WALLOONS WATER MANAGEMENT STRATEGY

Summary

The initial water management strategy for the Walloons consists of:

- building water treatment facilities to treat the produced water to a high standard and discharging the treated water to the Condamine River System;
- constructing evaporation ponds to handle the feed and discharge water related to the water treatment facility;
- constructing lined holding ponds to allow produced water to be pumped to the feed pond of the water treatment facility; and
- Constructing lined ponds for holding produced water from pilot trials.

It is OE's view that this strategy will facilitate:

- A substantial reduction in the environmental footprint (required evaporation pond areas) of the project;
- Augmentation of environmental flows in the Condamine River and improved riparian stock and domestic supplies;
- Provision of additional supplies to existing and new licensed irrigators along the river;
- Possible improvement in urban supplies to Miles and Chinchilla;

The strategy will also allow OE to continue to pursue alternative beneficial uses of the water, including:

- Meeting the demands of future industrial users by redirecting some of the water flows from the developed infrastructure. It is noted the earliest this is expected to occur is 2012;
- Irrigation. OE is assessing a range of crops and trees that may be grown in the Walloons area.
- Water injection of high quality water into existing aquifers for storage and future reuse (pending appropriate legislative changes); and
- The possible future use of salt recovery processes to reduce waste products.

1. Introduction

This document covers the water management strategy in relation to the produced water associated with the Origin Energy (OE) Walloons development to get to a plateau gas rate of 90 TJ/day. The expected water profile associated with this gas ramp up is shown in Figure 1.

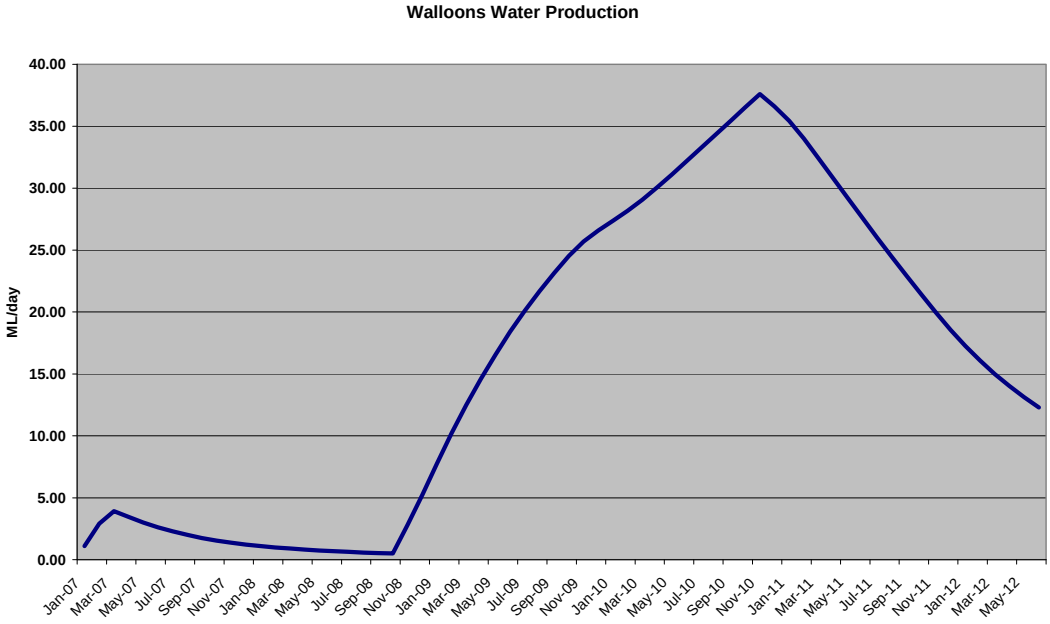

Figure 1 Expected water profile for the Walloons development gas ramp up to 90 TJ/day.

