Webinar: The Bradfield Scheme

Question Details		
#	**Question**	**Answer**
1	I think the term Bradfield Scheme is Obsolete and what is needed to study is a full and comprehensive variation to that project that negates the need for any diversion tunnels to the west and for the following reasons;	I suspect these days many of the calls for construction of the Bradfield Scheme use the term 'Bradfield Scheme' as a metaphor for government investment in water infrastructure. Please note that Bradfield Scheme variations using pumped pipelines were explored. This is outlined in Section 14.3 of the comtemporary report. This variation explored a range of pumped pipeline and channel configurations from Hells' Gates to the Flinders catchment. To cut a long story short the conclusions and key messages remain unchanged, the 'dead weight' remains the costly diversion infrastructure. CSIRO reports on the Bradfield Scheme can be found at: https://www.csiro.au/en/research/natural-environment/water/water-resource-assessment/the-bradfield-scheme-assessment
2	How has the Bradfield Scheme created a positive impact in tackling climate change linked to floods and droughts?	We evaluated the Bradfield's Scheme and variants of the Bradfield Scheme over about a 125 years , a period that encompassed many very dry and wet periods. The method used to evaluate streamflow under future climates assumed the modes of variability into the future were similar to the historical climate. For the purposes of this analysis this was deemed to be appropriate. If the findings of this study had suggested that further analysis of the Bradfield Scheme and its variants were warranted then this could have been explored further.
3	The Mt Foxton site and storage combined with the Herbert river Hydro electric power diversion is far and more beneficial and ticks all the boxes on the following main points, 1/. Green Energy 2/. Gravity diversion to the western side of the Great dividing Range without any need for expensive tunnels . 3/. Flood mitigation on the eastern side of the ranges, 4/. There are sites from Hughenden and south where the salinity issues you are raising do not exist, and the more temperate climate is more amenable to many types of food production. 5/. the Diversion channel into the Warrego River is much shorter than what Bradfield had envisaged. 6/. this also provides for greater water supply security to increasing productive capacity on the Eastern side of the Great Divide in the Charters Towers region. And there is much much more.	Regarding point 1. It is unclear what the Herbert River hydro- power diversion is? If it involves releasing water down Herbert River Gorge, which is below the point of diversion to the Burdekin catchment, (Herbert River Gorge is the only place where there is sufficient head in the Herbert for hydropower generation in the Herbert catchment but of course would be highly contentious) for hydropower generation then there would be less water available for diversion to the Burdekin catchment. If you are proposing that the Mt Foxton site only impounds inflows from the Burdekin catchment, then there is the question as to why a potentially profitable hydro power enterprise on Herbert River Gorge in the Herbert catchment would seek to defray the costs of a nearby loss making diversion scheme enterprise in the Burdekin catchment. Rational actors would simply discard the costly diversion scheme. If the intent is to generate hydropower along the water supply line then as outlined in the presentation and reports there is insufficient head for hydropower generation along the water supply line between the Tully catchment and Hell's Gates/Mt Foxton for hydropower generation.
		Regarding points 2 &4. I direct you to Section 14.3 of the Contemporary Bradfield report. Here we report on a Bradfield variation that involves pumped pipelines to the Flinders catchment. The best option was found to be a lower alignment pumped pipeline - channel combination as this option passes through large areas of sandy loam soils before reaching the Flinders River. These soils would potentially be suitable for high-value irrigated horticulture. Agreed along the Flinders River there are large areas of recent alluvial clay soils that would be moderately suitable for broad acre irrigation. We identified between about 100,000 and 150,000 ha. However, from the financial side, the fundamental challenge remains to find a value-added benefit from moving the water relative to the cheaper alternative of using it in place. If diversion infrastructure is only adding cost, without value, (while moving water inland where crop yield per ML will be lower) then it won't stack up financially. There are likely better cost-benefit options for using the water in the Burdekin catchment (e.g., raising the Burdekin Falls Dam wall and for which there is already a provision in the Burdekin Water Plan), and any diversion proposal would need to perform better than the best alternative base case (with more rational use of diversion infrastructure). In Section 14.4 of the contemporary report we further illustrate the point that using the water locally and matching supply to existing and realistic forecast demands of high-value crops (and assuming the same optimistic set of assumptions) is considerably better (i.e. losses are less) than options that involve long distance diversion infrastructure.
		Regarding point 3 flood mitigation potential is modest (see Chapter 11 of contemporary report).
