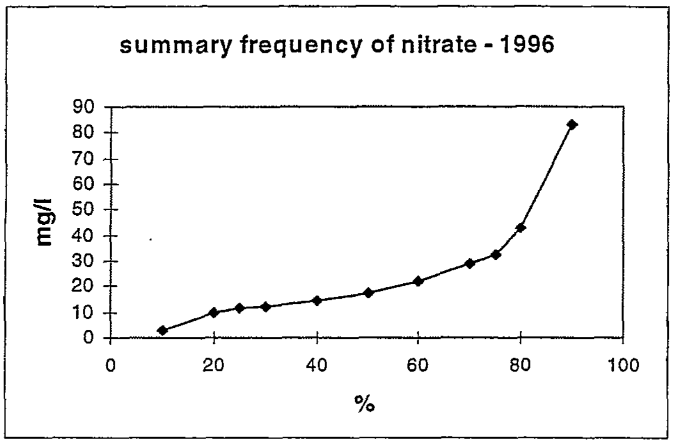
Tab 4: Summary frequency of chloride (annual mean values in mg/l)

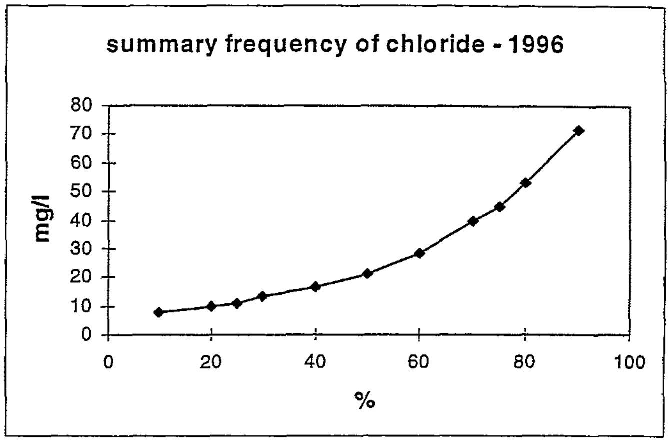
					Percentile											
YEAR	sampl. sites	mean va	ev.	min	10	20	25	30	40	50	60	70	75	80	90	max
1991	85	30,05635	28343	1,4	6,03	9	10,275	11,03	14	17,5	22,92	27	32,425	39,84	58,96	266
1992	85	30,96765	33727	1,4	6,28	7,98	9,2	10,38	14,02	16,6	22,5	27,56	31,6	38,26	54,64	548
1993	84	30,14744	67404	1,9	6,7	8,58	9,6	11,1	14,42	17,6	22,58	27,52	33,1	40,04	61,42	460
1994	83	38,31424	38885	1,7	6,41	8,7	9,275	11,03	14,7	17,5	23,18	28,24	33,525	39,32	60,95	947,1
1995	81	39,66234	25997	1,6	7,35	9,1	10,3	12,35	15,4	19,05	23,6	31,5	35,75	42,4	63,1	962,7
1996	94	35,8197861	46,4115366	1,94	7,57	9,68	10,775	13,3	16,4	21,3	28,3	39,7	44,75	53	71,95	468

Fig 3: 25 %, 50 % and 75 % percentiles for nitrate and chloride (1991 - 1996).

Tab 5 and Fig 4: Summary frequency of nitrate and chloride in 1996

1996					Percentile											
para	sampl. sites	mean value		min	10	20	25	30	40	50	60	70	75	80	90	max
nitrate	94	30,5079492		0	2,705	9,61	11,275	12,2	14,6	17,55	22,2	29,1	32,425	42,6	83,1	251
chloride	94	35,8197861		1,94	7,57	9,68	10,775	13,3	16,4	21,3	28,3	39,7	44,75	53	71,95	468

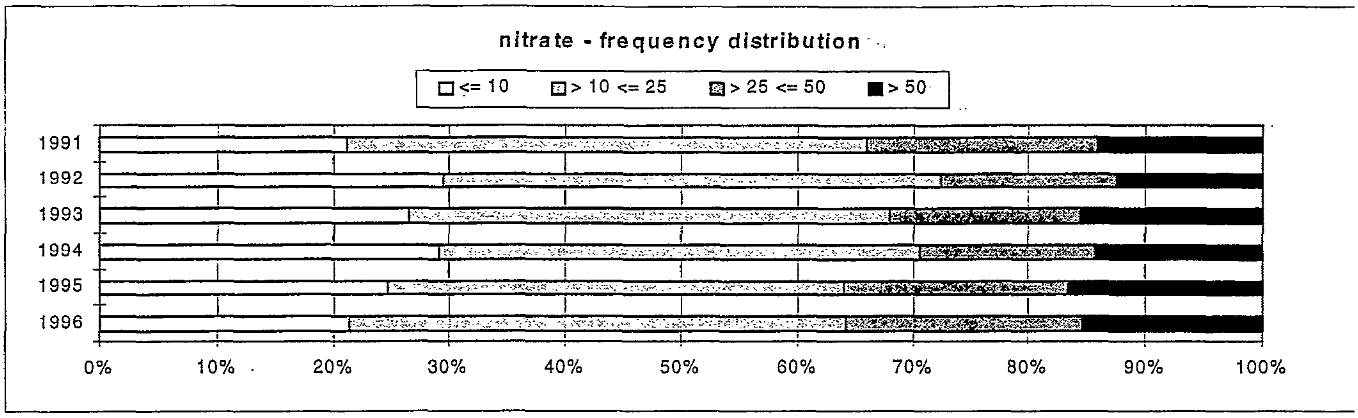


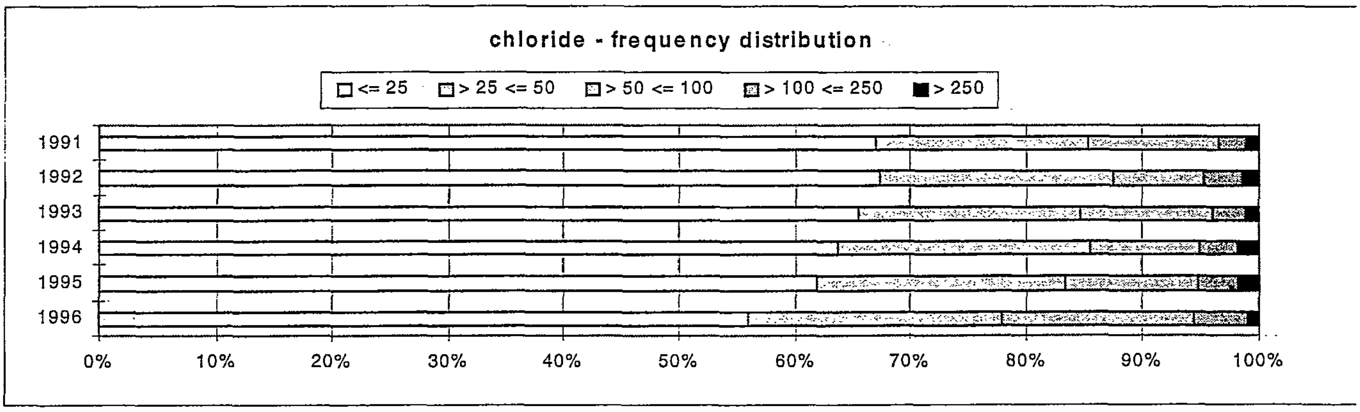


Tab 6, Fig 5: Frequency distribution of nitrate and chloride (annual mean values of sampling sites)

	frequency distribution in %				
nitrate	<= 10	> 10 <= 25	> 25 <= 50	> 50	sampling sites
1996	21%	43%	20%	16%	94
1995	25%	39%	19%	17%	81
1994	29%	42%	15%	14%	83
1993	26%	41%	17%	16%	84
1992	29%	43%	15%	12%	85
1991	21%	45%	20%	14%	85

	frequency distribution in %					
chloride	<= 25	> 25 <= 50	> 50 <= 100	> 100 <= 250	> 250	sampling sites
1996	56%	22%	17%	5%	1%	94
1995	62%	22%	11%	3%	2%	81
1994	64%	22%	9%	3%	2%	83
1993	65%	19%	11%	3%	1%	84
1992	67%	20%	8%	3%	1%	85
1991	67%	18%	11%	2%	1%	85


nitrate - frequency distribution
<= 10
> 10 <= 25
> 25 <= 50
> 50
1991
1992
1993
1994
1995
1996
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%


chloride - frequency distribution
<= 25
> 25 <= 50
> 50 <= 100
> 100 <= 250
> 250
1991
1992
1993
1994
1995
1996
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%

3. EXAMPLES OF NATIONAL GROUNDWATER QUALITY REPORTING

3.1 Denmark

3.2 USA

GRUNDVANDSOVERVÅGNING 1995

DANMARKS OG GRØNLANDS GEOLOGISKE UNDERSØGELSE
MILJØ- OG ENERGIMINISTERIET

GEUS

Særudgivelse
Redaktør: Ole Stig Jacobsen
Tegning: Annabeth Andersen, Gitte Nicolaisen
Eva Melskens og Helle Zettervall
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Danmarks og Grønlands Geologiske Undersøgelse
Thoravej 8, DK-2400 København NV
Telefon: 31 10 66 00
Telefax: 31 19 68 68

I kommission hos:
Geografforlaget Aps
Ekspedition: Fruerhøjvej 43, 5464 Brenderup
Telefon: 64 44 16 83
Telefax: 64 44 16 97

3. English Summary

3.1 The monitoring programme

In the autumn of 1987, the Danish Parliament passed the Action Plan against Nutrient Pollution of the Danish Aquatic Environment. In connection with this plan, a nationwide monitoring programme on the aquatic environment was established on 1 October 1988. The monitoring programme also includes comprehensive monitoring of groundwater.

67 groundwater monitoring sites and 6 so-called agricultural watershed monitoring sites were established throughout Denmark. Within these respective areas 1.400 and 350 screens have been installed in order to monitor groundwater quality and its change over time. The monitoring programme includes the main inorganic components of groundwater (including nitrate and phosphates), inorganic trace elements, pesticides, and organic micropollutants.

The basic data are collected by the counties and reported to the Geological Survey of Denmark and Greenland (GEUS). Additionally, the results from the routine monitoring of abstraction wells by waterworks (*well quality control*) and from the monitoring of drinking water quality are included. The local authorities are responsible for these two types of monitoring.

3.2 The groundwater resource

Net precipitation

In nature water is in a constant cycle involving precipitation, evaporation, infiltration and run off. Part of the precipitation falling on land evaporates. The part which does not evaporate is called the net precipitation. The net precipitation either flows to the water courses by surface run-off or it infiltrates into the soil and eventually augments groundwater. Most of the generated groundwater slowly flows through the aquifers, exfiltrates into stream beds and lakes, and eventually reaches the sea through the streamflow.

The groundwater recharge

The annual groundwater recharge varies a great deal from region to region depending on precipitation, evaporation and local geological conditions. Based on their knowledge about local conditions, counties have made water balances and estimated the annual groundwater recharge. The groundwater recharge is highest in the central and southwester parts of Jutland where the annual recharge is 2,500-3,500 m^3 per hectare (250-350 mm). In the rest of the country the recharge is considerably smaller. In average the groundwater recharge is estimated to be between 250 and 500 m^3 per hectare (25-50 mm).

From streamflow data GEUS has estimated the actual groundwater recharge in the period 1989-1994. In general, these calculated figures confirm the estimates made by the counties.

Variation in time

Five catchment areas have been selected in order to illustrate the temporal variation in the groundwater recharge. For the selected areas, connected time series have been prepared for net precipitation, groundwater level, and stream base flow from 1965 to 1994. Groundwater recharge in the five catchment areas has shown considerable variation in the period 1965-1994. In the early 1980's the groundwater recharge was about 50% higher than in the mid 1970's. A clear connection between stream base flow and the groundwater levels was observed.

3.3 Classification of groundwater

The chemical composition of the groundwater varies in space. The variation is caused by the interaction between precipitation, evaporation and the hydrogeological conditions.

Water percolating from the surface contains a number of dissolved substances. This is caused partly by the passage through the atmosphere and partly by the effect of natural processes and anthropogenic activity on the ground surface. The substances can be divided into oxidizing substances (oxygen and nitrate), acidifying substances (e.g. carbon dioxide, nitric oxides and sulphur oxides) and xenobiotics (e.g., pesticides and chlorinated solvents).

The percolating water with its contents of oxidizing and acidifying substances and xenobiotics is not in chemical equilibrium with the geological layers through which the water passes. Therefore, water reacts with the minerals and organic substances of the sediments. As an example, the oxidizing substances will be consumed the reducing substances in the sediments, and the acidifying substances will consumed by reaction with limestone in the sediments. Thus, some of the components of the surface load are more or less transformed.

The chemical transformation of the oxidizing and acidifying substances can be described as two boundaries moving slowly downward in the aquifers. Above the oxidation boundary, oxygen and nitrate will typically occur, whereas deeper groundwater will be free from oxygen and nitrate. Likewise, the acidification boundary will separate the upper parts of the sediments from which carbonates have been leached from the lower parts where carbonates are present.

At greater depths where groundwater is old, the main part of the surface load has been transformed and therefore, the composition of groundwater largely is determined by local geology and the hydraulic characteristics of the aquifers.

The multiple variations in the composition of groundwater requires a simple system of classification. A classification system based on a division into six classes of groundwater (A,B,C,D,E,F) was presented in the GEUS monitoring report from 1993. On the basis of a statistical analysis of the natural constituents of groundwater, six major components were chosen as classification parameters (i.e., carbon dioxide, sulphate, chloride, bicarbonate, calcium and magnesium). The groundwater classes showed a characteristic geographical distribution.

In this report, the classes of groundwater have been evaluated in terms of pH and redox conditions. This evaluation showed that class A groundwater, which chiefly occurs in Western Jutland, represents soft groundwater derived from aquifers depleted of carbonates. The other major groundwater classes (B,C,D,E,F) represent groundwater from aquifers which contain carbonates to some extent or other. Therefore, these waters are more or less hard.

In relation to redox conditions, the division into classes of groundwater is less clear. Within all classes, groundwaters both rich and free of oxygen and nitrate can be found. Therefore, the classification of groundwater into classes is not complete in relation to redox conditions. This especially applies to classes A, B and D. Thus, classes E and F represent deep-lying groundwater free of oxygen and nitrate on the islands Zealand, Lolland and Falster. Class C largely represents groundwater free of oxygen and nitrate and affected by intensive water abstraction. Groundwater of class C is situated in the eastern parts of Zealand in and around the area of Copenhagen.

3.4 Nitrate

Land use

Within the agricultural watershed monitoring sites there is a considerable information on land use and farming practices. Monitoring of the agricultural watersheds has shown that nitrate leaching is much lower in natural areas than in agricultural areas. Similar results are observed in the groundwater monitoring programme where low nitrate contents are found within monitoring sites situated mainly in natural areas. Furthermore, the agricultural watershed monitoring programme shows that a considerable difference can be found in the annual nitrogen leaching between watersheds with sandy soils (137 kg N/ha) and watersheds with loamy soils (75 kg N/ha).

Status

Based on the data from the monitoring programme, there are pronounced regional differences in the nitrate content of groundwater. Also pronounced differences with depth are seen. Depending on how data are classified, differences in the nitrate content can be demonstrated based on a division into sedimentary rock types, classes of groundwater or hydraulic conditions.

Classes of groundwater

Generally,the nitrate content is highest within class A groundwater, where the median nitrate content is 29 mg/l; above the guideline value for nitrates in drinking water. Groundwater class B also has high nitrate levels with a median of approximately 11 mg/l. The two classes (A and B) are common in Jutland. Median concentrations, of course, mask high levels of nitrates in individual wells, especially for classes A and B.

Within the classes A and B about 25 per cent of the analyses exceed the maximum allowable concentration of nitrate in drinking water (50 mg/l), and concentrations greater than 100 mg/l are not unusual.

Geological conditions

The nitrate content is highest in the Quaternary and Miocene sandy aquifers where the median of nitrate concentration is approximately 13 mg/l. There are great variations in the data set and 25% of the analyses in the sandy aquifers have concentrations greater than 50 mg/l. The concentration in the limestone aquifers is considerably lower with a median of approx. 2 mg/l. Still, in a quarter of the analyses the nitrate concentration is greater than 23 mg/l. Probably this great variation is caused by the high nitrate concentrations found in the limestone aquifers in the counties of Århus, Viborg and Northern Jutland.

Water table conditions

High concentrations of nitrate are found especially in the unconfined aquifers. Usually, these aquifers have been oxidized to great depth. Therefore, the possibilities for nitrate reduction are limited.

Flow defined groups of screens

The well screens of the monitoring programme have been classified according to flow conditions. *Point monitoring screens* are screens which monitor groundwater from aquifers which are small, local and close to the surface. *Line monitoring screens* are monitoring groundwater along a stream line in the aquifer. Wells which are used for abstraction of water by waterworks are termed *volume monitoring screens*. The highest concentrations of nitrate are found in the point monitoring screens which normally represent shallow groundwater. Volume monitoring screens represent groundwater at greater depths and have a low concentration of nitrate.

Well quality control

To a large extent the above mentioned distribution of high concentrations of nitrate is also found when the results from the well quality control are examined. In parts of the counties of Northern Jutland, Viborg and Århus nitrate concentrations of more than 50 mg/l are frequently found (the so-called nitrate belt). Often aquifers in the nitrate belt are limestone aquifers and covered only by sandy, quaternary top layers with no significant nitrate reduction capacity.

Furthermore, elevated concentrations of nitrate (more than 25 mg/l) are found quite often in the county of Ribe, where especially waterworks abstracting from aquifers close to the surface are affected. Also, elevated concentrations of nitrate are found scattered in the county of Southern Jutland, in Vendsyssel and in the island of Funen (normally between 25 and 50 mg/l).

Change

Time series of nitrate have been produced for screens with more than one mg of nitrate per. litre. Hereby data are excluded for those aquifers where no nitrate have been found, and focus is put on the aquifers which are already affected, and where changes in surface load will be most pronounced.

The time series of nitrate have been examined statistically using linear regression analysis. No statistically significant trend in nitrate concentrations could be observed for the major part of the screens examined. For that relatively small number of screens where a change was observed, the number of screens with increasing and decreasing trends in nitrate concentrations were almost equal. Most of the significant changes in nitrate concentrations (increasing as well as decreasing) are observed in screens close to the surface.

In accordance with this no statistically significant change can be found within the monitoring programme at any of the groupings of screens which have been made. This also applies to the point monitoring screens, which are the screens where changes in surface load are expected to have the most immediate effect.

Generally, changes in the nitrate concentration of groundwater can be assumed only to take place with a considerable delay. Some of the changes which can be detected today are probably due to conditions prevailing before the start of the monitoring programme. Within the agricultural watershed monitoring programme focus is put on the youngest, recently formed groundwater. Possible changes in the nitrate load are expected to be registered here first. As is the case with the groundwater monitoring programme, no general trend in nitrate concentrations can be seen when a trend analysis is applied to the data from each and every screen within the agricultural watershed monitoring programme. The nitrate concentration of the most superficial aquifers has remained high and unchanged throughout the monitoring period.

No decrease in nitrate concentration

For the monitoring programme as a whole no change in the nitrate concentration of groundwater can be demonstrated for the period 1990-1994. Therefore, it can be concluded that the goal to reduce the amount of nitrogen leached to the aquatic environment by 50% which was set up in the Action Plan against Nutrient Pollution of the Danish Aquatic Environment has not yet been reached.

The nitrate contents of drinking water

In general, the drinking water nitrate content is low, and today about 70 per cent of the waterworks supply water with nitrate concentrations of less than 5 mg/l. Not quite 3 per cent of the number of waterworks which have been reported to the GEUS database, are unable to meet the maximum allowable concentration for nitrate in drinking water at 50 mg/l. In accordance with the results from the well quality control elevated concentrations of nitrate in drinking water are found most frequently in the counties of Århus, Viborg and Northern Jutland.

On a national basis drinking water quality has generally improved from 1985 to 1994. The number of waterworks which deliver water with nitrate concentrations of less than 5 mg/l has increased from 61 per cent to 71 per cent during this period. In general, the number of waterworks which supply water with elevated nitrate concentrations has decreased in the same period. Still, it must be pointed out that the positive development of drinking water quality does not indicate an improvement of groundwater quality. The reduction of nitrate concentrations in drinking water is due to the efforts made by the counties, the local authorities and the waterworks themselves to relocate water abstraction to aquifers less polluted with nitrate.

3.5 Phosphorous

Mainly, the surface load with phosphorous is due to the spreading of fertilizers, manure and sewage sludge on the fields. Still, the contribution by the surface load to the phosphorous contents of groundwater is very limited as most of the phosphorous supplied is fixed in the root zone.

Classes of groundwater

The major part of the phosphorous contents found in groundwater is of geological origin. The highest concentrations of phosphorous occurs in class E which represents old groundwater free from oxygen and nitrate. The somewhat high phosphorous concentrations in this type of groundwater may be due to the long residence time of groundwater in the aquifers, whereby phosphorous is slowly dissolved from inorganic phosphorous compounds. Further, the decomposition of organic matter under oxygen and nitrate-free conditions will result in a release of organically bound phosphorous.

No problem for water supply

Normally, phosphorous will be retained by the water treatment at the waterworks. Therefore, phosphorous in groundwater do not pose a problem for the supply of drinking water.

3.6 Sulphate

Sulphate in the groundwater is due mainly to the oxidation of the sulphide mineral pyrite in the sediments. Usually, moderately elevated concentrations of sulphate are caused by the supply of oxidizing compounds (e.g., oxygen and nitrate) by the percolating water. Highly elevated sulphate concentrations are caused by intensive water abstraction, which results in large draw down of the groundwater table. Thus, intensive oxidation of pyrite takes place by admission of atmospheric oxygen, whereby large amounts of sulphate are released. Furthermore, sulphate contents in groundwater stems from surface deposition of sulphurous compounds from power plants and incineration plants. Finally, in coastal areas sulphate may be due to intruding seawater.

Classes of groundwater

The highest sulphate contents occur in groundwater of class C which has a median of 115 mg/l. This is considerably above the guideline value of 50 mg/l for sulphate in drinking water. The second highest contents occur in class D groundwater where the median is 71 mg/l. Classes C and D both show large variations in data. The other major classes have low contents of sulphate.

Geological conditions

The highest sulphate content occur in the Quaternary, fine-grained aquifers where the median is around 60 mg/l. Based on the screen types, the sulphate content shows a dependence on depth. The more shallow screens (point monitoring screens) have the highest sulphate content, whereas the deeper-lying volume monitoring screens have the lowest content. Similarly, high sulphate contents are especially seen in the upper aquifers, where the median is around 50 mg/l.

In general, there is no difference in the sulphate contents of unconfined and confined aquifers. However, when looking exclusively on screens with high sulphate contents, it is characteristic that sulphate contents are higher in unconfined aquifers than in confined aquifers. This corresponds with the fact that variations in the water table primarily occur in unconfined aquifers.

Well quality control

Elevated sulphate contents are found especially in areas characterised by intensive abstraction. This applies to Copenhagen and environs, major parts of Bornholm, areas near Århus and Aalborg, and parts of Funen. In general the counties estimate that the increased sulphate contents are caused by an interaction between oxidation of pyrite and variations in ground water levels.

Change

No statistically significant trend in the sulphate contents can be seen in any of the groupings of screens which have been made. Still, based on the elevated contents of sulphate found in the well quality control, it is clear that the intensive abstraction, which has been carried out in a number of areas has resulted in a considerable increase in the sulphate content of groundwater.

Sulphate contents of drinking water

Approximately 65 per cent of the reported waterworks supply water, which meet the guideline value for sulphate of 50 mg/l. Only very few waterworks are not able to meet the maximum allowable concentration for sulphate in drinking water at 250 mg/l. Elevated sulphate contents in drinking water (defined as more than 100 mg/l) most frequently occur in the county of Copenhagen, in the islands of Bornholm and Funen. By and large this is in accordance with the results from the well quality control.

On national basis no significant change can be found in the sulphate contents of drinking water from 1985 to 1994.

3.7 Chloride and sodium

In coastal areas chloride is often derived from seawater intrusion into the aquifers. Chloride may also be derived from marine sediments. In some parts of the country chloride occurs in groundwater in connection with faults through which salt water can penetrate from great depths. From the surface chloride contents are augmented by precipitation, and by the spreading of road salt and fertilizers or by percolation from waste dumps.

Classes of groundwater

Groundwater of class C has significantly higher chloride contents than the rest of the major classes. Class C chiefly represents the more superficial screens around the large cities and in Zealand. Groundwater of class F is characterised by great variations in the contents of chloride. Class F mainly represents the deeper groundwater in Zealand.

Geology and water table conditions

No significant differences in the chloride contents occur between the sediment types investigated. Still, the chloride contents of the Miocene sandy aquifers in Western Jutland are lower than of the other sediment types. The confined aquifers have lower contents of chloride compared to the unconfined aquifers.

Marine influence

When the screens with the highest contents of chloride are examined (more than 100 mg/l) most of the screens are found in the coastal areas, apparently independent of the sediment type or other aquifer conditions.

Change

For the groundwater monitoring programme as a whole no increase in the chloride content can be seen from 1990 to 1994. However, the screens where an increase is observed are predominantly situated in the coastal areas of the country.

Well quality control

Within the well quality control elevated chloride contents are found especially in Copenhagen and environs, in the coastal areas of Western and Southern Zealand, and in the islands of Møn, Lolland and Falster. Furthermore, elevated chloride concentrations are found locally in the county of Funen and near Århus. In considerable parts of the counties of Århus and Northern Jutland a risk exists of chloride in the deeper parts of the aquifers, but generally the waterworks have been able to avoid these groundwater resources. Likewise, there are chloride problems at the Skaw, on the island of Læsø, near Thisted, and in areas along the west coast of Jutland.

Sodium

Often, elevated contents of sodium and chloride in groundwater occur at the same time, since the dissolution of ordinary sodium chloride carries equal parts of sodium and chloride to the groundwater. However, ion exchange may cause an increase in the sodium contents without a corresponding increase in the chloride contents. This is especially seen in parts of the county of Western Zealand.

Chloride contents of drinking water

Only a few waterworks supply water which do not meet the maximum allowable concentration for chloride in drinking water of 300 mg/l. Approximately 70 per cent of the waterworks meet the guideline value of 50 mg/l for drinking water. Elevated chloride contents of more than 100 mg/l especially occur in the counties of Copenhagen, Western Zealand and Storstrøm. This corresponds with information from the well quality control.

A small improvement can be seen in the chloride contents of drinking water from 1985 to 1994. This applies to the number of waterworks which meet the guideline value and the maximum allowable concentration, respectively. A weighed average of the chloride contents of drinking water also show a small improvement. As is the case with nitrate, the improvement is presumably due to administrative initiatives in order to improve the quality of drinking water.

3.8 Other major constituents

Fluoride

Fluoride in groundwater is of geological origin. Fluoride especially occurs in deep, old, and stagnant groundwater in sediment types containing lime. This is seen within the monitoring programme. In the island of Bornholm elevated fluorine concentrations are found in sandstones containing glauconite. Within the well quality control this pattern also is seen, and high fluorine concentrations are found mainly in the counties of Storstrøm, Roskilde, Western Zealand, and Bornholm.

Organic matter

Organic matter in groundwater occurs where deposits are rich in biological material. High contents of organic matter lends groundwater a brown or almost black colour, which makes it unfit for drinking water purposes. Generally, the problems with organic matter in the groundwater can only be evaluated to a limited extent from the monitoring programme, as sites with high contents of organic matter are not represented. Based on the well quality control data and the reports of the counties groundwater with high contents of organic matter has been found in the counties of Ribe, Southern Jutland and Ringkjøbing. Furthermore, brown water occurs at the Skaw and locally in the counties of Frederiksborg and Vejle.

3.9 Inorganic trace elements

Contents of inorganic trace elements in groundwater originates from the contents of these elements in the sediments. Further, trace elements in groundwater may also originate from anthropogenic activities.

There are great differences in the contents of the various inorganic trace elements. However, the major part by far of the analysis show very low concentrations (often below or near the detection limit). It applies to all trace elements that they sporadically occur in high concentrations in groundwater.

Controlling factors

A number of factors influence the concentration of trace elements in groundwater. Trace elements in groundwater may originate from anthropogenic activities at the surface, by weathering processes in the uppermost sediments, or from the sediments. The individual chemical properties of the trace elements determines which contents can be found in groundwater. However, the actual distribution and concentration of the trace elements are determined through the influence of Ph and the redox conditions, flow patterns and the possible retention of the trace elements in the sediments.

Flow

It is characteristic that the highest contents of trace elements are found in highly permeable aquifers with low inherent content of trace elements. Thus, there is no unambiguous connection between the contents of trace element in groundwater and the contents of the sediments.

The classes of groundwater and pH

By contrast, there is a clear dependence on the acidity (pH) of the groundwater and the concentration of inorganic trace elements. By comparing the contents of trace elements to the classes of groundwater it can be seen that the trace element contents of class A are significantly different from the rest of the classes. The groundwater in class A is acidic compared to the other classes.

Oxidation conditions

Furthermore, the oxidation conditions of the groundwater is important for the redox state and thereby the mobility of a number of trace elements. Within the monitoring programme lower contents of lead, cadmium, nickel, zinc, copper, and chromium are observed under reduced and nitrate-free conditions.

Oxidation of pyrite

Oxidation of pyrite may be of great importance for the supply of trace elements to groundwater as pyrite may contain smaller amounts of a number of trace elements. As pyrite decomposes the trace elements of pyrite are released to groundwater. Within the monitoring programme the highest contents of trace elements are found immediately below the regional groundwater table. These high contents of trace elements may be interpreted as a result of pyrite oxidation in the upper part of the aquifers, where oxygen is supplied by variations in the groundwater table, and nitrate is supplied from the spreading of fertilizers, manure etc. The contents of trace elements are generally decreasing with increasing depth below the groundwater table.

The uppermost groundwater

The supply of trace elements to groundwater from the surface have been evaluated for the uppermost groundwater. The contents of lead, cadmium, nickel, copper, chromium, and aluminium are higher in shallow screens when compared to the deeper screens. Likewise, the contents of copper, chromium, and aluminium are highest in screens placed in the secondary aquifers. Furthermore, the contents of lead, cadmium, nickel, zinc, copper, chromium, aluminium, and vanadium are higher in the unconfined aquifers than in the confined aquifers.

In order to estimate the influence of the surface load on the content of trace elements in the uppermost groundwater, the point monitoring screens placed in unconfined, secondary aquifers were compared to similar screens placed in a natural area. Higher contents of lead, cadmium, nickel, zinc, copper, chromium, aluminium, barium, and lithium occurred in agricultural areas and in built-up areas when compared to the contents of trace elements in natural areas.

The contents of trace elements in the uppermost groundwater in Central and Southern Jutland were investigated in relation to the contents of the sediments. It was shown that for some trace elements the contents of groundwater was considerably higher than what could be accounted for based on the inherent contents of the sediments. This shows that a major part of the contents of arsenic, lead, cadmium, nickel, copper, and chromium in the uppermost groundwater originate from anthropogenic activities at the surface.

Deep groundwater

In the deeper parts of the aquifers groundwater moves very slowly. Therefore, trace elements may be released to groundwater from the sediments as a result of dissolution processes. High contents of trace elements will occur where groundwater is in contact with deposits of marine clay with high contents of trace elements.

Well quality control

Nickel is the only trace element which is measured on a regular basis in the well quality control. The results show that nickel contents in groundwater exceed the maximum allowable concentration for drinking water in the Køge Bay area and scattered in the counties of Ribe and Ringkjøbing. In these areas nickel poses a major regional problem for water supply. Presumably, the high nickel contents are caused by pyrite oxidation as a relation between nickel contents and sulphate contents can be found.

In areas with acidic groundwater the well quality control measures for aluminium. Mainly, increased aluminium contents are presumed to be controlled by pH.

For the other trace elements only very limited data are available in connection with the well quality control.

General distribution model

Based on the results from the monitoring programme and the well quality control a general distribution model for trace elements in groundwater can be presented. Trace elements are supplied in the unsaturated zone by surface load or by weathering processes. The weathering processes are controlled by fluctuations in groundwater table or by the supply of nitrate. Thus, very high concentrations are generated immediately below the groundwater table. However, the dissolved trace elements are retained quickly in the sediments due to the continuous downward flow of groundwater. At greater depths, where groundwater is stagnant or flows very slowly the concentration may rise again by a slow release from the sediments.

With the exception of nickel, trace elements in groundwater do not pose a major problem for water supply today.

3.10 Pesticides

The monitoring programme

In the Danish monitoring programme the following pesticides are monitored: dichlorprop, mecoprop, MCPA, 2,4-D (phenoxyacids), atrazine and simazine (triazines), and dinoseb and DNOC (nitrophenols). One or more of the 8 pesticides have been found in 10 per cent of the well screens monitored between 1989 and 1994. On a county level the frequency of pesticides found vary between 0 and 16 per cent when the city of Copenhagen is excluded. The pesticides most frequently found are dichlorprop and mecoprop (phenoxyacids) and atrazine (triazine). Only a very limited number of nitrophenols have been found.

Pesticides most frequently are found in shallow groundwater less than 10 meters below ground surface, where 16 per cent of the well screens contain one or several pesticides. In general the occurence decreases with depth.

Age of groundwater

The age of groundwater have been estimated from tritium measurements. More than 95 per cent of the well screens which contained pesticides showed tritium contents corresponding to an age of less than 40 years. This age distribution corresponds to the general use of pesticides in Denmark.

Geology

No simple relation between the thickness of overlying layers of clay (clay and clay till) could be found based on the data from the monitoring programme. Apparently overlying layers of clay do not protect groundwater from being polluted with pesticides.

Geochemistry

Phenoxyacids have been found almost exclusively in groundwater with little or no oxygen and nitrate. Based on the results from the monitoring programme phenoxyacids are probably degraded when oxygen is present. When oxygen and nitrate are not present, the phenoxyacids apparently remain undegraded. Triazines can be found in both types of groundwater. Apparently triazines are not degraded in groundwater. No correlation between pesticide content and chloride, sulphate, bicarbonate and organic matter have been found. Findings of nitrophenols remains to few to assess the effect of the geochemical environment.

Well quality control

According to the reports by the counties about 3.700 water abstraction wells have been monitored for the 8 pesticides in the programme. On a national basis pesticides have been found in about 10 per cent of the wells monitored. The pesticides most frequently found by the waterworks are atrazine, dichlorprop and mecoprop. In 3 per cent of the wells the pesticide contents were above the maximum allowable concentration for drinking water. Most waterworks in Denmark rely on just aeration and filtration of groundwater in order to produce drinking water. The pesticides found in groundwater therefore probably will be found in drinking water as well.

Dug wells

Only a very number of analyses have been made on water from individually owned dug wells and borings. However, the relatively higher occurence of pesticides in shallow groundwater indicate that dug wells and shallow borings are prone to pesticide pollution.

Extended monitoring programmes

An extended monitoring programme for pesticides has been carried out by the county of Southern Jutland within the agricultural watershed of Bolbro Bæk. 18 pesticides and 2 metabolites were monitored. The results from this monitoring programme show that shallow groundwater less than 5-6 meters below the surface is strongly polluted with pesticides. 75 per cent of the monitored well screens contained one or several pesticides. If the monitoring had been restricted to the 8 pesticides covered by the national monitoring programme only 15 per cent of the well screens would have been noted as affected.

Similar results are reported from the county of Vejle. Here an extended monitoring programme comprising 12 pesticides and 4 degradation products was carried out in the 5 monitoring areas situated within the county. Pesticides or degradation products were found in 40 per cent of the well screens. Pesticides would have been found in only 3 per cent of the screens if only the 8 pesticides monitored nationally had been analyzed.

A review of international monitoring programmes showed that the frequency of findings increases with the number of pesticides and degradation products included in the monitoring programme. When more than 20 pesticides and degradation products are monitored it is common that pesticides or degradation products are found in 40 per cent of the well screens. Based on these results it must be concluded that the monitoring programme covers only a small number of pesticides compared to the pesticides which in practice be found in groundwater. The actual pesticide content of Danish groundwater therefore is known only with considerable uncertainty.

3.11 Organic micropollutants

The group of solutes termed organic micropollutants refers to a number of different chemicals. These chemicals are typically found in connection with point pollution. In the Danish monitoring programme 5 chlorinated solvents, 6 aromatic compounds and 9 phenolic compounds are monitored. Also VOX (sum of volatile organic halogens) is monitored. The presence of VOX may indicate that groundwater is polluted with other halogenated (i.e. chlorinated) compounds which are not analyzed routinely in the monitoring programme.

Pollution of groundwater by organic micropollutants is in most cases due to point pollution. This makes it difficult to evaluate the general effect of geology on the transport of organic micropollutants. It is the presence or the absence of a point source of pollution which determines whether organic micropollutants may be found in ground water or not.

Sources of pollution

The presence of organic micropollutants in groundwater predominantly originates from spillage or from waste disposals from different types of industrial activities. Organic solvents have been used in numerous types of industry. Aromatic compounds comes from the storage and handling of oil products in general. Phenolic compounds are frequently found along with pollution from gasworks, but may also originate from other sources.

The monitoring programme

Most substances within the group of organic micropollutants have only been found to a limited extent within the monitoring programme. Most of the compounds have been found only in between 0,1 and 3 per cent of the monitored well screens. Certain compounds, however, are found more frequently. Benzene, toluene, chloroform and phenol have been found in 5 per cent of the well screens monitored between 1989 and 1994.

Chloroform is more widely distributed compared to other chlorinated solvents. In most cases it has not been possible to identify the source. Recent research have shown that chloroform may be formed by certain microorganisms in the topsoil of coniferous forests. In the Danish monitoring programme the highest concentrations of chloroform in groundwater are found below woods with sandy topsoil. In most cases woods in sandy areas are coniferous.

Several findings of toluene within the monitoring programme are probably caused by the use of a glue containing toluene used to assemble some of the well screens. At present it is not possible to explain the relatively frequent findings of benzene and toluene. No sources of pollution with benzene and phenol are known within the affected monitoring areas.

Well quality control

There is no regular monitoring of all organic micropollutants in the wells of the Danish waterworks. Often monitoring for organic micropollutants is performed only in the case of a nearby potential source of pollution. Most frequently chlorinated solvents are monitored for. Organic micropollutants are most often found in urban areas, which corresponds to the fact that most of the potential sources of pollution are located in developed areas. Especially within the metropolitan area of Copenhagen frequent findings of chlorinated solvents have been made. The monitoring sites are predominantly located in agricultural areas which in general are less affected by with organic micropollutants. Therefore, the results from well quality control probably provide a more accurate picture of pollution with respect to organic micropollutants.

The county of Copenhagen has surveyed the content of organic micropollutants in groundwater. In connection with this survey the relationship between findings of chlorinated solvents in groundwater and the thickness of overlying layers of clay (clay, clayey till) was investigated. It could not be shown that overlying layers of clay had any significant protective effect against chlorinated solvents. Similarly, a survey by the city of Copenhagen showed that findings of chlorinated solvents reflect the location of point sources, and that findings only showed little dependence on the geological conditions.

Urban problem

With the possible exception of chloroform findings of organic micropollutants are linked to point sources of pollution from waste deposits, industrial activities etc. Pollution of groundwater with organic micropollutants is a typical problem of urban areas, with a high density of point sources. Concurrently with the ongoing national survey of waste deposits it is to be expected that the known number of point sources containing organic micropollutants will increase.

Groundwater Nitrate Content

8.2 Grundvandets indhold af nitrat

Nitratpuljen

I jorden findes en kvælstofpulje, hvis størrelse er bestemt af en balance mellem tilførsel af kvælstof, omsætning (mineralisering og denitrifikation) af kvælstofholdige forbindelse i jorden, samt udvaskning. Grundvandets indhold af nitrat skyldes overvejende udvaskning af nitrat fra kvælstofpuljen på landbrugsarealer.

Omsætning af kvælstof

Under nedbrydning af kvælstofpuljen frigøres uorganisk kvælstof, som normalt hurtigt ved hjælp af mikroorganismer omdannes til nitrat. Nitrat er meget opløselig i vand, og kan derfor både let optages af planterne og let udvaskes fra rodzonen. I iltfrie zoner af rodzonen kan der endvidere ske en reduktion af nitrat (denitrifikation) til f.eks. frit kvælstof, der afgives fra jorden til atmosfæren.

Udvaskning af nitrat

Baseret på data fra landovervågningen vurderes udvaskningen af kvælstof (primært i form af nitrat) fra rodzonen til i gennemsnit at være 75 kg N/ha pr. år for lerjorde og 137 kg N/ha pr. år for sandjorde (DMU, 1995). Den større nitratudvaskning fra sandjorde skyldes bl.a. større gødningstilskud, valg af afgrøde, gødskningspraksis og mindre omsætning af nitrat.

Koncentrationen af nitrat i det nedsivende vand fra rodzonen afhænger tillige af størrelsen af nettonedbøren (se kapitel 6). Såfremt grundvandsdannelsen er stor, sker der en større fortynding af den udvaskede mængde nitrat end ved èn mindre nettonedbør.

Årstidsvariationer

Grundvandsdannelsen varierer igennem året, således at hovedparten af grundvandsdannelsen sker i efterårs- og vintermånederne. Dette er samtidig med, at planteväksten og dermed kvælstofoptagelsen i planterne er mindst. Indholdet af nitrat i det terrænnære grundvand varierer derfor betydeligt i årets løb. Dette bekræftes af data fra landovervågningen, hvor eksempelvis det gennemsnitlige nitratindhold i det øverste grundvand i landovervågningsområdet Barslund Bæk varierer mellem 65-70 mg/l om sommeren og mellem 90-110 mg/l om vinteren (Viborg Amt, 1995).

Nitrat i grundvand

Det nitratholdige vand vil enten via afstrømning gennem dræn og øvre jordlag blive tilledt vandløb, søer og havet eller langsomt sive ned til dybere liggende dele af grundvandsmagasinerne. Ved nedsivningen sker der en tidsmæssig forsinkelse af nitratpåvirkningen af det dybere liggende grundvand.

Afhængigt af redoxforholdene i sedimenterne kan der under nedsivningen foregå en yderligere reduktion af nitrat til frit kvælstof ved oxidation af f.eks. pyrit (se afsnit 7.4 om grundvandets redoxforhold). I dele af landet, f.eks. i Vendsyssel, kan opstigende methan fra dybtliggende marine aflejringer tillige bidrage til en reduktion af nitrat.

Generelt er grænsen for udbredelsen af nitratholdigt grundvand (nitratfronten) bestemt af både typen og mængden af reducerende stoffer i jordlagene samt af grundvandets strømningsforhold.

I lerjordsområder, hvor grundvandsmagasinerne er dækket af mere eller mindre sammenhængende lerlag af varierende tykkelse, vil en mindre del af nettonedbøren strømme til grundvandsmagasinerne, mens størstedelen af nettonedbøren vil strømme til søer og vandløb bl.a. via drænrør. Nedsivning af nitratholdigt vand i lerjordsområder foregår desuden langsomt og ofte under reducerende forhold. Nitratindholdet reduceres derfor, således at grundvandet under sammenhængende lerlag sjældent er stærkt belastet.

I sandjordsområder kan nitratbelastningen nå langt ned under grundvandsspejlet, såfremt der ikke sker en reduktion af nitratindholdet. Dybden til nitratfronten i sandjorde kan derfor variere betydeligt fra sted til sted.

Nitratbelastningen af grundvandet kan lidt forenklet beskrives som værende et resultat af en nitrattilførsel, som er stærkt afhængig dels af arealanvendelsen, herunder landbrugspraksis, og dels af beskyttelsesgraden. Beskyttelsesgraden afhænger af forekomsten af tykke, sammenhængende og lavpermeable lerlag, samt jordlagenes evne til at reducere nitrat. Disse forhold er skitseret i figur 8.1.

Grænseværdi for nitrat

Den vejledende grænseværdi for nitrat i drikkevand er 25 mg/l, og det højst tilladte indhold er 50 mg/l.

8.2.1 Status

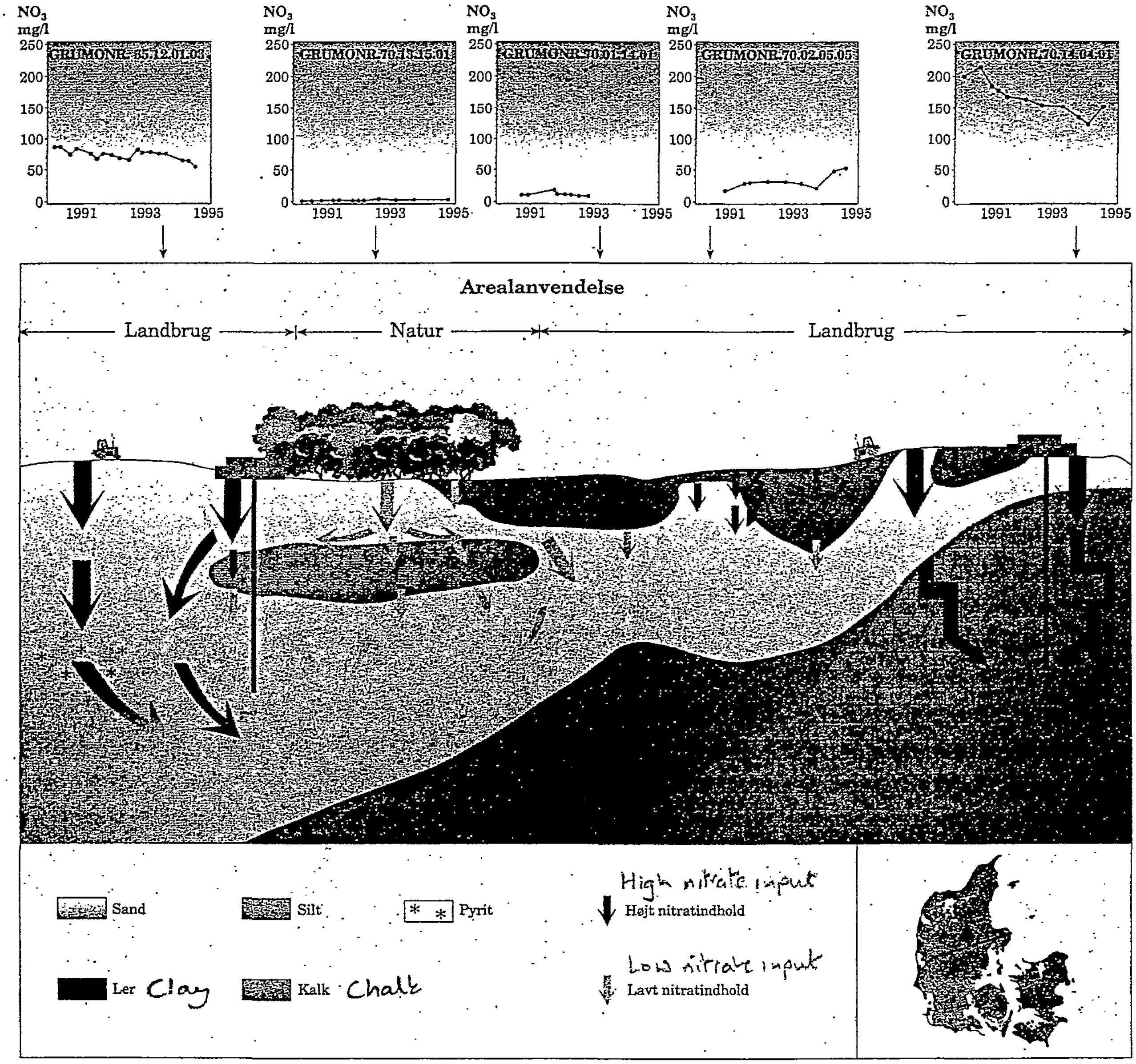
Følgende status over grundvandets indhold af nitrat er baseret på data fra grundvandsovervågningen og boringskontrollen.

