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Project	Gloucester Coal Seam Gas Project	From	Michael Ulph
Subject	Community Consultative Committee	Tel	4941 2841
Venue/Date/Time	Thursday 2 April Gloucester Country Club, 10am – 1pm	Job No	21/17714
Copies to	All attendees		
Attendees	Ian Shaw – AGL Lands Officer Toni Laurie – AGL Land and Approvals Manager Naomi Rowe – AGL Community Relations Manager Dr. Richard Evans – Independent Peer Reviewer, Principal Hydrogeologist (SKM) Ray Dawes - BGSPA Ed Robinson – Lower Waukivory Residents Group Gerald McCalden – The Gloucester Project Rod Williams – Community Representative Anna Kaliska – Mid Coast Water Clr Paul Hogan – Mid Coast Water David Mitchell – Avon Valley Landcare Clr Jerry Germon – Gloucester Shire Council Graham Gardner – Gloucester Shire Council Clr Tony McKenzie – Dungog Council Tim Hickman – Community representative Michael Ulph – GHD (Facilitator) Lilen Pautasso – GHD (Assistant Facilitator) Tim Weeks – Gloucester Shire Council (Observer)	Apologies	<b>Karen Hutchinson</b> <b>Lisa Schiff</b> <b>Terry Kavanagh</b>

Item	Action
<b>1. Introduction</b> <i>Welcome and Acknowledgement of Country</i>	
<b>2. Meeting agenda</b>	
▶ Introduction and welcome to new attendees	
▶ Discussion on first draft of Independent Peer Review of Phase 2	



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## Water Study

- ▶ Communication with peer reviewer and where to from here
  - ▶ Close of formal proceedings, followed by lunch
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### 2. New attendees

Michael noted that Garry Smith (BGSPA Alliance) has resigned from the CCC – replaced today by Ray Dawes.

Michael introduced Tim Weeks (Gloucester Council – Economic Development Manager) – put his attendance as an observer to the CCC. Constitution states that people can sit in for people who cannot attend, but does not however discuss observers.

Action: provide Terms of Reference to Ray Dawes – Michael.

#### **CCC: Are we reviewing the terms of reference at the next meeting?**

Michael: Yes. We will.

#### **CCC: Is there someone who will present these terms of reference?**

Michael: Yes. It is still evolving and we are yet to ratify it or have it completely agreed upon so that is why it will be the focus of our next meeting.

Naomi: As an observer, Tim, what would you like to get out of this?

Tim: As part of Gloucester Council I would like to be here because, at this stage, we're dealing with a lot of issues, not just with AGL but with other extraction companies around Gloucester Shire. I think it's important for us to be involved in this consultation process in order to listen to what is being discussed and what issues are being identified by the community. This is very important to us.

**CCC: There has been a fair turnover of participants and this has caused broken information to be delivered to new representatives and people entering the CCC with only very limited information. I don't think an issue for people to observe, but there needs to be more control over who represents. Observers are fine, but if there is going to be continued change in representatives then that might become an issue. Observers should be welcome because this is not a private session. Everything has been made public.**

Ian: The exclusivity of the CCC was put into the terms of reference simply because, if there was a change in representatives, the CCC did not have to spend most of the meeting bringing people up to speed on the issues at hand. If a permanent change was to occur, then the representative leaving the CCC would be responsible for this.

**CCC agreed for Tim Weeks to be an observer for this meeting.**

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### 3. Dr. Richard Evans – Presentation

Dr. Rick Evans. CCC to ask questions throughout the presentation. Rick has added slides that are not directly related to the report but explains some of the data so we're all on the same page. It is not

***Rick to provide full presentation to Michael for distribution to the***

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relevant specifically to this area but explains the ideas.

**CCC.**

It is important to remember that the purpose of the review is not to comment on the feasibility or otherwise of the proposed development. I am essentially reviewing three reports plus other data. This is an important distinction to make. What is also important is that the conceptual model is just that, it's not an impact assessment. It is important to appreciate that this is a two-step process – conceptual and numerical modelling. This distinction can be often lost.

