

Information Management of Point Source Monitoring

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Abstract

With increasing pressure on waterways from urban development and extreme weather patterns, better information systems are required that allow more rapid and comprehensive access to data on environmental pressures and waterway condition. The Queensland Environmental Protection Agency has been working on such a system that receives and stores electronic data on monitoring of licensed wastewater discharges in Queensland. The system is underpinned by an Oracle database but also includes a visualisation tool which allows data to be graphically displayed. In addition to accessing raw data on effluent water quantity and quality, it allows comparison with licence limits and estimation of loads over various time scales for contaminants such as nutrients or sediments. In addition, a spatial layer of the licensed activities, discharge locations and discharge limits has been generated and can be updated as the database is populated. The system will also be used to better inform State of Environment reporting, licencing decisions, catchment planning and water recycling projects. The development and features of the information system will be presented with some discussion of future development and applications.

Introduction

As with many parts of Australia, the population in Queensland is largely concentrated around coastal areas. Current and projected population growth in these areas, particularly in south east Queensland is substantial. In addition, there has been a significant industrial boom, particularly in the coal, coal seam gas and other parts of the mining sector. Furthermore, recent drought has resulted in an urban water crisis in some parts of the State and numerous major water infrastructure projects, such as large scale water recycling and desalination, have been undertaken. As a result, there appears to be an increase in the number and scale of activities that involve discharge of treated wastewater to waterways in the State. These activities, often referred to as point sources, include sewage treatment plants, advanced water treatment (typically involving membrane treatment and reverse osmosis concentrate), a range of mining activities, heavy industry, food processing and some aquaculture.

For effective regulation of point source activities, there is a need to obtain up-to-date and reliable monitoring information on the quality and quantity of effluent being released to the environment. Better knowledge about current industry performance helps target performers and benchmark 'best' practice. Knowledge of point source loads is also essential for good 'catchment-based' waterway management and is regularly used in south east Queensland as part of the Healthy Waterways Strategy planning process. Reporting of point source discharges is also required through mechanisms such as the State of the Environment Reporting, National Pollutant inventory and Moreton Bay Report Card in south east Queensland.

To assist with the regulation of point sources and better waterway management, the Queensland Environmental Protection Agency (EPA) have developed an information management system for monitoring of point source discharges to waters in Queensland. The information system includes an Oracle database, a graphing and visualisation tool (internal EPA only), and spatial data layer. The information system is designed to provide:

1. **Data Importing and Compliance Checking** – receiving raw electronic data from external licence holders and automatic checking and reporting of monitoring data against limits.
2. **Decision Making Support** – presenting information on discharges in Queensland including locations, raw data on quality and quantities, graphed data and load calculations

The key features of the information system and current implementation will be presented with some discussion of applications and future development.

Data Importing and Compliance Checking

Background information regarding the facilities and their permits are entered into the database by the EPA database manager. Following this, a template is produced and provided to the licence holder who can enter their end-of-pipe monitoring data and submit the file to the EPA as an email attachment. The database automatically checks the data against current permit limits and generates a report which documents potential exceedances. The report is emailed back to the licence holder and made available to internal EPA staff via an internal website. The licence holder and EPA staff can then discuss the validity of potential exceedances and where valid, any appropriate management response. Licence holders also receive automatic email reminders to submit data (currently on a quarterly basis for sewage treatment plants). Figure 1 shows a schematic of the flow of information for data importing and compliance checking within the Point Source Database (PSD).