The water management strategy proposed for the Walloons development can be considered very similar to that undertaken by OE at its Spring Gully Development. The section below gives an update of the current infrastructure at Spring Gully and the options for beneficial use OE is pursuing at Spring Gully.

The infrastructure at Spring Gully consists of:

- a centralised water collection system delivering water to a single point;
- short term storage ponds to facilitate initial water treatment and operational flexibility;
- an (integrated membrane system) water treatment facility (WTF) to desalinate the water to a standard suitable for beneficial uses;
- Discharge of high quality treated water to Eurombah Creek to augment environmental flows; and
- Evaporation ponds for storage and evaporation of the brine produced by the WTF.

The options being actively pursued for further beneficial use of the water at Spring Gully include:

- Irrigation of agricultural crops - Prior to the completion of the current WTF, water produced from reverse osmosis trials was successfully used in a field scale irrigation trial. OE has since undertaken an independent agricultural water use study (*Coal Seam Gas Water Management Study- Agricultural Use by Horizon Rural Management, September 2007*) for both Spring Gully and the Walloons to ascertain the potential viability of irrigated agriculture. OE will be calling for "Expressions of Interest" from local landholders in April 2008 for the implementation of an irrigation development at Spring Gully. In addition, OE has committed to an irrigated tree cropping trial for biofuel production in conjunction with the Queensland Government and the University of Queensland.

Tree planting is scheduled for May 2008. Detailed studies investigating the viability of tree cropping for carbon sequestration are currently in progress.

- Urban and Industrial Use – OE has undertaken an independent urban and industrial water use study (*Coal Seam Gas Water Management Study – Urban and Industrial by Parsons Brinkerhoff, December 2007*) for both Spring Gully and the Walloons. This study has identified a number of potential water users within to the proposed Surat Basin Development. OE in conjunction with Santos has submitted an "Expression of Interest" to Xstrata for the supply of water to the Wandoan coal development from Spring Gully/Fairview.
- Salt Recovery – Prior to the completion of the current WTF salt recovery from RO brine trials were completed at Spring Gully. Further investigations are continuing on increased recovery from the new WTF to facilitate the extraction of potentially commercial salts.
- Brine Injection – OE is a stakeholder in the nearby Fairview development. Trials for produced water reinjection are currently being undertaken on the Fairview development site. OE is awaiting the outcome of the work done by the Fairview Joint Venture (JV) before consideration is given to undertaking a similar development at Spring Gully.

2. Walloons Water Management

The alternative potential uses for CSG produced water in the Walloons include:

- Evaporation pond storage;
- Groundwater injection;
- River Discharge;
- Irrigation;
- Livestock;
- Aquaculture;
- Urban;
- Industrial; and
- Salt recovery.

All of the above identified uses except limited livestock consumption, evaporation pond storage and some industrial uses will require some form of treatment to make the water suitable for further use.

Evaporation Pond Storage

Water balance modelling indicates that at a peak water production rate of 37.5 ML/day a total pond area of approximately 750 hectares would be required to contain the volume of produced water, unless some other form of use/disposal is implemented. A WTF with a capacity of 32 ML/day operating at a recovery of 85% will reduce the total additional area of feed and brine evaporation ponds required to approximately 200 Hectares. It is estimated that an additional 60 hectares of ponds will be also required for pilot trials.

Groundwater Injection

The alternative aquifers for groundwater injection in the Walloons include:

- Injection into existing high permeability aquifers including the Hutton and Precipice Sandstones; and
- Injection into the developed coal seam after water and gas depletion.

Hutton and Precipice Sandstones
The Hutton and Precipice Sandstone aquifers form part of the Great Artesian Basin and are therefore subject to strict management guidelines. Utilisation of these aquifers in the area is significant with water supplying intensive livestock and industrial development as well as some domestic use.

Water quality in these aquifers varies widely but is comparable to CSG water in some areas and needs to be assessed over a wide range of parameters to compare with CSG production water. Further investigations are required to assess the compatibility of these activities with CSG produced waters.

