BIOREGIONAL ASSESSMENT CASE STUDY 1

BOX 1 EXECUTIVE SUMMARY

Key findings

The outputs of the Bioregional Assessment Technical Program (BATP) include:

- scientific advice on the likelihood of direct, indirect and cumulative impacts on economic, ecological and socio-cultural water-dependent assets arising from potential coal seam gas (CSG) and large coal mining developments
- modelling that provides information on the extent and nature of impacts in response to CSG extraction and coal mining developments
- advice on the likelihood of risks to water-dependent assets under CSG and coal mining development pathways – and potential consequences
- information on approaches to mitigate risk and minimise significant impacts (e.g. monitoring programs and additional risk assessment studies).

BATP products are used by the Department of the Environment and Energy (DoEE) to inform the decision-making processes prescribed under the Environment Protection and Biodiversity Conservation Act 1999. The technical advisor to the Department, the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC) has drawn heavily on the BATP outputs in formulating its advice and proposals as to conditions that might be attached to project approvals.

- Other BATP benefits include:
  - the wider economic benefit at the national level through increased productivity and profitability of the resources sector – with potential flow-through to increased government taxation and royalty revenues
  - greater certainty for project proposals (and allowing the ruling out of 'non-starter' projects at an earlier stage)
  - public good issues related to the availability of data, methods and models, so that assessments are updated over time
  - the analysis of potential impacts to water-dependent assets including the quantification/certainty of impacts on those assets.

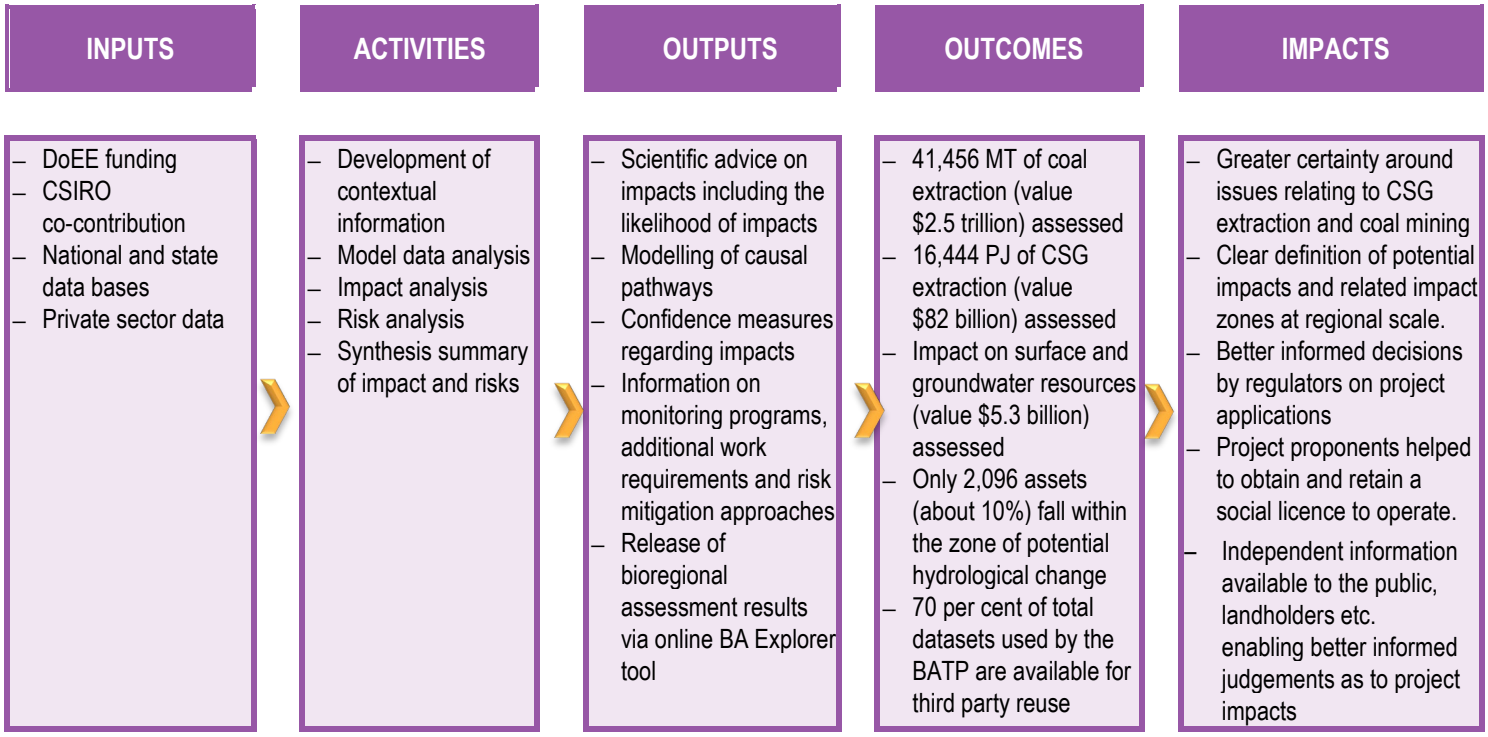
The BATP approach/methodology is readily adaptable for broader use in relation to extractive industries. The Government has already funded an expansion of BATP to undertake the assessment of impacts arising from tight and shale gas extraction. ACIL Allen has conservatively estimated the benefit-cost ratio of this project to be 7.48.

