Australia Pacific LNG Project

Volume 5: Attachments

Attachment 23: Conics IQQM Model - Gas Fields

Hydrologic Modelling of Permeate Discharge to Condamine River

Final Report

Prepared for: Origin Energy

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Job Reference: PR101377

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Quality Assurance Statement				
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1. Introduction

Australia Pacific LNG Pty Limited (APLNG) proposes to develop a world scale project sustaining a long-term industry that utilises APLNG's substantial coal seam gas resources in Queensland. The coal seam gas reserves occur in the Surat and Bowen Basins with the main development planned for the Walloons gas fields area.

The Walloons coal seam gas fields cover an area of 570,000 ha in the Queensland Western Downs region. APLNG's development plan will include up to 10,000 wells over a 30 year project lifespan. Gas and water gathering systems will be developed for delivery to gas plant facilities and water treatment facilities respectively. Associated infrastructure will include roads and access tracks, storage ponds, camps, communication infrastructure and other logistics support areas.

A significant amount of investigation of these gas resources is occurring at present, and approvals for extraction of coal seam gas are being obtained by resources companies. The gas could be used for industrial processes, power generation, or for export.

The gas is obtained by dewatering the coal seams. The water extracted is of poor quality (generally fairly brackish) and various options for its beneficial use or disposal have been investigated. One option is to treat the water by reverse osmosis to a high quality and to discharge it to local creeks or the Condamine River where it could be re-used by irrigators and other water users. The impacts of this discharge on the flow regime, in-stream habitat, creek stability, and downstream water users have to be considered in any proposal to discharge to local creeks or the Condamine River.

The Condamine-Balonne River system lies within the area of the Water Resource (Condamine and Balonne) Plan 2004 (listed under the Water Act 2000), which was approved in August 2004.

The Condamine and Balonne Resource Operations Plan (which implements the water resources plan) has been finalised for the upper and middle parts of the plan area, excluding the Oakey-Gowrie Creek sub-catchment.

The impacts of any discharge to the Condamine River will have to be assessed in relation to the water supply security and environmental flow objectives in the Water Resources Plan.

As part of this assessment, Conics-EHA was commissioned by Origin Energy Ltd to undertake hydrologic modelling to determine the impacts of discharge to the Condamine River at two locations, Condabri and Talinga, in relation to the supply security and environmental flow objectives for the Water Resources Plan.

The hydrologic model owned by Department of Environment and Resource Management (DERM) was made available for use for this assessment.

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2. Discharge to condamine river

The amount of water requiring treatment and discharge to local watercourses or the Condamine River will depend on the scale of the gas extraction projects, the properties of the of the coal seams and the amount of local use of the extracted water among other things. Discharges ranging up to 140 ML/day have been considered in this report.

A number of locations where the extracted water could be treated by reverse osmosis have been considered in planning studies. Two of these are Talinga and Condabri. The locations of these are described below.

2.1 Condamine River

The Condamine River is part of the Murray Darling Basin and drains the northern portion of the Darling Downs. Around 60 km south of Roma, it becomes the Balonne River and turns south-west, passing through St George. The Balonne River separates into a number of distributaries including the Balonne Minor, Culgoa, and Narran Rivers downstream of St George. Some of these distributaries eventually drain to the Darling River.

The section of the Condamine River where permeate discharges are likely to occur lies between Chinchilla Weir and the township of Condamine.

The catchment area of the Condamine River at Chinchilla Weir is approximately 19,190 km2 and the mean annual flow is approximately 280,000 ML assuming current water resources development and full utilisation of current water entitlements. The mean annual flow at the same location without any water resources development or use (pre-development situation) is estimated as approximately 440,000 ML.

Between Chinchilla Weir and Condamine Township, the river flows in a generally westerly direction. At Condamine township, the catchment area of the Condamine River is approximately 24,600 km2, and the mean annual flow is approximately 370,000 ML (assuming current water resources development and full utilisation of current water entitlements). The mean annual flow at the same location without any water resources development or use (pre-development situation) is estimated as approximately 570,000 ML.

The impact of water resources development upstream of, and along this river section has been to reduce the mean annual discharges by approximately one-third.

This section of river contains the regulated section of the Chinchilla Weir water supply scheme, and a number of high flow extraction licenses. Major tributaries contributing flow to the Condamine River in this section include Charlies Creek, Sixteen Mile Creek, Wieambilla Creek, Wambo Creek, and Bogrambilla Creek.

2.1.1 Talinga Discharge Location

One potential discharge point is from the existing water treatment facility at Talinga, at the confluence of Wieambilla Creek and the Condamine River. The AMTD of this location is 660km. **Figure** Error! **No text of specified style in document..1** indicates the location of this discharge point.

The location is approximately 37 river kilometres downstream of Chinchilla Weir, and approximately 47 river kilometres upstream of Condamine Township. The catchment area of the Condamine River at the proposed discharge point is approximately 24,300 km2.

A report (EECO 2009) examined the impacts of release of permeate from a proposed treatment plant into either Wieambilla Creek or directly into the Condamine River just downstream of the confluence of Wieambilla Creek with the Condamine River. The report assessed the impacts on river geomorphology and riparian and in-stream biota downstream of the

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potential releases points. The report did not consider impacts in relation to the Water Resource (Condamine and Balonne) Plan 2004.

The discharge point is located within the regulated section of the Chinchilla Weir Water Supply Scheme.

Condabri Discharge Location

A second potential permeate discharge location is near Condabri on the Condamine River. This location is indicated in **Figure** Error! **No text of specified style in document..1**, and has an AMTD of approximately 635.5 km. It is located about 22 river kilometres upstream of Condamine Township.

The discharge location is downstream of the regulated section of the Chinchilla Water Supply Scheme.

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Figure Error! No text of specified style in document..**1 Map of Condamine River Showing Potential Permeate Discharge Locations**

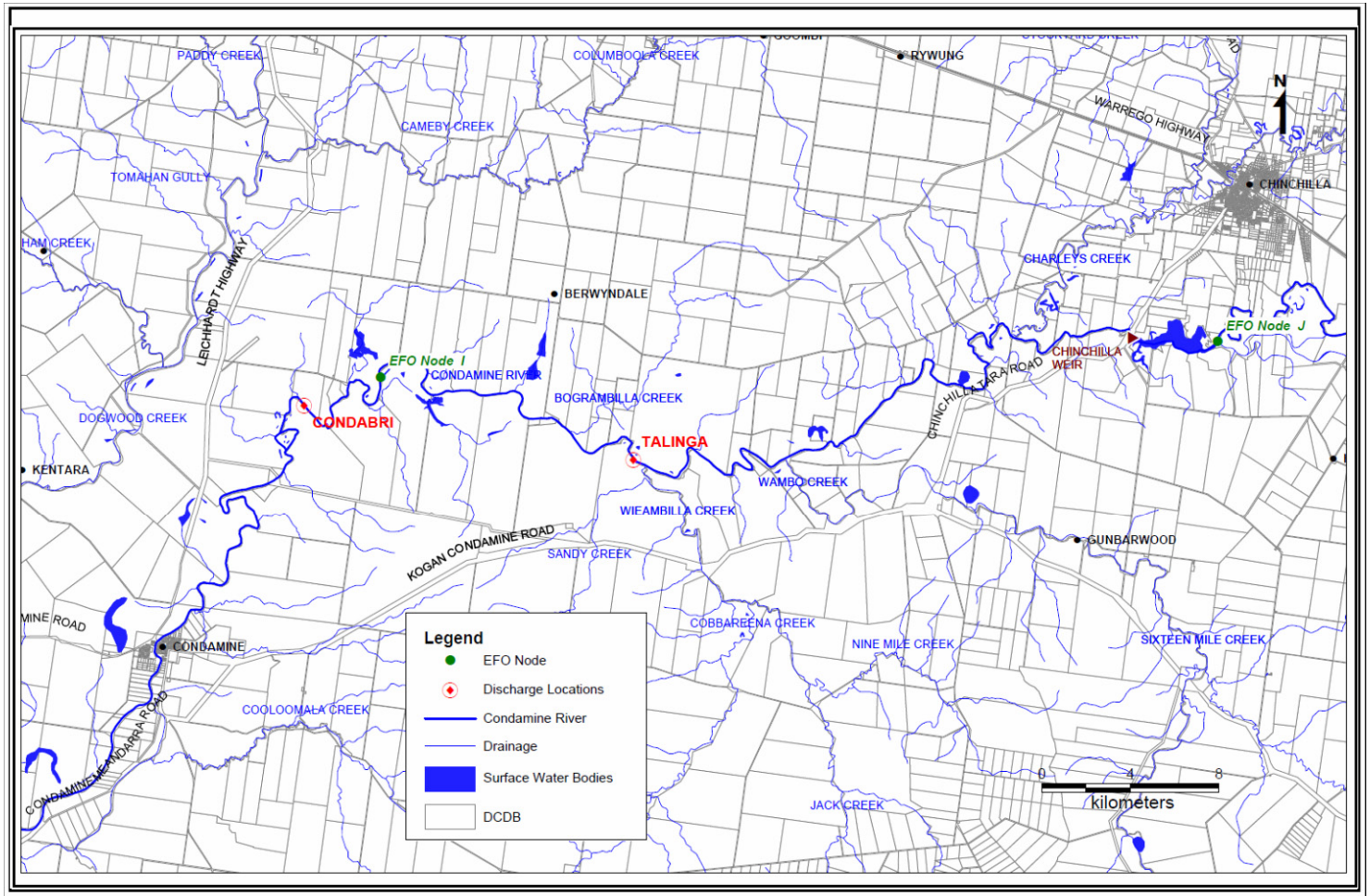

Figure 2.1 – Map of Condamine River Showing Potential Permeate Discharge Locations

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3. Water Resources Planning – Condamine – Balonne basin

3.1 Water Resource (Condamine and Balonne) Plan 2004

A Water Resources Plan has been prepared for the Condamine-Balonne River Basin. The plan is referred to as the Water Resource (Condamine and Balonne) Plan 2004. It is subordinate legislation to the Water Act 2000, and was approved in August 2004.

The purposes of a Water Resources Plan are to:

- Define the availability of water in the plan area;
- Provide a framework for sustainably managing water and the taking of water;
- Identify priorities and mechanisms for dealing with future water requirements;
- Provide a framework for establishing water allocations;
- provide a framework for reversing, where practicable, degradation that has occurred in natural ecosystems, including, for example, stressed rivers; and
- Regulate the taking of overland flow water.

To assist in achieving these aims, hydrologic models of the river basin have been developed by DERM and these models are used to quantify the impacts of various levels of water use and water development on the flows within the river basin. These models simulate the flows in the Condamine-Balonne River and major tributaries, the behaviour of storages and the extraction of water over a historical period over which hydro-meteorological information is available.

Performance indicators are statistical measures derived from output from the hydrological models, which are used to measure impacts of water resources development and use. The performance indicators include environmental flow objectives (EFOs) and water allocation security objectives (WASOs).

The performance indicators and their allowable range of variation are defined in the Water Resources Plan. Any changes in the locations or quantities of water use (including discharges to streams) must be shown to comply with the performance indicators as defined in the plan, for approval to be granted by DERM.

3.2 Resource Operations Plan

The Condamine and Balonne Resource Operations Plan (ROP) has been finalised for the upper and middle parts of the plan area, excluding the Oakey-Gowrie Creek sub-catchment. The plan was finalised in December 2008.

The ROP sets out the rules and requirements that guide the day-to-day management of water to achieve the objectives and outcomes of the Water Resource (Condamine and Balonne) Plan 2004.

The ROP includes rules for management of the storages and water supply schemes, and conversions and trading of water allocations in the upper and middle parts of the plan area.

3.3 Performance Indicators

Performance indicators are defined and described in Part 4 of the Water Resource (Condamine and Balonne) Plan 2004.

There are two types of performance indicators; Environmental Flow Objectives (EFOs) and Water Allocation Security Objectives (WASOs).

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3.3.1 Environmental Flow Objectives

The EFO's are assessed at a number of locations along the Condamine River, described in Schedule 2 of the plan. The performance indicators (flow statistics) at EFO nodes may be affected by changes in upstream development and water use.

The relevant downstream nodes at which the performance indicators may be affected by discharges at Talinga are:

Node I: Condamine River at the downstream border of the Chinchilla water supply scheme (AMTD 643.7 km);

Node H: Condamine River at Cotswold (AMTD 537.5 km); and

Node F: Balonne River at the upstream limit of the impounded area of the E.J. Beardmore Dam (AMTD 280 km).