		Regarding point 5, true using the Warrego River in the northern MDB to convey water would reduce the length of the channel and hence cost. However, aside from the fact that the Warrego River does not pass near any major irrigation areas in the northern MDB, natural drainage lines are inefficient at conveying water, but their use to convey diversion water presents numerous other challenges e.g. susceptible to erosion at high flows, not easy to accommodate modern control structures, capacity limitations etc. Some of these issues are discussed in the technical reports. In Section 5.7 of the contemporary technical report we report on calculations of losses in the Warrego River and other northern rivers of the MDB. These are very high, in some cases greater than 60%. For this reason we only considered constructured channels.
		Regarding point 6. Urban areas require considerably less water than required for irrigation. Charters Towers could potentially source its water from a new weir on the upper Burdekin River, which could also supply a modest amount of water for riparian irrigation. Planning is well advanced to start construction in 2023 of a relatively small but high yielding weir at a site at Big Rocks (see https://www.charterstowers.qld.gov.au/big-rocks weir). This structure is likely to comply with the Environmental Flow Objectives (EFOs) stipulated in the Burdekin Water Plan whereas the large dams at either Hell's Gates or Mount Foxton are not provided for in the water plan and would require substantial changes to the water plan's EFOs.
4	Was climate change (rainfall, temperatures and extreme events like cyclones) incorporated in the economic analysis - what future scenarios were considered - RCP? or SSP? -	Yes we did consider climate change impacts on runoff. The majority of GCMs in the Bradfield catchments project reductions in mean annual rainfall, which is only likely to make the economics of the scheme more challenging, particularly as some of the infrastructure that may have been optimised for the historical climate may well be oversized under a drier future climate (we did do a sensitivity analysis to a range of parameters including a reduction in water yield - this is all detailed in the technical report).
5	Has it been considered the gains from stoping the loss of agriculture land due to climate change and increase of drought?	This was not part of this study.
6	Chris Stokes video has gone out. A courageous decision by all to analyse propositions with such broad parameter coverage. Interesting proposing a revised scheme that would primarily benefit the St George irrigation area.	Taken as a comment on live action.
7	The scheme may have different levels of costs / benefits for the involved states. Did you analyse this aspect ?	Given the sensitivities of transferring water from Far North Queensland across State boundaries, we focused the contemporary version on taking water to NMDB, with most of the water used in QLD. Taking the water further south (where there are more water users), as Cuan noted, ~doubles channel costs, the key weakness - so has an even worse cost vs benefit. Using more water for supplementing existing farms further south (rather than new farms in QLD) would have a slightly greater benefit - but nowhere near enough to cover the additional diversion costs either. The financial analyses just treated all the off-farm infrastructure as being paid for by a single public investor. We did not consider how that would be split (but clearly there would need to agreement about costs and benefits between Cwth, QLD, NSW etc. if such a project ever went ahead). Splitting costs and benefits is even more of an issue for private investors that would use and pay for the water (irrigators in this case). The (high-value) citrus producers would be required to pay an 'altruistic' premium on the water, which they could afford to pay, but would be far more than they would have to pay if they bought existing entitlements elsewhere. So getting the scheme to stack up financially 'as a combined whole' is not enough: it has to stack up for each individual private and public investor/stakeholder - which is a higher bar that would be much more complex to achieve in practice.
8	Similar issues faced by some interbasin transfer schemes in the USA, especially Bradfield's reliance on a limited data set that over-estimated available water to divert.	Very interesting, thank you… we have been reading about this in the media in recent months.
9	If we applied the same analysis to the Snowy Mountains Scheme, how would it rate today?	To our knowledge such an analysis hasn't been undertaken, but we agree it would be an interesting exercise. It is worth noting, however, there are also likely to be many counter arguments to national building schemes from around the world (e.g. ghost cities in China) that may also be instructive to examine. Infrastructure Australia best practice guidelines for cost-benefit analyses do now recommend doing post project evaluation of costs and benefits. This has not often been done in the past, but would be useful to give context and learn lessons for preparing and evaluating future proposals.