Innovation impact

The BATP's use of a probabilistic, rather than deterministic modelling approach represents a significant innovation. The previous approach developed a single numerical groundwater model without any uncertainty analysis, which is insufficient to predict the range of potential impacts and their likelihood (especially when considering cumulative impacts in a risk management context).

This case study uses the evaluation framework outlined in the CSIRO Impact Evaluation Guide. The results of applying that framework in the case study into CSIRO's engagement in the Bioregional Assessment Program (BAP) through the Bioregional Assessment Technical Program (BATP) are summarised in **Figure 1.1**.

FIGURE 1.1 BIOREGIONAL ASSESSMENT TECHNICAL PROGRAM CASE STUDY – IMPACT FRAMEWORK DIAGRAM



SOURCE: ACIL ALLEN

1.1 Purpose and audience for case study

This case study describes the economic, environmental and social benefits arising from CSIRO's involvement in the overall BAP.

This evaluation is being undertaken to assess the positive impacts arising from the BATP project undertaken by CSIRO in collaboration with Geoscience Australia, the Bureau of Meteorology and the Department of the Environment and Energy. However, it can also be used to inform a range of other stakeholders. The case study can be read as a standalone report or aggregated with other case studies to substantiate the impact and value of the Land & Water (L&W) Business Unit's activities as a whole relative to the funds invested in these activities.

This information in this case study is provided for accountability, communication and continual improvement purposes. This case study is primarily intended to be an input into the independent review of the L&W Business Unit. Other audiences for this report may include Members of Parliament, Government Departments, CSIRO and the general public.

1.2 Background

The Australian Government (through the then Department of Sustainability, Environment, Water, Population and Communities – now the Department of the Environment and Energy (DoEE)) initiated the BAP in 2012 to better understand the future potential impacts (direct, indirect and cumulative) of coal seam gas and large coal mining developments on water resources and water-dependent assets. BAP covered 13 priority areas (sub-regions) across Queensland, New South Wales, Victoria and South Australia.

BAP funding was directed towards three key components:

- the Bioregional Assessment Technical Program (BATP)
- projects conducted by state government agencies in South Australia, Victoria and Queensland
- asset identification by natural resource management groups.

CSIRO involvement was limited to the BATP and accordingly, the focus of this case study is limited to the BATP. The BATP was conducted as a collaboration between CSIRO, Geoscience Australia (GA), DoEE and the Bureau of Meteorology (BoM), in consultation with state government agencies, catchment authorities, local governments and industry groups. BATP's goal is to improve the understanding of the potential impacts of coal seam gas (CSG) and coal mining developments on water and the environment, ensuring the best science is available to inform decision making, and providing a common information base for governments, landowners, the community, business and investors.

1.3 Impact Pathway

1.3.1 Project Inputs

The total funding of the BAP project as at March 2018 was about $98 million in cash and in-kind contributions (see **Table 1.1**) with the vast bulk of funds coming from DoEE. Funding directed towards the BATP totalled $65.4 million which included a CSIRO co-contribution of $8.5 million (around 13 per cent of the total BATP cost). The only other co-contributor to BATP was GA with an in-kind co-contribution of $0.6 million.

TABLE 1.1 SUPPORT FOR THE BAP/BATP

Contributor/type of support	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	TOTAL
Cash							
DoEE to CSIRO - BATP	$0.6m	$7.7m	$8.9m	$8.5m	$4.8m	$1.3m	$31.8m
DoEE to GA - BATP	$2.2m	$0.9m	$3.0m	$2.4m	$0.8m	$0.1m	$9.4m
DoEE to BoM - BATP	$0.8m	$3.6m	$3.0m	$4.6m	$1.8m	$1.3m	$15.1m
DoEE to State Govts and others	Total of $33.0m spread over several years spent outside of BATP						
In-kind/Co-contribution							
CSIRO - BATP	$0.1m	$2.0m	$2.4m	$2.3m	$1.3m	$0.4m	$8.5m
GA - BATP	-	-	-	-	$0.2m	$0.4m	$0.6m
Total	$3.7m	$14.2m	$17.3m	$17.8m	$8.9m	$3.5m	**$65.4**

NOTES: PAYMENTS TO GA AND BOM ARE BASED ON CONTRACTED FIGURES; WHEREAS PAYMENTS TO CSIRO AND IN-KIND CSIRO CONTRIBUTIONS ARE BASED ON ACTUAL RECORDED CSIRO REVENUE/EXPENDITURE RECORDS

SOURCE: ACIL ALLEN BASED ON CSIRO ADVICE; DOEE

Bioregional Assessments (BA) are multidisciplinary and involve a broad range of data from disciplines such as geology, hydrology, hydrogeology, modelling and ecology. The data are provided in many formats. The BATP invested in acquiring high-quality data to provide a robust foundation for the assessments. The strength of any assessment is determined by the quality, comprehensiveness and 'fitness for purpose' of the data.