The location of node I is indicated in **Figure** Error! **No text of specified style in document..1**

Discharges at Condabri will only affect nodes H and F as the inflow location is just downstream of node I.

The relevant performance indicators measured at these nodes are defined in the plan, and the definitions are summarised following.

- Low Flow: the total number of days in the simulation period in which the daily flow is not more than half the pre-development median daily flow.
- Summer Flow: the average number of days in summer (1st December to last day in February) that the flow is greater than the median pre-development flow.
- Beneficial Flooding Flow: The median of the wet season 90-day flows for the years in the simulation period. The wet season 90-day flow, for a year, means the total flow in the continuous 90 day period with the highest total of daily flows.
- 1 in 2 year flood: the daily flow that has a 50% probability of being reached at least once a year.

Section 12 of the plan describes the maximum changes to the above performance indicators that are allowable under the plan in relation to a decision about a change to water allocation rules.

At nodes F, H, and I, the performance indicators are required to be

- Not less than the lesser of the following—
- 66% of the indicator for the pre-development flow pattern;
- the indicator immediately before the decision is made; and
- Not more than the greater of the following—
- 133% of the indicator for the pre-development flow pattern;
- The indicator immediately before the decision is made.

3.3.2 Water Allocation Security Objectives

WASOs are measures of the security of supply to groups of water users. The WASO performance indicators are:

1. Annual volume probability. This is defined as:
    a. For a water allocation group for taking unsupplemented water—the percentage of years in the simulation period in which the volume of water that may be taken by the group is at least the total of the nominal volumes for the group; and
    b. For a water allocation group for taking supplemented water—the average annual volume of water that may be taken by the group in the simulation period as a percentage of the total of the nominal volumes for the group.
2. 45% annual volume probability. This is defined as:

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a. for a water allocation group, means the percentage of years in the simulation period in which the volume of water that may be taken by the group is at least 45% of the total of the nominal volumes for the group.

Any changes to the water allocation rules should not result in any reductions to the WASO performance indicators which applied just prior to the change.

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4. Hydroligic Model

The hydrologic model used in the analysis is the Integrated Quality Quantity Model (IQQM). This is a water resources simulation model with a daily time-step which is used to model surface water supply systems. Water storages, extraction points, stream transmission losses, and other processes are represented by nodes which are joined by links representing streams, channels or other connections.

IQQM models have been used by DERM for modelling Queensland river basins including the Condamine-Balonne as part of the water resources planning process. The models are used to evaluate the impacts of water resources development.

EFO and WASO performance indicators are derived from the outputs of the IQQM models. The impacts of any water resources developments, or changes to water allocation rules are evaluated using the relevant IQQM model, and the performance indicators.

4.1 IQQM for Resource Operations Plan

IQQM models were supplied by DERM for use in this analysis. Two models were supplied, one of the upper Condamine and one of the middle Condamine. The middle Condamine model has been used in this analysis, as there will be no impacts in the upper Condamine area.

The model supplied has the water resources developments, water allocations, and water sharing rules as described in the Resource Operations Plan for the Condamine Balonne. Some details of the model are as follows:

- Scenario name: 909B (Extended draft ROP model). (System file name MC0909B.sys).
- Model extent: from Cecil Plains (approx AMTD 891 km) to the confluence of Maranoa River and Balonne River (approx AMTD 260 km) just upstream of Beardmore Dam. The Maranoa River is also included in the model.
- Simulation Period: January 1890 to June 2006.
- Period used for deriving performance indicators: July 1922 to June 1995.

A node diagram of the model is included as **Figure Error!** NO TEXT OF SPECIFIED STYLE IN DOCUMENT..2.

The mid-Condamine hydrologic model was developed by DERM to simulate the streamflows (using a daily timestep) in the Condamine River and its major tributaries from Cecil Plains to the Maranoa River confluence over a historical time period, with various levels of water resources development and use in the river basin. The hydrologic model includes the following features:

- Inflows to the river system derived from recorded streamflow information at long streamgauging stations in the area, including Condamine River at Cecil Plains, Condamine River at Chinchila, Condamine River at Cotswold, and Balonne River at Weribone, among others. Where recorded streamflow information was not available flows were estimated by calibrated rainfall-runoff models.
- Water storages including Chinchilla Weir, Loudon Weir, Warra Weir, Condamine Weir, Surat Weir, Charlies Creek Weir, Cooby Creek Dam and Neil Turner Weir.
- Extractions for water supply to urban areas including Chinchilla, Toowoomba, Warra, Condamine, Dalby, Bell, Brigalow, Tara, Meandarra, Glenmorgan, Surat, and Dulacca.
- Extractions for irrigation, stock, domestic and other rural uses. These extractions could be by high flow diversion entitlements (waterharvesting), unsupplemented water licences, or by supplemented water licences in the Chinchilla Water Supply Scheme area.
- Streamflow transmission losses.
- Streamflow routing (delay and attenuation of flows along the river).

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The model was calibrated using available streamflow records, water use records, and storage construction details.

The model can be used to assess the impact of water resources development or other changes in the river system on the flows at various locations.

A number of post-processing programs were supplied by DERM as well as the model itself. The post processing programs were used to extract information from the model output and derive the performance indicators.

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FIGURE ERROR! NO TEXT OF SPECIFIED STYLE IN DOCUMENT..**2** **SCHEMATIC OF THE IQQM ROP MODEL OF MIDDLE CONDAMINE CATCHMENT**

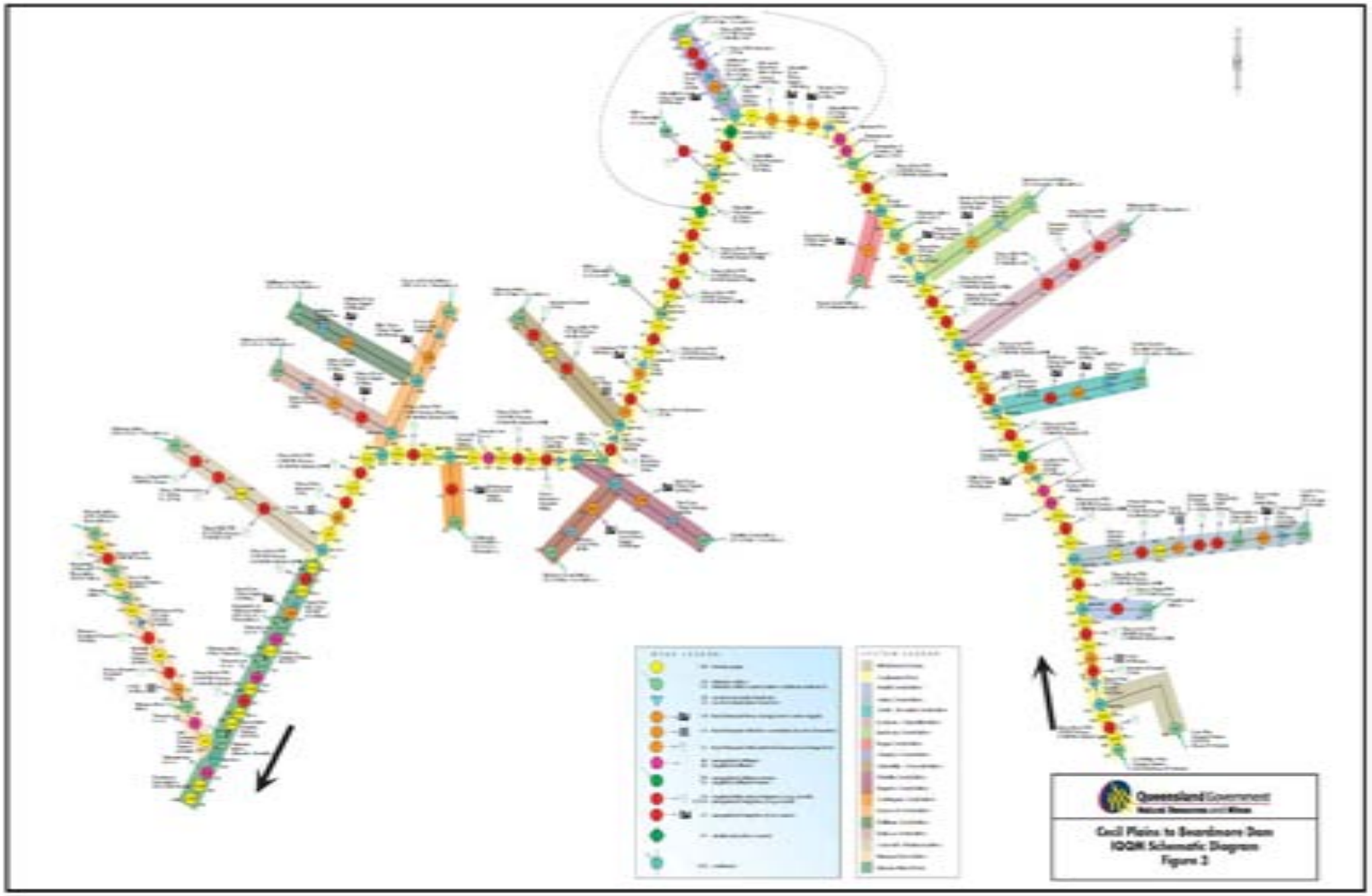

Figure 4.1 – Schematic Of The IQQM ROP Model Of Middle Condamine Catchment

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4.2 Modifications to IQQM

Some additional nodes were included in the IQQM to represent the two locations Talinga and Condabri at which potential permeate discharges occur.

The Talinga discharge node (AMTD 661 km) was inserted at a point just upstream of the Chinchilla Water Supply Scheme irrigator group in zone CBS-04. This zone extends from the confluence of Wambo Creek and the Condamine River to the downstream extent of the Chinchilla Weir Water Supply Scheme, AMTD 671.0 – 643.7 km. **Figure Error! No text of specified style in document..3** Location of Talinga Permeate Discharge Point in Relation to Middle Condamine IQQM Node Diagram

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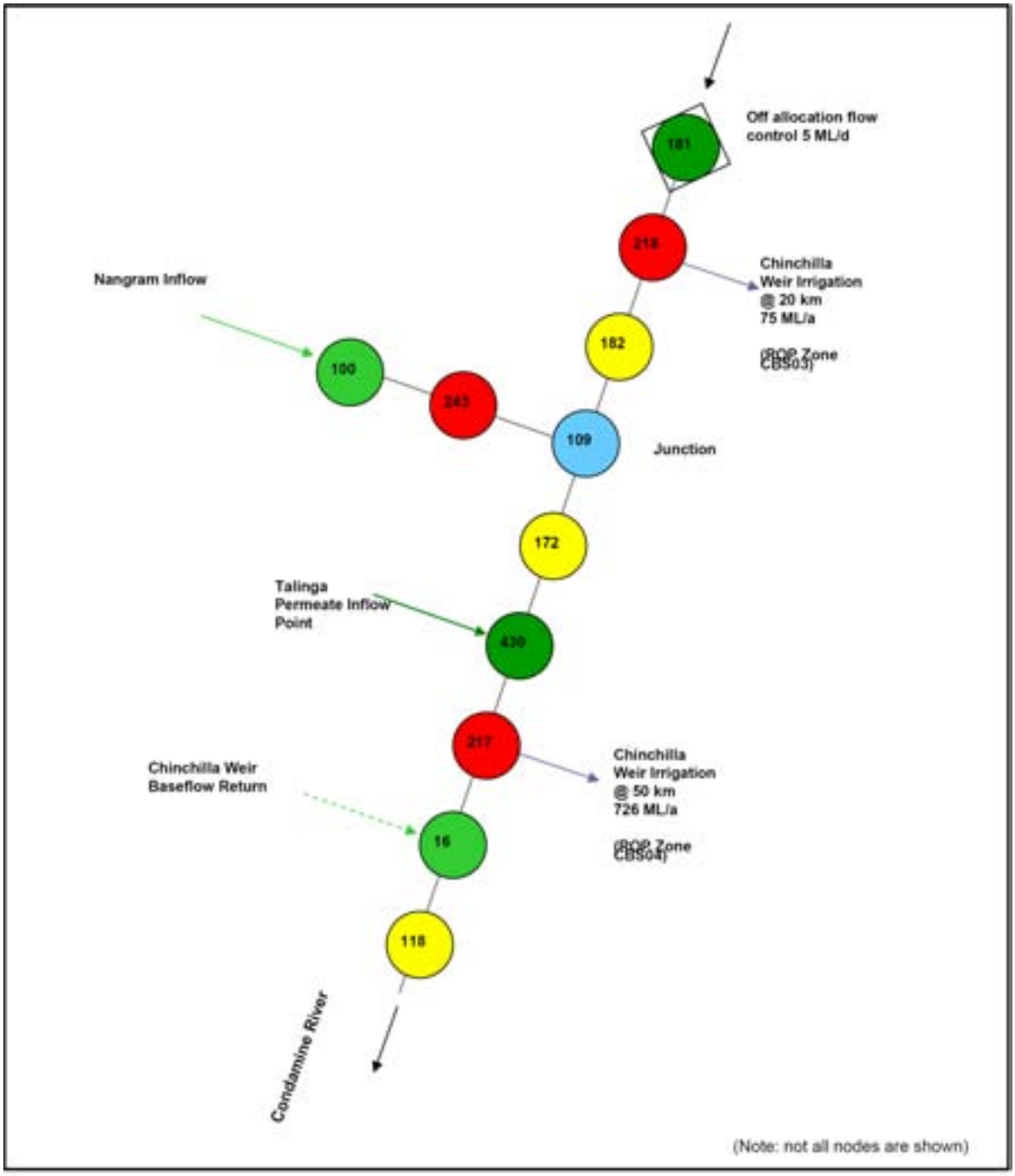

Figure 4.2 – Location of Talinga Permeate Discharge Point in Relation to Middle Condamine IQQM Node Diagram

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indicates the Talinga discharge node location in relation to other nodes in the model.

