# Development of a Web-based information system for Bankok, Thailand. Report on the development of user requirements

# Norwegian Institute for Water Research

# REPORT

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**Abstract**
This report describes the user requirements of the Internet module to be developed as part of the 'Metropole Watch - Environmental Monitoring and Management System for the Chao Praya River in the Metropole of Bangkok'. There are 4 main types of data that shall be presented on the Internet/Web: 1. Map-data (river, khlongs, administrative units, location of sampling points, pollution sources, etc) handled by a geographical information system (GIS). 2. Classified/aggregated water quality data in comparison with water quality standards, to be displayed on the map. 3. Time plots (graphs) of historical water quality data, displayed with water quality standards where these are defined. 4. Metadata (descriptions) of sampling locations and pollution sources.

All of these types of data are either stored in the ENSIS 2.05 database, or linked to the database. This document focus on presentation of manual monitoring retrieved from the ENSIS database, and does not describe the presentation of on-line monitoring data sampled by the instruments delivered by Oceanor. However, the report points out the interaction and possible integration with the Web-presentation of on-line data.

| 4 keywords, Norwegian | 4 keywords, English |
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| 1.   Web-basert informasjonssystem<br>2.   Vannressursforvaltning<br>3.   Hydroinformatikk<br>4.   ENSIS | 1.   Web-based information system<br>2.   Water resources management<br>3.   Hydroinformatics<br>4.   Environmental Surveillance and Information System (ENSIS) |

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# Development of a Web-based information system for Bangkok, Thailand

## Report on the development of user requirements

# Preface

The project 'Metropole Watch Environmental Monitoring and Management System for the Chao Praya River in the Metropole of Bangkok' is aimed at improving the environmental situation in the capital of Thailand. This is done by implementing an operational management system and by providing adequate training and capacity building with respect to this system. An important part of the management system is to provide targeted environmental information to decision-makers, sectoral authorities and the general public with use of state-of-the-art Internet technology. This document describes the user requirements of such a system based on ENSIS 2.05 as the source of information.

This project is funded by the Bangkok Metropolitan Administration with Oceanor, Trondheim as the contractor.

Oslo, June 2003

*Tor Haakon Bakken, project leader NIVA*

# Content

# Summary

This report describes the user requirements of the Internet module to be developed as part of the 'Metropole Watch - Environmental Monitoring and Management System for the Chao Praya River in the Metropole of Bangkok'. There are 4 main types of data that shall be presented on the Internet/Web:

- Map-data (river, khlongs, administrative units, location of sampling points, pollution sources, etc) handled by a geographical information system (GIS)
- Classified/aggregated water quality data in comparison with water quality standards, to be displayed on the map.
- Time plot (graphs, not tables) of historical water quality data, displayed with water quality standards where these are defined.
- Metadata (descriptions) of sampling locations and pollution sources.

All of these types of data are either stored in the ENSIS 2.05 database, or linked to the database. This document focus on presentation of manual monitoring retrieved from the ENSIS database, and does not describe the presentation of on-line monitoring data sampled by the instruments delivered by Oceanor. However, the report points out the interaction and possible integration with the Web-presentation of on-line data.

# 1. Introduction

## 1.1 Purpose of the document and the software

This is the report that describes the user requirements of the Internet (Web) presentation of environmental (water quality) data and information for the Bangkok Metropolitan Administration (BMA), Thailand. The pupose of this report is to express, summarise and compile the user requirements of the system, and to provide a common understanding of the final system among decision-makers and managers within BMA, and the developers. Based on these user requirements, a prototype of the Web system will be developed, before the complete system is programmed and finalised.

This document is written based on the description stated in the proposal, discussions among the members of the project team, and general knowledge about the capabilities and constraints of available technology (see Bakken et al, 2003, and http://www.grenlandsluft.no/apnee/).

The document is intended to be read by potential users of the Internet module, by programmers of the application, by project partners, and by the responsible persons within the Bangkok Metropolitan Administration (BMA).

The purpose of the software to be developed based on this report, is to:
- provide a general overview of the environmental situation in the Bangkok area,
- provide an overview of the different types of pollution sources, and which individual polluters that cause pressure to the environment,
- stimulate the exchange of environmental data and information between sectoral authorities and different administrative levels,
- stimulate the general public to a higher environmental awareness.

Please note that this report does not include any detailed information about the Web presentation of on-line monitoring data sampled instruments delivered by Oceanor. It is assumed that on-line presentation is fully specified by other project partners. However, the topic of the integration between the existing BMA web site, the on-line presentation and the presentation described in this report, is discussed in section 2.3.

## 1.2 Target user group

The Web module will, in general, provide less detailed information than the ENSIS expert system, and the user groups of the Web module will typically be:

- General public
- Media
- Politicians
- Educational Institutions
- Industry
- NGOs

The Web module is intended to increase their knowledge and awareness about environmental problems. This knowledge is required to take appropriate actions, to influence decision-making, and to be able to participate in the public debate. The information provided to this category of users should not only be focused on the type of data which are required for planning, but also be relevant for their daily behaviour.

## 1.3 General assumption about data, data distribution and software

This specification is based on the following assumptions:

- The ENSIS database (version 2.05) is installed in BMA
- The data, information and maps described exist in (or is directly linked to) the ENSIS database of BMA
- The data and maps stored within or linked to the ENSIS database is technically available for distribution over the Internet
- The data and maps stored within or linked to the ENSIS database is legally (meaning all licence agreements with data and map-owners are arranged) distributed over the Internet
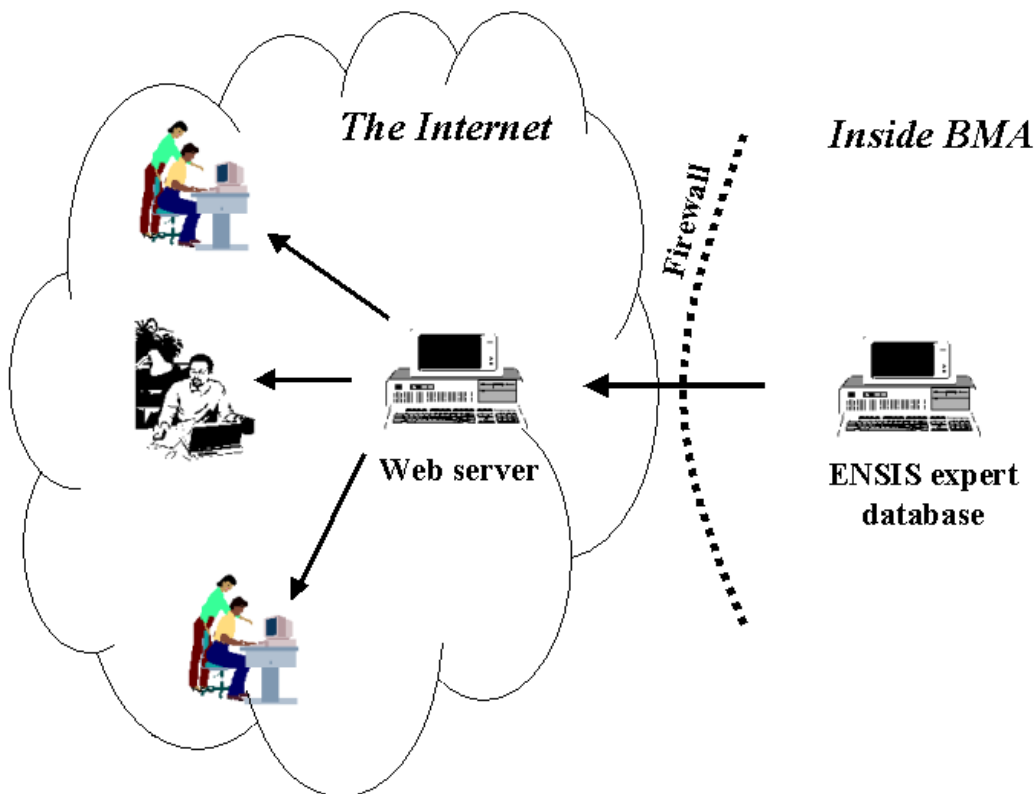


