RS.01 Hotham-Williams-Murray River Salinity Recovery Project

Project Outline

January 2007

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Introduction

The Hotham-Williams-Murray River Salinity Recovery Project is a strategic initiative of the South West Catchment Council, funded through the National Action Plan for Salinity and Water Quality, a joint programme of the Western Australian and Australian Governments.

Through a tender process develop by the South West Catchments Council (SWCC) as part of its South West Natural Resource Management Investment Plan 2006-2008 (IP2) the Peel-Harvey Catchment Council in partnership with GHD Pty Ltd and the Department of Water (Water and Rivers Commission)), were successful in being awarded funding to undertake the Hotham-Williams-Murray River Salinity Recovery Project.

Project Methodology: Summary

Background

The Salinity Situation Analysis of the Murray-Hotham-Williams River Salinity Recovery Project will be delivered in three parts[1]:

- Part 1: Strategic (Desktop) Salinity Investigation.
- Part 2: Development and Implementation of Monitoring Program.
- Part 3: Development of LUCICAT catchment model & assessment of base case scenarios.

Part 1 Strategic Salinity Investigation

The aim of Part 1 will be to develop a conceptual model for salinity within the catchment including:

- Understanding the drivers and trends in salinity development within the catchment.
- Define key strategic sub catchments and tributaries.
- Inform other components of this project.

Part 2 Development and Implementation of Monitoring Program

The aim of Part 2 will focus on determining the monitoring requirements for the project. This will include collecting additional information required for input to the LUCICAT Model and reviewing requirements for additional ongoing monitoring within the catchment, including an assessment of the need for additional permanent gauging stations.

[1] *A significant amount of text contained in this document has been taken from the original project proposal developed by the three parties and documented by GHD, all acknowledgement is given to GHD as the original authors of the included text.*

Part 3 Development of Catchment Modelling & assessment of base case scenarios

Part 3 of the project will include the development of a hydrologic model of the catchment initially as a means of testing base case scenarios; however the model will provide a means of assessing a range of potential management options. This part of the project will include:

- Defining inputs to the numerical catchment model (LUCICAT), including critical land use parameters.
- Model development.
- Modelling of base case scenarios, as a means of determining relative extent, or boundary conditions for potential modelled options.

This project will not include the development and detailed assessment of salinity management options. Moreover the project is focused on developing an interim salinity situation statement that will inform the development of potential management options to be undertaken in a subsequent project.

The catchment hydrologic model, LUCICAT is the tool by which a subsequent analysis of potential management options can be undertaken.

The assessment of management options is recommended for the next phase of the Hotham-Williams-Murray Rivers Salinity Management / Recovery Plan, to be funded through potential subsequent investment.

Detailed Project Methodology

Part 1: Strategic Salinity Investigation.

The Strategic Salinity Investigation (Part A) of the project forms the foundation on which the remainder of the Salinity Management / Recovery Project will build. The outcomes of the Strategic Salinity Investigation will identify priorities and target areas for the development of the monitoring strategy, will form the basis of inputs to the catchment model, and will ultimately shape the development and implementation of management options.

The objective of the proposed Salinity Investigation is to develop a strong conceptual hydrogeological model for the catchment. In particular, the objective is to understand the relationship that exists between groundwater rise, salinity development within the catchment, and expression of stream flow salinity.

This will require spatial and temporal analysis of three principal datasets:

- Catchment Salinity – including catchment salinity mapping and Land Monitor.
- Groundwater monitoring data.
- Stream flow monitoring data.

The analysis will be undertaken within the context of other available base data sets for the catchment, including: a digital terrain model, aerial photography, vegetation, geological and hydrology, cadastre and other related data sets.

The proposed methodology is similar to that adopted by the Department for Water in undertaking salinity situation assessments for water resource recovery catchments including the Collie and Warren Catchments.

The components of this investigation are presented below.

Collation of technical data.

The following GIS datasets will be collated and used to initiate the development of the LUCICAT Model:

- *Topography (contours), including DTM if available.*
- *Landscape soils maps.*
- *Geological series 1:250,000.*
- *Roads.*
- *Surface hydrology.*
- *Digital, rectified, aerial photographs.*
- *Time series satellite imagery to define catchment land use.*
- *Groundwater monitoring (DAWA Ag bores dataset).*
- *Stream flow monitoring data (DoW WIN database)*
- *Vector Land Monitored dataset including salinity 1987 – 1992, salinity 1995 – 1998, Valley hazard mapping 0 - 1 m & 1 --2 m.*
- *Sub catchments, based on watersheds of surface water hydrology.*

- *Geophysical datasets held by community and all mining companies within the catchment.*

Data sets such as the Peel-Harvey Salinity Snapshot events, other community data and datasets held by mining companies active in the study area will be accessed and included in the model where possible.