The Condabri discharge node (AMTD 635.5 km) was inserted at a point just downstream of the EFO node I (AMTD 643.7 km). This is downstream of the Chinchilla Water Supply Scheme

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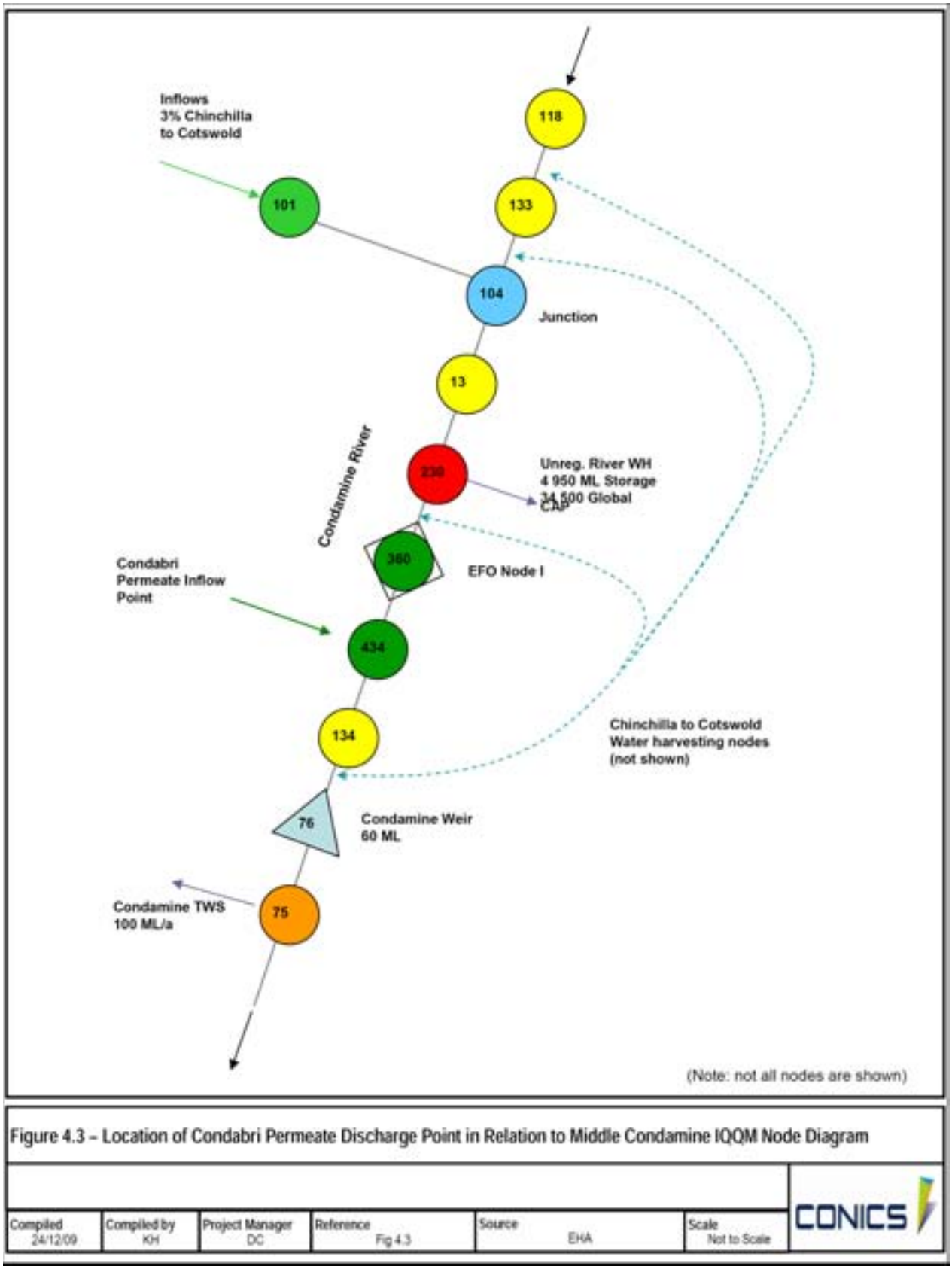

Figure 4.3 – Location of Condabri Permeate Discharge Point in Relation to Middle Condamine IQQM Node Diagram

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Figure Error! No text of specified style in document..4 indicates the location of the Condabri node in relation to the other model nodes.

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Figure Error! No text of specified style in document..**3 Location of Talinga Permeate Discharge Point in Relation to Middle Condamine IQQM Node Diagram**

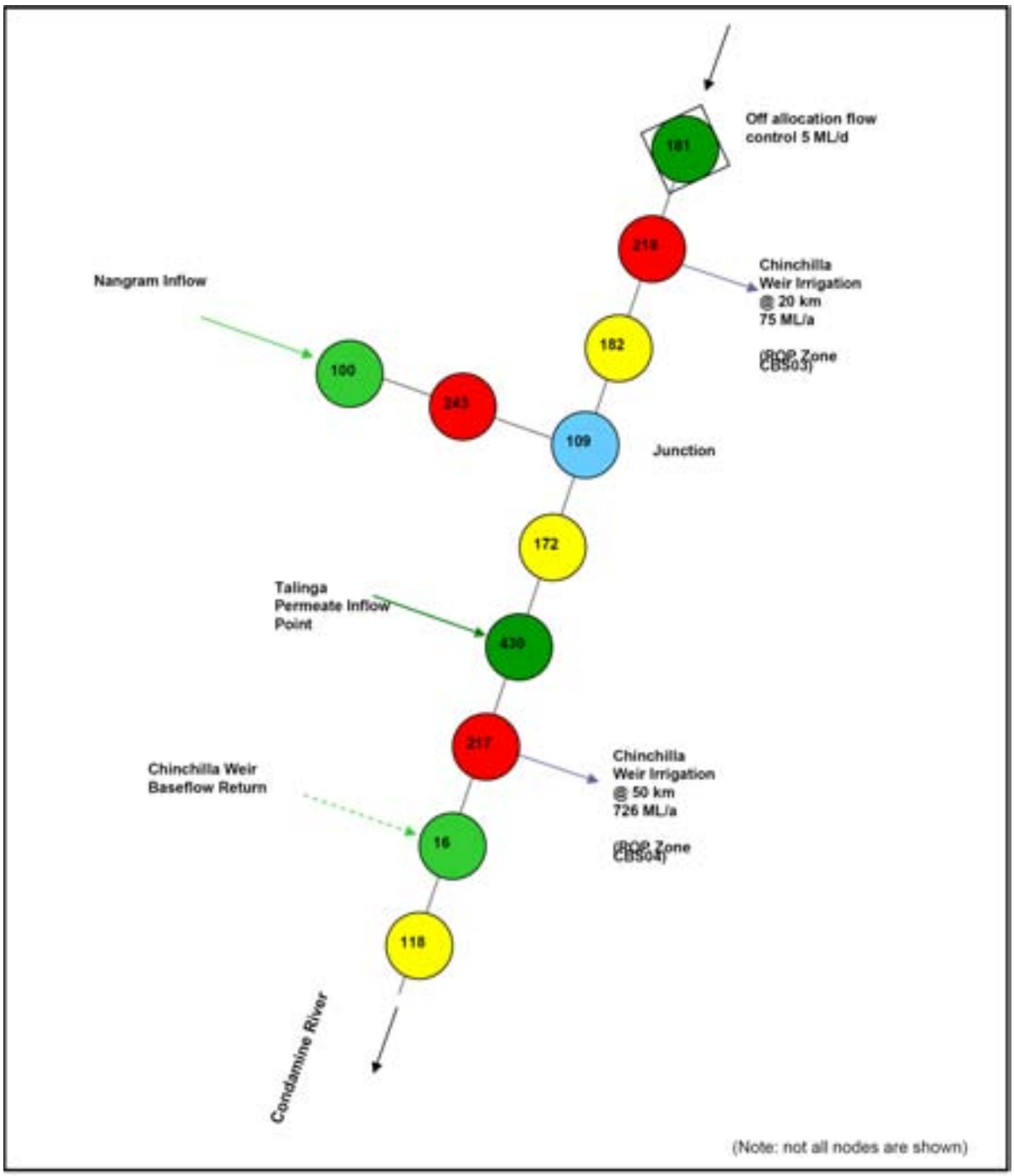

Figure 4.2 – Location of Talinga Permeate Discharge Point in Relation to Middle Condamine IQQM Node Diagram

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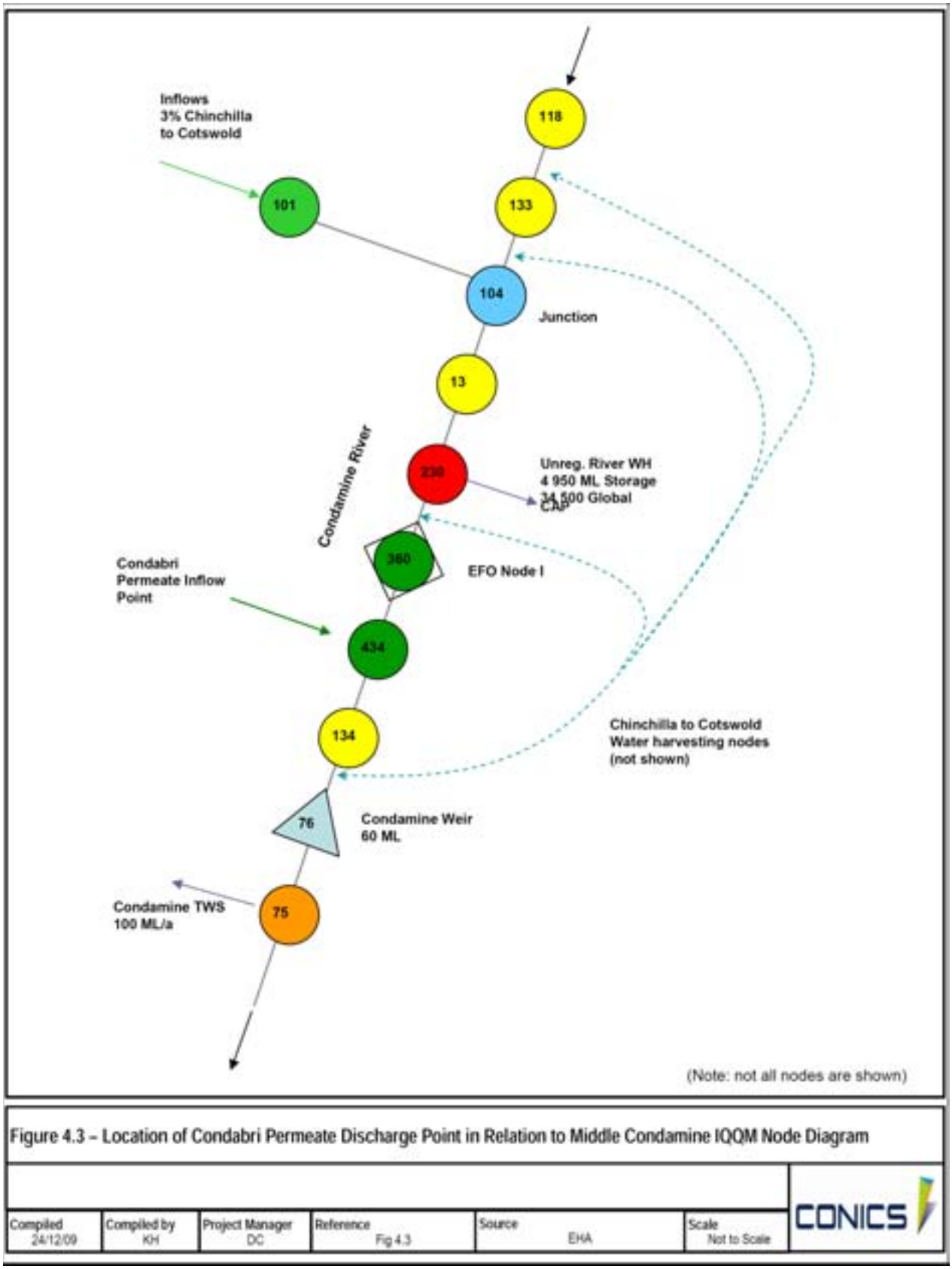

Figure 4.3 – Location of Condabri Permeate Discharge Point in Relation to Middle Condamine IQQM Node Diagram

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Figure Error! No text of specified style in document.**.4 Location of Condabri Permeate Discharge Point in Relation to Middle Condamine IQQM Node Diagram**

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4.3 Results of Modelling

There are a number of options regarding the location of permeate discharge points, the quantity of the discharge, and the pattern of discharge throughout the year. A representative number of scenarios were modelled to investigate the impacts, and the compliance with the Water Resources Plan.