*Figure 1.1. The figure gives a very simplified view of the data distribution and setup of hardware in the central station of BMA. The left part of the figure indicates the public available Internet, the right part the internal ENSIS expert database, and the dotted line a firewall that controls/limits the network traffic to only dedicated users/administrators preparing data for Internet distribution.*

## 1.4 Definitions, acronyms and abbreviations

| Short version | Full name/description |
|---|---|
| BMA | Bangkok Metropolitan Administration |
| ENSIS | Environmental surveillance and information system |
| FAQ | Frequently asked question |
| GIS | Geographical information system |
| GUI | Graphical user interface |
| NGO | Non-governmental organisations |
| QA/QC | Quality assurance/quality control |
| UN EPA | United States Environmental Protection Agency |
| WQ | Water quality |
| WQC | Water quality classification |
| WWTP | Waste water treatment plant |

# 2. Overall structure of the information system

## 2.1 ENSIS WaterQuis (version 2.05) - Overview of the expert system

ENSIS WaterQuis is a management and decision support system for the environmental protection of water resources. WaterQuis provides a database for secure storage of environmental data, information and modelling results. A geographic information system interface (GIS) provides easy and user-friendly access and presentation to all data stored in the database, including water quality and quantity monitoring data and modelling results. The system can be used as a management tool for planners, an information tool for the public and an expert system for specialists. The functionality described is implemented in the 'expert' version of ENSIS, which will be installed at the BMA central station during early autumn 2003. Selected data, and to some extent functionality from this expert system, will be made available on the Internet (Web) to the general public. Basic features of ENSIS WaterQuis (version 2.05) are:

*Monitoring:*
- Geographical information system (GIS)
- Description and registration of all types of physical and chemical monitoring data
- Search for data by geographical and numerical criteria
- Manual and automatically data acquisition system
- Graphical presentation of data
- Numerical presentation of data
- Statistical processing of data
- Environmental classification system for water quality
- Tools for quality control of data

*Pollution sources inventory*
- Registration of discharge from domestic waste water
- Registration of discharge from industry
- Registration of pollution from diffuse sources
- Model for calculation of pollution load

*Basic water resources information*
- Definition and registration of information and data about catchments, rivers and lakes
- Definition and registration of coastal information

*Data flow in and out of the system*
- Import and export from/to external data sources
- Report generator
- System for document handling and storage of images

*Technology*
- Support of thin client technology
- Running on Windows OS
- Based on Oracle database technology

- GIS-system based on ESRI-products (compatible with ArcView/ArcGIS)
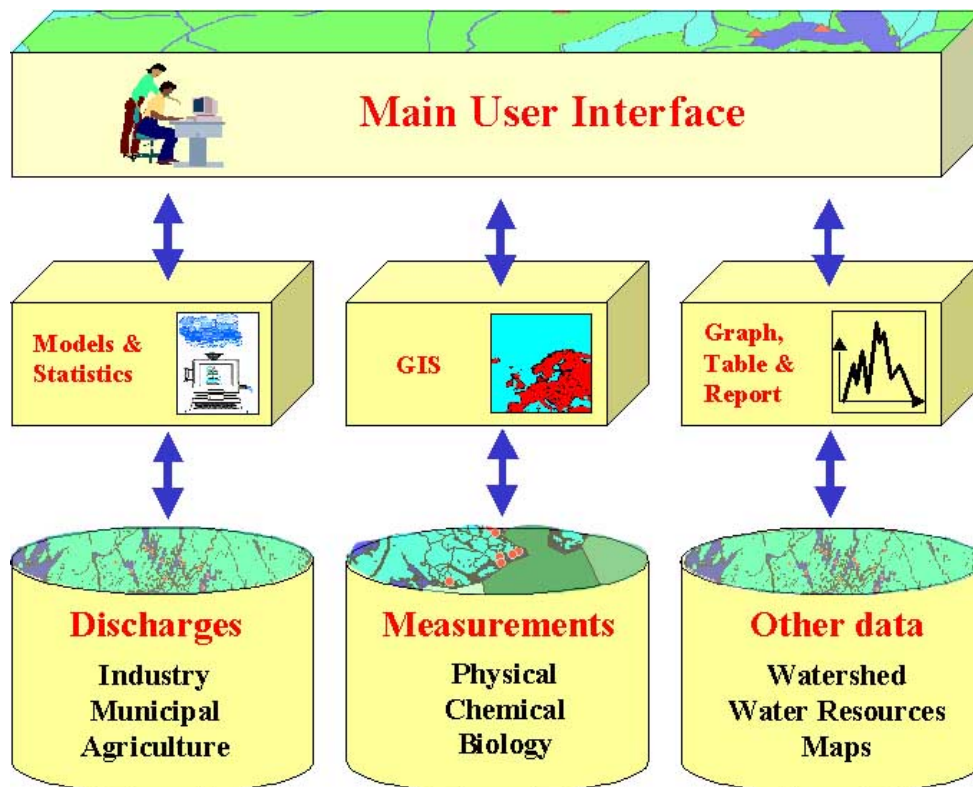


*Figure 2.1. The figure shows schematically the structure of ENSIS 2.05, the data types to be stored in the database and the implemented type of functionality.*

ENSIS WaterQuis, version 2.05, is now installed and/or applied in a large number of projects, in Norway, Europe and Asia. For more information about ENSIS, see http://www.niva.no/ensis and Bakken et al, 2001.