***Rick went on to outline his scope which is to review the three reports and comment on whether enough work is being done at the conceptual model stage and if the fundamental data that exists is fair and reasonable. Rick stated that he will be looking at the suitability of the network, identify gaps and provide contextual comments on hydraulic fracturing. Important to note that the comments on fracking are broad comments and are not specific to the area at all. Similarly Rick will not be looking at the quality aspects of fracking or irrigation – not part of the scope.***

**CCC: John Ross was talking about 'other information' that he gave to you for this review. I know what we have been given but is there other information that the committee should have received that has been included in this review?**

Toni: I'm not sure what information this is.

Rick: All the extra data is referenced in the review and has been added as a reference at the back of the report. There are some emails with data and they have been referenced throughout. I was given a CD with raw data and there was other information on the fracking methods and other emails with odd bits of data. I can't say that this was significant data but nonetheless it is not private.

Toni: If anyone is interested we can make this information available.

**CCC: I think that it needs to be available so it is a transparent process.**

Toni: Yes. I think this information included excerpts from the REF's as well as the raw data as discussed at the last CCC meeting. If the CCC is interested we can definitely forward it on to you and make the data available.

**CCC: The emails from John are referenced too?**

Rick: Yes. It is all referenced with a date.

**CCC: The reason I ask is because, when you go to a public meeting one of the questions you are sure to be asked is, are any of the compounds used in fracking going to impact on the quality of the water. I understand this is not part of the brief but how will we mediate that at a public meeting?**

Rick: Assuming that this does come up as a big issue, clearly it's not part of my brief but I can do my best to respond. There are obviously many different types of materials. I don't know specifically what materials AGL will be using but there are certain toxicological reports available and that explains what the toxicity of the types of things that are added. As well as the toxicity of the individual materials, there is

***AGL to pass on any additional data used by Rick to CCC members***



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also total toxicity.

***Rick went on to explain how these toxicity tests work and how this information can be found online to help better inform interested individuals. Rick was deliberately vague on this aspect as it is not part of his brief but stated that this is a major task and that it is fair to say that the effects are still under consideration.***

**Overview Comments (see also slides below)**

Rick: In the broadest of terms I am quite happy and in agreement with the PB conceptualisation and the work that they have done. They are actually talking about four basic hydrogeological units, they discuss decreasing hydraulic conductivity/permeability with depth, they provide a broad conceptualisation of what the actual discharge mechanism is, and they talk about that, in the natural state, there is a dominance of lateral processes (horizontal flow). And they do also acknowledge that further work is to be done on faults. While I have identified the areas that are not clear or need further development I am not implying that the overall report is rubbish, not at all. Because I am looking at things in greater detail, you tend to find a few things that don't make sense. However, these are observations and aren't bad conclusions.

**CCC: In terms of the scope of the brief (e.g. water quality based on impacts of fracking), it seems to me that a question for us to consider is why we need to have the whole thing so constrained. I raise the question about not having such a broad scope.**

Rick: I do talk about the need to expand on a number of aspects. I don't see incompatibility in terms of my brief on the area that is being looked at and what needs to be carried out. I haven't commented on impacts because that work hasn't been done and that is generally what people want to know. People want to know what the impacts are but the bottom line is that this work hasn't been done yet.

**CCC: Is the data set already collected representative of the whole Basin? In other words, can it be extrapolated to all areas of the Basin to get a high degree of confidence?**

Rick: Any hydrogeological assessment does require extrapolation from known data into unknown areas so there is always a degree of professional judgement involved and my recommendation of further studies is designed to enable one to do that extrapolation. Based on existing data can you do it? I think, no. There is additional work to be done, which I've recommended. There can be further discussion on the scope of the works, But I would hope that one would get to a sufficient stage of understanding so that you could do that. When you say a 'high degree of confidence', it's not so black and white because what you do is you have the conceptual model phase then you do the numerical model phase and you look at the results coming out of the numerical model and ask, 'does that make sense' and is it consistent with the conceptual model – so there is a cyclical level of understanding in the evolution of understanding.

Rick: some wrong conclusions have been made in the PB report – some conclusions are wrong while others are made too early. Many of these concerns can be addressed with further work. Not a huge amount of additional work, but one can get a higher degree of

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understanding from this.



