Guideline: Works that interfere with water in a watercourse—watercourse diversions

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Contents

Introduction

There are four parts to this document that proponents should refer to when proposing and undertaking a watercourse diversion as part of a new or amended environmental authority.

Part 1 Overview and application process

Part 1 contains introductory information including a brief description[1] of the application process requirements for environmental authorities for watercourse diversions.

Part 2 Manual

Part 2 contains information on the technical requirements to develop a functional design, design plan and operation and monitoring plan for watercourse diversions.

Part 3 Certification process[2]

Part 3 contains information that will assist proponents and certifiers in understanding certification requirements.

Part 4 Guidance information

Part 4 contains guidance information that may be useful to proponents and certifiers for watercourse diversions.

[1] Detailed guidance on the application process is contained in the Department of Environment and Heritage Protection (EHP) documentation.
[2] This information is replicated in the EHP Guideline on the process

Part 1 Overview

1.1 Scope

This guideline provides technical advice to proponents seeking approval to divert a watercourse[3] (a 'watercourse diversion') associated with a resource activity under a new or amending environmental authority (EA) pursuant to the *Environmental Protection Act 1994* (EPAct). A watercourse diversion must meet criteria defined under section 20(4) of the *Water Act 2000* (the Water Act).

This specifies that:

A person may interfere with water if—

a) the interference is a diversion of a watercourse and is associated with a resource activity; and

b) the impacts of the interference were assessed as part of a grant of an environmental authority for the resource activity; and

c) the environmental authority was granted with a condition about the diversion of the watercourse.

This guideline does not apply to existing watercourse diversions authorised under the Water Act or other relevant legislation (e.g. *Central Queensland Coal Associates Agreement Act 1968*). It is not proposed that current authorised watercourse diversions regulated under the Water Act will automatically transition across to the EPAct or a transition will be encouraged. Existing water licences will remain under the regulatory framework of the Water Act *unless* a proponent requests a transition to the EPAct. Such a transition could only occur under an amendment to an existing EA. The administering authority for the EPAct will decide on a case-by-case basis whether or not this application for an EA amendment represents a minor amendment. The watercourse diversion must achieve the outcomes of a permanent or temporary watercourse diversion (as defined within this guideline) as part of any future performance criteria.

Watercourse diversion design, operation and monitoring should be based on current engineering practice and other relevant guiding principles from past research such as the Australian Coal Association Research Program (ACARP) Projects – Stream Diversions within the Bowen Basin[4]. A permanent watercourse diversion should be designed and operated to ensure that it is stable, self-sustaining and does not impact on the adjoining upstream and downstream reaches of the existing watercourse. A temporary watercourse diversion should meet most EA conditions required for permanent watercourse diversions, however, a temporary watercourse diversion is not expected to be self-sustaining or incorporate natural features typical of the region.

This guideline aims to assist proponents in satisfying the technical requirements of the application and approval process in meeting key objectives and performance-based outcomes for permanent and temporary watercourse diversions. The responsibility for ensuring the accurate assessment, documentation of the design and the adequate performance of watercourse diversions rests with the holder of the authority and its consultants (i.e. the suitably qualified and experienced person (SQEP)). In deciding to issue an EA the administering authority will rely on the certification(s) given by SQEP as outlined in documentation submitted to the administering authority.

[3] See Part 4 of this guideline.
[4] The ACARP projects (C8030, C9068 and 9068) established a set of key hydraulic, geomorphic and revegetation criteria for diversion design that was developed from natural watercourses within the Bowen Basin.

The administering authority may, as part of a later auditing strategy, review the documentation in detail for conformance with the EA.

This guideline does not limit, amend or change in any way, any other requirements to be complied with under conditions of an EA and/or regulations for the design, operation and monitoring of a watercourse. Further, it does not negate any lawful requirements of the EPAct, other Commonwealth, state or local government laws or requirements under relevant standards or agreements**.**

1.2 Background

Resource deposits frequently extend beneath Queensland's streams and river systems. The viability of a resource project can depend on the feasibility of diverting a watercourse to allow access to a resource deposit. Diverting a watercourse may be viable where it is economically feasible (based on the total cost over the life of the watercourse diversion) and where the impacts of the watercourse diversion can be adequately mitigated and managed.

Watercourses are key components of landscapes and communities across Queensland. Watercourses are valued for their water supply, recreation, environmental values and for aesthetic and cultural reasons. As a result, proposals to divert watercourses can generate community interest and require regulatory approval.

Watercourse diversions are subject to regulatory approval under the Water Act, however, where a watercourse diversion is proposed as part of a resource activity, recent reforms to the Water Act now mean that regulatory approval may occur as a part of issuing an EA under the EPAct.

Watercourse diversion designs should consider the geomorphologic, hydrologic and ecological components of a watercourse as well as its hydraulic and engineering components. Watercourse diversions should be designed, constructed, operated and maintained according to an engineering standard appropriate to meeting the outcomes as described below (section 1.4) in this guideline.

1.3 Objectives for watercourse diversion

All permanent watercourse diversions should aim to achieve the following key objectives:

i) be self-sustaining[5] and include geomorphic and vegetation features of regional watercourses and the surrounding landscape; and

ii) where possible, positively contribute to river health values for the system; and

iii) not impose liability on the State, the proponent or the community to maintain the watercourse diversion and its associated components.

1.4 Outcome requirements for watercourse diversion design

1.4.1 Permanent watercourse diversions

A permanent watercourse diversion will need to satisfy the outcomes stated in the conditions of the relevant EA before the relevant EA can be surrendered. The model EA conditions are based on the outcomes listed below. The permanent watercourse diversion should be designed, constructed, operated and maintained such that the conditions of the EA (i.e.

[5] A self-sustaining diversion functions without features or characteristics that rely on ongoing maintenance or that impose a financial or other burden on the proponent, government or the community.

outcomes) can be achieved prior to surrender of the EA. Specific actions such as staged construction, revegetation or maintenance may occur over a number of years before all the required outcomes are achieved.

Outcome 1: The permanent watercourse diversion incorporates natural features (including geomorphic and vegetation) present in the landscape and in local watercourses.

Outcome 2: The permanent watercourse diversion maintains the existing hydrologic characteristics of surface water and groundwater systems.

Outcome 3: The hydraulic characteristics of the permanent watercourse diversion are comparable with other local watercourses and are suitable for the region in which the watercourse diversion is located.

Outcome 4: The permanent watercourse diversion maintains sediment transport and water quality regimes that allow the watercourse diversion to be self-sustaining, while minimising any impacts to upstream and downstream reaches.

Outcome 5: The permanent watercourse diversion and associated structures maintain equilibrium and functionality and are appropriate for all substrate conditions they encounter.

1.4.2 Temporary watercourse diversions

A temporary watercourse diversion may be required in the following circumstances:

- to enable the construction of a permanent watercourse diversion within a mined area following the recovery of the resource underneath the diverted watercourse
- to enable the construction of a permanent watercourse diversion “offline” while the recovery of the resource underneath the existing watercourse occurs, or
- when a permanent watercourse diversion is proposed in the future however uncertainty in economics and mine planning make it ‘feasible’ for a short term or temporary watercourse diversion to be constructed.

A temporary watercourse diversion will need to satisfy the outcomes below.

Outcome 1: The temporary watercourse diversion maintains the existing hydrologic characteristics of surface water systems.

Outcome 2: The hydraulic characteristics of the temporary watercourse diversion are comparable with other local watercourses and suitable for the region in which the watercourse diversion is located.

Outcome 3: The temporary watercourse diversion maintains sediment transport and water quality regimes that minimise any impacts to upstream and downstream reaches.

Outcome 4: The temporary watercourse diversion and associated structures maintain equilibrium and functionality and are appropriate for all substrate conditions they encounter.

1.5 Application and approval process for environmental authorities

In brief, the following application process will apply when it has been identified that a permanent or temporary watercourse diversion is required as part of a resource activity (i.e. on tenement). For an applicant to apply under the EPAct, the watercourse diversion must be located within the resource tenure boundary. If the watercourse diversion is partly located off tenement then the applicant will need to apply for a water licence under the Water Act.