Review Current Gauging Stations

A review of the three existing gauging stations within the project area will be undertaken. The review will include an assessment of the accuracy of the three gauging stations located on the Murray, Hotham and Williams Rivers.

The assessment will include:

- Quality of information collected from gauging stations.
- General assessment of accuracy.
- The quality of the site - in context of providing accurate flow in representative water quality.

Information generated from this part of the project will help inform the need for additional gauging stations within the catchment, however will need to be considered within the context of other information generated within the project.

Preliminary Catchment Hydrogeologic Assessment.

A preliminary analysis of available data as background to the salinity situation analysis will be undertaken. This will include the review of a range of datasets forming a preliminary geomorphologic assessment of the catchment. The purpose is to determine the underlying geological and geographic features influencing groundwater and surface water flows within the catchment.

This desktop assessment will provide background information important in undertaking the salinity trend analysis for the catchment.

Ground Truth Land Monitored Dataset

The Land Monitor data set will be critical to undertaking the salinity situation analysis, as it provides a spatial and temporal account of salinity. Previous analysis of Land Monitor data undertaken within catchments with a similar geomorphology to the project area indicates that Land Monitor provides a good indication of the relative distribution of salinity. However, as this is interpreted remotely sensed data, ground truthing is necessary, both in determining its accuracy and to identify underlying trends that may exist within the dataset itself (GHD 2006).

Ground truthing will involve comparing Land Monitor with digital rectified aerial photography, time-series satellite imagery, in addition to limited aerial mapping of salinity within the catchment. Aerial salinity mapping has been shown to be effective in other catchments, in improving the quality of aerial photograph interpretation.

Salinity Trend Analysis

The objective of the salinity trend analysis is to identify the spatial distribution of salinity within the catchment, define when land became saline, and define areas at risk of further salinity development. These three criteria are critical in devising potential salinity management options. For instance, managing options for mildly saline land, or land at risk

of salinity, are likely to be very different from options for managing moderately - highly saline land.

The salinity trend analysis will also identify risks to key assets within the catchment.

Salinity trend analysis will be undertaken within three parts.

- Temporal and spatial analysis of the Land Monitor dataset overlaid with sub-catchments within the Murray, Williams and Hotham River catchments.
- A review of the groundwater monitoring data will be undertaken to identify groundwater trends within the catchment.
- Analysis of stream flow monitoring data.

The objective of the salinity trend analysis is to develop an understanding of the relationship between groundwater rise, development of salinity within the catchment and stream flow salinity. An effective conceptual hydrogeological model for the catchment will require an understanding of the basic relationships that exist between these three primary datasets.

Vegetation health trend analysis for the catchment has previously been undertaken and has in other areas been previously used as supporting data for salinity trend analysis, particularly in identifying areas at high risk of further salinity development (GHD 2006 b).

The preliminary hydrogeological assessment, overlayed with the salinity trend analysis, will provide the foundation for the conceptual hydrogeological model for the catchment. The primary purpose of the conceptual hydrogeological model for the catchment is to:

- Define areas of salinity within the catchment.
- Define salinity trend analysis at a sub catchment scale.
- Determine the areas at highest risk of further salinity development.
- Predict changes in area impacted by salinity.
- Predict changes in stream flow salinity.

It is assumed that the primary purpose of undertaking the investigation is to determine the risk of further salinity within the catchment; however a brief assessment of nutrients and pH will also be undertaken where data is available. This assessment will be limited to the area upstream of the Swan Coastal Plain, and will not include assessment of acid sulphate soils.

Interim Salinity Status Statement

The information developed through this project will be presented as a Draft Interim Salinity Status Statement for the Murray, Williams & Hotham River Catchments; this report will include:

- Geomorphology and hydrogeology of the catchment.
- History of the catchment, including periods of major clearing and anecdotal evidence regarding salinity development.
- Salinity trend analysis, including current distribution of salinity, patterns of salinity development and areas at greatest risk of developing salinity.
- Interpretation of groundwater and stream flow trends.
- Rainfall run-off relationship, including potential impacts of climate change predictions on stream flow.
- Gap analysis including specific recommendations for detailed salinity investigation.