OE's assessment, based on the current information available, of the respective aquifers is that the:

- Hutton Sandstone has insufficient reservoir quality in the development area to be a suitable candidate.
- Precipice Sandstone is either poorly developed or absent in the development area. Suitable reservoir quality is mapped to be approximately 15 km away in the Condabri region.

Consequently, injection into these aquifers was not considered as part of this development.

Coal Seam Aquifers
Both the Juandah and the deeper Taroom coal seams exist in the Walloons area. OE's gas production will draw from both seams. Other gas producers such as QGC are also drawing from these seams. Successful injection of water into these seams is unlikely until such time as the gas has been depleted very late in the life of the field.

River Discharge

Discharge of CSG water to the environment requires salinity reduction, specific ion (fluoride) removal, and pH adjustment to make the water suitable. OE propose to do this through use of an Integrated Membrane System (IMS) that will produce permeate with water quality consistent with that currently found in the Condamine River system.

Integrated Membrane System
The proposed Integrated Membrane System (IMS) at the Walloons will comprise four major modules. These include disc filtration (DF), microfiltration (MF), ion exchange (IX) and reverse osmosis (RO) systems. All interconnecting pipe work, tankage, services, lighting, clean-in-place (CIP) systems and integration and control systems will allow fully automatic and unattended operation for extended periods. All critical process parameters will be measured and recorded.

Water from the field collection system will flow into a lined feedwater settling pond to facilitate temperature reduction, mineral oxidation and continuity of supply to the IMS. Water will then overflow via controlled siphon into a lined IMS feedwater pond.

Water which is high in suspended solids and algae of varying genera/species will be pumped to the IMS from the IMS feedwater pond. Water will enter the first stage of the IMS consisting of an automated self cleaning disc DF to remove gross suspended solids. Backwash water from the DF will be returned to the open feedwater settling pond under residual head.

Filtered water from the DF will then enter into the second stage of the IMS. The second stage will consist of an MF system which will remove all suspended solids from the water

with an estimated recovery of typically 92 - 97%. The MF system will be comprised of hollow-fibre membrane filtration modules, along with all required pumps, tanks, piping, valves, instrumentation, and controls required for a complete and functional MF system allowing continuous operation of the IMS during backwash or chemical cleaning of the MF. Backwash water from the MF will be returned to the feedwater settling pond under residual head.

The third stage of the IMS will be a Weak Acid Cation Exchange (IX) system to remove cations which may cause later fouling of the RO system. The IX will consist of multiple operating vessels allowing continuous operation of the IMS during IX regeneration. Regeneration of the IX will be with hydrochloric acid. The IX regeneration waste water will be returned to the chemical wastewater pond under residual head. The IX will be capable of removing typically 98 - 99% of each of the multivalent cations including calcium, magnesium, aluminium, iron, barium and strontium on a continuous basis before exhaustion. Water produced by the IX after regeneration will be capable of being dosed with sodium hydroxide to raise the pH to that equivalent to the microfiltered feed water prior to feeding the RO, however low pH water produced by the IX will normally be returned to the feedwater settling pond without sodium hydroxide dosing. Sufficient capacity will be provided in the feedwater pumps, DF, MF, and IX to allow for the recycling of IX water to the feedwater settling pond under continuous RO operation;

The fourth stage of the IMS will be an RO system designed to remove soluble salts. It will consist of a three array membrane design, with low and high pressure feed pumps prior to the first stage, inter-stage pumping between the first and second array and the second and third array to facilitate flux balancing, reduced energy demand and optimum recovery. The first and second array shall be capable of an automated permeate flush on typically a 24 hour cycle. A third stage bypass will be installed to accommodate higher TDS water quality. The third array shall be capable of an automated permeate flush on typically an 8 hour cycle. Allowance will be made for the installation of an energy recovery turbine or similar device after the third array along with all other required pumps, tanks, piping, valves, instrumentation, and controls required for a complete and functional RO system.