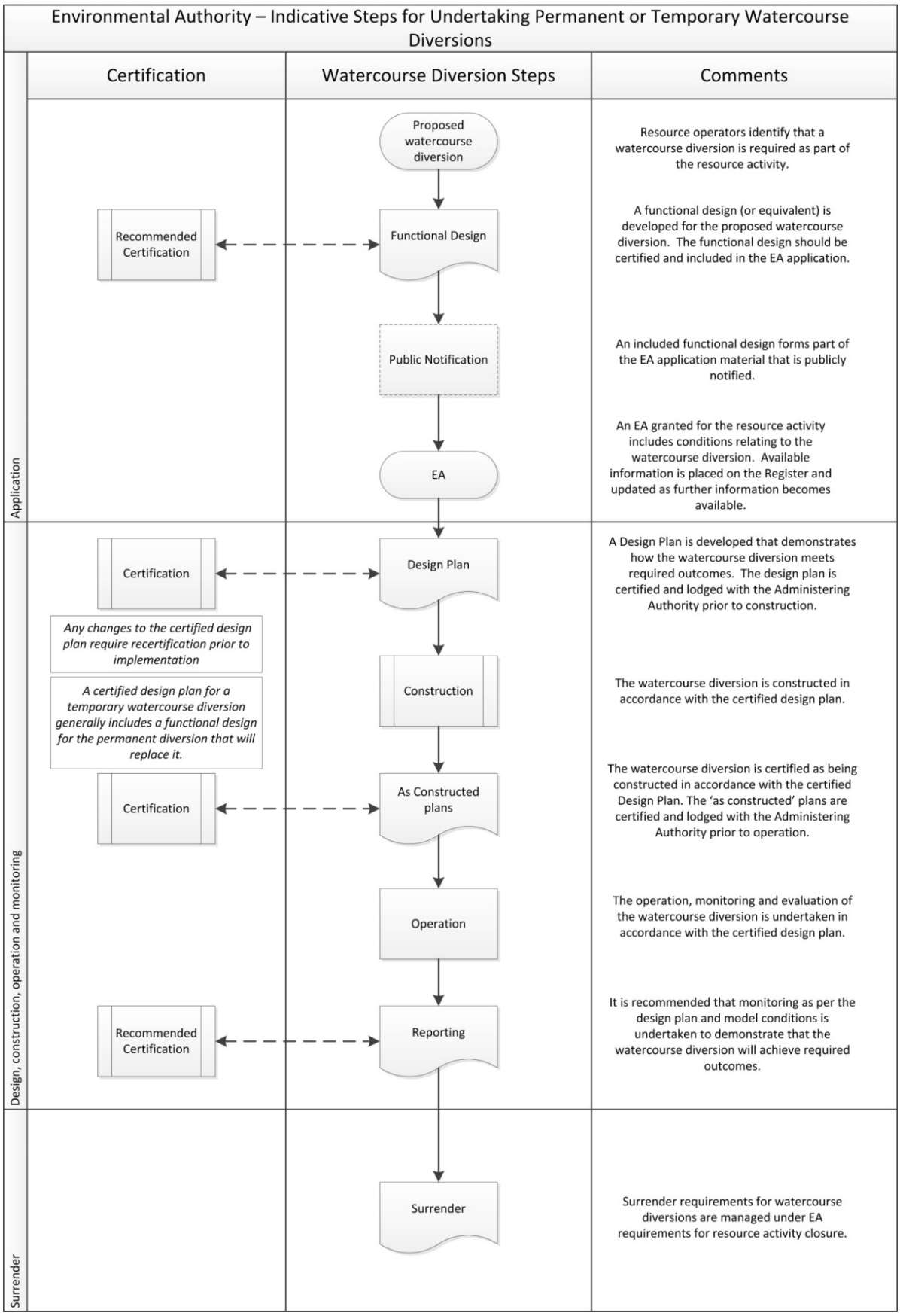

Figure 1: Assessment and approval flowchart for watercourse diversion to be conditioned as part of an environmental authority, or amendment to an environmental authority.

Figure 1 identifies the key steps of the application process under the EPAct and subsequent development of the design, construction, operation and monitoring phases of the watercourse diversion. Sections 1.5.1 to 1.5.9 provide further information on the application process. For more detailed guidance on the EA application process and supporting material refer to the Department of Environment and Heritage Protection website at www.ehp.qld.gov.au.

Proponents should liaise with other water users and communities along the existing watercourse to understand potential impacts to affected person/s from the watercourse diversion. Proponents may need to enter into agreements with affected parties where the parties' ability to access existing surface and groundwater resources are impacted.

1.5.1 Functional design

Proponents are strongly encouraged to engage with the administering authority[6] prior to undertaking a functional design for a watercourse diversion, in order to clarify application requirements. A 'functional design' is a document that describes 'conceptually' how a watercourse diversion can satisfy the outcomes identified in section 1.4 of this guideline. The document should include, but not be limited to:

- geomorphic and vegetation assessment of the existing watercourse
- hydrologic conditions of the existing watercourse
- the proposed watercourse diversion route
- details of any temporary diversions that may be required as part of a staged process towards the final permanent watercourse diversion.
- hydraulic conditions of the existing watercourse and proposed watercourse diversion
- details of the substrate on which the watercourse diversion will be constructed, and
- a statement of how the watercourse diversion meets the outcomes.

Section 1.5.8 of this guideline provides further guidance on certification requirements. The functional design should provide sufficient detail to demonstrate that the final design will meet the stated outcomes in section 1.4.

For proposed temporary watercourse diversions, a functional design for the permanent watercourse diversion that will replace the temporary watercourse diversion will need to be submitted as part of the application process. Refer to Parts 2 and 3 of this document for further guidance on technical requirements for the functional design.

1.5.2 Public notification

An application for a watercourse diversion will normally require public notification under the EA application process. The functional design will be made available to the public as part of the application material for the EA (or as part of the EIS process). Where a submission is made in reference to the application, the administering authority may request the applicant respond to the submission.

Proponents should discuss with the administering authority any changes to the proposed watercourse diversion made following the notification process and prior to the finalisation of the draft EA, to determine if the changes will affect the assessment process.

[6] And in turn with Department of Natural Resources and Mines (DNRM).

1.5.3 Environmental authority

The EP Act provides for the granting of EA's for watercourse diversions associated with resource activities.

Model conditions have been developed for permanent and temporary watercourse diversions associated with resource activities. These reflect the outcomes stated above in Section 1.4 above. Refer to the Guideline: *Model Mining Conditions* (available at www.ehp.qld.gov.au) for further information on applying model conditions.

Additional watercourse diversions that were not proposed in the EA application are likely to require an amendment to the EA, and may require public notification if the changes are significant.

In addition, if the design plan is conceptually or significantly different from the functional design submitted as a part of the application process these changes should be discussed with EHP to determine if a further EA amendment would be required. Supporting documentation for the EA amendment should include a certified functional design plan (see Figure 1).

The details of watercourse diversions authorised under an EA should be recorded on the Register of Watercourse Diversions kept by the holder of the authority. It is the responsibility of the holder of the authority to ensure any register is accurately maintained.

1.5.4 Design plan

A 'design plan' is a document that contains relevant information regarding the design, operation, monitoring and revegetation of a watercourse diversion that addresses the EA conditions for watercourse diversions (i.e. outcomes identified in section 1.4 of this guideline) and any site-specific conditions on the EA relating to the watercourse diversion. The document should include, but not be limited to:

- required information for a functional design
- the location, function and description of geomorphic and riparian vegetation features within the proposed watercourse diversion
- results from hydrologic, hydraulic and sediment transportation modelling used in the design of the watercourse diversion
- a revegetation and vegetation management plan (a revegetation plan)
- the staged development of a permanent watercourse diversion including the proposed use of temporary watercourse diversions with identified lifespans (if relevant)
- engineering drawings depicting the physical attributes and dimensions of the watercourse diversion
- all investigation and other reports relied on by the design, and
- plans and specifications sufficient to complete construction and revegetation in accordance with the design.

It is also recommended that a design plan include an operation and monitoring plan that includes an assessment process that demonstrates that the watercourse diversion is meeting the required outcomes, and includes the proposed timing and frequency of assessments

Section 1.5.8 of this guideline provides further guidance on certification requirements. Refer to Parts 2 and 3 of this document for further guidance on the technical requirements for the design plan.

1.5.5 Construction

The certified design plan must be submitted to the administering authority prior to the commencement of construction. Following construction, a SQEP must certify that the watercourse diversion has been constructed in accordance with the certified design plan.

1.5.6 As constructed plans

‘As constructed’ engineering plans must accompany the certifier’s report for lodgement with the administering authority within the period specified in the EA post construction of the watercourse diversion.

Both the certified design plan and the ‘as constructed’ plans may be used for auditing purposes by the administering authority.

1.5.7 Monitoring and reporting

It is recommended that an operational and monitoring plan should form part of the design plan for a watercourse diversion. The operational and monitoring plan should outline how the EA holder plans to undertake monitoring of the diversion against the specified outcomes and outline how responses to any recommendations on remedial actions would be implemented. Refer to Part 2 of this document for further guidance on the technical content of an operation and monitoring plan.

The authority holder is expected to undertake timely monitoring by suitably qualified persons and appropriate and timely action to rectify the cause of any change to equilibrium that threatens the performance and integrity of the watercourse diversion and/or adjoining watercourses. If the administering authority takes action for non-compliance with the specified outcomes, the EA holder’s ongoing operation and monitoring plan and responses to recommended remedial actions would inform this action.