## 2.2 Schematically overview of the Internet module



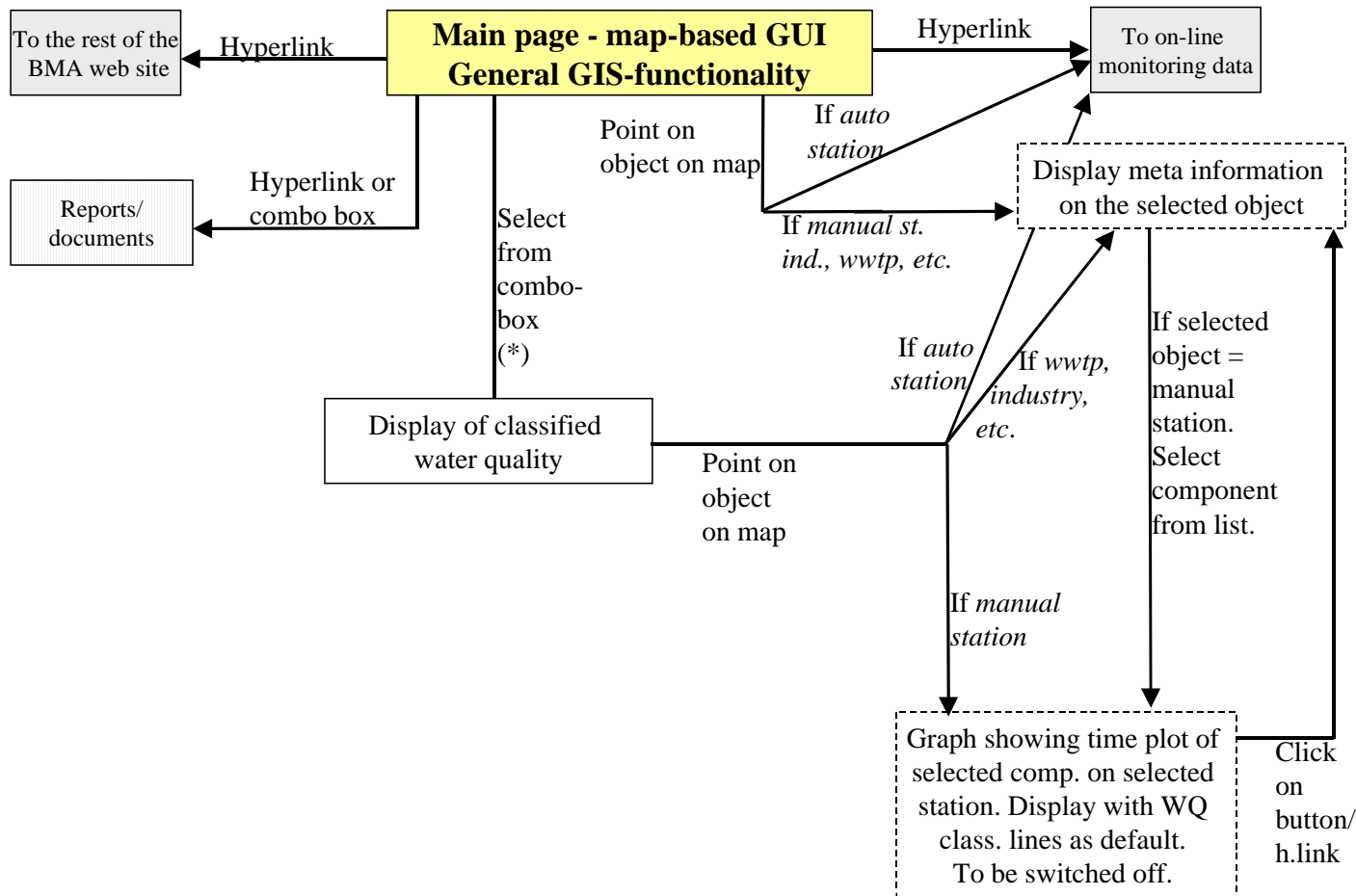*Figure 2.2. The figure displays the overall structure of the specified Web-site. The asterix in the text indicates selection of pollution type/component and period of data. Boxes with dotted frames might be implemented as pop-up windows or with use of frames.*

## 2.3 Relations to the BMA web site and the Web presentation of on-line data

The Web module defined in this document and the presentation of on-line data shall both follow as close as possible to the design standard of the official and main BMA Web site (see http://www.bma.go.th/bmaeng/bmaeng2003.html) and the home page of BMA Department of Drainage and Sewerage (see http://dds.bma.go.th/). However, a distiction between the Web sites showing manual and automatic water quality data and the main site of BMA should be done to emphasise that these pages are developed as part of the project 'Metropole Watch - Environmental Monitoring and Management System for the Chao Praya River in the Metropole of Bangkok'. This distinction can be made by providing a persistent heading on each Web page of the short name of the project.

The presentation of the automatic and the manual water quality data should be integrated technically and harmonised by its design. This requires a very close interaction and co-operation between the developers to ensure a seamless system.

# 3. Detailed user requirements

## 3.1 Map-part (GIS) of the system

This part of the functional specification contains more details about the implementation of GIS functionality.

The map interface shall consist of 4 parts: detailed map, overview map, toolbars and list of map layers. The figures below (3.1 and 3.2) show how this can be implemented. In addition, there should be a scale bar showing the distance on the detailed map.

Maps that are to be published on the Internet must be made available, and the conditions regarding publishing must be clarified.

**Detailed map:**
The detailed map is where the user can explore the water quality of Bangkok. Users should be able to select different themes, zoom and pan. In addition, information about the different themes (for instance station, water quality) can be explored. There are 2 main options on how to display the maps, either by raster maps or by vector maps. Which option to choose will be decided when the maps are made available. If there are good quality raster maps available, these would be prefered. In the following the two different ways of presenting the map on the Web is described and shown.

**Option 1, Vector maps:**
This option includes one map layer for each theme, meaning one map layer for river, lake, road, khlongs etc. The user should be able to turn the layers on and off. The detailed map should by default show the following themes:

- Outer border of the city (BMA region)
- Districts inside the BMA area
- Chao Phraya River
- Khlongs
- Roads

Symbols used in these themes should be fixed and not editable.

**Option 2, Raster maps:**
Instead of the different themes it should be decided if it is better to use only one raster image map. This will make the map more familiar for the user. This option depends on the availability of a good quality map.