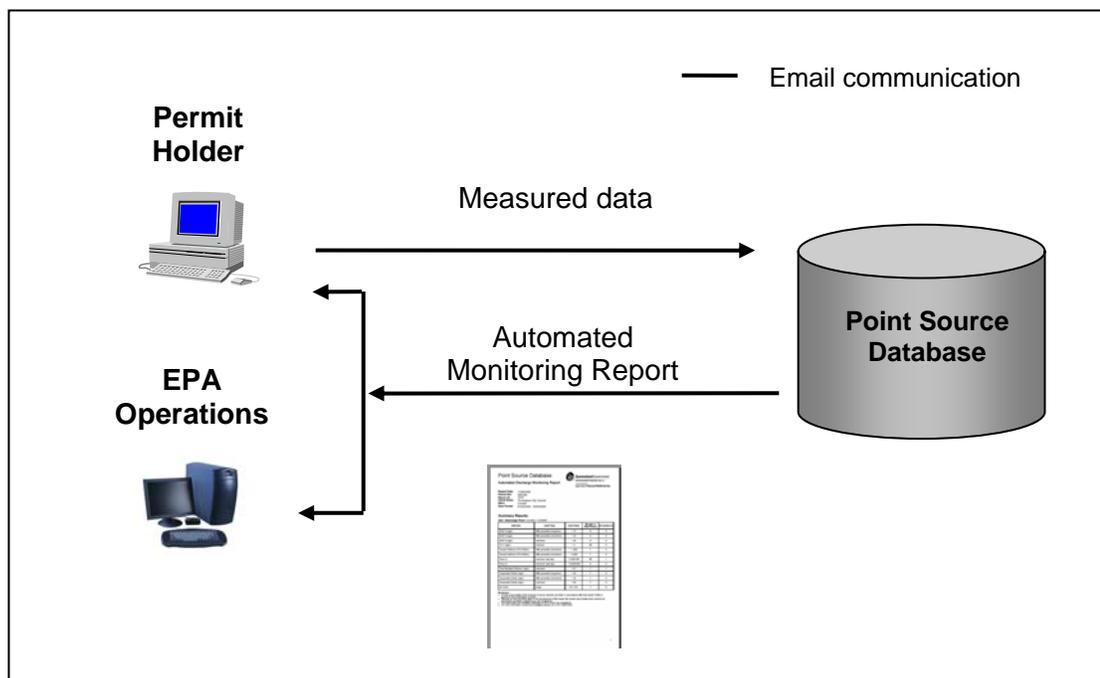


Figure 1. Schematic of the Point Source Database

An example of an Automated Discharge Monitoring Report produced on submission of data is shown in Figure 2. The types of limits, the value of the limit, the number of results submitted and the number of results that exceed the limits are presented in the report. Furthermore, on the second page of the report details of the exceedence are supplied including the date of the exceedence and the value which exceeds. This provides an effective compliance tool by clearly indicating results that may need further investigation.