1.5.8 Certification

The administering authority will rely on the certification of the functional design and design plans submitted by the holder of the authority and given by the SQEP . Certification should be in accordance with the form of certification provided in Part 3 of this guideline. The administering authority may audit these documents against required outcomes and may take action, for instance where false and misleading information has been provided.

1.5.9 Surrender

To successfully surrender the EA or part thereof, the area subject to the EA, including the watercourse diversion, will have to be rehabilitated as part of the post-mining landscape.

Part 2 Technical requirements manual

This part is defined as the ‘manual’ and contains technical information requirements for authority holders (and certifiers) seeking approval for a watercourse diversion under a new or existing EA pursuant to the EPAct.

Functional design and design plan guidance has been developed to assist with achieving key objectives and outcomes for permanent watercourse diversions. Specific guidance relevant to temporary watercourse diversions are documented separately in section 3 of this manual and should be referred to when designing such structures. For both permanent and temporary watercourse diversions, it is recommended that an operation and monitoring plan forms part of the design plan to describe the operation and monitoring process that will demonstrate how the watercourse diversion is performing in relation to the required outcomes and model conditions.

Both permanent and temporary watercourse diversions should be developed with consideration of mine planning. The functional design and design plan should document this by showing the development and evolution of the watercourse diversion in association with mining infrastructure, resource activities, operational activities and mine rehabilitation.

Resource activities should not impact on the watercourse diversion, the adjoining watercourse or floodplain corridor such that they prevent the watercourse diversion meeting the key outcomes listed in section 1.4.

The purpose of this part is to:

- Provide guidance for authority holders, and certifiers in watercourse diversion design. and operation including revegetation, maintenance and monitoring.
- The manual is structured in three sections:
- Section 1: Key principles of permanent watercourse diversion design
- Section 2: Functional design, design plan and operation and monitoring of permanent watercourse diversions
- Section 3: Functional design, design plan and operational and monitoring of temporary watercourse diversions.

Section 1: Key principles of permanent watercourse diversion design

The following key principles have been developed to assist with the interpretation of the outcomes for permanent watercourse diversions. A permanent watercourse diversion will contain features that do not require on-going maintenance at the time of surrendering the EA.

Key principles
Outcome 1 **The permanent watercourse diversion incorporates natural features (including geomorphic and vegetation) present in the landscape and in local watercourses.**
1. The watercourse diversion should incorporate geomorphic and riparian vegetation features appropriate to the landscape in which the watercourse diversion is located. 2. Revegetation is planned, managed and monitored and utilises a trajectory pathway to ensure self-sustaining vegetation communities are achieved.
Outcome 2 **The permanent watercourse diversion maintains the existing hydrologic characteristics of surface water and groundwater systems.**
1. The watercourse diversion maintains the hydrologic characteristics of surface water flows and groundwater interactions where they exist. 2. A watercourse diversion should minimise any impacts to upstream and downstream reaches.
Outcome 3 **The hydraulic characteristics of the permanent watercourse diversion are comparable with other local watercourses and suitable for the region in which the watercourse diversion is located.**
1. The watercourse diversion includes sufficient floodplain corridor width so as to allow for natural channel evolution processes. 2. Watercourse design relies on grade, plan form and vegetation as mechanisms to manage stream energy and may include artificial structures that do not require ongoing maintenance.
Outcome 4 **The permanent watercourse diversion maintains sediment transport and water quality regimes that allow the watercourse diversion to be self-sustaining, while minimising any impacts on upstream and downstream reaches.**
1. The watercourse diversion does not cause erosive or depositional events inconsistent with the existing sediment transport regime unless designed to promote watercourse health.

2. The watercourse diversion maintains sediment transport and water quality regimes that:
    a. are comparable with upstream and downstream reaches or local watercourse with geomorphically similar characteristics to the existing watercourse reaches on which the watercourse diversion is proposed, and
    b. suitable for the region in which the watercourse diversion is located.

Outcome 5

The permanent watercourse diversion and associated structures maintain equilibrium and functionality and are appropriate for all substrate conditions they encounter.

1. Watercourse diversion design, construction, operation and monitoring are appropriate to the substrate characteristics on which the watercourse diversion is constructed.
2. A watercourse diversion should achieve the best environmental outcome regardless of substrate material encountered along the watercourse diversion route.

Section 2: Functional design, and design plan of permanent watercourse diversions

2.1 Functional design of permanent watercourse diversions

A functional design for a watercourse diversion 'conceptually' describes how the watercourse diversion can meet the required outcomes. The functional design should include conceptual mine planning throughout mine life associated with mining infrastructure, resource activities, operational activities and mine rehabilitation that may directly or indirectly affect the watercourse diversion. If the watercourse diversion alignment is located through spoil, the proponent should justify that the watercourse diversion will achieve the best environmental outcome in preference to locating the watercourse diversion through *in situ* material.

The following criteria should be considered when developing the proposed functional design:

1. The watercourse diversion should tie-in with the existing or receiving watercourse within the resource tenure boundary.
2. The equilibrium and performance of a watercourse diversion is assisted by vegetation within the watercourse diversion and adjoining floodplain and does not include artificial structures for grade control that require ongoing maintenance.
3. The length of the channel should be equivalent to the length of the watercourse it replaces.
4. Bed grade/slope should be equivalent to the existing watercourse.
5. Batter slopes should be designed to maintain channel equilibrium through different substrate.

A functional design should include, but is not limited to:

- geomorphic and vegetation assessment of the existing watercourse
- hydrologic conditions of the existing watercourse
- the proposed watercourse diversion route
- hydraulic conditions of the existing watercourse and proposed watercourse diversion
- details of the substrate on which the watercourse diversion will be constructed, and
- a statement of how the watercourse diversion meets the outcomes.

The following key outcomes and assessment criteria should be addressed and documented within a functional design report when submitting an application.

The functional design plan should be certified by a SQEP as ensuring that the watercourse diversion will achieve the outcomes stated in the table below.

Functional design

Outcome 1

The permanent watercourse diversion incorporates natural features (including geomorphic and vegetation) present in the landscape and in local watercourses.

Geomorphic and vegetation criteria

- A geomorphic and riparian vegetation study of existing watercourses that will be influenced by the watercourse diversion and the proposed watercourse diversion route.
- A conceptual plan of the watercourse diversion incorporating the geomorphic and riparian features of the existing watercourse and/or the landscape along the proposed watercourse diversion route.

If the proposed watercourse diversion route is unable to reflect features of the watercourse to be diverted, the functional design should:

- identify the characteristics of the proposed watercourse diversion route that prevent the inclusion of identified features (for instance, a change in substrate), and
- justify that watercourse diversion cannot be located along an alternate route that can reflect the features of the watercourse to be diverted.

Outcome 2

The permanent watercourse diversion maintains the existing hydrologic characteristics of surface water and groundwater systems.

Surface and ground water criteria

The functional design should include an investigation of surface and groundwater interactions that:

- identifies the connectivity (if any) between surface water and groundwater flows including proposed final voids adjacent to the proposed watercourse diversion
- identifies any surface and groundwater users (such as landholders, communities or ecosystems) that are dependent on the connectivity within the watercourse and adjoining floodplain
- outlines how the watercourse diversion will be designed to address any reliance by users on pre-existing groundwater connectivity and how impacts on users will be mitigated, and
- includes findings from past groundwater studies where relevant/available.

Where the surface and groundwater systems cannot be replicated, the investigation should include evidence that:

- no better/feasible alternatives for the watercourse diversion exist that maintain surface and groundwater systems and that any impacts on the surface and groundwater systems are restricted within the mining lease tenure, or
- evidence of consultation and agreement with affected parties or other impacted water users.

Hydrologic model criteria

An appropriate hydrological model should provide:

- evidence that the watercourse diversion will maintain existing hydrological conditions
- mean annual flow, catchment yield and downstream hydrograph characteristics of the existing and/or receiving watercourse and proposed watercourse diversion

- evidence that actual flow records (where available) are used for model calibration
- peak flows (m^3/s) for annual exceedance probability (AEP) 50%, 2%, 1% , 0.1%, and
- peak flows for low flow channel and bankfull capacity for the existing watercourse and proposed watercourse.

Outcome 3

The hydraulic characteristics of the permanent watercourse diversion are comparable with other local watercourses and suitable for the region in which the watercourse diversion is located.

Hydraulic criteria

An appropriate hydraulic model should provide:

- an assessment of average channel energy conditions for the existing watercourse and proposed watercourse diversion
- a review of potential changes in flood heights pre and post watercourse diversion within the existing and adjoining watercourses
- evidence that the watercourse diversion will not incorporate features or structures that require on-going maintenance to maintain hydraulic conditions for equilibrium of watercourse diversion surfaces, and
- evidence that the watercourse diversion design has taken into account an adequate floodplain corridor width and the resultant hydraulic conditions will not compromise the equilibrium and performance of the watercourse diversion and adjoining watercourses.