The following figures (3.1 and 3.2) show the two options. The web page must be adjusted and harmonized to the BMA design of the existing BMA web-page.
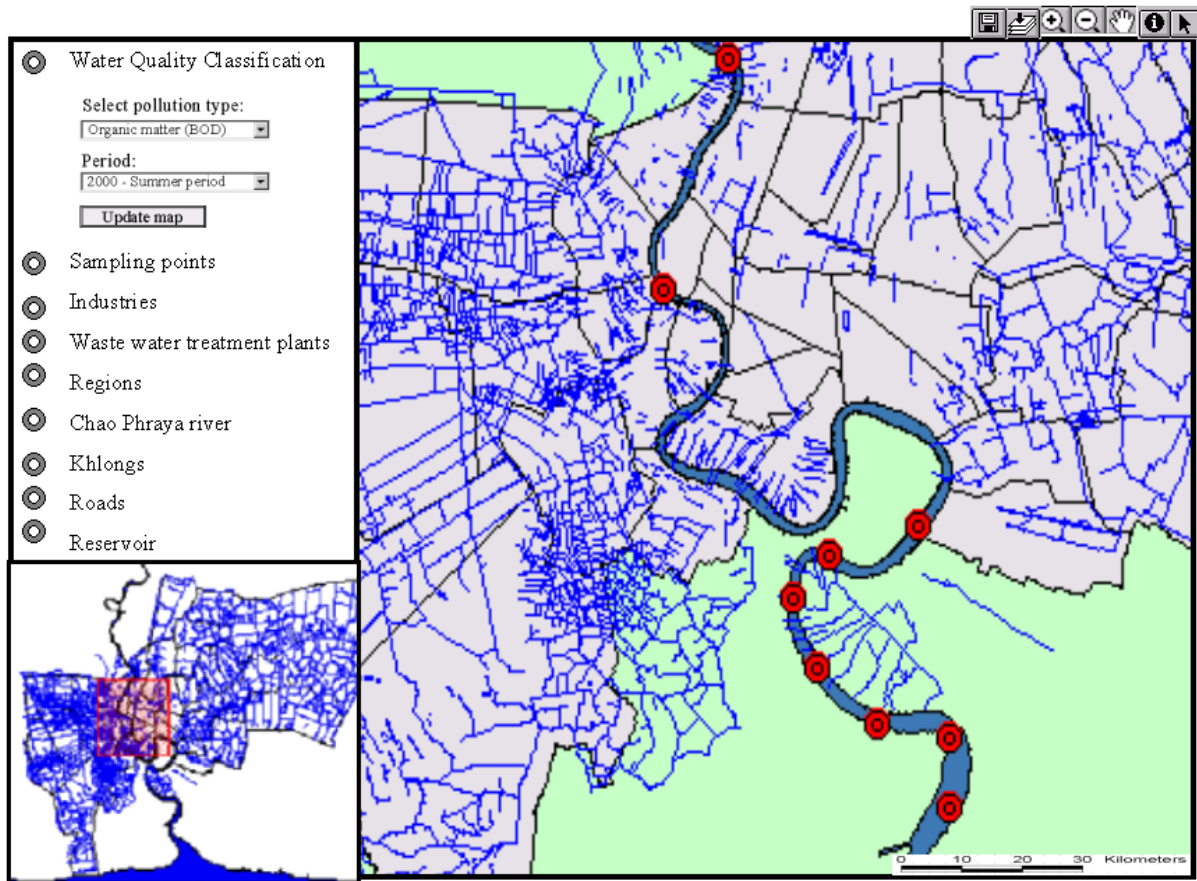
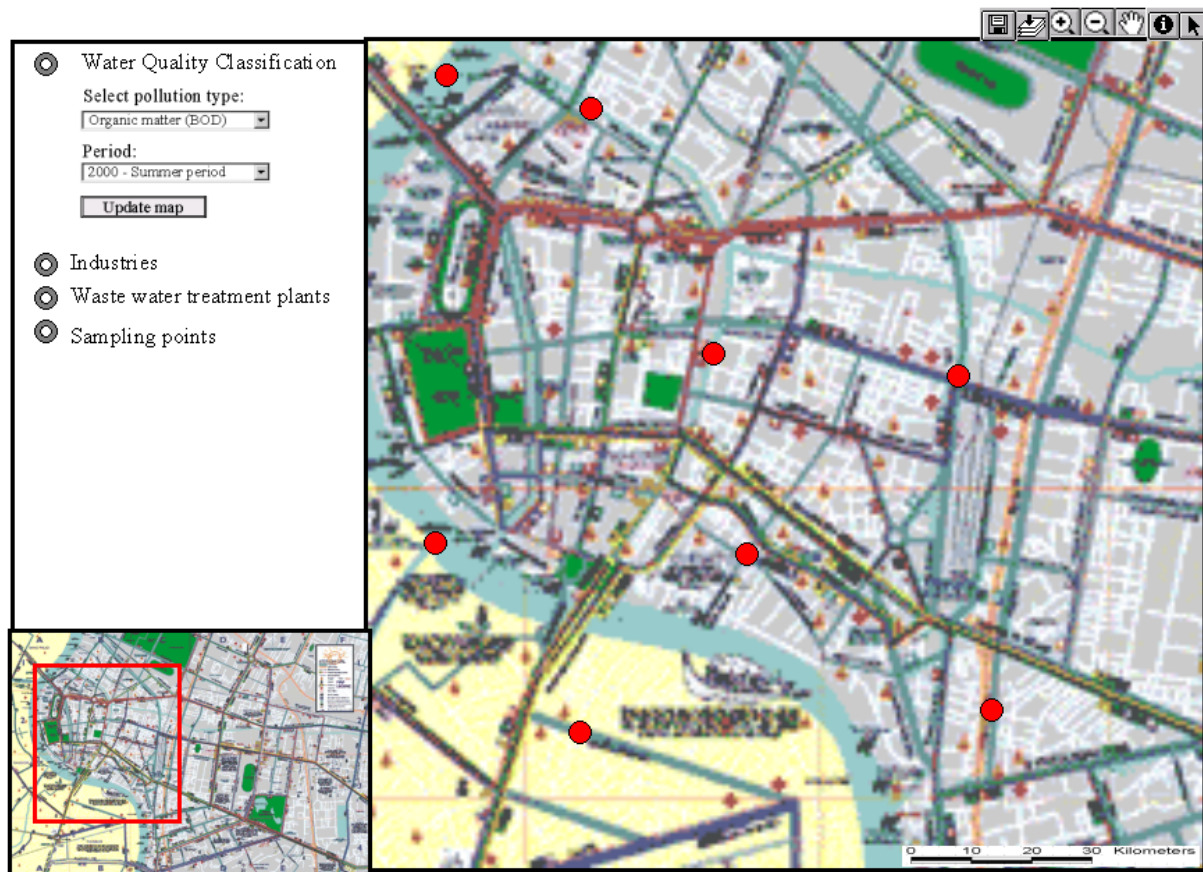*Figure 3.1. This figure exemplifies how option 1 can look like.*

*Figure 3.2. This figure exemplifies how option 2 can look like.*

Additional information available in the map should be:
- Automatic monitoring stations – the placement of the automatic monitoring stations (link to web-page of automatic monitoring data).
- Manual monitoring stations – the placement of the manual monitoring stations with direct access to the web page of manual monitoring data (from ENSIS).
- Water quality classification – one layer for each pollution type (component) and each time period there exist datasets of classified/aggregated water quality for. There must be combo boxes to select 'classification layer' (i.e. organic matter, nutrients, oxygen depletion, etc and time period of relevance). See sections 3.2.1 and 3.4 for detailes about this.
- Industries – the placement of the industries, if available.
- Waste water treatment plants – the placement of the WWTP.