10	How does the Mt Foxton dam compare to the Hell's Gate dam?	Mount Foxton is downstream of Hell's Gates and has about a 15% larger catchment area than Hell's Gates. Consequently the inflows and yield from Mt Foxton are larger than Hell's Gates, however, the cost of building a dam at Mount Foxton is significantly greater than at Hell's Gates as it is a much wider site. For the purpose of gravity diversion, Mount Foxton is also lower in the landscape than Hell's Gate, consequently the dead storage volume and surface area of the minimum level for gravity flow is considerably larger than those of Hell's Gates, and after release water to meet WASO (ie to ensure reliability of existing downstream users is not compromised) the yield of Mt Foxton is only marginally higher than Hell's Gates under these circumstances (ie 10%), but capital unit cost (ie $/ML) notably higher (ie >20%). At the end of the day whether one selects Hell's Gates or Mount Foxton (even if Mt Foxton had twice the yield of Hell's Gates, which it doesn't) has no bearing on the results as the diversion infrastructure costs are the dominant factor influencing the outcomes of the study. The other real world' consideration is that neither Hell's Gates or Mount Foxton could divert even modest quantities of water and still comply with the EFO stipulated in the current Burdekin Water Plan. If at some later date the plan was amended (which would have to be done in consultation with stakeholders), based on other recent precedents it is unlikely that the plan would be amended to an extent that Hell's Gates or Mount Foxton could be used to their full potential (i.e. near their hydrological limits). It is probably worth noting that although Mt Foxton's yield is slightly higher than Hell's Gates, in a real world setting a dam at Mt Foxton would have to release more water than Hell's Gates to comply with the downstream EFO and WASO stipulated in a revised plan. This would only further enhance Hell's Gates as being the more cost effective of the two sites.
11	Has CSIRO assess any similar long-distance schemes to supply mining and related industry? We do have such "immortal projects" in Mongolia promoted by government to supply industry based on Rio-Tinto's Oyu-Tolgoy Copper mining complex and other industries planned in Southern Gobi Region. So I am very interested in modern assessment of such schemes by credible institutions.	No we haven't. Typically mining doesn't need much water relative to agriculture or the quantities involved in a Bradfield Scheme (the only mining enterprise that use large quantities of water are coal (in the order of 10's GL) and to a lesser extent gold (i.e. <1 GL)) and the water usually doesn't need to be of high quality so mines can often develop their own local water supplies. Maybe in some areas of the world (Southern Gobi Region?) there simply isn't any water resources available and water diversion infrastructure may be required? The main difference to our analysis, however, which was focused on water for agriculture, is that mining has a higher capacity to pay for water than agriculture so it maybe that the economics of doing so is different.
12	Is most large scale irrigation infrastructure simply subsiding agriculture from the public purse? Do the end users of the water really pay for the real cost of it? How many of the existing major dams show positive cost-benefit?	Mainly the industrial farming enterprises (subsidisation)
		Not many post-project (ex-post) evaluations have been conducted to actual realised cost-benefit (vs what was used in initial proposal (ex-ante) to motivate for the project). But both an Australian and an international meta-analysis showed actual dam costs on average were double proposed costs. So yes, costs are typically greater than benefits. (For water infrastructure operators those benefits would be via water payments that may well fall short of covering their full actual costs). That is easier to justify for domestic consumption (e.g., reducing local food costs and paying for it in a different way) than for exports. But, as noted in the presentation, it is a global phenomenon that public infrastructure costs usually exceed the market benefits that they generate (this is not unique to regional Australia nor water infrastructure in particular). So cost benefit analyses (CBA), done on a like-for-basis (such as Infrastructure Australia's best practice guidelines), provide a useful tool for comparing public investment options. Even if there is a determination to go ahead with a loss-making infrastructure investment at least CBAs can be used to: 1) select alternative options that reduce that loss; and 2) make it clear how big the loss is. Also, it is difficult for new water infrastructure to compete with existing developments because: 1) the best dam/development sites tended to be built first, and the remaining options will get progressively poorer as each additional site is developed; 2) there is long history of subsidising irrigation developments (which is embedded in the reduced cost of water and the outputs produced with it, which depresses the value assigned to produce from future developments), making it difficult for unsubsidised future developments to compete with established ones.
13	Could climate resilient water sources in the region also include managed aquifer recharge?	Yes. In many places it is often considered that robust water supply strategies encompass multiple options and sources of water.
14	Would the Bradfield scheme aggravate the risks of channel avulsion the farmed Burdekin Delta and the erosion of the Cape Bowling Green peninsula? These risks for the present situation are detailed in Wolanski,E., Hopper, C. (2022). Dams and climate change accelerate channel avulsion and coastal erosion and threaten Ramsar-listed wetlands in the largest Great Barrier Reef watershed. Ecohydrology & Hydrobiology 22, 197-212.	Thanks Eric, possibly. This was not explicitly assessed in this study, as the focus of Chapter 10 was on the change in delivery of fine <16 um sediment (and PN) impact on the GBR. However, it is likely that the current Burdekin Falls Dam is having an impact on the Delta now - the additional change in flow due to Hells gate was <20%
		1.2^4=2.07. As the sand transport capacity in the river goes like speed^4, the impact of 20% decrease on the flow is a doubling of the siltation of the delta, and hence enhancing the risks of avulsion, would be very high indeed.