Outcome 4

The permanent watercourse diversion maintains sediment transport and water quality regimes that allow the watercourse diversion to be self-sustaining, while minimising the impacts to upstream and downstream reaches.

An appropriate sediment transportation model should provide:

- an investigation of the current watercourse and proposed watercourse diversion sediment transportation regime.

Outcome 5

The permanent watercourse diversion and associated structures maintain equilibrium and functionality and are appropriate for all substrate conditions they encounter.

Substrate criteria

An investigation of substrate conditions should describe the substrate along the proposed watercourse diversion alignment.

Additional criteria for watercourse diversions through spoil

If the proposed watercourse diversion route is located on or within spoil material, an investigation of spoil substrate conditions should provide:

- the location and description of any existing or proposed spoil material along the proposed watercourse diversion alignment, and
- an evaluation of sub-surface water movement within the watercourse diversion footprint and adjacent floodplain.

2.2 Design plan of permanent watercourse diversions

A 'design plan' is a document setting out how the design, operation, monitoring and revegetation of a watercourse diversion will achieve the conditions of the EA (i.e. outcomes) as outlined in section 1.4 and any site-specific conditions on the EA relating to the watercourse diversion.

The purpose of a design plan is to provide detailed design and construction plans that, if the watercourse diversion is built in accordance with these plans, will meet the objectives specified for permanent watercourse diversions. The level of information provided in the design plan will vary for each watercourse diversion depending on factors such as size, location, substrate and influences of resource activities (e.g. watercourse diversions that incorporate levee banks for floodplain corridor containment, construction through spoil or directly impacted by subsidence from underground mining).

The design plan should include, but is not limited to:

- required information for a functional design
- the location, function and description of geomorphic and riparian vegetation features within the proposed watercourse diversion
- results from hydrologic, hydraulic and sediment transportation modelling used in the design of the watercourse diversion
- a revegetation and vegetation management plan (a revegetation plan)
- engineering drawings depicting the physical attributes and dimensions of the watercourse diversion
- all investigation and other reports relied on by the design, and
- plans and specifications sufficient to complete construction and revegetation in accordance with the design.

It is also recommended that a design plan include an operation and monitoring plan that includes an assessment process that demonstrates that the watercourse diversion is meeting the required outcomes, and includes the proposed timing and frequency of assessments

An SQEP certifies that the watercourse diversion if built, operated and maintained in accordance with the design plan will achieve the outcomes stated in the EA conditions.

The following key outcomes and assessment criteria should be addressed and documented within a design plan report.

Design plan
Outcome 1 **The permanent watercourse diversion incorporates natural features (including geomorphic and vegetation) present in the landscape and in local watercourses.**
Geomorphic criteria • the location, function and description of geomorphic features within the proposed watercourse diversion. ***Criteria relating to vegetation*** A revegetation and vegetation management plan (revegetation plan) should include: • the proposed vegetation communities adopted within the watercourse diversion

footprint including the adjoining floodplain
- site preparation and planting techniques to promote vegetation including retention and reuse of topsoil and measures to mitigate adverse substrate characteristics
- the management of vegetation to reduce the impact of weeds, cattle grazing and soil erosion, and
- a self-sustaining trajectory pathway for revegetation of disturbed surfaces and anticipated cover levels during mine life to achieve required hydraulic criteria.

Outcome 2

The permanent watercourse diversion maintains the existing hydrologic characteristics of surface water and groundwater systems.

The design plan should include a detailed description of:
- the development and calibration, or sensitivity analysis, of the hydrologic model, including the referencing of methodologies used to generate flood frequency analysis, and
- any design implications and construction processes that necessitate a lateral dis-connectivity of sub-surface flow between the watercourse and an adjacent final void (if proposed).

Outcome 3

The hydraulic characteristics of the permanent watercourse diversion are comparable with other local watercourses and suitable for the region in which the watercourse diversion is located.

Hydraulic criteria

The design plan should include:
- a detailed description of the development and calibration, or sensitivity analysis, of the hydraulic model
- hydraulic modeling results provide evidence that impacts upstream and downstream or within the watercourse diversion footprint can be managed or mitigated
- a sensitivity analysis for hydraulic roughness during the watercourse diversion life to determine if proposed roughness levels will provide conditions necessary to ensure the equilibrium and performance of the watercourse diversion, and
- a hydraulic analysis that identifies if the extent and depth of inundation between existing and post-diversion conditions has changed.

Criteria for watercourse diversion features

The design plan should include:
- a floodplain of sufficient capacity to maintain the hydraulic conveyance of flood events without impacting on the equilibrium and performance of the watercourse diversion or adjoining watercourses
- a staged development of the floodplain (if relevant) when planning for mineral resource extraction adjacent to the watercourse diversion. Hydraulic modelling must be performed at each development stage to determine the impact on the watercourse diversion and adjacent watercourse
- the location and hydraulic effect of features that do not require ongoing maintenance, and
- the location and hydraulic effect of features that are designed to direct local drainage into the watercourse diversion.

Outcome 4

The permanent watercourse diversion maintains sediment transport and water quality regimes that allow the watercourse diversion to be self-sustaining, while minimising the impacts to upstream and downstream reaches.

The design plan should include a sediment transport analysis that identifies how the watercourse diversion will manage erosion or deposition events such that they are consistent with the existing sediment regime.

Outcome 5

The permanent watercourse diversion and associated structures maintain equilibrium and functionality and are appropriate for all substrate conditions they encounter.

Substrate criteria

The design plan should include:

- a geotechnical analysis and accompanying map of substrate material encountered within the watercourse diversion alignment that identifies soil chemical and physical properties including constraints to equilibrium of watercourse diversion surfaces, vegetation establishment and persistence, and
- a system for ensuring appropriate remedial actions are undertaken where potential or existing change to equilibrium is identified during monitoring as a result of substrate or spoil characteristics.

Additional criteria for watercourse diversions through spoil

The design plan should include:

- the specification of spoil placement and sequencing, and
- the settlement process and timing of operation that will ensure the watercourse diversion, once constructed, operates in a stable manner.

2.3 Operation and monitoring for permanent diversions

An 'operation and monitoring' plan is a document that describes the operating conditions throughout the life of the watercourse diversion to achieve the requirements of the design plan. It is recommended that an operation and monitoring plan forms part of the design plan. The monitoring component should provide for the collection of evidence that the watercourse diversion is operating as designed and detail proposed management actions to rectify any issues that will not achieve the intended design requirements. The ACARP project C9068 refers to specific monitoring programs developed for stream diversions. The timing and frequency of monitoring should be specified in the operation and monitoring plan.

It is recommended that the watercourse diversion be inspected by an SQEP who prepares an inspection report. This should indicate whether the watercourse diversion is operating in accordance with the design requirements, or alternatively, recommend measures that the proponent needs to implement over an appropriate timeframe to allow the watercourse diversion to operate as intended. In cases where monitoring identifies that the watercourse diversion is not evolving towards achieving the required outcomes, the operation and monitoring plan should recommend a process to ensure that outcomes are achieved.

The following key outcomes and assessment criteria should be addressed and documented within a design plan when submitting an application.

Operation and monitoring
Outcome 1 **The permanent watercourse diversion incorporates natural features (including geomorphic and vegetation) present in the landscape and in local watercourses.**
Geomorphic and vegetation criteria Operation and monitoring plans should include a monitoring and evaluation section that describes: • the process that will be adopted to assess the performance of geomorphic features following flow events. The performance should be compared to the performance of geomorphic features located in the adjacent or local watercourses. • geomorphic and riparian vegetation features are in place or are progressing in line with expected development as identified in the design report • monitoring of riparian vegetation with consideration of the role of vegetation at a landscape scale, and • other factors that are negatively impacting vegetation and management actions to counteract these factors.
Outcome 2 **The permanent watercourse diversion maintains the existing hydrologic characteristics of surface water and groundwater systems.**
Operation and monitoring plans should include a monitoring and evaluation section that describes: • the monitoring and evaluation of surface flows and groundwater (where applicable) levels such that any changes in the existing flow regimes are identified.