Arealanvendelsen

Generelt kan overvågningsområderne for grundvand karakteriseres som værende landbrugsdomineret, og kun overvågningsområdet Asserbo kan karakteriseres som værende et egentligt naturområde. Arealanvendelsen kendes ikke i detaljer i overvågningsområderne.

I landovervågningsområderne er kendskabet til arealanvendelsen bedre. Dette har dannet baggrund for en vurdering af arealanvendelsens betydning for nitratindholdet i grundvandet. Fra landovervågningen er det således dokumenteret, at nitratbelastningen er markant lavere på naturarealer end på landbrugsarealer. Nitratindholdet på naturarealer ligger ofte under 5 mg/l, mens nitratindholdet på landbrugsarealer er på op til 85 mg/l (DMU, 1995).

Dette stemmer overens med observationerne i overvågningsområdet Asserbo i Nordsjælland, hvor mere end 80% af arealet er beplantet med skov. Området er domineret af sandede aflejringer med ringe grad af beskyttelse mod nitratnedsivning, men der observeres lave nitratkoncentrationer (0-10 mg/l). Dette er betydelig mindre, end hvad der observeres i andre geologisk tilsvarende overvågningsområder. Århus Amt (1995) konstaterer det samme for overvågningsområdet Hvinningdal i Midtjylland. I dette område er der konstateret både høje og lave nitratværdier, men amtet vurderer, at de lave nitratkoncentrationer kan relateres til de arealer, der er beplantet med skov eller ligger hen som vedvarende græs.

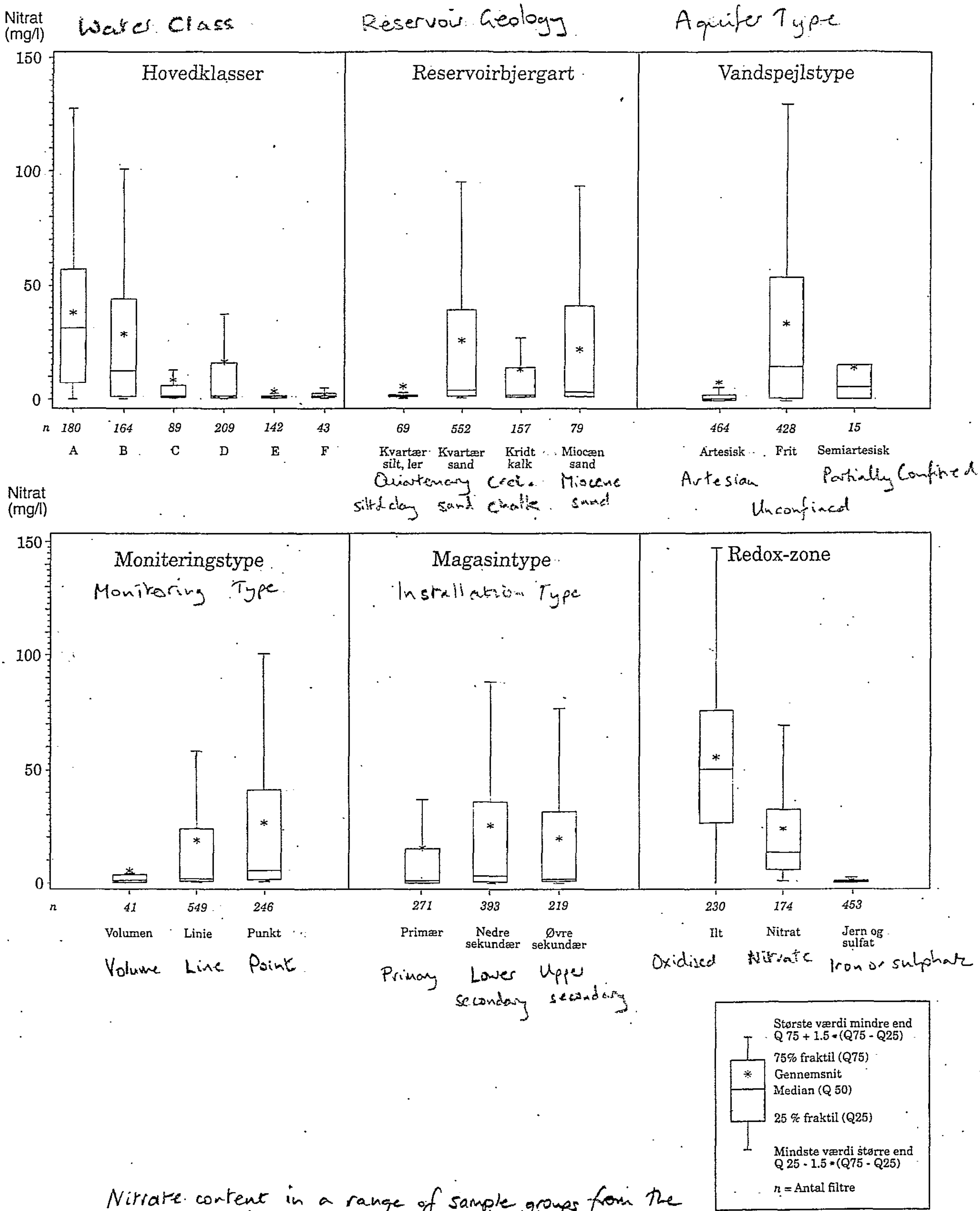


Figur 8.1: Nitratbelastningen af grundvandet i relation til arealanvendelsen og beskyttelsesgraden, herunder lerdække samt jordlagenes reduktionskapacitet. Eksempler på variationen i indholdet af nitrat i de øvre grundvandsmagasiner er illustreret i et geologisk snit fra Midtjylland til Djursland.

Fra landovervågningen er det desuden påvist, at gødskningspraksis har en afgørende indflydelse på nitratbelastningen, idet de højeste værdier for nitrat er observeret i landbrugsområder, hvor der gødskes med husdyrgødning (DMU, 1995). Variationer i kvælstofudvaskning i relation til landbrugspraksis er detaljeret refereret i Petersen (1995).

Nitratindholdet i grundvandet

I det følgende fokuseres der på nitratindholdet i relation til hovedklasser, reservoirbjergarter, vandspejlstyper, moniteringstyper, magasintyper samt redox-zoner. Nedenstående boxdiagram illustrerer den variation i nitratindholdet, der er observeret i grundvandsovervågningen (figur 8.2). I det følgende udtrykkes indholdet i de forskellige filtertyper ved medianen efterfulgt af spredningen, angivet som intervallet mellem 0,05 og 0,95 fraktilen i parentes.



Nitrate content in a range of sample groups from the overview period 1990-1994 (data above detection limits.)

Figur 8.2: Indholdet af nitrat i forskellige filtertyper fra overvågningsområderne i perioden 1990-1994 (data over detektionsgrænsen).

Hovedklasser

Nitratindholdet i hovedklasserne A og B adskiller sig signifikant fra hinanden, mens hovedklasserne C, D, E og F ikke kan skelnes statistisk fra hinanden. De største medianværdier for nitrat ses for hovedklasserne

A og B, på henholdsvis 31 mg/l (1 til 127) og 12 mg/l (1 til 101). Hovedklasserne A og B findes spredt i det meste af Jylland. Hovedklasserne C, D, E og F indeholder generelt kun små koncentrationer af nitrat med medianværdier på omkring eller mindre end 1 mg/l. Der er dog store variationer i nitratindholdet inden for hovedklasse D (<1 til 36).

Reservoirbjergarter

I relation til reservoirbjergarten observeres det højeste nitratindhold i de kvartære og miocæne sandmagasiner, der ikke statistisk kan adskilles på grundlag af nitratindholdet. Medianværdierne er på henholdsvis 3 mg/l (<1 til 94) og 2 mg/l (<1 til 92). Sandmagasinerne findes overvejende i Jylland. Kalkmagasinerne, der typisk er mere udbredt i Østdanmark, adskiller sig signifikant ved en lavere medianværdi på 1 mg/l (<1 til 26). Et minimalt indhold af nitrat ses for de fintkornede kvartære bjergarter.

Vandspejlstyper

Der er signifikante variationer i nitratindholdet i relation til vandspejlsforholdene. Den højeste medianværdi på 15 mg/l (<1 til 130) forekommer i de frie magasiner. Denne magasintype findes typisk, hvor der ikke er noget lerdække, hvilket er karakteristisk for øvre magasiner i Jylland samt mere lokalt i resten af landet. Lavere medianværdier på 1 mg/l (<1 til 6) optræder i de artesiske magasiner.

Moniteringstyper

I overvågningsprogrammet skelnes der mellem 3 moniteringstyper, som med hensyn til indholdet af nitrat adskiller sig statistisk fra hinanden. De punktmoniterende filtre, der repræsenterer det mest overfladenære vand, har den højeste medianværdi på 5 mg/l (<1 til 100 mg/l), mens liniemoniterende filtre udviser et lavere nitratindhold på 1,5 mg/l (<1 til 58). I de volumenmoniterende filtre er medianværdien for nitratkoncentrationen på 1 mg/l (<1 til 3).

Magasintyper

Der er ligeledes signifikant forskel på nitratindholdet i relation til magasintyperne, hvor medianværdien for de øvre sekundære magasiner er 2 mg/l (<1 til 77) og for de nedre sekundære 3 mg/l (<1 til 88), mens den mindste medianværdi ses for de primære magasiner på 1 mg/l (<1 til 37).

Redox-zoner

Opdelingen i redox-zoner er bl.a. foretaget på grundlag af nitrat, hvilket afspejles i variationerne på figur 8.2. For ilt-zonen er både medianværdien og gennemsnittet af nitratindholdet over drikkevandskravet på 50 mg/l (1 til 147). I ilt-zonen foregår der sjældent nogen nævneværdig nitratreduktion, og koncentrationen af nitrat i denne zone afspejler direkte overfladebelastningen. Den næsthøjeste medianværdi ses i nitratzonen på 13 mg/l (1 til 69). Indholdet af nitrat i jern og sulfat-zonen (den anaerobe zone) er under 1, betinget af definitionen på jern og sulfat-zonen. Redox-zonerne findes i alle egne af Danmark, men udbredelsen af zonerne i dybden er betinget af de geologiske forhold, som allerede nævnt. Ilt- og nitrat-zonerne er typisk meget tykkere i sandjorde end i lerjorde.

Lave nitrat-koncentrationer

Uanset hvordan filtrene i grundvandsovervågningen opdeles, findes der filtre, hvor nitratindholdet er lavt (< 10 mg/l), hvilket enten skyldes en lille nitratbelastning eller at de pågældende filtre er godt beskyttet.

På grund af nitrattilførslen fra overfladen, ses generelt det højeste nitratindhold nær overfladen og et aftagende indhold med dybden p.g.a. nitratreduktion. Under nitratfronten er nitratindholdet meget lille, hvilket afspejles i indholdet af nitrat i hovedklasserne C, E og F, som overvejende repræsenterer jern og sulfat-zonen (den anaerobe zone), hvor en eventuel nitrattilførsel er blevet omsat i overliggende sedimenter. De volumenmoniterende filtre repræsenterer de dybe filtre, hvor nitratindholdet er blevet omsat eller opblandet med mindre nitratbelastet grundvand. De artesiske magasiner udgør det velbeskyttede grundvand, og har som følge deraf sjældent et højt nitratindhold.

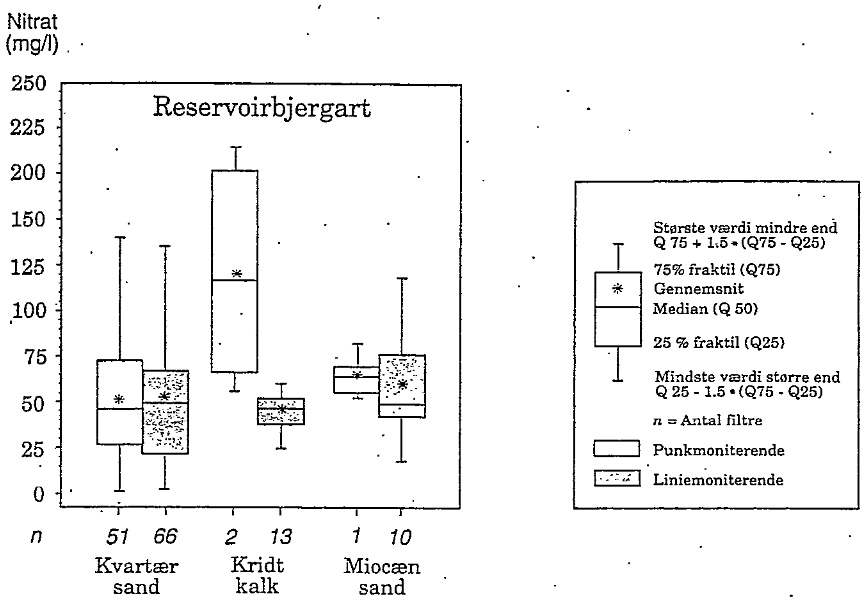
Lertykkelse

Nitratindholdet i overvågningsområderne i relation til tykkelsen af overliggende lerlag er vist på figur 8.3. Figuren viser, at nitratindholdet generelt ikke overstiger 25 mg/l for reservoirtyper dækket med mere end 15 m ler, men også at høje koncentrationer af nitrat forekommer under mere end 30 meter lerdække. Forhøjede nitratkoncentrationer i områder dækket med tykke lersedimenter kan være et resultat af en stor grundvandsdannelse gennem huller i lerdækket (såkaldte geologiske vinduer) eller sprækker i lerlaget, hvorved beskyttelsesgraden mod nitrat er væsentlig nedsat.

De forhold, der afspejles i figur 8.3, kan ikke umiddelbart overføres til boringskontroldata, idet grundvandet i de punkt- og liniemoniterende filtre repræsenterer grundvand, som er dannet inden for et rimeligt begrænset geografisk opland. I boringskontrollen er grundvandet typisk dannet over større arealer, hvor lerdækkets tykkelse og dermed beskyttelsesgrad kan være umulig at fastlægge.

Høje nitrat-koncentrationer

Høje koncentrationer af nitrat i grundvandet skyldes en stor nitrattilførsel. Nogle grundvandstyper er dog mere udsatte end andre. Høje nitratkoncentrationer samt store variationer i nitratindholdet observeres i hovedklasserne A, B og D, i de øvre magasiner, i de frie magasiner samt i sand- og kalkmagasiner. De store variationer skyldes, at der inden for disse filtertyper findes filtre, som ligger både over og under nitratfronten, i både belastede og ikke belastede områder samt under en varierende udbredelse af beskyttende lerlag (figur 8.1). Variationen i nitratindholdet i det mest belastede grundvand er vist i figur 8.4. I figuren indgår kun filtre fra ilt-zonen, som er opdelt i relation til reservoirbjergart og moniteringstype.

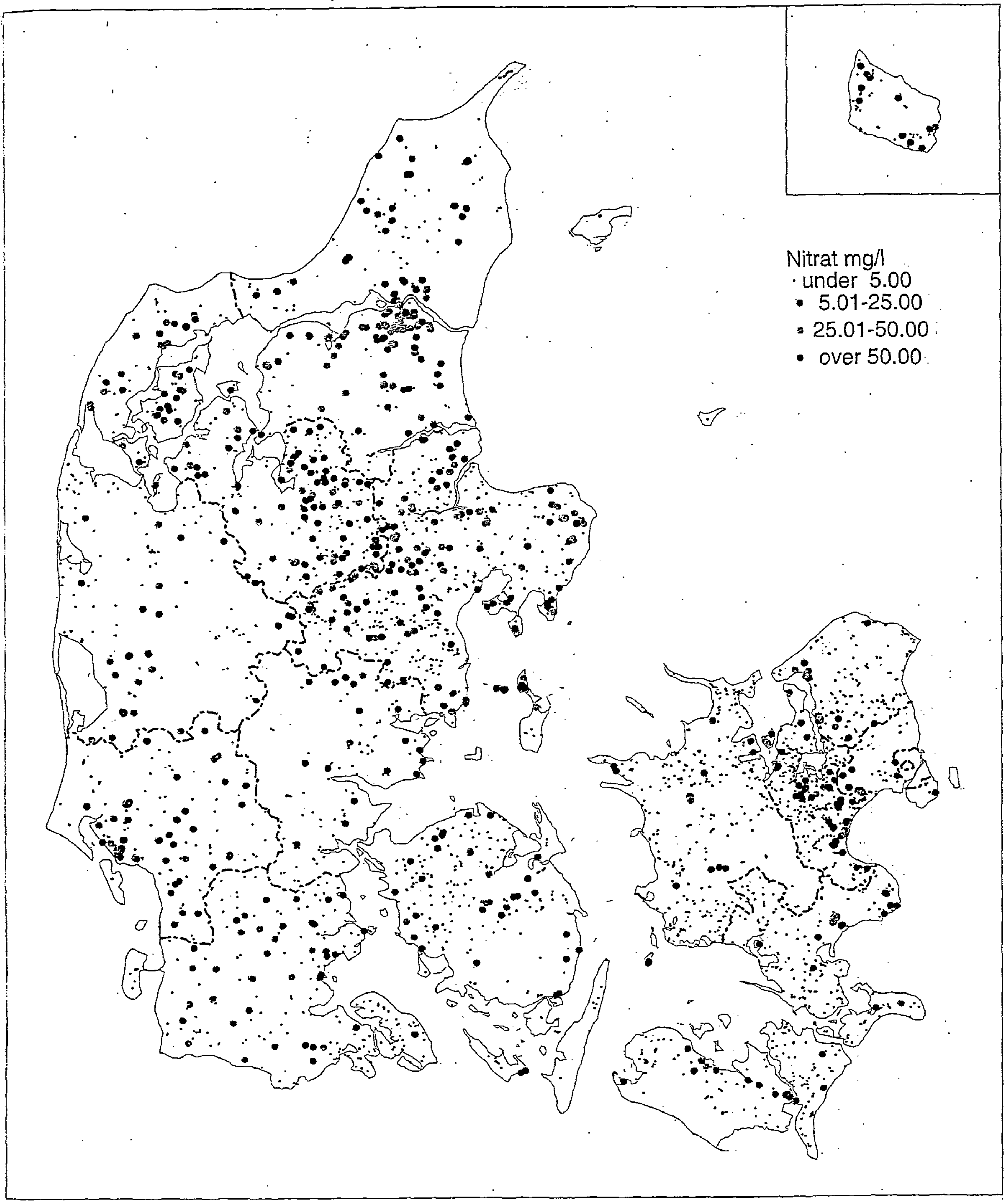


Figur 8.4: Indholdet af nitrat i ilt-zonen i relation til reservoirbjergart og moniteringstype.

Nitrat i boringskontrollen

Boringskontrollen er baseret på vandværkernes indvindingsboringer, som findes spredt ud over hele landet. Resultaterne fra boringskontrollen giver derfor en bedre beskrivelse af den del af grundvandet, der aktuelt udnyttes til vandforsyning på landsplan. Vurderinger af grundvandets nitratindhold på grundlag af data fra boringskontrollen er behæftet med en vis usikkerhed, idet vandkvaliteten på vandværkerne påvirkes af, at nitratpåvirkede boringer lukkes, og at vandindvindingen omlægges til grundvandsmagasiner uden nitrat.

Desuden påvirkes den tidsmæssige udvikling i indvindingsboringerne i nogen grad af selve indvindingen, idet nitratholdigt vand fra de øvre dele af magasinerne kan trækkes ned i boringerne. Derfor afspejler udviklingen i boringskontroldata i højere grad de tekniske og administrative bestræbelser på at skaffe nitratfrit grundvand end nitratindholdet i grundvandet. Data fra boringskontrollen anvendes derfor i denne rapport kun til en vurdering af det grundvand, der aktuelt udnyttes til vandforsyning. Grundvandets indhold af nitrat baseret på data fra boringskontrollen fremgår af figur 8.5.



Figur 8.5: Nitratindholdet i boringskontrollen for perioden 1990-1994.

Regional fordeling af reservoirtyper og nitratforurening

På Sjælland, Lolland og Falster findes der generelt lave værdier for nitrat i de vandførende lag bestående af primært kalk. Dette er i overensstemmelse med, at grundvandsmagasinerne ofte er dækket af et relativt tykt og sammenhængende moränelersdække. Omkring Roskilde og spredt i Nord- og Vestsjælland ses dog forhøjede nitratværdier i forbindelse med områder, hvor lerlagene er af relativ ringe tykkelse.

På Bornholm er grundvandsmagasinernes dæklag ofte tynde, hvorfor grundvandet generelt er sårbart overfor nitratnedsivning. Grundvandet er flere steder på Bornholm nitratpåvirket, men kun få steder overstiger nitratindholdet drikkevandskravet (Bornholms Amt, 1995).

Grundvandsmagasinerne på Fyn består af kvartære sand- og grusaflejringer samt prækvartære opsprækkede lerstensformationer og kalk. Magasinerne er hovedsagelige artesiske, idet de ofte er overlejret af moræneler af varierende tykkelse. Der findes dog områder på Nordfyn, Sydøstfyn og Ærø samt omkring Middelfart, Odense, Assens og Fåborg, hvor der optræder nitratkoncentrationer på op til 30 mg/l og enkelte steder op til 80 mg/l. Disse områder er alle karakteriseret af, at lerdækket er tyndt eller mangler (Fyns Amt, 1995).

I Jylland vest for den sidste istids hovedopholdslinie består grundvandsmagasinerne af sandede fluviale smeltevandssedimenter aflejret under sidste istid samt bakkeøernes sandede aflejringer fra forrige istid. Det er primært frie magasiner uden lerdække. Underliggende miocæne kvartssandsaflejringer repræsenterer ofte de lidt dybere grundvandsmagasiner. I disse egne findes der ofte meget høje nitratkoncentrationer i de øvre magasiner, mens de nedre magasiner generelt har et meget forskelligt indhold af nitrat. Dette skyldes et varierende indhold af brunkul og pyrit, som lokalt kan reducere nitratmængden betydeligt.

Umiddelbart øst og nord for isens hovedopholdslinie findes grundvandsmagasinerne ofte i sandede kvartære formationer, som er mere eller mindre overlejret af moræneler. Dæklagene kan være forstyrret af isens bevægelser og yder i så tilfælde kun en begrænset beskyttelse mod nitratnedsivning. Dette gælder i store dele af Sønderjyllands Amt, Vejle Amt, den sydvestlige del af Århus Amt, den nordlige del af Ringkjøbing Amt samt hovedparten af Viborg Amt.

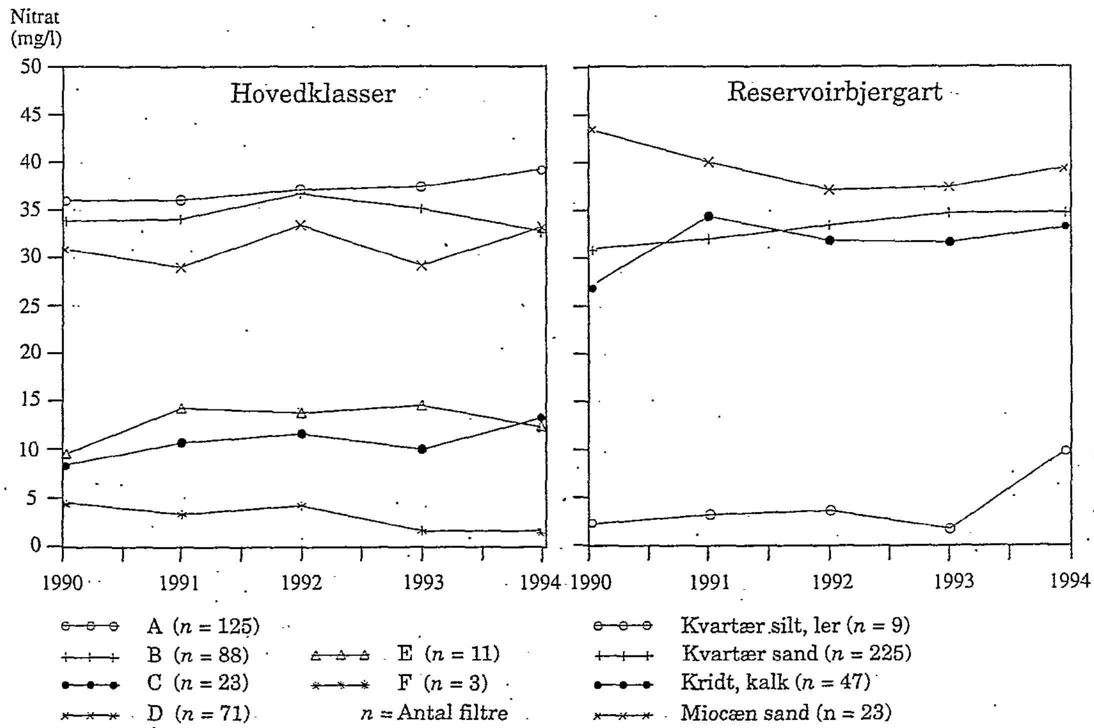
På Djursland findes grundvandsmagasinerne i smeltevandssand, skrivekridt og kalksten uden eller med kun et tyndt overliggende lerlag. Nitratreduktionen i disse sedimenter er stærkt begrænset, hvilket medfører høje nitratkoncentrationer på over 50 mg/l, specielt i de øvre dele af grundvandsmagasinerne.

Nitratkoncentrationer på over 50 mg/l ses også flere steder i Himmerland. Grundvandsmagasinerne findes her i smeltevandsaflejringer, skrivekridt og kalksten og er dækket af lerlag med stærkt varierende tykkelse. Høje koncentrationer af nitrat (bl.a. omkring Aalborg) ses, hvor magasinerne kun er dækket af tynde lerlag.

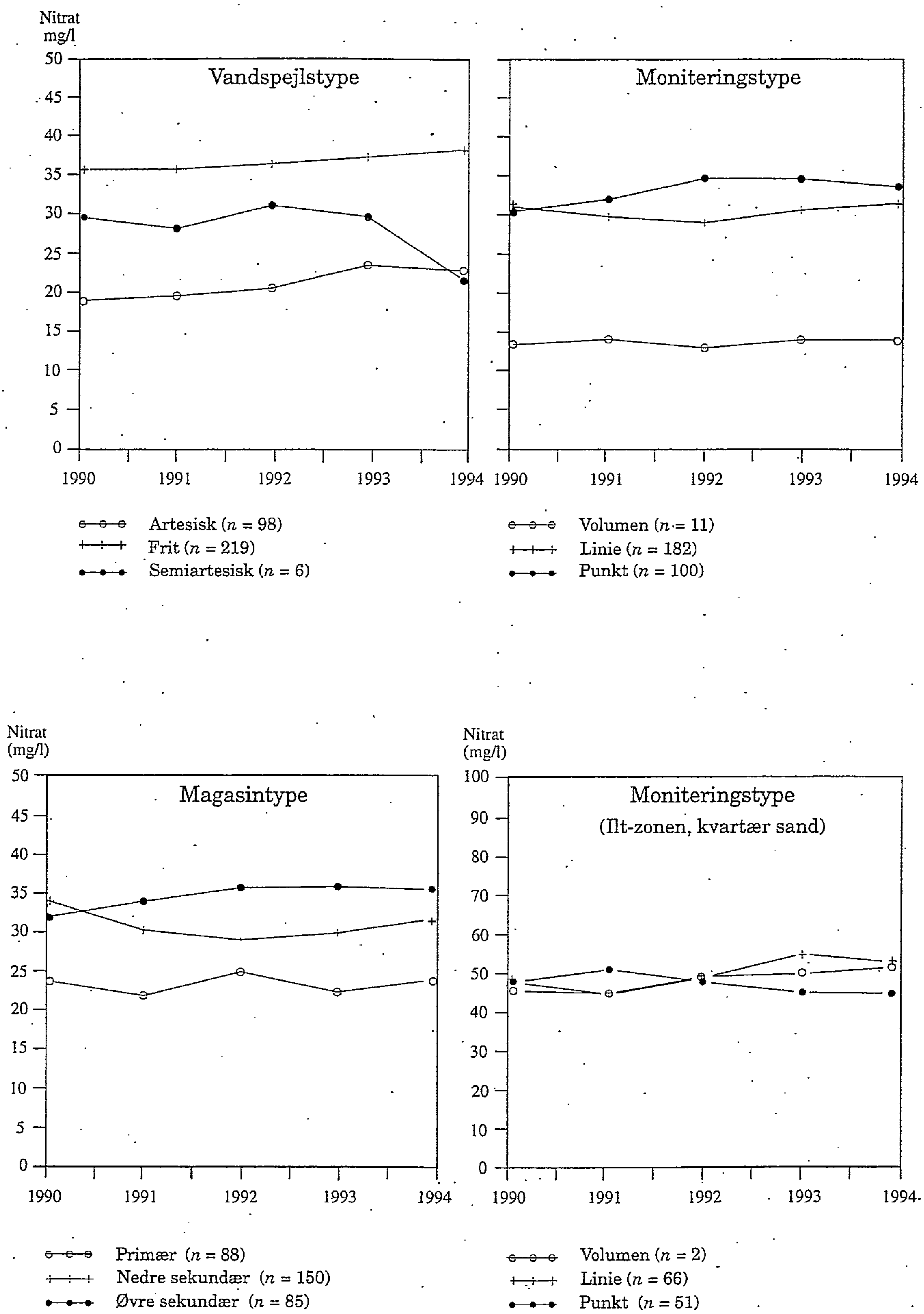
I Vendsyssel forekommer der grundvandsmagasiner i skrivekridt, smeltevandsaflejringer og marine sandaflejringer. Magasinerne er typisk artesiske og generelt godt beskyttet mod nitratnedsivning af tykke lag af smeltevandsler. Nogle steder er skrivekridtsmagasinerne kun dækket af tynde lerlag, hvilket forklarer enkelte høje nitratkoncentrationer i boringskontrollen.

8.2.2 Udvikling

I grundvandsovervågningen er der målt nitrat mindst en gang om året i perioden 1990 til 1994 i 321 filtre, hvor medianværdien for nitratindholdet samtidig overstiger 1 mg/l. Disse filtre indgår i nedenstående vurdering af udviklingen i det nitratholdige grundvand. Udviklingen er først vurderet for nitratholdigt vand (over 1 mg NO_3/l), det vil sige grundvand fra ilt- og nitrat-zonerne (figur 8.6 - 8.10), og efterfølgende for den øverste del af dette grundvand, svarende til grundvand fra iltzonen alene (figur 8.11).



Figur 8.6 og 8.7: Nitratindholdets udvikling i relation til hovedklasser og reservoirbjergart (data: >1 mg NO_3/l).



Figur 8.8, 8.9, 8.10 og 8.11: Nitratindholdets udvikling i relation til vandspejlstype, moniteringstype, magasintype og i iltzonen i sandede kvartære magasiner i relation til moniteringstypen (data >1 mg NO_3/l indgår i figur 8.8 til 8.10; data >1 mg NO_3/l og >3 mg O_2/l i figur 8.11).

I ingen af ovenstående opdelinger (figur 8.6 - 8.11) kan der påvises en signifikant ændring i nitratindholdet for perioden 1990 til 1994. Figur 8.11 viser udviklingen i de sandede kvartære reservoirbjergarter, men et tilsvarende billede ses for både kalkbjergarter og miocænt sand. Dette er bemærkelsesværdigt, idet disse filtre repræsenterer de mest sårbare og belastede filtre, som hurtigt bliver påvirket af en ændret arealanvendelse (f.eks. formindsket nitrattilførsel).

Udvikling per filter

For at undgå at en eventuel udvikling i grundvandets nitratindhold skjules ved anvendelse af gennemsnitsbetragtninger, er der foretaget en statistisk test af, om de variationer, der måles i hvert filter, repræsenterer en signifikant udvikling. I alt er 1290 filtre i overvågningsprogrammet testet. Af de 592 filtre, hvor der er målt mere end 1 mg NO_3/l mindst en gang i perioden 1990-1994, ses en signifikant stigning i nitratindholdet i 106 filtre (18%), et signifikant fald i nitratindholdet i 80 filtre (13,5%), mens der ikke kan konstateres en signifikant ændring i nitratindholdet i 68,5% af filtrene. Antal filtre og den procentvise andel af filtre, hvor der ses et fald eller en stigning i relation til filterdybde, reservoirtype, vandspejltype, hovedklasse og reservoirbjergart er angivet i bilag 5.

Generelt er andelen af filtre, hvor der ses et fald eller en stigning lille og af samme størrelsesorden. De fleste signifikante variationer observeres i de øvre filtre (0-20 meter under terræn), i de artesiske magasiner, i hovedklasserne A, B og D samt i kambriske, prækambriske og kalkreservoirer. Filtertyper med en større andel af filtre med et stigende nitratindhold end et faldende nitratindhold omfatter hovedsageligt primære magasiner, hovedklasse C samt kambriske og prækambriske reservoirer.

Landovervågningen

At der generelt ikke kan erkendes en udvikling i nitratindholdet i overvågningsområderne for grundvandet er i overensstemmelse med konklusionerne fra landovervågningsområderne. Kun ganske få af disse filtre viser en signifikant udvikling og med nogenlunde lige hyppige stigninger som fald i nitratindholdet. På baggrund af landovervågningen er det endvidere konkluderet, at der ikke kan konstateres en sammenhæng mellem udviklingstendenserne i de enkelte filtre og gødningstype, jordtype eller filterdybde (DMU, 1995).

Amternes vurdering

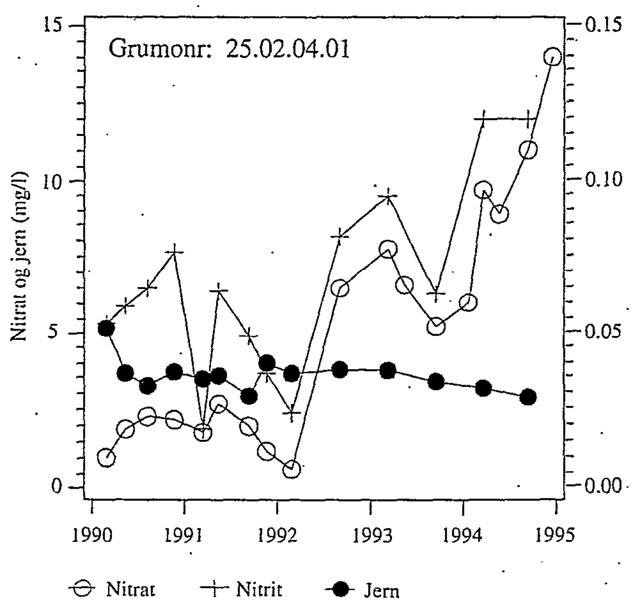
De fleste af amterne har observeret store udsving i nitratindholdet gennem de sidste 5 år, men dog uden klare udviklingstendenser. Overordnet vurderer amterne, at der ikke kan spores nogen effekt af vandmiljøplanen i grundvandets nitratindhold.

Ribe Amt er det eneste amt, der konstaterer et fald i grundvandets nitratindhold, som kan relateres til en ændret arealanvendelse inden for de seneste få år (Ribe Amt, 1995). Denne konklusion bygger på punktmoniterende filtre i overvågningsområdet Forumlund. På grundlag af CFC-aldersdatering af grundvandet i området er der imidlertidig tvivl om, hvorvidt grundvandet er yngre end 5 år. Det kan derfor ikke entydigt afgøres, om de påviste ændringer i grundvandets nitratindhold er relateret til en ændret landbrugspraksis som følge af vandmiljøplanens tiltag.

I Syd- og Vestsjælland er der konstateret en svag, men generel stigning specielt i ubeskyttede og overfladenære filtre (Vestsjællands Amt og Storstrøms Amt, 1995). Roskilde Amt (1995) anfører, at der muligvis er tale om en svag stigning i nitratindholdet i grundvandet, som er klassificeret som hovedklasserne C, D og E. Frederiksborg Amt (1995) og Bornholms Amt (1995) mener ikke at kunne observere en generel udvikling, men de konstaterer, at visse boringer har en markant stigning i nitratindholdet. Bornholms Amt konstaterer, at det specielt gælder i de øvre oxiderede zoner i sandstens- og grundfjeldsmagasinerne. Ringkjøbing Amt (1995) og Fyns Amt (1995) finder, at overvågningsområderne ikke i tilstrækkelig grad repræsenterer amternes grundvand.

Nitratgennembrud

En vurdering af nitratproblemets omfang skal desuden ses i lyset af, at en ændring i nitratbelastningen ikke nødvendigvis kan spores i grundvandet som et stigende nitratindhold, men som en ændring i sedimenternes redoxkapacitet. Flere amter fremhæver, at der er tydelige tegn på, at nitrat over de sidste fem år har fået en stadig større rumlig udbredelse (Sønderjyllands Amt, Århus Amt og Bornholms Amt, 1995). Hvis koncentrationen af nitrat i et filter stiger fra f.eks. under 1 mg/l til over 1 mg/l, svarer det til et skift fra jern og sulfat-zonen til nitratzonen. Grænsen på 1 mg/l er arbitrær, men den illustrerer det forhold, at nitratfronten har passeret det pågældende filter; et såkaldt nitratgennembrud. Dette implicerer, at nitratfronten er rykket dybere ned, og at en større del af det overfladenære grundvand fremover vil udvise et stigende nitratindhold. Århus Amt (1995) og Bornholms Amt (1995) har observeret nitratgennembrud i flere boringer. Nordjyllands Amt (1995) bemærker, at nitratgennembrudet i Albæk er forstærket. Figur 8.12 viser et eksempel på et nitratgennembrud fra overvågningsområdet Brokilde i Roskilde Amt. Nitratindholdet stiger fra et rimeligt stabilt niveau til koncentrationer omkring 15 mg/l.



Figur 8.12: Nitratgennembrud ved Brokilde.

Der ses ofte en karakteristisk udvikling af andre komponenter end nitrat i forbindelse med et skift i redoxforholdene. Figur 8.12 viser, at nitrit forekommer, hvilket afspejler at nitrat reduceres, idet nitrit forekommer som et mellemprodukt i nitratomdannelsen. Koncentrationen af jern falder ligeledes omkring nitratfronten.

8.2.3 Diskussion og sammenfatning

Problemområder

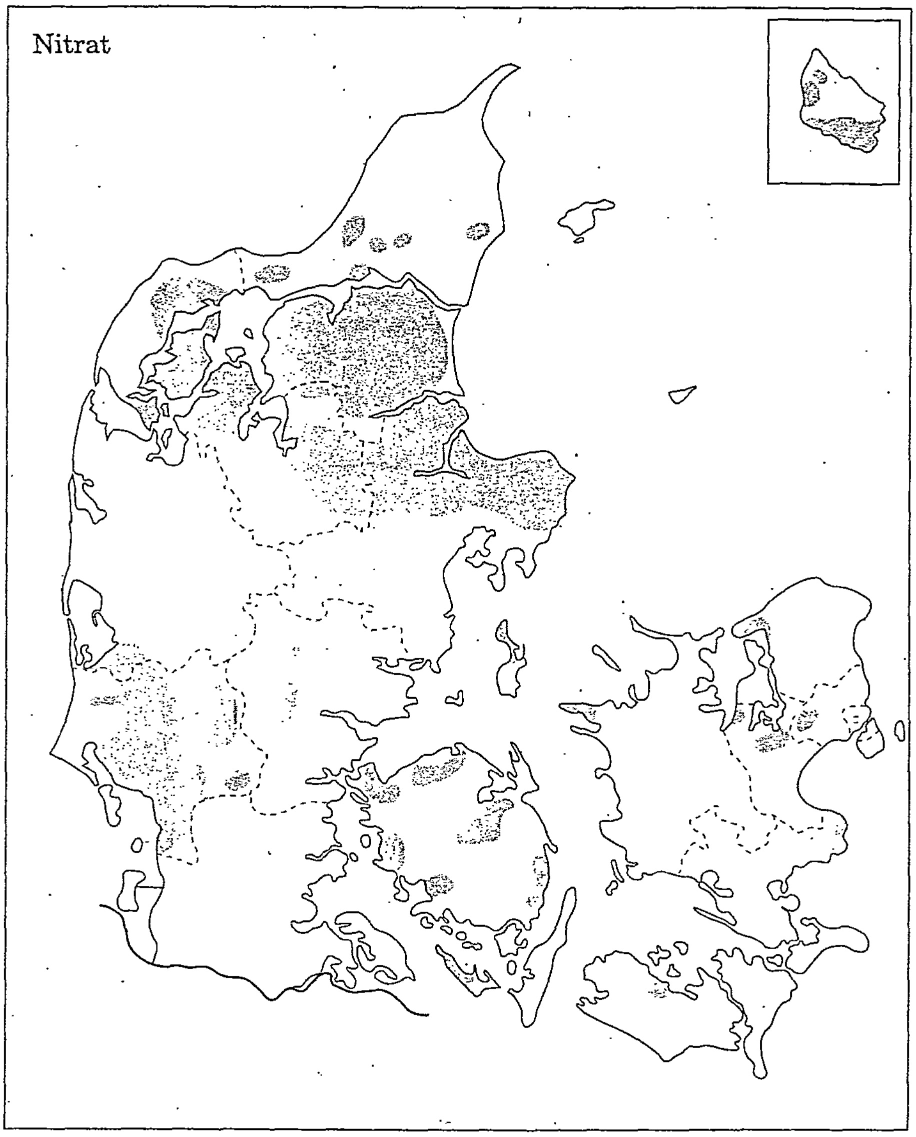
Problemområder for nitrat kan karakteriseres som områder, hvor nitratbelastningen på grund af arealanvendelsen er stor, og hvor beskyttelsesgraden er ringe, samtidig med at grundvandsdannelsen er stor og af vital betydning for områdets drikkevandsforsyning.

På figur 8.13 er der indtegnet de områder, som af amterne anses for at være problemområder i relation til nitrat. Det kan skyldes et aktuelt problem med forhøjede nitratkoncentrationer, eller geologiske forhold der medfører en forhøjet risiko for fremtidige nitratproblemer. På grund af store regionale variationer i drikkevandsbehovet, grundvandets nitratindhold og størrelsen af grundvandsressourcen, er det ikke givet, at et nitratproblem i et amt anses for ét tilsvarende problem i et andet amt. Derfor er der i visse tilfælde foretaget en konkret vurdering af problemets omfang og udstrækning. For nogle amters vedkommende har områdernes udstrækning måttet skønnes ud fra amtsrapporterne.

Overordnet er der god geografisk overensstemmelse mellem påviste forhøjede nitratindhold i boringskontrollen og de problemområder for nitrat, der er angivet af amterne. Inden for problemområderne kan der dog påvises mange boringer, der yder vand med lavt eller intet nitratindhold. Dette afspejler dels variationen i nitratbelastningen og i de geologiske forhold, således at der også inden for problemområderne kan findes mere velbeskyttede områder med lavt nitratindhold, og dels at det administrativt er forsøgt at forbedre drikkevandskvaliteten, uden at dette nødvendigvis afspejler en forbedret kvalitet af grundvandet. Den regionale fordeling af problemområderne afspejler generelt magasinernes sårbarhed (lerlagenes tykkelse og reduktionskapacitet) og nitratbelastningen.

Vandmiljøplanen og Roskilde Amt

Det kan ikke forventes, at vandmiljøplanen vil have den samme effekt overalt i landet. Således forventer Roskilde Amt (1995) kun en lille effekt, idet landbrugsområderne traditionelt har været hvede- og frøavlsområder, hvor kravet om vintergrønne marker længe har været opfyldt, og antallet af husdyrbrug er meget begrænset. På den baggrund mener amtet, at miljøtiltagene inden for opbevaring og udbringning af husdyrsgødning kun vil have en ubetydelig effekt på nitratbelastningen inden for amtet.



Figur 8.13: Problemområder med nitrat.

Sammenfatning

Der kan påvises en sammenhæng mellem observerede høje nitratkoncentrationer i overvågningsprogrammet for grundvand og i boringskontrollen i relation til nitratbelastning, beskyttelsesgrad, filterdybde, redoxforholdene og reservoirbjergart.

Høje koncentrationer af nitrat forekommer overvejende i overfladenære og sekundære i sand- og kalkmagasiner, hvor der ikke findes beskyttende lerlag, og hvor redoxkapaciteten er lille. Disse nitratbelastede områder findes udbredt i store dele af Jylland, specielt på Djursland, i Himmerland og i betydelige dele af Viborg Amt, samt mere lokalt i resten af landet.

Generelt kan der ikke påvises entydige udviklingstendenser i grundvandets indhold af nitrat. Dette gælder også for det overfladenære og iltet grundvand, hvor det forventes, at en ændring i arealanvendelsen først vil kunne observeres. På grundlag af overvågningsprogrammet kan det konkluderes, at der ikke kan påvises et fald i grundvandets indhold af nitrat, og at der generelt ikke kan spores nogen effekt af de initiativer, der er iværksat for at begrænse nitratbelastningen af grundvandet i forbindelse med vandmiljøplanen. Nitratindholdet i grundvandet udgør således fortsat en alvorlig trussel mod den fremtidig drikkevandsforsyning i store dele af Jylland samt lokalt i resten af landet.

8.3 Grundvandets indhold af fosfor

Tilførsel og udvaskning af fosfor

Fosfor er et vigtigt næringsstof, der hovedsageligt tilføres med handels- og husdyrgødning på landbrugsjorde. Den mængde fosfor, som ikke optages af planterne, vil i overvejende grad blive fastholdt i jorden. I sandjorde er det typisk jordens indhold af aluminium- og jernhydroxider, som har den største evne til at fastholde fosfor, mens det i kalkjorde er calcium, der primært medvirker til, at fosfor bindes. Dette medfører, at det kun er en lille andel af fosforbelastningen, der kan udvaskes og dermed belaste grundvandet.

Udvaskningen af fosfor er i størrelsesordenen 3-4 gange større fra landbrugsjorde end fra naturområder (Kristensen et. al., 1990). Udvaskningen er desuden betinget af jordtypen. Udvaskningen af total fosfor er beregnet til gennemsnitlig at være 0,6 og 1,3 kg P/ha pr. år på henholdsvis sand- og lerjorde (NPo, 1991).

Der anvendes store mængder af fosfor i vaskemidler og industrien, hvilket betyder, at der er en betydelig fraførsel af fosforforbindelser fra byer m.v. Denne belastning ender ofte som spildevand. Kun sjældent medvirker spildevand til en fosforbelastning af grundvand. Hvor der lokalt observeres et forhøjet indhold af fosfor i overfladenært grundvand, kan det dog skyldes nedsivende spildevand fra f.eks. rensningsanlæg, utætte kloakker m.v.

Fosfor i grundvand

Fosfor indgår i en række mineraler, som findes i jorden (f.eks. apatit), som generelt er tungtopløselige, men som ved forvitring vil kunne tilføre grundvandet små mængder af fosfor. På grund af fosforindholdet i levende organismer findes der ofte fosforforbindelser i sedimenter med et højt indhold af organisk stof. Gamle marine aflejringer indeholder f.eks. ofte større mængder af fosfor, enten som udfældet fosforit (som efterfølgende kan frigive fosfor til grundvand) eller bundet i organisk stof, som under reducerende forhold kan omsættes og derved frigive fosfor.