Scenarios described in this report are summarised in the following **Table Error! No text of specified style in document..1.**

Table Error! No text of specified style in document..**1 Scenario Summary – Modelling of Permeate Release at Condabri or Talinga**

Scenario Reference	Release at Talinga ML/day	Periods of No Release at Talinga	Release at Condabri ML/day	Periods of no Release at Condabri	Figure Number Reference
T2	50	Nil (continuous discharge for whole year)	-	-	Figure 4.4
C2	-	-	65	Nil (continuous discharge for whole year)	Figure 4.5
TC1	35	Nil (continuous discharge for whole year)	30	Nil (continuous discharge for whole year)	-
T17	50	3 months – Aug, Sept and Oct	-	-	Figure 4.6
T10	100	4 months – Aug, Sept, Oct and Nov	-	-	Figure 4.7
T13	100	During periods of no natural flow at location just upstream of discharge point to maximum duration of 30% of year (commencing 1 July)	-	-	Figure 4.8
T19	100	During periods of no natural flow at location just upstream of discharge point to maximum duration of 20% of year (commencing 1 July)	-	-	Figure 4.9
T20	100	During periods of no natural flow at location just upstream of discharge point to maximum duration of 10% of year (commencing 1 July)	-	-	Figure 4.10
T21	100	Nil (continuous discharge fro whole year)	-	-	Figure 4.11
TC7	35	Nil (continuous discharge for whole year)	80	4 months – Aug, Sept, Oct and Nov	Figure 4.12
TC10	35	Nil (continuous discharge for whole year)	35	3 months – Aug, Sept and Oct	Figure 4.13

Comments are made in the following sections about the results of the above scenarios in terms of the flow duration curves at downstream locations, the compliance with Water Resource Plan performance indicators, and other general comments.

4.3.1 Talinga Discharge of 50 ML/day (Scenario T2)

The performance indicators at EFO nodes F, H, and I for a range of discharges at Talinga are tabulated in Appendix A. The results indicate that discharges up to 50 ML/day can be accommodated within the allowable range of variation of the EFO

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performance indicators. For discharges of 55 ML/day or higher the number of low flow days at Node I reduces to less than 66% of the pre-development low flow days.

Daily flow duration curves at Node I (Condamine River downstream of the Chinchilla Weir Water Supply Scheme) are plotted as **Figure Error! No text of specified style in document..5.** Flow duration curves for the pre-development case (i.e. without any water resources development or use in the basin), the ROP base case, and for the ROP case with the additional 50 ML/day discharge at Talinga are plotted.

The change in the low-flow regime can be ascertained from this plot. Over the simulation period 1922 to 1995, and the pre-development situation, flows of 1 ML/day or greater would have been expected for about 95% of time. With development as permitted in the Resource Operations Plan (approximating current development) flows of this order could be expected only 75% of time. With the additional 50 ML/day release to the river at Talinga, flows of 1 ML/day will occur continuously, closer to the pre-development situation.

The WASO performance indicators were checked. There were no reductions in the performance indicators for any of the user groups.

There were improvements (increases) in the WASO performance indicators for the following groups:

- Stock and Domestic users from Chinchilla to Weribone. Users with stock and domestic licences along the river downstream of Chinchilla Weir to Weribone will experience improved supplies. The modelling indicates diversions to this group will increase by approximately 40%;
- Water users in the Chinchilla Water Supply Scheme Zone CBS04. Downstream of the Talinga discharge node, there is a group of irrigators in the ROP zone CBS-04. This group has a combined water allocation of 726 ML. The supply to this group of irrigators will be improved with discharge to the river at Talinga. With a constant continuing discharge of 50 ML/day at Talinga, the model results indicate (for the simulation period 1922 to 1995) that the mean annual diversions to this group will increase from 606 Ml/yr to 783 ML/yr - an increase of 29%. The reliability of supply to this group (as measured by the Supplemented Annual Volume Probability - see report for definition) will increase from 83.5% to 107.5%; and
- Condamine Town Water Supply.

4.3.2 Condabri Discharge of 65 ML/day (Scenario C2)

Performance indicators at EFO nodes F, and H for a range of discharges at Condabri are tabulated in Appendix B. The results indicate that discharges up to 65 ML/day can be accommodated within the allowable range of variation of the EFO performance indicators. For discharges of 70 ML/day or higher the number of low flow days at Node H reduces to less than 66% of the pre-development low flow days.

Daily flow duration curves at Node H (Condamine River at Cotswold) are plotted as **Figure Error! No text of specified style in document..6**. Flow duration curves for the pre-development case (i.e. without any water resources development or use in the basin), the ROP base case, and for the ROP case with the additional 65 ML/day discharge at Condabri are plotted.

The change in the low-flow regime can be ascertained from this plot. Over the simulation period 1922 to 1995, and the pre-development situation, flows of 1 ML/day or greater would have been expected for about 82% of time. With development as permitted in the Resource Operations Plan (approximating current development) flows of this order could be expected less than 50% of time. With the additional 65 ML/day release to the river at Condabri, flows of 1 ML/day or greater will occur 92% of time, much closer to the pre-development situation.

The WASO performance indicators were checked. There were no reductions in the performance indicators for any of the user groups.

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There were improvements (increases) in the WASO performance indicators for the following groups:

- Stock and Domestic users from Chinchilla to Weribone (significant increases in reliability of supply); and
- Condamine Town Water Supply.

4.3.3 Concurrent discharge at Talinga and Condamine (Scenario TC1)

It is understood that there are plans to discharge 35 ML/day from a treatment plant at Talinga (EECO 2009).

There is potential to make releases from Condabri and still comply with the WRP. A series of cases was run to determine the additional daily volume of discharge that could be released at Condabri while 35 ML/day was being released at Talinga.

Performance indicators at EFO nodes I, F, and H for a range of discharges at Condabri (with concurrent 35 ML/day discharge at Talinga) are tabulated in Appendix B. The results indicate that additional discharges up to 30 ML/day can be accommodated within the allowable range of variation of the EFO performance indicators. For discharges of 33 ML/day or higher at Condabri the number of low flow days at Node I reduces to less than 66% of the pre-development low flow days.

There were no reductions in the WASO performance indicators for any of the water user groups.

There were improvements (increases) in the WASO performance indicators for the following groups:

- Stock and Domestic users from Chinchilla to Weribone (significant increases in reliability of supply);
- Water users in the Chinchilla Water Supply Scheme Zone CBS04; and
- Condamine Town Water Supply.

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Figure Error! No text of specified style in document..**5 Flow Duration Curve for EFO Node I – with Discharge at Talinga**

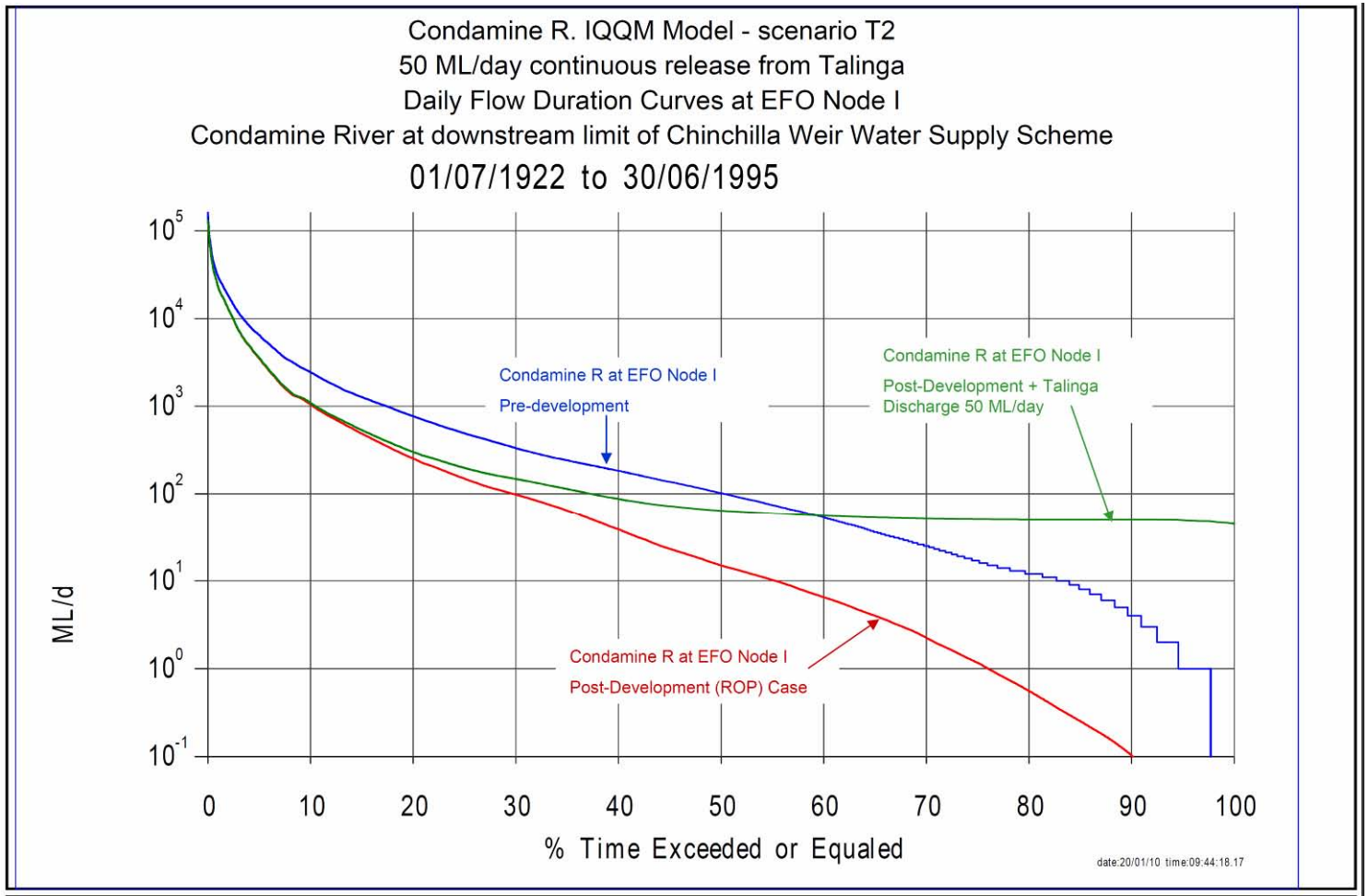

Figure 4.4 – Flow Duration Curve for EFO Node I – with Discharge at Talinga

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24-12-09	KH	DC	Fig 4.4	EHA	Not to Scale