Outcome 3 **The hydraulic characteristics of the permanent watercourse diversion are comparable with other local watercourses and suitable for the region in which the watercourse diversion is located.**
Operation and monitoring plans should: • provide evidence that demonstrates the watercourse diversion meets proposed hydraulic modelling outcomes and validates relevant assumptions in accordance with the design plan • include specific monitoring locations for areas that are proposed, or are likely, to be altered by floodplain development activities • include reference reaches within the adjacent watercourse to determine natural channel evolution processes and any potential impact resulting from the watercourse diversion, and • identify specific AEP flow events that trigger additional monitoring to ensure that the performance of the watercourse diversion is in accordance with the design plan.
Outcome 4 **The permanent watercourse diversion maintains sediment transport and water quality regimes that allow the watercourse diversion to be self-sustaining, while minimising any impacts to upstream and downstream reaches.**
Operation and monitoring plans should include a program that: • provides evidence that demonstrates sediment transportation rates are consistent with the design plan, or • establishes a system for identifying reasons for any inconsistency and proposing appropriate measures to address inconsistencies if they are observed.
Outcome 5 **The permanent watercourse diversion and associated structures maintain equilibrium and functionality and are appropriate for all substrate conditions they encounter.**
Operation and monitoring plans should include: • the location of areas to be monitored • targeted monitoring frameworks identifying high risk areas and how these will be monitored, and • a system for ensuring appropriate remedial actions are undertaken where potential or existing change to equilibrium is identified during monitoring as a result of substrate or spoil characteristics.

Section 3: Requirements for the functional design and design plan of temporary watercourse diversions

3.1 Functional design of temporary watercourse diversions

A temporary watercourse diversion should minimise any impact on hydrology and the existing sediment transport regime. Incorporation of artificial energy dissipation structures for channel bed grade control can be included as a design feature where it satisfies all outcomes.

An SQEP should certify a functional design plan for temporary watercourse diversions as ensuring that the watercourse diversion will achieve the outcomes stated in the table below.

The following key outcomes and assessment criteria should be addressed and documented within a functional design report when submitting an application for a temporary watercourse diversion.

Functional design
Outcome 1 **The temporary watercourse diversion maintains the existing hydrologic characteristics of surface water systems.**
Hydrologic criteria An appropriate hydrological model should provide: • evidence that the temporary watercourse diversion will maintain existing hydrological characteristics • mean annual flow, catchment yield and downstream hydrograph characteristics of the existing and/or receiving watercourse and proposed temporary watercourse diversion • evidence that actual flow records (where available) are used for model calibration • peak flows (m^3/s) for annual exceedance probability (AEP) 50%, 2%, 1%, 0.1%, and • peak flows for low flow channel and bankfull capacity for the existing watercourse and proposed watercourse.
Outcome 2 **The hydraulic characteristics of the temporary watercourse diversion are comparable with other local watercourses and suitable for the region in which the watercourse diversion is located.**
Hydraulic criteria An appropriate hydraulic model should provide: • an assessment of average channel energy conditions for the existing watercourse and proposed temporary watercourse diversion • a review of potential changes in flood heights pre and post watercourse diversion within the existing and adjoining watercourses • evidence that the temporary watercourse diversion may incorporate features or structures that require on-going maintenance to maintain adequate hydraulic conditions for equilibrium of temporary watercourse diversion surfaces, and • evidence that the temporary watercourse diversion design will not compromise the

equilibrium and performance of the temporary watercourse diversion and adjoining watercourses.

Outcome 3

The temporary watercourse diversion maintains sediment transport and water quality regimes that minimise any impacts to upstream and downstream reaches.

An appropriate sediment transportation model should provide:

- an investigation of the current watercourse and proposed temporary watercourse diversion sediment transportation regime.

Outcome 4

The temporary watercourse diversion and associated structures maintain equilibrium and functionality and are appropriate for all substrate conditions they encounter.

Substrate criteria

An investigation of substrate conditions should provide a description of the substrate along the proposed temporary watercourse diversion alignment.

Additional criteria for watercourse diversions through spoil

If the proposed temporary watercourse diversion route is located on or within spoil material, an investigation of spoil substrate conditions should provide:

- the location and description of any existing or proposed spoil material along the proposed temporary watercourse diversion alignment, and
- an evaluation of sub-surface water movement within the temporary watercourse diversion footprint and adjacent floodplain.

3.2 Design plan of temporary watercourse diversions

The following key outcomes and assessment criteria should be addressed and documented within a design plan report.

An SQEP certifies the design plans for temporary watercourse diversions as ensuring that the watercourse diversion will achieve the outcomes stated in the model conditions.

Design plan
Outcome 1 **The temporary watercourse diversion maintains the existing hydrologic characteristics of surface water systems.**
The design plan should include: • a detailed description of the development and calibration or sensitivity analysis of the hydrologic model including the referencing of methodologies used to generate flood frequency analysis.
Outcome 2 **The hydraulic characteristics of the temporary watercourse diversion are comparable with other local watercourses and suitable for the region in which the watercourse diversion is located.**
Hydraulic criteria The design plan should include: • a detailed description of the development and calibration or sensitivity analysis of the hydraulic model • hydraulic modelling results provide evidence that impacts upstream and downstream of the temporary watercourse diversion footprint can be managed or mitigated • a sensitivity analysis for hydraulic roughness during the temporary watercourse diversion life to determine if proposed roughness levels will provide conditions necessary to ensure the equilibrium and performance of the temporary watercourse diversion, and • a hydraulic analysis that identifies if the extent and depth of inundation between existing and post-diversion conditions has changed. ***Temporary watercourse diversion features*** The design plan should include: • A staged development of the floodplain (if relevant) when planning for resource activities adjacent to the temporary watercourse diversion. Hydraulic modelling must be performed at each development period to determine the impact on the temporary watercourse diversion and adjacent watercourse • the location and hydraulic effect of features, and • the effect on hydraulic conditions within the temporary watercourse diversion of features (e.g. batter drains) that direct overland flow to the watercourse diversion.

Outcome 3

The temporary watercourse diversion maintains sediment transport and water quality regimes that minimise any impacts to upstream and downstream reaches.

The design plan should include a sediment transport analysis that identifies how the temporary watercourse diversion will manage erosion or deposition events such that they are consistent with the existing sediment regime.

Outcome 4

The temporary watercourse diversion and associated structures maintain equilibrium **and functionality and are appropriate for all substrate conditions they encounter.**

Substrate criteria

The design plan should include:

- a geotechnical analysis and accompanying map of all substrate material encountered within the temporary watercourse diversion alignment that identifies soil chemical and physical properties including constraints to equilibrium of temporary watercourse diversion surfaces, vegetation establishment and persistence, and
- a system for ensuring appropriate remedial actions are undertaken where potential or existing change to equilibrium is identified as a result of substrate or spoil characteristics.

Additional criteria for temporary watercourse diversions through spoil

The design plan should include:

- the specification of spoil placement and sequencing, and
- the settlement process and timing of operation that will ensure the temporary watercourse diversion once constructed operates in a stable manner.

3.3 Operation and monitoring of temporary watercourse diversions

An 'operation and monitoring' plan is a document that describes the operating conditions throughout the life of the temporary watercourse diversion to achieve the requirements of the design plan. It is recommended that an operation and monitoring plan forms part of the design plan. The monitoring component should provide for the collection of evidence that the temporary watercourse diversion is operating as designed and detail proposed management actions to rectify any issues that will not achieve the intended design requirements. The ACARP project C9068 refers to specific monitoring programs developed for stream diversions. The timing and frequency of monitoring should be specified in the operation and monitoring plan.

It is recommended that the temporary watercourse diversion be inspected by an SQEP who prepares an inspection report. This should indicate whether the temporary watercourse diversion is operating in accordance with the design requirements, or alternatively, recommend measures that the proponent needs to implement over an appropriate timeframe to allow the temporary watercourse diversion to operate as intended. In cases where monitoring identifies that the temporary watercourse diversion is not evolving towards achieving the required outcomes, the operation and monitoring plan should recommend a process to ensure that outcomes are achieved.

The following key outcomes and assessment criteria should be addressed and documented within a design report when submitting an application.

Operation and monitoring
Outcome 1 **The temporary watercourse diversion maintains the existing hydrologic characteristics of surface water systems.**
Operation and monitoring plans should include a monitoring and evaluation section that describes: • the monitoring and evaluation of surface water levels such that any changes in the existing flow conditions are identified.
Outcome 2 **The hydraulic characteristics of the temporary watercourse diversion are comparable with other local watercourses and suitable for the region in which the watercourse diversion is located.**
Operation and monitoring plans should: • provide evidence that demonstrate the temporary watercourse diversion meets proposed hydraulic modelling outcomes and assumptions in accordance with the design plan • include specific monitoring locations for areas within the vicinity of the temporary watercourse diversion that are proposed, or are likely, to be altered by floodplain development activities • include reference reaches within the adjacent watercourse to determine natural channel evolution processes and any potential impact resulting from the temporary watercourse diversion • identify specific AEP flow events that are required to be monitored to ensure that the performance of the temporary watercourse diversion is in accordance with the design

plan, and • identify potential and actual instabilities within the reference reaches of the existing watercourse and proposed temporary watercourse diversion.
Outcome 3 **The temporary watercourse diversion maintains sediment transport and water quality regimes that minimises any impacts to upstream and downstream reaches.**
Operation and monitoring plans should include a program that: • ensures sediment transportation rates are consistent with the design plan, or • establishes a system for identifying reasons for any inconsistency and proposing appropriate measures to address inconsistencies if they are observed.
Outcome 4 **The temporary watercourse diversion and associated structures maintain equilibrium and functionality and are appropriate for all substrate conditions they encounter.**
Operation and monitoring plans should include: • the location of the areas to be monitored • targeted monitoring frameworks identifying high risk areas and how these will be monitored, and • appropriate remedial actions where potential or existing change to equilibrium is identified as a result of substrate or spoil characteristics.