The BATP drew heavily on existing national geological, topographic, hydrological and biological spatial data maintained as part of the Australian Spatial Data Infrastructure by Commonwealth agencies in collaboration with states and territories. Relevant databases included:

- OZMIN - containing coal reserves and coal resource estimates and spatial data relating to deposits
- PEDIN - containing basic petroleum well metadata such as location, operator and total depths (links to other databases of stratigraphic information; organic geochemistry; and petrophysical analyses
- Australian Water Resources Information System (AWRIS) - containing water information supplied to the BoM by over 200 organisations across Australia
- The Australian Hydrological Geospatial Fabric (Geofabric) – a framework for discovering, querying, reporting and modelling water information
- National Groundwater Information System (NGIS) - a spatially-enabled groundwater database populated with bore and bore log data (lithology, hydrostratigraphy and bore construction) from state and territory groundwater databases
- National Aquifer Framework (NAF) - a three-tiered system for naming and grouping geologic units, hydrogeologic units and hydrogeologic complexes in Australia
- National Atlas of Groundwater Dependent Ecosystems (GDE Atlas) - presenting the current knowledge of GDEs across Australia, including known GDEs as well as ecosystems that potentially use groundwater.

BATP was also able to access well reports and geophysical logs held by State agencies, though digital copies of geophysical logs for older wells could be purchased from a commercial supplier if required. Hydrogeological data was available through a number of state agencies (such as state geological surveys and state water departments); universities and private companies.