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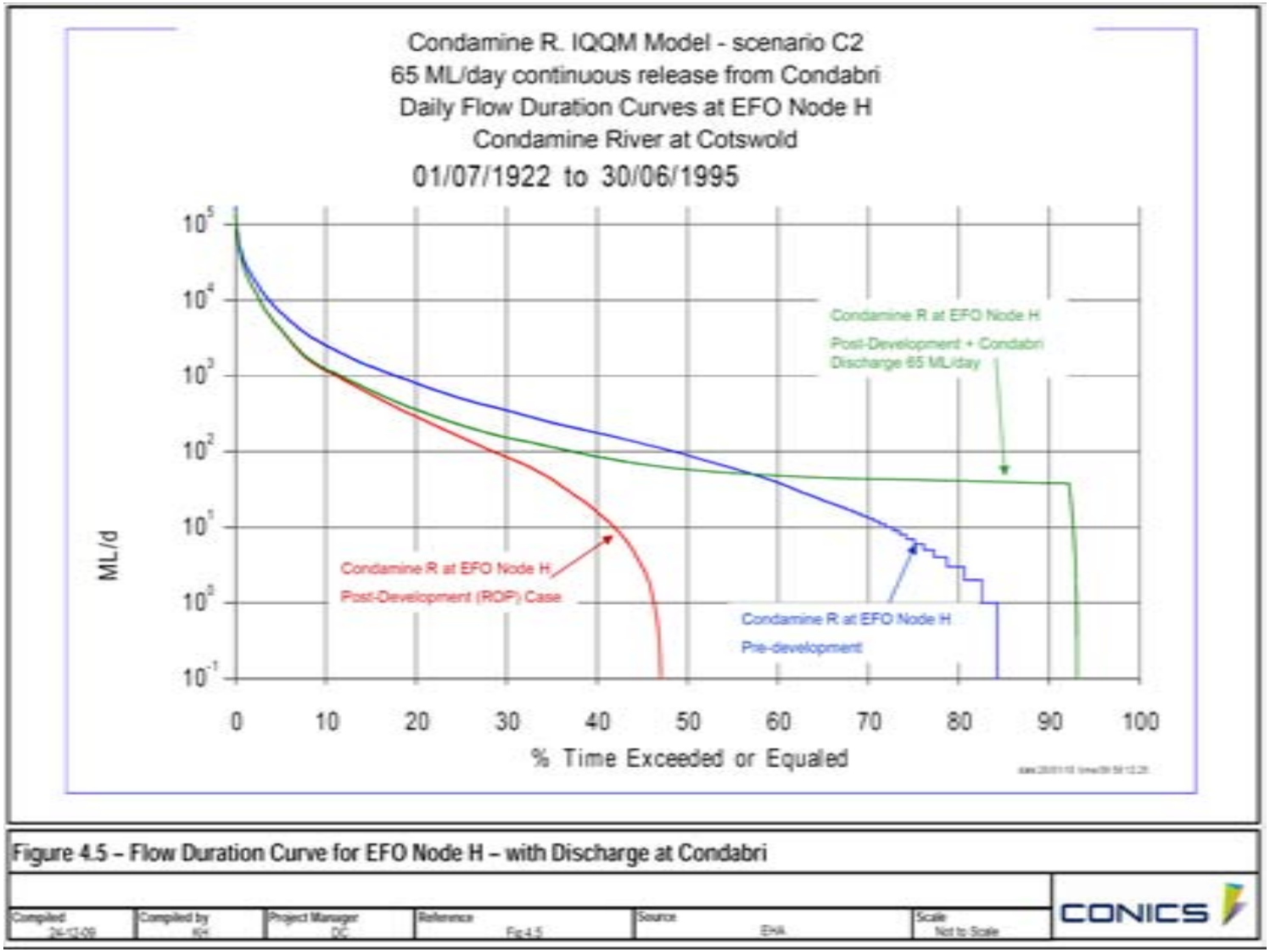
Figure Error! No text of specified style in document..**6 Flow Duration Curve for EFO Node H – with Discharge at Condabri**



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4.3.4 Talinga Discharge for 9 Months of year (Scenario T17)

For this scenario, it is assumed that there are no releases from Talinga to the river during the months of August, September and October. For the remainder of the year it would be possible to release up to 50 ML/day and still comply with the EFO performance indicators.

It is not possible to release greater than what could be released continuously at Talinga (ie Scenario T2) while still complying with the EFO performance indicators.

Daily flow duration curves for two EFO nodes downstream of Talinga [Condamine River at downstream limit of Chinchilla Weir Water Supply Scheme (Node I) and Condamine River at Cotswold (EFO Node H)] are plotted in **Figure Error! No text of specified style in document..7.** At each location the daily flow duration curve for the pre-development scenario, and the post development scenario plus the Talinga release are plotted.

4.3.5 Talinga Discharge for 8 Months of year (Scenario T10)

For this scenario, it is assumed that there are no releases from Talinga to the river during the months of August, September October and November. For the remainder of the year it would be possible to release up to 100 ML/day and still comply with the EFO performance indicators.

A significant increase in the discharge is possible from Talinga (compared to the continuous release case T2) while still complying with the performance indicators at the EFO nodes.

Daily flow duration curves for two EFO nodes downstream of Talinga [Condamine River at downstream limit of Chinchilla Weir Water Supply Scheme (Node I) and Condamine River at Cotswold (EFO Node H)] are plotted in **Figure Error! No text of specified style in document..8**. At each location the daily flow duration curve for the pre-development scenario, and the post development scenario plus the Talinga release are plotted.

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Figure Error! No text of specified style in document..**7 Flow Duration Curves – Talinga Release for 9 Months of the Year**

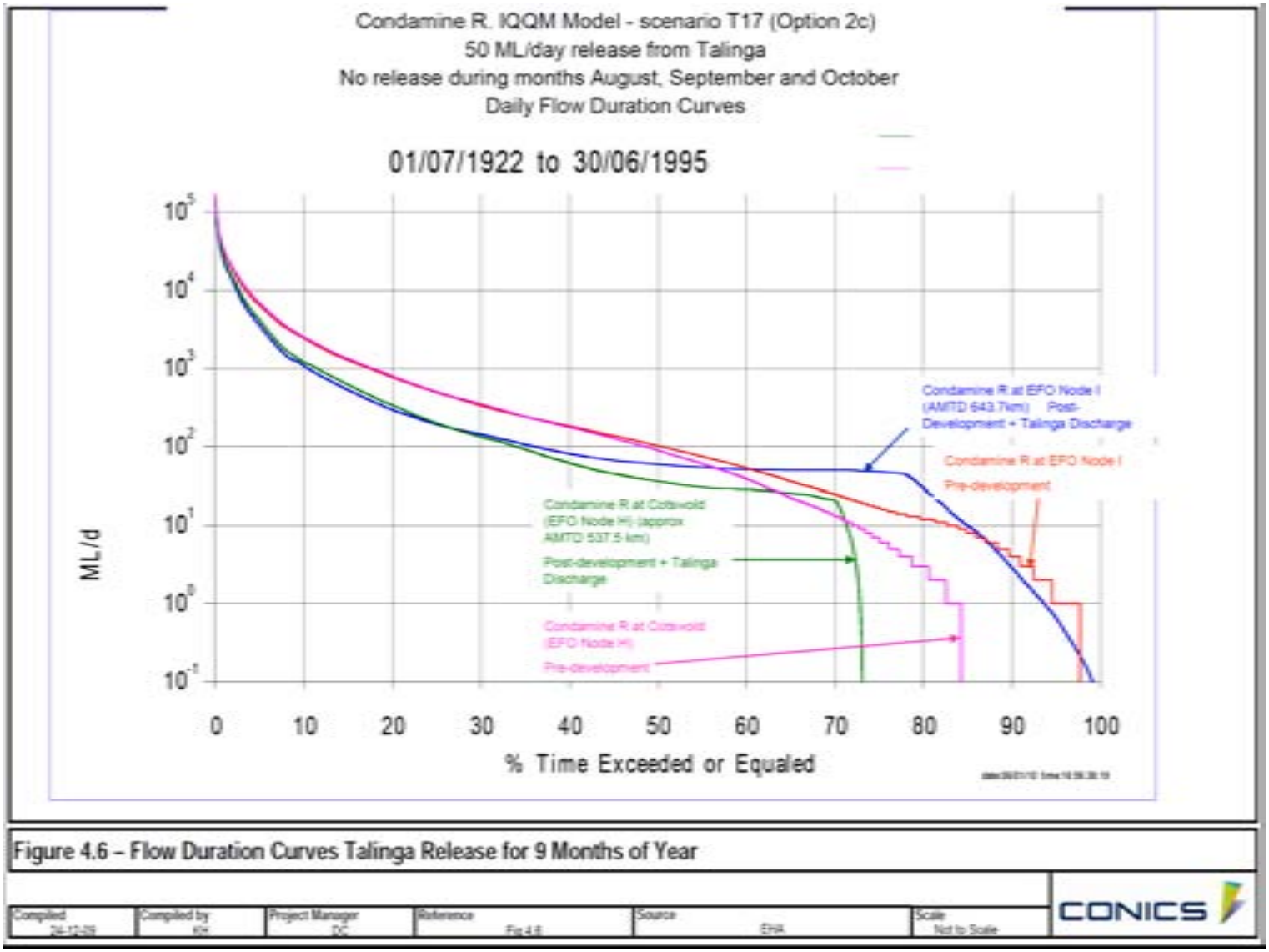

Figure 4.6 – Flow Duration Curves Talinga Release for 9 Months of Year

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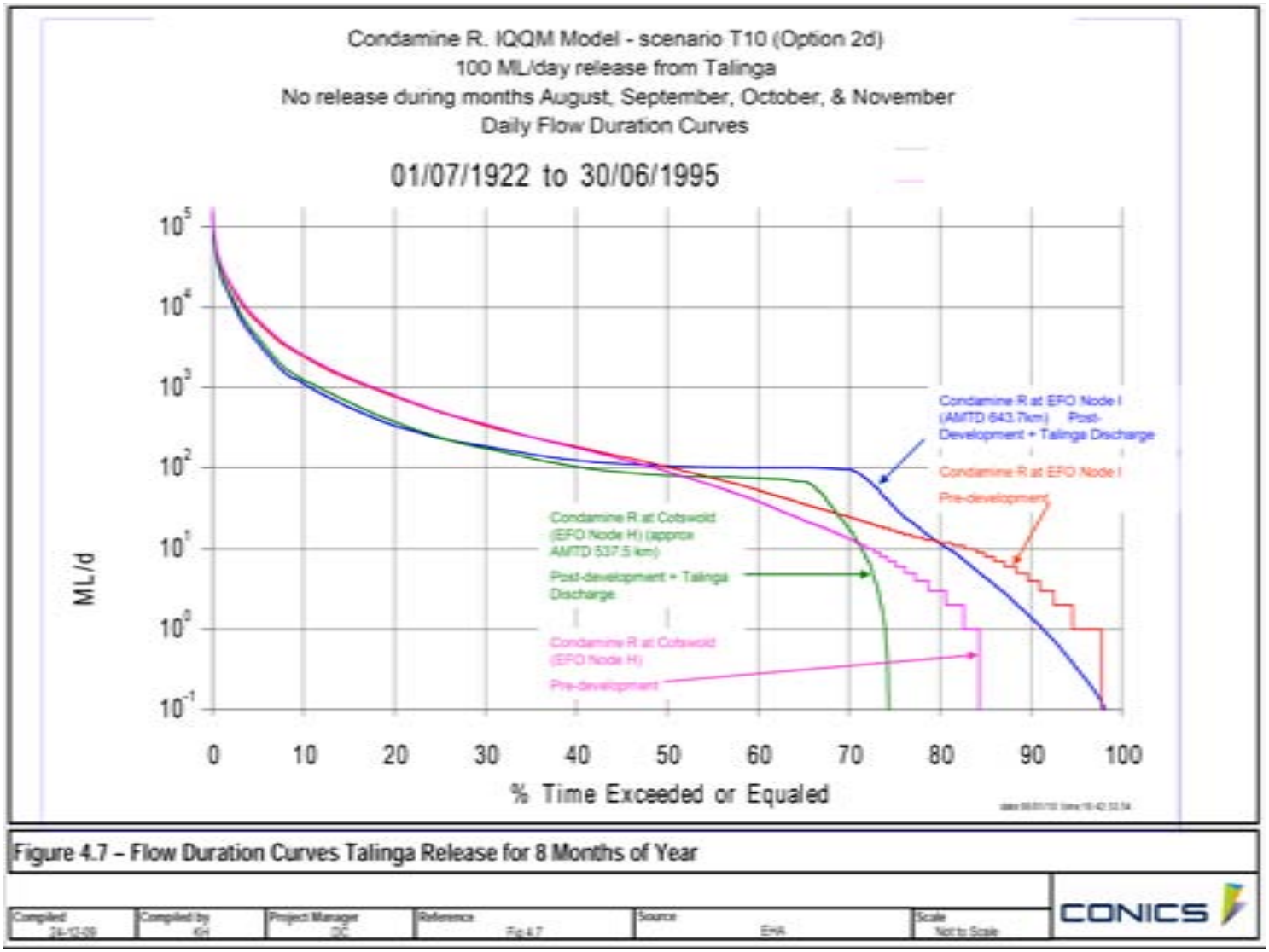
Figure Error! No text of specified style in document..**8 Flow Duration Curves – Talinga Release for 8 Months of the Year**



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4.3.6 Talinga – No Release During No-flow Periods (Max 30% of Year) Scenario T13

With this option, it is assumed that there are no releases from Talinga during periods of no natural flow just upstream of the discharge point. A no-flow period was assumed to be a period when the flow in the Condamine River just upstream of Talinga was less than 6 ML/day, as releases in the flow range flow range 0 to 6 ML/day could be made from Chinchilla Weir to supplemented licence holders downstream of Talinga. The maximum period of no release from Talinga was limited to 30% of the year for this scenario. For accounting purposes, each year was assumed to commence 1st July.