Part 3 Certification requirements

Certification is made by a suitably qualified and experienced person (SQEP) as defined in the model conditions for watercourse diversions. This definition includes a requirement that the SQEP is a Registered Professional Engineer of Queensland (RPEQ) under the provisions of the *Professional Engineers Act 2002* and has appropriate levels of expertise.

Where the certifier does not hold relevant qualifications and experience within each field of expertise, the certifier may choose to obtain certification for matters relevant to those fields from component experts. Ideally component experts should have the relevant expertise as defined in the relevant part of the SQEP definition. The certifier must certify that the component advice or certifications are appropriate and therefore that the content of those advices or certifications can be relied on in determining whether a diversion design will achieve required outcomes (including conditions of the EA).

It is recommended that a SQEP certify a functional design provided as part of an environmental impact statement or EA application.

Prior to commencement of construction, the EA holder must submit a design plan in which a SQEP must certify that a watercourse diversion, if constructed in accordance with the design plan, will achieve the required outcomes (conditions of the EA).

Prior to commencement of operation, a SQEP must certify that the watercourse diversion has been constructed in accordance with the certified design plan. Certification should take the form of a declaration (see the templates on the following pages) made by the person giving the certificate.

Form of certification for suitably qualified and experienced person

- **Form of certification (watercourse diversion)**
- **Name of registered professional engineer providing certification**
- **Address of registered professional engineer providing certification**

Statement of certification

I hereby state that I meet the requirements of the definition of 'suitably qualified and experienced person' for watercourse diversions as stated in <*insert relevant environmental authority or, for a functional design, the relevant model condition guideline*>.

Statement of certification

I hereby certify that the <functional design/detailed design plan/construction report/as constructed drawings> titled <report name/ref> and dated <date> for the <name of watercourse diversion>:

• Relates to watercourse diversion of <name or description of water course> between <co-ordinates or description of upstream limit of watercourse diversion> and <co-ordinates or description of downstream limit of watercourse diversion>

• Includes all relevant material relied on by me

• Is in accordance with all relevant requirements of the <*insert relevant environmental authority or, for a functional design, the relevant model condition guideline*>

• <Includes component certifications for the following specialist components: …..>

• Is in accordance with all relevant conditions of <name of Environmental Authority>

<I further certify that the component certifications for the specialist components listed above are appropriate and that the content of those certifications can be relied on in determining that the watercourse diversion design will achieve required outcomes.

<Identify, where appropriate, what is not included in the certification - including information about any limitations, restrictions or exclusions that apply to the certification>

I [full name of person making the declaration], declare that the information and opinions provided as part of this certification is true to the best of my knowledge and belief. I acknowledge that it is an offence under section 480 of the *Environmental Protection Act 1994* to give the administering authority a document containing information that I know is false, misleading or incomplete in a material particular.

Signed: ……

[Signature of certifier/including registered professional engineer reference number/s]

Date: ……

Form of Certification for Component Expert

- **Form of certification (watercourse diversion)**
- **Name of professional person providing certification**
- **Address of professional person providing certification**

(Note: Not required by the administering authority – this may be completed and submitted at the discretion of the suitably qualified and experienced person)

Statement of certification

I hereby state that I meet the requirements of the definition of 'component expert' for <type of expert> as stated in <*insert relevant environmental authority or, for a functional design, the relevant model condition guideline*>.

Statement of certification

I hereby certify that the <description of component> entitled <report name/ref> and dated <date> for the <name of watercourse diversion>:

• Relates to watercourse diversion of <name or description of water course> between <co-ordinates or description of upstream limit of watercourse diversion> and <co-ordinates or description of downstream limit of watercourse diversion>

• Includes all relevant material relied on by me

• Is in accordance with all relevant requirements of the <*insert relevant environmental authority or, for a functional design, the relevant model condition guideline*>

• Is in accordance with all relevant conditions of <name of Environmental Authority>

<Identify, where appropriate, what is not included in the certification - including information about any limitations, restrictions or exclusions that apply to the certification>

I [full name of person making the declaration], declare that the information and opinions provided as part of this certification is true to the best of my knowledge and belief. I acknowledge that it is an offence under section 480 of the *Environmental Protection Act 1994* to give the administering authority a document containing information that I know is false, misleading or incomplete in a material particular.

Signed: ……

[Signature of certifier/including professional qualification or affiliation]

Date: ……

Part 4 Guidance for proponents and designers

The following information is for guidance purposes only for designing and certifying a watercourse diversion as part of a new or amended EA application.

4.1 Definition of a watercourse

The Water Act defines a watercourse as a feature that meets sections 5 and 5A of that Act and Section 3 of the Water Regulation 2002. A watercourse diversion for a resource activity under this guideline only requires approval under the EA where a feature that meets this definition is diverted. A watercourse does not include any section of a feature that has a tidal influence, or is upstream or downstream from a defined limit.

Watercourse determinations are undertaken by the department responsible for the Water Act. Proponents are encouraged to contact DNRM to determine whether any features in the location of proposed activities are watercourses as defined under the Water Act *and* Water Regulation 2002. Proponents are encouraged to seek this determination prior to lodgement of an application for an EA. This will minimise costs and delays associated with unnecessary applications and public notification processes.

4.2 ACARP projects—stream diversions within the Bowen Basin

The objectives and outcomes identified in this guideline are consistent with findings of the ACARP projects undertaken between 1999 and 2002:

- Project C8030 – *Maintenance of Geomorphic Processes in Bowen Basin River Diversion*
- Project C9068 – *Monitoring and Evaluation Program for Bowen Basin River Diversions*
- Project 9068 – *Bowen Basin River Diversions Design and Rehabilitation Criteria*

The ACARP projects established a set of key hydraulic, geomorphic and revegetation criteria for watercourse diversion design that was developed from natural watercourses within the Bowen Basin. While the ACARP projects and their respective reports are specific to the diversion of watercourses in the Bowen Basin, the principles in the reports can be adopted for watercourses in other locations. Each watercourse diversion application should be supported by a geomorphic and vegetation investigation to identify the individual parameters for the specific locality.

The following concepts were developed from the findings the ACARP projects and should be considered in the design of a watercourse diversion[7]:

1. The watercourse is part of a system
2. Watercourses are dynamic systems
3. Each watercourse is unique
4. The watercourse has thresholds (for equilibrium and function)

[7] The ACARP report *Maintenance of Geomorphic Processes in Bowen Basin River Diversions* (2000) identifies five concepts to consider when designing a watercourse diversion.

5. The concept of a stable (fixed) watercourse is often unrealistic
6. A watercourse diversion in equilibrium has an increased chance of achieving long-term community, agency and mine objectives.

4.3 Economic assessment

Proponents should take into account the full cost of designing, constructing, and operating the watercourse diversion through to surrender of the EA, as well as the potential impacts of diverting the watercourse, before committing to a watercourse diversion as part of the resource activity.

4.4 Design concepts for watercourse diversions

The following concepts should be considered when undertaking a design of a watercourse diversion.

- A watercourse diversion functions as a part of the larger watercourse and the surrounding landscape. It should not create a discontinuity within the watercourse between upstream and downstream reaches and must not limit potential for recovery and/or rehabilitation of those reaches.
- The watercourse diversion incorporates the natural features that were present in the pre-existing watercourse[8] or adjacent reaches (or a defined regional alternative) and provides for instream, riparian and floodplain (where present) process continuity. A self-sustaining watercourse diversion functions without features or characteristics that rely on ongoing maintenance or that impose a financial or other burden on the proponent, government or the community.
- Where possible and relevant, the pre-existing surface water flow regime and the surface/groundwater interaction are maintained to ensure the continued viability of surrounding water users, including wetlands and groundwater-dependent ecosystems.
- Alluvial processes such as low flow meander migration (if part of the geomorphic character and behaviour of adjoining reaches) are provided for by locating the watercourse diversion within an appropriate corridor. The corridor width should ensure that the integrity of mining-associated structures such as levee banks and final voids are not compromised by future channel migration.

4.5 Guidance notes—functional design

The following notes relate to the specific outcomes in this guideline for designers to consider when developing a functional design for a watercourse diversion.