The distance bar indicates the scale of the map by providing a bar indicating the length, for instance a bar indicating the length of 10 km.

**Overview map:**
The overview map should be a simple map showing the full extent of Bangkok area (project area). This extent of the map should not be changed. The idea of this part is to show the users where the location of the main map is in relation to the full extent of the map. A red frame can indicate where the boundaries of the main map are. It should be able to pan (moving the focus of the detailed map) directly on the overview map (will update the detailed map).

Themes to be displayed in the overview map depend on the available maps. Alternative themes are:

**Option 1 (above):**
- Border of the city
- Districts inside the BMA area
- Chao Phraya river

**Option 2 (above):**
Suitable raster image.

**Toolbars**
The buttons, given in table 3.1, should be available for the user. Examples of buttons and icons are given in figures 3.1 and 3.2. The functionality of the buttons should also be indicated by yellow tooltips as the user moves the cursor above the buttons. If the buttons are replaced by text strings there will be no need for tooltip. Tooltip should be available wherever there are buttons.

*Table 3.1. The table describes the GIS-functionality.*

| | |
|---|---|
| Zoom in | 1. When the user presses 'Zoom in' and clicks in the map, the map display shall be zoomed in a specified number of times (i.e. 4 X). <br><br> 2. When the user presses 'Zoom in' and marks an area in the map, the map display shall be zoomed in to cover the marked area. |
| Zoom out | The map shall be zoomed out when the user presses 'Zoom out' button and then clicks in the map. The map display shall be zoomed out in a specific number of times (i.e 4 X). |
| Zoom to previous extent | When the user presses this button the map display shall be zoomed out or in to the previous extent. |
| Zoom to full extent | When the user presses this button the detailed map display shall have the same extent as the overview map, and the whole overview map shall be displayed. |
| Pan | 1. The user should be able to use this functionality to move the map in a certain direction by click in the map, hold the left mouse button down, move the cursor (lift the focus to desired location), and release the mouse-button (standard panning). <br><br> 2. The hand indicates that the user can move/pan the map. The user presses this button and clicks on the location of the map that shall be in the centre of the map. <br><br> Alternatively: <br> People that are not experienced with GIS might not intuitively understand the functionality. For this reason, it might be better to construct buttons with arrows, in 8 different directions. When the users presses the button pointing straight up, the centre of the map will be changed to a more |

| | |
|---|---|
| | northern location. |
| Identify | This is an important function in the map. This button is used to identify/show graphs (time series plots) of monitored water quality and metadata information about monitoring locations, industries and waste water treatment plants. See section 3.2 for details. |
| Save map | This starts up the rasterization engines and stores the main map to a compressed file (i.e. jpg-file) with a user-specified name at a user-specified location (for instance local computer or network). The file shall be stored with the same configuration (themes turned on, zoom, etc) as given in the detailed map. |

**List of map layers**

All map themes available for the web should be listed. The default map layers should be marked and shown. The order of the themes and the symbols of the themes should be default. The first layer in the list indicates that this theme should be displayd on top.

**Option 1:**

*Table 3.2. Proposed attributes of map themes.*

| Theme | Attribute |
|---|---|
| Water quality classification | Symbols used in ENSIS |
| Automatic monitoring stations | Blue circles |
| Manual monitoring stations | Light blue circles |
| Industries | For instance yellow triangle |
| Waste water treatment plants | For instance green circle |
| Roads | Light brown lines |
| Khlongs | Blue line |
| Chao Phraya River | Blue area (same colour as the khlongs) |
| Reservoir | Blue area (same colour as the khlongs) |
| Regions | Outline of regions, light colour |
| Boundary of Bangkok | Thick black line |

**Option 2:**

*Table 3.3. Proposed attributes of map themes.*

| Theme | Attribute |
|---|---|
| Water quality classification | Symbols used in ENSIS |
| Automatic monitoring stations | Blue circles |
| Manual monitoring stations | Light blue circles |
| Industries | For instance yellow triangle |
| Waste water treatment plants | For instance green circle |
| Raster image | Default picture |

The size of the attributes must be adjusted to the given scale.

It should be discussed if the themes should be switched on/off as a function of scale. It should also be discussed if maps of varying degree of detail should be changed/replaced as a function of scale. This latter point will ensure that the 'correct' level of details is always presented to the user. This should be discussed and adjusted when the maps are available.

## 3.2 Search and display of environmental data and information

The main types of relevant environmental data and information to be presented are:

- Classified/aggregated water quality data in comparison with water quality standards.
- Time plot (graphs, not tables) of historical water quality data, displayed with water quality standards where these are defined.
- Metadata (descriptions) of sampling locations and pollution sources (but not discharge data from pollution sources).
- Map-data (river, khlongs, administrative units, location of sampling points, pollution sources, etc). Details about maps and themes are given in section 3.1.

*Important note:*
The Internet application described in the user requirements requires that data are entered or imported (manually or automatic) into the ENSIS system, or generated within the ENSIS system (for instance by classification of water quality), and that this information is constantly updated by BMA. The Internet application can, of course, only display data/information that is available directly from the ENSIS database, or indirectly by external links to the database (for instance linked shapefiles). The quality of the data/information to be displayed will never be better than the data/information that is available from the data source (ENSIS database and links). It is also of major importance that both the on-line and manual monitoring data that is presented on the Internet are thoroughly quality-controlled data.

### 3.2.1 Classified/aggregated water quality

The classification will in principle follow the methodology pointed out by SFT (1997). The way to access this type of data is via the map interface. The type of aggregated data to be shown on the map (which pollution type/component, which year to show data from, and maybe which period of the year/season) is for instance selected via a combo box. The data is stored in the ENSIS database as 'Station datasets'. The combination of component and time period must, of course, already be available in the database. No calculations are made 'on the fly', the system only extracts data already prepared data (station datasets).

Basically, the user will select one specific pollution type (nutrients-TP, organic matter-BOD, oxygen conditions-DO, etc.), and data from one specific period (for instance summer period 1999) before the classified data is switched on the map. The pollution types to be available in the combo-box are discussed further in section 3.4. The periods to be available in the combo-box will be a function of selected pollution type and data that are available from the database. Only those periods that are available in the database should be listed in the combo-box. The map should be updated when the operator presses the update button. Be aware that 'None'

should be an item in both combo boxes to support the possibility of having a map display without classified data switched on.