With this release method, it was found that a maximum release of 100 ML/day could be made from Talinga while still complying with the performance indicators at the EFO nodes. For higher discharges than 100 ML/day at Talinga, the summer flow statistic at EFO node I does not comply with the WRP objectives

Daily flow duration curves for two EFO nodes downstream of Talinga [Condamine River at downstream limit of Chinchilla Weir Water Supply Scheme (Node I) and Condamine River at Cotswold (EFO Node H)] are plotted in **Figure Error! No text of specified style in document..9**. At each location the daily flow duration curve for the pre-development scenario, and the post development scenario plus the Talinga release are plotted.

Comparison of the flow duration curve for the pre-development scenario with the corresponding curve for the post development plus Talinga release scenario at both locations indicates a flows exceed 10 ML/day for a similar percentage of time.

4.3.7 Talinga - No Release During No-flow Periods (Max 20% of Year) Scenario T19

This scenario is similar to the scenario described in the preceding section, except that the period of no releases from Talinga to Condamine River is limited to a maximum of 20% of the year.

In this scenario, it is assumed that a release of 100 ML/day is made from Talinga excepting on days of no natural river flow. The period of no releases from Talinga to Condamine River is limited to a maximum of 20% of the year. The results indicated that some of the performance indicators at the EFO nodes I and H for this release scenario will be outside the range permitted in the WRP. The number of low flow days (as defined in the WRP) are less than 66% of the pre-development low flow days at these EFO nodes.

Flow duration curves both pre-development, and scenario T19 for the two EFO nodes I and H are plotted as **Figure Error! No text of specified style in document..10**. For this scenario, there is a fairly close correspondence in the low flow portion of the pre-development and scenario T19 flow duration curves at the two EFO nodes, indicating this release strategy would result in a similar low-flow regime to that which occurred pre-development.

4.3.8 Talinga - No Release During No-flow Periods (Max 10% of Year) Scenario T20

This scenario is similar to the two scenarios described in the preceding sections, except that the period of no releases from Talinga to Condamine River is limited to a maximum of 10% of the year.

In this scenario, it is assumed that a release of 100 ML/day is made from Talinga excepting on days of no natural river flow. The period of no releases from Talinga to Condamine River is limited to a maximum of 10% of the year.The results indicated that some of the performance indicators at the EFO nodes I and H for this release scenario will be outside the range permitted in the WRP. The number of low flow days (as defined in the WRP) are less than 66% of the pre-development low flow days at these EFO nodes.

Flow duration curves both pre-development, and scenario T20 for the two EFO nodes I and H are plotted as **Figure Error! No text of specified style in document..11**.

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4.3.9 Talinga – Continuous Release of 100 ML/day (Scenario T21)

A constant continuing release of 100 ML/day to Condamine River will not comply with the EFOs as the number of low flow days at both the EFO node I and EFO node H will be less than 66% of the pre-development low flow days.

The flow duration curves (pre-development and scenario T21) for both EFO nodes I and H are plotted as **Figure Error! No text of specified style in document..12**.

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Figure Error! No text of specified style in document..**9 Flow Duration Curves – No Talinga Release During No-flow Periods to Max 30% of the Year**

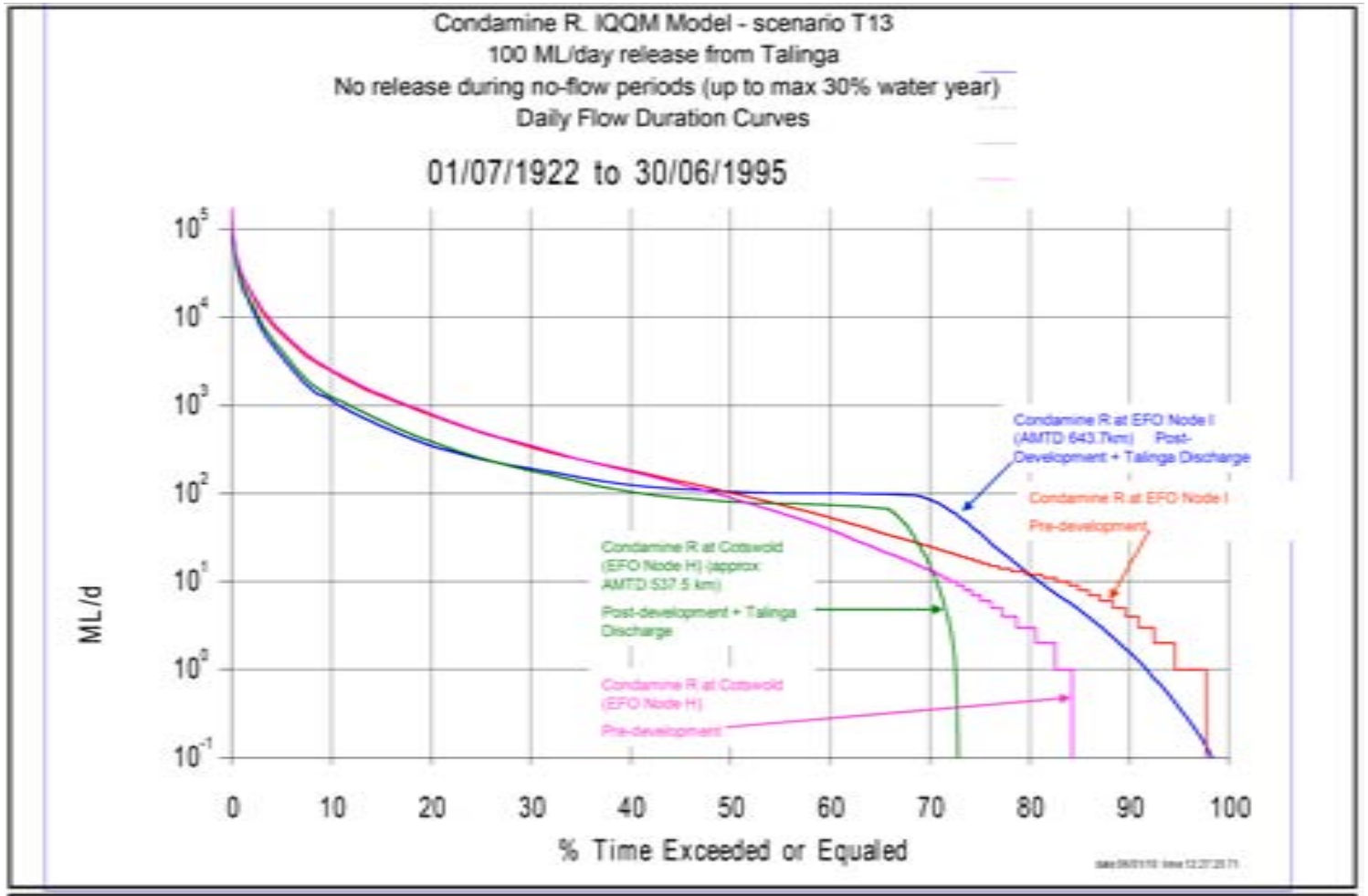

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Figure Error! No text of specified style in document..**10** **Flow Duration Curves – No Talinga Release During No-flow Periods to Max 20% of the Year**

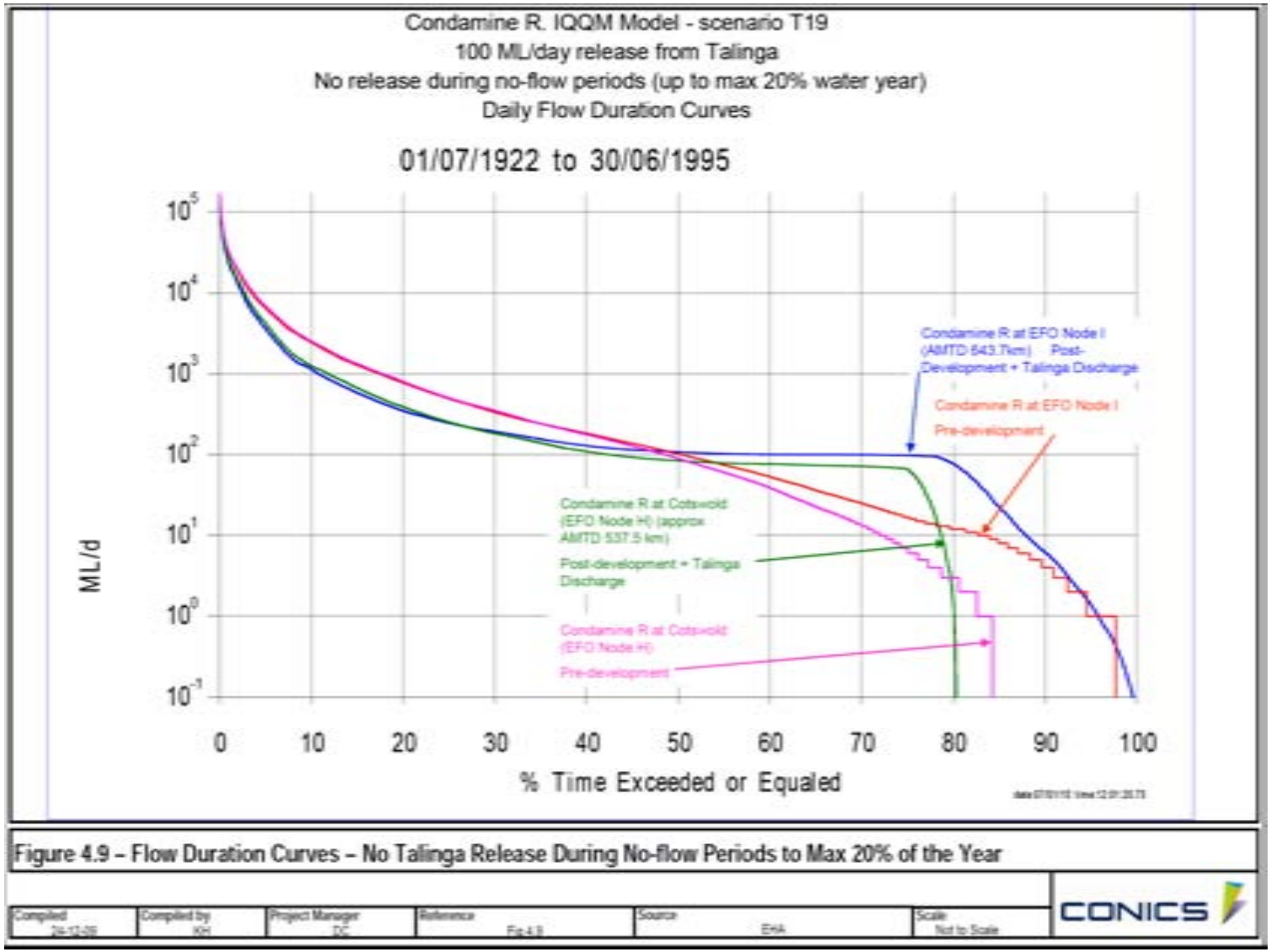

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Figure Error! No text of specified style in document..**11** **Flow Duration Curves – No Talinga Release During No-flow Periods to Max 10% of the Year**