15	It is the conservative side of politics, in particular the National Party, who continue to push the Bradfield Scheme. Have they, and the general public, been advised that the concept is a complete economic dud?	We delivered our reports to the Federal Government in 2020 and 2021. We were not privy as to when, how or whom the reports were distributed. However, the reports were all publicly released in August 2022 and are available on the internet (search CSIRO and Bradfield).
16	Existing Bulk water diversion diagram very interesting (previous slide). Shows the influence in CQ of Mining now and near future, if you consider the proposed extension to Alpha! If you want to fix water security in productive agriculture areas, build a coal mine first!?	In more recent years, it has been urban water security (rather than coal mines) that have driven investment in regional water grids (like the current investment in the Toowoomba to Warwick pipeline as well as the Rockhampton to Gladstone pipeline).
17	The Wet tropics - Tully local govt area suffers from water shortages? red on Tom's map.	Water restrictions were required in some small towns in that area 2019-20 due to inability of exiting local water infrastructure to supply their needs.
18	Is there sufficient head to consider siphonage as a means of transfer	Inverted siphons are used extensively in the current design, where ever the canal intersects major waterways. The issue however is available grade. This is primarily governed by the elevations of the two catchment boundaries intersected. The pumped/pipeline solution of course represents the ultimate 'siphon' solution. That was not viable.
19	Are there any other large-scale diversion projects that may be viable in Australia? Such as a diversion from the Clarence river to the Mole River which would require much less diversion infrastructure	The Clarence diversion idea is perhaps a further example of a regional water grid in that part of the world. The regional grid idea is also well advanced in Victoria…
20	great. can we divert urban runoff and use it for irrigation purpose after the necessary treatment undertaken?	This is certainly being looked at more and more — an example of one that is being developed at the moment is the Wamuran Irrigation Scheme in south-east Queensland see https://www.unitywater.com/about-us/projects-in-your-area/major-projects/wamuran-irrigation-scheme
21	Cuan are you not missing the point /	Taken as a comment (without a specific question).
22	Trying to get my head around the numbers. Did you say 1,000GL/year (or 1270, 1880, 2280)? The median price of water in the MDB is $8,000ML/year? So the 1,000 GL would be worth $8b (yes there are other challenges, considerations). In any case, yes, there are much better alternatives, with using water at the source and reusing (some of) it downstream again, and with sustainable adaptation options.	Water was priced using 2 different approaches (see slide #3 of financial analyses, which is Table 9.1 in the 'Contemporary Bradfield' report): 1) water pricing per supplied ML: $3,220 for each ML extracted (for 'moderate risks') 2) water pricing for ongoing entitlement: up front $37,500 per ML payment for ongoing annual entitlement (to cover capital costs of scheme) plus ongoing $230 per ML extracted (to cover recurrent scheme costs). (volume weighted average pricing for total lifetime water used by scheme, with optimistic assumptions about matching demand to supply). Entitlements for horticulture were treated as 100% reliable and broadacre entitlements would only receive their full allocation in 75% of years. Comparisons to the SMDB markets were just as an indicative point of reference for the most important and active water market in the country (the 'Bradfield' NMDB water wouldn't be well connected to the SMDB markets hydrologically or financially - not without building an even longer and much more expensive channel). Also note the entitlements are not priced simply by dividing the total volume by the total capital cost of the infrastructure. Discounted cash flows were used both for the capital costs (with expenditure spread out over an indicative multi-year construction schedule) and for entitlement payments (assuming these would only be auctioned off when the water supply came on line and the irrigation area was developed, assumed as year 12 after construction began). Any further delays between the start of construction and the complete sale of entitlements would increase the (volume weighted average) entitlement prices required to cover capital costs.

23	The Mt Foxton Site has an FSL of 390 RL and gravity feed requires no tunnelling .	Please see above comments on Mount Foxton. At the end of the day whether one uses Mount Foxton or Hell's Gates makes no difference to this analysis, conclusions or key messages.
24	The yield is 4 times that of Hells Gate.	No the yield of Mount Foxton is not 4 times the yield of Hell's Gates. Reservoir storage capacity does not equal reservoir yield. Reservoir yield is less, often considerably less (particularly in oversized dams relative to inflows) than the reservoir storage capacity. Consider an extreme example where you have a 1km high dam on a small catchment. It would have the same yield as a 500 m high dam on the same small catchment because the yield is limited by the catchment inflows.