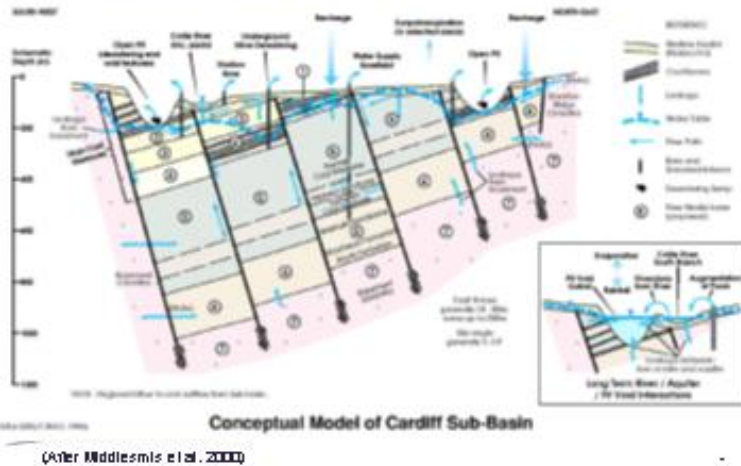
### **Conceptual model**

Naomi: Rick, what do the numbers represent?

Rick: The numbers represent the amount of recharge, discharge, the amount of flow. All factors are quantified with some degree of confidence.

Rick: The conceptual model only covers a very small part of what is 'stage 1'. They don't extend far enough and my understanding is that there is probably enough existing data which would allow someone to extend their special coverage up, down and across the value much more. The PB report also only looks at 200-300m whereas most of the action is between 200-1000m. The fact that we don't have any deeper data is a concern. The model is a bit too limited at the moment and that needs to be addressed.

## Conceptual Model – What is a conceptual model?



### Conceptual Model – Coverage of model

- > Apparent that the conceptual model is:
  - o Spatially limited – cross sections represent only a small part of Stage 1 GFDA and area that would be covered by a numerical model. Can be expanded by using existing data and by new drilling.
  - o Vertically limited – conceptual model developed in PB (2012) strongly focussed on upper 200-300m. Further description required on units at depth

SKM

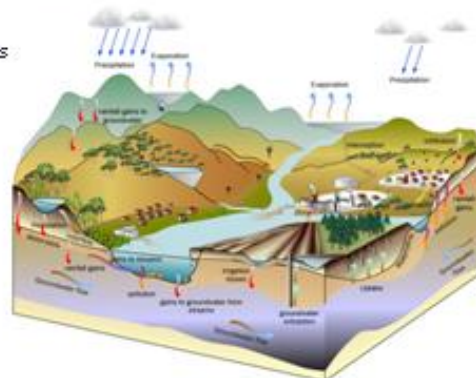
### Conceptual Model – Water Balance

- > Conceptual model will be strengthened by a water balance (WB). (also strong recommendation of MDB Modelling Guidelines)
- > Should include pre-, maximum & post-development
- > Advantage of conducting a water balance:
  - o Starts process of defining / conceptualising model boundaries
  - o Highlights components of WB, with uncertainty
  - o Begins to put into perspective possible scale of potential impacts
  - o Highlight assumed rate and timing of recharge after end of CSG development

SKM

## Conceptual Model – Water Balance

With components quantified



SKM

### Water balance

Rick: Water balance is simply where, at the conceptual model stage, you define in quantitative terms the actual major flow processes occurring. The current guidelines that exist state that at the conceptual

model stage, one needs to do a water balance. I suggest that it is done at three stages (pre, maximum and post development). Effectively 3 water balances.

**CCC: What is the purpose of doing a post development in 100 years' time?**

Rick: Purely to understand the rate at which recovery occurs. Because if this goes ahead then you would be depressurising a typical pressure of about 200m pressure decline, and by depressurising the coal seams that induces a stress on the coal seams which could then induce leakage. The post development is about getting a feel for how long it would take for the coal seams to equilibrate.

**CCC: I understand the technical reasons for doing it. I want to know the social/political reasons of doing the study 100 years down the line.**

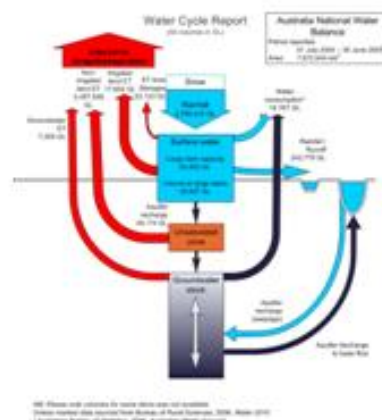
Rick: I'm purely keeping mind to the hydrogeological study. Not the social or political aesthetics. Part of the foundations in my mind is to know how long it will take for the coal seam to recover. That is why the post development is about understanding the long term effects. It's about coming up with an objective assessment of the effects.