Outcome 1

The geomorphic and riparian vegetation study should include:

- an assessment of the geomorphic and riparian features at least one kilometre upstream and downstream of the tie-in locations of the proposed watercourse

[8] The pre-existing watercourse is the section of the original watercourse that the watercourse diversion replaces.

diversion or other watercourses that are intercepted along the proposed watercourse diversion route including existing drainage features such as anabranches or abandoned channels

- the section of the existing watercourse to be diverted
- evidence (where applicable) of distinct changes in geomorphic and riparian features, and
- photographs depicting geomorphic and riparian vegetation features of the existing and/or intercepted watercourses.

Outcome 2

The hydrologic investigation should include reference to Bureau of Meteorology (BOM) and DNRM rainfall and river gauging stations located within the contributing or nearby local catchments. Rainfall intensity-frequency-duration data from sources such as Australian Rainfall and Runoff (AR&R) should be referenced when determining hydrologic characteristics across contributing catchments.

Outcome 3

Hydraulic criteria

The following criteria should be considered when undertaking the hydraulic analysis of the proposed watercourse diversion:

- a description of the suitability of the hydraulic model used to generate hydraulic conditions of the existing watercourse and proposed watercourse diversion
- the relevant ACARP projects findings on critical thresholds for stream hydraulic conditions identified in Table 1 of this document should be referenced when comparing the hydraulic conditions of the proposed watercourse diversion
- hydraulic modelling should extend at least one kilometre upstream and downstream from the watercourse diversion footprint, and
- the three key hydraulic parameters—shear stress, stream power and velocity should be included for representative AEP flood events.

Hydraulic roughness

Roughness can be described as the following:

- inherent properties of *in-situ* material such as bedrock
- remedial activities such as deep ripping that provide an undulating and unconsolidated effect on soil surfaces
- construction materials that are designed for stabilising surfaces i.e. rock, and
- existing or proposed vegetation.

The level of roughness required to demonstrate that the watercourse diversion meets the intended outcomes and design criteria should be described. Stabilising design surfaces particularly low flow channels or batter drains with rock may be required due to mine operational constraints and concentration of flow. Vegetation is seen as the most appropriate roughness element to ensure that a watercourse diversion meets and maintains desired hydraulic criteria for both short and long-term operational conditions.

Short-term vegetation levels are defined as cover levels primarily influenced by ground cover and based on providing equilibrium to the newly constructed watercourse diversion surfaces.

Long-term vegetation levels are defined as cover levels described as multi-storey species including shrubs and trees and reflect the characteristics of regional ecosystems and the intended land use post mine rehabilitation. Short and long-term vegetation levels incorporated within the hydraulic modelling should be:

- achievable within the desired timeframe that provides equilibrium within the watercourse diversion and adjoining watercourse; and
- reflect existing conditions within local watercourses and adjoining floodplains.

4.6 Guidance notes—design plan

The following notes relate to the specific outcomes in this guideline for certifiers to consider when developed a design plan for a watercourse diversion.

Outcome 1

Watercourse Features

Examples of existing watercourse features (where present) should be included within the watercourse diversion:

- bed grade
- bed width
- top width
- bank/batter slope
- benches and terraces
- length of watercourse to be diverted
- channel capacity
- meander characteristic, and
- other features such as riffles, point bars and large woody debris.

Where bedrock is encountered along the watercourse diversion alignment, the equilibrium and performance of the watercourse diversion should not be reliant on the bedrock if the quality and durability of the rock requires on-going maintenance.

Specific design criteria

The following criteria should be considered when developing the design plan:

- the proposed depth of cut to achieve the design bed gradient should consider slope equilibrium from in-stream, rainfall and overland flow conditions on batter slopes
- the watercourse diversion is designed to accept overland flow from engineered structures or existing drainage features
- the impact of levees on the function and integrity of the watercourse diversion, and
- a timeframe showing the construction, revegetation and operational phases to ensure that the integrity and performance of the watercourse diversion meets design criteria.

Revegetation and management plan (revegetation plan)

A watercourse diversion may traverse different landscape units including alluvial plains, valley fill margins and rock outcrops. It is considered appropriate to revegetate the local ecosystems that naturally occur within each landscape unit.

Successional and self-sustaining vegetation communities follow a trajectory pathway that infers vegetation will naturally evolve. The trajectory pathway should provide evidence vegetation succession is occurring throughout the evolution of the watercourse diversion life. Initial and ongoing management of the watercourse diversion will influence vegetation meeting the design trajectory pathway.

Outcome 2

Hydraulic criteria

The hydraulic criteria of the existing watercourse should be used as first preference to develop design parameters for the watercourse diversion. The ACARP guideline values (Table 1) were derived to assist watercourse diversion design within the Bowen Basin for velocity, stream power and shear stress. The designer should also consider other design principles where relevant when undertaking the design process. The minimum requirement when undertaking a hydraulic analysis is to review the watercourse and diversion energy conditions for the 2% and 50% AEP flood events. The hydraulic modelling may extend to less frequent AEP flood events when the watercourse diversion is located within a defined flood corridor width, especially where the corridor is bounded by levee banks and/or final voids are proposed.

Scenario	Stream power (Watts/metre^2)	Velocity (Metres/second)	Sheer stress (Newtons/metre^2)
50% AEP (no vegetation)	<35	<1.0	<40
50% AEP (vegetated)	<60	<1.5	<40
2% AEP	<150	<2.5	<50

Table 1: Guideline values for average stream powers, velocity and shear stresses for streams within the Bowen Basin (source: ACARP 9068 – Bowen Basin River Diversions Design and Rehabilitation Criteria).

Watercourse diversion features

Floodplain

A proposed watercourse diversion should include an adjacent floodplain corridor width that provides for natural channel evolution and migration, and additional flow capacity during high flow events. The design floodplain width should consider but not be limited to the geomorphic study of the existing watercourse, substrate criteria, hydrologic assessment of the contributing catchment area, the location and extraction of mineral resource and mining infrastructure.

A reduction in floodplain area either via levees or increasing channel cross-section from deeper excavation within the existing landscape may result in changes to afflux. A detailed analysis should be undertaken to provide evidence of the extent and depth of inundation from existing to developed conditions for nominated AEP flood event. If an increase in afflux occurs outside the mining lease boundary, the authority holder must take action to minimise any impact.

Appropriately engineered structures must be incorporated to define watercourse or floodplain boundaries where constrained by mining infrastructure or activities. These may require separate approval under the EA. The proponent should contact the administering authority if these structures are proposed.

Energy dissipation structures for example a drop structure

A permanent watercourse diversion cannot rely on structures requiring ongoing maintenance to manage in-stream hydraulic conditions. These place an ongoing liability on the proponent, government and community to maintain these features. A watercourse diversion constructed with structures that require ongoing maintenance will not achieve surrender of the EA.

Temporary watercourse diversions

Temporary watercourse diversions may contain energy dissipation structures to alleviate elevated hydraulic conditions and avoid instabilities within the watercourse diversion and adjoining reaches. The design life of the energy dissipation structure should complement the intended operational life of the temporary watercourse diversion.

Outcome 4

General comments

Analysis of the current and predicted hydraulic conditions within the watercourse diversion footprint should provide direct input into the sediment transportation dynamics that could be expected during the evolution processes of the watercourse diversion. Proposed changes to the existing regime should be for the purposes of improved river health.

If an alternative stream type is proposed other than the pre-existing watercourse (e.g. alluvial/floodplain stream type to an incised channel stream type), the design plan must include evidence of local watercourse geomorphic conditions relevant to the adopted geomorphic features.

If the design allows for the natural evolution (instead of construction) of geomorphic features present within the existing watercourse, the design plan must identify how the watercourse diversion will develop these features and how any impacts incurred during their development are managed.

4.7 Guidance notes—operation and monitoring plans

General

Watercourses diversions are not static and should be designed, operated and managed to replicate a functioning dynamic watercourse. A monitoring and evaluation plan[9] (within an operation and monitoring plan) should demonstrate that the watercourse diversion is developing and operating as designed and can identify issues before major instabilities occur that require significant rehabilitation. A monitoring and evaluation plan may also support any defence against a compliance/enforcement action and ultimately support the surrender of the EA by providing evidence that the watercourse diversion is meeting, or is capable of meeting, the outcomes identified in Part 1.

Outcome 4

The selection of monitoring points must be appropriate to provide evidence on whether the sediment transportation regime is consistent with the intended outcome.

Outcome 5

[9] Further information on monitoring and evaluation and the trajectory approach for watercourse diversions can be found in the ACARP project C9068 report.

A watercourse diversion is often most susceptible to changes to equilibrium from flow events at the commencement of operation. Increases in sediment generation rates can unduly impact the adjoining watercourse. The equilibrium and functionality of the watercourse diversion should be designed to minimise erosion by flow events immediately following commencement of operation.