25	Chris you have not once mentioned the Environmental needs of the Murray Darling Basin and ST George needs should not be the only requirement that you seem to focus on.	Environmental needs of the MDB could be met far more cheaply by water buybacks - hence the indicative comparisons of the water pricing from our analyses to MDB water market prices (see Q22 above where some of these details are recapped). Linking the diverted water (hydrologically and into water markets) in the southern MDB, would require an even longer channel, with even greater expense and even higher costs for the diverted water. Using the natural drainage lines of the northern MDB to convey the diversion water (in order to lower the costs) would incur very large losses (see calculations reported in Section 5.7 of the Contemporary Bradfield technical report) and the actual amount of water making it to the southern MDB to provide environmental benefit would be but a fraction of that diverted into the most northern part of the MDB. Then, there is also the contagion issue of exporting unsustainable water practices from one catchment to another a set of catchments (ie robbing Peter to pay Paul), rather than dealing with the root cause of the problem in place . Any support for such a notion within the beneficiary catchment would likely be more than offset by environmental concerns in the catchments where those problems were exported to (not to mention the loss to consumptive users in those catchments for future economic development).
26	Are we seeing anything from the relevant agencies to suggest that they are considering the grid idea?	Yes. DRDMW (state department) is conducting three regional water studies in south-west, central and northern parts of Queensland see https://statements.qld.gov.au/statements/92804
27	The effective capacity of Mt Foxton is 7,000 GL This allows Charters Towers and Townsville to be sorted, with 1,000 GL per year (when drought) Bradfield and Hells Gate ignores these zones. This thumbs down for Foxton will require more number crunching.	Please see earlier comments on Mount Foxton. Note regional urban centres require very small volumes of water relative to the volumes used by irrigation areas (or being considered in this study). Charters Towers could potentially source its water from a new weir on the upper Burdekin River, which could also supply a modest amount of water for riparian irrigation. Planning is well advanced to start construction in 2023 of a relatively small but high yielding weir at a site at Big Rocks (see https://www.charterstowers.qld.gov.au/big-rocks-weir). This structure is likely to comply with the EFOs stipulated in the Burdekin Water Plan whereas the large dams at either Hell's Gates or Mount Foxton are not provided for in the water plan and would require substantial changes to the water plan's EFOs. An interesting earlier (2018) comparison of other aspects relating to the two dams is available at https://s3-ap-southeast-2.amazonaws.com/os-data-2/townsvilleenterprise-com-au/documents/hells_gates_dam_-_executive_summary.pdf. No doubt the Queensland Government will be considering the implications of all such water infrastructure proposals (including others such as Urannah Dam and the Burdekin Falls Dam Raising which are provided for within the current water plan) when they come to review the Burdekin water plan (which is dues to be updated by September 2023 – see https://www.business.qld.gov.au/industries/mining-energy-water/water/catchments-planning/water-plan-areas/burdekin). Regarding Townsville's water supply, there are already provisions for Townsville's water supply from the Burdekin with new bulk water pipeline infrastructure connecting the Burdekin, Haughton and Ross Rivers that will meet Townsville's future projected growth for years to come. Townsville can source additional water from the Burdekin catchment without the need to construct additional water storage infrastructure, as it has an option over a large volume of existing water allocations from the Burdekin Haughton water supply scheme that were originally earmarked for Townsville at the time that the scheme was established.
28	I'd be keen to see a more "engineering-focused" webinar (rather than the "cost/benefit" focus of this one) dealing with some of the likely challenges that would need to be overcome for these schemes.	The presentation was prepared for a very broad audience so we can appreciate that it may have been too high-level with insufficient engineering/technical detail for some. Please note Kevin Devlin, our 'resident' channel and reticulation infrastructure expert with 40+ years experience, ison the panel and would be more than happy to speak to challenges of diversion infrastructure, particularly in tropical environments if asked. We do have numerous sections in the technical reports that discuss engineering aspects of diversion infrastructure. For example Section 6.4.5 of the original Bradfield Scheme report and Section 6.6 discusses the bulk water supply channel to the MDB including the potential to capture additional water enroute and the pros and cons of different methods of doing so. We hope this is helpful.
29	Are Tom's interconnected regional grids similar to that of Seqwater's network or larger?	They would be of a similar size as the regions cover very large areas - the regional grids would extend this scale of thinking too regional Queensland (not just the south-east of the state).
30	What ecological and cultural aspects have been taken into account?	We have a chapters on ecological and cultural considerations. These are qualitative discussions rather than quantative analysis. I refer you to Chapters 9 and 11 in the Historical Bradfield technical report and Chapters 12 and 13 in the Contemporary Bradfield technical report
31	Thanks everyone for the Webinar.	
32	Thank you, well presented and informative	