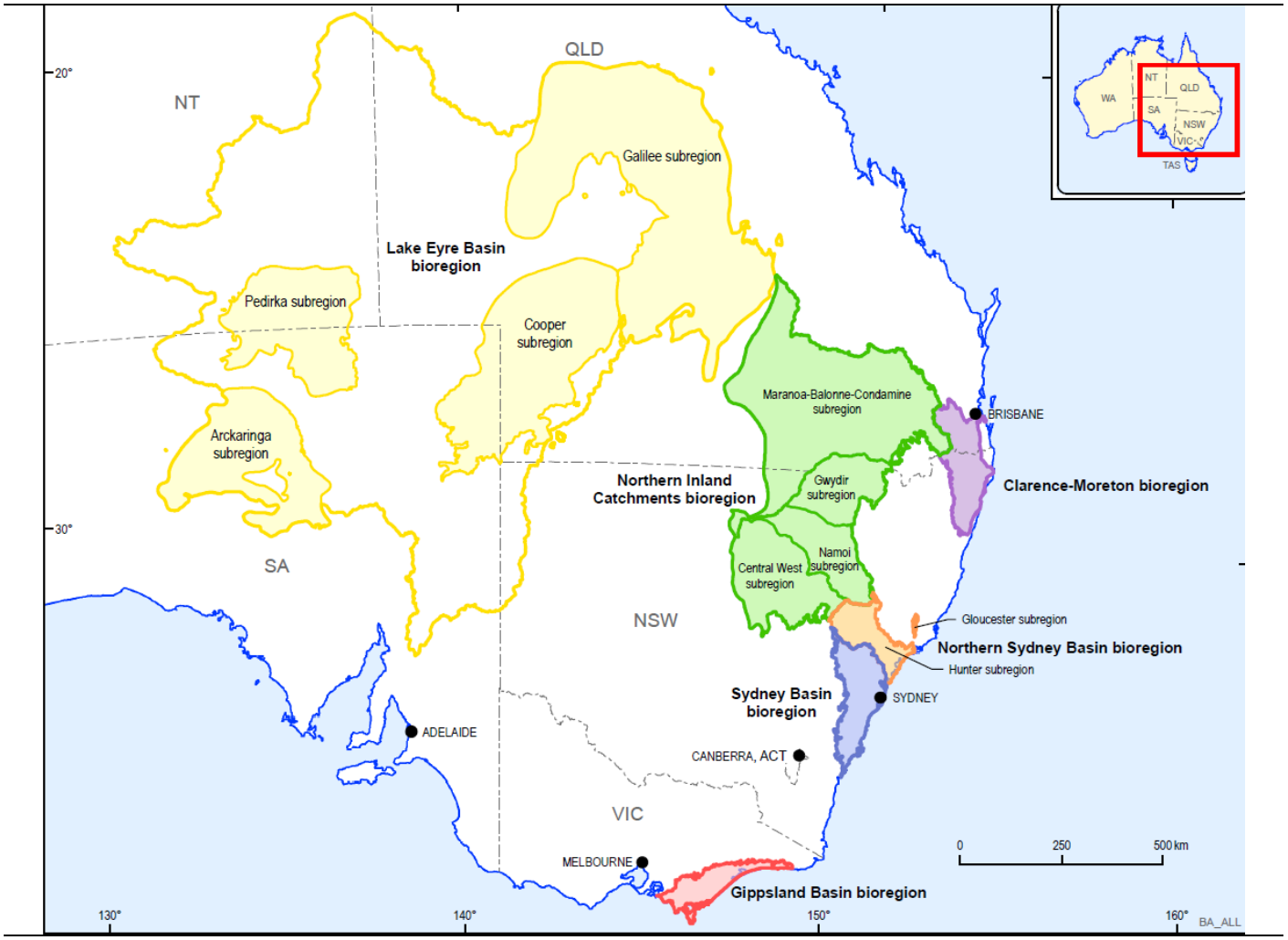
1.3.2 Project activities

The BATP work program was structured to:

- define, characterise and explain conceptual models that establish causal pathways describing the chain of interactions and events that connect depressuring and dewatering of coal seams at depth with impacts on anthropogenic and ecological receptors located at depth or at the surface
- generate quantitative, semi-quantitative or qualitative analyses of the likelihood of impacts of CSG and coal mining developments on receptors from the application of ecology, surface water and groundwater hydrology, hydrogeology and CSG or coal resource development models
- develop improved assessments of the likelihood of risks to receptors and the subsequent values of water-dependent assets from CSG and coal mining developments
- provide information on the level of confidence attached to scientific advice on these impacts
- identify monitoring programs, BA review frequency and additional risk assessment studies that could be undertaken outside of the bioregional assessment process to help minimise impacts of CSG and coal mining developments on water resources.

BATP covered 13 priority areas (sub-regions) across Queensland, New South Wales, Victoria and South Australia (see **Figure 1.2**).

FIGURE 1.2 BATP PRIORITY SUBREGIONS



SOURCE: CSIRO LAND & WATER

CSIRO led assessments for Northern Inland Catchments; Clarence-Moreton; Northern Sydney Basin and Sydney Basin. To deliver the above work program, the BATP focused on four components of activity:

1. Contextual information: presents the context and background against which qualitative and quantitative assessments of impact and risk of CSG and coal mining development are generated
2. Model-data analysis: evaluates and synthesises information from data and models to develop a quantitative description of the hydrologic relationship between coal seam depressurisation and dewatering and associated impacts on anthropogenic or ecological receptors
3. Impact and Risk analysis:
   - reports and records the direct, indirect and cumulative impacts and associated uncertainties of impacts of CSG and coal mining development on receptors within assets and their associated uncertainties
   - provides a scientific assessment of the likelihood of impacts on receptors contained within assets based on the propagation of uncertainties from models and data
4. Outcome summary: delivers a summary of outcomes used to support scientific advice on impacts and risk of CSG and coal mining development on water resources.

The development of baseline information so that impacts can be assessed against the current state of the region is a key element of any BA. Information generated during components one and two accumulates to provide knowledge used in the impact analysis and risk analysis components. The impacts and risks are focused through the receptors contained within water-dependent assets. The components are not sequential in time; rather they are largely overlapping, and information passes between components of the BA via multidisciplinary interactions. In this way, groundwater and hydrogeology information on dewatering at depth can inform ecological impacts on receptors at the surface. A key aspect of a BA is the characterisation and propagation of uncertainties to provide scientific advice on the likelihood of impacts on receptors and their associated risks.

1.3.3 Project outputs

Outputs from the BATP consist of:

- scientific advice on the likelihood of direct, indirect and cumulative impacts of additional coal resource development on water-dependent assets including:
  - quantitative, semi-quantitative and qualitative results from relevant ecological, surface water hydrology, groundwater, hydrogeology and CSG or coal mining development models that provide information on the extent and nature of impacts in response to pathways of CSG and coal mining developments
  - advice on the likelihood of risks to receptors and water-dependent assets under CSG and coal mining development pathways – and the potential consequences
- conceptual modelling of causal pathways establishing the chain of interactions connecting depressurisation and dewatering of coal seams at depth with impacts on assets located at or near the surface
- measures of the level of confidence attached to the advice regarding impacts on water dependant assets
- information on monitoring programs, the nature and type of additional risk assessment studies that may be required, and possible approaches to risk mitigation in order to minimise significant impacts.

The BATP methodology and guidelines were endorsed by the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC), established under the *Environment Protection and Biodiversity Conservation Amendment (Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development) Bill 2012* to provide advice to the Federal Minister for the Environment on potential water-related impacts of coal seam gas (CSG) and large coal mining developments[1].

Publications - *Release of bioregional assessment results* - the first component of work that brings together background information about each subregion or bioregion in reports and registers was available as technical products finalised through to mid-2016. Full results from the BAs were released starting in late-2016 and are ongoing. This includes products providing model-data analysis and impact analysis which will be jointly released with a synthesis of the full bioregional assessment. Products from the BATP include compilations of relevant data, descriptions of coal resources, lists of water-dependent assets, conceptual models, water balances, outputs of hydrological and receptor impact models, and descriptions of the possible impacts of coal seam gas and coal mining developments on water resources including the likelihood, severity and uncertainty associated with the impacts.