In-situ soil

Soils are the basic resource that influences the establishment of vegetation that provides equilibrium to watercourse diversion surfaces. Different soil media may require remedial actions to assist with the establishment of vegetation.

Soils descriptions should be undertaken using a soil classification system recognised in Australia, such as the Isbell, Raymond (2002) Australian Soil Classification 2nd Edition, CSIRO Publishing, Australia.

Re-engineered spoil

Watercourse diversions constructed through spoil will require re-engineered soil profiles that consider and minimise vertical displacement and sub-surface water movement. Their design should be based on the specific characteristics and variable nature of the spoil.

Spoil material is variable and often is a poor substrate for plant establishment and persistence. Where the watercourse diversion is located on spoil, the revegetation plan must include any particular requirements necessary to establish and support self-sustaining vegetation communities.

Appendix A: Definitions

Administering authority: The agency that administers the environmental authority provisions under the *Environmental Protection Act 1994.*

Annual exceedance probability (AEP): the probability that at least one flood event in excess of a particular magnitude will occur in any given year.

Appropriately qualified person for inspection: a person who is a Registered Professional Engineer of Queensland under the provisions of the *Professional Engineers Act 2002*, and has knowledge of engineering principles related to the structures, geomechanics, hydrology, hydraulics and environmental impact of watercourse diversions.

Associated structures: infrastructure that is associated with the operation of the watercourse diversion such as batter chutes, rock revetment works and levees.

Australian Coal Association Research Program (ACARP): for watercourse diversions, see section 3 of this Guideline. Further information on ACARP can be found at their website www.acarp.com.au .

Catchment yield: Surface runoff generated from a rainfall event from a watershed or catchment.

Certification: means assessment and endorsement must be undertaken by a suitably qualified and experienced person in relation to any assessment or documentation required by the conditions on the environmental authority, including design plans, 'as constructed' drawings and specifications, construction, operation or reports regarding watercourse diversions.

Channel capacity: the total volume of water the channel can carry during bank-full flow events.

Component expert
Geomorphologist: person who has demonstrated competency and relevant experience in stream geomorphology and watercourse diversions.
Geotechnical expert: person who has demonstrated competency and relevant experience in geotechnical assessment of soil characteristics suitable for watercourse diversions.
Vegetation expert: person who has demonstrated competency and relevant experience in the identification, role and function of vegetation with watercourses and adjoining floodplains, and has demonstrated competency and relevant experience in revegetation of watercourse diversions and adjoining floodplains.
Groundwater expert: person who has demonstrated competency and relevant experience in groundwater systems.
Surface Water expert: person who has demonstrated competency and relevant experience in hydrology.
Engineer: person who is a Registered Professional Engineer of Queensland (RPEQ) under the provisions of the Professional Persons Act 2002 or has similar qualifications under a respected professional registration association, and has demonstrated competency and relevant experience in design and construction of watercourse diversions.
Soils expert: person who has demonstrated competency and relevant experience in soil classification including the physical, chemical and hydrologic analysis of soil.

Construction or constructed: is the process of building a new or modifying an existing watercourse diversion, but does not include investigations and testing necessary for the purpose of preparing a design plan.

Design plan: is a document that contains the design of a watercourse diversion that addresses the outcomes stated in the model conditions and any other conditions on the environmental authority relating to the watercourse diversion. The document should include, but not be limited to:

- required information for a functional design
- the location, function and description of geomorphic and riparian vegetation features within the proposed watercourse diversion
- results from hydrologic, hydraulic and sediment transportation modelling used in the design of the watercourse diversion
- a revegetation and vegetation management plan (a revegetation plan)
- engineering drawings depicting the physical attributes and dimensions of the watercourse diversion
- all investigation and other reports relied on by the design, and
- plans and specifications sufficient to complete construction and revegetation in accordance with the design

It is also recommended that a design plan include an operation and monitoring plan that includes an assessment process that demonstrates that the watercourse diversion is meeting the required outcomes, and includes the proposed timing and frequency of assessments

Drop structure: is a manmade structure that passes water to a lower elevation while controlling the energy and velocity of the water. Drop structures assist with water oxygenation and erosion prevention

Environmental Authority (EA): see Schedule 4 of the *Environmental Protection Act 1994.*

Environmental value: see section 9 of the *Environmental Protection Act 1994.*

Equilibrium: A state where 'balance' is achieved despite changing variables.

Functional design: is a document that contains 'conceptual' information about the design, operation and revegetation criteria of a watercourse diversion that addresses the outcomes stated in the model conditions and any conditions on the environmental authority relating to the watercourse diversion. The document should include, but not be limited to:

- geomorphic and vegetation assessment of the existing watercourse
- hydrologic conditions of the existing watercourse
- the proposed watercourse diversion route
- hydraulic conditions of the existing watercourse and proposed watercourse diversion
- details of the substrate on which the watercourse diversion will be constructed, and
- a statement of how the watercourse diversion meets the outcomes.

Functionality: the purpose that something is designed or expected to fulfil.

Holder: for a mining tenement, means a holder of the tenement under the *Mineral Resources Act 1989* or, for an environmental authority, the holder of an environmental authority under the *Environmental Protection Act 1994.*

Interfere: see Chapter 2 of the *Water Act 2000.*

Levee: an embankment that provides for the containment and diversion of stormwater or flood flows from a contributing catchment, or containment and diversion of flowable materials resulting from releases from other works, during the progress of those stormwater or flood flows or those releases; and does not store any significant volume of water or flowable substances at any other times.

Minimise: to reduce to the smallest possible amount or degree.

Permanent watercourse diversion: is a man-made structure that incorporates the geomorphologic, hydraulic, hydrologic and ecological components of a local watercourse and is designed, constructed, operated and maintained according to an engineering standard that ultimately achieves a self-sustaining watercourse able to function without features or characteristics that rely on ongoing maintenance or that impose a financial or other burden on the proponent, government or the community.

Pre-existing watercourse: the section of watercourse from which the flow of water will be diverted as a result of the construction and operation of a watercourse diversion.

Rehabilitation: the process of stabilising and revegetating mining activity disturbance.

Revegetation: the re-establishment of vegetation on soil surfaces associated with the construction or rehabilitation of a watercourse diversion

Resource activity: See section 107 of the *Environmental Protection Act 1994.*

Self-sustaining: A self-sustaining watercourse diversion functions without features or characteristics that rely on ongoing maintenance or that impose a financial or other burden on the proponent, government or the community.

Spoil: overburden and other substrate material removed from the ground, relocated and stored or stockpiled as part of a resource activity.

Suitably qualified and experienced person: a person who is a Registered Professional Engineer of Queensland under the provisions of the *Professional Engineers Act 2002,* and has an **appropriate level of expertise** in the structures, geomechanics, hydrology, hydraulics and environmental impact of watercourse diversions.

An ***appropriate level of expertise*** includes:

- demonstrable competency, experience and expertise in–
    - investigation, design or construction of watercourses diversions
    - operation and maintenance of watercourse diversions
    - geomechanics with particular emphasis on channel equilibrium, geology and geochemistry
    - hydrology with particular reference to flooding, estimation of extreme storms, water management or meteorology
    - hydraulics with particular reference to sediment transport and deposition and erosion control
    - hydrogeology with particular reference to seepage and groundwater
    - solute transport processes and monitoring thereof; or
- Sufficient knowledge and experience to certify that where the **suitably qualified and experienced person** has relied on certification provided by other **component expert/s***–
    - they consider it reasonable to rely on that advice and information, and
    - the expert providing the advice and information has knowledge, competency, suitable experience and demonstrated expertise in the matters related to watercourse diversions.

Temporary watercourse diversion: is a man-made structure that may incorporate geomorphologic, hydraulic, hydrologic and ecological components of a local watercourse and is designed, constructed, operated and maintained to a lower engineered standard than a permanent watercourse diversion but must not compromise the equilibrium and performance of the watercourse diversion and adjoining watercourses.

Tenement: means tenure under the *Mineral Resources Act 1989, Petroleum and Gas (Production and Safety) Act 2004, Petroleum Act 1923, Geothermal Energy Act 2010 or*

Greenhouse Gas Storage Act 2009. For example, under a mining tenement under the *Mineral Resources Act 1989*.

Tie-in location: the location at which a watercourse diversion joins an existing watercourse or drainage feature.

Void: any manmade open excavation in the ground.

Water: See Schedule 4 of the *Water Act 2000.*

Water users: persons or entities that hold an existing water entitlement and authorisation to take or interfere with water under the *Water Act 2000.*

Watercourse: see sections 5 and 5A of the *Water Act 2000.*

Watercourse diversion: a man-made structure that diverts or interferes with the course of flow within a watercourse, but that does not impound water.

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