Fosfor i grundvand findes i en række forskellige forbindelser. Derfor omtales grundvandets totale indhold af fosforforbindelser i det følgende som fosfor (P_T), hvilket inkluderer alle former for opløst og komplekst bundet organisk samt uorganisk fosfor.

Grænseværdi for total fosfor

Det højst tilladte indhold af total fosfor i drikkevand er 0,15 mg/l.

Welcome to the USGS Ground Water Information Pages

These pages are designed to provide useful information about ground-water resources of the Nation and **ground-water activities** of the USGS.

USGS Ground Water Information	Programs	Pubs	Techniques	Other sources

Do you want information about ground-water resources?

PROGRAMS

USGS offices in every State conduct ground-water studies in cooperation with local and State governments, with other Federal Agencies, and as part of the USGS Water Resources Programs. Contacts are available in each state to assist with any questions.

PUBLICATIONS

Information about ground-water resources of the Nation, including the location, the extent, and the geologic and hydrologic characteristics of major aquifers, are available in the Ground Water Atlas of the United States, and other **USGS Ground Water Publications** and USGS Fact Sheets.

Need information about USGS ground-water techniques?

TECHNIQUES

Scientists in the USGS have long been active in development and implementation of techniques useful in ground-water investigations. Applications software, including **groundwater flow models** and **geochemical models**, surface and borehole geophysical tools, chemical and isotopic age-dating methods, and hydrogeologic mapping, are all different facets of USGS technical capabilities in ground-water studies.

Are there other places that can furnish ground-water information?

OTHER SOURCES

The USGS is part of the community of ground-water scientists. Community groups, scientific and professional societies, State Agencies, and other Federal Agencies are additional sources of information about ground water.

Need more information about USGS Ground-Water Information?

Contact the USGS Office of Ground Water via email, or call 703-648-5001.

DOI	USGS	Biology	Geology	Mapping	Water	*Help!*

We want your feedback!

U.S. Department of the Interior, U.S. Geological Survey
Maintainer: Office of Ground Water
Last update: 12:55:56 Tue 22Sep1998
URL: http://water.usgs.gov/public/ogw/

USGS Water NAWQA Help!

The National Water-Quality Assessment Program

INTRODUCTION

The Nation's water resources are the basis for life and our economic vitality. These resources support a complex web of human activities and fishery and wildlife needs that depend upon clean water. Demands for good-quality water for drinking, recreation, farming, and industry are rising, and as a result, the American public is concerned about the condition and sustainability of our water resources. The American public is asking: Is it safe to swim in and drink water from our rivers or lakes? Can we eat the fish that come from them? Is our ground water polluted? Is water quality degrading with time, and if so, why? Has all the money we've spent to clean up our waters, done any good? The U.S. Geological Survey's **National Water-Quality Assessment (NAWQA) Program** was designed to provide information that will help answer these questions.

NAWQA is designed to assess historical, current, and future water-quality conditions in representative river basins and aquifers nationwide. One of the primary objectives of the program is to describe relations between natural factors, human activities, and water-quality conditions and to define those factors that most affect water quality in different parts of the Nation. The linkage of water quality to environmental processes is of fundamental importance to water-resource managers, planners, and policy makers. It provides a strong and unbiased basis for better decisionmaking by those responsible for making decisions that affect our water resources, including the United States Congress, Federal, State, and local agencies, environmental groups, and industry. Information from the NAWQA Program also will be useful for guiding research, monitoring, and regulatory activities in cost effective ways.

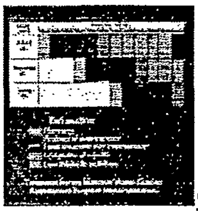
PROGRAM DESIGN

The NAWQA Program's unique design provides consistent and comparable information on water resources in 60 important river basins and aquifers across the Nation. Together, these areas account for 60 to 70 percent of the Nation's water use and population served by public water supplies and cover about one-half of the land area of the Nation. Investigations of these 60 areas, referred to as "study units," are the principal building blocks of the NAWQA Program.

The similar design of each investigation and use of standard methods make comparisons among the study unit's results possible. Regional and national assessments can be made. These regional and national assessments, referred to as "National Synthesis," focus on priority national issues, including non-point source pollution, sedimentation, and acidification. Each issue is unique and manifests itself differently among the Nation's diverse geographic, geologic, hydrologic, and climatic settings. The challenge and goal for NAWQA is, therefore to identify the common environmental characteristics associated with the occurrence of key water-quality constituents and to explain their differences throughout the Nation.

PROGRAM IMPLEMENTATION

In 1991, NAWQA began the transition from a pilot program to a full-scale program with the start of 20 study-unit investigations, along with synthesis activities on a national scale. In October, 1993 an additional 20 study-unit investigations started. When fully implemented in 1997, the program will include hydrologic investigations of 60 study areas that are distributed throughout the Nation.



(15KB GIF). To make the program cost effective and manageable, intensive assessment activities in each of the study units are being conducted on a rotational rather than a continuous basis, with one-third of the study units being studied intensively at any given time For each study unit, 3- to 5-year periods of intensive data collection and analysis will be alternated with 5- to 6-year periods of less intensive study and monitoring.

Locations of the 60 NAWQA study units and their proposed implementation dates (26K GIF)

Coinciding with the study-unit investigations are the national synthesis assessments. The large geographic extent and large variability in environmental factors throughout the Nation, and limited resources make it necessary to focus on a limited set of high priority water-quality issues. Generally, two to four national synthesis topics will be studied at a given time. Two issues of national priority--the occurrence of nutrients and pesticides in rivers and ground water--were selected as the first issues investigated by national synthesis. These topics were ranked among the highest in importance because of widespread environmental and public health concerns and because information necessary for a national assessment of these contaminants was incomplete.

The next topic for national synthesis is the occurrence and distribution of volatile organic compounds (VOCs). Many VOCs are toxic and are a major focus of a number of Federal regulations related to water quality. Major work elements planned for the study of VOCs in 1994 and 1995 are to (1) identify regulated and non-regulated VOCs; (2) determine the amounts of VOCs released to water, land, and air, and (3) evaluate strategies to characterize the use and releases of VOCs to the environment, including ground water.

The first two years of both study-unit investigations and national synthesis studies involve compilation and analysis of existing information. In addition to USGS data, information and methods developed by other Federal agencies, as well as by State and local agencies, universities, and volunteer organizations are reviewed and integrated as appropriate. This preliminary information on water-quality conditions, trends, and functions forms the basis of a three-year period of intensive data collection and analysis to fill identified gaps in subsequent years.

Perennial data collection and sequential assessments in the study units and regional and national synthesis are key attributes of the program, not only to define changes and trends, but also to build an evolving understanding of water quality in each of the study units and across the Nation. This understanding will be achieved through careful analysis and interpretation of long-term data sets on the physical, chemical, and biological characteristics of the water resource. The data sets will be related to carefully compiled information on hydrology and geology and changes in land-use activities and management practices. The long-term commitment of the NAWQA Program to water-quality monitoring at local, regional, and national scales is designed to answer critical questions about the status and trends in the quality of our Nation's water.

EARLY FINDINGS

The NAWQA Program is producing many useful findings about our local, regional, and national water resources.

Highlights of NAWQA Study Unit Findings

- Hudson River Basin
- Delmarva Peninsula
- Western Lake Michigan drainage
- Red River of the North
- Trinity River Basin
- Lower Kansas River Basin
- Rio Grande Valley
- Upper Snake River Basin
- Yakima River Basin
- Nevada Basin and Range

Selected early results from the National Synthesis on Pesticides and Nitrates include the following:

- A review of existing information on pesticides in the atmosphere showed that pesticides have been detected in most samples analyzed throughout the Nation. Pesticides were ubiquitous and were generally detected wherever they were sought. The degree of use and environmental persistence explain the dominant patterns in frequency of detection. The review revealed that no consistent, long-term studies at a national scale have been done.
- A statistical analysis of the occurrence of nitrate in streams at about 150 sites in 10 states in the Midwest, showed there was a relation between the concentration of nitrate and each of the following: the amount of precipitation, rate of streamflow, the acreage of the basin planted in corn, the acreage planted in soybeans, cattle density, and population density. These findings help State and local managers to focus scarce monitoring resources to the most critical areas.
- Estimates of point- and nonpoint-source nitrogen loadings were made for about 90 watersheds throughout the United States. The relative proportions of input to streams vary as a function of climate, hydrology, land use, population, and physiography. A large percentage of point-source loads occur near cities. Nonpoint loading varies widely, and is strongly influenced by precipitation and runoff. However, no single nonpoint-nitrogen source is dominant everywhere. Information derived from NAWQA study units will aid in the development of methods to reduce point- and nonpoint-source nitrogen loading.
- Effects of agricultural activities on ground-water quality was studied in five regions from New York to Nebraska. The quality of water in surficial, unconsolidated aquifers was affected by the geology and soils, land-management practices, fertilizer use, and the amount of irrigation. Concentrations of nitrate were greatest in areas that are heavily irrigated or areas that have well-drained soils or sediments.

Results from the NAWQA Program are being released to the public through a variety of publications as elements of the studies are completed.

COMMUNICATION AND COORDINATION

Communication and coordination between U.S. Geological Survey personnel and other interested scientists and water-management organizations are critical components of the NAWQA program. Early in the program, the National Academy of Sciences reviewed the proposed activities and issued a report supporting the program. Since 1991, the NAWQA Advisory Council, a panel of Federal scientists, has met to ensure use of the best and most current scientific methods and to ensure national relevance of the program's findings. In 1993, representatives from National, State, and regional organizations; Native American groups; professional and technical societies; public interest groups; private industry; and the academic community were invited to join the Council. At the study-unit level, each investigation now underway has a local liaison committee consisting of representatives with water-resources responsibilities or interests from Federal, State, and local agencies, universities, and the private sector. Specific activities of each liaison committee include (1) the exchange of information about water-quality issues of regional and local interest, (2) the identification of sources of data and information, (3) assistance in the design and scope of project products, and (4) the review of project planning documents and reports.

U.S. Geological Survey
Open-File Report 94-70
By P.P. Leahy and T.H. Thompson

For further information on this and related studies, contact:
NAWQA Program
U.S. Geological Survey
413 National Center
Reston, Virginia 20192
email: nawqa_whq@usgs.gov

URL: http://wwwrvares.er.usgs.gov/nawqa/NAWQA.OFR94-70.html
Maintainer: kjhitt@usgs.gov
Last modified: Fri May 30 14:44:41 1997

USGS Water NAWQA Help!

National Water-Quality Assessment (NAWQA)
National Synthesis--National Assessments of Water Quality

National Synthesis is the synthesis of results from all study units with information from other programs, agencies, and researchers to produce regional and national assessments for priority water-quality issues.

National Synthesis of water-quality data, based on aggregation of consistent information obtained from the study units, is a major component of the National Water-Quality Assessment Program. Differences and similarities in water-quality conditions among study areas will be highlighted as will trends and their causes. The first topics addressed by the National Synthesis are pesticides, nutrients, volatile organic chemicals, and aquatic biology. Discussions on these and other water-quality topics will be published in periodic summaries of the quality of the Nation's ground and surface water, as the information becomes available.

The goals of National synthesis are:

- Assess water quality across the Nation and trends over time
- Relate status and trends in water quality to natural and human factors
- Determine effects water quality might have on aquatic life
- Provide information for water-resources management

Accomplishing these goals is a scientific challenge because national water-quality issues of interest are, in essence, common issues that manifest themselves differently among the Nation's diverse climates, soils, agricultural practices, and geographic, geologic, and hydrologic settings. The challenge of National synthesis is to identify the common characteristics in how these water-quality issues occur and to explain their differences.

The NAWQA program addresses a broad spectrum of water-quality issues. The first topics discussed by the National Synthesis are pesticides, nutrients, volatile organic compounds, aquatic biology, and trace elements. These issues of National priority have been selected to be investigated by National Synthesis because they are the concern of public officials and scientists throughout the Nation and they affect large geographic areas and are persistent and recurring.

- Pesticides
- Nutrients
- Volatile Organic Chemicals
- Aquatic Biology
- Trace Elements
- SPARROW: Surface Water-Quality Modeling

URL: http://wwwrvares.er.usgs.gov/nawqa/natsyn.html
Maintainer: kjhitt@usgs.gov
Last modified: Fri Jan 9 11:53:05 1998

USGS
science for a changing world
National Water Quality Assessment
Pesticide National Synthesis Project

PROVISIONAL DATA -- SUBJECT TO REVISION

Pesticides in Surface and Ground Water of the United States: Summary of Results of the National Water Quality Assessment Program (NAWQA)

July 22, 1998 Record of Revisions

Pesticides National Synthesis Project
National Water-Quality Assessment
U.S. Geological Survey

TABLE OF CONTENTS

INTRODUCTION

Final results from the first cycle of NAWQA water-quality data collection during 1992-1996 include analyses of 76 pesticides and 7 selected pesticide degradation products in about 8,200 samples of ground water and surface water in 20 of the nation's major hydrologic basins

(NAWQA study units). These data are the most extensive ever collected for such a wide range of pesticides and locations. The 76 herbicides, insecticides, and fungicides targeted in the study account for approximately 75 percent of the total amount (by weight) of pesticides used for agriculture in the U.S., and also a substantial portion of urban and suburban use. In addition, 7 volatile organic pesticides, which are used as fumigants, were analyzed in a subset of about 2000 ground water samples.

This statistical summary of national results for ground water and surface water is one of a series of products that will describe findings from the NAWQA studies. This summary updates and replaces a similar preliminary summary that was first provided on this web page August, 1997 and removed for revision in May of 1998. Final revisions to data resulting from additional data submissions and quality control checking, combined with changes in methods for aggregating data (described below), have resulted in changes from the preliminary summary, particularly in maximum concentrations for some compounds.

OVERVIEW OF RESULTS

Fifty-eight pesticides were detected at least once at or above 0.01 μg/L in both ground water and surface water. Only 6 of the 83 compounds measured (not including fumigants) were never detected in streams (2,4,5-T; 3-OH-carbofuran; chloramben, clopyralid, MCPB, and silvex). Pesticides were more frequently present and at higher concentrations in streams compared to ground water. More than 95 percent of all samples collected from streams contained one or more pesticides, compared to less than 50 percent of samples collected from wells.

The same herbicides were most commonly found in streams and ground water -- the most commonly detected were atrazine and metolachlor, used primarily on corn and soybeans; prometon, used primarily in non-agricultural applications in urban and suburban areas; and simazine, which is used in both agricultural and non-agricultural settings. Some insecticides were commonly found in streams, but none were found often in ground water. The insecticides detected most frequently in streams were diazinon, chlorpyrifos, and carbaryl, all of which have substantial urban and suburban use.

SELECTED HIGHLIGHTS

(Adapted from a poster presented at the 9th International Congress of Pesticide Chemistry, August 1998: "Pesticides in streams and ground water of the United States, 1993-95" by Robert J. Gilliom, Jack E. Barbash, Yvonne M. Gobert, Dana W. Kolpin, Steven J. Larson, Naomi Nakagaki, and William G. Wilber)

More than 95% of all samples collected from streams and rivers contained at least one pesticide, compared to about 50% for ground water (Figure 1).

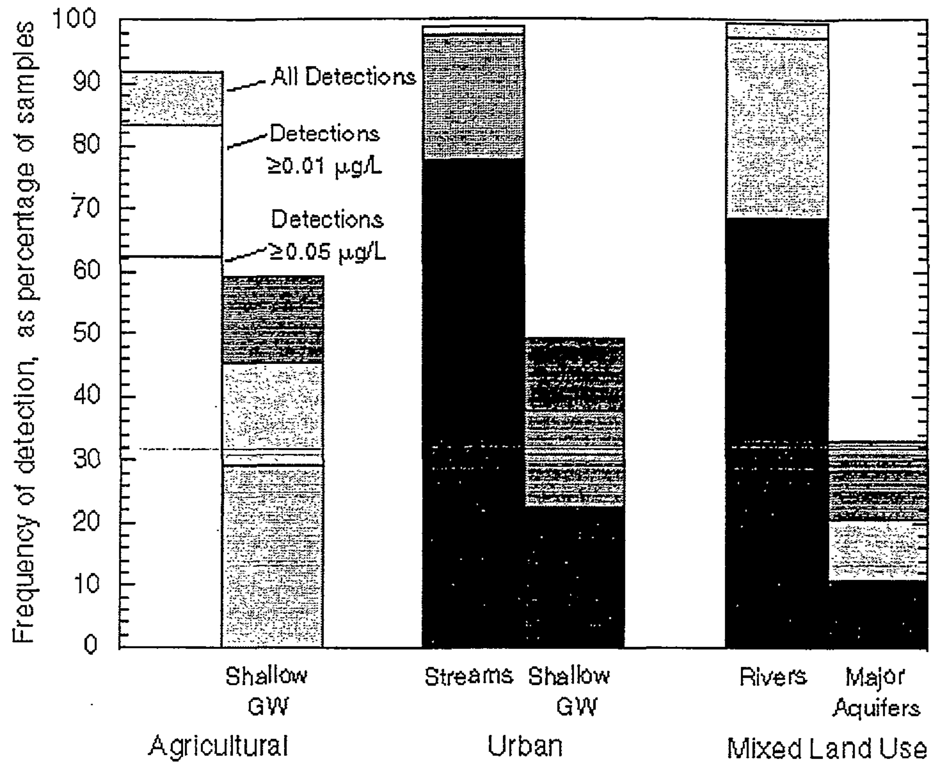


Figure 1. *Summary of detections of one or more pesticides.*

Most detections in streams were greater than 0.01 µg/L and more than half were greater than 0.05 µg/L. Agricultural and urban streams, as well as major rivers, had relatively similar high frequencies of detection. Detection frequencies in ground water were highest in shallow ground water in agricultural areas, somewhat lower in shallow ground water in urban areas, and lowest in major aquifers. The major aquifers are generally deeper, have variable land-use influences, and were sampled using existing production wells. Compared to streams, ground water generally had a greater proportion of detections below 0.05 ug/L in all land use and hydrologic settings.

The 21 most commonly detected pesticides exceeded 0.05 µg/L in more than 10 percent of stream samples or in more than 1 percent of ground water samples within at least one of the land-use categories (Figure 2).

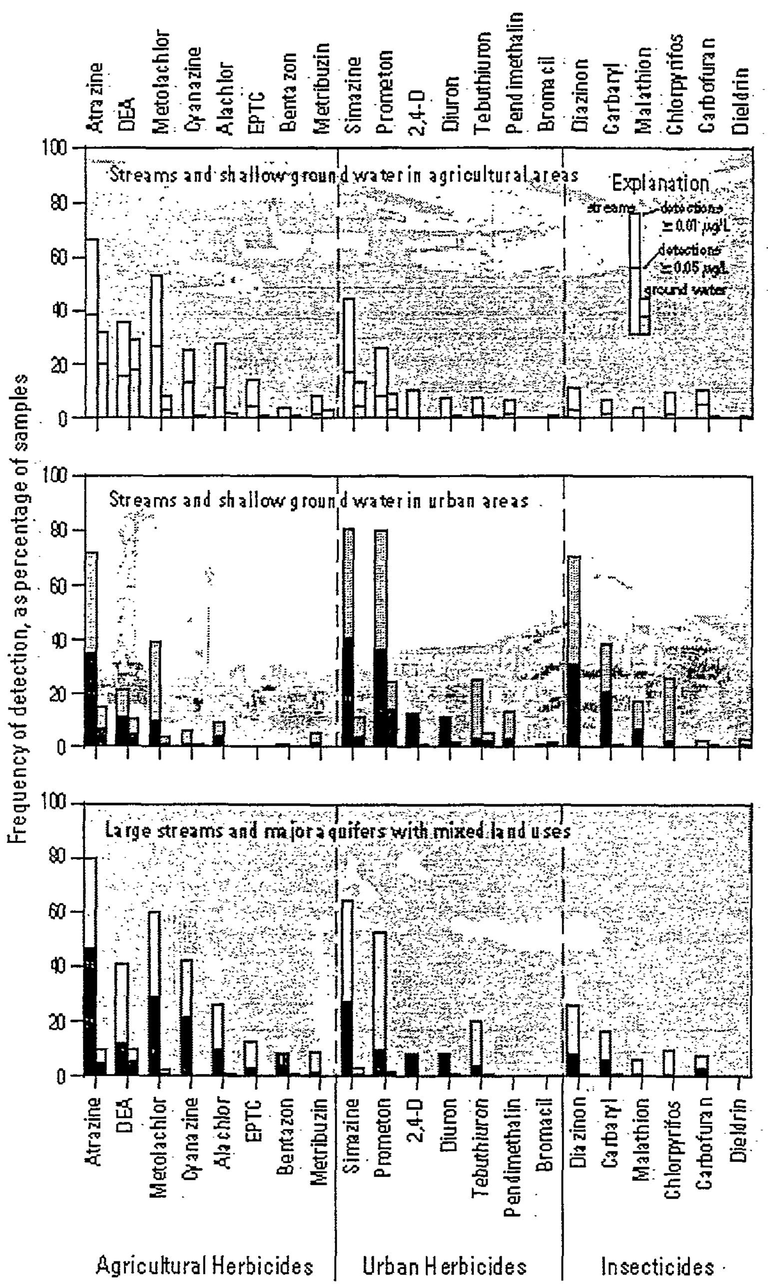


Figure 2. Patterns of occurrence of the 21 most detected compounds.

The most freqently detected pesticides in agricultural areas were the major herbicides, atrazine and its degradation product deethylatrazine (DEA), metolachlor, cyanazine, and alachlor, which rank 1, 2, 4, and 5 in national herbicide use for agriculture. These most heavily used herbicides also account for most of the detections in larger rivers and major aquifers and many detections in urban streams and shallow ground water.

The herbicides that were generally found most often in urban areas are simazine, prometon, 2,4-D, diuron, and tebuthiuron, with simazine and prometon accounting for most detections in streams and shallow ground water. 2,4-D and prometon rank 1 and 14 among herbicides in frequency of home and garden use, and 2,4-D, simazine, and diuron rank 3, 18, and 23, respectively in national herbicide use for agriculture. Prometon and tebuthiuron have no reported agricultural use.

Insecticides were much more frequently detected in urban streams than in agricultural streams and were seldom detected in ground water in any setting. Most detections were accounted for by diazinon, carbaryl, malathion, and chlorpyrifos, which nationally rank 1, 8, 13, and 4 among insecticides in frequency of home and garden use.

Low-level mixtures are the most common form of pesticide exposure for stream ecosystems and water users -- most samples with a detectable pesticide contained mixtures of two or more detectable pesticides (Figure 3).

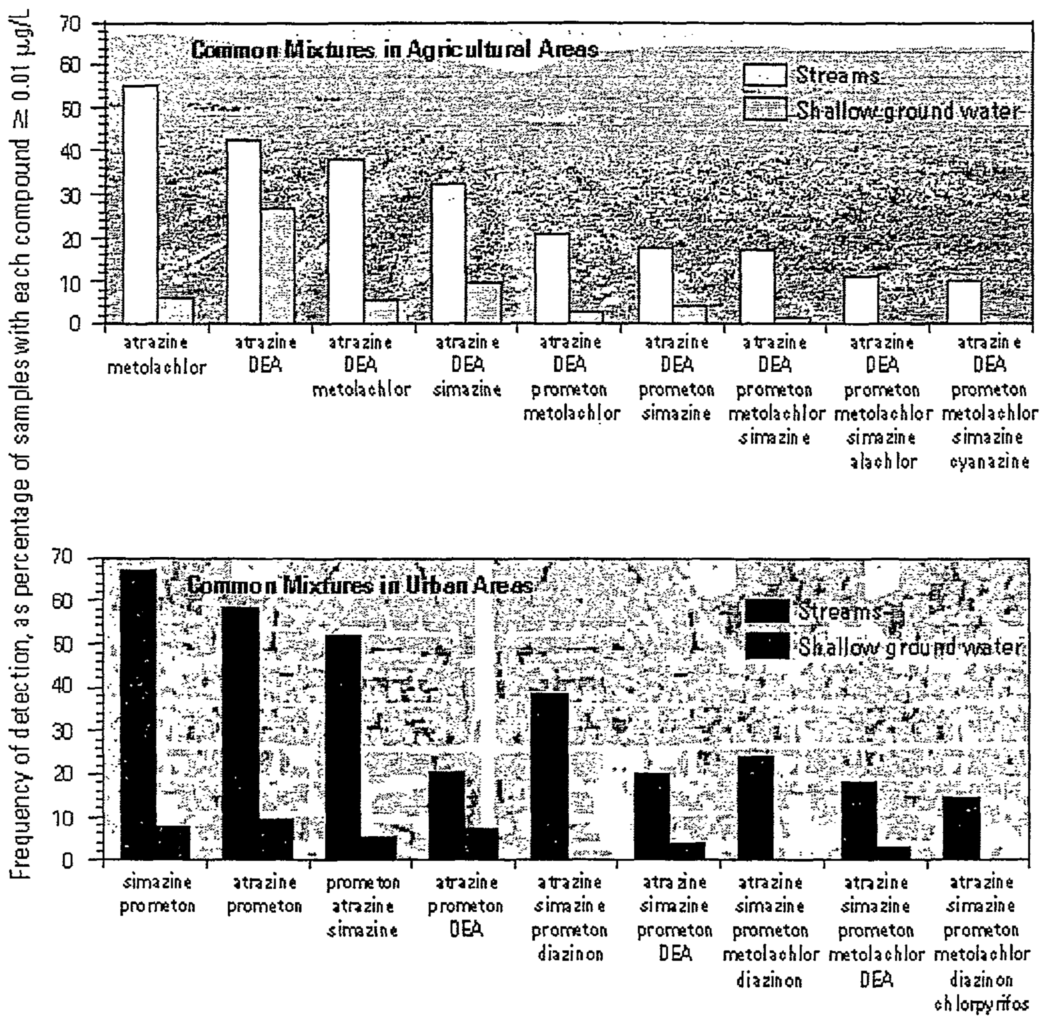


Figure 3. Frequency and composition of common mixtures in samples with detections.

More than 50 percent of all stream samples contained 5 or more pesticides and about 25 percent of ground water samples had 2 or more pesticides. In accordance with use patterns, the composition of the most common mixtures differs between urban and agricultural areas and among agricultural areas with different crops and pests. For example, simazine and prometon were present in the most commonly occurring mixtures of 2 or more compounds in urban areas, whereas atrazine, DEA, and metolachlor were the most common compounds in mixtures found in agricultural areas. A distinctive feature of urban streams was the common occurrence of mixtures with both herbicides and insecticides. More than 10 percent of urban stream samples contained a mixture of at least four herbicides plus diazinon and chlorpyrifos.

Drinking-water standards for individual pesticides were rarely exceeded in streams or ground water, but aquatic-life criteria were commonly exceeded in some streams.

Most of the major aquifers and about half of the shallow ground-water zones sampled are sources of drinking water. Most concentrations are substantially below U. S. Environmental Protection Agency (EPA) drinking-water standards, which were exceeded in less than 1 percent of the wells sampled. In streams, peak levels of several herbicides frequently occurred above EPA drinking-water standards in some agricultural areas, but annual average concentrations, which are used for regulation, rarely exceeded standards.

For drinking water, NAWQA results are generally good news if evaluated on the basis of current regulations for individual pesticides. This conclusion is tempered, however, by the fact that criteria are not established for many pesticides, mixtures and degradation products are not considered, and a limited range of potential effects have been assessed. Thus, the full significance of pesticides in drinking water is difficult to evaluate.

Concentrations in streams more frequently exceeded criteria for the protection of aquatic life than drinking-water criteria. Aquatic-life criteria established by EPA, Canada, or the International Joint Commission for the Great Lakes were exceeded by a least one compound in one or more samples for about two thirds of the streams sampled -- most commonly by the herbicides atrazine or cyanazine, or the insecticides azinphos-methyl, chlorpyrifos, diazinon, or malathion. Many of the exceedances were only one or two samples, but sustained periods of time with exceedances were common for atrazine and diazinon at some sites.

For aquatic life, NAWQA results indicate a relatively high potential for effects in some streams, with the additional concerns (as for drinking water) that criteria have not been established for many pesticides, mixtures and degradation products are not considered, and a limited range of potential effects have been assessed.

The geographic distribution of pesticide concentrations generally follows regional patterns in agricultural use and the influence of urban areas (Figures 4-7).

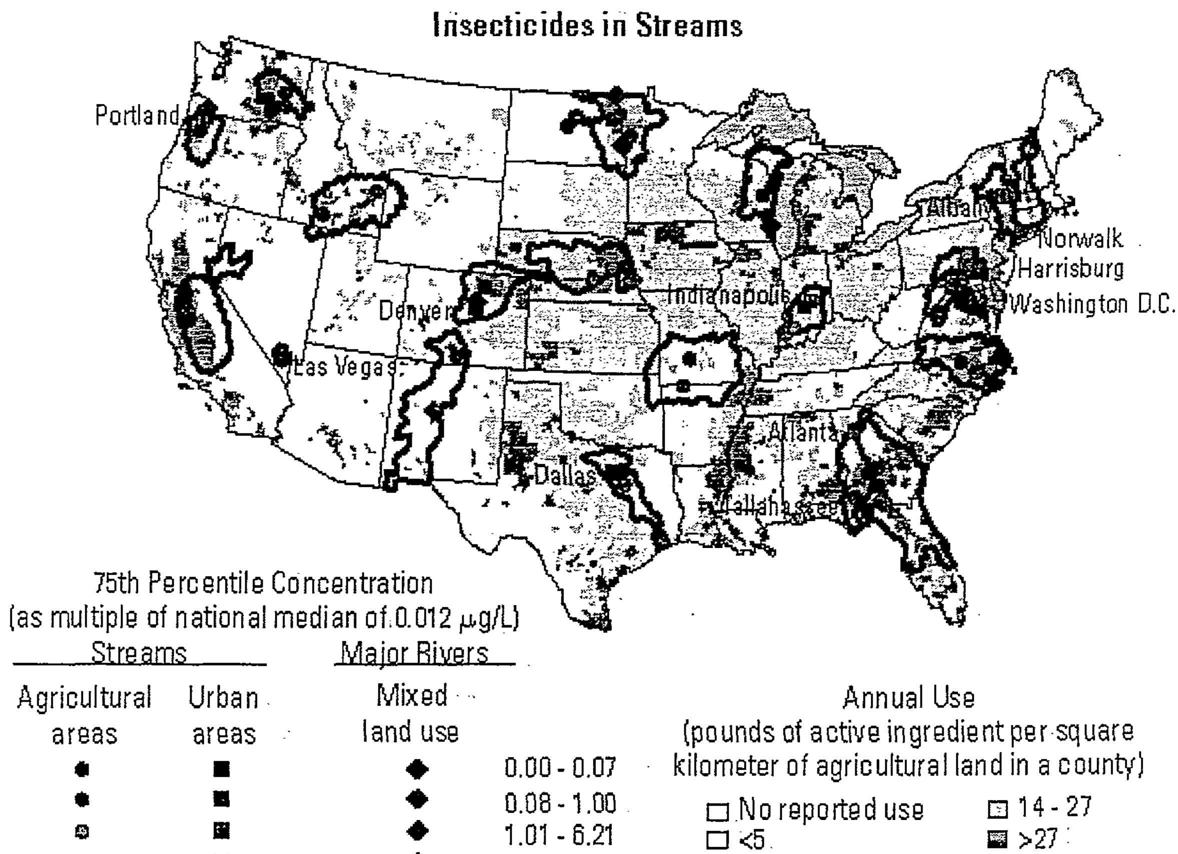


Figure 4. Geographic distribution of insecticides in streams.

The geographic distribution of the concentrations of pesticides in streams was evaluated by determining the annual 75th percentile of monthly median concentrations of total herbicides and total insecticides (sum of all compounds of each type) for each site, expressing the values for each site as multiples of the national median, and ranking by national quartiles. For ground water, the overall detection frequency of any pesticide of each type was determined for each study, values were expressed as multiples of the national median, and each study was ranked by national quartiles. Blue (lowest) and green symbols on the maps indicate where values were less than the national median and orange and red (highest) symbols indicate where values were greater than the national median.

Results for pesticides in streams show that herbicides and insecticides in agricultural streams, and in most large streams and rivers in agricultural regions, were generally highest in areas of the nation with the greatest agricultural use (Figures 4 and 5). Herbicide concentrations were generally greatest in the streams of the central U.S. where use is most extensive. Urban streams had the highest insecticide concentrations, with 7 of 11 having total insecticide concentrations in the upper 25 percent, but some agricultural streams in irrigated agricultural areas of the western U.S. also had high levels.

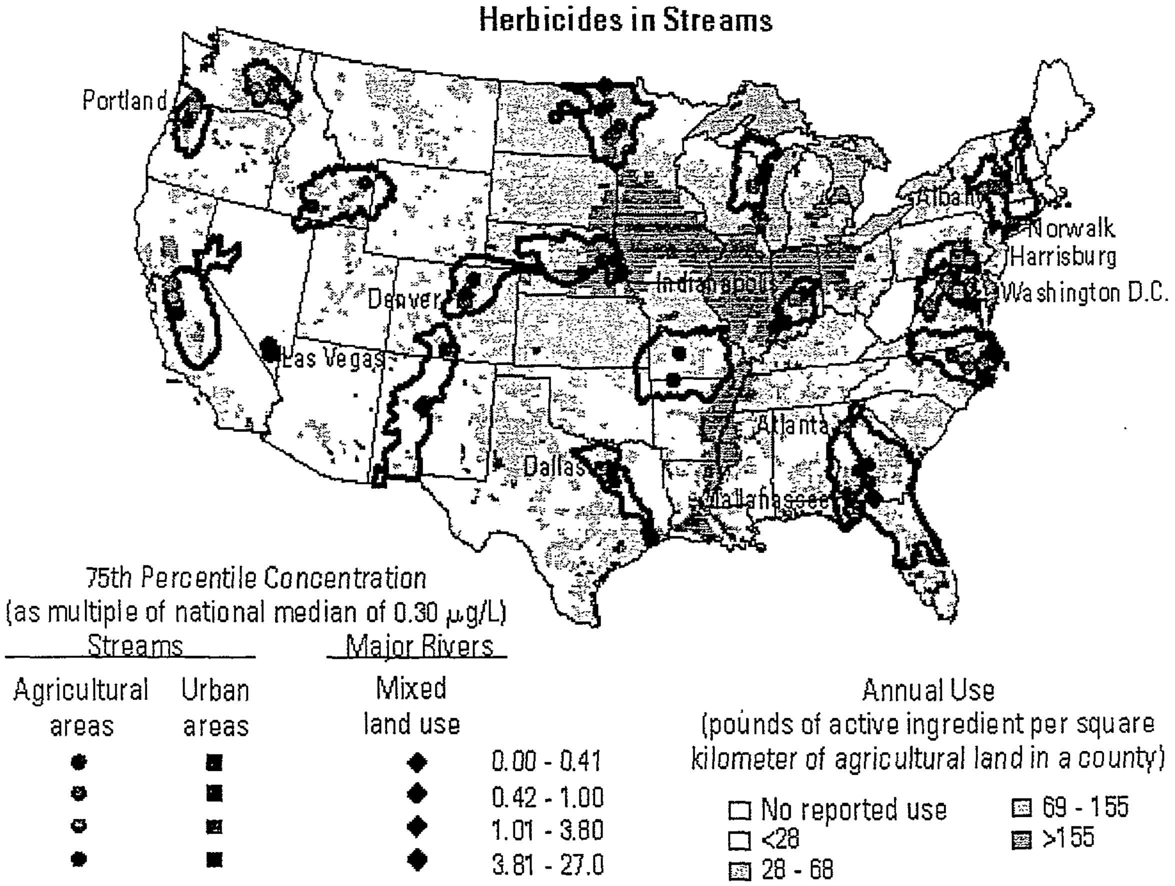


Figure 5. *Geographic distribution of herbicides in streams.*

Results for pesticides in ground water show that herbicides were highest in shallow ground water within agricultural areas and lowest in major aquifers, but the locations of areas with the highest detection frequencies do not follow use patterns as clearly as for streams (Figure 7). Insecticides were seldom detected in ground water and patterns are unclear (Figure 6). Pesticides in ground water, compared to streams, are more variably affected by local hydrogeologic factors, such as soil conditions and the depth and type of aquifer.

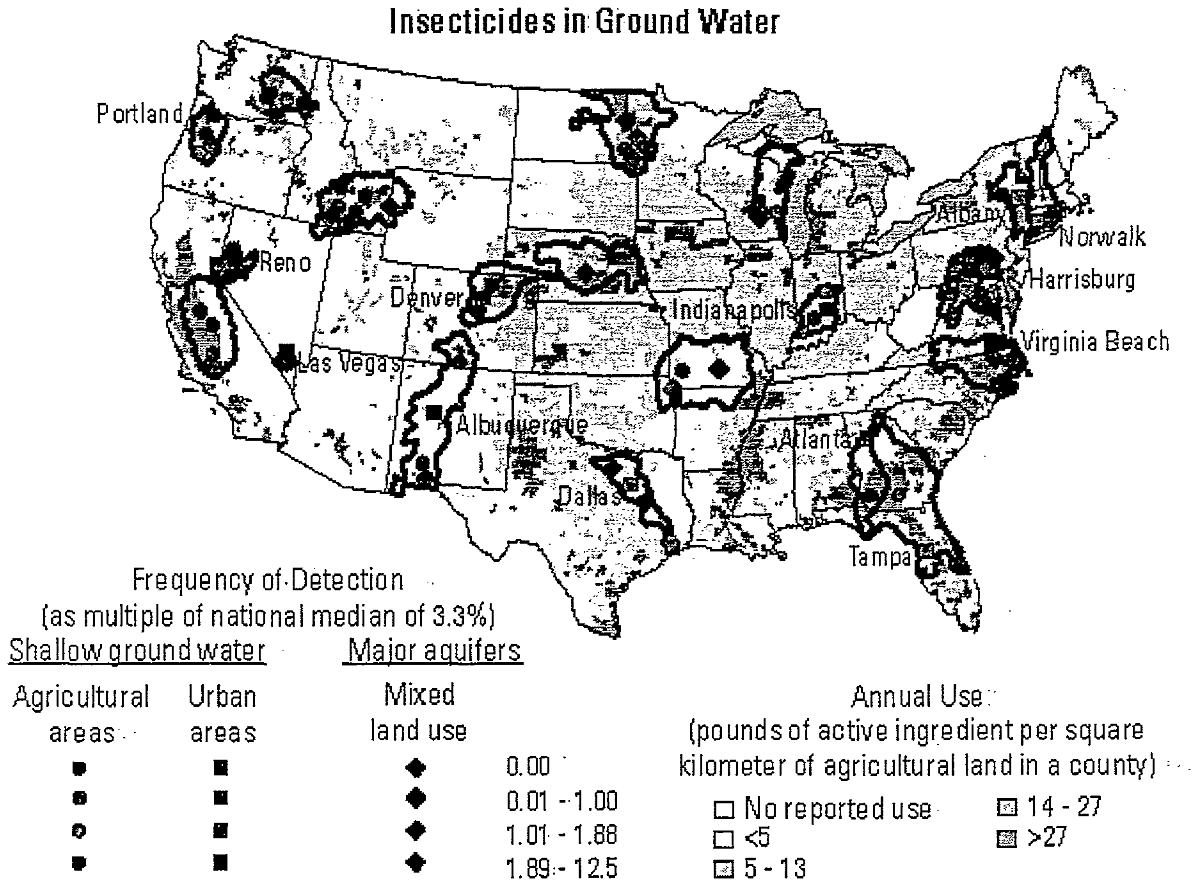


Figure 6. Geographic distribution of insecticides in ground water.

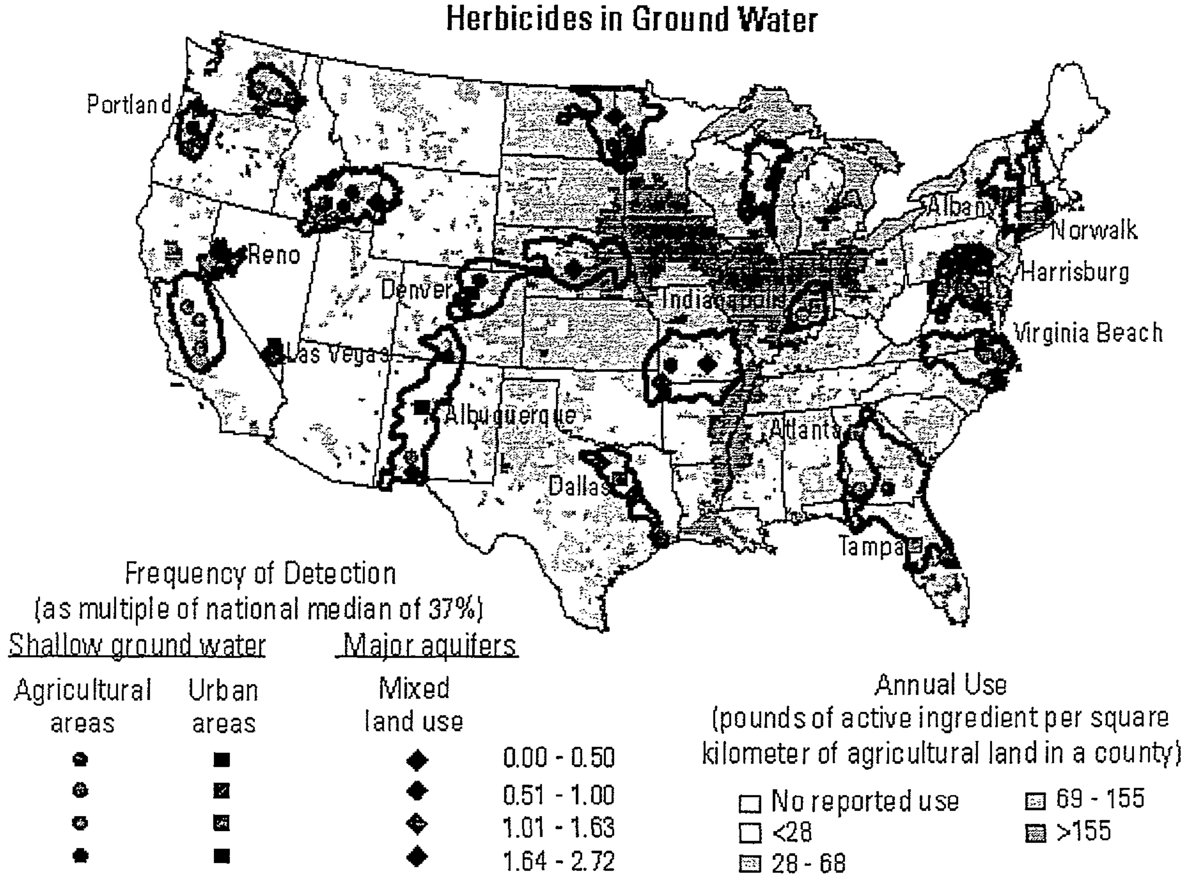


Figure 7. Geographic distribution of herbicides in ground water.

SAMPLING DESIGN AND CONSIDERATIONS FOR DATA INTERPRETATION

NAWQA studies are based on a complex sampling design that targets specific land use and hydrologic conditions in addition to assessing the most important aquifers and streams in each area studied. The studies are not designed to produce a statistically representative analysis of national water-quality conditions, especially with results only from the first 20 study units. The NAWQA sampling design is described by Gilliom and others (1995) and the relation of the 20 study units to the entire U.S. is described by Gilliom and others (1997).

For both streams and ground water, a major component of the sampling design is to target specific watersheds and shallow ground water areas that are influenced primarily by a single dominant land use(agricultural or urban) that is important in the particular area. This component of the design facilitates the summary of results by agricultural and urban land use settings, but results require careful interpretation.

In particular, the NAWQA design does not result in an unbiased representation of all streams or shallow ground water in agricultural settings. For agricultural land use, the focus was limited to the most important agricultural settings within the first 20 study units. Thus, some agricultural activities and related pesticide use that may be very important in a particular part of the nation are not included. For example, the 20 study areas did not include intensive rice growing areas. On the other hand, a particular pesticide may be important in one or two of the 20 study units, but not in the others, and the averaged results may be misleading in this regard. Another possibility is that use of a particular pesticide is much greater than average in the watersheds and ground-water areas studied, leading to an overestimate of occurrence and concetrations relative to other areas. Similar biases are possible for urban areas as well, but the dominant pesticides used are probably more similar among urban areas than they are among agricultural areas with different crops.

For both streams and ground water, statistical summaries for agricultural and urban land uses and for major streams and aquifers were prepared from a carefully selected subset of the complete NAWQA data set in order to control or minimize biases due to different temporal sampling strategies and special studies. The criteria for data selection are described below for each situation. These summaries by NAWQA study component provide a balanced summary of results. In addition, a summary of all data collected, including all types of land use settings and many different types of hydrologic conditions, is included for the purpose of cross-checking with the original data that can be downloaded.

The summaries by NAWQA study component are designed to give a broad and averaged perspective on national results with the understanding that more detailed analysis, which fully considers the sampling design and the variable nature of pesticide use patterns and hydrologic conditions, is underway.

PESTICIDES IN STREAMS

Tables 1-4 summarize the results of NAWQA sampling for pesticides in streams within the first 20 NAWQA study units. Table 1 summarizes results from 1058 sites where stream water was sampled for pesticides. These include sites sampled many times over several years, as well as sites sampled only once or twice. The results summarized in Table 1 are from all stream samples analyzed for pesticides from 1992 through 1996, including samples collected on a fixed sampling frequency, high flow samples, low flow samples, diurnal and storm hydrograph samples, and samples collected as part of special synoptic studies. Because all sites and all samples are included, the summary statistics shown in Table 1 are likely to be biased for many applications. For most compounds, the detection frequencies and concentration percentiles shown will be biased high for commonly occurring conditions because more samples were collected at sites where concentrations were high, or samples were collected more frequently during periods of elevated concentrations. For some compounds, on the other hand, the values shown may be biased low because sampling was not conducted during high-use periods. The maximum concentrations shown in Table 1 are the highest concentrations observed in all NAWQA stream samples.

The summary data shown in Table 1 provide a basis for comparison and cross-checking with the complete stream-water data set available for downloading. Table 1 SHOULD NOT be presumed to be a statistically representative summary of the NAWQA pesticide results. The summaries in Tables 2-4, although also not a statistically representative sampling of the nation, are more representative and comparable assessments of pesticide levels in streams because both the sites and samples were carefully selected to control or minimize bias.