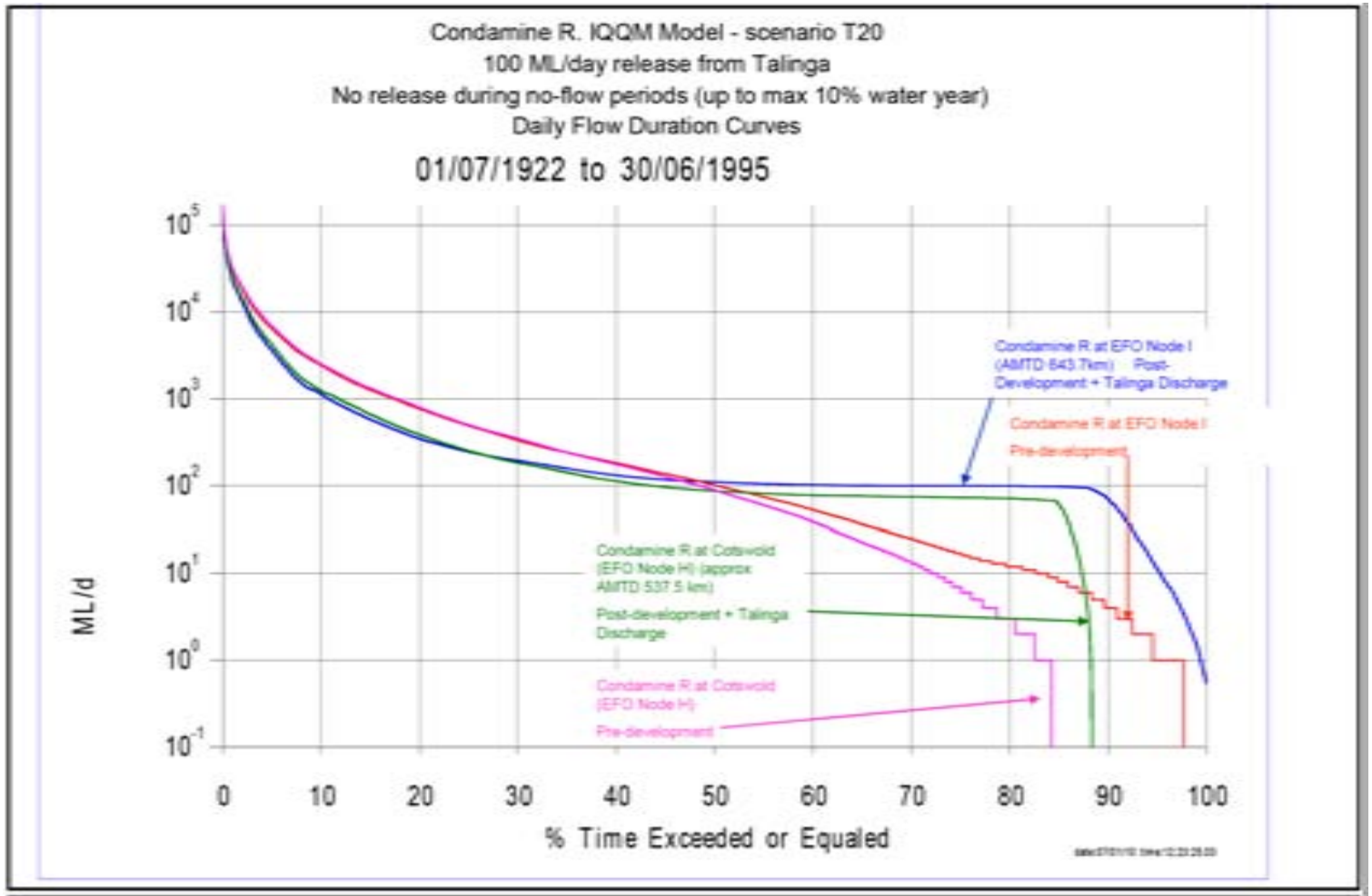

Figure 4.10 – Flow Duration Curves – No Talinga Release During No-flow Periods to Max 10% of the Year

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24-12-09	KH	DC	Fig 4.10	EHA	Not to Scale

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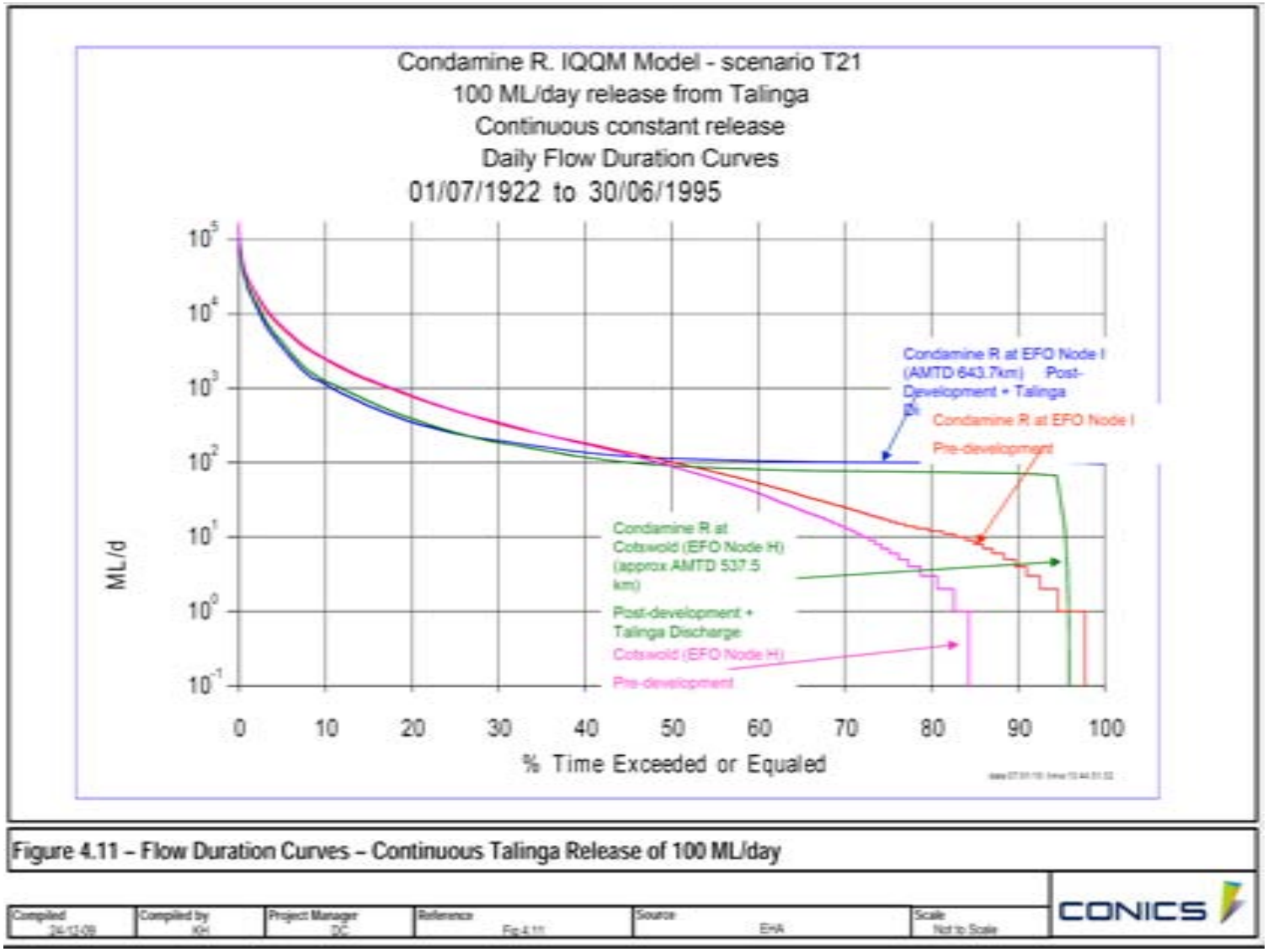
Figure Error! No text of specified style in document..**12** **Flow Duration Curves – Continuous Talinga Release of 100 ML/day**



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4.3.10 Talinga Continuous Release - Condabri 8 Month Release (Scenario TC7)

This scenario assumes releases from both Condabri and Talinga to the Condamine River. A constant release of 35 ML/day from Talinga is made, while at Condabri, releases are made only during the 8 month period January to July inclusive and December. No releases occur from Condabri during the months August to November inclusive.

A maximum of 80 ML/day can be released at Condabri while still complying with the EFOs

When greater releases than 80 ML/day are made, the summer flow statistic at Cotswold (EFO node H) increases above 133% of its pre-development value.

Flow duration curves for this scenario are plotted in **Figure Error! No text of specified style in document..13**.

4.3.11 Talinga Continuous Release - Condabri 9 Month Release (Scenario TC10)

This scenario assumes releases from both Condabri and Talinga to the Condamine River. A constant release of 35 ML/day from Talinga is made, while at Condabri, releases are made only during the 9 month period January to July inclusive, November and December. No releases occur from Condabri during the months August to November inclusive.

A maximum of 35 ML/day can be released at Condabri while still complying with the EFOs

When greater releases than 35 Ml/day are made, the low flow statistic at Cotswold (EFO node H) falls below 66% of the pre-development value.

Flow duration curves for this scenario are plotted in **Figure Error! No text of specified style in document..13**.

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Figure Error! No text of specified style in document..**13** **Flow Duration Curves – Continuous Talinga Release – Condabri Release for 8 months**