The IMS will be capable of successfully and reliably treating Walloons water with an RO recovery range of 85 – 92%.

The Condamine River system in the vicinity of the Walloons Development

The Condamine River is part of the Murray Darling Basin and drains the northern portion of the Darling Downs. In the region of interest for this study, it flows West to East. Around 50km south of Roma it turns south west and becomes the Balonne River, passing through St George and ultimately becomes the Darling River.

The potential discharge locations (close to the confluence of the Condamine River and Wieambilla Creek) are all contained within the area covered the *Department of Natural Resources and Water (DNR&W) Condamine and Balonne draft resource operations plan – July 2007*. More particularly, the potential discharge locations are contained within the Chinchilla Weir Water Supply Scheme; Figure 2 presents the area covered by this scheme. The existing flow regime has been modified by water resource development – including "local" water storage and extraction at Chinchilla Weir and Chinchilla Water Supply Scheme (WSS) as well as upstream extraction and developments.

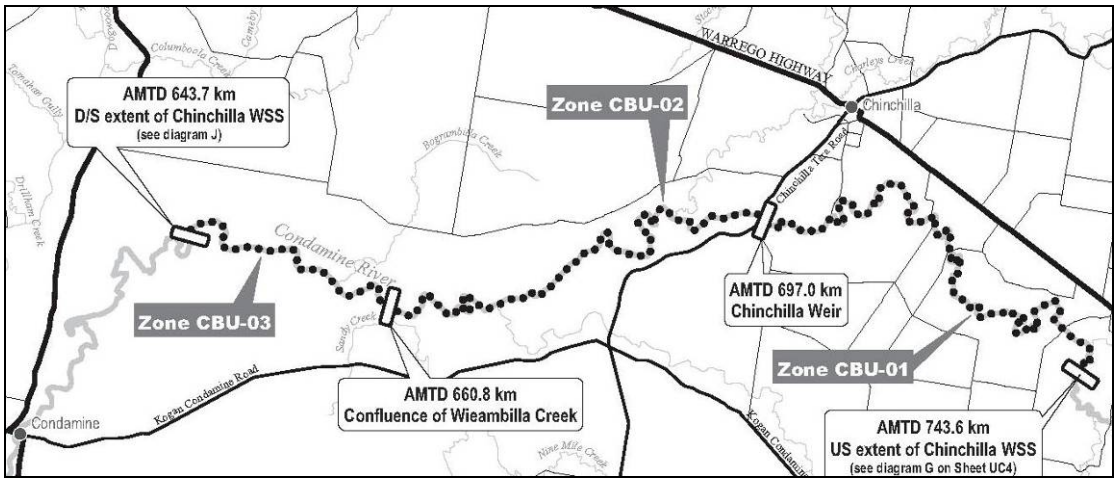

Figure 2 Condamine Balonne unsupplemented zones CBU-01, CBU-02 & CBU-03 extract of Sheet CB2, Condamine Balonne draft resource operations plan, NRW, 2007.

The closest gauging station to the potential discharge locations is at the Chinchilla Weir outlet and the next closest gauge is approximately 160km downstream at Cotswold. Figure 3 presents flow exceedence curves derived from the Chinchilla gauge record divided (1/7/1973 nominally adopted) into pre and post weir construction periods. These figures indicate that the release of an additional 35 ML/d would have no real impact on higher flow regimes (>300Ml/day). Such a release would also bring flows of between 50 and 300 Ml/day closer to the pre 1973 frequencies. However, for approximately 30% of the time (for flows previously < 35 ML/d), it makes flows larger than they would have been in pre 1973 conditions.