Tables 2-4 summarize the results of NAWQA sampling for pesticides in streams draining relatively homogenous basins that represent specific agricultural and urban land uses (indicator sites) and streams draining large basins with mixed land uses (integrator sites). The summaries in Tables 2-4 are based on samples collected during a one-year period at 65 sites located on streams within the first 20 NAWQA study units. The sites used for these summaries are listed in Table 5, along with the number of samples collected at each site and the time period used for summarizing results. Table 2 summarizes results from 40 streams with primarily agricultural basins. These agricultural indicator sites have relatively small basins (27 to 6000 sq km, with most less than 1000 sq km) and include a variety of different crop types and agricultural practices. Table 3

4. ENVIRONMENT AGENCY DATABASE FIELD LISTINGS

4.1 WIMS

4.2 Hydrolog 3

WIMS Physical Tables / Columns

Report Produced on : 07 April 1998

Table Name	Column Name	Null?	FormatName	Length	Decimal	Table Description
ACTS	ACT_CODE	No	Char	2	0	Unique identifier for Act/Paragraph/Schedule under which a consent has been issued, varied or terminanted
	ACT_TEXT	No	Char	70	0	Description of the Act/Paragraph/Schedule for which ACT_CODE is the identifier
	ACT_TYPE	No	Char	10	0	Brief description of ACT_TEXT status
ADVERTISEMENTS	ADV_APL_NUMBER	No	Char	16	0	Application id to which advertisement relates
	ADV_DATE	No	Date		0	Date advertisement placed in newspaper
	ADV_ID	No	Number	8	0	Unique id to identify advertisement placed in relation to an application for consent to discharge
	ADV_PBL_CODE	No	Char	2	0	Unique code to identify the publication in which the advertisement was made.
	ADV_TEXT	No	Char	70	0	Brief description of advertisement text)
AGREEMENTS	AGR_CATC_HYDRO_ID	Yes	Char	6	0	The code for the catchment within which the site lies. This must correspond to an entry in the table CATCHMENTS
	AGR_CHARGE_STATUS	Yes	Char	1	0	Set to "C" by the user if the consent is chargeable. May need to become mandatory if a WIMS/CFD interface is to be constructed.
	AGR_COMMENT	Yes	Char	70	0	Any comment added by the Agency in relation to the consent.
	AGR_COMPARATIVE	Yes	Char	1	0	Set to "C" by the user if the consent contains comparative/differentail conditions.
	AGR_CONFIDENTIAL	Yes	Char	1	0	This is set to "Y" if the user has applied for and received a certificate of confidentiality from the Secretary of State.
	AGR_CONT_USER_REF	Yes	Char	15	0	The id of the Controlled water which the site is adjacent to. The data must correspond to an entry in table CONTROLLED_WATERS.
	AGR_DATE_STAMP	Yes	Date		0	Date record entered on the system. Generated by the database system
	AGR_EFFECTIVE	Yes	Date		0	The date upon which the consent becomes effective. Used in South West as the *discharge will commence or the date of issue if this is not known.*
	AGR_HISTORIC_STATUS	Yes	Char	1	0	No longer needed. Used in relation to Control of Pollution Act 1974 & transferred from Wessex Water mainframe.
	AGR_ISSUED	Yes	Date		0	The date on which the consent document was issued to the applicant or his/her agent.
	AGR_PREV_CONSENT	Yes	Char	13	0	Previous consent number for this site in relation to the discharges covered by this consent.
	AGR_REC_WATER	Yes	Char	30	0	Free format text field for entering the name of the receiving water for discharges from the site.
	AGR_RESP_HOLDER	Yes	Number	8	0	The Responsibility id for the holder of the consent.
	AGR_RESP_ID	Yes	Number	8	0	The responsibility number for the officer responsible for monitoring/sampling at this site (either physically or managing)
	AGR_REVIEW	Yes	Date		0	The earliest date on which the consent can be reviewed. This defaults to the period required by legislation but can be changed by the user if an earkler date has been agreed with the discharger.
	AGR_REVIEW_CODE	Yes	Char	1	0	Code to indicate how the review date has been arrived, i.e. default or amended by the user.
	ARG_RESP_COMPLY	Yes	Number	8	0	Responsibility id of officer responsible for compliance assessment

Table Name	Column Name	Null?	FormatName	Length	Decimal	Table Description
AGREEMENTS	AGR_APL_NUMBER	No	Char	16	0	Unique identifier for agreement (Consent) i.e Consent Number or Consent Folio Number
	AGR_DSI_NGR	No	Char	12	0	The National Grid Reference of the site, normally the entrance to the site, for which the consent has been issued. The NGR corresponds to a record on the table DISCHARGE_SITES.
	AGR_FULL_STATUS	No	Char	2	0	Code from ACTS corresponding to the relevant legislation applying to the cosent
	AGR_REVOCATION	No	Date			
	AGR_SIGNED	No	Date		0	Date consent document was signed by the authorised Agency officer under the Scheme of Delegation
	AGR_VERSION	No	Number	2		The version number of the consent.
AGREEMENTS_JNL	AGR_CATC_HYDRO_ID	Yes	Char	6		
	AGR_CHARGE_STATUS	Yes	Char	1		
	AGR_COMMENT	Yes	Char	70		
	AGR_COMPARATIVE	Yes	Char	1		
	AGR_CONFIDENTIAL	Yes	Char	1		
	AGR_CONT_USER_REF	Yes	Char	15		
	AGR_DATE_STAMP	Yes	Date			
	AGR_EFFECTIVE	Yes	Date			
	AGR_HISTORIC_STATUS	Yes	Char	1		
	AGR_ISSUED	Yes	Date			
	AGR_PREV_CONSENT	Yes	Char	13		
	AGR_REC_WATER	Yes	Char	30		
	AGR_RESP_COMPLY	Yes	Number	8		
	AGR_RESP_HOLDER	Yes	Number	8		
	AGR_RESP_ID	Yes	Number	8		
	AGR_REVIEW	Yes	Date			
	AGR_REVIEW_CODE	Yes	Char	1		
	AGR_REVOCATION	Yes	Date			
	AGR_APL_NUMBER	No	Char	16		
	AGR_DSI_NGR	No	Char	12		
	AGR_FULL_STATUS	No	Char	2		
	AGR_JNL_DATE	No	Date			
	AGR_JNL_USER	No	Char	12		
	AGR_SIGNED	No	Date			
	AGR_VERSION	No	Number	2		
ANALYTICAL_METHODS	AM_DETECTION_LIMIT	Yes	Number	10	5	What is the limit of detection for this method of analysis?
	AM_USER_METHOD_DESC	Yes	Char	30	0	Further comments made by the user to describe the analytical method

Table Name	Column Name	Null?	FormatName	Length	Decimal	Table Description
ANALYTICAL_METHODS	AM_ACCREDITED	No	Char	1	0	Does the lab have NAMAS accreditation for this method?
	AM_CALCULATED	No	Char	1	0	Is the method a calculated method?
	AM_DETE_CODE	No	Char	4	0	The code of the determinand for which the analytical method is used. The code must exist in the table DETERMINANDS
	AM_IN_SITU	No	Char	1	0	Is this an in situ method of analysis?
	AM_LAST_CHANGED	No	Date		0	Date the method details were last changed.
	AM_METHOD_CODE	No	Char	3	0	Unique code for the analytical method
	AM_METHOD_DESC	No	Char	30	0	Description of the analytical method
	AM_STATUS	No	Char	1	0	Is this method still used by the laboratory?
APPLICATIONS	APL_ACK	Yes	Char	1	0	Has the application been acknowledged?
	APL_AD_WAIVED	Yes	Char	1	0	Has advertising of the application been waived?
	APL_AUTH_DEC	Yes	Date	1	0	Date by which the application must be determined (defaults to statutory time period
	APL_C_EXEMPT	Yes	Char	1	0	Has a certificate of exemption been applied for?
	APL_CATCH_HYDRO_ID	Yes	Char	6	0	Code for catchment within which the site is located. This must have a corresponding entry on the table CATCHMENTS
	APL_COMMENT	Yes	Char	70	0	Any comment added by the user
	APL_CONT_USER_REF	Yes	Char	15	0	Code for the controlled water to which the site is adjacent. This must have a corresponding entry in the table CONTROLLED_WATERS
	APL_DOE	Yes	Date		0	Date application was sent to Doe for comment/determination
	APL_DSI_NGR	Yes	Char	12	0	NGR of the site (normally the site entrance) to which the application relates. The NGR must have a corresponding entry in the table DISCHARGE_SITES
	APL_DSI_NGR_EAST_NUMBE R	Yes	Number	6	0	Easting for Site NGR (calculated by system)
	APL_DSI_NGR_NORTH_NUM BER	Yes	Number	6	0	Northing for Site NGR (calculated by system)
	APL_EXT_AGRD	Yes	Date		0	Has an extension been agreed with the applicant/agent for determination of the application?
	APL_EXT_REQ	Yes	Date		0	Date extension to determination period was requested
	APL_FILE_REF	Yes	Char	12	0	Free format field for user to enter the filing system reference
	APL_GRANTED	Yes	Date		0	Date consent was granted
	APL_HEAR_ENQ	Yes	Char	1	0	Type of hearing (Public enquiry etc.) if a hearing has been requested.
	APL_HEAR_REQ	Yes	Char	1	0	Code to indicate which party has requested the hearing/enquiry
	APL_HEAR_REQ_DATE	Yes	Date		0	Date the request for a hearing/enquiry was made.
	APL_HER_ENQ_DATE	Yes	Date		0	Date of hearing/enquiry
	APL_LOCAL_AUT	Yes	Date		0	Date the application was forwarded to the Local Authority for representations/comment
	APL_MAFF	Yes	Date		0	Date the application was forwarded to MAFF for comment
	APL_PREV_CONS	Yes	Char	8	0	Previous consent number which the application will replace
	APL_PROHIB	Yes	Char	1	0	Does a prohibition notice apply to this site in relation to this application?
	APL_REC_WATER	Yes	Char	30	0	Text description of receiving water for proposed discharges from site.

Table Name	Column Name	Null?	FormatName	Length	Decimal	Table Description
APPLICATIONS	APL_RECEIVED	Yes	Date		0	Date application form was received from the applicant
	APL_REN_CODE	Yes	Char	2	0	Code to indicate the type of receiving environment for proposed discharges. The code entered must exist on the table CATCHMENT_REF_CODES under the domain APPLICATIONS.APL_REN_CODE
	APL_RESP_ID	Yes	Number	8	0	Responsibility id of the officer responsible for dealing with the application
	APL_RESP_REP	Yes	Number	8	0	Responsibility id of body making representations
	APL_RESP_SUBMIT	Yes	Number	8	0	Responsibility id of the person/body submitting the application.
	APL_SS_APPLIC	Yes	Date		0	Date application was sent to Secretary of State for determination (if applicable)
	APL_SS_APPLIC_CODE	Yes	Char	1	0	Code to indicate party requesting Secretary of State to call in the application (Code must exist in table CATCHMENT_REF_CODES in domain APPLICATIONS.APL_SS_APPLIC_CODE
	APL_SS_CLOSE	Yes	Date		0	Date by which representations must be made to Secretary of State
	APL_SS_DEC	Yes	Char	1	0	Code to indicate Secretary of State's decision. Code must exist in table CATCHMENT_REF_CODES with domain APPLICATIONS.APL_SS_DEC
	APL_SS_DEC_DATE	Yes	Date		0	Date on which Secretary of State issued decision
	APL_THIRD_PARTY	Yes	Date		0	Date representations were received from any third party
	APL_ISSUED	No	Date		0	Date application form was issued to the applicant or agent
	APL_LAST_REPRESENTATIONS	No	Date			
	APL_NUMBER	No	Char	16	0	Unique number to identify the application. This becomes the consent number upon determination and issue
	APL_STATUS	No	Char	1	0	Status of the application/application form
AREAS	AREA_APL_NEXT	No	Number	6	0	
	AREA_DESC	No	Char	70	0	
	AREA_NAME	No	Char	3	0	
AUTHORITIES	AUTH_DETAILS	Yes	Char	60		
	AUTH_ID	Yes	Char	2		
	AUTH_NAME	Yes	Char	26		
	AUTH_TYPE	Yes	Char	1	0	
CALCULATIONS	CALC_TEXT	Yes	Char	70		SQL text being run to carry out the determination.
	CALC_DETE_CODE	No	Char	4		The code of the determinand being calculated
	CALC_LINENO	No	Number	4		Sequential line number for the SQL held in the calculation
CATCHMENT_HELP_TEXT	HT_HELP_TEXT	Yes	Char	132		
	HT_TYPE	Yes	Char	10		
	HT_COLUMN	No	Char	100		
	HT_SEQ_NO	No	Number			
	HT_TABLE	No	Char	100		
CATCHMENT_REF_CODES	RV_ABBREVIATION	Yes	Char	240		Abbreviation for the name of the reference item

Table Name	Column Name	Null?	FormatName	Length	Decimal	Table Description
CATCHMENT_REF_CODES	RV_HIGH_VALUE	Yes	Char	240		The high value for a reference data item held in the table
	RV_MEANING	Yes	Char	240		The description of the value of this item
	RV_TYPE	Yes	Char	10		Free format field, normally contains the inititials of the user entering a record.
	RV_DOMAIN	No	Char	100		The table and column which anyitem held in the table is used as a look-up.
	RV_LOW_VALUE	No	Char	240		The low value for a reference data item held in the table.
CATCHMENT_REF_VALUES	RV_ABBREVIATION	Yes	Char	240		
	RV_COLUMN	Yes	Char	100		
	RV_DOMAIN	Yes	Char	100		
	RV_HIGH_VALUE	Yes	Char	240		
	RV_MEANING	Yes	Char	240		
	RV_TABLE	Yes	Char	100		
	RV_TYPE	Yes	Char	10		
	RV_LOW_VALUE	No	Char	240		
CATCHMENTS	CATC_DESC	Yes	Char	70		Description of the catchment.
	CATC_AREA_NAME	No	Char	1		Id of the area within which the catchment lies.
	CATC_HYDRO_AREA_ID	No	Char	6		Unique id for the hydrometric catchment/sub catchment
	CATC_NAME	No	Char	25		Name of the catchment.
CLASSIFICATION_WATER_LINKS	CWL_EFFECTIVE_DATE	Yes	Date			The date from which the classification takes effect
	CWL_CLASSIFICATION_CODE	No	Char	2		Classification code for Controlled water
	CWL_CONTROLLED_WATER_CODE	No	Char	15		Unique code for the controlled water
	CWL_HISTORIC_STATUS	No	Char	1		Historic status of the classification, either C(urrent) or H(istoric)
CLASSIFICATIONS	CLAS_SMPT_TYPE	Yes	Char	2		
	CLAS_CODE	No	Char	2		
	CLAS_DESC	No	Char	70		
COMM_TYPES	COMM_DESC	No	Char	32		Description of type of letter
	COMM_ID	No	Char	2		Unique Id for type of letter
COMMUNICAT_CC	CC_NEXT_VALUE	No	Number	38		Next sequence number for communications
COMMUNICATIONS	COM_CONTROLLED_USER_REF	Yes	Char	15		
	COM_DESC	Yes	Char	70		
	COM_LET_TEMP_ID	Yes	Number	8		
	COM_SAMPLE_ID	Yes	Number	8		
	COM_STATUS	Yes	Char	2		

Table Name	Column Name	Null?	FormatName	Length	Decimal	Table Description
COMMUNICATIONS	COM_TYPE_TEMP_HOLDER	Yes	Char	2		
	COM_ACTION_DATE	No	Date			
	COM_DATE_STAMP	No	Date			
	COM_ID	No	Number	8		
	COM_RESPONSIBLE_ID	No	Number	8		
	COM_TYPE_ID	No	Char	2		
	COM_USER_STAMP	No	Char	12		
CONSENT_ROLES	CRO_AGENT_ROLE	Yes	Char	2		The ROLE of the consent agent. *Must be a valid value from the ROLES table*
	CRO_APPLICANT_ROLE	Yes	Char	2		The ROLE of the consent applicant. Must be a valid value from the ROLES table
	CRO_END	No	Date			End date of applicability of ROLE code.
	CRO_START	No	Date			Start date of applicability of ROLE code.
CONSULTATIONS	CONS_COMMENT	Yes	Long			Consultation comments made by consultee. In South West, this information is copied/pasted from E-Mail
	CONS_DATE_REC	Yes	Date			Date comments were received.
	CONS_APL_NUMBER	No	Number	16		Application number to which consultation relates
	CONS_DATE_PASSED	No	Date			Date the consultation was passed to Agency consultee
	CONS_RESP_ID	No	Number	8		Responsibility id Agency employee acting as consultee for this application
CONTROLLED_WATER_TYPES	CWT_DESC	No	Char	70		Description of the controlled water type
	CWT_SHORT_CODE	No	Char	4		Unique id for the type of controlled water
CONTROLLED_WATERS	CONT_AREA	Yes	Char	1		The Agency wq operational area in which the controlled water lies.
	CONT_EASTING1	Yes	Number	6		The 6 figure easting for CONT_GRID_REF_I
	CONT_EASTING2	Yes	Number	6		The 6 figure easting for CONT_GRID_REF_2
	CONT_GRID_REF_1	Yes	Char	12		The NGR of the upstream point of the controlled water
	CONT_GRID_REF_2	Yes	Char	12		The NGR of the downstream point of the controlled water
	CONT_LENGTH	Yes	Number	8	2	The length of the controlled water
	CONT_LENGTH_UNIT	Yes	Char	4		The code for units (from table UNITS) in which the length is measured
	CONT_NORTHING1	Yes	Number	6		The 6 figure northing for CONT_GRID_REF_I
	CONT_NORTHING2	Yes	Number	6		The 6 figure northing for CONT_GRID_REF_2
	CONT_RESP_ID	Yes	Number	8		Responsibility id of Agency officer with responsibility for the controlled water (normally the officer with water quality management responsibility)
	CONT_NAME	No	Char	50		Name of controlled water
	CONT_TYPE	No	Char	2		The type of controlled water
	CONT_USER_REF	No	Char	15		Unique id for controlled water
	CONT_WAT_CAT_TYPE	No	Char	2		The controlled water category
	CONT_WATER_COURSE	No	Char	25		The name of the watercourse in which the controlled water lies

Table Name	Column Name	Null?	FormatName	Length	Decimal	Table Description
CONVERSION_FACTOR_SQL_LINES	CFSL_CONVERSION_FROM	No	Char	4		The unit being converted
	CFSL_CONVERSION_TO	No	Char	4		The unit being calculated
	CFSL_LINENO	No	Number	3		Sequence number of the line in the formula
	CFSL_TEXT	No	Char	70		The SQL text
CONVERSION_FACTORS	CONV_COMMENT	Yes	Char	70		Comments
	CONV_FORMULA	Yes	Char	70		Formula to carry out conversion
	CONV_FROM	No	Char	4		Unit to convert from
	CONV_TO	No	Char	4		Unit to convert to
DEPARTMENTS	DEPT_ACTIVE	Yes	Char	1		Is department active?
	DEPT_DESCRIPTION	Yes	Char	32		Description/name of department
	DEPT_ID	Yes	Char	2		Unique Id for Agency department
	DEPT_PRINTER	Yes	Char	25		Id of Department printer (for printing of Traders letters)
DETERMINAND_DETERMINAND	DETE_CALC_ON	No	Char	4		Code being determined
	DETE_CODE	No	Char	4		Code being used in calculation
DETERMINANDS	DETE_CALCULATED	Yes	Char	1		Is this a calculated determinand?
	DETE_REVERSE_LOGIC	Yes	Char	1		Indicates that the compliance logic for this determinand is the reverse of normal. eg Dissolved Oxygen - High value = good; low value = bad
	DETE_CODE	No	Char	4		Unique code for determinand
	DETE_DESC	No	Char	70		Full name/description of determinand
	DETE_SHORT_DESC	No	Char	12		Short description of determinand for inclusion in hardcopy prints, determinand name fields on forms
	DETE_UNIT	No	Char	4		Code for the units in which the determinand is measured.
DISCHARGE_SITES	DSI_ADD1	Yes	Char	32		!st line of address of discharge site
	DSI_ADD2	Yes	Char	32		2nd line of address of discharge site
	DSI_ADD3	Yes	Char	32		3rd line of address of discharge site
	DSI_ADD4	Yes	Char	32		4th line of address of discharge site
	DSI_COMMENTS	Yes	Char	80		Any comments relating to the discharge site
	DSI_COUNTRY	Yes	Char	1		Indicates the country in which the Discharge Site is situated
	DSI_DC_REF	Yes	Char	2		Indicates the local authority in which the Discharge Site is situated
	DSI_EASTING	Yes	Number	6		6 figure easting for discharge site
	DSI_NORTHING	Yes	Number	6		6 figure northing for discharge site
	DSI_POST_CODE	Yes	Char	10		Postcode of address of discharge site
	DSI_TYPE	Yes	Char	2		Type of site. THe type must exist in CATCHMENT_REF_CODES in the domain DISCHARGE_SITES.DSI_TYPE
	DSI_AREA	No	Char	1		Indicates the Environment Agency area in which the Discharge Site is situated

Table Name	Column Name	Null?	FormatName	Length	Decimal	Table Description
DISCHARGE_SITES	DSI_LNAME	No	Char	35		Long name of the discharge site
	DSI_NGR	No	Char	12		National Grid Reference for the discharge site
	DSI_PAR_CODE	No	Number	4		Code for parish within which discharge site lies. Must exist in table PARISHS
	DSI_SNAME	No	Char	12		Short name for the discharge site
	DSI_SUBAREA	No	Char	1		Indicates the Environment Agency sub-area in which the Discharge Site is situated
DISTRICT_COUNCILS	DC_CC_REF	No	Char	2		Reference code for County Council within which District Council lies
	DC_LNAME	No	Char	20		Name of the district council
	DC_REF	No	Char	2		Unique code for District Council
DUMP	FIRST_VALUE	Yes	Number			
	HOW_MANY	Yes	Number			
	MEDIAN	Yes	Number			
	SECOND_VALUE	Yes	Number			
	WHICH_ONE	Yes	Number			
DUTY_ROTA	DUTY_DATE	Yes	Date			
	DUTY_DEPT	Yes	Char	2		
	DUTY_EMPNO	Yes	Char	4		
EFF_SPEC_BOD85	ESP_CODE1	Yes	Char	1		
	ESP_CODE2	Yes	Char	1		
	ESP_CODE3	Yes	Char	1		
	ESP_DETE_CODE	Yes	Char	4		
	ESP_MEAS_METHOD	Yes	Char	1		
	ESP_VAL1	Yes	Number	12	5	
	ESP_VAL2	Yes	Number	12	5	
	ESP_VAL3	Yes	Number	12	5	
	ESP_AGCO_ID	No	Char	16		
	ESP_EFF_NUM	No	Number	2		
	ESP_MONTH_FROM	No	Char	2		
	ESP_MONTH_TO	No	Char	2		
	ESP_OL_REF	No	Number	2		
EFFLUENT_CONDITIONS	EFCO_SEQUENCE	Yes	Number	3		Sequence of condition to be stored in the table (should be sequence in which it appears in the consent document)
	EFCO_AGCO_ID	No	Char	16		Consent number
	EFCO_AGCO_VERSION	No	Number	2		
	EFCO_EFF_NUM	No	Number	2		Effluent number
	EFCO_OL_REF	No	Number	2		Outlet reference

Table Name	Column Name	Null?	FormatName	Length	Decimal	Table Description
EFFLUENT_CONDITIONS	EFCO_STCO_CODE	No	Number	4		Cde for condition. Code must appear in table STANDARD_CONDITIONS
EFFLUENT_CONDITIONS_JNL	EFCO_SEQUENCE	Yes	Number	3		
	EFCO_AGCO_ID	No	Char	16		
	EFCO_AGCO_VERSION	No	Number	2		
	EFCO_EFF_NUM	No	Number	2		
	EFCO_JNL_DATE	No	Date			
	EFCO_JNL_USER	No	Char	8		
	EFCO_OL_REF	No	Number	2		
	EFCO_STCO_CODE	No	Number	4		
EFFLUENT_SPECIFICS	ESP_88_FLAG	Yes	Char	1		No longer used
	ESP_CODE1	Yes	Char	1		The code for the type of limit (eg maximum) that applies to ESP_VAL1. Must exist in domain EFFLUENT_SPECIFICS.ESP_CODE1 in CATCHMENT_REF_CODES
	ESP_CODE2	Yes	Char	1		The code for the type of limit (eg maximum) that applies to ESP_VAL2. Must exist in domain EFFLUENT_SPECIFICS.ESP_CODE2 in CATCHMENT_REF_CODES
	ESP_CODE3	Yes	Char	1		The code for the type of limit (eg maximum) that applies to ESP_VAL3. Must exist in domain EFFLUENT_SPECIFICS.ESP_CODE3 in CATCHMENT_REF_CODES
	ESP_DESC	Yes	Long			If the condition is a non-standard text condition (ie specific t this effluent and not generally used), the text of the condition is placed in this field.
	ESP_DETE_CODE	Yes	Char	4		Determinand code (must appear in table DETERMINANSD) if the condition relates to a numeric determinand.
	ESP_MEAS_METHOD	Yes	Char	1		The method of measurement (A - Absolute or C - Comparative/Differential) that applies to the condition if it is a numeric condition.
	ESP_VAL1	Yes	Number	12	5	The value of the first of three possible limits which apply to the condition in the specified sate range
	ESP_VAL2	Yes	Number	12	5	The value of the second of three possible limits which apply to the condition in the specified sate range
	ESP_VAL3	Yes	Number	12	5	The value of the third of three possible limits which apply to the condition in the specified sate range
	ESP_AGCO_ID	No	Char	16		Consent number
	ESP_AGCO_VERSION	No	Number	2		The consent AGREEMENT version number
	ESP_EFF_NUM	No	Number	2		Effluent number
	ESP_MONTH_FROM	No	Char	2		Month from which condition is valid (defaults to 01 - January)
	ESP_MONTH_TO	No	Char	2		Month to which condition is valid (defaults to 12 - December)
	ESP_NUM	No	Number	2		Sequence number for condition - the order in which the appear on the foem when displayed.
	ESP_OL_REF	No	Number	2		Outlet number
EFFLUENT_SPECIFICS_JNL	ESP_88_FLAG	Yes	Char	1		
	ESP_CODE1	Yes	Char	1		
	ESP_CODE2	Yes	Char	1		
	ESP_CODE3	Yes	Char	1		

Table Name	Column Name	Null?	FormatName	Length	Decimal	Table Description
EFFLUENT_SPECIFICS_JNL	ESP_DESC	Yes	Long			
	ESP_DETE_CODE	Yes	Char	4		
	ESP_MEAS_METHOD	Yes	Char	1		
	ESP_VAL1	Yes	Number	12	5	
	ESP_VAL2	Yes	Number	12	5	
	ESP_VAL3	Yes	Number	12	5	
	ESP_AGCO_ID	No	Char	16		
	ESP_AGCO_VERSION	No	Number	2		
	ESP_EFF_NUM	No	Number	2		
	ESP_JNL_DATE	No	Date			
	ESP_JNL_USER	No	Char	8		
	ESP_MONTH_FROM	No	Char	2		
	ESP_MONTH_TO	No	Char	2		
	ESP_NUM	No	Number	2		
	ESP_OL_REF	No	Number	2		
EFFLUENTS	EFF_DESC	Yes	Char	80		Free format description for effluent.
	EFF_DWF	Yes	Number	9	2	The consented dry weather flow for the effluent in cubic metres/day
	EFF_FLOW_CODE	Yes	Char	2		Code to indicate the type of flow measurement used for the effluent discharge. the code must exist in the domain EFFLUENTS.EFF_FLOW_CODE in CATCHMENT_REF_CODES.
	EFF_MAX_DAILY	Yes	Number	9	2	The consented maximum daily flow for the effluent in cubic metres/day
	EFF_MAX_RATE	Yes	Number	9	2	The consented maximum rate of flow for the effluent in litres/sec.
	EFF_MEAN	Yes	Number	9	2	The consented mean flow for the effluent in cubic metres/day
	EFF_OP_REQS	Yes	Char	80		Free format text for holding details of any operational requirements required of the dicharger
	EFF_SMPT_USER_REF	Yes	Char	8		The sampling point number/User Reference Number against which samples taken of this effluent are stored in the SAMPLES and MEASUREMENTS table.
	EFF_TMEN_CODE	Yes	Char	2		Code for type of treatment. Must exist in table TREATMENTS.
	EFF_AGCO_ID	No	Char	16		Consent number to which effluent relates
	EFF_AGCO_VERSION	No	Number	2		Version number of Consent AGREEMENT.
	EFF_NGR	No	Char	12		NGR of the effluent sampling point
	EFF_NUM	No	Number	2		nth effluent discharging via the outlet EFF_OL_REF
	EFF_OL_REF	No	Number	2		Outlet number to which effluent relates
	EFF_SPT_CODE	No	Char	2		Code for sampling point type.
EFFLUENTS_JNL	EFF_DESC	Yes	Char	80		
	EFF_DWF	Yes	Number	9	2	
	EFF_FLOW_CODE	Yes	Char	2		

Table Name	Column Name	Null?	FormatName	Length	Decimal	Table Description
EFFLUENTS_JNL	EFF_MAX_DAILY	Yes	Number	9	2	
	EFF_MAX_RATE	Yes	Number	9	2	
	EFF_MEAN	Yes	Number	9	2	
	EFF_OP_REQS	Yes	Char	80		
	EFF_SMPT_USER_REF	Yes	Char	8		
	EFF_TMEN_CODE	Yes	Char	2		
	EFF_AGCO_ID	No	Char	16		
	EFF_AGCO_VERSION	No	Number	2		
	EFF_JNL_DATE	No	Date			
	EFF_JNL_USER	No	Char	8		
	EFF_NGR	No	Char	12		
	EFF_NUM	No	Number	2		
	EFF_OL_REF	No	Number	2		
	EFF_SPT_CODE	No	Char	2		
GAZ_WATERS	GAZWAT_CONT_USER_REF	Yes	Char	15		Controlled water reference from CONTROLLED_WATERS
	GAZWAT_GAZ_REF	Yes	Char	8		Gazetteer reference from GAZETTEER
GAZETEER	GAZ_DISTRICT	Yes	Char	2		Id of District Council responsible for place
	GAZ_EASTING	Yes	Number	6		Easting for GAZ_GRID
	GAZ_FIRE	Yes	Char	2		Id of Fire brigade responsible for place
	GAZ_GRID	Yes	Char	8		Grid reference of central point in place
	GAZ_NORTHING	Yes	Number	6		Northing for GAZ_GRID
	GAZ_PLACENAME	Yes	Char	32		Name of town/village etc
	GAZ_PLC_DATA	Yes	Char	80		Data transferred from Wessex Water plc system and not translated
	GAZ_POLICE	Yes	Char	2		Id of Police force responsible for place
	GAZ_REF	Yes	Char	8		Unique id for place name
GENERIC_DETERMINANDS	GDE_DETE_CODE	No	Char	4		Determinand code used for particular function. eg No effluent flow at time of sampling.
	GDE_FUNCT_CODE	No	Char	1		Function to which determinand refers.
GRID_CONVERSION	GRID_EAST	Yes	Number	1		Number to be used to prefix for easting
	GRID_NORTH	Yes	Number	1		Number to be used in prefix for northing
	GRID_PREFIX	Yes	Char	2		NGR Grid Reference characters
JOURNAL	WHAT	Yes	Char	250		
	WHEN	Yes	Date			
LETTER_SIGNATORIES	LSI_AREA	No	Char	1		The AREA of the letter signatory.
	LSI_END	No	Date			End date of period of applicability

Table Name	Column Name	Null?	FormatName	Length	Decimal	Table Description
LETTER_SIGNATORIES	LSI_RESP_ID	No	Number	8		The RESP_ID of the letter signatory.
	LSI_START	No	Date			Start date of period of applicability
	LSI_SUB_AREA	No	Char	1		The SUB_AREA of the letter signatory.
LIMITS	LIM_CLASS_CODE	Yes	Char	2		
	LIM_END_DATE	Yes	Date			
	LIM_LOWER_LIMIT	Yes	Number	12	5	
	LIM_SEASON_CODE	Yes	Char	2		
	LIM_SMPT_USER_REFERENCE	Yes	Char	8		
	LIM_START_DATE	Yes	Date			
	LIM_STATUS	Yes	Char	1		
	LIM_SURV_ID	Yes	Number	8		
	LIM_UPPER_LIMIT	Yes	Number	12	5	
	LIM_DETERMINAND_CODE	No	Char	4		
	LIM_TYPE	No	Char	1		
LINK_TABLE	PAR1	Yes	Char	30		
	PAR10	Yes	Char	30		
	PAR11	Yes	Char	96		
	PAR12	Yes	Char	96		
	PAR13	Yes	Char	30		
	PAR14	Yes	Char	30		
	PAR15	Yes	Char	30		
	PAR16	Yes	Char	30		
	PAR17	Yes	Char	30		
	PAR18	Yes	Char	30		
	PAR19	Yes	Char	30		
	PAR2	Yes	Char	30		
	PAR20	Yes	Char	30		
	PAR3	Yes	Char	30		
	PAR4	Yes	Char	30		
	PAR5	Yes	Char	30		
	PAR6	Yes	Char	30		
	PAR7	Yes	Char	30		
	PAR8	Yes	Char	30		
	PAR9	Yes	Char	30		
	USER_NAME	No	Char	30		

Table Name	Column Name	Null?	FormatName	Length	Decimal	Table Description
LOAD_ERRORS	LE_DETERMINAND_CODE	Yes	Char	4		
	LE_ERROR_CODE	No	Char	1		
	LE_LAB_REF_NO	No	Char	6		
	LE_SAMP_MEAS	No	Char	1		
	LE_SOURCE	No	Char	8		
MANDATORY_PUBLICATIONS	MPU_END	No	Date			End date for the period of applicability.
	MPU_PBL_CODE	No	Char	2		The code for the mandatory publication (currently the London Gazette). This code must exist in the PUBLICATIONS table.
	MPU_START	No	Date			Start date for the period of applicability.
MEASUREMENTS	MEAS_DATE_STAMP	Yes	Date			Date measurement was loaded or last amended.
	MEAS_SIGN	Yes	Char	1		Sign/qualifier for result - "<",">" or " "
	MEAS_TEXT_RESULT	Yes	Long			Field to hold text results. Eg. GCMS reports.
	MEAS_ANAL_METH_CODE	No	Char	2		Code for analytical method. Must be on table ANALYTICAL_METHODS and must be a current method of analysis.
	MEAS_DETERMINAND_CODE	No	Char	4		Code f determinand measured. Must exist on table DETERMINANDS.
	MEAS_LIMITS	No	Char	1		Flag to indicate whether sample is within or outside a measured limit (such as a consent limit) and takes the values "Y" (limit exceeded), "N" (not exceeded) or "U" (unmeasured or unmeasurable). This flag is set when the measurement result is transferred to the table after validation.
	MEAS_RESULT	No	Number	12	5	Actual amount of determinand detected, or a numeric code for semi-quantitative determinands such as "No of bathers on beach"
	MEAS_SAMPLE_ID	No	Number	8		Unique Id of sample to which measurements relate. This is a sequential number (see SAMPLE)
MEASUREMENTS_JNL	MJ_ANAL_METH_CODE	Yes	Char	2		Analytical method code
	MJ_DETE_CODE	Yes	Char	4		Determinand code
	MJ_LAB_REF_NO	Yes	Char	6		Laboratory reference number of sample to which the measurement relates
	MJ_LIMITS	Yes	Char	1		Limits exceedence flag - "Y", "N", "U"
	MJ_RESULT	Yes	Number	12	5	Result
	MJ_SIGN	Yes	Char	1		Sign/qualifier ("<", ">", " ")
	MJ_SOURCE	Yes	Number	8		Source of sample to which the measurement relates. The source must be present on table ORGANISATIONS
	MJ_TEXT_RESULT	Yes	Long			Field for text results. Eg. GCMS reports
	MJ_UNIT_CODE	Yes	Char	4		Unit code
	MJ_DATE_STAMP	No	Date			Date of entry of journal record
	MJ_REASON_FOR_CHANGE	No	Char	70		Valid reason for changing the original measurement record
	MJ_SAMP_ID	No	Number	8		Id of sample to which journal record relates
	MJ_USER_STAMP	No	Char	12		WIMS Id (ie LOGIN name) of User amending measurement result details
MEASUREMENTS_LOAD	ML_ANAL_METH_CODE	Yes	Char	2		Code for analytical method

Table Name	Column Name	Null?	FormatName	Length	Decimal	Table Description
MEASUREMENTS_LOAD	ML_DETERMINAND_CODE	Yes	Char	4		Code for determinand
	ML_LAB_REF_NO	Yes	Char	6		Laboratory reference number for sample
	ML_RESULT	Yes	Number	12	5	Measured result reported by the laboratory or measured in situ by sampler (eg Temperature)
	ML_SAMP_ID	Yes	Number	8		Id of sample to which measurement relates.
	ML_SIGN	Yes	Char	1		Sign/qualifier ("<", ">", " ")
	ML_SOURCE	Yes	Number	8		Id of sample source (laboratory)
	ML_TEXT_RESULT	Yes	Long			Field for text results. Eg. GCMS reports
	ML_UNIT_CODE	Yes	Char	4		Code for units
MEASUREMENTS_LOAD_JNL	MLJ_ANAL_METH_CODE	Yes	Char	2		
	MLJ_DETERMINAND_CODE	Yes	Char	4		
	MLJ_ID	Yes	Number	8		
	MLJ_RESULT	Yes	Number	12	5	
	MLJ_SIGN	Yes	Char	1		
	MLJ_SOURCE	Yes	Number	8		
	MLJ_UNIT_CODE	Yes	Char	4		
	MLJ_DATE_STAMP	No	Date			
	MLJ_LAB_REF_NO	No	Char	6		
	MLJ_REASON	No	Char	70		
	MLJ_USER_STAMP	No	Char	12		
OLD_CONSENT_LIMITS	LIM_CLASS_CODE	Yes	Char	2		
	LIM_END_DATE	Yes	Date			
	LIM_LOWER_LIMIT	Yes	Number	12	5	
	LIM_SEASON_CODE	Yes	Char	2		
	LIM_SMPT_USER_REFERENCE	Yes	Char	8		
	LIM_START_DATE	Yes	Date			
	LIM_STATUS	Yes	Char	1		
	LIM_SURV_ID	Yes	Number	8		
	LIM_UPPER_LIMIT	Yes	Number	12	5	
	LIM_DETERMINAND_CODE	No	Char	4		
	LIM_TYPE	No	Char	1		
	OL_AGCO_VERSION	No	Number	2		The version number of the consent AGREEMENT
OPS$PUBLIC_USER	USER_AREA	Yes	Char	1		
	USER_DEPARTMENT	Yes	Char	2		
	USER_EMPNO	Yes	Char	4		

Table Name	Column Name	Null?	FormatName	Length	Decimal	Table Description
OPS$PUBLIC_USER	USER_LETTER_PRINTER	Yes	Char	25		
	USER_PARTY_ID	Yes	Char	4		
	USER_REGIONAL_ACCESS	Yes	Char	1		
	USER_REPORT_PRINTER	Yes	Char	25		
	USER_SCREEN_PRINTER	Yes	Char	25		
	USER_USERNAME	Yes	Char	12		
ORG_CC	CC_NEXT_VALUE	No	Number	38		Next number to be assigned to an organisation
ORGANISATIONS	ORG_ADD3	Yes	Char	32		3rd line of address of organisation
	ORG_ADD4	Yes	Char	32		4th line of address of organisation
	ORG_FAX	Yes	Char	12		Fax number of Organisation
	ORG_NOTE1	Yes	Char	70		Note 1 on organisation (Free format test
	ORG_NOTE2	Yes	Char	70		Note 2 on organisation (Free format test
	ORG_P_ID	Yes	Char	4		Party Id of Oeganisation. Set by the user when assigning Party status to an Organisation
	ORG_POSTCODE	Yes	Char	10		Postcode of address of organisation
	ORG_TELEPHONE	Yes	Char	12		Telephone number of organisation
	ORG_ADD1	No	Char	32		1st line of address of organisation
	ORG_ADD2	No	Char	32		2nd line of address of organisation
	ORG_ID	No	Number	8		Unique system generated Id for organisation
	ORG_NAME	No	Char	50		Name of organisation
OUTLETS	OL_COMMENT	Yes	Char	70		Any notes relating to the outlet
	OL_DWF	Yes	Number	9	2	Consented dry weather flow. IT IS PREFERABLE TO RECORD THIS AGAINST THE RELEVANT RECORD ON TABLE EFFLUENTS
	OL_HYDRO_REF	Yes	Char	34		The controlled water ithin which the outlet lies
	OL_SMPT_USER_REF	Yes	Char	8		Sampling point reference number for the outlet. IT IS PREFERABLE TO RECORD THIS AGAINST THE RELEVANT RECORD ON TABLE EFFLUENTS
	OL_AGCO_ID	No	Char	16		Consent number to which the outlet relates
	OL_CODE	No	Char	2		Code to indicate the contents of effluent(s) discharging via the outlet. Must appear in CATCHMENT_REF_CODES in the domain OUTLETS.OL_CODE
	OL_NGR	No	Char	12		The NGR of the point at which the outlet enters the receving water
	OL_REF	No	Number	2		The number of the outlet on the site (starting at 1)
OUTLETS_JNL	OL_COMMENT	Yes	Char	70		
	OL_DWF	Yes	Number	9	2	
	OL_HYDRO_REF	Yes	Char	34		
	OL_SMPT_USER_REF	Yes	Char	8		
	OL_AGCO_ID	No	Char	16		
	OL_AGCO_VERSION	No	Number	2		

Table Name	Column Name	Null?	FormatName	Length	Decimal	Table Description
OUTLETS_JNL	OL_CODE	No	Char	2		
	OL_JNL_DATE	No	Date			
	OL_JNL_USER	No	Char	8		
	OL_NGR	No	Char	2		
	OL_REF	No	Number	2		
OUTPUT	DLL1	Yes	Number	12	5	
	DLL2	Yes	Number	12	5	
	DLL3	Yes	Number	12	5	
	DLL4	Yes	Number	12	5	
	DLL5	Yes	Number	12	5	
	DLL6	Yes	Number	12	5	
	DUL1	Yes	Number	12	5	
	DUL2	Yes	Number	12	5	
	DUL3	Yes	Number	12	5	
	DUL4	Yes	Number	12	5	
	DUL5	Yes	Number	12	5	
	DUL6	Yes	Number	12	5	
	FAIL1	Yes	Char	1		
	FAIL2	Yes	Char	1		
	FAIL3	Yes	Char	1		
	FAIL4	Yes	Char	1		
	FAIL5	Yes	Char	1		
	FAIL6	Yes	Char	1		
	GROUP_NUM	Yes	Number	4		
	LINE_NO	Yes	Number	6		
	LT1	Yes	Char	1		
	LT2	Yes	Char	1		
	LT3	Yes	Char	1		
	LT4	Yes	Char	1		
	LT5	Yes	Char	1		
	LT6	Yes	Char	1		
	RESULT_1	Yes	Number	12	5	
	RESULT_2	Yes	Number	12	5	
	RESULT_3	Yes	Number	12	5	
	RESULT_4	Yes	Number	12	5	
	RESULT_5	Yes	Number	12	5	

Table Name	Column Name	Null?	FormatName	Length	Decimal	Table Description
OUTPUT	RESULT_6	Yes	Number	12	5	
	SAMP_DATE	Yes	Date			
	SAMP_TIME	Yes	Char	4		
	SIGN_1	Yes	Char	1		
	SIGN_2	Yes	Char	1		
	SIGN_3	Yes	Char	1		
	SIGN_4	Yes	Char	1		
	SIGN_5	Yes	Char	1		
	SIGN_6	Yes	Char	1		
	SMPT	Yes	Char	8		
	UNIQUE_K	Yes	Char	4		
OUTPUT_D	DETE1	Yes	Char	4		
	DETE2	Yes	Char	4		
	DETE3	Yes	Char	4		
	DETE4	Yes	Char	4		
	DETE5	Yes	Char	4		
	DETE6	Yes	Char	4		
	GROUP_NUM	Yes	Number	4		
	UNIQUE_K	Yes	Char	4		
OUTPUT_S	AVG_CI_H	Yes	Number	12	5	
	AVG_CI_H1	Yes	Number	12	5	
	AVG_CI_L	Yes	Number	12	5	
	AVG_CI_L1	Yes	Number	12	5	
	AVG_RES	Yes	Number	12	5	
	AVG_RES1	Yes	Number	12	5	
	DETE_NO	Yes	Char	1		
	GROUP_NUM	Yes	Number	4		
	MAX_RES	Yes	Number	12	5	
	MIN_RES	Yes	Number	12	5	
	NO_R	Yes	Number	4		
	NO_S	Yes	Number	4		
	NUM_GRT	Yes	Number	4		
	NUM_LES	Yes	Number	4		
	PERC_CI_H	Yes	Number	12	5	
	PERC_CI_L	Yes	Number	12	5	

Table Name	Column Name	Null?	FormatName	Length	Decimal	Table Description
OUTPUT_S	PERCILE	Yes	Number	12	5	
	SMPT	Yes	Char	8		
	STD	Yes	Number	12	4	
	STD_CI_H	Yes	Number	12	5	
	STD_CI_H1	Yes	Number	12	5	
	STD_CI_L	Yes	Number	12	5	
	STD_CI_L1	Yes	Number	12	5	
	STD1	Yes	Number	12	5	
	UNIQUE_K	Yes	Char	4		
OUTPUT_SF	DETE_NO	Yes	Char	1		
	GROUP_NUM	Yes	Number	4		
	P	Yes	Number	12	5	
	P_H	Yes	Number	12	5	
	P_L	Yes	Number	12	5	
	P_NO	Yes	Number	2		
	SMPT	Yes	Char	8		
	UNIQUE_K	Yes	Char	4		
PARISHS	PAR_CODE	No	Number	4		Unique code for parish
	PAR_DC_REF	No	Char	2		Reference of district council where parish is located
	PAR_NAME	No	Char	25		Name of parish
PARTIES	P_ADD3	Yes	Char	32		3rd Line of address of Party
	P_ADD4	Yes	Char	32		4th Line of address of Party
	P_NOTE1	Yes	Char	70		Note 1 (free format)
	P_NOTE2	Yes	Char	70		Note 2 (free format)
	P_POSTCODE	Yes	Char	10		Postcode of address of Party
	P_TELEPHONE	Yes	Char	12		Telephone number of party
	P_ADD1	No	Char	32		1st Line of address of Party
	P_ADD2	No	Char	32		2nd Line of address of Party
	P_ID	No	Char	4		Unique Id for party
	P_NAME	No	Char	32		Name of Party
PLC_SITE_TYPES	PST_END	No	Date			
	PST_SPT_CODE	No	Char	2		
	PST_START	No	Date			
PRINTERS	PRIN_DESCRIPTION	Yes	Char	25		Name/Description of printer

Table Name	Column Name	Null?	FormatName	Length	Decimal	Table Description
PRINTERS	PRIN_QUEUE_NAME	Yes	Char	25		Id of Printer queue
PROP_DISCHARGES	PDI_COMMENT	Yes	Char	80		User comments on the discharge
	PDI_DWF	Yes	Number	7	1	Prposed dry weather flow of discharge in cubic metres/day
	PDI_HYDRO_REF	Yes	Char	34		Id of controlled water to which it is proposed to make discharge
	PDI_MAX_DAILY_VOL	Yes	Number	7	1	Prposed maximum daily volume of discharge in cubic metres/day
	PDI_MAX_RATE	Yes	Number	7	1	Prposed maximum daily rate of discharge in litres/sec
	PDI_MEAN_D_VOL	Yes	Number	7	1	Prposed mean daily volume of discharge in cubic metres/day
	PDI_NGR	Yes	Char	12		NGR of outlet of proposed discharge
	PDI_NGR_EAST_NUMBER	Yes	Number	6		Easting for PDI_NGR
	PDI_NGR_NORTH_NUMBER	Yes	Number	6		Northing for PDI_NGR
	PDI_NGR_SAMP	Yes	Char	12		NGR of proposed sampling point
	PDI_TYPE	Yes	Char	2		Code for type of discharge which must exist in CATCHMENT_REF_CODES in the domain PROP_DISCHARGES.PDI_TYPE.
	PDI_APL_NUMBER	No	Number	16		Discharge consent Application number (from table APPLICATIONS)
	PDI_NUMBER	No	Number	1		Incremental number (set by system) for each discharge proposed with the application
PUBLIC_ACCESS	PREG_ADD1	Yes	Char	32		
	PREG_ADD2	Yes	Char	32		
	PREG_ADD3	Yes	Char	32		
	PREG_ADD4	Yes	Char	32		
	PREG_AGR_APL	Yes	Char	16		
	PREG_APL_NUMBER	Yes	Char	16		
	PREG_FEE	Yes	Number	5	2	
	PREG_FIRST_NAME	Yes	Char	20		
	PREG_POST_CODE	Yes	Char	10		
	PREG_PURPOSE	Yes	Char	70		
	PREG_TIME_SPENT	Yes	Char	6		
	PREG_TITLE	Yes	Char	3		
	PREG_COMM_ID	No	Char	2		
	PREG_CRITERIA	No	Char	70		
	PREG_ID	No	Number	8		
	PREG_REQUESTED	No	Date			
	PREG_SUPPLIED	No	Date			
	PREG_SURNAME	No	Char	20		
PUBLICATIONS	PBL_CODE	No	Char	2		Unique id for publication
	PBL_DESCRIPTION	No	Char	70		Name of publication in which applications for consent to discharge are advertised.