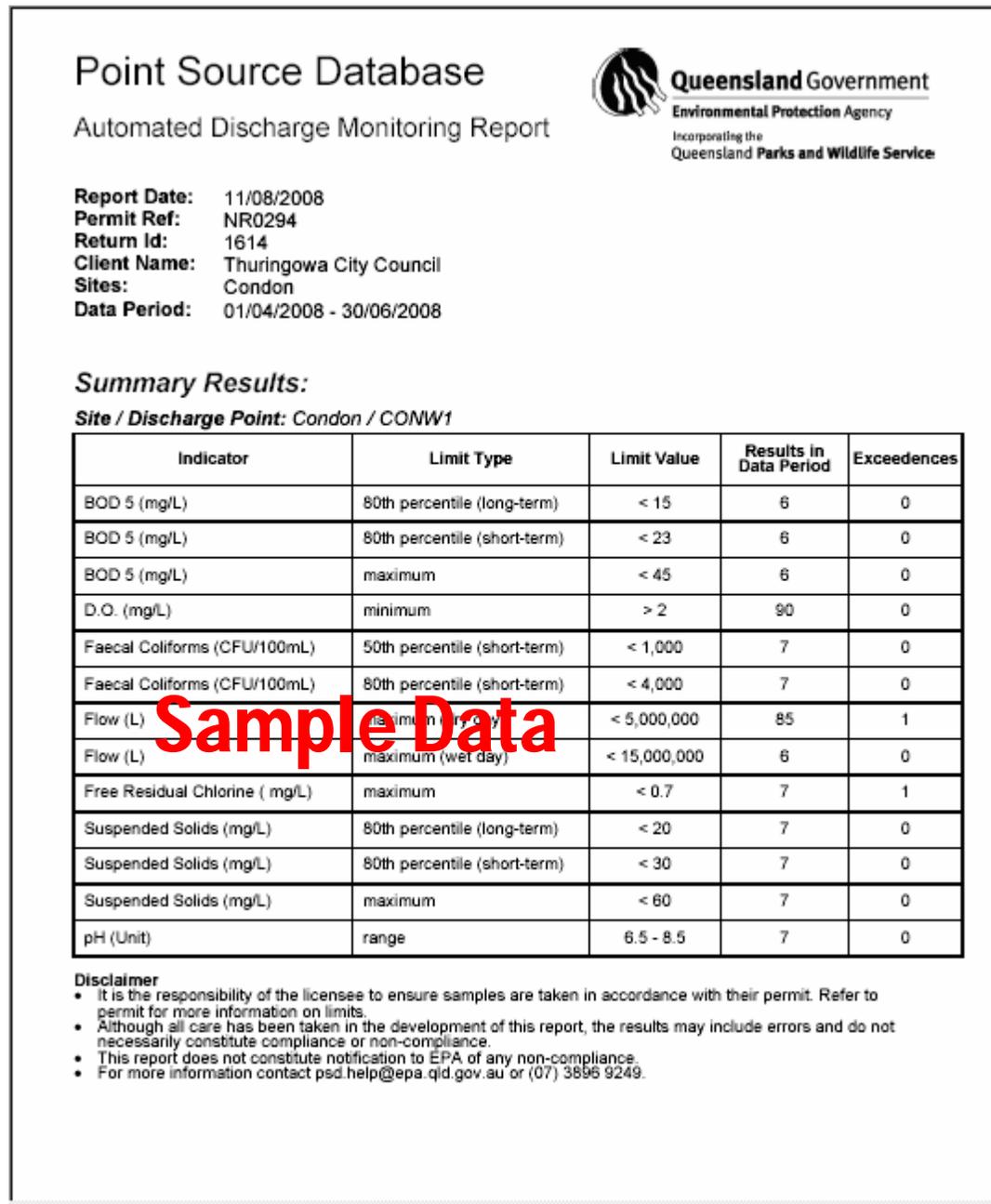


Figure 2. Example of an Automated Discharge Monitoring Report

Decision Making Support

There are a number of ways the information stored in the Point Source Database can be accessed which vary, dependant on whether the request is internal or external to the EPA. For EPA staff, PSD Online can be used to view and download data or graphs. Additionally, a spatial layer of information is exported to EPA Geographical Information Systems (GIS) where the location of the facilities and the permit limits can be viewed. For external organisations, raw monitoring data and the spatial layer can be requested by email. Requests for point source or other water quality data can also be made from Freshwater & Marine Sciences Group via email from water.data@epa.qld.gov.au. The Spatial GIS layer of locations and limits can be requested via email from data.coordinator@epa.qld.gov.au.

More details of these information management tools are provided below, Figure 3 illustrates the methods of information access to EPA staff and external groups.