Outputs (or products) include:

- context statements for regions/sub-regions

[1] see http://www.bioregionalassessments.gov.au/methods/bioregional-assessment-methodology

- resource assessments for regions/sub-regions
- water dependant asset registers for regions/sub-regions
- current water accounts and water quality for regions/sub-regions
- data registers for regions/sub-regions
- data analysis for regions/sub-regions
- conceptual modelling for regions/sub-regions
- water balance assessments for regions/sub-regions
- surface water numerical modelling for regions/sub-regions
- groundwater numerical modelling for regions/sub-regions
- impact and risk analysis for regions/sub-regions
- outcome synthesis reports for regions/sub-regions.

Work is ongoing and not all publications/products are currently available for all regions/sub-regions at this stage. Reports and datasets are publicly available online and users can explore more detailed results through the online Bioregional Assessment (BA) Explorer tool - a mapping tool that displays results of each bioregional assessment as it is released.

Innovation

Key innovations in the BATP approach include:

- analysis of potential cumulative impacts from proposed new coal resource developments to water-dependent assets that are valued by the community, including the quantification of just how certain or uncertain impacts to these assets are
- a probabilistic, rather than deterministic modelling approach, which means the likelihood of a certain impact occurring is clearly articulated
- public accessibility and interactivity of results on the information platform, which allows technical outputs to be easily interpreted and visualised (being delivered in concert with complete assessments in 2017/18)
- public availability of data, methods and models used, so that data can be added, and the assessments updated over time.

A probabilistic, as against a deterministic, modelling approach is a significant innovation. The general approach currently used in environmental impact assessments is the development of a single numerical groundwater model with some sensitivity analysis. When considered in a risk management context, particularly when considering cumulative impacts, this approach does not predict the probability distribution of potential impacts.

Taking account of the complexities and inherent uncertainties associated with conceptualising and estimating hydraulic characteristics (i.e. parameterisation) of groundwater systems, predictive uncertainty analysis is a major step forward in the groundwater modelling process. A quantitative uncertainty analysis delivers the range of model prediction scenarios, each plausible in that they are consistent with all available information and data. Uncertainty analysis also provides insight into what are the main sources of uncertainty and how much the uncertainty in model outcomes can be reduced by additional data.

It is acknowledged that there are a range of externalities (e.g. limited formal training/guidance, timing, cost, project staging etc.) that need to be considered to increase adoption and uptake of uncertainty analysis for project scale environment impact assessments. A robust uncertainty analysis is important for regulatory decision-making, as it will inform and ensure management options and approaches are commensurate with the level of risk and its likelihood for any particular impact.

1.3.4 Project Outcomes

BATP provides transparent scientific information to better understand the potential impacts of unconventional gas and coal mining developments on water resources and water-dependent assets. It assesses the potential impacts, particularly focusing on regional scale and cumulative impacts, due to CSG and open-cut and underground coal mining developments (in the past, present and foreseeable future), indicating the level of impact and the probability of that impact occurring.

The potential additional resource extraction assessed under the BATP were as follows:

- 41,456 million tonne (MT) of additional coal extraction - total value $2.5 trillion
- 16,444 PJ of additional CSG extraction - total value $82 billion.

The water usage (based on extraction licences that have been granted) considered in the BATP assessments included a:

- current volume of groundwater take of 817 GL/year - total value $1.6 billion
- current volume of surface water take of 1853 GL/year - total value $3.7 billion.

In total 25,830 water-dependent assets were identified across the 13 priority areas and potential impacts were assessed for 18,635 of these. The remaining assets (in the Sydney, Cooper and Gippsland subregions) were not assessed due to technical issues (the Victorian Government led the Gippsland assessment and as such it was not part of the BATP). **Box 1.1** captures the outcomes of the assessment of these 18,635 assets - with potential impacts ruled out with regard to the vast majority (almost 90 per cent) of water dependant assets, noting that impacts were only assessed for those coal resource developments that were able to be modelled. Approximately 20 per cent of coal resource developments could not be modelled due to insufficient information being available.

Over 1100 metadata statements have been published to date. Licensing agreements have been negotiated such that more than 70 per cent of total datasets used by the BATP to date are available for third party reuse.

BOX 1.1 IMPACT ASSESSMENT OUTCOMES

Potential impacts were assessed for 18,635 out of 25,830 water-dependent assets. These assets consisted of:

- 15,845 ecological assets
- 1,846 economic assets
- 944 socio-cultural assets.

Of the water-dependent assets examined by the project, 16,539 of the 18,635 (almost 90 per cent) were found to be not affected by any adverse potential impacts associated with hydrological changes. The 2096 assets that were identified as being within a zone impacted by potential hydrological changes consisted of:

- 1761 ecological assets
- 248 economic assets
- 87 socio-cultural assets.