Table Name	Column Name	Null?	FormatName	Length	Decimal	Table Description
PURPOSES	PURP_LETT	Yes	Char	1		Indicates purposes which generate traders letters
	PURP_CODE	No	Char	2		Unique code for sample purpose
	PURP_DESC	No	Char	70		Desciption of sample purpose
REGION_AREAS	AREA_CODE	No	Char	1		Unique code for Agency Area
	AREA_DESC	No	Char	70		Agency Area name
REGION_SUB_AREAS	SAR_ARE_CODE	No	Char	1		Unique code for Agency Area
	SAR_DESC	No	Char	70		Agency Sub-Area name
	SAR_SUB_AREA_CODE	No	Char	1		Unique code for Agency Sub-Area
REPORT_PARAMETERS	CD_CONSENT_NO	No	Char	16		
	CD_DATE_TIME	No	Char	25		
	CD_USERNAME	No	Char	20		
REPRESENTATIONS	REP_CLOSE	Yes	Date			
	REP_ADV_ID	No	Number	8		Id of advertisement (see ADVERTISEMENTS) to which representation made.
	REP_CODE	No	Char	2		
	REP_DATE	No	Date			Date representation made
	REP_RESP_ID	No	Number	8		Responsibility id of representor
RES_CC	CC_NEXT_VALUE	No	Number	38		
RESERVED_NOS	RSVD_COMMENT	Yes	Char	60		
	RSVD_INITS	No	Char	3		
	RSVD_NO	No	Char	16		
RESPONSIBILITIES	RESP_DATE_FROM	Yes	Date			The date on which the responsibility starts
	RESP_DATE_TO	Yes	Date			The date on which the responsibility ends
	RESP_ORG_ID	Yes	Number	8		The Id of the organisation to which this responsibility relates
	RESP_PARTY_ID	Yes	Char	4		Party Id of person/organisation to whom this responsibility relates
	RESP_ID	No	Number	8		Unique id generated by system
	RESP_ROLE_CODE	No	Char	2		Code for role (from ROLES) to which this responsibility relates
RESULT_CODES	DETE_CODE	Yes	Char	4		Determinand code
	INTERPRETATION	Yes	Char	40		Interpretation of result
	RESULT	Yes	Number	8		Result recorded by sampler/laboratory
RIVERS	RIVER_AREA	Yes	Char	1		Area in which watercourse lies. THIS COLUMN IS BEING DROPPED FROM THE NATIONAL SYSTEM
	RIVER_MOUTH_DESC	Yes	Char	40		Textual description of mouth
	RIVER_MOUTH_EASTING	Yes	Number	6		Easting of mouth NGR
	RIVER_MOUTH_LONGDESC	Yes	Char	150		Long textual description of mouth

Table Name	Column Name	Null?	FormatName	Length	Decimal	Table Description
RIVERS	RIVER_MOUTH_NORTHING	Yes	Number	6		Northing of mouth NGR
	RIVER_SOURCE_DESC	Yes	Char	40		Textual description of source
	RIVER_SOURCE_EASTING	Yes	Number	6		Easting of source NGRngr
	RIVER_SOURCE_LONGDESC	Yes	Char	150		Long textual description of source
	RIVER_SOURCE_NORTHING	Yes	Number	6		Northing of source
	RIVER_DIST	No	Number	6	3	Distance upstream of mouth of watercourse into which this watercourse drains.
	RIVER_LENGTH	No	Number	6	3	Length of watercourse in kilometres
	RIVER_MOUTH_NGR	No	Char	12		NGR of mouth of watercourse
	RIVER_NAME	No	Char	40		Name of watercourse
	RIVER_REF	No	Char	49		Hydrological reference of watercourse
	RIVER_SOURCE_NGR	No	Char	12		NGR of source of watercourse
ROLES	ROLE_CODE	No	Char	2		Unique Id for role
	ROLE_DESC	No	Char	70		Description of role, including job titles and external roles.
SAMPLE_ANAL	SAN_DESC	Yes	Char	70		Description of analysis type
	SAN_END	Yes	Date			Date to which cost applies
	SAN_UNIT_COST	Yes	Number	8	2	Unit cost of the analysis
	SAN_NAME	No	Char	12		Generic name for analysis type
	SAN_START	No	Date			Date from which cost applies
SAMPLE_ANAL_TYPE	SAT_CONSTANT	Yes	Number	8	2	Constant to be applied.
	SAT_DESC	Yes	Char	70		Description for type of sample
	SAT_FACTOR	Yes	Number	3		Multiplication factor for costs
	SAT_NAME	No	Char	12		Name for sample type
SAMPLE_CC	CC_NEXT_VALUE	No	Number	38		Next available sample number
SAMPLE_MATERIAL	SMC_CODE	No	Char	4		Unique code for material
	SMC_DESC	No	Char	70		Description of sample material
SAMPLE_SAMPLE	SAMS_ASS_SAMP_ID	No	Number	8		
	SAMS_SAMP_ID	No	Number	8		
SAMPLED_CONSENTS	CONSENT	Yes	Char	6		
	EFFLUENT	Yes	Number			
	OUTLET	Yes	Number			
	SITENO	Yes	Char	40		
	STYPE	Yes	Char	2		
	TOTAL	Yes	Number			
	POINT	No	Char	8		

Table Name	Column Name	Null?	FormatName	Length	Decimal	Table Description
TEMP_LIMITS	LIM_SEASON_CODE	Yes	Char	2		
	LIM_SMPT_USER_REFERENCE	Yes	Char	8		
	LIM_START_DATE	Yes	Date			
	LIM_STATUS	Yes	Char	1		
	LIM_SURV_ID	Yes	Number	8		
	LIM_UPPER_LIMIT	Yes	Number	12	5	
	LIM_DETERMINAND_CODE	No	Char	4		
	LIM_TYPE	No	Char	1		
TREATMENTS	TMEN_CODE	No	Char	2		Unique code for treatment
	TMEN_DESC	No	Char	70		Description of effluent rteatment
UNITS	UNIT_CODE	No	Char	4		Reference table holding details of units of mewsurement for quantitative, semi-quantitave, qualitatice, physical and microbiological determinds
	UNIT_DESC	No	Char	70		Full description of unit
	UNIT_SHORT_DESC	No	Char	8		Short description of unit for display on forms, reports, letters, etc.
USER_PROFILE	ATTRIBUTE	Yes	Char	240		
	CHAR_VALUE	Yes	Char	240		
	DATED_VALUE	Yes	Date			
	LONG_VALUE	Yes	Long			
	NUMERIC_VALUE	Yes	Number	15	2	
	PRODUCT	Yes	Char	30		
	PROFILE	Yes	Char	240		
	USERID	Yes	Char	30		
USERS_NON_STAFF	USER_AREA	Yes	Char	1		
	USER_DEPARTMENT	Yes	Char	2		
	USER_EMPNO	Yes	Char	4		
	USER_LETTER_PRINTER	Yes	Char	25		
	USER_PARTY_ID	Yes	Char	4		
	USER_REGIONAL_ACCESS	Yes	Char	1		
	USER_REPORT_PRINTER	Yes	Char	25		
	USER_SCREEN_PRINTER	Yes	Char	25		
	USER_USERNAME	Yes	Char	12		
WATER_CATEGORIES	WAT_DESC	No	Char	70		Description of water category
	WAT_TYPE	No	Char	2		Code for type of water category

Table Name	Column Name	Null?	FormatName	Length	Decimal	Table Description
SAMPLES_JNL	SJ_REASON	No	Char	70		Reason for making change
	SJ_USER_STAMP	No	Char	12		Login of user making change
SAMPLES_LOAD	SL_CONFIDENTIAL	Yes	Char	1		Indicates Sample has Confidential status
	SL_ID	Yes	Number	8		Id of sample
	SL_LAB_REF_NO	Yes	Char	6		Reference number of sample assigned by laboratory
	SL_MATERIAL	Yes	Char	4		Code for sample material
	SL_MECHANISM	Yes	Char	4		Mechanism by which sample was taken
	SL_NOTES	Yes	Char	255		SAmpler/Laboratory notes.
	SL_PARTY_ID	Yes	Char	4		Party Id of sampler. This is converted to responsibility upon actual load to the SAMPLES table
	SL_PURPOSE_CODE	Yes	Char	2		Purpose for which sample was taken
	SL_RECEIPT	Yes	Date			Date sample received at laboratory
	SL_SAMPLE_DATE	Yes	Date			Date of sample
	SL_SAMPLE_TIME	Yes	Char	4		Time of sample
	SL_SAMPLES_PART	Yes	Char			Flag to indicate sample is incomplete for manual data entry
	SL_SMPT_USER_REFERENCE	Yes	Char	8		URN/Reference number odf site from which sample was taken
	SL_SOURCE	Yes	Number	8		Id of laboratory analysing sample (from ORGANISATIONS table)
	SL_STATUS	Yes	Char	2		Status of sample
	SL_AREA_CODE	No	Char	1		Area code
	SL_COMP	No	Date			
	SL_SUB_AREA_CODE	No	Char	1		Sub-Area code
SAMPLES_LOAD_JNL	SLJ_ID	Yes	Number	8		
	SLJ_LAB_RECD_DATE	Yes	Date			
	SLJ_MAT_CODE	Yes	Char	20		
	SLJ_MECHANISM	Yes	Char	4		
	SLJ_NOTES	Yes	Char	80		
	SLJ_PARTY_ID	Yes	Char	4		
	SLJ_PURPOSE_CODE	Yes	Char	2		
	SLJ_SAMPLE_DATE	Yes	Date			
	SLJ_SAMPLE_TIME	Yes	Char	4		
	SLJ_SMPT_USER_REFERENCE	Yes	Char	8		
	SLJ_SOURCE	Yes	Number	8		
	SLJ_STATUS	Yes	Char	2		
	SLJ_DATE_STAMP	No	Date			
	SLJ_LAB_REF_NO	No	Char	6		

Table Name	Column Name	Null?	FormatName	Length	Decimal	Table Description
SAMPLES_LOAD_JNL	SLJ_REASON	No	Char	70		
	SLJ_USER_STAMP	No	Char	12		
SAMPLING_MECHANISMS	SM_CODE	No	Char	4		Unique code for sampling mechanism
	SM_DESC	No	Char	70		Description of sampling mechanism
SAMPLING_POINT_CLASSES	SPC_CODE	No	Char	1		Unique code for sampling point classes
	SPC_DESC	No	Char	70		Description of sampling point class
SAMPLING_POINT_TYPES	SPT_CODE	No	Char	2		Unique code for type of sampling point
	SPT_DESC	No	Char	70		Description for type of sampling point
SAMPLING_POINTS	SMPT_CATCH_AREA	Yes	Char	5		Catchment area for storage of groundwater data
	SMPT_CLASS	Yes	Char	1		The code for tha class of sampling point which must exist in SAMPLING_POINT_CLASSES
	SMPT_CONS_USER_REF	Yes	Char	13		
	SMPT_CONTROLLED_WATER_ID	Yes	Char	15		Id of the controlled water within which the sampling point lies
	SMPT_EASTING	Yes	Number	6		Easting of SMPT_GRID_REF
	SMPT_FILING_REF	Yes	Char	70		Column to hold Id of manual file relating to site
	SMPT_HYDRO_DIST	Yes	Number	6	3	For samples containing a value in SMPT_HYDROLOGICAL_REF, this column must be completed. It is the distance in kilometres from the mouth of the watercourse to the sampling point
	SMPT_HYDRO_REF	Yes	Char	49		For samples located on a watercourse, this column holds the Hydrological Reference of the watercourse
	SMPT_HYDROLOGICAL_REF	Yes	Char	32		Not used
	SMPT_LAST_SAMPLED	Yes	Date			Date last sampled. This field is updated by the system when data is transferred to the SAMPLES table.
	SMPT_NORTHING	Yes	Number	6		Northing of SMPT_GRID_REF
	SMPT_RESP_ID	Yes	Number	8		Responsibility id of officer responsible for monitoring/managing the site
	SMPT_SIDE	Yes	Char	1		The location of the sampling point in relation to the bank/coastline.
	SMPT_UPSTREAM	Yes	Char	8		For sampling points used to monitor discharge consents with comparative/differential conditions, this column holds the SMPT_UER_REFERENCE for the site against which comparisons are made. This site must exist on SAMPLING_POINTS and must be present for Traders letters/compliance to work
	SMPT_URN_ORIG	Yes	Char	13		Contains the Reference number attributed to the site on the previous archive system
	SMPT_AREA_CODE	No	Char	1		Agency Area in which Sampling Point is situated
	SMPT_COMMENTS	No	Char	2000		Sampling Point Comments
	SMPT_COUNTRY	No	Char	1		The Country in which the Sampling Point is situated
	SMPT_DATE_STAMP	No	Date			Date record created
	SMPT_DC_REF	No	Char	2		The Local Authority the Sampling Point is situated in
	SMPT_GRID_REF	No	Char	12		NGR of sampling point

Table Name	Column Name	Null?	FormatName	Length	Decimal	Table Description
SAMPLING_POINTS	SMPT_LONG_NAME	No	Char	150		Long name of sampling point
	SMPT_SHORT_NAME	No	Char	40		Short name of sampling point
	SMPT_STATUS	No	Char	1		Status of sampling point - must be O(pen) or C(losed)
	SMPT_TYPE	No	Char	2		Type of sampling point (must exist in table SAMPLING_POINT_TYPES)
	SMPT_USER_REFERENCE	No	Char	8		Unique reference id for sampling point
	SMPT_USER_STAMP	No	Char	12		LOGIN of user creating record
SEASONS	SEAS_CODE	No	Char	2		
	SEAS_DESC	No	Char	70		
	SEAS_END_DATE	No	Char	4		
	SEAS_START_DATE	No	Char	4		
SEC_ADM_GROUP_ROLES	ACTION	No	Char	6		
	APPLIED	No	Char	1		
	GROUP_ID	No	Number	4		
	ROLE_ID	No	Number	4		
	ROLE_NAME	No	Char	30		
SEC_ADM_GROUPS	APPLIED	No	Char	1		
	GROUP_ACTION	No	Char	6		
	GROUP_DESCRIPTION	No	Char	80		
	GROUP_ID	No	Number	4		
	GROUP_NAME	No	Char	30		
SEC_ADM_OBJECT_PRIVS	APPLIED	No	Char	1		
	OBJECT_ACTION	No	Char	6		
	OBJECT_ID	No	Number	4		
	OBJECT_PRIVILEGE	No	Char	30		
SEC_ADM_OBJECTS	APPLIED	No	Char	1		
	OBJECT_ACTION	No	Char	6		
	OBJECT_DESCRIPTION	No	Char	80		
	OBJECT_ID	No	Number	4		
	OBJECT_NAME	No	Char	30		
	OBJECT_OWNER	No	Char	30		
SEC_ADM_PRIVS	PRIVILEGE	No	Char	30		
SEC_ADM_ROLE_PRIVS	ACTION	No	Char	6		
	APPLIED	No	Char	1		
	OBJECT_ID	No	Number	4		

Table Name	Column Name	Null?	FormatName	Length	Decimal	Table Description
SEC_ADM_ROLE_PRIVS	OWNER	No	Char	30		
	PRIVILEGE	No	Char	30		
	ROLE_ID	No	Number	4		
	TABLE_NAME	No	Char	30		
SEC_ADM_ROLES	APPLIED	No	Char	1		
	ROLE_ACTION	No	Char	6		
	ROLE_DESCRIPTION	No	Char	80		
	ROLE_ID	No	Number	4		
	ROLE_NAME	No	Char	30		
SEC_ADM_USER_GROUP	ACTION	No	Char	6		
	APPLIED	No	Char	1		
	GROUP_ID	No	Number	4		
	GROUP_NAME	No	Char	30		
	USERNAME	No	Char	8		
SEC_ARE_PRIVS	SAC_AREA	No	Char	1		User's Area
	SAC_SUB_AREA	No	Char	1		User's Sub-Area
	SEC_USERNAME	No	Char	30		User's Username
SEC_AUD_GROUP_ROLES	ACTION	No	Char	6		
	APPLIED	No	Char	1		
	AUDIT_DATE	No	Date			
	AUDIT_TYPE	No	Char	15		
	AUDIT_USER	No	Char	30		
	GROUP_ID	No	Number	4		
	ROLE_ID	No	Char	30		
SEC_AUD_GROUPS	APPLIED	No	Char	1		
	AUDIT_DATE	No	Date			
	AUDIT_TYPE	No	Char	15		
	AUDIT_USER	No	Char	30		
	GROUP_ACTION	No	Char	6		
	GROUP_DESCRIPTION	No	Char	80		
	GROUP_ID	No	Number	4		
	GROUP_NAME	No	Char	30		
SEC_AUD_ROLE_PRIVS	ACTION	No	Char	6		
	APPLIED	No	Char	1		

Table Name	Column Name	Null?	FormatName	Length	Decimal	Table Description
SEC_AUD_ROLE_PRIVS	AUDIT_DATE	No	Date			
	AUDIT_TYPE	No	Char	15		
	AUDIT_USER	No	Char	30		
	OWNER	No	Char	30		
	PRIVILEGE	No	Char	30		
	ROLE_ID	No	Number	4		
	TABLE_NAME	No	Char	30		
SEC_AUD_ROLES	ACTION	No	Char	6		
	APPLIED	No	Char	1		
	AUDIT_DATE	No	Date			
	AUDIT_TYPE	No	Char	15		
	AUDIT_USER	No	Char	30		
	ROLE_DESCRIPTION	No	Char	80		
	ROLE_ID	No	Number	4		
	ROLE_NAME	No	Char	30		
SEC_AUD_USER_GROUPS	ACTION	No	Char	6		
	APPLIED	No	Char	1		
	AUDIT_DATE	No	Date			
	AUDIT_TYPE	No	Char	15		
	AUDIT_USER	No	Char	30		
	GROUP_ID	No	Number	4		
	USERNAME	No	Char	30		
SMPT_PURPOSES	SPU_PURP_CODE	No	Char	2		Code for sample purpose
	SPU_SPT_CODE	No	Char	2		Code for sampling point type
SPLIT_SAMPLE_DETERMINANDS	SSD_DETERMINAND_CODE	No	Char	4		Determinand code
	SSD_SS_SAMP_ID	No	Number	3		Id of Split sample to which determinand relates
	SSD_SS_SEQ_NO	No	Number	3		Sequence number of determinand
	SSD_STATUS	No	Char	1		Stauts of determinand
SPLIT_SAMPLES	SS_LAB_REF_NO	Yes	Char	12		Laboratory reference number for sample
	SS_MECHANISM	Yes	Char	2		Sampling mechanism code
	SS_NOTES	Yes	Char	80		SAmpler/Laboratory notes
	SS_PURPOSE_CODE	Yes	Char	2		Sample purpose code
	SS_DATE_STAMP	No	Date			Date split sample record created
	SS_SAMPLE_DATE	No	Date			Date of sample

Table Name	Column Name	Null?	FormatName	Length	Decimal	Table Description
SPLIT_SAMPLES	SS_SAMPLE_TIME	No	Char	4		Time f sample
	SS_SMPT_USER_REFERENCE	No	Char	8		Sampling point reference number to which the split sample relates
	SS_SOURCE	No	Number	8		Source (laboratory) of sample
	SS_USER_STAMP	No	Char	12		LOGIN of user creating split sample record
SS_CC	CC_NEXT_VALUE	No	Number	38		Next available number
STAFF	STAFF_CAR_PERMIT	Yes	Char	4		Not used
	STAFF_DIRECT	Yes	Char	12		Not used
	STAFF_EMPNO	Yes	Char	4		Not used
	STAFF_EXTENSION	Yes	Char	4		Not used
	STAFF_FLOOR	Yes	Char	3		Not used
	STAFF_FORENAME	Yes	Char	11		Forename of staff member
	STAFF_HOME	Yes	Char	12		Not used
	STAFF_INCIDENT_DEPT	Yes	Char	2		Incident system department to whch officer is assigned
	STAFF_LEFT	Yes	Date			Date officer left the Agency
	STAFF_LETTER_PRINTER	Yes	Char	25		Printer assigned as default for printing letters created by STAFF_WIMS_NAME
	STAFF_LOCATION	Yes	Char	13		Office at which staff member is based
	STAFF_MOBILE	Yes	Char	12		Not used
	STAFF_PAGER	Yes	Char	12		Not used
	STAFF_PARTY_ID	Yes	Char	4		Party Id assigned to staff member
	STAFF_REPORT_PRINTER	Yes	Char	25		Printer assigned as default for printing reports created by STAFF_WIMS_NAME
	STAFF_SCREEN_PRINTER	Yes	Char	25		Printer assigned as default for printing screen dumps requested by STAFF_WIMS_NAME
	STAFF_SEQUENCE	Yes	Number	4		Unique sequence number for staff record
	STAFF_STARTED	Yes	Date			Date officer started employment. Note, the job title record is updated if the officer changes job.
	STAFF_SURNAME	Yes	Char	15		Surname of Staff member
	STAFF_TITLE	Yes	Char	20		Officers job title
	STAFF_UNIQUE_ID	Yes	Number	6		
	STAFF_WIMS_NAME	Yes	Char	12		WIMS login
	STAFF_WIMS_REQUEST	Yes	Char	1		
	STAFF_WQ_AREA	Yes	Char	1		Operational area within which officer is employed
STAFF_GROUP	STG_DESC	Yes	Char	70		
	STG_END	Yes	Date			
	STG_RATE	Yes	Number	8	2	
	STG_NAME	No	Char	12		
	STG_START	No	Date			

Table Name	Column Name	Null?	FormatName	Length	Decimal	Table Description
STANDARD_ACTIONS	STAC_CODE	No	Char	2		Code for Standard Action
	STAC_DESC	No	Long			Description of Standard action
STANDARD_CONDITIONS	STCO_CODE	No	Number	4		Code for standard condition
	STCO_DESC	No	Long			Text for standard condition
STEPS	STEP_DESC	Yes	Long			Textual report on action taken by Agency and/or discharger.
	STEP_ACTIONED	No	Date			Date action taken
	STEP_SMPT_REF	No	Char	8		Sampling point reference number
	STEP_STACT_CODE	No	Char	2		Code for standard action from STANDARD_ACTIONS
STW_LOOKUP	LIMIT	Yes	Number	3		No of failed samples allowed
	LOW_NO	Yes	Number	3		Lower number of samples taken
	UPP_NO	Yes	Number	3		Upper limit of samples taken
SURVEY_CC	CC_NEXT_VALUE	No	Number	38		
SURVEY_DETERMINAND	SD_DETE_CODE	Yes	Char	4		
	SD_LOWER_LIMIT	Yes	Number	12	5	
	SD_SURV_ID	Yes	Number	8		
	SD_UPPER_LIMIT	Yes	Number	12	5	
SURVEY_PURPOSE	SP_PURPOSE	Yes	Char	2		
	SP_SURV_ID	Yes	Number	8		
SURVEY_SAMPLING_POINT	SSP_EXT_REFERENCE	Yes	Char	5		
	SSP_SMPT_USER_REFERENCE	Yes	Char	8		
	SSP_SURV_ID	Yes	Number	8		
SURVEY_TYPES	ST_CODE	No	Char	8		
	ST_DESC	No	Char	70		
SURVEYS	SURV_END_DATE	Yes	Date			
	SURV_OWNER	Yes	Char	14		
	SURV_ID	No	Number	8		
	SURV_NAME	No	Char	32		
	SURV_ST_CODE	No	Char	8		
	SURV_START_DATE	No	Date			
TEMP_LIMITS	LIM_CLASS_CODE	Yes	Char	2		
	LIM_END_DATE	Yes	Date			
	LIM_LOWER_LIMIT	Yes	Number	12	5	

Table Name	Column Name	Null?	FormatName	Length	Decimal	Table Description
TEMP_LIMITS	LIM_SEASON_CODE	Yes	Char	2		
	LIM_SMPT_USER_REFERENCE	Yes	Char	8		
	LIM_START_DATE	Yes	Date			
	LIM_STATUS	Yes	Char	1		
	LIM_SURV_ID	Yes	Number	8		
	LIM_UPPER_LIMIT	Yes	Number	12	5	
	LIM_DETERMINAND_CODE	No	Char	4		
	LIM_TYPE	No	Char	1		
TREATMENTS	TMEN_CODE	No	Char	2		Unique code for treatment
	TMEN_DESC	No	Char	70		Description of effluent rteatment
UNITS	UNIT_CODE	No	Char	4		Reference table holding details of units of mewsurement for quantitative, semi-quantitave, qualitatice, physical and microbiological determinds
	UNIT_DESC	No	Char	70		Full description of unit
	UNIT_SHORT_DESC	No	Char	8		Short description of unit for display on forms, reports, letters, etc.
USER_PROFILE	ATTRIBUTE	Yes	Char	240		
	CHAR_VALUE	Yes	Char	240		
	DATED_VALUE	Yes	Date			
	LONG_VALUE	Yes	Long			
	NUMERIC_VALUE	Yes	Number	15	2	
	PRODUCT	Yes	Char	30		
	PROFILE	Yes	Char	240		
	USERID	Yes	Char	30		
USERS_NON_STAFF	USER_AREA	Yes	Char	1		
	USER_DEPARTMENT	Yes	Char	2		
	USER_EMPNO	Yes	Char	4		
	USER_LETTER_PRINTER	Yes	Char	25		
	USER_PARTY_ID	Yes	Char	4		
	USER_REGIONAL_ACCESS	Yes	Char	1		
	USER_REPORT_PRINTER	Yes	Char	25		
	USER_SCREEN_PRINTER	Yes	Char	25		
	USER_USERNAME	Yes	Char	12		
WATER_CATEGORIES	WAT_DESC	No	Char	70		Description of water category
	WAT_TYPE	No	Char	2		Code for type of water category

Table Name	Column Name	Null?	FormatName	Length	Decimal	Table Description

End Of Report

23.6.98

Hydrolog 3 - from Steve Hall

Groundwater System – Station Manager Relational Database

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AbstractionLicenceDetails

Field Name	Field Pos	Field Type	Field Length
Abstraction_Licence_Ref	: 0 :	Text	20
Abstraction_Licence_Usage	: 1 :	Text	100
Annual_Quantity_Value	: 2 :	Double	+/-1.8e300
Annual_Quantity_Value_Unit	: 3 :	Text	3
Daily_Rate_Value	: 4 :	Double	+/-1.8e300
Daily_Rate_Value_Unit	: 5 :	Text	3
Abstraction_From_Date	: 6 :	Date/Time	Any Date and Time
Abstraction_To_Date	: 7 :	Date/Time	Any Date and Time
Abstraction_Comments	: 8 :	Memo	1.2 GB of text data
Licence_Holder_Address_id	: 9 :	Long Integer	+/-2147483

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AdditionalInfoForStatParam

Field Name	Field Pos	Field Type	Field Length
Stat_Param_Id	: 0 :	Text	10
Asset_Details	: 1 :	Boolean	Yes/No
Auto_Validation	: 2 :	Boolean	Yes/No
Borehole_Details	: 3 :	Boolean	Yes/No
Derivations	: 4 :	Boolean	Yes/No
Flow_Gauge_Details	: 5 :	Boolean	Yes/No
Instrumentation	: 6 :	Boolean	Yes/No
Measurement_Reference_Details	: 7 :	Boolean	Yes/No
Nearest_Neighbours	: 8 :	Boolean	Yes/No
Raingauge_Details	: 9 :	Boolean	Yes/No
Station_Classification	: 11 :	Boolean	Yes/No
Logger_Details	: 12 :	Boolean	Yes/No
Derived_Archive_Details	: 13 :	Boolean	Yes/No
Pipe_Flow_Dimensions	: 14 :	Boolean	Yes/No

****

AdditionalInformationList

Field Name	Field Pos	Field Type	Field Length
Additional_Information	: 0 :	Text	50

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AddressDetails

Field Name	Field Pos	Field Type	Field Length
Address_id	: 0 :	Long Integer	+/-2147483
Address_Type	: 1 :	Text	50
Surname	: 2 :	Text	50
First_Name	: 3 :	Text	50
Title	: 4 :	Text	20
Address1	: 5 :	Text	50
Address2	: 6 :	Text	50
Address3	: 7 :	Text	50
Address4	: 8 :	Text	50
Post_Code	: 9 :	Text	20
Telephone	: 10 :	Text	50
Fax	: 11 :	Text	50
Email	: 12 :	Text	50

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AddressTypeLookup

Field Name	Field Pos	Field Type	Field Length
Address_Type	: 0 :	Text	50

****

AllHistoryData

Field Name	Field Pos	Field Type	Field Length
Hist_Id	: 0 :	Long Integer	+/-2147483
From_Date	: 1 :	Date/Time	Any Date and Time
To_Date	: 2 :	Date/Time	Any Date and Time
Stat_Param_Id	: 3 :	Text	10
History_Type	: 4 :	Text	50

Should this be transferred from Hydrolog 2 ? YES

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ArchiveType

Field Name	Field Pos	Field Type	Field Length
Archive_Type	: 1 :	Text	20

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AssetDetails

Field Name	Field Pos	Field Type	Field Length
File_Id	: 0 :	Text	6
Asset_Type	: 1 :	Text	20
Hist_id	: 2 :	Long Integer	+/-2147483
Description	: 3 :	Memo	1.2 GB of text data
Asset_Picture	: 4 :	Binary OLE	32K of Binary Data
Asset_Map	: 5 :	Binary OLE	32K of Binary Data
Enclosure_Type	: 6 :	Text	50
Gas	: 7 :	Boolean	Yes/No
Electric	: 8 :	Boolean	Yes/No
Water	: 9 :	Boolean	Yes/No
Sewage	: 10 :	Boolean	Yes/No
Telephone	: 11 :	Boolean	Yes/No
Portable_Test	: 12 :	Boolean	Yes/No
Battery_Power	: 13 :	Boolean	Yes/No
Battery_Status_Primary	: 14 :	Boolean	Yes/No
Battery_Status_Backup	: 15 :	Boolean	Yes/No
Battery_Type	: 16 :	Text	50
Battery_Replacement_Date	: 17 :	Date/Time	Any Date and Time
Connected_To	: 18 :	Text	50
Access_Description	: 19 :	Memo	1.2 GB of text data
Security_Details	: 20 :	Memo	1.2 GB of text data
Key_Type	: 21 :	Text	50
Last_Inspection_Date	: 22 :	Date/Time	Any Date and Time
Inspection_Interval_Value	: 23 :	Long Integer	+/-2147483
Inspection_Interval	: 24 :	Text	20
Portable_Last_Test_Date	: 25 :	Date/Time	Any Date and Time
Portable_Test_Interval_Value	: 26 :	Long Integer	+/-2147483
Portable_Test_Interval	: 27 :	Text	20
Asset_Picture_Type	: 28 :	Text	3
Asset_Map_Type	: 29 :	Text	3

No History

check ?

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AssetTypeLookup

Field Name	Field Pos	Field Type	Field Length
Asset_Type	: 0 :	Text	20

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AutoValidation

Field Name	Field Pos	Field Type	Field Length
AutoVal_id	: 0 :	Text	12
Stat_Param_Id	: 1 :	Text	10
Auto_Validation_Type	: 2 :	Text	40
Threshold	: 3 :	Double	+/-1.8e300
Warning	: 4 :	Boolean	Yes/No
Display	: 5 :	Boolean	Yes/No
Report	: 6 :	Boolean	Yes/No
Threshold_Units	: 7 :	Text	20
Description	: 8 :	Text	50

Autovalidation to be done on Hydrolog?

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AutoValidationTypes

Field Name	Field Pos	Field Type	Field Length
Auto_Validation_Type	: 0 :	Text	40
Type_Number	: 1 :	Byte	0 to 255

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BoreholeConstructionDetails

Field Name	Field Pos	Field Type	Field Length
Stat_Param_Id	: 0 :	Text	10
Construction_Method	: 1 :	Text	50
Construction_Start_Date	: 2 :	Date/Time	Any Date and Time
Construction_End_Date	: 3 :	Date/Time	Any Date and Time
Geophysical_Log	: 4 :	Boolean	Yes/No
Construction_Level	: 5 :	Double	+/-1.8e300
Construction_Level_Unit_Id	: 6 :	Text	3
Well_Driller_Address_id	: 7 :	Long Integer	+/-2147483
Comments	: 8 :	Memo	1.2 GB of text data

****

AssetDetails

Field Name	Field Pos	Field Type	Field Length
File_Id	: 0 :	Text	6
Asset_Type	: 1 :	Text	20
Hist_id No History	: 2 :	Long Integer	+/-2147483
Description	: 3 :	Memo	1.2 GB of text data
Asset_Picture	: 4 :	Binary OLE	32K of Binary Data
Asset_Map	: 5 :	Binary OLE	32K of Binary Data
Enclosure_Type	: 6 :	Text	50
Gas	: 7 :	Boolean	Yes/No
Electric	: 8 :	Boolean	Yes/No
Water	: 9 :	Boolean	Yes/No
Sewage	: 10 :	Boolean	Yes/No
Telephone	: 11 :	Boolean	Yes/No
Portable_Test	: 12 :	Boolean	Yes/No
Battery_Power	: 13 :	Boolean	Yes/No
Battery_Status_Primary	: 14 :	Boolean	Yes/No
Battery_Status_Backup	: 15 :	Boolean	Yes/No
? Battery_Type	: 16 :	Text	50
Battery_Replacement_Date	: 17 :	Date/Time	Any Date and Time
? Connected_To	: 18 :	Text	50
Access_Description	: 19 :	Memo	1.2 GB of text data
Security_Details	: 20 :	Memo	1.2 GB of text data
Key_Type	: 21 :	Text	50
Last_Inspection_Date	: 22 :	Date/Time	Any Date and Time
Inspection_Interval_Value	: 23 :	Long Integer	+/-2147483
Inspection_Interval	: 24 :	Text	20
Portable_Last_Test_Date	: 25 :	Date/Time	Any Date and Time
Portable_Test_Interval_Value	: 26 :	Long Integer	+/-2147483
Portable_Test_Interval	: 27 :	Text	20
Asset_Picture_Type	: 28 :	Text	3
Asset_Map_Type	: 29 :	Text	3

check ?

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AssetTypeLookup

Field Name	Field Pos	Field Type	Field Length
Asset_Type	: 0 :	Text	20

****

AutoValidation

Field Name	Field Pos	Field Type	Field Length
AutoVal_id	: 0 :	Text	12
Stat_Param_Id	: 1 :	Text	10
Auto_Validation_Type	: 2 :	Text	40
Threshold	: 3 :	Double	+/-1.8e300
Warning	: 4 :	Boolean	Yes/No
Display	: 5 :	Boolean	Yes/No
Report	: 6 :	Boolean	Yes/No
Threshold_Units	: 7 :	Text	20
Description	: 8 :	Text	50

Autovalidation to be done on Hydrolog ?

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AutoValidationTypes

Field Name	Field Pos	Field Type	Field Length
Auto_Validation_Type	: 0 :	Text	40
Type_Number	: 1 :	Byte	0 to 255

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BoreholeConstructionDetails

Field Name	Field Pos	Field Type	Field Length
Stat_Param_Id	: 0 :	Text	10
Construction_Method	: 1 :	Text	50
Construction_Start_Date	: 2 :	Date/Time	Any Date and Time
Construction_End_Date	: 3 :	Date/Time	Any Date and Time
Geophysical_Log	: 4 :	Boolean	Yes/No
Construction_Level	: 5 :	Double	+/-1.8e300
Construction_Level_Unit_Id	: 6 :	Text	3
Well_Driller_Address_id	: 7 :	Long Integer	+/-2147483
Comments	: 8 :	Memo	1.2 GB of text data

****

BoreholeDetails

Field Name	Field Pos	Field Type	Field Length
Stat_Param_Id	: 0 :	Text	10
Borehole_Type	: 1 :	Text	20
Pump_Test	: 2 :	Boolean	Yes/No
National_Reference	: 3 :	Text	20
Abstraction_Licence_Ref	: 4 :	Text	20
Borehole_Response	: 5 :	Text	30
Aquifer_Type	: 6 :	Text	50
Main_Aquifer	: 7 :	Text	20
Aquifer_Unit	: 8 :	Text	30
Aquifer_Code	: 9 :	Text	10
Drift_Cover	: 10 :	Text	50
Groundwater_Unit_No	: 11 :	Text	10
Ground_Level	: 12 :	Double	+/-1.8e300
Ground_Level_Unit_Id	: 13 :	Text	3
Well_Depth	: 14 :	Double	+/-1.8e300
Well_Depth_Unit_Id	: 15 :	Text	3
Surface_Diameter	: 16 :	Double	+/-1.8e300
Surface_Diameter_Unit_Id	: 17 :	Text	3
Rest_Water_Level	: 18 :	Double	+/-1.8e300
Rest_Water_Level_Unit_Id	: 19 :	Text	3
Rest_Water_Level_Date	: 20 :	Date/Time	Any Date and Time
Position_Of_Datum	: 21 :	Text	50
Pumping_Water_Level	: 22 :	Double	+/-1.8e300
Pumping_Water_Level_Unit_Id	: 23 :	Text	3
Pumping_Water_Level_Date	: 24 :	Date/Time	Any Date and Time
Datum_Survey_Type	: 25 :	Text	20
Pump_Invert_Level	: 26 :	Double	+/-1.8e300
Pump_Invert_Level_Unit_Id	: 27 :	Text	3
Comments	: 28 :	Memo	1.2 GB of text data
WIMS_Reference	: 29 :	Text	50
Owner_Address_id	: 30 :	Long Integer	+/-2147483
Occupier_Address_id	: 31 :	Long Integer	+/-2147483

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ChannelType

Field Name	Field Pos	Field Type	Field Length
Channel_Type_No	: 0 :	Integer	+/-327676
Channel_Type	: 1 :	Text	50

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ClassificationFlowType

Field Name	Field Pos	Field Type	Field Length
Flow_Type	: 0 :	Text	20

No Flow Data

****

DataType

Field Name	Field Pos	Field Type	Field Length
Data_Type	: 0 :	Text	20

****

DerivedArchiveDetails

Field Name	Field Pos	Field Type	Field Length
DARG_id	: 0 :	Text	20
Stat_Param_Id	: 1 :	Text	10
Equation	: 4 :	Text	255

Derived not in use HL 2

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chk ind

DimensionDetails

Field Name	Field Pos	Field Type	Field Length
Dimension_Id	: 0 :	Text	50
Dimension_Type	: 1 :	Long Integer	+/-2147483
Dimension_Value	: 2 :	Text	20
Dimension_id_Type	: 3 :	Text	50

****

DimensionTypes

Field Name	Field Pos	Field Type	Field Length
Dimension_Description	: 0 :	Text	50
Dimension_Type	: 1 :	Long Integer	+/-2147483

Internal usage

****
FlowGaugeDetails

Field Name	Field Pos	Field Type	Field Length
Stat_Param_Id	: 0 :	Text	10
Flow_Gauge_Type	: 1 :	Text	20
Hist_id	: 2 :	Long Integer	+/-2147483
Dimension_id	: 3 :	Text	50
Comments	: 4 :	Memo	1.2 GB of text data
National_Reference	: 5 :	Text	20

from Hydrolog ?

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FlowGaugeType

Field Name	Field Pos	Field Type	Field Length
Flow_Gauge_Type	: 0 :	Text	50
List_Of_Dimensions	: 1 :	Text	50

from Hydrolog 2

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InstrumentationDetails

Field Name	Field Pos	Field Type	Field Length
Stat_Param_Id	: 0 :	Text	10
✓Monitor	: 1 :	Text	20
✓Instrument_Status	: 2 :	Text	50
✓From_Date	: 3 :	Date/Time	Any Date and Time
✓To_Date	: 4 :	Date/Time	Any Date and Time
✓Model	: 5 :	Text	50
✓Description	: 6 :	Text	100
✓Serial_Number	: 7 :	Text	20
✓Power_Requirements	: 8 :	Text	50
Battery_Power	: 9 :	Boolean	Yes/No
✓ Battery_Type	: 10 :	Text	50
✓ Battery_Replacement_Date	: 11 :	Date/Time	Any Date and Time
✓ Sensor	: 12 :	Text	50
✓ Sensor_Model	: 13 :	Text	50
✓ Sensor_Description	: 14 :	Text	100
✓ Sensor_Serial_Number	: 15 :	Text	20
✓ Range_Of_Operation	: 16 :	Text	50
✓ Comments / others	: 17 :	Memo	1.2 GB of text data
✓ Last_Calibration_Date	: 18 :	Date/Time	Any Date and Time
✓Calibration_Interval_Value	: 19 :	Integer	+/-327676
✓Calibration_Interval	: 20 :	Text	20
✓ Sample_Interval_Value	: 21 :	Integer	+/-327676
✓Sample_Interval	: 22 :	Text	20

✓

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LinkParametersToUnits

Field Name	Field Pos	Field Type	Field Length
Param_Unit_Id	: 0 :	Text	4
Parameter_Id	: 1 :	Text	2
Unit_Id	: 2 :	Text	3

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LinkStationToParam

Field Name	Field Pos	Field Type	Field Length
Stat_Param_Id	: 0 :	Text	10
File_Id	: 1 :	Text	6
Display_Param_Unit_Id	: 2 :	Text	4
Archive_Start_Date_Time	: 3 :	Date/Time	Any Date and Time
Archive_End_Date_Time	: 4 :	Date/Time	Any Date and Time
Summary_Start_Date_Time	: 5 :	Date/Time	Any Date and Time
Summary_End_Date_Time	: 6 :	Date/Time	Any Date and Time
Pre_Set_Scale_Min	: 7 :	Double	+/-1.8e300
Pre_Set_Scale_Max	: 8 :	Double	+/-1.8e300
Gap_Criteria	: 9 :	Long Integer	+/-2147483
Interpolate_Data	: 10 :	Boolean	Yes/No
AutoVal_Available	: 11 :	Boolean	Yes/No

Is this Hydrolog ?