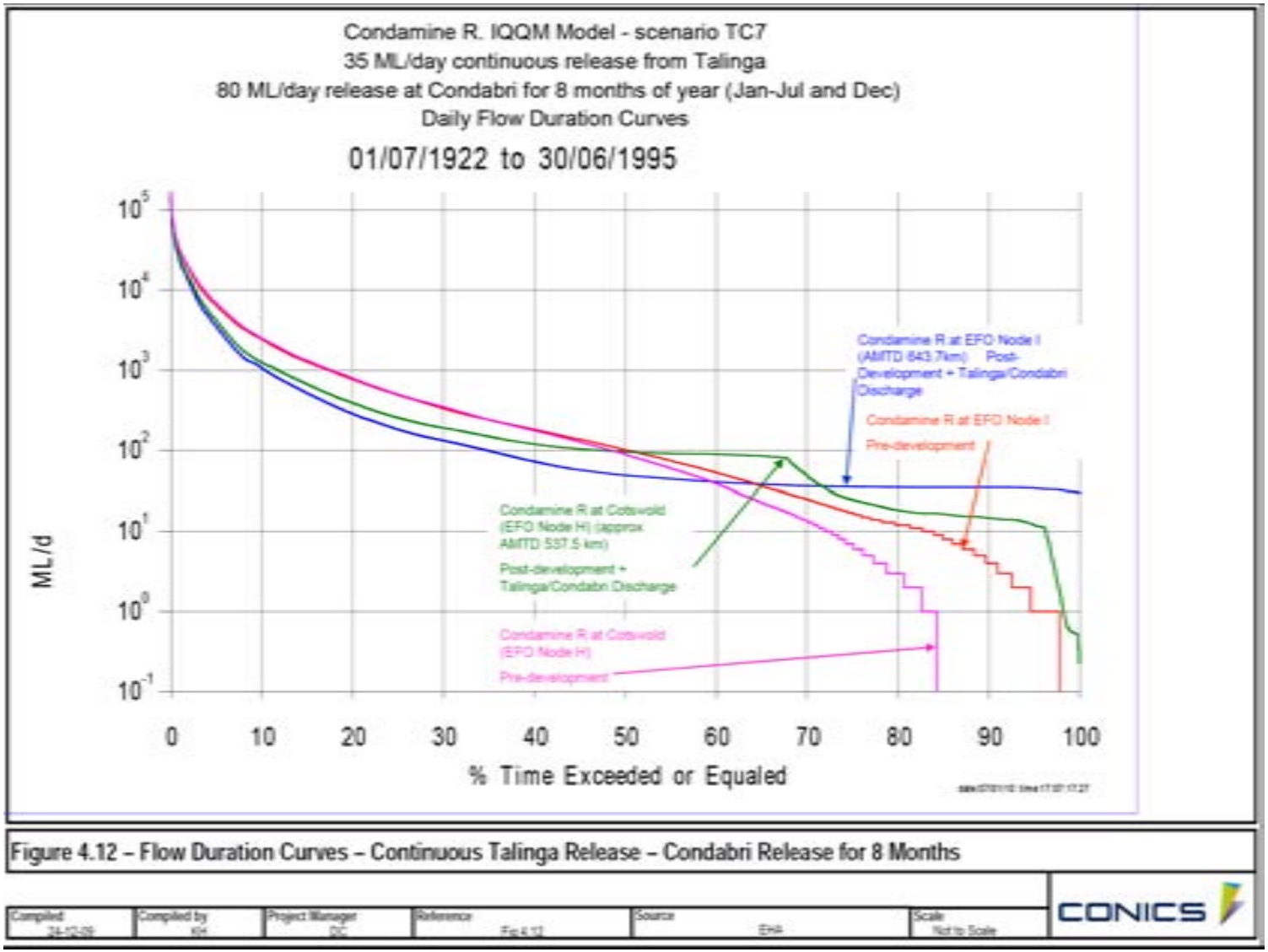

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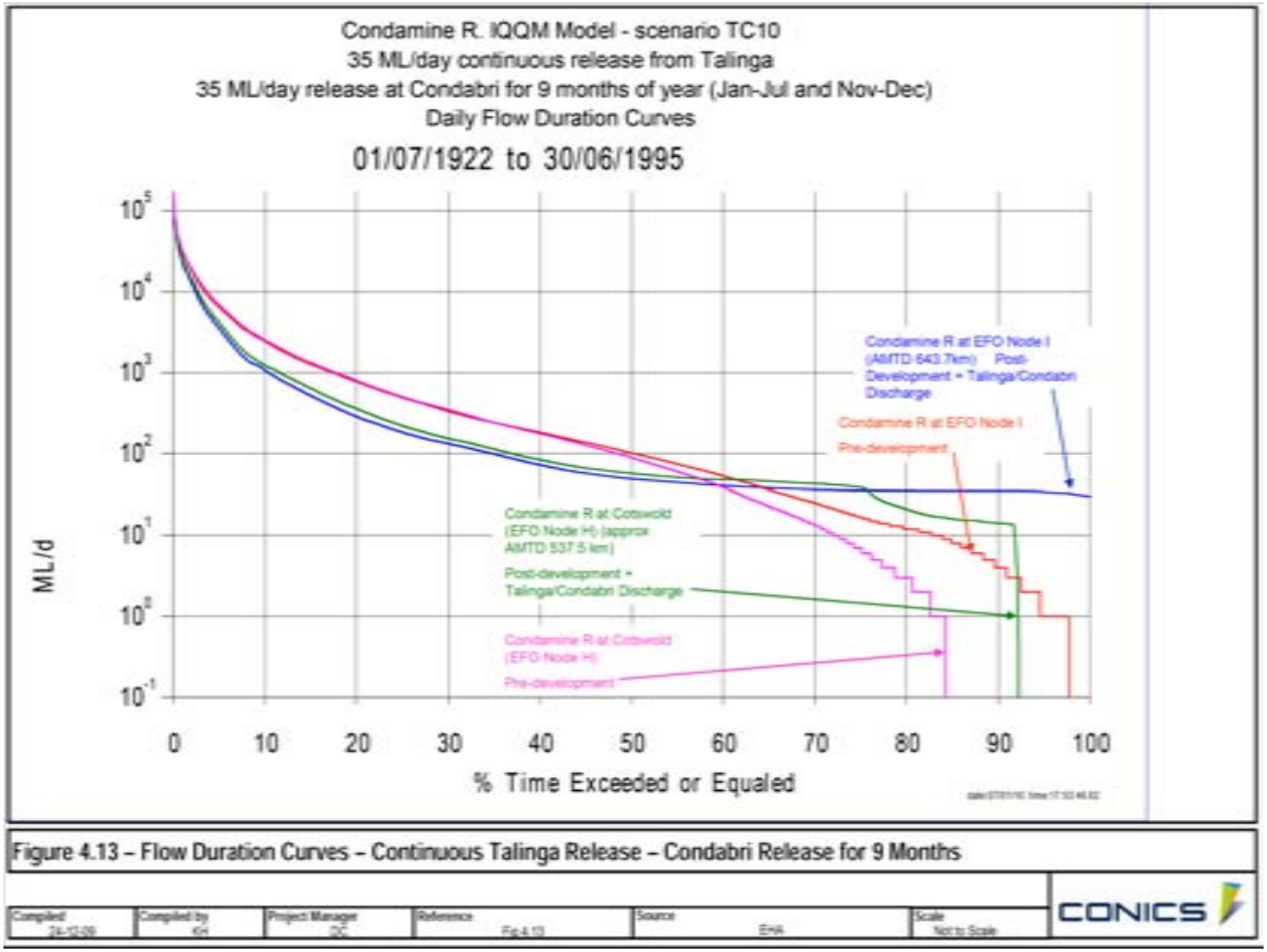
Figure Error! No text of specified style in document..**14** **Flow Duration Curves – Continuous Talinga Release – Condabri Release for 9 months**



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5. Summary and Discussion

The impacts of releases of treated water discharging from coal seam water treatment plants to the Condamine River at two locations - Talinga and Condabri - have been evaluated in relation to environmental flow objectives (EFOs) and water allocation security objectives (WASOs) described in the Water Resource (Condamine and Balonne) Plan 2004.

A hydrologic model developed by DERM was made available for use in this analysis. The model is an Integrated Quantity Quality Model (IQQM) of the middle reaches of the Condamine - Balonne River. The model extends from Condamine River at Cecil Plains downstream to the confluence of the Maranoa River and the Balonne River. The model simulates the streamflows at various locations along the river system over the historical period 1890 to 2006, as well as the extractions for rural and urban uses. It has been used by DERM to quantify the impacts of water resources development and use on the streamflows along the Condamine Balonne River and its major tributaries. The statistics of the simulated streamflow sequences for various levels of water resources development can be compared with the statistics of the pre-development streamflows, and used as a measure of the impacts of development.

The Water Resource (Condamine and Balonne) Plan 2004 (subordinate legislation to the *Water Act 2000*) amongst other things defines the availability of water in the plan area, and provides a framework for water management. It specifies an allowable range of variation of flow statistics (or performance indicators) at key locations (Environmental Flow Nodes) to which any change in water resources development and use should comply. The flow statistics are derived from the DERM hydrology model.

A broad appreciation of the impact of development in the Condamine Balonne River Basin in the locations of potential permeate discharges can be obtained from the DERM hydrology model.

Without any water resources development or use in the river basin, the mean annual flow at Chinchilla is estimated to be about 440,000 ML/yr. At the proposed Condabri discharge location point, the pre-development mean annual flow is approximately 570,000 ML/yr.

The mean annual extraction from the Condamine River and its tributaries upstream of and including the Chinchilla Weir Water Supply Scheme for urban supply, rural water supply, irrigation and water harvesting is approximately 220,000 ML/yr, assuming full utilisation of the current water entitlements. This is approximately 40% of the natural flow at the downstream limit of the Chinchilla Weir Water Supply Scheme.

The cumulative extractions above can be compared with the potential permeate discharge volumes. If the potential permeate discharges are in the range 20 ML/day to 100 ML/day, then the average annual contributions of permeate to the river lie in the range 3% to 17% of the volumes which are being extracted from the river upstream of the discharge points under current water entitlements. The permeate contributions represent only a small percentage of the current upstream water extractions.

If constant releases are made to a river at a certain location, there will be changes in the flow regime downstream of that location. The changes will include an increase in the frequency of low flows, an increase in the average flow, and a decrease in the variability of the flow. The magnitude of the impact will depend on the relative magnitudes of the releases and the naturally occurring streamflows.

The DERM hydrologic model described above was used to simulate the streamflows at locations downstream of the potential discharge points, for a range of possible discharge magnitudes and annual patterns from the treatment plants. For each permeate discharge option simulated, the performance indicators were derived from the simulated streamflow sequences at the downstream EFO nodes. These performance indicators were compared with the pre-development performance indicators to check whether they were within the range allowed by the Water Resources Plan. The critical EFO performance indicators were the number of “low flow days”, and the number of “summer flow days” (defined earlier in this

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report). With higher discharges, either the number of low flow days could fall below 66% of the pre-development low flow days value, which was the minimum percentage allowed by the plan, or the summer flow days could increase to greater than 133% of the pre-development summer flow days which was the maximum percentage allowed by the plan. Other performance indicators; "beneficial flooding flow" and "1 in 2 year flood"; were relatively insensitive to the range of release options modelled.

The options modelled included releases at Talinga, releases at Condabri, and concurrent releases at both Talinga and Condabri. Tabulations of the performance indicators at the relevant EFO nodes for selected options modelled are contained in Appendix A (Talinga), Appendix B (Condabri) and Appendix C (concurrent Talinga and Condabri).

The analyses indicate that constant releases of up to 50 ML/day at Talinga, or constant releases of up to 65 ML/day at Condabri will comply with the EFOs specified in the water resources plan.

Concurrent constant daily releases of 35 ML/day at Talinga and up to 30 ML/day at Condabri will also comply with the EFOs in the water resources plan.

The amounts which are able to be released are constrained by the low flow performance indicator at the environmental flow objective (EFO) nodes I or H.

It may be possible to release or pump the permeate to locations other than the Condamine River for part of the year (for example directly to ring tanks from which it could be used for irrigation), therefore some options of releases for only part of the year were modelled.

If releases were made to the Condamine River only during the 8 months December to July inclusive, a constant daily release of 100 ML/day would be possible while still complying with EFO performance indicators.

Another option considered was to cease releasing (or divert releases elsewhere) during periods of no flow in the river, up to some maximum number of days per year. This strategy would minimise the impact of releasing on the low flow regime at downstream locations. If releases ceased during no-flow periods - provided the number of days of no-release did not exceed 30% of the year - it was found that releases of up to100 ML/day could be made while still complying with EFOs.

Some options were modelled with a constant continuing release of 35 ML/day at Talinga, while at Condabri, releasing for only part of the year. Assuming that constant continuing releases of 35 Ml/day were made at Talinga, while concurrent releases were made at Condabri only during the 8 month period December to July inclusive, a maximum of 80 ML/day could be released at Condabri while still complying with the EFOs in the plan.

None of the above release options impact adversely on the water allocation security objectives for any water user groups. There are however improvements in the reliability of supply to stock and domestic users, Condamine Town Water Supply, and some supplemented irrigation users from the Chinchilla Water Supply Scheme. These users will benefit from the releases.

For example, the supply to the group of irrigators downstream of Talinga that are supplied by releases from Chinchilla Weir will be improved with discharge to the river at Talinga. With a constant continuing discharge of 50 ML/day at Talinga, the model results indicate (for the simulation period 1922 to 1995) that the mean annual diversions to this group will increase from 606 Ml/yr to 783 ML/yr - an increase of 29%. The reliability of supply to this group (as measured by the Supplemented Annual Volume Probability – defined earlier in this report) will increase from 83.5% to 107.5%

Improvements to the supply reliability for users from the St George Water Supply Scheme will also result, but this has not been quantified as the available model does not extend downstream far enough to include the St George scheme. The mean annual flow in the Balonne River just upstream of Beardmore Dam would increase by an estimated 10,000 ML/yr if there were constant continuing releases of 50 ML/day at Talinga. A portion of this volume after losses would be available as additional supply to irrigators in the St George Irrigation Area. As the modelled release is constant from year to year, the

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benefit would be greater during dry periods and low flow years. For example, an annual flow of approximately 22,000 ML occurred in the 1992-93 water year. An additional 10,000 ML/yr would represent a 50% increase in the flow during this year.

In summary, the impacts of a number of discharge options to the Condamine River have been assessed in relation to the water supply security objectives and environmental flow objectives in the Water Resources Plan. It was found to be possible to release significant volumes from Talinga or Condabri, while still complying with the environmental flow objectives and water allocation security objectives in the Water Resources Plan. As described above, there will also be benefits to a range of water users downstream of the potential discharge locations.

For each of the options modelled, flow duration curves at relevant EFO nodes downstream of the release point have been plotted and are included as figures in this report. These curves show how frequently flows are exceeded, and give an indication of the flow regime. Pre-development flow duration curves have also been included in the plots for comparison purposes.

The statistics and the flow duration curves are based on the simulated flow sequences for the period 1st July 1922 to 30th June 1995, consistent with the Water Resources Plan. In the scenario modelling of the discharge options it has been assumed that the releases occur over the whole simulation period. In reality, coal seam gas extraction will have some limited (and only approximately estimated) life, therefore simulation of the discharge continuing over a long period will give a fairly conservative result.

The impacts on stream stability, riparian and in-stream biota among other things in the vicinity of the discharge location would need to be considered separately to the analyses described in this report.

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6. References

EECO 2009: *APLNG Pty Ltd – Walloons Development – Talinga Development Project – Reverse Osmosis Permeate Discharge Assessment,* EECO Environmental Engineering, June 2009.

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