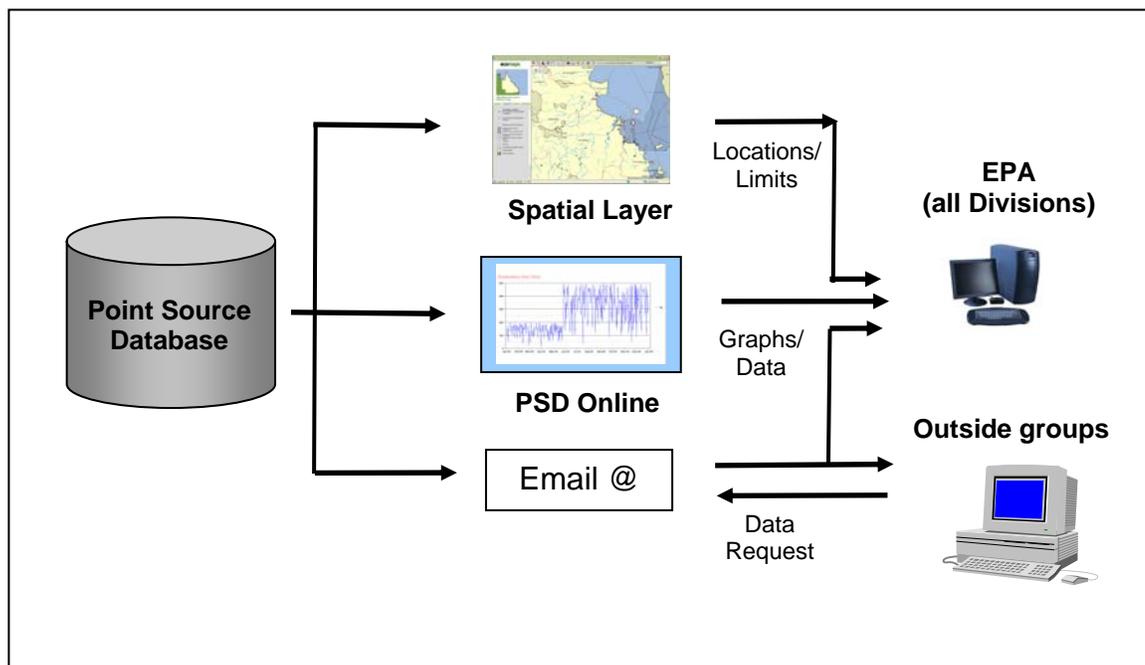


Figure 3. Schematic of data access methods

PSD Online

PSD Online is a flexible graphing tool which allows charts to be created using the data submitted by licence holder's. Data for all sites and indicators stored in the database can be accessed by the user. The date range of interest can be selected, sorting and filtering can be done on catchment, stream, activity type and sewage treatment plant capacity using the selection grid, see figure 4. The data can be presented with relevant limits which can be used to visually determine compliance and this data can be exported from the database in an excel spreadsheet. Detailed instructions on how to use the software is supplied in an Online Help Manual. Figure 5 is a sample chart showing changes in total nitrogen and total phosphorus concentrations for a discharge over time and comparison to limits.

Point Source Data Online Home > Features > Data Online

» Features » Data Request » What's New » Feedback » Disclaimer » Help

SITE	DP	PERMIT	Active	CLIENT	BASIN	STREAM
Beaudesert	BEAW1	SR2218	Y	Beaudesert Shire Council	Logan-Albert River BASIN	LOGAN RIVER
Beenleigh	GCCCRP3	SR2206	Y	Gold Coast City Council	Logan-Albert River BASIN	ALBERT RIVER
Bitumen Plant	BITW1	SR0070	Y	Shell Company of Australia	Brisbane River BASIN	BRISBANE RIVER
Bi Bi	BLW1	SR0307	Y	Maroochy Shire Council	Maroochy River BASIN	MAROOCHY RIVER
Bohle	TVLW3	NR0137	Y	Townsville City Council	Test Basin 001	My test stream 1
Bowen	BDWW1	NR0329	Y	Bowen Shire Council	Proserpine River BASIN	PACIFIC OCEAN
BP Refinery	BPRW1	SR0084	Y	BP Australia Ltd	Brisbane River BASIN	BRISBANE RIVER
BP Refinery STP	BPRW2	SR0084	Y	BP Australia Ltd	Brisbane River BASIN	BRISBANE RIVER
BP Whinstanes	BPWW2	SR115	Y	BP Australia Ltd	Brisbane River BASIN	BRISBANE RIVER
BP Whinstanes	BPWW1	SR115	Y	BP Australia Ltd	Brisbane River BASIN	BRISBANE RIVER
Brendale	PRSCW12	SR1248	Y	Pine Rivers Shire Council	Pine River BASIN	SOUTH PINE RIVER
Bribie Aqua	BIAW1	ENDC00143505	Y	Department Primary Indust	Brisbane River BASIN	MORETON BAY
Bribie Island	BRW1	SR1750	Y	Caboolture Shire Council	Queensland Coastal	GROUNDWATER

1. Choose Indicator(s)

BOD 5 (mg/l)
D.O. (mg/l)
Faecal Coliforms (CFU/100ml)
Flow (L)
Free Residual Chlorine (mg/L)
Suspended Solids (mg/l)
Total Nitrogen (mg/l)
Total Phosphorus (mg/l)
pH (Unit)

2. Pick FROM date
9/12/2007

3. Pick TO date
9/12/2007

4. Choose Type of Limit
Not Available

Data/Graph

SITE Brendale Sewage Treatment Plant

PERMIT SR1248 (Click for details)

CLIENT Pine Rivers Shire Council

DP_ID PRSCW12

DP_DESCR Sewage wastes from STP via an outfall pipe to the South Pine River approx. 7.5km AMTD

DP_MAIN Y

DP_LAT -27.3233 (Click for Map)