- Discussion of implications of salinity and stream flow trend analysis.

Part 2: Development of Implementation and Monitoring Strategy.

Completion of the *Strategic Salinity Assessment* (Part 1) of the project will identify gaps in information that will be important in formulating a monitoring strategy for the catchment.

The specific objective of this component (Part 2) of the project aims to develop and implement a preliminary monitoring strategy for the project area. The purpose of this monitoring strategy is to further inform data inputs to the catchment model, in addition to the commencing ongoing monitoring. It is described as a preliminary monitoring strategy, as a subsequent development and implementation of management options may result in further monitoring requirements.

Gap Analysis.

The Gap analysis is designed to identify gaps in monitoring. It will be undertaken as a means of determining the interim monitoring requirements, specifically for further defining parameters for the LUCICAT Model to be developed in Part 3 of the project. This component of the project will also inform the requirement for additional salinity monitoring sampling points outlined below.

Assessment of Ongoing Monitoring Requirements

The brief for this project includes the establishment of two additional permanent gauging stations within the catchment. The extent to which these additional gauging stations will assist in the development of a salinity recovery/management strategy for the catchment is unclear.

There are currently three permanent gauging stations located within the lower reaches of the Murray, Williams and Hotham Rivers. These gauging stations have between 30 - 70 years of recorded flow data, however periods of intermittent or inconsistent data may influence the effectiveness of the data record. It is possible that two additional gauging stations located in the middle reaches of the catchment may provide a more effective dataset considering the relative contributions of salinity from upper and lower reaches of the catchment. However, it is likely that eight to 10 years of flow data would be required for this information to be of value. This period of recorded data is considered to be the minimum required to effectively calibrate a flow model for the particular gauged site.

An assessment of the ongoing monitoring requirements of the catchment will be undertaken, including a specific assessment of the requirements for additional permanent gauging stations. This will include an assessment of the condition of the current gauging stations within the catchment, and will in part be informed by the component of Part 1 of the project associated with reviewing the rating of gauging stations within the catchment. Two reports will be developed detailing a) the condition of existing gauging stations and b) the rationale behind the decision in relation to additional gauging stations.

The decision to install additional permanent monitoring sites is also contingent upon agreement for these sites to be monitored and operated as a part of the strategic water quality monitoring network on an ongoing basis, this also may influence the location of any new proposed infrastructure.

On-ground Monitoring

Presented below is the range of salinity investigation tools that may be implemented:

- ***Salinity Monitoring Sample Points***: Previously annual snapshot monitoring of salinity has been undertaken by Ribbons of Blue and the Peel-Harvey Catchment Council. Spot monitoring such as this provides a geographic description of salinity concentrations within the catchment. This will be important in defining areas within the catchment delivering high salt loads, and represents an important input into the LUCICAT model to be developed in Part 3 of the project.
- ***Temporary Gauging***: A small number of salinity monitoring sites may be established at strategic locations in the catchment within the constraints of the allocated budget. Continuous salinity data will significantly enhance the spot monitoring undertaken at the various sampling points within the catchment. This additional continuous salinity data will provide a temporal context to stream flow analysis, which is important in understanding the mechanism by which salts move around the catchment. In particular, the temporal dynamics of salt mobilisation within the catchment will be important; both in context of potential management options, but also to more effectively determine risks to receiving environments.
- ***Installation/Upgrading of Permanent Gauging Stations***: Depending on the outcome of the monitoring strategy for the catchment, there may be a requirement to upgrade current gauging stations within catchment, or indeed install additional permanent gauging stations. A provisional budget has been identified for this component project, and will be reviewed on development of the monitoring strategy.
- ***Data Interpretation & Reporting*****:** Effective design of monitoring and high-quality data interpretation will be key factors in determining the success of these project components.

The outcomes of Part 2 & 3 will be appended to the documentation of the outcomes of Part 1 - forming the *Interim Salinity Situation Report for the Murray, Williams and Hotham Catchments.*

Part 3: Model Development / Base Case Scenario Modeling

Background

The principal purpose of undertaking catchment hydrologic modelling is to better inform extrapolated transit salinity development, determine base case scenarios, and develop a tool for undertaking assessment of the potential salinity catchment management options. The LUCICAT model has previously been employed by the Department of Water to develop the management option analysis for water resource management catchments in Western Australia.