**CCC: Would it be done over a period of years so you can see what's going to happen in 20-30 years, essentially?**

Rick: Yes. That's right. What I'm trying to do is to set the scene on what the fundamental aspects are. The water balance allows you to see what the scales of the potential impacts are and highlights uncertainty. I'm pushing the PB people to do more conceptual thinking at this stage. There has been no attempt to put any numbers on these events yet, however rough they are at the conceptual model stage.

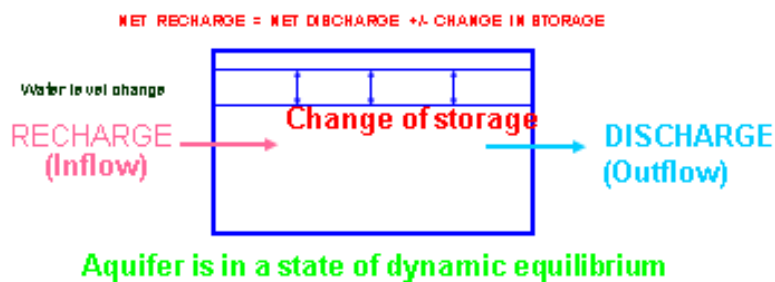
Rick: By putting numbers on these aspects you can have an informed discussion on what the impacts are (e.g. Gigalitres).

**Conceptual Model – Water Balance**





## Conceptual Model Water Balance



SKM

### **Recharge – Discharge model**

Rick: There are many different components to recharge and discharge. The +/- change of storage is how much the water in the aquifer is going up and down.

**CCC: Earlier you said the pressure lock would be between 200-400 metres?**

Rick: I'm being told the average is 200 but can go up to 400. How the differences in the water balance in the aquifer impact on recharge/discharge is important in this model. The major process that is occurring is ET (Evaporative Transpiration) – it will be about 80% of the water balance. That is the major impact at the surface in changes in discharge. The water balance is about understanding how the outflow changes. Unless we put numbers on outflow we can't have logical discussion on what the impacts are.

**CCC: last time you mentioned the distinction between depressurisation and dewatering. From what you looked at, have you got a better understanding of what they will be using?**

Rick: We are undoubtedly looking at depressurisation. I don't think they use the term accurately in the report. We're not actually, in my mind, talking about drying out of the coal seams. They'll still be fully saturated and under some pressure.

**CCC: At this stage do you start developing gradient potentials as a result of the depressurisation?**

Rick: Yes, absolutely. As soon as you depressurise you develop a hydraulic gradient.

**CCC: Do you quantify that at this stage?**

Rick: Normally not because you get this from the numerical model. You normally cannot do this at the conceptual stage enough. As soon as



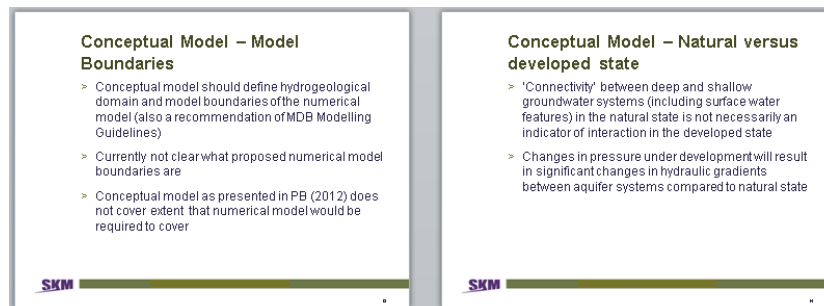
you start to depressurise the coal you develop a hydraulic gradient which is the pulling of pressure back to equalise. Coal seam gas developments would only work if there are low permeability materials around the coal seam. That hydraulic gradient drives leakage back into the system which is usually very slow. If the leakage is so high that there is significant recharge into the coal seam then the water that is produced would be so great then it would be an unviable operation in that well.