SOURCE: ACIL ALLEN

1.3.5 Adoption

Commonwealth and state regulators have used BATP products to inform decision-making, including under the *Environment Protection and Biodiversity Conservation Act 1999* (the protection of water resources from a large coal mining or CSG development were included as a controlling provision under the Act in 2013). The IESC has drawn heavily on the BATP outputs in formulating its technical advice to the Department. Key examples include:

- Gloucester bioregional assessment products were considered (by the Commonwealth Minister/Minister's delegate) in the approval decision for Stratford coal mine and are referenced in approval conditions for the project
- the approval conditions for the Shenhua Watermark project, in the Namoi subregion, require a Water Impact Verification Report to be prepared with reference to the bioregional assessment methodology
- the Namoi context statement was referenced in IESC advice on the Santos Narrabri Gas Project
- the Namoi context statement and coal resource assessment report were referenced by the IESC in its advice on the Watermark Coal Project
- the Hunter products have been used by the IESC to inform advice on water balance/modelling on Wambo
- draft bioregional assessment products for the Maranoa-Balonne-Condamine subregion were considered by the IESC and the Environment Standards Division in the approval decision for the New Acland Coal Mine.

While DoEE was the client (and key user) for BATP work, other stakeholders are utilising BATP outputs and methodologies in a variety of ways:

- the Hunter results are being used by the NSW Government to inform management of the Hunter Regulated River
- NSW Department of Primary Industries (DPI) Water has used the hydrological modelling outputs to inform business case for investment in groundwater monitoring infrastructure in the Hunter subregion
- NSW DPI Water has requested access to geological models in Clarence-Moreton and Namoi to define placement of monitoring bores under the Water Monitoring Framework
- GA have requested access to Gippsland Basin Bioregional Assessment datasets to inform regional petroleum resource advice
- recently-released datasets from the Maranoa-Balonne-Condamine assessment have been used for research at the University of Queensland

- background information products have been referenced by other stakeholder publications, e.g., Queensland Gasfields Commission citing Galilee bioregional assessment contextual products.
- extensive work has been conducted by state government agencies on ecological assets including Great Artesian Basin Springs throughout Queensland, New South Wales and South Australia (within the Lake Eyre Basin and Northern Inland Catchments bioregions).
  - numerous flora and fauna studies have been conducted, including the discovery of only the third known location of the Aramac Hardyhead (endangered fish)
  - water chemistry data has also been gathered to help identify the source aquifers for the spring complexes - leading to the identification of a new shallow aquifer for regulators to manage as a viable water resource under the South Australian Far North Water Allocation Plan
  - this work will also inform future management of water resources, through the Great Artesian Basin Strategic Management Plan and the State of the Basin report presented to the Lake Eyre Basin Ministerial Forum.

1.3.6 Impacts

The BATP can deliver greater certainty around issues relating to CSG extraction and coal mining operations – in particular, in defining potential impacts and related impact zones, but:

- the full range of BATP products for a number of key regions have only been partially released (the remainder are expected to be launched in 2018)
- this limited public exposure/use to date makes it difficult to assess the full impact of BATP.

However, the use of BATP as set out at Section 1.3.5 clearly points to the importance of and significant role BATP products play in assisting decision makers assessing project applications. BATP products provide a verifiable, independent source of robust scientific advice. The probabilistic, rather than deterministic modelling approach, means the likelihood of a certain impact occurring is clearly articulated. The analysis of potential impacts to water-dependent assets that are valued by the community, including the quantification of just how certain or uncertain impacts to these assets are can be a central consideration in the project approvals process. Where some level of impact is predicted, BATP can play a vital role in helping to define monitoring needs and make good provisions.

The impact and benefits of BATP extend well beyond DoEE (the client) to include project proponents (coal companies), State and local governments, land holders, interest groups and the general public. Benefits/impacts include:

- assistance in providing project proponents with a social licence to operate
- potentially shortening the timeframes for the project approvals process
- providing an important independent information source in the public domain as to development impacts which can be used by the general public, landholders etc. in making their own assessment of projects and thus make informed judgements as to whether or not they want to support/oppose a particular project
- the public accessibility and interactivity of results on the information platform allows technical outputs to be easily interpreted and visualised
- the potential to give confidence that some area or assets are very unlikely to be affected, given the BA Explorer tool enables access to data down to 1 km^2 scale enabling impact zones to be clearly delineated.

Knowledge gained from Bioregional Assessment data management methods and processes is being utilised more broadly. It is being used as part of the groundwater data management strategy for future Geoscience Australia projects. The use of 'River Styles' by the BATP ensures that the BA assessments will be aligned with the bioregional assessments with DPI Water assessment and water management activities.