In summary, it is estimated that approximately 65% of the time (i.e. for flows between 400 ML/d and 35 ML/d) the discharge flow will restore a more natural flow regime to the river by counterbalancing the impact of upstream diversions (i.e. the Chinchilla Weir) and abstractions. For the remaining 35 % of the time (i.e. for flows below 35 ML/d) the discharge will be greater than natural (i.e. pre Weir). This flow has the potential to have a significant beneficial impact including the provision of environmental flows and additional water for rural and municipal uses.

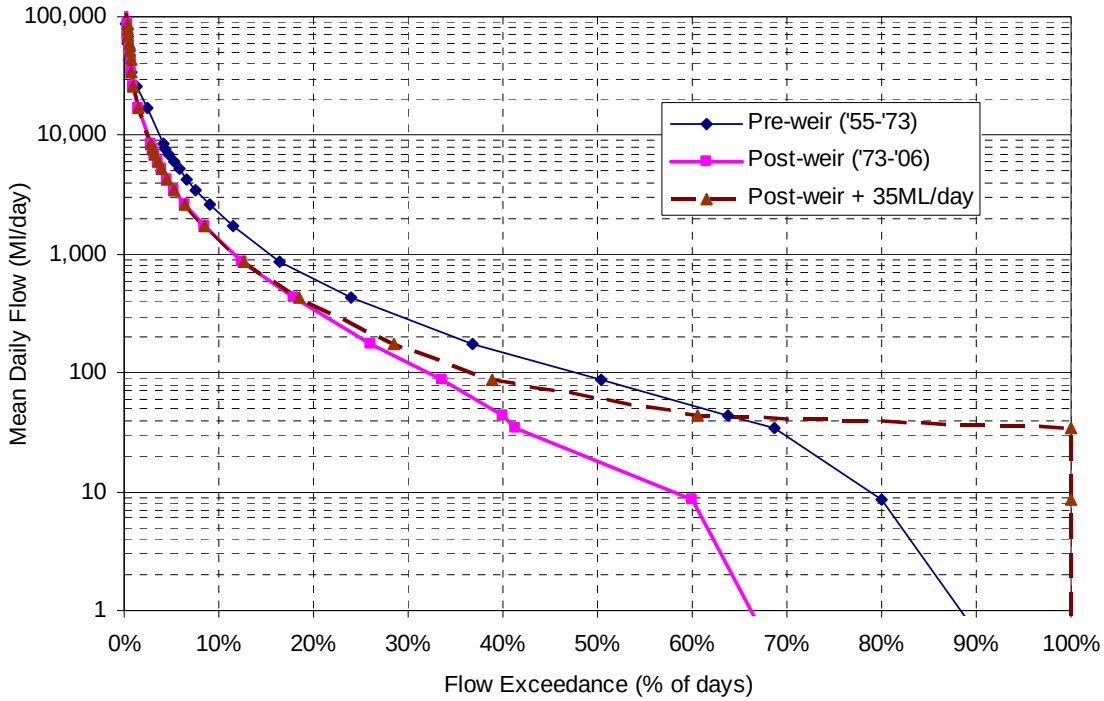

Figure 3 – Flow exceedance characteristics for the Chinchilla Weir.

Potential for Water Allocations

The Walloons development is within the regulated reach of the Condamine River where allocated water is supplied to landholders from Chinchilla Weir. This system is regulated by DNR&M and operated by Sunwater. It is possible that an agreement can be reached where treated water is incorporated into the system to make beneficial use of the water.

A number of landholders also hold water harvesting licences on the river but the minimum flow before pumping can commence under these licences is well above the discharge flows expected from the Walloons development. A change in the water harvesting conditions administered by DNR&W would be required to allow access to the discharge water from the river. Under the correct conditions it may be possible for landholders to take the discharged water directly from the river and then temporarily transfer water harvesting entitlements to other irrigators both upstream and downstream of the development.