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LoggerChannelDetails

Field Name	Field Pos		Field Type	Field Length
Logger_Channel_id	:	0 :	Text	20
Logger_id	:	1 :	Text	20
Channel_Number	:	2 :	Integer	+/-327676
Channel_Type_No	:	3 :	Integer	+/-327676
Collect_Data	:	4 :	Boolean	Yes/No
Derivation_No	:	5 :	Integer	+/-327676
Date_Of_Last_Download	:	6 :	Date/Time	Any Date and Time
Interval	:	9 :	Text	20
Period	:	10 :	Integer	+/-327676
Use_Pointer	:	11 :	Boolean	Yes/No
Bucket_Size	:	12 :	Double	+/-1.8e300
Comment	:	13 :	Memo	1.2 GB of text data

#1 Hydrolog 2

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LoggerCrossReferenceDetails

Field Name	Field Pos		Field Type	Field Length
XRef_id	:	0 :	Text	20
Stat_Param_Id	:	1 :	Text	10
Logger_Channel_id	:	2 :	Text	20
Logger_Type	:	3 :	Text	50

Hydrolog 2

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LoggerDerivationType

Field Name	Field Pos		Field Type	Field Length
Logger_Derivation_No	:	0 :	Integer	+/-327676
Logger_Derivation_Type	:	1 :	Text	50

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LoggerDetails

Field Name	Field Pos		Field Type	Field Length
✓ Logger_Id Reference	:	0 :	Text	20
✓ Logger_Name	:	1 :	Text	50
✓ Logger_Type	:	2 :	Text	50
✓ Telephone	:	3 :	Text	20
✓ Baud_Rate	:	4 :	Integer	+/-327676
✓ Auto_Poll	:	5 :	Boolean	Yes/No
✓ Comments	:	6 :	Memo	1.2 GB of text data

✓

****
LoggerScaleFactors

Field Name	Field Pos		Field Type	Field Length
Logger_Channel_id	:	1 :	Text	20
LZ	:	2 :	Double	+/-1.8e300
LR	:	3 :	Double	+/-1.8e300
EZ	:	4 :	Double	+/-1.8e300
ER	:	5 :	Double	+/-1.8e300
Greater_than_Threshold	:	6 :	Double	+/-1.8e300
Less_than_Threshold	:	7 :	Double	+/-1.8e300
K1	:	8 :	Double	+/-1.8e300
K2	:	9 :	Double	+/-1.8e300
K3	:	10 :	Double	+/-1.8e300
K4	:	11 :	Double	+/-1.8e300

Hydrolog 2

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MaintenanceSchedule

Field Name	Field Pos		Field Type	Field Length
File_Id	:	0 :	Text	6
Asset_Type	:	1 :	Text	20
From_Date	:	2 :	Date/Time	Any Date and Time
To_Date	:	3 :	Date/Time	Any Date and Time
Maintenance_Type	:	4 :	Text	50
✓ Work_Required	:	5 :	Memo	1.2 GB of text data
✓ Last_Inspection_Date	:	6 :	Date/Time	Any Date and Time
Inspection_Interval_Value	:	7 :	Long Integer	+/-2147483
? Inspection_Interval	:	8 :	Text	20

✓

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MeasurementReferenceDetails

Field Name	Field Pos		Field Type	Field Length
Stat_Param_Id	:	0 :	Text	10
Hist_id	:	1 :	Long Integer	+/-2147483
Reference_Type	:	2 :	Text	20
Reference_Value	:	3 :	Double	+/-1.8e300
Unit_Id	:	4 :	Text	3

```
***************************************************
MeasurementReferenceTypes
       Field Name                    Field Pos  Field Type    Field Length
Reference_Type                         :  1  :    Text          20

***************************************************
MonitorType
       Field Name                    Field Pos  Field Type    Field Length
Monitor_Type                           :  0  :    Text          50

***************************************************
NameConversionTable
       Field Name                    Field Pos  Field Type    Field Length
Original_Name                          :  0  :    Text          40
Actual_Name                            :  1  :    Text          40
Symbol                                 :  2  :    Text          2
Short_Name                             :  3  :    Text          6

***************************************************
NeighbourDetails
       Field Name                    Field Pos  Field Type    Field Length
Neighbour_Id                           :  0  :    Text          50
Stat_Param_Id                          :  1  :    Text          10
Nearest_Neighbour_Stat_Param_Id        :  2  :    Text          10
Relation_id                            :  3  :    Text          50
Position_In_Group                      :  4  :    Integer      +/-327676

***************************************************
ParameterTypes
       Field Name                    Field Pos  Field Type    Field Length
Parameter_Id                           :  0  :    Text          2
Parameter_Name                         :  1  :    Text          30
Stored_Unit_Id                         :  2  :    Text          3
Report_Label                           :  3  :    Text          20
Graph_Label                            :  4  :    Text          10
Archive_Type                           :  5  :    Text          50
Used_In_System                         :  6  :    Boolean      Yes/No
Data_Type                              :  7  :    Text          50
Rate                                   :  8  :    Boolean      Yes/No

***************************************************
PipeFlowDimensions
       Field Name                    Field Pos  Field Type    Field Length
Stat_Param_Id                          :  0  :    Text          10
Hist_Id                                :  1  :    Long Integer +/-2147483
Pipe_Type                              :  2  :    Text          20
Pipe_Height                            :  3  :    Double       +/-1.8e300
Pipe_Width                             :  4  :    Double       +/-1.8e300
X_Measurement_Base                     :  5  :    Text          10
User_Pipe_Id                           :  6  :    Text          50

***************************************************
PipeMeasurementBaseTypes
       Field Name                    Field Pos  Field Type    Field Length
X_Measurement_Base                     :  0  :    Text          10

***************************************************
PipeUserDefinedDimensions
       Field Name                    Field Pos  Field Type    Field Length
User_Pipe_Id_Y                         : -1  :    Text          50
User_Pipe_Id                           :  0  :    Text          50
X_Left                                 :  1  :    Double       +/-1.8e300
X_Right                                :  2  :    Double       +/-1.8e300
Y_Depth                                :  3  :    Double       +/-1.8e300

***************************************************
PollingGroupDetails
       Field Name                    Field Pos  Field Type    Field Length
Polling_Group_id                       :  0  :    Text          50
Polling_Group_Name                     :  1  :    Text          40
Logger_Channel_id                      :  2  :    Text          20
Date_Of_Next_Poll                      :  3  :    Date/Time    Any Date and Time
Polling_Frequency                      :  4  :    Date/Time    Any Date and Time
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PumpTestDetails

Field Name	Field Pos	Field Type	Field Length
Stat_Param_Id	0	Text	10
Pump_Test_Ref_No	1	Text	20
Pump_Test_Date	2	Date/Time	Any Date and Time
Pump_Test_Duration_Value	3	Double	+/-1.8e300
Pump_Test_Duration_Interval	4	Text	20
Pump_Test_Reliable_Yield_Value	5	Double	+/-1.8e300
Pump_Test_Reliable_Yld_Unit_Id	6	Text	3
Comments	7	Memo	1.2 GB of text data
Transmissivity	8	Double	+/-1.8e300
Transmissivity_Unit_Id not on.	9	Text	3
Storativity	10	Double	+/-1.8e300
Pump_Test_Type	11	Text	100
Observation_Station_Id	12	Text	10
No_Of_Steps	13	Long Integer	+/-2147483
Step_Duration	14	Long Integer	+/-2147483
Step_Duration_Time_Unit	15	Text	20
Analysis_Method	16	Text	100
Pump_Rate_Value	17	Double	+/-1.8e300
Pump_Rate_Unit_Id	18	Text	2
Leakage_Coef_Value	19	Double	+/-1.8e300
Leakage_Coef_Unit_Id not on.	20	Text	3
Well_Efficiency	21	Text	20
Software_Package	22	Text	50
Analysis_By	23	Text	50
Pump_Diameter_(mm)	24	Double	+/-1.8e300
Pump_Type	25	Text	30
Maximum_Drawdown	26	Double	+/-1.8e300
Maximum_Drawdown_Unit_Id	27	Double	+/-1.8e300

not on. (No_Of_Steps, Step_Duration, Step_Duration_Time_Unit)

— advise units

put steptest

— advise units

****

RainGaugeDetails

Field Name	Field Pos	Field Type	Field Length
Stat_Param_Id	0	Text	10
National_Number	1	Text	10
Gauge_Type	2	Text	20
Bucket_Size	3	Double	+/-1.8e300
Altitude	4	Double	+/-1.8e300
Altitude_Unit_Id	5	Text	3
Comments	6	Memo	1.2 GB of text data
Next_Calibration_Date	7	Date/Time	Any Date and Time
Hist_Id	8	Long Integer	+/-2147483
Observer_Address_id	9	Long Integer	+/-2147483
Gauge_Address_id	10	Long Integer	+/-2147483

WARNING. Unable to make changes in Hydrolog 3. use Hydrolog 2.

****

RatingCurves

Field Name	Field Pos	Field Type	Field Length
Full_Curve_Id	0	Long Integer	+/-2147483
Segment_Number	1	Long Integer	+/-2147483
Min_Stage	2	Double	+/-1.8e300
Max_Stage	3	Double	+/-1.8e300
C	4	Double	+/-1.8e300
a	5	Double	+/-1.8e300
B	6	Double	+/-1.8e300
Comments	7	Text	50

Hydrolog 2.

****

RatingHistories

Field Name	Field Pos	Field Type	Field Length
Rating_History_Id	0	Text	20
From_Date	1	Date/Time	Any Date and Time
To_Date	2	Date/Time	Any Date and Time
Comments	3	Text	255

Hydrolog 2.

****

RatingHistoryLink

Field Name	Field Pos	Field Type	Field Length
Rating_History_Id	0	Text	20
Stat_Param_Rating_Set_Id	1	Text	20

****

RatingSetCurveLink

Field Name	Field Pos	Field Type	Field Length
Stat_Param_Rating_Set_Id	: 0 :	Text	20
Full_Curve_Id	: 1 :	Long Integer	+/-2147483

Hydrolog 2

****

SampleArchive

Field Name	Field Pos	Field Type	Field Length
Stat_Param_Id	: 0 :	Text	10
Date_Time	: 1 :	Date/Time	Any Date and Time
Data_Value	: 2 :	Double	+/-1.8e300
Code	: 3 :	Integer	+/-327676

****

SensorType

Field Name	Field Pos	Field Type	Field Length
Sensor_Type	: 0 :	Text	50

****

StationClassification

Field Name	Field Pos	Field Type	Field Length
Stat_Param_Id	: 1 :	Text	10
From_Date	: 2 :	Date/Time	Any Date and Time
To_Date	: 3 :	Date/Time	Any Date and Time
Flow_Type	: 4 :	Text	20
Classification	: 5 :	Text	20
Reliability	: 6 :	Text	20
Comment	: 7 :	Text	255

Hydrolog 2.

****

StationComments

Field Name	Field Pos	Field Type	Field Length
File_Id	: 0 :	Text	6
Station_Comments	: 1 :	Memo	1.2 GB of text data

Hydrolog 2.

****

StationDetails

Field Name	Field Pos	Field Type	Field Length
Station_Id	: 0 :	Text	20
Station_Name	: 1 :	Text	50
File_Id	: 2 :	Text	6
Location_Description	: 3 :	Text	50
NGR	: 4 :	Text	12
Area_Ref	: 5 :	Text	20
Day_Start	: 6 :	Date/Time	Any Date and Time
Archive_Start_Date_Time	: 7 :	Date/Time	Any Date and Time
Archive_End_Date_Time	: 8 :	Date/Time	Any Date and Time
Summary_Start_Date_Time	: 9 :	Date/Time	Any Date and Time
Summary_End_Date_Time	: 10 :	Date/Time	Any Date and Time
Active_Site_Indicator	: 12 :	Boolean	Yes/No
HLog2_Station	: 13 :	Boolean	Yes/No
Rainark_Station	: 14 :	Boolean	Yes/No

Detail taken from Hydrolog 2 not able to change in Station Manager

****

StationStatisticsData

Field Name	Field Pos	Field Type	Field Length
Stat_Param_Id	: 0 :	Text	10
Stat_Id	: 1 :	Long Integer	+/-2147483
Statistic_Type	: 2 :	Text	30
Statistic_Value	: 3 :	Double	+/-1.8e300
Statistic_Unit_Id	: 4 :	Text	3

Hydrolog 2.

****

StatisticTypes

Field Name	Field Pos	Field Type	Field Length
Statistic_Type	: 1 :	Text	30

****

StnRatingSetCommentLink

Field Name	Field Pos	Field Type	Field Length
Stat_Param_Id	: 0 :	Text	10
Stat_Param_Rating_Set_Id	: 1 :	Text	20
Rating_Set_Id	: 2 :	Text	20
Comments	: 3 :	Memo	1.2 GB of text data

Hydrolog 2

```
****************************************************
StratigraphyDetails
       Field Name                      Field Pos  Field Type    Field Length
Stratigraphy_id                          :  0  :     Text          20
Stat_Param_Id                            :  1  :     Text          10
From_Level                               :  2  :     Double        +/-1.8e300
To_Level                                 :  3  :     Double        +/-1.8e300
Stratum                                  :  4  :     Text          50
Lithology                                :  5  :     Text          50
Liner_Type                               :  6  :     Text          50
Diameter                                 :  7  :     Double        +/-1.8e300
Comments                                 :  8  :     Memo          1.2 GB of text data

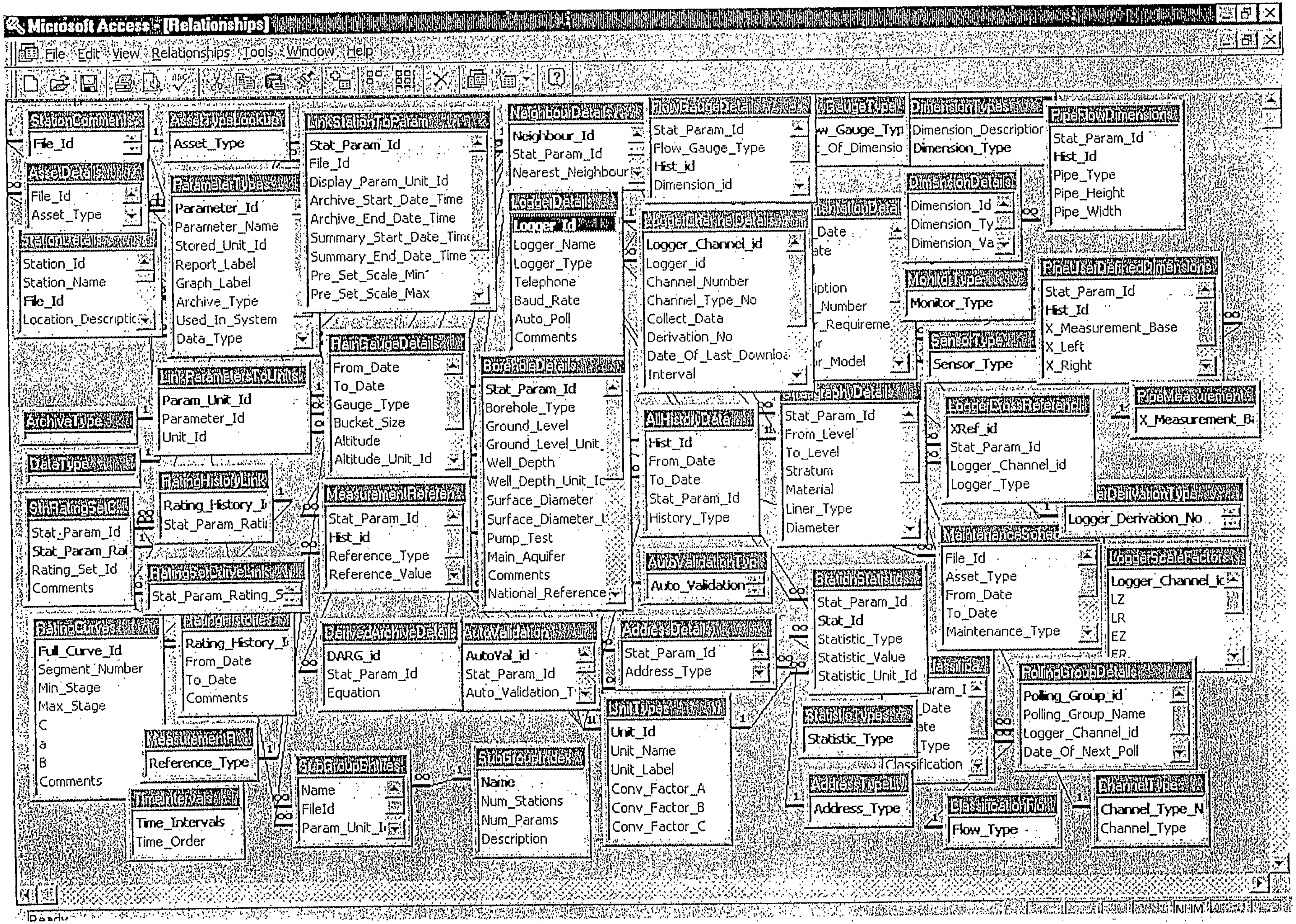
****************************************************
SubGroupEntries
       Field Name                      Field Pos  Field Type    Field Length
Sub_Group_Entries_id                     :  0  :     Long Integer +/-2147483
Sub_Group_ID                             :  1  :     Long Integer +/-2147483
FileId                                   :  2  :     Text          6
Param_Unit_Id                            :  3  :     Text          4
Entry_Order                              :  4  :     Long Integer +/-2147483

****************************************************
SubGroupIndex
       Field Name                      Field Pos  Field Type    Field Length
Name                                     :  0  :     Text          50
Description                              :  1  :     Text          100
Sub_Group_Id                             :  2  :     Long Integer +/-2147483

****************************************************
SystemInformation
       Field Name                      Field Pos  Field Type    Field Length
Licence_Name                             :  0  :     Text          50
Version_Number                           :  1  :     Text          10
Dial_Up_Prefix                           :  2  :     Text          10

****************************************************
TimeIntervals
       Field Name                      Field Pos  Field Type    Field Length
Time_Intervals                           :  0  :     Text          20
Time_Order                               :  1  :     Integer       +/-327676