1.3.7 Potential future impacts

A strong outcome of the BATP is the consistent stakeholder expectation[2] that its products will enable a '*rule out*' approach to assessing potential direct, indirect and cumulative impacts. The BATP products are considered to be of an appropriate scale to enable use by project proponents and regulators to compare and contrast predicted impacts of a proposed development to inform one of two general conclusions:

- BATP products and the project proponent's assessment of zone of impact is consistent and therefore the proponent can focus further analysis to address key uncertainties within the zone of impact

[2] Jacobs Group (Australia) Pty Limited 2017; *Evaluation of Bioregional Assessment Program – (for) Commonwealth Department of Energy and Environment*; Final Report Dec 2017

— BATP products show the extent of an impact of a potential development is of potentially spatially greater and/or higher impact than proffered by the project proponent - the proponent must justify why they believe their potential impacts are of a smaller scale and/or less impact in contrast with the BATP products.

In assessing cumulative impacts, the BATP presents the results of modelling as probabilities - percentiles from 5th to 95th. It is considered that if hydrological changes have at least a 95 per cent chance of being below a specified threshold, the risk of impacts is effectively '*ruled out*'. This '*rule out*" approach identifies areas where further work is required to assess the local-scale impacts of a specific development. There is potential for BATP to address issues around '*stranded resources*' through demonstration that a precautionary approach does not need to apply where it can be demonstrated there is no impact (i.e. hydrological changes have at least a 95 per cent chance of being below a specified threshold).

The BATP approach/methodology is readily adaptable for broader use in relation to extractive industries (i.e. Pilbara iron ore). The Government clearly recognises its potential with DoEE funding the Geological and Bioregional Assessment (GBA) Program, which will build on lessons from the Bioregional Assessment program to assess potential impacts from shale gas extraction in three basins (GBA budget of $30.4 million).

Broader BATP benefits are likely to include:

— wider economic benefit at the national level - increased productivity and profitability of the Australian (and global) resources sector and more fully realising the economic value of its resources – with potential flow-through to increased government taxation and royalty revenues

— enabling project proponents to make better informed judgements as to the likelihood of project approvals (and allowing the ruling out of '*non-starter*' projects at an earlier stage)

— public good issues related to:
  - the public availability of data, methods and models used, so that data can be added to and the assessments updated over time
  - the analysis of potential impacts to water-dependent assets (that are valued by the community), including the quantification/certainty of potential impacts on these assets arising from resource development projects.

1.4 Counterfactual and Attribution

1.4.1 Counterfactual

There are no other research groups in Australia or elsewhere with the broad capability and data access to undertake the full suite of research and development essential to delivering the BATP components for which it was responsible. The BATP products would not exist without the efforts of CSIRO and the other project partners.

1.4.2 Attribution

At this stage there is limited quantifiable benefit from the BATP. In the absence of other data, the ratio of project inputs (i.e. the funding split between CSIRO, GA and BoM) is considered to be a reasonable proxy. Hence ACIL Allen has assumed that that around 60 per cent of any benefits can be attributed to CSIRO.

1.5 Evaluating the Impacts

1.5.1 Cost-Benefit Analysis

Costs

The costs of BATP are shown at **Table 1.1**. Of a total BATP budget of $65.4 million, CSIRO's share was $40.3 million ($31.8 million provided by DoEE and a CSIRO co-contribution of $8.5 million). In present value terms, the total BATP R&D cost is $76.8 million in 2017/18 dollars under a 7 per cent real discount rate.

Benefits

Given the lack of quantifiable benefits and the fact that a number of key BATP products are yet to be released, it is difficult to conduct a meaningful cost-benefit analysis of BATP. However, to provide some insights as to BATP's potential, we have carried out some analysis of the Shenhua Watermark Coalmine Project (Watermark Project) where BATP products were referenced by the IESC in its advice on the Watermark Project. Approval conditions and approval requires the preparation of a Water Impact Verification Report with reference to the bioregional assessment methodology. Details of the Watermark Project, including a benefit-cost analysis, are at **Box 1.2**.

BOX 1.2 SHENHUA WATERMARK COALMINE PROJECT

The Shenhua Watermark Project involves the construction and operation of an open cut coal mining operation approximately 25 km south-east of the township of Gunnedah (the Watermark Project is approximately 282 km by rail from the Port of Newcastle). The $1.2 billion coal mine has been approved by the Australian Federal Environment Minister and NSW Government.

The mine has a possible production target of some 159 million tonnes of coal over the 30 year mine life-cycle which is broken up into around 133 million tonnes of metallurgical coal and 26 million tonnes of thermal coal. The mine has an anticipated workforce of up to 600 full-time equivalent employees during construction and an average of 425 full-time equivalent employees during the operation of the Watermark Project. The Watermark Project will involve the construction and operation of:

- Coal handling and preparation plant to process the raw coal
- Administration building, workshop and related facilities
- Train loadout, rail spur and loop to connect to the rail line to Newcastle
- Mine access road
- Water management and reticulation infrastructure
- Communications and electricity infrastructure.