Potential Environmental Impacts

OE has commissioned studies into the potential environmental impacts of the discharge of treated water to the Condamine River. Preliminary results from these studies indicate that there is little likelihood that the discharge will adversely affect water quality or biota in Condamine River or its tributaries. This view is supported by the results of the discharge of treated water to Eurombah Creek which has been taking place at OE's Spring Gully site since December 2007.

Irrigation

Water suitable for river discharge would generally be suitable for irrigation of most crops on most soils. Minor amendment of calcium/magnesium levels may be required depending on soil characteristics. Therefore, the water treatment system required would be consistent with that required for river discharge. It is possible that marginally higher salinity would be acceptable depending on the type of crops grown, soil type and whether the permeate is blended with water from other sources.

The irrigation area required to utilise the volume of water produced would be dependant on a number of factors including the volume of water produced with time, the volume of storage available for permeate, the type of crops grown and the intensity of production applied to the development. The *Agricultural Water Use Study by Horizon Rural Management (2007)* includes the Walloons area in the assessment of irrigation water use.

Livestock

Water suitable for river discharge would also be considered suitable for livestock. Therefore, the level of water treatment provided by the WTF would be consistent with that required by livestock. The supply of treated water to livestock enterprises is likely to form only a small part of the water management plan.

Aquaculture

The Department of Primary Industries and Fisheries (DPI) and the Department of State Development (DSD) have both expressed interest in aquaculture development. As a consequence DPI/DSD have received federal funding to investigate the feasibility of a regional aquaculture industry based on CSG development. Interest in these types of projects are also being investigated by a number of landholders in the area who are in the early stages of aquaculture development based on existing water harvesting/irrigation schemes.

Aquaculture should be considered as a possible adjunct to alternative water uses to improve overall project economics. Aquaculture could potentially be applied to produced water or alternatively in permeate or concentrate storage after IMS water treatment. Due to the high alkalinity in the produced water, aquaculture is most likely to be successful in treated water or treated water combined with water from other sources.

Urban

Municipalities in the vicinity of the development area include Miles and Chinchilla.

Miles draws water from a weir on Dogwood Creek and a sub-artesian bore located in the Precipice Sandstone. Murilla Shire Council (now Dalby Regional Council) has entered into an agreement with Queensland Gas Company Limited (QGC) to supply 1 ML/day of treated CSG water. OE and QGC have agreed to cooperate on water management and will be participating in the supply of water to Miles. The parties are also in discussions with Chinchilla to supply up to 3 ML/day of treated water from the Kenya joint development.

Additional water could be supplied to Chinchilla by substitution of irrigation allocation from Chinchilla Weir with project water discharged to the Condamine River. Alternatively, additional irrigation supplies can be provided from Chinchilla Weir by providing project water directly to Chinchilla. Such an arrangement would be subject to agreement between landholders, DNR&W, the Queensland Environmental Protection Agency (EPA), Sunwater and the Dalby Regional Council.

Industrial

New developments requiring significant amounts of water are likely to proceed as part of the Surat Basin Development. Some of this water could potentially be supplied untreated. The presence of a large reliable water source is likely to make a future large scale industrial development very attractive but this demand is unlikely to occur within the timeframe of the initial Walloons development. OE has undertaken an independent Urban and Industrial Water Use Study which includes the Walloons area.

In addition, OE and QGC have submitted an "Expression of Interest" to Xstrata for the supply of water to the proposed Wandoan coal mine development.

Salt Recovery

A range of salt recovery trials in conjunction with IMS trials were undertaken at the OE Spring Gully development site with potential salt products including precipitated calcium carbonate, sodium sulphate and sodium chloride being the focus of the trials. The salinity of the water in the Walloons is less than Spring Gully but the distribution of salts is similar. With potentially higher IMS recoveries achievable in the Walloons the concentrate stream will be similar in quality to Spring Gully and therefore suitable for similar processes. Because the Walloon development is closer to sources of supply for inputs (e.g. hydrated lime and sulphuric acid) as well as potential markets, the economics of salt recovery may be more attractive.