DP_LON 153

BASIN Pine River BASIN

STREAM SOUTH PINE RIVER

Figure 4. Initial screen showing the selection grid of PSDOnline

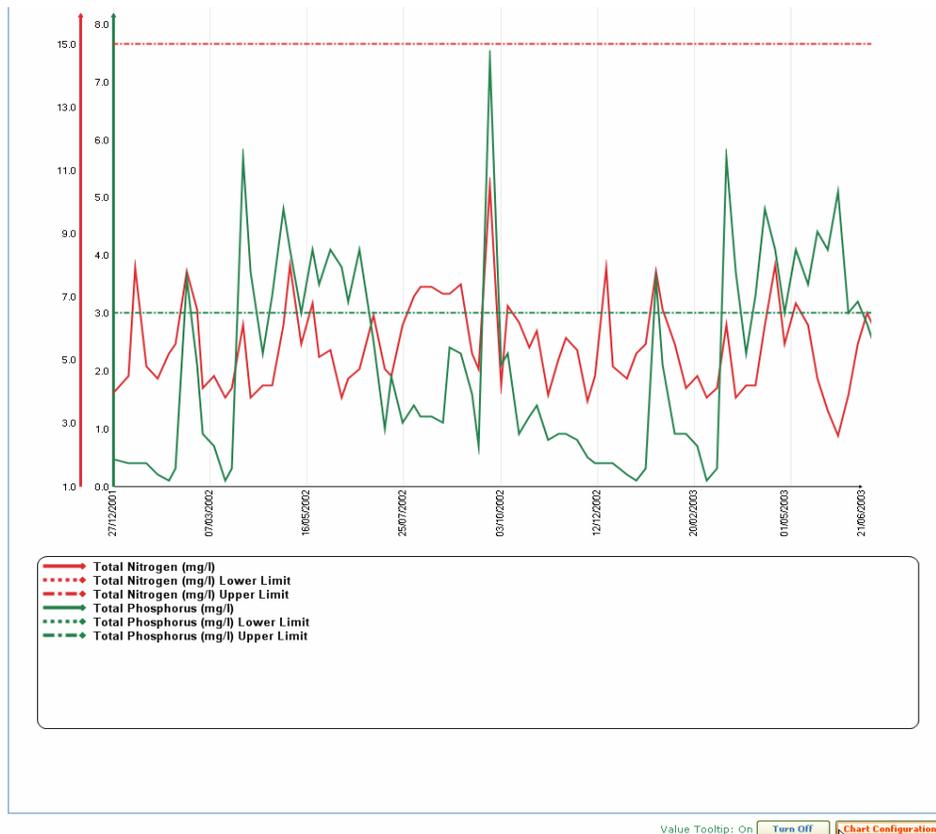


Figure 5. Example of PSD Online graphing for changes in total nitrogen and total phosphorus concentrations for a discharge and comparison to limits

PSDOnline also incorporates a load estimation function. This load estimation can be performed on any nutrient species as well as total suspended solids. Currently, loads can be calculated over various time periods. The load calculation is prescribed by the following formula:

$$\text{Daily Load (kg)} = \text{Flow (L)} \times \text{Concentration (mg/L)} \times 10^6 \text{ (mg/kg)}$$

However, since Flow is generally measured daily and concentration measured usually every week or every two weeks, the next available nutrient concentration is used to calculate the load for each day of that week or fortnight. This daily load can also be summed to produce monthly or annual loads. Although if alternative calculations are preferred, the data can be exported in a spreadsheet format for customized data manipulation.

A common problem with all environmental data is periods of missing data, therefore a feature of the load estimator is the capacity to estimate missing flow using a common statistical model. Briefly, as long as a minimum number of flow values are present in the estimation period, the mean flow of the sample (i.e. the values that are present) is calculated and approximated to the mean flow of the population (i.e. all values in the estimation period). This allows an adjusted load to be calculated which provides a more useful comparison than a load calculated using incomplete data.

Various time periods can be used for calculation, such as daily, monthly and annual loads (based on calendar or financial years). This tool provides a quick easy way to compare point source loads over different plants, different streams and different catchments. Also information can be used to assess the effectiveness of load management or to target the point sources with the most significant environmental impact. The total nitrogen point source loads of 5 large treatment plants in a Queensland catchment was substantially reduced in the five years between 2002 and 2007. However, using data from PSDOnline, information can be compared regarding the relative contribution of each plant to the total nitrogen load, see Figure 6 below. This information can provide information on the effectiveness of treatment plant upgrades or suggest where future improvements would have the most benefit.