Benefit Cost Analysis

The benefit-cost analysis (undertaken as part of the EIS) identified and quantified all the material economic costs and benefits of the Watermark Project (NPV to 2013 figures; based on 7 per cent discount rate). Key outcomes were:

- The Project will have a net production benefit of $3,047 million with a minimum of $1,315 million of these net production benefits accruing to Australia
- This net production benefit is distributed amongst a range of stakeholders including the local community, Shenhua Watermark, its shareholders and government
- The Project is estimated to have net social benefits to Australia of between $1,315 million and $1,639 million
- Key beneficiaries include the Australian Government with a $745 million net benefit (corporate tax); NSW Government with a $565 million net benefit (royalties) and the local community with a $11 million benefit (voluntary infrastructure and service contributions to local government)
- The Project will create $960 million in direct and indirect output or business turnover in the region and 1,208 direct and indirect jobs (including 774 flow-on jobs to support the mine and supply goods and service to direct mine workers
- Shenhua Watermark is expected to pay more than $1.3 billion in company taxes and over $1.5 billion in State Government royalties over the life of the Project.

SOURCE: TAKEN FROM SHENHUA EIS DOCUMENTATION

While the Shenhua Watermark Coalmine Project has now completed the government approvals process, significant investment, work and time will be required to bring the project to fruition and for benefits to flow.

The Project represents only a very small proportion of the coal resources encompassed by BATP (approximately 0.4 per cent) but provides an indication of magnitude of benefits which might accrue. Furthermore, it is difficult to discern exactly how important BATP was in informing a positive approvals decision. However, we know the Watermark Project was under immense scrutiny from local farmers in the region who were concerned over the mine's impact on groundwater resources/water tables and the surrounding environment. The approving agencies (both Commonwealth and State) found that while the mine would impact biodiversity, air, and noise quality, the project proponent had the capacity to manage these issues.

Assessment of benefits against costs

Suppose that, in the absence of BATP, there would have been a 5 per cent probability that the Shenhua Watermark Coalmine Project would not have been approved by the Australian and NSW Governments. Based on the cost-benefit analysis undertaken as part of the EIS for the project which indicated a minimum of $1.315 billion in net project benefits to Australia, this would have resulted in expected foregone benefits of approximately $66 million (that is, 5% x $1.315 billion). The estimated benefits of BATP from this project alone thus covers the total BATP budget of $65.4 million, bearing in mind the project only represents 0.4 per cent of the coal resources encompassed by BATP (with no consideration of the CSG resources). This suggests that the current and future benefits of BATP are likely to far outweigh its costs.

In Section 1.3.4, it was indicated that 41,456 MT of additional coal extraction have been assessed under BATP, of which perhaps 80 per cent (33,165 MT) can potentially be extracted. Assuming a present value of net benefits over 30 years of $8.22 million per

MT (based on the Shenhua example) and that 20 per cent of the 33,165 MT of resources were to be extracted steadily over a period of 25 years, the present value of total benefits would be approximately $25.4 billion under a 7 per cent real discount rate. If 2 per cent of these benefits can be (conservatively) attributed to BATP's assistance to regulatory decision-making, then the total present value of benefits of BATP would be $508 million plus $66 million (Shenhua) equalling $574 million.

Subtracting the present value of BATP R&D costs from the present value of benefits, the net present value (NPV) of BATP is thus $574 million minus $76.8 million equalling $497.2 million in 2017/18 dollars (under a 7 per cent real discount rate). The benefit-cost ratio (BCR) is 7.48 ($574 million over $76.8 million).

Sensitivity analysis

In the central case of the cost-benefit analysis, it is assumed that there would have been a 5 per cent probability that the Shenhua Watermark Coalmine Project would not have been approved by the Australian and NSW Governments in the absence of BATP. If the probability is 10 per cent instead of 5 per cent, the BCR would increase from 7.48 to 8.34. Conversely, if the probability is 2 per cent, the BCR would decrease to 6.96.

In the central case of the cost-benefit analysis, it is assumed that 20 per cent of the maximum extractable coal resources assessed under BATP would be extracted over 25 years. If the proportion over the same time period is 40 per cent instead of 20 per cent, the BCR would increase from 7.48 to 14.09. Conversely, the BCR would decrease to 4.17 if the proportion is 10 per cent.

In the central case of the cost-benefit analysis, it is assumed that 2 per cent of benefits from extraction of additional coal assessed under BATP can be attributed to BATP's assistance to regulatory decision-making. If the attribution rate is 5 per cent instead of 2 per cent, the BCR would increase from 7.48 to 17.40. Conversely, the BCR decreases to 4.17 if the attribution rate is 1 per cent.

1.5.2 Externalities or other flow-on effects on non-users

Positive externalities will accrue to the broader community in the form of avoided detrimental environmental outcomes arising from the application of better informed terms and conditions imposed as part of the project approvals process or from rejection/cancellation of projects where the impact is deemed to deleterious. National economic externalities may include increased productivity and profitability of the resources sector, avoiding '*stranded resources*' and more fully realising economic resource values – with potential flow-through to increased government taxation/royalty revenue.