Select pollution type:
| Organic matter (BOD) | ▾ |

Period:
| 2000 - Summer period | ▾ |

| Update map |

*Figure 3.3. The figure indicates how the selection mechanism of classified water quality can be implemented.*

The classified water quality should be presented by putting the station dataset directly 'on top' of the map that is already manipulated by the user. This means that the dataset should not change the zooming, the number of layers shown, etc, only be put on top of the existing map. Examples of presentation of datasets are given in the figures 3.4-3.6.
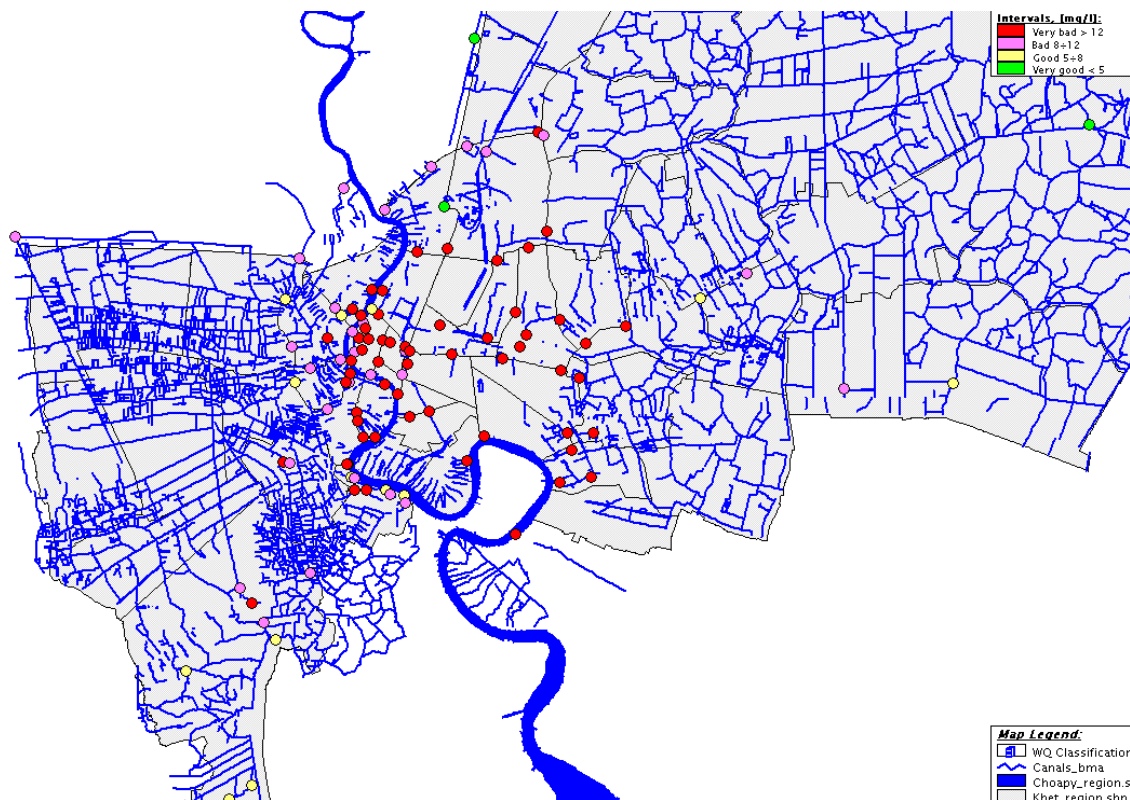


*Figure 3.4. The figure shows spatial presentation of classified water quality, with BOD as an example for the year 1997. Be aware of that this is only an example, and that additional/other*

*map themes should be present and the legends should be made nicer. Please note also that the classes of water quality standards are probably not correct.*
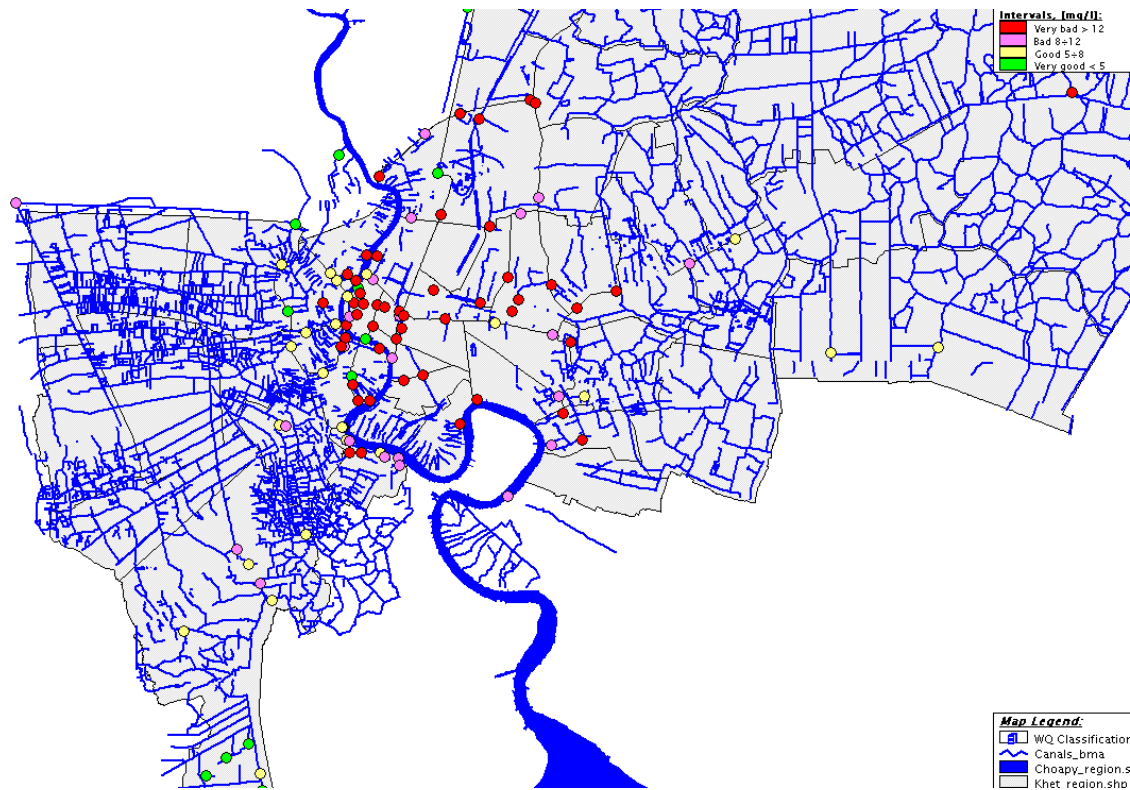