****************************************************
UnitTypes
       Field Name                      Field Pos  Field Type    Field Length
Unit_Id                                  :  0  :     Text          3
Unit_Name                                :  1  :     Text          30
Unit_Label                               :  2  :     Text          10
Conv_Factor_A                            :  3  :     Double        +/-1.8e300
Conv_Factor_B                            :  4  :     Double        +/-1.8e300
Conv_Factor_C                            :  5  :     Double        +/-1.8e300
```



Microsoft Access - [Relationships]
File Edit View Relationships Tools Window Help
StationComments
File_Id
AssetTypeLookUp
Asset_Type
LinkStationToParam
Stat_Param_Id
File_Id
Display_Param_Unit_Id
Archive_Start_Date_Time
Archive_End_Date_Time
Summary_Start_Date_Time
Summary_End_Date_Time
Pre_Set_Scale_Min
Pre_Set_Scale_Max
NeighbourDetails
Neighbour_Id
Stat_Param_Id
Nearest_Neighbour
FlowGaugeDetails
Stat_Param_Id
Flow_Gauge_Type
Hist_id
Dimension_id
DimensionTypes
Dimension_Description
Dimension_Type
PipeFlowDimensions
Stat_Param_Id
Hist_Id
Pipe_Type
Pipe_Height
Pipe_Width
AssetDetails
File_Id
Asset_Type
ParameterTypes
Parameter_Id
Parameter_Name
Stored_Unit_Id
Report_Label
Graph_Label
Archive_Type
Used_In_System
Data_Type
LoggerDetails
Logger_Id
Logger_Name
Logger_Type
Telephone
Baud_Rate
Auto_Poll
Comments
LoggerChannelDetails
Logger_Channel_id
Logger_id
Channel_Number
Channel_Type_No
Collect_Data
Derivation_No
Date_Of_Last_Download
Interval
DimensionDetails
Dimension_Id
Dimension_Type
Dimension_Value
StationDetails
Station_Id
Station_Name
File_Id
Location_Description
MonitorTypes
Monitor_Type
PipeUserDefinedDimensions
Stat_Param_Id
Hist_Id
X_Measurement_Base
X_Left
X_Right
RainGaugeDetails
From_Date
To_Date
Gauge_Type
Bucket_Size
Altitude
Altitude_Unit_Id
SensorTypes
Sensor_Type
LinkParametersToUnits
Param_Unit_Id
Parameter_Id
Unit_Id
BoreholeDetails
Stat_Param_Id
Borehole_Type
Ground_Level
Ground_Level_Unit
Well_Depth
Well_Depth_Unit_Id
Surface_Diameter
Surface_Diameter_Unit
Pump_Test
Main_Aquifer
Comments
National_Reference
AllHistoryData
Hist_Id
From_Date
To_Date
Stat_Param_Id
History_Type
Stat_Param_Id
From_Level
To_Level
Stratum
Material
Liner_Type
Diameter
PipeMeasurement
X_Measurement_Base
ArchiveTypes
DataTypes
LoggerCrossReference
XRef_id
Stat_Param_Id
Logger_Channel_id
Logger_Type
RatingHistoryLink
Rating_History_Id
Stat_Param_Rating
StnRatingSets
Stat_Param_Id
Stat_Param_Rating
Rating_Set_Id
Comments
MeasurementReference
Stat_Param_Id
Hist_id
Reference_Type
Reference_Value
Logger_Derivation_No
MaintenanceSchedule
File_Id
Asset_Type
From_Date
To_Date
Maintenance_Type
AutoValidationTypes
Auto_Validation
LoggerScaleFactors
Logger_Channel_id
LZ
LR
EZ
ER
RatingSetCurveLinks
Stat_Param_Rating_Set
StationStatistics
Stat_Param_Id
Stat_Id
Statistic_Type
Statistic_Value
Statistic_Unit_Id
RatingCurves
Full_Curve_Id
Segment_Number
Min_Stage
Max_Stage
C
a
B
Comments
RatingHistories
Rating_History_Id
From_Date
To_Date
Comments
DerivedArchiveDetails
DARG_id
Stat_Param_Id
Equation
AutoValidation
AutoVal_id
Stat_Param_Id
Auto_Validation_Type
AddressDetails
Stat_Param_Id
Address_Type
PollingGroupDetails
Polling_Group_id
Polling_Group_Name
Logger_Channel_id
Date_Of_Next_Poll
UnitTypes
Unit_Id
Unit_Name
Unit_Label
Conv_Factor_A
Conv_Factor_B
Conv_Factor_C
StatisticTypes
Statistic_Type
Classification
MeasurementRefTypes
Reference_Type
StnGroupEntities
Name
FileId
Param_Unit_Id
StnGroupIndex
Name
Num_Stations
Num_Params
Description
AddressTypes
Address_Type
ClassificationFlow
Flow_Type
ChannelTypes
Channel_Type_No
Channel_Type
TimeIntervals
Time_Intervals
Time_Order
Ready
NUM

5. EVALUATION OF SOFTWARE PACKAGES

5.1 Aquachem

5.1.1 Introduction

Aquachem is an integrated software package developed specifically for graphical and numerical analysis and modelling of aqueous geochemical datasets. It has been developed by Waterloo Hydrogeologic Inc. in Canada. It features a customisable geochemical database, automatic calculation of geochemical parameters, and a wide range of data processing and presentation options.

For this study the distributors Scientific Software Group provided a full copy of Aquachem 3.6.2 for evaluation purposes. It is understood that a new version of Aquachem is due for release in March 1999, which will have an Access based database and will be Year 2000 compliant.

5.1.2 Compatibility with MS Office

Data import

Data can easily be imported into Aquachem as tab delimited ASCII files of a form which can easily be created with Access or Excel. A masking file is required to tell Aquachem the format of the data to be input. An existing masking file can be used, or updated, or a completely new masking file can be created. The routines in Aquachem for editing and creating masking files are easy to use. If the first row of the ASCII file contains the same field names as are used within Aquachem (which can be done with Access), then data import is virtually automatic.

Graphics export

Graphics can be exported from Aquachem using the 'Copy Graph' option. For some reason the graphs tend to occupy only a small corner of the picture created, requiring cropping in Word or Powerpoint. The quality of the pasted graphics is not very good, but can be improved by enlarging the graphic on the screen prior to copying and pasting (see examples). All pasted graphs have a pale grey background which cannot be removed.

Data export

Data can be exported from Aquachem as ASCII tab delimited files, in a form that can easily be read by Excel without any reformatting. Only sample data are exported (not the results of geochemical calculations). Summary statistics tables can be exported as unformatted text.

Data management

Data in Aquachem are held within the Aquachem database. Previously imported data can be updated and appended. There is room in the 'header information' to record Sample ID, Site, Location, Date, Project, Geology, Lithology, Reference and Water Type. Information such as

Groundwater Body can be stored in the Project Field. Records can be selected and omitted, to reduce a large dataset down to a manageable size.

Simple searches can be undertaken for a number of criteria, but the operators are limited to ">", "<", "=" and 'Like'. Thus, if appropriate information is entered into the database, searches can be made by Borehole, Groundwater Body, Geology, Date, etc.. Box searches around a point can be made, but radial searches are not possible.

Data can be assigned to groups for plotting. The group assignment appears to be lost on opening and closing a project.

A key feature of Aquachem is the 'Identify' tool which allows points on graphs or maps to be identified by point and clicking on them with the mouse, either in the data table or on the graph.

5.1.3 Data processing and presentation capabilities

Time series

Aquachem has the facility for time series plots. All selected data from a single parameter are plotted against date, which may lead to a meaningless jumble if data from more than one well are plotted on the same graph. Data from a number of wells may be plotted by assigning different wells to different groups. Time series plots for a number of parameters can be plotted on the same page using the facility for printing multiple graphs.

Bar charts

Histograms of frequency of different concentrations for a given parameter can be plotted for any selected data set. The location of any sample on the frequency chart can be identified with the 'Identify' tool. No other bar charts are supported.

Cross plots

Scatterplots can be produced, plotting any two parameters against each other. The sum of two parameters (e.g. Na+ K) can also be used for one axis.

Mapping

Aquachem has the facility for plotting of a basic map showing well locations, with the option for importing a .dxf file to use as a background. Map symbol sizes can be varied according o concentration of any parameter, providing a useful visual estimate of distribution of elevated values.

Contouring

Aquachem does not have the facility for any contouring.

Box plots

Aquachem does not have any facility for generation of boxplots.

Piper diagrams

Piper diagrams can be easily plotted using Aquachem. There are plenty of options including with or without a grid, addition of legend, and symbol size dependent on a chosen parameter. The fonts for the axis labels are easily changed. The default axes can be changed to include for example Na+K instead of Na.

Other Geochemistry plots

Aquachem has the facility for the following other geochemistry plots for multiple samples:

- Durov
- Langelier-Ludwig (Na+K v. Cl+S04)
- Schoeller (including the option for a large number of user selected parameters)
- Ternary

It also has the facility for the following geochemical plots for single samples

- Stiff
- Pie
- Radial

Simple statistics

Aquachem will produce a simple statistical summary of all selected records. An example is shown below.

	Min	**Max**	**Average**	**St.Dev.**	**Dev. Coeffn**	**Var%**	**Sample No**
Na	7.0	47.0	17.204	12.558	72.994	85.0	23
Ca	118.0	139.0	127.0	5.641	4.442	15.0	23
Mg	1.4	7.1	3.346	2.089	62.418	80.0	23
Cl	13.0	83.0	32.208	22.234	69.031	84.0	24
SO4	1.0	73.0	27.583	23.884	86.587	99.0	24
NO3	3.7	9.2	5.415	1.301	24.033	60.0	64
NO2	0.003	0.097	0.01	0.019	180.15	97.0	64

The summary statistics do not include any calculations of percentiles.

Simple geochemical calculations

Aquachem has the facility for a wide range of geochemical calculations including ion balance, milli-equivalents, milli-moles, sum of anions, sum of cations and hardness. It also includes options for comparing groundwaters and mixing groundwaters.

Comparison with standards

Aquachem has the facility to produce reports listing determinands above standard for each sample in the working set. The standards are determined in the masking file used for data import, or in the File - Preferences - Data Structure option.. The default standards are alleged to be based on the Directive of the EEC on the quality of water for human consumption, 1980. It should be possible to enter UK drinking water standards, but during evaluation difficulty was encountered in changing the reference, although the standard could be changed.

There is no facility for automated visual comparison with standards although it would be possible to run a search for values above standard, and highlight or change the symbols on the values identified.

Trend analysis with confidence limits

Aquachem does not have any facility for statistical trend analysis.

Other capabilities

Aquachem has an interface with the Fortran geochemical modelling program PHREEQC (which can be downloaded free off the Internet). According to the Help information, no particular knowledge of PHREEQC is necessary for simple simulations such as speciation and saturation calculations, dissolving or precipitation of minerals or mixing solutions. The Aquachem database can be used to generate PHREEQC input files for more complex modelling.

Aquachem has a function to calculate geothermometer estimates by a number of different methods. There is also a function to produce geothermometer plots to compare estimates from different geothermometers. These tools may be useful for data interpretation, but evaluation of them is beyond the scope of this project.

5.1.4 General features

Handling of less-than values

Aquachem has two options for the treatment of less-than values in calculations and on graphs - to ignore them, or to take them as the detection limit. Although the presence of less than values is indicated in the database form for each well, there is no indication on any of the graphs that there may be results below detection limits. This is potentially misleading and not in line with the Environment Agency Code of Practice for Data Handling. It would be possible to individually assign all less-than values to a specific group to see different plot symbols, but this would be time consuming and operators would be unlikely to do this routinely. It does not appear possible to run a search for the presence of less-than values.

Quality of graphical output including customisation

The graphics are generally of high quality when printed directly from Aquachem. As described above some quality is lost when copied and pasted into MS Office. Font style and size can be changed, and there are options for text location. There do not appear to be options for line thickness, which might be important when designing a graph for overhead presentation.

Accessibility (ease of use without training)

Aquachem is easy to use without training, once the basic layout of the package has been grasped.

Convenience

Some features of Aquachem appear to be quite user-unfriendly. The screen always shows the 'record list' which includes a listing of some header information for all active records. It does not appear possible to sort this record list, or select which information appears in it.

During evaluation Aquachem appeared to crash or hang quite frequently, for example during some searches.

Automation of Routine Tasks

Aquachem does not appear to allow automation of routine tasks other than the default tasks for which it is set up. It does not have a memory of previous searches, so for example routine searches by groundwater body or a box search must be keyed in freshly each time they are required.

Customisation

Aquachem has no facility for customisation for user-defined tasks, such as statistics. It does allow choice of the parameters to be plotted in each graph type.

Year 2000 Compliance

The current version of Aquachem is not fully Year 2000 compliant. If dates after the Year 2000 are imported then the individual database records show the correct data, time series plot correctly, and a search for all dates before 2000 successfully excludes dates in the new millennium. The depiction of the date in the 'record list' is however corrupted.

Technical Support

The software developers Waterloo Hydrogeologic were quite unhelpful when approached for an evaluation copy of the software (they advocated purchase of a copy and taking advantage of the 30 day money back guarantee). They have not been approached for further technical support, but have a reputation for unhelpfulness with other software.

The distributors Scientific Software Group have been very helpful when approached, and provided virtually instant responses to email requests for information, including an evaluation copy of the software. They were supportive but initially ineffective when problems arose with installation of the software, and did eventually come up with a working solution (copy all the installation disks onto a temporary folder on the C: drive, and install from there). They have also provided limited information to technical queries.

Help

The online Aquachem Help is largely limited to descriptions of the file menus, and does not include any search facilities. It is therefore good for explaining what the software does, but not good for finding out how to do something you think it might be able to do.

5.2 HydroGen32

5.2.1 Introduction Brief Description of package, purpose, etc.

Hydrogen32 is designed for the graphical analysis of water quality data, developed by Formlink Pty Ltd of Australia. The results of chemical analysis of water samples are entered into a grid in mg/l. This information is then used to calculate milli-equivalents or milli-equivalent percentages, water type, sodium absorption ratio and sodium percentage. Graphs can also be constructed from the information in the grid.

For this study the distributors recommended the evaluation copy of the software available from the Formlink website on the internet. The evaluation software can be used for 45 days or 100 uses, and has virtually all the capability of the actual software. It is rendered unusable for standard use by distortion of the axes titles and data points on printing.

5.2.2 Compatibility with MS Office

Data import

Hydrogen32 has space for 20 parameters within its database, of which only eight may be non-ionic in character. Data can be imported as .csv files, of a form which can be created with Access. The file also requires dates to be set up as four digit years, with leading digits. Values below detection limits are not supported, so that negative values and less than signs must be removed from the data prior to import.

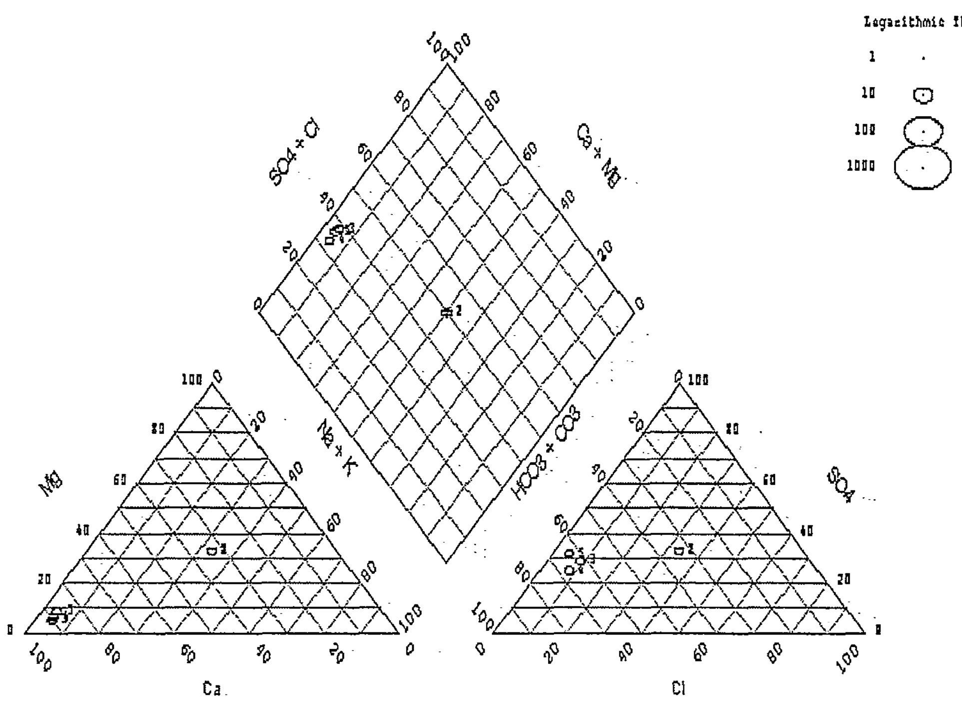
A template can be set up to receive the information. This is achieved by creating a project, changing the column parameters (only 8 may be non-ionic and those which are ionic must have values entered for molecular mass and valance) and saving the project as a template.

The data import aspect of this program can be frustrating as there is no help given on how the input file should be modified if the initial import attempt is unsuccessful.

It is possible to import a large amount of data, but the software performance is reduced with large datasets. The program did not respond to selection of records by mouse clicks when there was a large number (>5000) of records in the database, however it did when the dataset was more manageable (50). It is likely to be more practical to select the data subsets in Access and only use a working subset of data in Hydrogen32.

Graphics export

Graphics can be exported from Hydrogen32 using the 'copy graph image' in edit. The quality of the pasted graphs is not very good. Graphs cannot be modified once they have been pasted into the package. e.g.:



Data export

Data can be exported from Hydrogen32 as .csv files comma delimited files. The export wizard requires selection of the required parameters for export, and both the analytical data and the calculated values (e.g. meq's, SARs) can be exported. The resulting csv file can be easily read in Excel.

Data Management

Data are held in Hydrogen32 within the grid system which serves as a database. Previously imported data can be appended or overwritten but not updated. The sample information which can be recorded is limited to Sample Reference and Date, an ID number is assigned to each record when it is selected by a check mark next to it. This ID number will be changed if the record or other records are de-selected, it can be displayed on the graph next to the datapoint if required.

It appears to be the intention of the program that only selected records will appear on a table and those can be changed by deselecting and refreshing the graph. However, this option does not appear to function in the version provided for evaluation. The graph must be re-created afresh in order for only the selected records to feature.

There is a facility for performing searches on the data using a button within the toolbar of the data grid window. The search can be defined as "equal to, not equal to, less than, less or equal, more or equal, more than, between, not between" a value of any of the parameters used, including dates.

The data can be sorted by any parameter, but dates are treated as text strings, so that they are sorted by day then month then year rather than in chronological order.

There is no facility for grouping the data beyond simple selection or non-selection.

There is no 'point and shoot' facility allowing points on graphs or maps to be identified in the grid system or vice-versa.

5.2.3 Data processing and presentation capabilities

Time series

Hydrogen32 does not have the facility for time-series plots.

Bar charts

There is a facility in Hydrogen32 for creating bar graphs. This can be used for example to compare cation concentrations data for individual samples, but it does not appear possible to create summary histograms, for example the frequency of different concentrations for a given parameter.

Cross plots

Scatterplots can be produced in Hydrogen 32, plotting any two parameters against each other.

Mapping

Hydrogen 32 does not have the facility for mapping.

Contouring

Hydrogen32 does not have the facility for contouring.

Box plots

Hydrogen32 does not have the facility for box plots.

Piper diagrams

Piper diagrams can be easily plotted using Hydrogen32. There are a number of options including with or without a grid, labels beside data points, data beside graph. There is the option of data circles (e.g. For total dissolved solids) and points can be assigned a particular colour or symbol. The axes themselves can be changed (e.g. From Na to Na+K) by editing the mapping, however, the fonts for the axes are not easily changed. It does not appear possible to add a legend to a Piper diagram.

Other Geochemistry plots

Hydrogen32 has the facility for the following other geochemistry plots for multiple samples:

- Durov
- Expanded Durov
- Ternary
- Schoeller

Hydrogen32 has the facility for the following other geochemistry plots for individual samples:

- Stiff
- Radial
- Pie
- Vectors

Simple statistics

Hydrogen32 does not have the facility to perform statistics on the data.

Simple geochemical calculations

Hydrogen32 has the facility for a range of geochemical calculations, including ion balance, milli-equivalents, milli-equivalents (percentages), Sodium Absorption Ratio (SAR) and Sodium Percentage (NAP). It also give a description of the water type (e.g. Ca, HCO3, SO4).

Comparison with standards

Hydrogen32 does not have the facility to compare data with standards, although if the standards were known the "select rows by criteria" button could be used to select those records where the value is greater than the standard.

Trend analysis with confidence limits

Hydrogen32 does not have any facility for statistical trend analysis.

Other capabilities

Hydrogen32 does not have any other capabilities than those discussed above.

5.2.4 General features

Data handling - less than values, nil and null values

There is no special facility for handling less than, nil or null values.

Where an imported value is left blank Hydrogen32 assigns it a value of 0, where the value is text or preceded by a < or - sign the import fails and the user is forced to re-examine the data file to find the source of the failure.

Where an attempt is made to enter a value into the grid as text, a negative value, a < value or a blank an "invalid number format" error message occurs.

Quality of graphical output including customisation

The graphics are of high quality when printed directly from Hydrogen32, however the quality is slightly impaired when the graphs are exported to other applications. There is little flexibility to customise the page set-up when printing directly from Hydrogen32. Only one graph can be printed per page and the associated data can be printed out on separate pages or not as required.

There is no facility for changing the font size or styles.

It is easy to add the users company logo to all graphs produced with Hydrogen32.

Accessibility (ease of use without training)

Hydrogen32 is relatively easy to use without training. The electronic help files were not available with the evaluation copy. With these, the package might have been even easier to learn.

Convenience

The assignment of random ID numbers to selected records was not ideal. It would have been more desirable if the unique ID numbers assigned by the Access database could have been used.

Some features appear only to be available on buttons rather than in pull-down menus, making them more difficult to find.

Automation of Routine Tasks

The package does not have a facility allowing the automation of routine tasks other than the default tasks for which it is set up. The package does not however have a memory of previous searches.

Customisation

A project template can be set up which removes the necessity of re-defining the parameters used each time data is imported. Graphs can be customised and saved within projects and project templates to remove the necessity of re-customising the graph.

Year 2000 Compliance

Hydrogen32 appears to be Year 2000 compliant. As the package does not perform time series plots the purpose of the date is merely to provide an identifier. However, dates are entered with a four digit year so dates beyond the year 2000 are unlikely to present a problem.

Technical Support

Formlink were approached by email regarding the lack of help files with Hydrogen, and responded virtually immediately with a manual and offer of further help.

Help

The online Hydrogen32 help was not operational in the evaluation copy provided.

5.2.5 Conclusions

Assessment of the evaluation copy shows that, although easy to use for specific tasks, Hydrogen32 is very limited in its capabilities compared to Aquachem. It has no facility for identifying values below detection limits, or treating them as recommended by the

Environment Agency Code of Practice for Data Handling. It only holds a limited amount of sampling information (i.e. reference and date) and cannot be used for time series plots. The Piper diagrams are reasonable, but data point identification and legends are poor compared to Aquachem.

5.3 Groundwater for Windows

5.3.1 Introduction

GroundWater for Windows is a relational database and groundwater information system which was originally developed for the United Nations. It is no longer supported by the United Nations, but continues to be developed by the original authors Dr Jasminko Karanjac and Dr Dusan Braticevic. It is essentially freeware, but the authors charge a basic price of US$395 to cover distribution of manuals and software, and technical support for the first six months. Having paid this initial fee the software and manuals can be freely distributed within the organisation.

Groundwater for Windows includes modules for groundwater data processing and presentation, including:

- Chemical Data
- Pumping Test Processing and Aquifer Parameters
- Well Logs and Well Construction Data
- Lithologic, Hydrogeologic and Stratigraphic Cross-Sections
- Mapping
- Abstraction
- Step Drawdown Test Data
- Water Level Measurement Data
- Grain Size Distribution Curves
- Hydrogeological Calculations

The Chemical Data module of Groundwater for Windows v1.31 bought from Dr Jasminko Karanjac was used for this evaluation.

5.3.2 Compatibility with MS Office

Data import

According to the manual, data can be imported from ASCII files. The ASCII files appear to be of a specific width delimited format which could be generated from Access, possibly via Excel for some formatting. The data import facility has not been tested using Environment Agency Data for this project.

Graphics export

It does not appear possible to export the graphics generated by GWW (including geochemical diagrams and maps) in a form compatible with MS Office. There is no 'Copy Graph' function, and the 'Save Graph' function does not appear to save graphs to externally accessible files.

As a result of this significant limitation in the software a full evaluation of GWW was not carried out because the software is considered unlikely to be compatible with the Environment Agency 'harmonised desktop'.

Data export

GWW data can be exported as standard ASCII width delimited files, which can be read by Excel or Access. They need some reformatting for the files to be usable.

5.3.3 Data processing and presentation capabilities

Time series

GWW does not appear to have the facility for the plotting of time series of water chemistry data, although the advertising literature on the internet suggests that this should be possible.

Bar charts

GWW has no facility for plotting bar charts of water chemistry data.

Cross plots

GWW has no facility for generating cross plots of water chemistry data.

Mapping

The locations of water samples can be plotted on maps in GWW. According to the manual basemaps can be imported as .dxf files, but this has not been tested with Environment Agency data.

Contouring

It is understood that GWW is capable of contouring any space distributed parameter including chemical constituents, but this facility has not been evaluated for this project.

Box plots

GWW has no facility for generating box plots.

Piper diagrams

Piper diagrams can be generated very easily using GWW.

Other Geochemistry plots

GWW also supports the generation of Schoeller Diagrams, Stiff Diagrams and Wilcox Diagrams. Wilcox diagrams are irrigation water quality diagrams and not appropriate to UK Groundwater applications.

Simple geochemical calculations

GWW allows calculation of milli-equivalents from data entered as milligrams per litre.

Comparison with standards

GWW does not have any facility for routine comparison with standards.

Trend analysis with confidence limits

GWW does not have an facility for trend analysis with confidence limits.

Other capabilities

As described in the introduction above GWW has a wide range of other capabilities, which have not been evaluated for this project.

5.3.4 General features

Data handling - less than values, nil and null values

Not evaluated.

Quality of graphical output including customisation

The graphical output is of acceptable quality when printed, but not as good as Aquachem or HydroGen32. As described above the graphics cannot be exported to MS Office.

Accessibility (ease of use without training)

GWW has such a range of options that it is quite difficult to load up and get running, and all functions are not clear and intuitive. Data import may be awkward.

Convenience

GWW does not appear particularly convenient to use.

Automation of Routine Tasks

GWW does not appear to allow easy automation of routine tasks.

Customisation

Data entry forms, graphical output, maps etc. can be customised to some extent to suit the user.

Year 2000 Compliance

It is not known whether GWW is Year 2000 compliant. The functions evaluated in this study did not include any time dependant facilities.

Technical Support

Technical support is provided by email by the hydrogeologist author, Dr Jasminko Karanjac. During the evaluation helpful responses to problems were received almost by return of email.

Help

The help files are not detailed and are limited in extent.

5.3.5 Conclusions

Groundwater for Windows has a wide ranging functionality for general groundwater data processing and presentation. It is however very limited in its compatibility with other systems, including data import and, particularly, graphics export. This makes it unlikely to be compatible with the Environment Agency 'harmonised desktop' and therefore unsuitable for Environment Agency purposes.

5.4 Chemstat

5.4.1 Introduction

Chemstat is software designed for the statistical analysis of groundwater quality data at hazardous waste land disposal sites in the United States (RCRA facilities - Resource Recovery and Conservation Act 1976). The literature suggests that 'the number of samples and number of wells are limited only by available computer memory'. It was recommended for further consideration in this study because of its advertised ability to carry out statistical analysis including box and whisker plots, and time series plots.

A fully working copy of Chemstat Version 1.51 was supplied by the distributors Scientific Software Group for evaluation purposes.

5.4.2 Compatibility with MS Office

Data import

Chemstat allows straightforward import of ASCII files of a fixed form which can be generated using Access or Excel. Import data for one parameter can be easily generated using an Access query, but import of data for more than one parameter would require concatenation in Excel or Word of data files exported as individual queries.

Graphics export

Chemstat allows export of graphics as pictures to MS Office using Copy Graph. The quality of the exported graphics is acceptable for inclusion as document figures, although the default font size is rather small.

Data export

Tables including summary statistics can be imported as rich text files or tab delimited files, allowing manipulation in Word or Excel.

5.4.3 Data processing and presentation capabilities

Time series

Chemstat allows straightforward plotting of time series data. Time series data can be plotted on one graph for one well or many wells over a specified time period. Data for a number of parameters from one well only can be plotted on the same chart.

Bar charts

Chemstat has no facility for the plotting of bar charts.

Cross plots

Chemstat has no facility for the plotting of cross plots.

Mapping

Chemstat has no facility for mapping.

Contouring

Chemstat has no facility for contouring data.

Box plots

Chemstat can be used to generate box and whisker plots to compare data for individual wells, but the wells cannot easily be grouped to allow comparison of multiple wells from different areas. The Agency requires to be able to produce box and whisker plots to compare data from different groundwater bodies, aquifers etc. It might be possible to achieve this with Chemstat by adapting the data import files to treat the grouped data as if they were wells (i.e. to put for example the name of the groundwater body in the place reserved for well name) but this is unlikely to be generally satisfactory.

Piper diagrams

Chemstat has no facility for drawing Piper diagrams.

Other geochemistry diagrams

Chemstat has no facility for drawing other specialist geochemical diagrams.

Simple statistics

Chemstat includes fixed routines for generating summary statistics for data from each well, including mean, standard deviation and quartile statistics. There is no option for customisation to include other percentiles, or to group the data other than by well.

Simple geochemical calculations

Chemstat does not include any facility for simple geochemical calculations.

Comparison with standards

If entered with the data, values for comparison such as drinking water standards can be automatically plotted on the time series concentration graphs for each of the monitoring occasions. It does not appear possible to join the points to make a line.

Trend analysis with confidence limits

See statistics review.

Other capabilities

Chemstat includes a range of graphical and tabular statistical analysis methods, listed below. The Chemstat Help option provides user-friendly descriptions of how and when to use the analysis methods. Graphical methods such as Shewhart-CUSUM and Exponentially Weighted Moving Average Control Charts can be used for intra-well or inter-well comparisons.

Chemstat Analysis Methods

Data Display	Results View Basic Statistics Quartiles
Graphs	Box-Plot Concentration vs. Time Graph Multiple Well Concentration vs. Time Graph Multiple Parameter Concentration vs. Time Graph Shewhart-CUSUM Control Chart Exponentially Weighted Moving Average Control Chart Probability Plot
Parametric Methods	Parametric ANOVA Parametric Prediction Limit Parametric Tolerance Limit Confidence Interval
Non-Parametric Methods	Kruskal-Wallis Wilcoxon Rank-Sum Inter-Well Wilcoxon Rank-Sum Intra-Well Poisson Prediction Limit Poisson Tolerance Limit Non-Parametric Prediction Limit Non-Parametric Tolerance Limit
Distribution Testing	Levene's Test for Homogeneity of Variance Shapiro-Wilks Test of Normality Shapiro-Francia Test for Normality
Coefficient of Variation	Bartlett's Test Skewness Coefficient D'Agostino's Test for Normality

5.4.4 General features

Data handling - less than values, nil and null values

Chemstat requires that values below detection limit are imported as 'negative the detection limit', and null values are imported as "NA" or "NS". Within the program it allows the user to easily switch between non-detects treated as zero, non-detects treated as detection limit, and non-detects treated as half the detection limit. Separate symbols can be applied to the graphs to indicate values below detection limits. Data can therefore be treated as recommended by the Environment Agency Code of Practice for Data Handling.

Quality of graphical output including customisation

The quality of graphical output is generally acceptable. The size and colour of symbols, and size, colour and font of text can be altered extensively. Unfortunately it does not appear possible to change the position of any of the graph objects, or dimensions or position of the graph box. This means that if for example the text is enlarged sufficiently to be easily read when projected, the graph itself becomes overprinted.

Accessibility (ease of use without training)

Chemstat is quite easy to use and comes with a tutorial and on-line help. The search options for Help are poor compared to MS Office, but acceptable.

Convenience

Chemstat is relatively inconvenient to use compared to some packages. For example, fonts must be changed separately for each group of text, using a pull-down menu each time, while graph symbols can be changed using a button. Altering and appending data is impossible, and any alteration to data appears to require it to be re-imported.

Automation of Routine Tasks

The routine tasks performed by Chemstat are already automated, and there is little scope for further automation given the limited functionality of the software.

Customisation

Graph font size etc. can be customised to a limited extent, but there is generally little scope for customisation within Chemstat.

Year 2000 Compliance

It is understood that Chemstat is Year 2000 compliant. A trial of import of data including dates later than 2000 was successful, with time series graphs drawn successfully.

Technical Support

No technical support was offered or requested for this software. The manual and help documents do not indicate any email address or contact for further help. The distributors (Scientific Software Group) may be able to offer some technical support.

Help

The on-line help files for ChemStat are good for getting specific information about when and how to use the specific options offered by the software. They are less useful if you don't know exactly what you want to do (e.g. there is no search response to 'compare wells').

5.4.5 Conclusions

Assessment of the evaluation copy (a fully working set of the software) shows that, although easy to use for specific tasks, Chemstat is very limited in its capabilities. Its capabilities for data handling, including treatment of results below detection limits, match the requirements of the Environment Agency Code of Practice to a great extent. However, limitations including particular the inflexibility for grouping data by anything other than well name restricts its overall usefulness. It is also relatively expensive. The graphics are less attractive than its main competitor Aardvark.

5.5 Aardvark

5.5.1 Brief Description

Aardvark is described as a 'data interpretation package for non-statisticians' developed by WRc Medmenham to look at routine quality data. It was specifically designed for surface water quality data, but can also be used for groundwater quality data, or any other quality data collected over time. It is designed for the analysis of data from one monitoring point over time, and is not suitable for inter-well comparisons.

We were provided with a demonstration disk of Aardvark Version 2.2 (July 1997) by WRc Medmenham. This came with limited documentation and a severely limited number of uses (opening files 15 times, 3 demo files).

5.5.2 Compatibility

Data import

The file menu offers two options "Open Data File" and "Open CSV File". The Help file does not include any information regarding data file format, but the example data files appear to be width delimited ASCII files, which must be accompanied by control files. There is no description of "Open CSV Files" in the Help files.

It is understood from conversations with the developer WRc that Aardvark imports data from ASCII files, with the format of the data input file recognised by a control file. The format of the data and control files is standard for most WRc data handling packages, and according to WRc is widely in use within the Environment Agency. Creation of control files is very awkward and not intuitive. However, once a working control file has been set up, then any data file formatted in the same style can be imported very easily into Aardvark.

Graphics export

There is a 'copy graph' function that allows export of graphics to MS Office. The quality of such graphics export is reasonable.

Data export

Data cannot be readily exported from Aardvark. Summary statistics data can be exported but only as picture files (using the 'Copy Graph' function) and cannot be reformatted.

Year 2000 Compliance

Aardvark 2.2 is not Year 2000 compliant. According to WRc Aardvark 2.3 is due out soon and will be Year 2000 compliant. Aardvark 2.3 will be provided at no extra cost to owners of Aardvark 2.2.

5.5.3 Data processing and presentation capabilities

Time series

Aardvark is designed for time series analysis of data, and performs this task very well. There are functions to allow assessment of seasonal variations in the data, including the capability to plot data 'year on year'. Up to two determinands can be plotted at the same time, either on the same scale, or separately. It does not appear possible to group the data at all (i.e. separate data files are required for each monitoring location).

Bar charts

Aardvark allows generation of histograms showing the frequency distribution of the data. No other bar charts are supported.

Cross plots

Aardvark allows generation of cross plots of pairs of determinands only.

Mapping

Aardvark has no facility for mapping.

Contouring

Aardvark has no facility for contouring data.

Box plots

Aardvark has no facility for generating box plots, although the summary statistics required to produce a box plot are supported.

Piper diagrams

Aardvark has no facility for drawing Piper diagrams.

Other geochemistry diagrams

Aardvark has no facility for drawing other specialist geochemical diagrams.

Simple statistics

Aardvark includes fixed routines for generating summary statistics for all the data in the file. This includes means, standard deviations, and percentiles. The 'Statistical Confidence Summary' includes confidence limits around the calculated percentiles, as specified by the Code of Practice for Data Handling. The summary statistics cannot be exported for reformatting in MS Office.

There is no option for customisation and no facility to group the data other than by year.

Simple geochemical calculations

Aardvark does not include any simple standard geochemical calculations. The values for two determinands can be added, subtracted, multiplied or divided to create a new determinand.

Comparison with standards

The 'Highlight Extremes' option can be used to compare results with standards. There is no facility for inputting standards with the data set to allow automatic comparison with standards.

Trend analysis with confidence limits

Aardvark has powerful trend analysis capabilities, reviewed further in the statistical ranking exercise (Appendix F).

Other capabilities

Aardvark contains a number of different analytical methods for examining time series data, including

- Time Series Plot
- Histogram
- Year on year plot
- Cusum plot
- Normal probability plot
- Intersample times
- Autocorrelations
- Yearly statistics
- Selected yearly statistics

These are explained to a greater or lesser extent in the Help Files.

5.5.4 General features

Data handling - less than values, nil and null values

Aardvark can treat less-than values as zero, the detection limit, or any multiplier of the detection limit (e.g. 0.5) depending on the set-up in the control file. Comparison of results obtained by treating less-than values in different ways as recommended by the Code of Practice for Data Handling is therefore possible, but not fully automated. Aardvark can differentiate between nil and null values if they are specified in the data input file.

Quality of graphical output including customisation

The on-screen graphics in Aardvark are extremely good. The print quality is also generally good, although some of the effect is lost in black and white printing. Font size and style can be changed separately for the screen and printer, but since there is no Print Preview the effect of changes to printer settings can only be evaluated by printing. No customisation, for example of axis scales, is possible. It does not appear possible to customise headers and footers.

Accessibility (ease of use without training)

Once the data are loaded then Aardvark is very easy to use without training. Data import is simple once control files and import file formats have been set up, but this requires some file manipulation. It could be easily automated from Access.

Convenience

Aardvark is convenient and easy to use for the routine tasks for which it is designed. Data import appears to be awkward, and files cannot be appended, so any changes would require the data to be re-imported. Changing of fonts, titles, etc. is inconvenient but possible.

Automation of Routine Tasks

Aardvark is already automated for the routine tasks for which it is designed. No further automation is possible, although user default settings can be saved. Automation of routine data import may be possible if the data files are such that the control structure will be consistent.

Customisation

There is relatively little customisation possible.

Technical Support

Technical support is provided by WRc, who were very helpful when approached with technical problems during evaluation.

Help

The Help file is quite useful and easy to read but does not appear completely internally consistent (for example in the section 'Are we complying with a 95%ile limit?' there is a reference to a 'values above limit' option, which does not appear anywhere else in Help or on the menus). Not all menu options are referred to, including 'Open CSV File'.

5.5.5 Conclusions

Aardvark appears to be very good at what it does, but what it does is very limited. It is an excellent tool for time series analysis of data from a single monitoring point. The statistical analysis does require sufficient data to establish trends, and groundwater quality datasets with sufficient data from a single point are relatively unusual. Aardvark is better suited to the analysis of surface water quality data where large datasets exist. Having said this, where significant groundwater quality datasets exist, Aardvark is an ideal tool for analysis.

5.6 ESRI Packages - ArcView 3.1, Spatial Analyst and 3D Analyst

5.6.1 Introduction

ArcView is a desktop Geographical Information System (GIS) and mapping software package. It has been developed by Environmental Systems Research Institute Inc. (ESRI), based in the USA. The package was originally designed as a more user-friendly interface and viewer of the more complex and expensive ARC/INFO GIS system. The software has been developed extensively in recent years to have more capability as a stand alone tool.

The basic ArcView (Version 3.1), released in September 1998, only has a contouring capability with the Spatial Analyst or 3D Analyst extensions. A full working version of both these extensions were provided by ESRI for a 6 week evaluation period.

ArcView has been adopted as standard GIS software by the Environment Agency, and is expected to be available in all offices if required. The extensions 3D Analyst and Spatial Analyst are not anticipated to be widely available at present.

5.6.2 Compatibility

Data import

If computer tabular data exists it can easily be pulled into ArcView using one of two methods. This data is stored and displayed as an ArcView Table. Two formats can be loaded directly into an ArcView table: dBASE (III/IV) and ASCII (either comma or tab delimited). Many data-storage packages can save data in at least one of these formats.

The second alternative is using ArcView built in SQL connection feature allowing the user to connect to a database server and run an SQL query to retrieve records from it. The SQL feature loads the results of the query into a table, thus reducing the data quantity to those required for mapping. This feature can connect to widely available database software packages such as MS Access, Oracle, Sysbase and MS Excel. On PC platforms files are connected through the database servers ODBC (Open Database Connectivity). These drivers are installed as standard with the packages, and you must use the ODBC Administrator (through Control Panel), to configure the file you wish to connect to before importing.

ArcView does not copy the data into the table but connects them by a link that is revised on opening of the project file. The advantage of this is that the file can be updated in its original format, and these changes are reflected in the table once reopened. The database or input file cannot be edited in ArcView, but the table can be exported to disk and reimported once updated, therefore avoiding changing the original database.

Graphics import

ArcView can import a wide range of graphics for use as background maps or features as a guide for editing and digitising. ArcView supports the standard image data formats including bitmaps (.bmp) and tiff files which are commonly used in scanners. ArcView can import satellite imagery, in single and multiple bands. ArcView supports the following image formats:

- BSQ, BIL and BIP
- ERDAS LAN and GIS
- ERDAS IMAGINE
- JPEG
- BMP
- TIFF

ArcView has a Computer Aided Design (CAD) Reader extension provided with the standard ArcView package, allowing the user to integrate the drawing files into the view without conversion. These files can be symbolised, queried and analysed like any other spatial data. Individual CAD layers can be selected and highlighted. This enables the user to select only the desired information. Data can be attributed to the CAD file features or to your own tabular data.

If no background mapping data exists for a particular location, ArcView contains a library of maps from across the world, stored on CD-Rom. There is a detailed map available for the United Kingdom that contains county boundaries, spot city locations, main rivers and motorways. This could be used as a very basic background for a location map. The co-ordinate system of this UK map can be set to UK National Grid co-ordinates.

Graphics export

ArcView can export a map as a graphics file in a number of formats. The information contained in the active view can be exported as a complete file or clipped with no buffer around the information. This allows the user to zoom into the desired region of the map and copy that clipped region it into a document. The Table of Contents and titles etc are not exported, and therefore the view should be placed into an ArcView layout which can contain this information if desired. File export formats which can be imported into MS Office documents are Windows Metafiles (*.wmf) or Bitmaps (*.bmp), both of which are supported by ArcView export. The imported files are of good quality for printing and overheads.

Data export

Any ArcView table, including features selected using a query expression to make a theme table, can be exported in ASCII or dBASE format, which can easily be imported into most database software. There cannot be a direct link back into Access or Excel.

5.6.3 Functions

Mapping

ArcView is a very powerful mapping tool. It can use the imported tables to determine the positions and attributes of the data set (e.g borehole location and water quality determinants). The basic ArcView package can take a data set and use the x & y co-ordinates to position the point data. All attributes of the correct variable type (i.e. a number not a string) can be used to present a gradational symbol size or colour. Any two of the attributes in the table can be selected for the co-ordinates, so x & z co-ordinates can be selected. However this does not constitute a cross section because points cannot be joined.

The number of classification divisions, colour and symbol type can be easily adjusted by the user. This control of the classification allows the user to select appropriate divisions e.g. above and below the standard required and highlight them accordingly. The legend and divisions can be saved as a default and subsequently loaded into other Themes. This enables the quick and simple comparisons of a similar data sets e.g. the comparison of historic records.

ArcView is very user-friendly for the production and presentation of mapping. There is a layout option which allows the user to assemble all the components including the current map view with legend, frame, north arrow, scale bar and titles. All these features can be easily customised, and alternative features (i.e. scale bars, arrow types, line types) are available for inclusion. Once customised, the layout can be saved and used again as a default, simplifying the production of identical maps.

The map area produced in the layout can either be set or linked to the view, allowing the user complete control of map area to be plotted. It is possible to select the scale and unit settings to ensure the region chosen conforms to a specific scale.

Contouring

To enable contouring ArcView requires one or both of the extensions; Spatial Analyst and 3D Analyst. Spatial Analyst is a module that creates, imports and analyses Grid raster data from vector or tabular information. It can graduate the coverage by distinguishing the z co-ordinate intervals by a variety of colours. These colours can be a default group or user defined. Spatial Analyst can only represent elevation in two dimensions and cannot produce a 3-D graphic of that image. 3D Analyst can process and create a grid surface (i.e. same as Spatial Analyst) and create, import and analyse a TIN (Triangulated Irregular Network) surface. This three dimensional surface can be viewed in all planes and angles using the 3D Scene Viewer.

Both packages can produce contours from a surface produced from a tabular data set containing x, y and z co-ordinate. The z co-ordinate could be any numerical value such as a chemical determinand. The surface can be created from a variety of sources such as spot heights including borehole or GPS data sources.

A choice between creating a gridded surface or a TIN is dependant on the users requirements and data source quality and size. A gridded surface is more simple and efficient, with surface digital elevation models more widely available commercially. The interpolation methods available in both extensions used to generate a regular mesh of points from the imported data set, are as follows:

- Inverse Distance Weighted (IDW)
- Spline
- Kriging
- Trend

The most appropriate method for mapping groundwater or pollution is the Spline option. This is best for gently varying surfaces such as groundwater, but large changes would be more appropriate to use the IDW method. There are good descriptions provided in the help files and in the manual for each of the techniques. Once created the contours are simply created with the distance between them user defined. The Kriging and Trend procedures are not available from the user interface, but are available through the use of an Avenue Script.

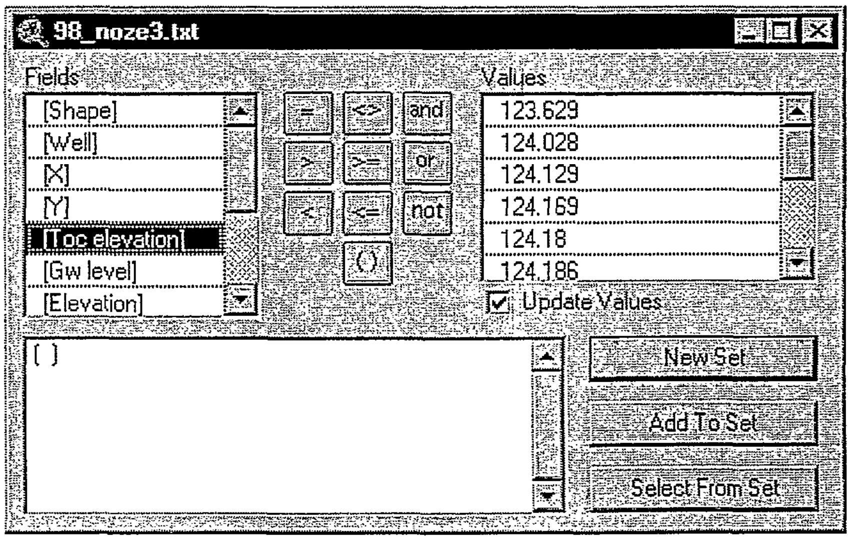
The production of a TIN can use similar data sets for creating the surface. The model is more accurate because levels can be assessed anywhere in the surface, unlike a grid model which has square cells at the same value. However the processing is less efficient than the grid module and therefore TINs are more complex to build and process.

In ArcView the region that is to be contoured can be easily selected either by zooming into the desired area or selecting the extents of certain views e.g. extent of boreholes or site plan. All values outside this region will be ignored and not effect the contouring. Line coverages such as faults & other discontinuities can be specified to produce hard or soft breaklines in the TIN Surface and thus a breakline in the contour lines, providing enough data is available.

Legends and scalebars etc. can be included easily in the output with the contour lines as described in the mapping section.

Searches

ArcView has the ability to build a query expression which can include multiple attributes, operators (including logical) and calculations to select features in a view. A copy of the Query Builder Dialog box below illustrates the range of operators available, and the simplicity of building a query. The output of the query is highlighted on screen, and tabulated as a separate set of records containing all the original attributes. This table is available for exporting back into a database via an ASCII or dBASE file.



The GIS system can also easily perform searches spatially as well as by attribute. Allowing the search to be specified in a certain area using another shapefile, or contained within a defined polygon, or site boundary from a CAD Drawing. Features can be selected within a specified radius from a chosen point by drawing a circle of chosen location and radius.

Using the SQL link query option a separate set of records held in a database such as Access a selected set of records can be brought into ArcView before further queries are run within ArcView, possibly using the other spatial data.

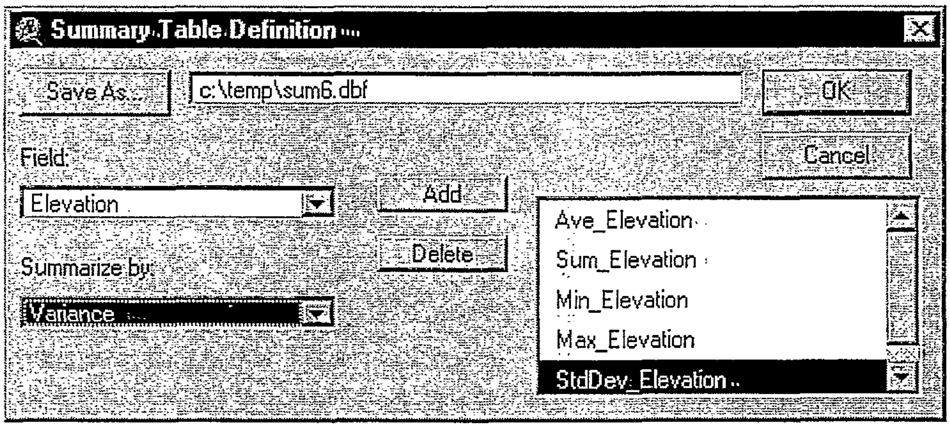
Data Handling

ArcView is in general very versatile in its handling of data, as a result of the way that ArcView imports the text files into tables. If there are point location co-ordinates ArcView will create a point shapefile with the other fields in the table available as attributes for analysing, querying, or contouring etc. If there are no tabular co-ordinates but a drawing file exists with the location points marked, the table of attributes can be joined to these as long as there is a common field (e.g. borehole label). The advantage of having the ability to have attribute fields is that there can be many fields represented by symbols, surfaces or text labels on the same map.

For ArcView to use a particular field in the table for contouring or calculating purposes it must be a numerical value. If, for example, a field has a 'less-than symbol' in front of the value it will be defined as a text file and not recognised as a number. If even one value in a field is text then the whole attribute field will not be available for analysis. However a point attribute can have a unique value where it will assign any field as a text label even if it is a text type.

Data Processing

ArcView has the facility to 'summarise' a field or selected articles within a field in a table. Depending on the field type, the field can be summarised by a number of factors such as maximum, minimum, average, sum. The window below illustrates the options available for summarising a data field by a series of methods.

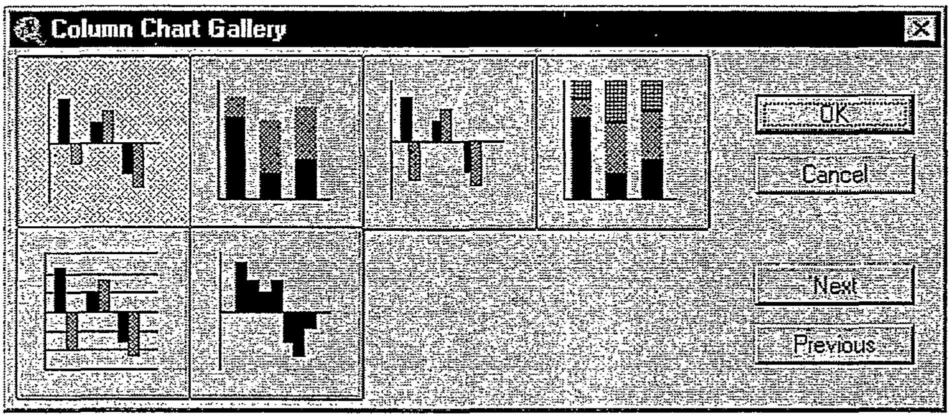


The output of this summary is stored in a table that can be charted or mapped depending on the users requirements. The only drawback to the summarising procedure is that it requires the summary to be completed on one field with a single value. Therefore to include all of the data for one site there has to be a field for every borehole with the same entry. Otherwise the statistics are calculated on each individual data set. This is not difficult to overcome by adding an additional field with an identical entry in each. ArcView does not have a built-in facility to calculate non-parametric summary statistics e.g. median and percentiles.

There is also the facility to chart any field in a specified table. The charting can be placed on the actual map or in a separate window. The charts groups available are as follows:

- Area Chart
- Bar Chart
- Column Chart
- Line Chart
- Pie Chart
- Scatter Chart

Within each chart group there is a gallery of options for the user to best display the data. A chart window can be either printed directly, or included in a map layout.



5.6.4 Useability

Quality of graphical output

The quality of the graphical output from ArcView is one of its main advantages. The graphical display is very customisable. The software allows the user to zoom in to the desired output and actually print that area. The output is in effect dictated by the user, not the software.

Being a GIS based software program, the software produces a high standard of basemaps and a high level of control over what data is presented. There are a good selection of symbols, colours and line styles available to the user. The majority of property styles in ArcView can be edited giving the user complete control over the end output. When the graphics are copied into an MS Office program there is no loss of quality.

Printing

The printing of maps in ArcView is of very high quality, and can be printed from any basic colour printer or plotter. A black and white copy of a colour map could print out too dark if there is little contrast between the colours. If a black and white copy is required for presentation, the colours should be adjusted accordingly, (a grey scale can be selected).

Accessibility (ease of use without training)

ArcView is a very user-friendly, relatively simple package to operate. The user has to possess a degree of understanding how best to deal with spatial data to attain the best results. Certain elements of the data handling are not inherently obvious and may require some time reading the manual and helpfiles. The editing of results and image is straightforward and has a standard format. Once the procedures of how to manipulate the table information into a graphical output have been grasped, even complex tasks should be straightforward.

The add-on packages Spatial and 3D Analyst are slightly more complex initially to operate. The commands and functions of the extensions are, in general, built to the same format as ArcView. Therefore an experienced operator, with some understanding of contouring procedures should have little trouble operating the extensions.

Automation of Routine Tasks

Functions allowing copying of setups between themes and projects allow easy repetition of routine tasks such as creating numerous maps of similar format, even for different areas. ArcView supports a customisation and application development macro system called Avenue. With Avenue, the user can customise the way ArcView looks, modify or create new tools, and integrate ArcView with other Applications. The user can even develop and distribute custom applications on top of ArcView. A library of existing sample scripts are available for modification or for use an example to suit the users needs.

Technical Support

ESRI offer a very good telephone and e-mail technical support system. The usual procedure is to log a help call by phone, fax or e-mail and wait for a reply from the ESRI Help desk. The help desk usually reply within the day and are helpful and knowledgeable about the package. ESRI also support a very informative Web Site that contains answers to many frequently asked questions. Avenue Scripts can be downloaded from the site providing a wide variety of solutions and applications.

Help

For the majority of applications and commands, the on-line helpfiles are descriptive and clear to follow. The Help files for Avenue request commands though, are often very limited and lack detail about its function and syntax. The manuals for ArcView and Avenue are clear and informative with useful screen reproductions provided. The manuals do sometimes lack the detail required, which must be sought in the on-line help. The 'Quick Start Tutorial' section of the manual is a very useful way to gain experience in using ArcView's commands and procedures for the novice.

5.6.5 Conclusions

ArcView is a powerful and user-friendly mapping and desktop GIS package. The addition of the 3D Analyst extension adds the functionality required for the generation of contour maps of water quality determinands. The purchase of Spatial Analyst would not be recommended as the only extension due to its inability to process TIN surfaces and no 3D viewing capacity.

3D Analyst can create and analyse both Grid and Tin surfaces and has a 3D viewing capacity, allowing the user flexibility for contouring.

Key advantages include SQL links with Access-type databases and spreadsheets, the ability to carry out spatial and data searches, and data processing facilities. The interaction with other spatial data such as mapping, digital terrain models, other GIS systems and CAD drawings for spatial queries. These digital formats are becoming increasingly more widely available, and ESRI is a leader in packages in this field. Disadvantages include relatively high cost of ArcView, and that you have to buy an expensive extension to be able to even import 3D surfaces intelligently. The inability to select kriging interpolation (the Surfer default method) from the user interface unless you can code in Avenue is also a drawback.

5.7 Surfer for Windows

5.7.1 Introduction

Surfer for Windows (Version 6.03) is a contouring and 3D Surface Mapping package which is produced by Golden Software Inc, Colorado, USA. This widely used package is distributed in the UK by GeoMEM Software, based in Blairgowrie, Perthshire.

Surfer, like ArcView (with extensions), interpolates the user provided irregularly spaced XYZ data into a regularly spaced grid using a variety of techniques. This grid is then used to produce contour maps and surface plots. The package uses a worksheet function to allow the user to import, transform, join or enter data to be processed.

Surfer for Windows has been recognised by the Environment Agency as a standard software package suitable for incorporation into the 'harmonised desktop'. It is currently in use for groundwater quality contouring in several Agency regions.

5.7.2 Compatibility

Data import

Surfer for Windows stores the data used for contouring in a worksheet form within the package. Data for these worksheets can be pulled in from the following sources:

- Excel Workbooks (*.xls) - one worksheet at a time.
- Lotus 1-2-3 spreadsheets (*.wks)
- ASCII Files (*.dat) - delimited by commas, tabs or spaces

Once brought into the worksheet space there is no link retained to the original file and therefore should any data changes occur in the file the data need to be re-imported. Imported data sets can be combined within Surfer's worksheets by simply copying and pasting between the worksheets.

Graphics import

Surfer can import Windows Metafiles and Bitmaps for use as background mapping. These files once imported cannot be edited but can be stretched and scaled. Surfer has a drawing exchange file (DXF) import filter which scans the file and presents the user with information concerning the file extent, line colours and layers. Any layer or layers can be frozen at this stage, and will not imported into the application.

Graphics export

Surfer for Windows has an export command which allows the user to convert the current image in either a Windows Metafile (*.wmf) or as a DXF file format. A Windows Metafile is easily imported into MS Office packages and is of good quality. The file can be sized as desired by the user once imported as a picture. A DXF file can be imported into packages with the ability to read such files, e.g. AutoCAD and ArcView for a more intelligent presentation of the file. When imported into AutoCAD the application will read the line styles and colours from the entities file. None of the polygons (i.e. contours) will be filled.

Data export

The worksheet files can be saved as an ASCII file should any calculations be performed within the worksheets. There is no option to save back into a spreadsheet or database.

5.7.3 Functions

Mapping

Surfer can be used to create maps. There is the ability in Surfer to change the symbols for parameter values or concentrations. Every symbol can be changed manually in colour, shape or size for each gradation. There is also an option in the post map dialog, to scale symbols by linear or square root proportionality. A classed post map can also be produced, which allows the user to define the symbol type and interval for the classes The minimum or maximum value can also be reset for display. Values outside that threshold are not displayed.

It is possible to zoom into a desired regions of a plot by clicking the zoom in button and pointing on the desired region, or by using a fence. You cannot use a fence to zoom out. Unlike ArcView, you cannot export a region of the plot to a metafile, it exports the whole selected window only.

It is possible to generate a scalebar, legend and titles on the plot page. However, some users of the package prefer to output the plots into a drawing package (for example MS Powerpoint) where the layout can be more easily controlled. Simple drawing objects can be included in the plots, and therefore a frame can easily be drawn around the map.

A cross section can be derived from the contour surface using the Slice command. The package exports a data file of x, y, surface elevation (z value), accumulated distance along line into a comma delimited data file along a user defined boundary line. The elevation and accumulated distance can then be plotted against each other using Excel or equivalent, to produce a surface profile line.

Contouring

Surfer has powerful contouring capabilities. It creates a regular network of z values from an irregular data source. The interpolation of those point values is determined by the method chosen. The most common method used is the kriging geostatistical gridding method. This method attempts to express the trends in the data. With the most appropriate interpolation factors chosen this method produces a reasonable surface.

Other methods are listed below for the calculation of the grid:

- Inverse Distance - tends to produce the bullseye contours
- Kriging
- Minimum curvature
- Polynomial regression
- Radial basis functions

- Triangulation with interpolation

The software offers the triangulation or TIN surface as a gridding method. The advantages of this method is that it can preserve a breakline such as a fault.

Once a surface has been created, a contour map can be easily produced. The user can select the range to be contoured, the contour fill colours, and the contour intervals among others.

Unwanted areas can be masked by use of Surfer's Blanking procedure. This procedure basically entails the user setting up a blanking shape file which can be defined by drawing or polygons. Once created the area blanked will not be included in the contoured are and have no influence on the grid shape. It is also possible to use the 'map limits' command to clip the area gridded to a defined box, by co-ordinates (i.e. xmin, xmax, ymin, ymax).

Data Processing

Surfer has limited data processing capabilities. The package allows you to create a surface by some function of two others e.g. surface C = (surface A - surface B). The package is not designed for any complex data processing which would be better completed in Excel before importing into Surfer.

Searches

Surfer has the capability to perform searches from a specific point. Any points outside of that search area are not considered in the grid interpolation calculations. The search is completed by ellipse, which is circular by default, but can be elongated to a user defined radius and angle.

Surfer cannot run queries of the input data, or query the output spatially. Using the function option you could combine the grids for two different years of data in some form to define the difference between them.

Data Handling

The data used for the gridding process has to be numerical. Data stored in a text format will be ignored. Therefore the user has to ensure that the data source is defined as a numerical type. If, for example a less than sign (<) precedes a number, it will be considered as a text string. Data can be easily sorted in the Surfer worksheet in ascending or descending order.

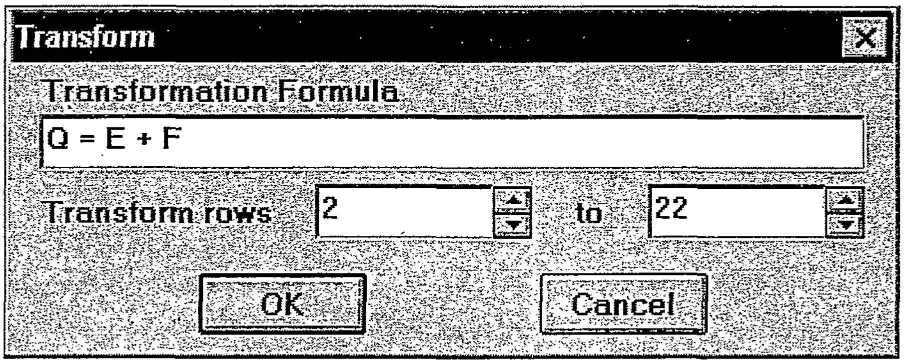
Data Processing

Surfer can perform a statistical analysis of any user-selected group of cells in a worksheet. Below is the results output from one such analysis. This has been pasted in using the 'copy to clipboard' option in the statistics dialog box.

21	Number of numeric cells
2470.632	Sum
117.6491	Average
0.7661933	Standard Deviation
116.429	Minimum
118.945	Maximum

Surfer does not have the capability to calculate percentiles.

Using the transform command in the Worksheet a variety of calculations can be performed and entered into a free column. The window below demonstrates the method, using the column letter as an identifier, and row numbers. This method is fairly cumbersome as the worksheet cannot be accessed with the transform dialog box active.



Example of a transform box to allow calculations in the worksheets where the letters represent column names

5.7.4 Useability

Quality of graphical output

The graphical output from Surfer is of reasonable quality considering the cost of the package. Colour ramps can be easily adjusted for the filling of the contours and line thickness. The 3D view of the gridded surface is not as professional as the ArcView 3D Analyst, because it retains the grid lines on its output It is possible to create hillshade in a surface which creates a terrain visualisation in 2 dimensions. For plots of groundwater or pollution plumes this feature is of little use.

Certain elements such as a lack of a north arrow and the lack of a default layout leads to a slightly less professional output unless the user has lots of time to set one up. The lack of ability to copy a portion of the Surfer image into another package as a picture is something that could be improved.

Printing

The black & white printout of a contour plot from surfer can come out slightly too dark to distinguish between the contours. The colour plots do come out very clearly on a standard colour printer. The contrast in a colour ramp in a legend can sometimes be slightly blocky.

Accessibility (ease of use without training)

Surfer is very easy to use, once familiar with the worksheet and grid import methods. Like any surface interpolation method, to obtain the best results required some manipulation of the data sets, (especially sets of limited size), and interpolation techniques. The package would not require the user to attend a specific training course to use it successfully.

Convenience

Surfer is a very user-friendly mapping and contouring package, that is very accessible to even an inexperienced user. Its simplicity in the processes and displays makes the package very quick to pick up, as long as the user is aware of its limitations

Automation of Routine Tasks

Surfer has a macro system that can automate any procedure performed by the keyboard or mouse. A macro script combines BASIC-like functions and statements with commands and arguments specific to Surfer. The package has a text editor called GS Scripter included with the package, that can be used to edit and write scripts to automate tasks. OLE 2.0 compliant programs (e.g. MS Excel) can supply programmable objects to GS Scripter allowing the Script to extract data directly from Excel spreadsheets. Unlike Visual Basic for Applications, macros cannot be recorded.

Technical Support

Technical support from the vendor was not sought during this evaluation, and has not been a requirement of users consulted during this study.

Help

The manual and on-line help files are very clear, and explain functions and dialogs to the user. The files are sometimes a bit too simplistic and for more complex applications could be a bit lacking in detail.