Definition of modelling parameters for (LUCICAT)

LUCICAT models salinity at a catchment scale using a range of physical catchment parameters. Some of these catchment parameters, including sub catchment boundaries, will be developed during part one of the project. Other parameters including catchment land use and definition of channel networks are specific inputs to LUCICAT, and will need to be developed during Part 3 of the project.

In particular, an assessment of historic land use change within the catchment will be undertaken through interpretation of time series satellite imagery for the project area. Interpretation will provide an indication of periods during which major clearing occurred within the catchment. This GIS based component of the project will be undertaken using available aerial photography and satellite imagery.

Other parameters specific to LUCICAT include topography, soil depths, groundwater levels, and stream flow networks.

Catchment Hydrologic Model (LUCICAT)

LUCICAT is a water balance model developed by the Department of Water that uses catchment land use change and other parameters to model stream flow generated on a daily time step.

The model consists of five salt & water stores:

- Dry, wet and subsurface and stores for vertical and lateral water flow (3).
- A transient stream flow (1)
- A saturated groundwater store (1).

The model simulates components of hydrology by mimicking surface run-off, intermittent and deep groundwater interactions following rainfall. The model also simulates groundwater discharge to stream flow, and evapotranspiration processes occurring within the catchment.

This daily time step model has previously performed well in simulating daily stream flow in catchments in the southwest of Western Australia. The model has been used in undertaking the Warren and Collie River salinity situation analysis, and has been successfully applied to assessment of potential management options within these catchments.

Provided is a summary of the steps required in the modelling process:

- Data definition, including land use history, topography, soil depths, groundwater levels etc (described above).
- Model development and Input of daily rainfall and pan evaporation etc

- Calibration of the LUCICAT Model with recorded time series stream flow data.
- Run case scenarios, to identify any bugs within the model and determined robustness.
- Manipulation of land use change and rainfall data to predict potential changes in stream flow.

Modelling of the Base Case Scenarios.

Running of base case scenarios is generally undertaken to determine the robustness of model performance under a range of scenarios and to define the extremities of outcomes likely considering a limited number of potential management options.

Running of base case scenarios may also provide feedback in terms of the accuracy of information and robustness of data used as input to the model. This is a particularly important consideration in determining whether that information collected during this project, in addition to the development of the model, is sufficient to progress to the development and implementation of potential catchment salinity management options.

In the event that the analysis is sufficiently robust to progress to the assessment of alternative catchment management options, running base case scenarios provides a framework by which to better determine the range of management options to be assessed. In addition, the base case scenario provides an effective means of undertaking the community consultation component likely to be included in the development of alternative catchment management options.

It is considered that the preliminary scoping of potential management options will provide valuable input into developing the scope of works for subsequent investment into the development of a Management /Recovery plan for the Williams, Hotham and Murray Rivers.

Reporting

Reporting outcomes associated with Parts 2 & 3 of the project will be appended to the information collected during Part 1 of the project to finalise the ***Interim of Salinity Statement for the Murray, Hotham and Williams River catchments*****.**

Project Timeline

Table 1 ***Basic timeline of project activities***

		Q2 Oct-Dec 2006	Q3 Jan-Mar 2007	Q4 Apr-Jun 2007	Q5 Jul-Sep 2007	Q6 Oct-Dec 2007	Q7 Jan-Mar 2008	Q8 Apr-Jun 2008	Q9 Jul-Sep 2008
Part 1	*Collate technical data*								
	Steering Committee Establishment								
	Review of current infrastructure								
	Preliminary Catchment Hydrogeologic Assessment								
	Ground Truth Land Monitored Dataset								
	Salinity Trend Analysis								
	Reporting								
	SWCC M&E Plan Development								
Part 2	*Workshop - review methodology*								
	Gap Analysis								
	Stream flow monitoring								
	Temporary Gauging								
	Snapshot Monitoring								
	Data analysis and reporting								
	Upgrade/install gauging stations								
Part 3	*Definition of modelling parameters*								
	Model development								
	Base case scenarios								
	Report to Community Forum (PHCC ACF)								
	Interim Salinity Statement for H-W-M Rivers								
	Reporting								