*Figure 3.5. The figure shows spatial presentation of classified water quality, with BOD as an example for the year 1998. Be aware of that this is only an example, and that additional/other map themes should be present and the legends should be made nicer. Please note also that the classes of water quality standards are probably not correct.*
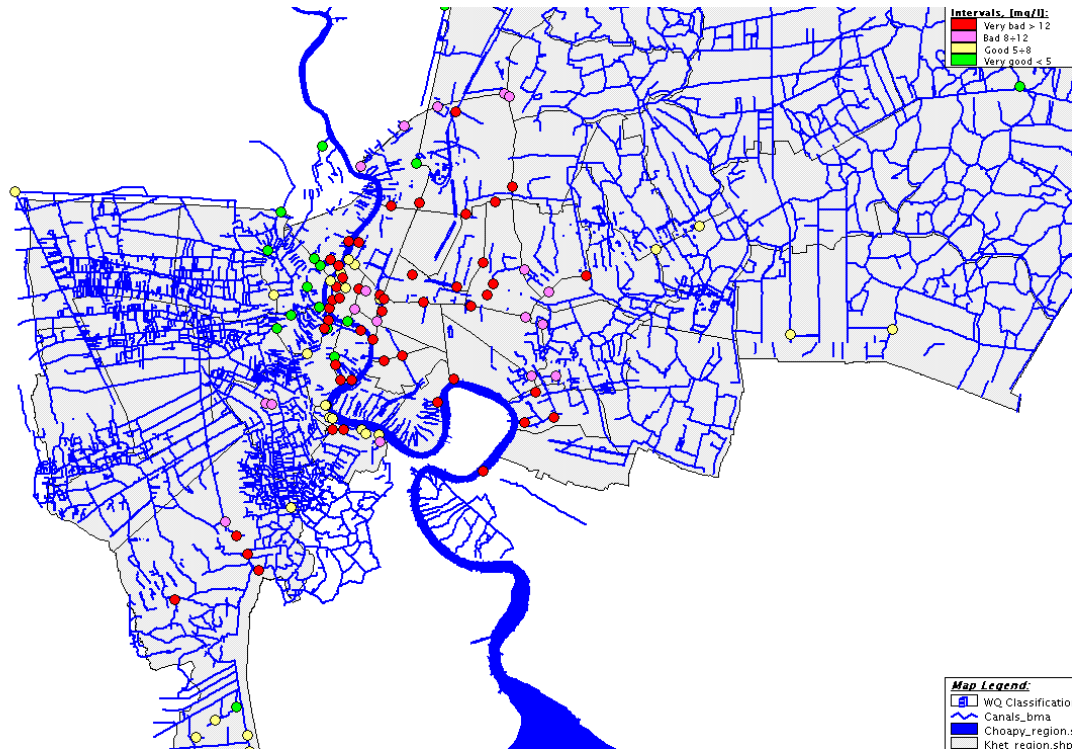
*Figure 3.6. The figure shows spatial presentation of classified water quality, with BOD as an example for the year 2000. Be aware of that this is only an example, and that additional/other map themes should be present and the legends should be made nicer. Please note also that the classes of water quality standards are probably not correct.*

### 3.2.2 Time plot (graphs) of historical water quality data

From the spatial presentation of classified data the user can go further and inspect historical monitoring data. This is done by clicking on the station in question, and a graph showing the trend will appear in a new separate pop-up window, within frames or similar. It should be evaluated if pop-ups should be used since these can simply be turned off in browsers and are often used for commercial purpose. By default, the component already presented on the map, and the selected station shall be shown. Each individual sample for the entire period data exist from shall be presented, and not only the period of the aggregation. By default, also the classification system, if a classification system is available for this component, shall be shown with the same limits and colours as on the map (see figure 3.7). A classification system will always be defined if the user launches the time series graph from the map of classified data, but if the user selects to display each sample via the station description form (meta data about the station), a classification system might not be defined. In the case of no classification system, the classes shall of course not be presented by default, and the possibility to switch water quality standards on shall be disabled.
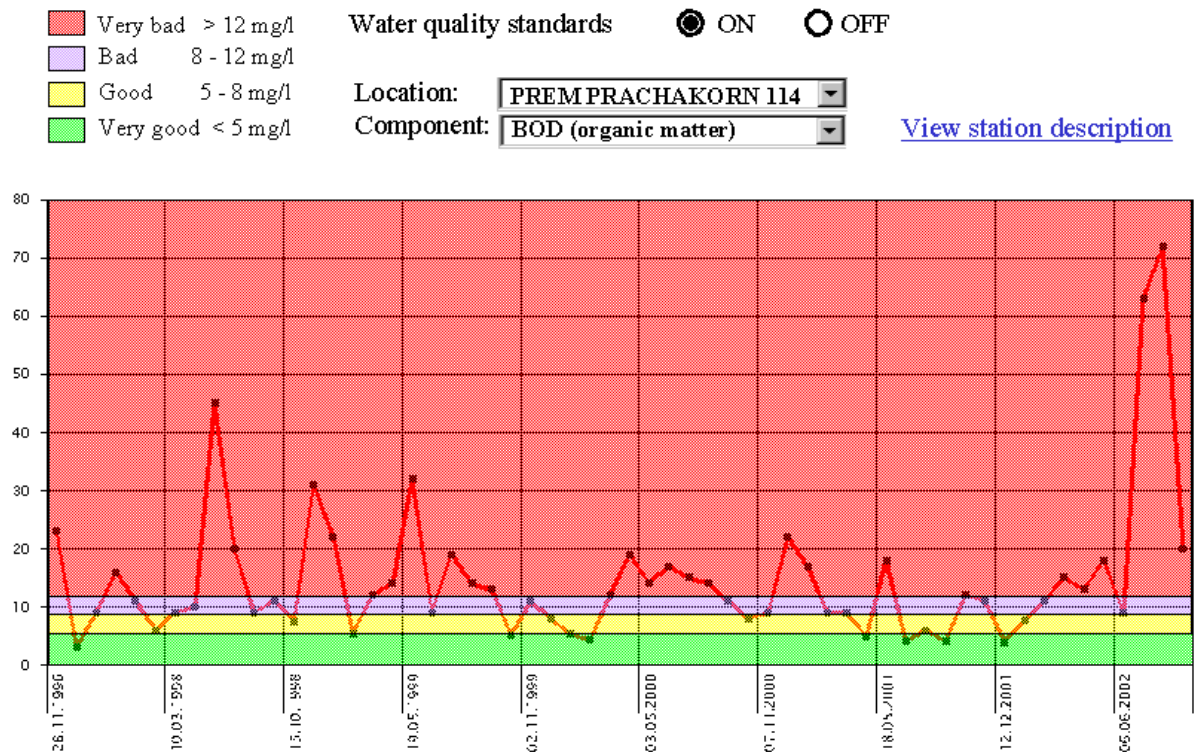
*Figure 3.7. The figure shows historical monitoring data, with BOD from PREM PRACHAKORN 144 as an example. The water quality standards are switched on (default choice). Please note that the classes of water quality standards are probably not correct.*

The user can from this dialogue (figure 3.7) select to present monitoring data from another sampling point, or another component from the same sampling point. If a component is not defined within the water quality standard, the water quality standard shall not be shown, and the possibility to switch this on shall be disabled.