5.7.5 Conclusions

Surfer is a powerful contouring package, which is well liked by its users, and is relatively cheap. It does however have a number of disadvantages compared to the ESRI ArcView GIS system (with extensions). These include no facility to link to a data source, requiring complete re-import of data to incorporate changes, and limited search and data processing facilities within the software. The mapping and data presentation tools (frames, legends, scales etc.) are also limited compared to ArcView. It is considered appropriate for use for simple one-off contour mapping tasks, but probably unsuitable for long-term data presentation projects as required by the Agency national groundwater monitoring strategy.

6. RANKING OF STATISTICAL PACKAGES.

6.1 Overview

The ranking of statistical packages was carried out by Sandro Leidi and Professor Ian Wilson, of the Statistical Services Centre, University of Reading.

This report takes the form of an overview of the ranking exercise, and the recommendations arising from the ranking exercise, followed by more specific details regarding the individual packages.

The following packages were evaluated.

software	version	copy
STATISTICA	97	demo
CHEMSTAT	1.12	demo
SYSTAT	6.0	demo
Aardvark	2.2	demo
SPSS	8	working
SAS	6.12	working
MINITAB	12	working
S-Plus	4	working
EXCEL	97	working

6.1.1 Review Considerations

The review was carried out on a Pentium II PC-6266 Accelerator machine with 64 MB RAM, 4GB Hard disk, 266 Mhz speed .

The following features of the software reviewed were considered.

A: Specific requirements for statistical software

Ease of use by computer literate non-statisticians

We have included ease of data management and writing, saving and executing batch files with user specified commands for routine tasks.

Appropriateness of statistical methods for Agency Purposes

These are listed in the next section.

Validity of the above methods

Generally speaking, the theory behind the computational methodology used by any specific statistical software is sound, and minor differences do not cause conclusions about significance tests to differ. We have some reservations concerning EXCEL only.

Compatibility with other groundwater quality software

We have assessed in particular data import via Microsoft ACCESS and EXCEL, reporting via WORD and POWERPOINT, and compliance with the ODBC protocol.

Value for Money

The financial outlay to buy either annual or perpetual licence was assessed against the capabilities offered by each software.

B: Statistical exploratory tools and techniques defined as core data processing and presentation tasks

Boxplots, histograms and scatterplots

European Environment Agency regulations focus on graphical exploratory tools as the standard format for routine presentation of ground water quality data.

Time series plots to assess trends in time and seasonal cycles.

Given the nature of sample collection, time is a fundamental aspect that underlies trends and cycles in water quality data. As such, both aspects need accounting for when performing statistical analyses.

The 7 features above formed the core of the evaluation. Some more useful features were also evaluated.

Contour plotting

ArcView is a specialist GIS software package that can handle spatial representation of water quality levels. However, some statistical software has good capabilities for this and some uses geostatistics (e.g. kriging) to produce water quality maps by contour plotting. Geostatistics makes use of local information around sample points to extrapolate irregular geographic patterns.

Control charts: Cusum and Shewhart charts

Though not reviewed by Boak (1996), we believe that control charts are a valuable tool to compare visually current records from the same well with its baseline and past values. This is termed "within well" comparison (EPA, 1992).

Cluster analysis

This is a multivariate technique suitable for the identification of water types according to their chemical composition, as mentioned in Boak (1996).

Brushing - identification of individual records.

The identification of extreme values as compared to some compliance limit is of importance when visualising data. Brushing allows one or more points to be highlighted, usually in several data presentations.

Customised tables of summary statistics including percentiles

Specifically requested by the EUROWATERNET Guidelines for presentation of summary statistics for groundwater quality data, 2 features were reviewed. Firstly the ability to cross tabulate summaries according to, say, monitoring point and year, and secondly the ease of producing several percentiles from records as requested by the user. On top of this, domestic requirements by DoE's effluent compliance tables and the Urban Waste Water Treatment Directive for presentation of water quality data require Confidence Limits to be attached to percentiles to make allowance for sampling variability (Ellis *et al*, 1993)

As for other popular statistical analysis techniques, such as ANOVA (for testing differences between mean values of sampling wells) we have decided not to assess these, although their use is recommended by current US regulation by USEPA concerning landfill impact on groundwater quality (EPA, 1992). This is because the technique is inappropriate to take into account variation in time and space. Recent suggestions to account for spatial variation by considering variance components (Davis, 1994) focus unnecessarily on declaring statistical significance of determinand levels between single wells.

6.1.2 Method Of Assessment

The capability of each package to produce the desired output was tested by use of either their own example datafiles or by importing the same dataset across software packages whenever possible. For example, the same example file from SYSTAT, containing co-ordinates of latitude, longitude and uranium levels, was used to produce contour plots in S-Plus, MINITAB and SPSS, but not in STATISTICA, since importing data was not possible with its demo version. Compatibility with the MS Office Suite was tested by exporting output the quick way, using CUT & PASTE icons. On-line help files and manuals were consulted extensively to assess other features such as compliance with the ODBC protocol.

Ranking scoring system

The ranking system used a 5 point scale which rates each feature reviewed as follows:

rating	score
poor	1
fair	2
average	3
good	4
excellent	5

6.1.3 Preliminary Considerations

Most commands are accessible from the menus and dialogue boxes. However, some commands and options are available only by using the command language, which leads to a need to learn syntax for customisation of output. The command language allows jobs to be saved in a syntax file so that routine analysis can be run in an automated job.

Most standard statistical software automatically records commands specified via dialogue boxes in a temporary file called Command Log, which can be opened, its syntax edited and saved at any time during the session. Most software reviewed works this way, except for EXCEL (user must activate the macro recorder), and AARDVARK and CHEMSTAT that do not possess such feature.

The usual operating system of a proper statistical software packages keeps datasets, syntax, output and graphs each in separate windows. This not only promotes a clean way of exploring and analysing datasets, storing output and saving syntax for routine tasks, but also speeds up the process by considering separate columns as data structures simply by using either the column identity code or its title as the name of the vector of records below. What looks like a spreadsheet with the dataset in statistical software is actually just a rectangle for data editing and storage that works mostly in columns. Software not specifically designed with this purpose in mind, like the EXCEL spreadsheet, does not take this format and makes performing simple exploratory tasks cumbersome and slow.

None of the reviewed software has a feature to produce diagrams favoured by hydrogeologists, namely Durov, Schoeller and Piper diagrams. Only the software CHEMSTAT had the ability to represent measurements below detection limits as required by the data handling code of practice (NRA).

6.1.4 Software Evaluation

The results of the individual reviews carried out on the packages are collated in Sections F2 to F9. Two main features were assessed, and specifically the capabilities that are listed as subheadings below:

Ease of use by computer literate non-statisticians

- Writing and saving batch files with user specified commands for routine tasks.
- Data management

Appropriateness of statistical methods for environment agency purposes

- Geographical representation: kriging, contour plotting and map import
- Control charts
- Boxplots
- Time series plots and trend analysis

- Multivariate techniques - K means cluster analysis
- Non detected and detection limits
- Brushing - identification of individual records
- Customised tables of summary statistics including percentiles

The menu sequence is included in capitals to enable the reader to reproduce the same output, analysis or graph that was used to assess the above features.

Also the packages' compatibility with other standard ground water quality software was reviewed, in particular data entry via Microsoft Access and Excel and reporting with Word and Powerpoint. User licence prices were included and a final general evaluation was given for each package.

6.1.5 Summary Of Evaluation

For ease of use and learning a new package by a computer literate non-statistician, the packages MINITAB, SYSTAT and SPSS come top, but AARDVARK stands out, it being targeted at ground water data. We feel that S-Plus is better suited to research and SAS does not offer analysis tools on the pull down menu.

Plotting features for histograms, scatterplots and boxplots for exploratory and summary tasks are generally good, with SYSTAT and SPSS leading on boxplots.

AARDVARK offers an automated brushing facility highlighting extreme values compared to compliance standards as good as MINITAB's interactive brushing feature. Control charts feature well in most software. MINITAB and SAS offer additional interactive decision rules.

In regard to import-export of datasets from the EA databases, all software is ODBC compliant except for CHEMSTAT, SYSTAT and AARDVARK. These read ASCII files and some other less standard formats.

By its very nature, time series is a topic difficult to grasp, but the approach taken by AARDVARK is both theoretically simplest and visually more effective than all others. Other packages offer perhaps too general a range to enable a quick choice of the appropriate technique.

When it comes to importing maps and drawing contour lines, SYSTAT offers the best 3-D features with ample choice of current geostatistical techniques.

S-Plus has become linked recently with ArcView GIS.

Cross classification tables of summary statistics including all required percentiles can be produced best by SPSS and, less easily, by Excel. The table format is not common to output from other packages. However, Minitab is the only package that produces by default Confidence Limits for any percentile, a requirement likely to become the domestic standard for compliance purposes in future. Tables can be produced from its output, but in a rather convoluted way.

As for value for money a single user commercial licence for almost all packages costs well below £1,000 which is the price of AARDVARK. Adoption of SAS would cost in excess of a disproportionate £4,500.

We rather feel that software offering a huge range of capabilities, such as STATISTICA and S-Plus, can become confusing when the user has to decide which of the many available technique is appropriate.

We do not recommend EXCEL for statistical analysis, nor CHEMSTAT for data management and general plotting tasks. AARDVARK would be the ideal candidate if it included currently missing features such as boxplots, batch files, data management and the ODBC protocol.

6.1.6 Recommendations

Finally, top of our ranking exercise came MINITAB, followed by SYSTAT and STATISTICA in that order, but in our judgement no one statistical package will serve all needs. MINITAB is a straightforward package, much used in Universities and therefore familiar to many graduates. It is relatively easy to use for most general statistical purposes.

S-Plus has much more extensive capability for advanced users who can cope with its interface and benefit from its extensive programming language

AARDVARK has been designed for a more limited purpose than the other packages but what it does it does very well and it too deserves a place.

SAS is probably ruled out because it is hard to learn, cumbersome to use and expensive. EXCEL and CHEMSTAT are too limited and SYSTAT, STATISTICA and SPSS do not offer much advantage over MINITAB for general EA purposes.

Table F.1 : Results of the ranking exercise (Software packages are listed in order of decreasing capability from left to right)

Feature	Standard statistical packages						MS Office	Water quality statistics packages	
	Minitab	Systat	Statistica	SPSS	S-Plus	SAS	Excel	Aardvark	Chemstat
Ease of use	4	4	3	4	2	2	4	5	4
Batch files	4	4	4	5	4	4	3	1	1
Data mgmt	4	4	4	5	4	5	3	3	1
Histograms & scatterplots	5	5	5	5	4	5	3	5	1
Boxplots	4	5	4	5	4	4	1	1	3
Time series	4	4	4	4	4	5	1	5	3
Tabulation	4	3	3	5	3	1	3	3	3
ODBC compliance	5	4	5	5	5	5	5	4	2
Value for money	4	4	4	3	3	1	4	3	3
Sub-Total	38	37	36	41	33	33	27	30	21
Brushing	5	3	4	1	4	4	1	5	1
Control charts	5	4	4	4	4	5	1	5	3
Contour maps	3	5	4	1	4	2	1	1	1
Multivariate	4	4	4	4	4	4	1	1	1
Total	55	53	52	51	49	48	31	42	27

Ranking system: 1- poor; 2 - fair; 3 - average; 4 - good; 5 - excellent.

6.2 AARDVARK version 2.2

Developer: Water Research Centre, Henley Rd, Medmenham, Marlow SL7 2HD, UK.

6.2.1 Ease of use by computer literate non-statistician

Quick to learn because the restricted range of techniques available for analysis and illustration aids quick exploration of datasets. Choice of exploratory and statistical techniques is restricted to those relevant to water quality data.

There is no syntax to be learnt as a program window is not available.

Writing and saving batch files with user specified commands for routine tasks

No such capability is available.

Data management

None of the data manipulation for creation of new variables (e.g. restricting records selected by date of sampling, or output saved from analyses) seems to be added to the data sheet. No direct data input, can only retrieve it.

6.2.2 Appropriateness of statistical methods for Agency purposes

Geographical representation - kriging - contour plotting - maps

Not available.

Control charts

Cusum (Cumulative Sum) plots are the only control chart available under the SINGLE menu but they are explained very simply in the on-line help. There is an interactive display for assessing significance of Cusum slope which can be placed on each individual point.

Boxplots

Feature not available.

Time series plots & trend analysis

This section is well explained in simple terms in the on-line help and user manual, both in terms of seasonal fluctuations [a simple *sine-cosine* model] and long term trend. The feature of plotting one year on top of another is useful to check consistency of cycles over the years. Many topics of this features are exploratory and visualise clearly yearly means and highlight extreme values. Trend analysis has the capability of deciding where to place a turning-point if this can be identified at a specific point in time. Its treatment of this topic is excellent.

Multivariate techniques - K means cluster analysis

Not available.

Non detected and detection limits

Not available.

Brushing - identification of individual records

Strictly speaking not available, but it is automatically done by the HIGHLIGHT EXTREMES option under OPTIONS menu when using TIME SERIES plots.

Customised tables of summary statistics including percentiles

A limited feature available at the touch of an icon or under SINGLE> DETERMINAND SUMMARY gives 9 percentiles: 0,5,10,20,50,80,90,95,100. Not customisable, cannot be saved and isn't up to presentation standard. SINGLE> YEARLY STATISTICS is the output that comes closer to the Eurowaternet draft guidelines, although it just gives sample size, mean, stdev, min & max.

6.2.3 Compatibility with other Ground Water quality software

Not ODBC compliant, it can import and export data in ASCII format (delimited by spaces) and *.CSV (comma delimited).

6.2.4 User licence price

A single user licence costs £1,000. There is no distinction between academic and commercial licences.

6.2.5 Evaluation

Specifically tailored to illustrate water quality data, it takes into account that date/time of sampling is the most salient feature of this, providing routine exploratory methods for long series like the year-on-year plots. Also considers that the sampling intervals may not be regularly spaced. Descriptive statistics give histograms, time series and non-parametric estimates of quantiles automatically, the latter is handy to check against compliance limits that recognise variability. It's the only package that automatically highlights extreme raw values with reference to a compliance limit. Its histograms are customisable just in the way that matters statistically, without gimmicks, and allow choice of the 3 most common distributions of determinands.

The combined use of its Cusum Charts, Trend Analysis and Seasonality cycles is a must for the visual exploration of data collected over time. It also addresses the concept of revising the sampling frequency on the basis of the amount of variability observed from baseline and past data.

6.3 CHEMSTAT version 1.12

Developer: Scientific Software Group, P.O. Box 23041, Washington DC 20026-3041, USA.

6.3.1 Ease of use by computer literate non-statisticians

Fairly quick to learn through various short tutorials, it is frustrating because little is customisable and no command or programming language is available.

Does not have a separate worksheet window to view datasets, so data cannot be viewed.

Writing and saving batch files with user specified commands for routine tasks

No such facility, cannot save session commands.

Data management

Has been tested on data sets with up to 5,000 samples. It is possible to filter records by site, well suite, start and end date, but only at the import stage, that is, only a subset of the database will be imported. The filter works only on importing a new dataset. Thus the filtering of data subsets within CHEMSTAT cannot be done on any other variable than the WELL identifier, which is inconvenient.

6.3.2 Appropriateness of statistical methods for Agency purposes

Geographical representation - kriging - contour plotting - maps

No such facility.

Control charts

Only one control chart is available, a combined Cusum-Shewhart on USEPA recommendation. Its various parameters used to derive control limits can be changed by the user under OPTIONS>CONTROL CHART Options. This is for some users an advantage over other packages, where the user is baffled by a plethora of different control charts.

Boxplots

Box plots are adequate but not customisable, and they appear automatically once the menu is selected: there is no dialogue box, since columns are previously defined at import data stage. Very restrictive.

Time series plots & trend analysis

Very good output (though automatic, no dialogue box) since time axis is scaled to sampling interval length. Graph fills up its own window making the most of available space.

Multivariate techniques - K means cluster analysis

No such facility.

Non detected and detection limits

Specifically tailored for groundwater quality in accordance with USEPA regulations, it can represent non-detection by either DL or ½DL or 0, DL being the detection limit.

Brushing - identification of individual records

No such capability.

Customised tables of summary statistics including percentiles

Default tables under ANALYSIS> QUARTILES cannot be customised and are not produced to presentation standard. Poor.

6.3.3 Compatibility with other ground water quality software, in particular data entry via Microsoft Access-Excel and reporting with Word and Powerpoint

Paired with its own database ChemPoint, it can read only tab-delimited flat files in ASCII format and convert from GRITS/STAT format (a database developed by the Office of Solid Waste at USEPA). Datasets are saved in binary format thus cannot be read by a text editor.

The format for importing data is very strict, as it must contain identification for sampling date, well, hydraulic gradient of the well (upstream-background or downstream-compliance) and determinand analytical suite.

6.3.4 User licence price

A single user commercial licence costs $825 - £540.

6.3.5 Evaluation

It is highly specific to the sampling of groundwater from wells around a landfill site, so it uses the pertinent terminology and deals easily with real-life situations like replicate samples on the same date, non-detects, background vs compliance comparisons: there's even an icon to swap the hydraulic gradient of any identified well. The filtering system by well is also easy and relevant. The statistical tools available offer a restricted choice, tailored around USEPA regulation, possibly a good feature but with little room for manoeuvre.

However, it focuses too much on testing differences of means between wells by ANOVA. Importing data is also cumbersome and its data management capability is nil. In practice every dataset has to be imported from a database already formatted not only for the type of statistical analysis to implement but also for graphical investigation, which makes it very restrictive. Various features requested for EA purposes are missing, especially histograms and scatterplots.

6.4 MINITAB version 12

Developer: Minitab inc., 3081 Enterprise Drive, State College, PA 16801-3008 USA.

6.4.1 Ease of use by computer literate non-statisticians

Possibly the easiest of all the software packages reviewed, with a very comprehensive help file which, unlike other software packages presents exhaustive examples for obtaining the described output. Can produce analysis via the window menu first and the corresponding syntax is automatically pasted in WINDOW>HISTORY ready to be copied into a text file.

Writing and saving batch files with user specified commands for routine tasks

No in-built window that can be saved directly as syntax, but can be done by using a text editor and then invoking the resulting macro in the session. Must remember to save as a text file with a *.MAC extension. It's laborious.

Data management

Easy to derive data from existing sets even by use of complex formulae, which are readily available in the dialogue boxes under the CALC menu. Also the menu MANIP provides commands for many data management tasks, such as (re)coding, (un)stacking, ranking, sorting and concatenating.

6.4.2 Appropriateness of statistical methods for Agency purposes

Geographical representation - kriging - contour plotting - maps

2-D contour mapping is fairly good and easy to customise and the resulting contour maps are less cluttered than those of SYSTAT. However, it is unclear which method is being used for interpolation in areas not covered by the irregular grid of the sampling scheme. 3-D plots can be easily customised, which makes the graph less cluttered. Import of maps is not mentioned and presumably cannot be done.

Control charts

There are a large number, which makes the selection tricky. However, once the choice is made then help files with examples and the interactive use of decision - stopping rules is superb. Take CUSUM charts: if the optional decision mask is superimposed on the chart, it can be repositioned interactively, shifting it along the x axis. Parameters forming the mask can be rectified by the user. Guidelines on the choice of appropriate chart are given.

Boxplots

These can be fully customised in their appearance, including confidence intervals inside the boxes. To create boxplots for each group, you must also have a column of categorical data. The column of categorical data can be numeric, text, or date/time. Reference lines indicating compliance levels can be readily added. Raw records can be displayed too. Multiple boxplots of the same category split by a further second grouping variable cannot be overlaid on the same graph unless the data are unstacked in separate columns.

Time series plots & trend analysis

Good default plots, but it is assumed data are at equally spaced intervals even though a date/time x axis can be used. When dates are not equally spaced it suggests switching to a scatterplot instead. Can easily plot several time series in one graph.

The TREND ANALYSIS dialogue box under STATS>TIME SERIES has a choice of linear, quadratic and exponential trends, and can store residuals of de-trended data.

Multivariate techniques - K means cluster analysis

Many of the major techniques are available via the menu, named by the commonest name, with little room for confusion. Options for storage of output with all techniques. As for cluster analysis, user must specify the initial number of clusters and it is not obvious how to obtain a scatterplot of the raw data with a different symbol per cluster.

Non detected and detection limits

For less than/non detect records, under STAT > RELIABILITY/SURVIVAL > PARAMETRIC DISTRIBUTION, it gives estimates (also non-parametric) of the quantiles of a populations, with confidence intervals and a choice of 8 distributions.

Customised tables of summary statistics including percentiles

Generally a poor feature accessible via STATS> TABLES> CROSS TABULATION, with default statistics: mean, standard deviation and 0,25,50,75,100 percentiles, respectively named minimum, 1st quartile, median, 3rd quartile and maximum. A table cannot be stored in columns or report format. Can classify records by 2 categories (say year & monitoring point) but the dialogue box options to be clicked to do this are fiddly.

The pull-down menu cannot be used to find the non-parametric percentiles. The syntax: TALLY 'determinand'; CUMP (cumulative %); STORE C2 C3 is required. This will store the unique sorted values of the determinand in C2 and the corresponding percentiles in C3.

The sequence STAT> RELIABILITY/SURVIVAL> PARAMETRIC DISTRIBUTION ANALYSIS - ARBITRARY CENSORING gives by default many percentiles that can be saved in the worksheet and selected for presentation. The default table cannot be suppressed, only expanded! However, it does give confidence limits attached to percentiles for distributions and levels specified by the user. It has just 1 classifying factor to split records from the same borehole according to year, say. An example follows, but to import it into WORD as a table the selected cells must be copied into EXCEL first.

Percentiles for a log-normal distribution

		90%CI	
Percentile	estimate	lower	upper
50	31.0	41.2	52.8
70	37.7	54.4	70.8
75	39.8	58.7	77.2
80	42.4	63.8	85.1
90	49.8	79.1	110.5
95	57.0	94.2	137.7
99	73.3	129.9	209.1

6.4.3 Compatibility with other ground water quality software

It is fully compliant with the ODBC protocol, so can import data from databases such as Access, Oracle, Sybase and SAS. No problem importing text and figures into Powerpoint.

6.4.4 User licence price

The price of a single user commercial licence is $975 - £600, and a network licence depends on the number of users, information can be found on: http://www.minitab.com/products/pricing/coprilis.htm

6.4.5 Evaluation

The exploratory stage shows that its histograms and scatterplots are very good, better than its boxplots. Easy to learn, it produces superb control charts . Has good data management. It's a little laborious for batch files. Brushing produces an impressive display with individual identification of brushed points. Also an extra worksheet opens within the graph window displaying the entire row of records for brushed points. It is the only package that gives the relevant percentiles by default alongside their parametric confidence limits that can be specified by the user (90% as advised by NRA in Ellis *et al*, 1993). These can be formatted into tables and copied into WORD in a rather convoluted way that needs going via EXCEL first .

6.5 EXCEL '97

Developer: Microsoft Corporation

6.5.1 Ease of use by computer literate non-statisticians

At first glance it looks easy to use the menu choices, it soon turns out to be limited because graphs which appear are stored in the same window as the data unless requested to be placed in a separate sheet. It is not possible to produce a series of plots with the same customisation. It is deceptively easy to do data management via mouse: the end result is likely to be a jumble of data and the process is slow.

Writing and saving batch files with user specified commands for routine tasks

There is no automatic recording of syntax used unless a macro is being recorded. The syntax has many lines since areas of the spreadsheet that contain data must be selected and these will be different depending on the length of each data-set. The macro needs editing before re-using.

Data management

It carries some features of a database, such as check on input range (DATA>VALIDATION), but can only store flat data-set files. Unless using a macro, data management via the menu is somewhat limited. Highlighting of columns, shifting and dragging is simply not an option, since it does not keep a record of what was done unless a macro is being recorded. Does not recognise columns as data structures - vectors.

6.5.2 Appropriateness of statistical methods for Agency purposes

Geographical representation - kriging - contour plotting - maps

Its 2-D and 3-D graphing capabilities are good as they are interactive and a limited selection of default maps are available by selecting a toolbar icon. No importing of maps of interest from an archive is mentioned in its help files. No contour plotting by smoothing over an irregular grid is available.

Control charts

No such capability.

Boxplots

No such capability.

Time series plots & trend analysis

No such capability.

Multivariate techniques - K means cluster analysis

No such capability.

Non detected and detection limits

No such capability.

Brushing - identification of individual records

Very limited as the symbol for each case has to be edited individually. There is no visual link between the brushed case and the area of the spreadsheet containing the data.

Customised tables of summary statistics including percentiles

By using the sequence DATA> PIVOT TABLE REPORT it is easy to construct a table like the one below with minimum rearranging of the default table output. A short macro could be recorded to request that the desired statistics of routinely collected data are arranged in columns.

		Data			
sample site	year	mean	stdev	min	max
1	1983	2.69	0.25	2.31	3.02
	1984	2.66	0.19	2.39	2.89
	1985	2.45	0.47	1.70	3.10
2	1983	2.27	0.37	1.85	3.00
	1984	2.27	0.24	1.73	2.58
	1985	2.35	0.37	1.90	2.91
3	1983	2.53	0.23	2.24	2.90
	1984	2.91	0.31	2.16	3.33
	1985	2.62	0.39	1.98	3.09

The table shows 2 percentiles only: it is not obvious how to insert all desired summary statistics directly from the PIVOT TABLE menu, which has a list of available summaries but apparently no more than minimum and maximum in terms of percentiles.

							PERCENTILES								
site	**year**	**mean**	**sd**	**min**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**95**	**max**
1		2.52	0.37	1.70	2.02	2.16	2.33	2.43	2.50	2.66	2.81	2.87	3.00	3.06	3.33
2		2.56	0.32	1.85	2.10	2.29	2.40	2.49	2.57	2.66	2.75	2.84	2.96	3.01	3.15
3		2.61	0.33	1.79	2.17	2.32	2.44	2.53	2.60	2.74	2.82	2.88	3.05	3.09	3.37

The table above was produced by substantial cutting & pasting of the formula PERCENTILES available under INSERT> FORMULA> STATISTICS menu. Again it is not clear how to cross classify by SITE and YEAR without using DATA> PIVOT TABLE REPORT. Notice that in the example by Eurowaternet, the table above is not a cross tabulation, but it looks like records have been stored in separate columns.

6.5.3 Compatibility with other ground water quality software

It is fully compliant with ODBC protocol.

6.5.4 User licence price

One single commercial user copy costs $400, about £250.

Prices of Office97 suite can be found on:

http://www.microsoft.com/office/office/pricing.asp?prev=111111

6.5.5 Evaluation

To perform any statistical analysis an add-in module must be added by selecting TOOL>ADD-INS>ANALYSIS TOOLPACK, which has a limited range of statistical techniques. Despite it combining WORD and ACCESS in the Microsoft Office suite we advise strongly against using it for data management purposes, including Exploratory data analysis. Its scatterplots are OK, but histograms are lengthy to obtain via TOOLS > DATA ANALYSIS > HISTOGRAM: the chart output is unusual in that bars are separate and the bin-interval has to be pre-specified by the user.

The validity of its methodology is sometimes questionable, as well as its required arrangement of datasets for almost all standard analyses, which is rather unusual. Its output appears in the same window as the dataset and is of difficult interpretation since it does not preserve the original names of columns.

6.6 SAS version 6.12

Developer: SAS Institute inc., Cary, NC 27513, USA.

6.6.1 Ease of use by computer-literate non-statisticians

Despite working in a windows environment, its pull down menu concerns the setting of global options and customisation of the computer environment set-up and not data exploration or analysis. Consequently basic tasks such as importing data-sets and producing histograms become arduous because syntax needs to be used. Icons on the toolbar are mainly for managing files and editing output. Its procedures are very flexible but as there are no dialogue boxes the syntax must be found on the on-line documentation which is so huge to the point of being confusing, or from reading a plethora of user manuals. Wrongly placed quotes cause many headaches for no obvious reason.

Writing and saving batch files with user specified commands for routine tasks

The commonest way of using SAS is by typing commands in the program editor window and running the program from it. Macros containing arguments can be easily written within the program editor around a finished piece of syntax, saved in an internal directory called 'library' and invoked by filename preceded by an % sign. However, for the employee untrained as a computer programmer just grasping the concept of how this is done is no mean task.

Data management

Possibly the most capable package of all, by its various flexible procedures it is possible to select specific blocks of data to import from a spreadsheet, transpose, merge, re-code etc., thanks to a sophisticated use of logical operators.

6.6.2 Appropriateness of statistical methods for Agency purposes

Geographical representation - kriging - contour plotting - maps

There are a wide selection of maps available by default in its own libraries and levels of measured water quality parameters can be displayed in the same format as reported in the BGS document.

However, contour maps on an irregularly sampled grid can only be done providing there are not many empty spaces left on the regular grid set up by default. If so, then manuals advise estimating the missing values by interpolation via the G3DGRID procedure to save in a new dataset and return to the GCONTOUR procedure. This is a most unsatisfactory way of proceeding.

Control charts

Contained in the QC (Quality Control) module, all types of control charts are available including the mask for the decision rule, as in MINITAB, but it isn't interactive.

Boxplots

Peculiar to the GRAPH module, the user has to specify the type of plot before invoking the GPLOT syntax; the option INTERPOLATION=BOX belongs to the symbol statement in the GOPTIONS line, which is not a procedure but re-sets the default type of plot. Despite the many options available which allow a full customisation, it takes a long time to find this out from manuals, most time consuming.

Time series plots & trend analysis

The plotting of multiple series can be done with the GPLOT procedure and date/time variables on the x axis are easily plotted at their actual intervals. Reference lines for compliance levels can be added. However, any other TS basic technique can only be done with procedures from the ETS (Time Series) module, including autocorrelation at various lags to check the length of seasonal cycles and cross correlations given as options in the IDENTIFY statement of PROC ARIMA. There is also a procedure TIMEPLOT though its advantages over GPLOT are not obvious.

Multivariate techniques - K means cluster analysis

The good flexibility of MODECLUS with its K= n option specifying the desired number of clusters is typical of SAS.

Non detected and detection limits

The LIFEREG procedure allows use of non detected records (less than) and by the OUTPUT statement the user can request predicted fitted values and estimated quantiles of the population.

Brushing - identification of individual records

This feature is available in the separate INSIGHT module, but this is a limited subset of the software.

Customised tables of summary statistics including percentiles

It is possible to produce very detailed tables customised by the user, obtaining the desired statistics via PROC UNIVARIATE, that gives by default 11 quantiles, namely 0,1,5,10,25,50,75,90,95,99,100 percentiles. However, the programming has to be done in a separate file and both the storage of the default statistics and the syntax needed to specify the table layout are fiddly.

6.6.3 Compatibility with other ground water quality software

Exporting graphs into the MS Office pair can only be done by creating a graphic metafile (*.CGM) that takes up lots of space or by capturing the image with a browser like Paint Shop Pro, since the usual COPY&PASTE shortcut cannot be used. Even copying from the output window is a lengthy procedure; either we copy relevant chunks and paste them one below the other, or export the entire output file and then do the editing in WORD or Powerpoint. Fully compliant with ODBC protocol it can load data in DB2, DB2/2, DB2/6000, and ORACLE format.

6.6.4 User licence price

Obtaining all required modules would cost about £4,500 + VAT for a single user commercial licence for the first year and a little less than half this much for subsequent years.

6.6.5 Evaluation

Besides the core modules, the user needs to buy additional modules for time series, control charts and brushing: this adds onto the already large initial financial layout, because every module is licensed separately, so there is a corresponding manual for every module.

Unless the modules are bought, the relevant on-line help cannot be accessed.

It is a non starter because of the complexity of its operating system, lack of proper pull down menu and its very expensive licence cost.

6.7 S-Plus version 4.0

Developer: Mathsoft International, Bagshot, Surrey GU19 5AQ, UK.

6.7.1 Ease of use by computer-literate non-statisticians

Despite having a pull down menu, it is baffling when first used because the user is required to specify almost all the desired output in advance, even for simple scatterplots. The vast choice can be a hindrance to the non-initiated: all types of plots come under the same menu, listed in alphabetical order. It takes some time to go half way down to, say, histograms. It also uses statistical jargon that could put off users; matrix for a dataset, vector for single columns and so on. The help system is equally huge, for example searching by the key-word 'time series' yields as many as 68 topics. Help files use technical jargon again and give no examples, which are only found in user manuals.

Writing and saving batch files with user specified commands for routine tasks

The syntax used is stored in the HISTORY window separately from the program window, which is where the output is. Separate command files for routine tasks can be created by using text editor commands such as FIX and EDIT and saved as text files known as 'functions'. Syntax used via menu can be copied and pasted from the WINDOW>HISTORY window. Functions must then be invoked (sourced) from the command window. The format of these functions is very flexible, but to understand it takes a while, as well as working out where such batch files are stored.

Data management

Storing imported data can be confusing as datasets become objects known as 'data frames' on which calculations cannot be performed, unless changed to become matrices. Once mastered its own language, it becomes powerful, working equally well on rows as on columns. Its own object browser is very handy to view quickly the content of each window.

6.7.2 Appropriateness of statistical methods for Agency purposes

Geographical representation - kriging - contour plotting - maps

Very promising, especially now that an extension as S+ for ArcView GIS software has become available (http://www.mathsoft.com/splus/splsprod/ arcview.htm). The 2-D contour plots available on the menu interpolates by default over areas not covered by irregular sampling grids, but it produces unconvincing results. It is not obvious how to add sampling locations and their groupings on the graph.

Control charts

These are not available via the menu: the user has to know that functions named CUSUM and SHEWHART can be invoked. Moreover, datasets cannot be used as they are but must be transformed into new 'objects' by computing group summary statistics using the function QCC(quality control charts), prior to creating the relevant control charts.

Boxplots

Fully customisable multiple boxplots. Unclear if it can produce multiple boxes per category according to a third cross-classifying variable as SYSTAT can.

Time series plots & trend analysis

Just as for control charts, datasets must be transformed into time series 'objects' before the function TSPLOT (not on the menu) can be used, since the menu choice only offers scatterplots that appear by default in the dialogue box TIME SERIES PLOT under GRAPHS. Unclear even in the HELP index where to find the option for analysis of trends in time series.

Multivariate techniques - K means cluster analysis

It has a function KMEANS available, described on HELP>CLUSTER index but it isn't available on the pull down menu.

Non detected and detection limits

No such capability, though it could be easily customised to deal with non detection records.

Brushing - identification of individual records

Quite easy to use, with case identification number appearing on the plot itself and a small window with just the case number (less handy than MINITAB)., One goes directly into GRAPH> BRUSH&SPIN which gives a scatterplot by default, rather than producing a graph first and then activating the brushing feature. Also the scales on axes don't appear by default but must be added manually.

Customised tables of summary statistics including percentiles

From the pull down menu STATISTICS> DATA SUMMARIES, the Summary Statistics or Cross Tabulations are of limited customisation. However, by using commands, the function QUANTILES gives 5 quantiles by default and can be customised to return as many quantiles as specified by the user. These are found via the function APPLY and stored for the elaboration of 2 way tables (function CROSSTABS), say, by year and borehole. The latter however, is not of easy use.

Compatibility with other ground water quality software

It is fully ODBC compliant, and can also export datasets compatible with ACCESS,ASCII, DBASE, EXCEL, FASCII, GAUSS, LOTUS, MATLAB, ODBC, PARADOX, QUATTRO, SAS, SAS TPT, SPLUS, SIGMAPLOT, SPSS, SPSS POR, STATA, SYSTAT.

A PowerPoint presentation icon is available on the toolbar and it gives direct access to this MS package for inclusion of S-Plus objects.

6.7.3 User licence price

A single user licence for an academic user licence which includes one year maintenance is £602 + VAT, just over £700.

6.7.4 Evaluation

Once its own language and workings have been learnt, it is a software package that matches excellent exploratory visual tools with modern statistical analyses. The latter feature is more suited to researchers than to routine presentation of results by non-statisticians. A time consuming aspect of the pull down menu is that the dialogue boxes are cleared after every clicking of OK; so the same variables have to be re-selected every time when wanting to reproduce the same graph with only slight alterations.

6.8 SPSS version 8

Developer: SPSS inc.,

6.8.1 Ease of use by computer-literate non-statisticians

Clicking the right button on the mouse when the arrow is pointing to any element inside a dialogue box provides a description of that single item that needs specifying, without ever leaving the dialogue box - directly activating an extra help window. Very useful. Does not use jargon, but simple terminology like in 2-way tables groups are defined as 'down' and 'across'.

.1 Writing and saving batch files with user specified commands for routine tasks

By just clicking on the PASTE button that appear in every dialogue box, the syntax appears in the SYNTAX EDITOR window. This can be edited and saved very simply in any directory, the dialogue box indicating clearly that it is a syntax file. Can be reopened and run quickly by clicking on a toolbar icon. Very comfortable as it is an internal window.

.2 Data management

Limited only by flat files, manipulation of dataset is almost as good as that of a database, with record selection, filtering of subgroups, sorting, transposing of columns into rows, merging and splitting files and variable aggregation.

6.8.2 Appropriateness of statistical methods for Agency purposes

Geographical representation - kriging - contour plotting - maps

Contour plotting is not available from the menu, using the syntax only produces character plots instead of high resolution graphs. Maps import is not mentioned in the help system.

Control charts

All those of standard use are available on the menu GRAPHS>CONTROL, with good description in the help files. It contains an option for specification of parameters for control limits. No mask available as stopping rule.

Boxplots

Sleek menu choice that goes straight to very informative boxplots, sample size of every box is shown by default. Clustered boxplots are one of the options. It is possible to plot different y variables on the same plot too, they appear side by side. Case number of outliers appear by default, as well as a summary table just above the boxplots, very handy.

Time series plots & trend analysis

Takes some time to discover that standard time series plot are available under GRAPH>SEQUENCE instead of TIME SERIES, but multiple series can be plotted on the same graph together and a date/time variable can be easily specified for the x axis. Trend analysis, defined as long-term changes in the level of a series, is removed by the differencing transformation, which is not very intuitive to a non-statistician.

Multivariate techniques - K means cluster analysis

All the most common techniques are available, but unfortunately are scattered over different choices of the STATS menu. K-MEANS CLUSTERS is under CLASSIFY, model based are under GLM, PCA (Principal Component Analysis) is the default EXTRACT method for FACTOR under the DATA REDUCTION main option. Their output is good.

Non detected and detection limits

Unclear if left censoring could be accounted for by one of the techniques available under STATS> SURVIVAL.

Brushing - identification of individual records

Such feature does not appear to be available.

Customised tables of summary statistics including percentiles

The table below is very close to the required specifications, except for formatting the decimal places of classifying factors. It was done entirely via dialogue boxes available in the menu, and copied directly and briefly edited in WORD 6. The menu sequence is STATISTICS> CUSTOM TABLES> BASIC TABLES, select WELL and YEAR in the 'subgroups down' box and DETERMINAND in the 'summary' box. Then select the many summary statistics available: counts, mean, stdev, min, max, percentiles available are just fine: 0,5,25,50,75,90,95,100. 95 & 99 do not appear, presumably because the method of interpolation using a sample size of 10 is too small to derive such high percentiles. One percentile can be requested and specified by the user, most useful would be the 90th percentile.

Well	Year	Count	Mean	Stdev	Min	25	Median	75	95	99	Max
1.00	1983	10	2.69	.25	2.31	2.38	2.80	2.86	.	.	3.02
	1984	11	2.66	.19	2.39	2.42	2.68	2.85	.	.	2.89
	1985	11	2.45	.47	1.70	2.07	2.46	2.88	.	.	3.10
2.00	1983	11	2.27	.37	1.85	1.93	2.18	2.56	.	.	3.00
	1984	11	2.27	.24	1.73	2.16	2.29	2.46	.	.	2.58
	1985	11	2.35	.37	1.90	2.03	2.29	2.66	.	.	2.91
	1985	11	2.35	.37	1.90	2.03	2.29	2.66	.	.	2.91
3.00	1983	10	2.53	.23	2.24	2.32	2.48	2.77	.	.	2.90
3.00	1983	10	2.53	.23	2.24	2.32	2.48	2.77	.	.	2.90

1984	10	2.91	.31	2.16	2.80	2.96	3.11	.	.	3.33
1985	10	2.62	.39	1.98	2.34	2.68	3.02	.	.	3.09

It is the cross tabulation table obtained with the minimum effort and up to presentation standards. If data are to be imported from spreadsheets, remember that SPSS 8 can only import data from EXCEL no later than version 4.

6.8.3 Compatibility with other ground water quality software

It is fully ODBC compliant, with an comprehensive description of related topics in HELP. Can import files from Systat, Excel, Lotus, dBase, tab-delimited and ASCII. Quick export of output and graphs to Word and Powerpoint.

6.8.4 User licence price

A single user commercial licence of SPSS 8 base module costs £800 + VAT. Additional modules at £300 + VAT may or may not be needed.

6.8.5 Evaluation

As it avoids statistical jargon it is very easy to learn through the very user friendly dialogue boxes. It has superb data management capabilities, with simple customisation of routine tasks by batch files. Excellent visual exploratory tools except for time series and contour plots.

6.9 STATISTICA version '97

Developer: Statsoft inc, 2300 East 14th St., Tulsa OK 74014 USA.

6.9.1 Ease of use by computer-literate non-statisticians

The HELP system is comprehensive and contains examples in the same way as MINITAB does. Its syntax is not that difficult to learn: it isn't case sensitive and explanatory comments are added in curly brackets However, the feature of taking commands being used via the menu and pasting them into a syntax window, which constitute a headstart in linking syntax with type of output produced, is missing. Its dialogue boxes are cluttered with too many options.

Writing and saving batch files with user specified commands for routine tasks

Recorded easily either as a sequence of keystrokes or as a proper syntax language. The relevant one is SCL, Statistical Command Language. Can be built up quickly since there are dialogue boxes offering default syntax for any type of graph and standard statistical functions and analysis techniques. There is a useful VERIFY button under the ANALYSIS menu, that checks the syntax window before executing the command.

Data management

The data sheet has almost all the features of an EXCEL spreadsheet such as drop&drag, fill; far from being a must, this could tempt users to tamper with data integrity. On the other hand output from analyses is automatically stored in scrollsheets in a tabulated form, ready for further calculations. This is very handy for correlation matrices in which significant coefficients are marked in red. It has a filtering feature much the same as SPSS, and sorting, transposing, ranking, recoding and, uniquely, lagging a variable both forward and backward.

6.9.2 Appropriateness of statistical methods for Agency purposes

Geographical representation - kriging - contour plotting - maps

Kriging is not specifically available as a smoother in the 3-D XYZ SURFACE and CONTOUR Graphs menu, though it could be specified by the user. The number of contour lines isn't available either in the initial dialogue box. The default number of 10 must be rectified by double clicking on the finished graph, which is inconvenient. Taking an EXCEL graph into a STATISTICA blank graph worked very well and text could be added around it. Presumably the same can be done with maps that are OLE (object linking & embedding) compliant.

Control charts

Contained in a separate module that must be switched on via ANALYSIS -> OTHER STATISTICS, this was not included in our demo. Judging by the relevant animated demo, control charts can be fully customisable, but there is no mention of the V-mask for stopping rule. It would be slightly confusing having to switch stat module, as would be the massive number of available charts and HELP files for modifying specifications.

Boxplots

Can produce boxplots according to 2 grouping categories, but does not display them in a clustered fashion as in SPSS & SYSTAT, but in separate plots side by side. This does not help the intra-category comparison much.

Time series plots & trend analysis

A simple and straightforward TIME SERIES PLOTS option is missing from the GRAPHS menu, so one is forced to use line graphs that can accommodate multiple variables. Alternatively the ANALYSIS module must be switched to TIME SERIES, which was not available on the demo.

Multivariate techniques - K means cluster analysis

Available under the CLUSTER module not in the demo, works in a similar way to other software with this capability.

Non detected and detection limits

Non detected values are specifically explained in one of the HELP files for the module SURVIVAL (referred to as 'left-censored', which stands for 'less than'), so it should be able to cope with this aspect.

Brushing - identification of individual records

Available on the toolbar button BRUSHING TOOL, this feature is animated, the rectangles drawn on areas to highlight move left to right, working even on matrix plots where brushed cases show simultaneously on all plots. However, animation is just a gimmick: compared to MINITAB that shows the entire set of measurements belonging to the brushed points on a separate small worksheet, STATISTICA only highlights the selected cases in red on a scrollsheet by clicking the mouse right button and selecting EDIT GRAPH DATA.

Customised tables of summary statistics including percentiles

Under ANALYSIS> FREQUENCY TABLES> FREQUENCY TABLES in our demo descriptive statistics are in some respect better than Minitab 12 since the cumulative frequency of the variable described go directly into a separate spreadsheet, but one cannot do a cumulative frequency plot since the variable values become row headings. As for user specified percentiles, under DESCRIPTIVE STATS> MORE STATS, the dialogue box says these are available in the same option of the non-parametric module. This can be switched on in a fully operating licence only but not in a demo version like ours. Nor was it possible to check quality of tables since the COPY option was not available for pasting into WORD 6.

6.9.3 Compatibility with other ground water quality software

Fully compliant with ODBC protocol.

6.9.4 User licence price

A single user commercial licence costs £800 + VAT. A version called QUICK STATISTICA with a selection of basic statistics and the full set of graphical feature costs £400 + VAT.

6.9.5 Evaluation

As the demo copy did not allow the COPY, PRINT and SAVE options for any output or graph we could not produce examples. These look OK on the screen and as the flying menu activated by the right hand button on the mouse has the option COPY GRAPH it is presumably possible to paste into WORD. The fact that there are so many options to customise output in the dialogue boxes is a hindrance when it comes to specifying any. It feels more of a data mining and Exploratory Data Analysis software package than one for standard statistical output. The concept of having to switch modules to go into quality control charts, time series and 2-way ANOVA adds a further layer to complication of choice of statistical procedure.

6.10 SYSTAT version 6.0

Developer: SPSS inc.,

6.10.1 Ease of use by computer-literate non-statisticians

The demo has examples for as many as 11 applications. Can be done by writing syntax and saving it in a command file that is submitted separately. The PLOT COMMANDS Help File gives a comprehensive list of all options that can be used to customise the contour line output. The demo example for the geological application indeed concerns groundwater quality measurements and is very relevant. Programming language is fairly easy to grasp.

Writing and saving batch files with user specified commands for routine tasks

It records commands you specify via dialogue boxes during the current session in a temporary file called Command Log, which can be opened, edited, and saved at any time during a session. The command log records only the commands from your current session and can be accessed via the long menu sequence WINDOW> COMMAND EDITOR> FILE> OPEN COMMAND LOG. Can be re-run by submitting the whole window once the command log file is opened again.

A command file is a text file that contains SYSTAT commands. Saving your analyses in a command file allows you to repeat them at a later date.

You can create a command file by typing commands in the Command Editor, or by making selections in the menus and dialogue boxes and then editing the resulting command log or output file. (To display commands in output, the command prompt must be on.)

Data management

Similarly to SPSS, its data management capabilities are very good, with sorting, merging, transposing, labelling and definition of variables as categories. It is possible to select a subset of records according to logical operators via dialogue boxes.

6.10.2 Appropriateness of statistical methods for Agency purposes

Geographical representation - kriging - contour plotting - maps

2-D representation - contour plotting is straightforward by using PLOT commands combined with a smoothing function such as kriging (normally intended for geostatistics). Neither is the syntax for 3-D plotting over an irregularly sampled grid of particular difficulty as there is a very clear example in the demo. Maps of Western Europe are available on CD. Allegedly version 8 can import map and data files directly from ArcView, a GIS software package.

Control charts

A very comprehensive battery which includes Cusum and Shewhart charts for 8 different distributions. Also ARL curves can be plotted derived from raw data collected. With QC charts the control limits that one usually specifies as some multiple of sigma, can be specified as probabilistic limits derived from a distribution most appropriate to the chart. Accessible from the menu GRAPHS>QUALITY CONTROL CHARTS. For CUSUM charts it has no stopping rule, i.e. no 'mask'.

Boxplots

Customisable boxplots are available for single and multiple responses overlaid in a single graph. Boxplots can be clustered according to an extra grouping category, this feature is only seen in its sister software SPSS.

Time series plots and trend analysis

It has a fairly complete battery not only of time series plots but also statistical functions like Auto Correlation Function to check existence and strength of seasonal/cyclic patterns, Cross Correlation Function to check association between separate sampling points. Time labels can be specified easily for display, something tricky in other packages. Plots can be created with in-built seasonal adjustment and also with a Fourier transform, which is the natural tool to investigate fluctuation in the frequency domain. Lots of transformations are available, such as removing the overall mean, trend, differencing and taking natural logs. As usual records are assumed to be taken at equally spaced time intervals. No trend analysis available in this menu. Several series in the same graph can only be plotted using scatterplot and not time series plots.

Multivariate techniques - K means cluster analysis

Under the menu STATS>CLUSTER ANALYSIS the choice of K-means clustering can split the datasets into smaller clusters. Some difficulty arises in that the number of clusters to be obtained has to be specified by the user in advance, so the operator ought to guess the final outcome. The new division identifiers can be saved in a separate datafile. There is a QUICK GRAPH option linked to the procedure that produces graphic representation of the original set now split into new clusters. Output displays min-max, mean and standard deviation beside every cluster, very useful for characterising newly formed groups.

Brushing - identifying individual cases visually

On the graph toolbar it has 3 options to select individual cases, select subsets of cases, and highlight selected cases. The case identification tool displays the case number for the selected case in the Graph window status bar (bottom right hand corner) only while the mouse button is held down and highlights the case in the Data window. The REGION and LASSO selection tools select subsets of cases for further analysis. All subsequent graphs and statistical procedures are restricted to these cases. Selection tools are available only for scatterplots.

Customised tables of summary statistics including percentiles

Tables can be saved in a separate file for inclusion in reports, but suffer from a very restricted customisation in the dialogue boxes of the STATS> CROSS TABS menu. Only 3 Percentiles are offered: min, median, max. Lower and upper quartiles aren't given.

Compatibility with other ground water quality software

Had no problem copying and pasting output into Word and Powerpoint, the latter much more professional looking. For 3-D graphs needing much space they sometimes cannot be displayed fully on the screen but are printed OK, with the exception of white foreground colour changing to a shade of grey.

The IMPORT command translates SPSS, Excel, Lotus, Symphony, dBase2-3-4 (from Access), DIF, map, and formatted ASCII text files into SYSTAT data files. Optional varlist lists the names of the variables (fields, columns) to import, the default is all variables in the file. Does not mention ODBC compliance specifically.

6.10.3 User licence price

A single user commercial copy costs £600 +VAT, and a network copy for commercial users is £1,170 + VAT.

6.10.4 Evaluation

Very good on the contour mapping side, less so on the ODBC front. Very good data management, very easy to learn considering it was the first time I had seen it. Strong on boxplots, less so on control charts, trend analysis of time series and brushing. Good scatterplots and histograms are easy to produce.

7. SOFTWARE COST ESTIMATES

7.1 Aquachem

7.2 Aardvark

7.3 ESRI Packages - ArcView 3.1, Spatial Analyst and 3D Analyst

7.4 Minitab

To: JANE THRASHER@GIBB.LAW (JANE THRASHER)
From: SCISOFTW@C2SMTP (Scientific Software Group){scisoftware@scisoftware.com}
Subject: Re: Aquachem Costs
Date sent: 30-Oct-98 18:57:50 +0000

Hi Jane,

Thanks for your message.á Yes, that is correct, the new version of Aquachem will be Year 2000 Compliant and is due to release in March, 1999.áá The Cost of
Upgrading to the new version has not yet been determined.á However, we have made a special arrangement for you.
When you purchase 40 Copies from us, in addition to your gov't & volume discount, we will issue Free Upgrades for all 40 Copies.á The Cost to the Agency would be $0.

Here is the price breakdown for 40 separate offices with one license of AquaChem for Windows 95/NT per office.

Regular Unit Price for AquaChem:á US$595
Government Discount:ááá 15%
New Unit Price: US$505.75

Total Price for 40 Different offices is 40 X US$505.75 = US$20,230.00

Based on the fact that you will be purchasing 40 copies, an additional 10% discount can be applied for this quote.á Therefore the final total, excluding shipping is US$18,207.00.

40 Copies of AQUACHEM $ 18,207.00
International Shipping (Federal Express) $ 250.00
TOTAL $ 18,457.00
á
These prices include a free upgrade to AquaChem 3.6 (Year 2000 Compliant) all International Shipping/Handling via Federal Express, all manuals/documentation,
and unlimited technical support.

Keep me posted on the situation, and if you have any questions, don't hesitate to contact me.

Kind Regards,
Chris

At 02:35 PM 10/28/98 +0000, you wrote:
>Chris Hardy
>Hydrology, Air and Other Environmental Software
>Scientific Software Group
>
>Dear Chris
>
>We have virtually completed our evaluation of the software for water
>quality data processing and presentation for the UK Environment
>Agency.á Thank you very much for your assistance in supplying us with
>evaluation copies of Aquachem and Chemstat, and we will be returning
>them to you very soon. (Please accept our apologies for keeping then
>for slightly longer than expected).
>

>Although we have some reservations regarding Aquachem 3.6 (including
>problems with installation and lack of Year 2000 compliance) we will
>be recommending the package to the Environment Agency as the package
>most appropriate to their needs for some tasks.á
>
>We would be grateful if you could supply us with an indication of the
>costs of installing Aquachem in the Agency.á The Agency would be
>looking to purchase copies of the software for 40 users, mainly for
>single users in individual area offices (i.e. not connected by a
>single network).á
>
>We understand from you that a new version of Aquachem (which will be
>Year 2000 compatible) is due for release in March 1999.á What will be
>the arrangement for users who purchase Version 3.6 between now and the
>release of the new version.á Please supply us with the expected cost
>to the Agency of any upgrade, and of the new release.
>
>We will not be recommending Chemstat to the Environment Agency.
>
>Thank you again
>
>Jane Thrasher
>Project Manager
>
>Gibb Ltd
>Gibb House
>London Road
>Reading RG6 1BL
>England
>
>Telephone +44 (0) 118 963 5000
>Fax +44 (0) 118 963 5290
>Email jthrashe@gibb.co.uk
>

Hydrology, Air & Other Env Software
Scientific Software Group
P.O. Box 23041
Washington, DC 20026-3041
e-mail: info@scisoftware.com
http://www.scisoftware.com
Ph:(703) 620-9214 Fax:(703) 620-6793

WRc

AARDVARK PRICE LIST

Stand-alone version

The licence price for the stand-alone version is £950 per copy, with special discounts for bulk purchases for five or ten PCs.

Licence prices for stand-alone version:

Single copy	£950		Discount
Packet of five	£4250	(£850 each)	£500
Packet of ten	£7500	(£750 each)	£2000

Network version

The licence price for the network version is £1000 per concurrent user, subject to a minimum price of £5000 per network server.

Support

All purchasers are entitled to three months' free software support, maintenance and minor upgrades, with annual follow-up costs thereafter of £100 per licensed user.

Contact

Teresa Francis
WRc plc
Henley Road
Medmenham
Marlow
Bucks, SL7 2HD

Tel: 01491 571531
Fax: 01491 579094
e-mail. Francis@wrcplc.co.uk

April 1996

From:	**Self <RDG10/JTHRASHE>**
To:	**mail@C2SMTP{deshughes@compuserve.com}**
Subject:	**3D Analyst costs**
Date sent:	**Wed, 28 Oct 1998 15:01:01**

Des Hughes
Environment Agency Account Manager
ESRI

Dear Des

We have virtually completed our evaluation of the software for groundwater quality data processing and presentation for the UK Environment Agency. Thank you very much for your assistance in getting Kara to supply us with evaluation copies of Spatial Analyst and 3D Analyst.

It looks very much as if we will be recommending the combination of ArcView 3.1 and 3D Analyst as the standard software package for water quality data mapping and contouring. The Agency would like to have an indication of costs involved, and we would be grateful if you could supply us with appropriate information.

Out project manager in the Agency has asked us to provide indicative costs for supply of software for 40 users, spread out between the 26 regional offices and national centres (i.e. not all on a single network). I understand that ArcView 3.1 is already quite widely installed within the Agency, but without 3D Analyst.

Our evaluation indicates that the groundwater quality data processing and presentation tasks required by the Agency can be completed by the combination of ArcView with 3D Analyst, without the requirement for Spatial Analyst, and we do not anticipate recommending the additional add-on.

Thank you again

Jane Thrasher
Project Manager

Gibb Ltd
Gibb House
London Road
Reading RG6 1BL
England

Telephone	+44 (0) 118 963 5000
Fax	+44 (0) 118 963 5290
Email	jthrashe@gibb.co.uk

Thrasher,Jane

From: Des Hughes [DESHUGHE@C2SMTP (Des Hughes)<deshughes@compuserve.com>]
Sent: 07 January 1999 10:39
To: Thrasher,Jane; Maillog_UK
Subject: EA Groundwater modelling

Jane, I am obviously pleased that your evaluation concluded that EA should purchase lots of our software!! I am unfortunately not able to provide you with EA prices for inclusion in your report since these are strictly confidential between ESRI (UK) and EA. I therefore believe that you will need to list quantities and product names and get EA to do the maths themselves.

Should you wish to reference the GIS Contract Manager at EA, her name is
Michelle Thorpe, tel 01392 444000, email
michelle.thorpe@environment-agency.gov.uk

I trust this is useful. Best Regards,

Des Hughes
Strategic Account Manager, ESRI (UK) Ltd

Email dhughes@esriuk.com (which routes through to deshughes@compuserve.com)
Home business telephone 01664 823923, fax 01664 823300, mobile 0966 293855
Head office telephone 01923 210450, fax 01923 210739
See our web site at www.esriuk.com

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3081 Enterprise Drive
State College, PA 16801-3008
U.S.A.
Toll-free telephone (US only): +1-800-448-3555
Telephone: +1-814-238-3280
Fax: +1-814-238-4383

E-mail
Academic: acadsales@minitab.com

Non-academic: commsales@minitab.com

URL: http://www.minitab.com

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Minitab Ltd.
Brandon Court, Unit E 1
Progress Way
Coventry CV3 2TE
United Kingdom

E-mail
Academic: acadsales@minitab.co.uk
Non-academic: comsales@minitab.co.uk

From within the UK:
Telephone: 01203-652777
Fax: 01203-652888
Toll free telephone: 0500-586587

From outside the UK
Telephone: +44-1203-652777
Fax: +44-1203-652888

See also:
Contacting customer support: Europe
More about Minitab Ltd.

Belgium, France, and Luxembourg

Minitab SARL
1 Citй Paradis
5иme Etage
75010 PARIS
FRANCE
E-mail: Bienvenue@minitab.fr

From within France:
Toll-free telephone:
Sales: 0800 777 200
Shipping/Accounts: 0800 9119 10
Fax: 01 55 33 12 39

From outside France:
Telephone (Sales): + 33 (0) 1 55 33 12 36
Fax: + 33 (0) 1 55 33 12 39

See also:
Contacting customer support: Europe

Germany, Austria, and Switzerland:

IQBAL-EDV Systeme
Heiser Weg 51
27616 Hollen
GERMANY
Telephone: +49-(0)4748-94990
Fax: +49-(0)4748-94931
E-mail: iqbal@bbv.ipnet.de

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08008 Barcelona
SPAIN
Telephone: +34-93-415-49-04
Fax: +34-93-415-72-68
E-mail: info@addlink.es
URL: http://www.addlink.es

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Via V. Pisani, 13
20124 Milano
ITALY

Telephone: +39-02-66981300
Fax: +39-02-66981300

Asia-Pacific

Australia and New Zealand:

SIR Pty. Ltd.
10-18 Cliff Street
Milsons Point NSW
2061
AUSTRALIA
Telephone: +61-299297466
Fax: +61-299297498
E-mail: minitab@sir.com.au
URL: http://www.sir.com.au

See also:
Contacting customer support: Asia-Pacific
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Latin America

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AIDE Consultores SRL
Bartolome Mitre 1617, Ofc 301
1037 Buenos Aires
ARGENTINA
Telephone: +54-1-371-6582
Fax: +54-1-371-6582
E-mail: AIDE@inca.com.ar
URL: http://usuarios.inca.com.ar/~aide

See also:
Contacting customer support: Latin America
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Mexico:

MultiON Consulting, S.A.
Vizcaya #8-201
A.P. 73-231
Mexico, D.F.
03740
Telephone: +52-5-598-9252
Fax: +52-5-563-0641
E-mail: ventas@multion.spin.com.mx

See also:
Contacting customer support: Latin America
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3081 Enterprise Drive
State College, PA 16801-3008
U.S.A.
Toll-free telephone (US only): +1-800-448-3555
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Commercial Software Price List

About the prices

These are the prices for customers in the **US and Canada only**. For all other countries, please **contact our sales representatives**.

The prices apply to the following products:

- MINITAB 12 for Windows 95 and Windows NT
- MINITAB 11 for Windows 3.1
- MINITAB 10xtra for Macintosh and Power Macintosh
- MINITAB en espacol 2.1 para Windows 3.1
- MINITAB en fran3ais 2.1 pour Windows 3.1

For information on pricing and availability of MINITAB on the DOS, mainframe, and minicomputer platforms, or for prices on other products from Minitab Inc, please **contact our sales representatives**.

Prices are in US dollars and do not include applicable tax or freight charges.

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- **Annual licenses for networks, labs, and multiple stand-alone PCs**
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Unit copies are stand-alone, non-networkable copies of MINITAB. Each individual copy comes with one set of MINITAB documentation. When purchasing multiple unit copies of MINITAB in one order, you are entitled to a multiple copy discount. For example, if you purchase 12 new copies of MINITAB at once, you will pay $625 per copy rather than $975, a savings of $4,200!

Number of copies	Price per copy
1	$975
2-4	$825
5-10	$725
11-20	$625
21-30	$525
31+	$475

Unit copies—upgrades

To be eligible for upgrade pricing you must already own a previous version of MINITAB. If you are in the USA or Canada, you can order your upgrade now: see the Upgrade Form. For all other countries, please **contact our sales representatives**. And if you are associated with an academic institution, see the **note above** for academic discount information.

Annual licenses for networks, labs, and multiple stand-alone PCs

Each Annual license allows you to use a networkable and sharable version of MINITAB that works for one year from the license date. During the course of the year, you get any updates or upgrades to MINITAB for free. You can renew the license each year.

Each license comes with one set of networkable media and one set of documentation. Additional sets of documentation can be purchased separately—see the Documentation Price List.

Number of users	**Price of license**
1-5	$1,875
6-10	$2,500
11-15	$3,500
16-20	$4,500
21-30	$6,500
31-40	$8,500
41-50	$10,500
50+	**Contact us.**

Number of users is defined as the number of simultaneous users on each network, plus the number of stand-alone computers on which Minitab is in active use concurrently.

Special licenses

If your licensing requirements do not fall into any of the above categories, we have other special licensing plans available. Please **contact our sales representatives**.