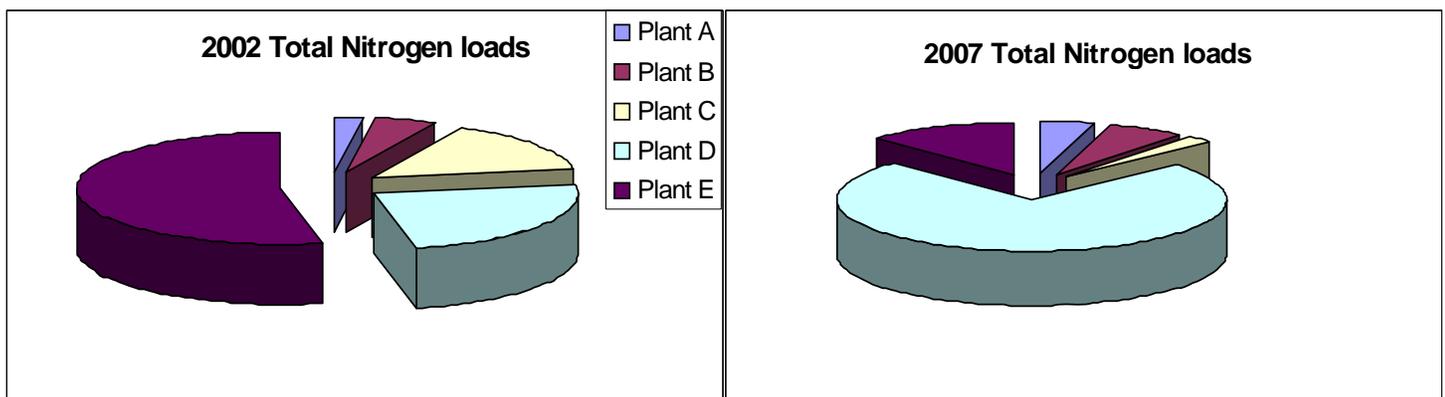


Figure 6. Various treatment plant contribution to loads of total nitrogen

Spatial Layer for GIS

In addition to the above mentioned features, the PSD allows the generation of a spatial layer for GIS that shows the location of the point source discharges and the limits which apply to those locations, see figure 7 below. This provides valuable information to EPA staff who can quickly view local point source discharges for a particular catchment. This can inform the approval process for future discharges or limits, by providing information on current discharge locations and limits in the catchment.