The user can from this dialogue go to the description of the station (metadata about the sampling location). The user can go to the metadata dialogue by clicking the hyperlink with the text 'View station description'.

Monitoring data that are shown in a graph are taken from the database (class TimeValue) in version 2.05 of ENSIS. The monitoring data that are displayed are each individual sample stored in the database. The data should not be presented in tables, only in graphs (as generated image).

### 3.2.3 Metadata (descriptions) of sampling locations and pollution sources

The meta data is accessed by user click on the map, or via a hyperlink on the graph displaying the manual monitoring data.  As a first proposal, the following meta data should be displayed as a function of element/object selected. It is again emphasised that the data to be displayed is a function of the data that is stored in the database.

**Manual station (sampling points):**
Station ID
Station code
Station name
Northern co-ordinate (and which co-ordinate system it is given in)
Eastern co-ordinate (and which co-ordinate system it is given in)
Medium monitored in (river, khlong, etc)
Measurement types
Surrounding area
Site classification code
Measured components (combo box or similar) and graph-button

**Industries**
ID
Name
Production
Etc

**WWTP**
ID
Name
Person equivalent (PE)
Etc

The meta data will appear in a new separate pop-up window, within frames or similar. It should be evaluated if pop-ups should be used since these can simply be turned off in browsers and are often used for commercial purpose.


## 3.3 Connection between the map and the data

Classified/aggregated water quality data is displayed on the map as a function of the selection in combo-boxes. The data is then spatially presented by colour codes. The data (quality controlled samples) the classification is based on, can be displayed in a graph by clicking on the desired sampling location (station) directly in the map. If classified data is shown and the user clicks on another map element (for instance an industry or a WWTP), meta information about this specific element will be retrieved. If an automatic station is clicked, the automatic monitoring data will be displayed.

If a classified water quality is not shown on the map, and the user presses a map element (station, industry, WWTP), meta data about this element shall pop up. This is almost identical to if the classified data is switched on, except for the fact that meta data about the sampling point/station appear instead of a graph. If an automatic station is clicked, the automatic monitoring data will be displayed.


## 3.4 Presentation and classification of water quality data

The data to be displayed will be a function of:

- which data that are available in the database
- which data that are meaningful to display for the general public (i.e. which data that easily can be linked with a 'public known' pollution problem)
- which data that produce an interesting spatial and temporal distribution

The final decision about which data to be displayed will be made after a thoroughly evaluation based on the criteria mentioned above. However, this decision will not hamper programming of the Web module.

The data will first of all be compared with national water quality standards of Thailand (see http://www.pcd.go.th/Information/Regulations/WaterQuality/WaterQualityStandards.cfm). If this is not suitable, the US EPA water quality classification system shall be applied (see http://www.epa.gov/waterscience/standards/), if this is considered relevant for freshwater in Bangkok. A more thorough evaluation of the monitoring data will clarify this issue. Colour codes given by the quality classification system should be applied. If no relevant classification system is available for certain components, a classification shall not be performed.

*Types of pollution:*
- Nutrients and algae (T-P)
- Organic matter (BOD)
- Oxygen conditions (DO)
- Hygienic conditions (T-Coliform)

*Monitoring data of the following components are available (June 2003):*
- Temperature
- pH
- DO
- H2S
- BOD
- SS
- TKN
- NH3N
- NO3N
- NO2N
- T-P
- T-Coliform

Water quality data will be classified with respect to environmental quality/standards and not the suitability of one specific user interest.

It must be given which classification system that is used, the name of the component, unit, time period in a legend.

## 3.5 Download of data and maps

It is assumed that each individual, quality-controlled sample of data, in tabular format, are not available for download. However, the graph displaying the same data will be available for download as an image. This type of download is automatically supported in browsers via the right-mouse button. In a similar way, download of maps (with defined zooming, attributes and layers) as images should be supported. It is again stressed that agreements for the distribution and download of data and maps should be sorted out with the data/map suppliers.

## 3.6 Help text on user operation and scientific terms

Help should be provided on different levels. The simplest and least detailed way is by a yellow tooltip when the cursor is moved on top of a specific control in the GUI. The explanation should preferably be shown in a yellow rectangle, or in the lower statusbar. However, it is a very limited amount of text that can be displayed this way. For this reason, a more or less standard help function should be implemented. This help text should contain explanation about GIS functionality, scientific terms, the process of classifying water quality data, etc.

It is recommended to limit the provided text to 'to the point' description of the functionality and content of the Web module, since users' willingness to read long explanations on the Web is considered limited. Hyperlinks to sites for more detailed explanations can be provided.

The more comprehensive text (than provided by tooltip) should be accessible by clicking a question mark (or a similar symbol) that is persistent in the GUI independent of the user operations within the Web module. If possible, it should be defined anchors within the help text that the system automatically recognises as a function of selection in the Web module.

## 3.7 Reports/documents for download

It shall be possible to download reports and documents (plans, policies, etc) via this Web site. However, some documents are already available from the existing BMA Web site. For this reason, a link to the BMA site of this information should be provided. In addition, it will probably be prepared standard reports based on the content of the ENSIS database and use of the built-in report generator. These reports shall be made available form the Web site descibed in this document. It is assumed that these documents/reports are of a limited number and search facilities are not necessary. Sorting of documents should preferably be implemented.

Files can be stored in any digital format, preferably as pdf-files, but actually freely. The system should support both viewing the content of the files within the browser (if desired viewer is installed on the local client) and direct download of files.

# 4. Technical requirements - from the user's perspective

The Web module should be developed with a technology that ensures properly access to the Web site via MS Internet Explorer version 5 or newer, and standard browser configuration (security settings, enabling/disabling of scripts, etc). The Web module should be tested against other browsers like Netscape, Opera, etc. and critical errors should be avoided.

If any unexpected behaviour happens on the client side due to problems with browser, settings, etc, he/she shall be prompted an intelligent message, indicating the cause and possible remedial action to avoid future errors.

The Web system should be developed for an optimum display on a desktop resolution of 1024*768 pixels.

The language of the system should be both Thai and English. However, the dynamic part displaying information from the database should be only in English, since all the information and data in the database is given in English.

The Web server should preferrable be run on MS Windows NT 4 and MS Internet Information Service (IIS).

# 5. References

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US Environmental Protection Agency. Water quality standards. Home page: http://www.epa.gov/waterscience/standards/.