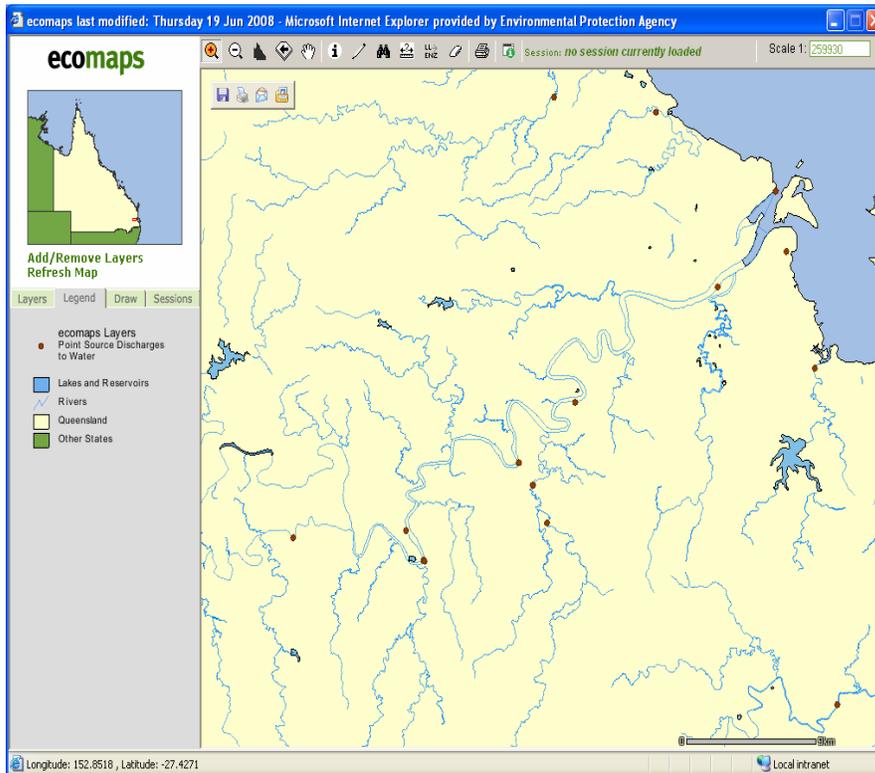


Figure 7. Screenshot of the Point Source discharges on the Brisbane River

Implementation Overview

The PSD has currently been implemented for sewage treatment plants in Queensland with capacity of greater than 10,000 equivalent persons (ERA 15 (e), (f) and (g) under Schedule 1 of the *Environmental Protection Regulation 1998*¹) and involve a direct discharge to waters. Additionally, the database also contains monitoring results for smaller plants as some licence holders who have more than one plant have chosen to submit results for all their plants electronically. Currently, point source data is available for over 60 plants in Queensland. Historical data for these discharges has been collected, in most cases back to the year 2000. Electronic submission of quarterly data commenced for these discharges in 2007.

The PSD has been initially set up to collect information on direct releases to water. However, flow measurements of “recycled water” leaving the registered operator’s premises are also being collected for some sewage treatment plants. At this stage, flows or quality of waters released to land via irrigation, covered under the permits are not collected or checked against permit limits, but it is aimed to collect this information in the future.

The next phase of the implementation will target major industry and the remaining sewage treatment plants, firstly in South East Queensland (SEQ) and then the remainder of Queensland. Some historical data for major industry in SEQ has already been collected for inclusion in the database.

Discussion

The information system described has the ability to capture up-to-date monitoring information on point source discharges in Queensland and has been implemented for major sewage treatment plants. The development and implementation of the system has occurred over the last six years and has required on-going improvements to ensure implementation has been successful. Many of the improvements focused around the compliance checking and reporting. This was mainly due to the complexity and variability of EPA permits limits across the State. Each limit type had to be programmed (hard coded) into the system using Java computer language. It is hoped that one of the benefits of the system will be the ability to more easily review limits, limit types and their effectiveness, which will lead to stream-lining of these permits in the future.

Implementation has been successful for one major industry sector (sewage treatment plants) in Queensland. Implementation required various information sessions with licence holders and the system was generally well received by these clients. The major amount of time required by EPA staff for implementation was the manual manipulation and importing of historical data. Historical data of at least 12 months was required to allow reporting of long term limits that are typically calculated using 1 year of data. Subsequent data was submitted using templates and some licence holders made errors in preparing monitoring data files which required checking and feedback. Manual generation of templates also required some time commitment.

Maintaining up-to-date limits was identified early as a potential challenge for the project. Although some systems are set up in the Agency to notify of updated or new permits, it was likely that up-to-date limits would be difficult to achieve. Currently the limits are displayed in the automated monitoring reports and therefore licence holders and EPA staff reviewing these reports can check and notify the database manager if the limits are not correct.

Major work was required to choose and develop the framework for the graphing tool, PSD Online. This current tool is a Microsoft Windows .Net application that interacts with the Oracle Point Source Database. It can now be accessed by any Agency networked computer. The .Net has been a useful platform for this type of application and the scale of use, given the flexibility and cost of development. Future expansion of the tool to ambient water quality data is also being considered.

Over the extended period of development and implementation, the database software and hardware for the system has become out-of-date and major upgrades have been required. In addition, some software improvements are planned to improve business performance. These include incorporating more rules to test for errors in the data import files, allowing clients to directly upload excel spreadsheets to the web instead of email and generate templates automatically from the limits stored in the database. Additionally, there are plans for the web interface to directly communicate data or formatting errors to licence holders and prevent data upload until these errors are addressed. This will minimize the involvement of the database manager for routine issues. A process to achieve these improvements is underway and has involved significant time and resources and close collaboration with the Agency's Information Technology (IT) Branch over the last two years. A major learning for the project team has been developing an understanding of the Agency and government IT requirements. The development of this project is ongoing.

The feedback from EPA staff on the PSD and related tools has been extremely positive. Managers and officers in the agency have been very supportive of the implementation and expansion of the system to other industry sectors. Various strategic projects for use of the data in the system are planned and opportunities will increase even more with greater implementation.

References

1. Environmental Protection Act 1994 (Qld) Environmental Protection Regulations 1998