**CCC: Does the impact of faulting develop at the same time?**

Rick: Yes. And I will be talking about this later on.

**Model boundaries**

Rick: the current conceptual model is on only a very small area of Stage 1. Because the current model is too small it will be difficult for them to develop a larger model later on.



**Natural versus developed stage**

Rick: The PB report was very careful to always refer to the 'natural state' but they do not define what the relationship is between the natural state and the stress state. The scope of the conceptual model needs to be broadened in order to better understand the stressed state. You have to discuss the difference between the two. In most cases the changes are not huge but it gives us a better idea of the gradient changes. This is a task that is done intrinsically in the numerical model process but should be applied to the conceptual model too.

**Conceptual model**

Rick: Require data on the deeper aquifers. There are implications with the lack of review of vertical leakage to charge of deeper units. There are implications that everything is on horizontal flow processes. That doesn't make sense to me – it should be a mixture of horizontal flow and vertical leakage. Recognising that in the geological world that everything leaks to some extent (the lack of leakage can be very slow) and that there are still finite vertical leakage rates that could occur. The significance of recharge from creeks over outcropping unites is not covered at all – this is not necessarily a problem, but should be spoken about more.

**CCC: Can you calculate the salinity of the deeper waters?**

Rick: You can use the hydrochemistry of the different waters in

different aquifers to calculate different leakage rates. You have to have significantly different chemical species within each layer to enable one to work out leakage rates on the base of hydrochemistry. It is a tool that is being used elsewhere, but whether it would work here I don't know. It can be used but I'm not saying that it ought to be used.

Rick: Continuity of the coal seams – the report is silent on the lateral continuity and this needs to be understood first in order to develop a numerical model.

**Conceptual Model**

- > Potentiometric surface data – only mapped for the alluvial aquifer. Conceptual model should include an estimate of starting heads in other layers, including the coal seams.
- > Recharge processes:
  - o Significance of vertical leakage to recharge of deeper units (not covered)
  - o Limited discussion on potential role of faults as enhanced recharge areas
  - o Significance of recharge from creeks over outcropping units (coals etc), (not covered)
- > Continuity of coal seams – lateral continuity?

**Connectivity and potential shallow aquifer / surface impacts (1)**

- > "there is no evidence of natural connectivity between shallow and deep gw systems" (PB, 2012)
  - o 'low permeability' material does not create a hydraulically separating layer (missing element in the discussion is around quantities and timeframes)
  - o 'locally saturated' used to describe the interburden – this requires clarification. If implying that there is an unsaturated zone between the deep and shallow aquifer systems, then further evidence is required

**Connectivity and potential shallow aquifer**

Rick: My fundamental problem is that this conclusion implies that there are no levels of permeability, and I would argue that a better way to look at it is in degrees.

**CCC: Most of the bores are about 200-300m, so what is your definition of shallow and deep?**

Rick: shallow is 200m and deeper is about 1000m.

**CCC: How can they make that statement if there are no bores that go down that far?**

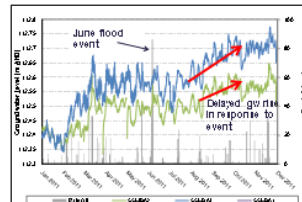
Rick: I would have to check that in the report. It may have been covered in the report, but I would have to look at this. I don't know what testing has occurred, but my point is that, when we're talking about low permeability materials we need to talk about quantities and timeframes. I don't think we should be talking about 'zero'.

**Connectivity and potential shallow aquifer / surface impacts (2)**

- > The following evidence provided for hydraulic separation of shallow and deep groundwater systems:
  - o Different chemistries – imply limited impact of vertical processes, not isolation of units
  - o Static nature of hydrographs
  - o Absence of response to rainfall recharge

The latter two are not supported by the data, as shown in subsequent slides

**Assessment of Monitoring Bore Hydrographs: S5MB**



**Connectivity and potential shallow aquifer (2)**

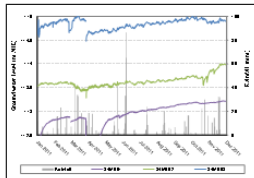
Rick: The model shows that there is finite hydraulic interaction between an event and the hydrogeology. There is a recharge event occurring as seen on the graph. Just because there is a hydraulic effect it doesn't mean there is a significant impact. It is nothing special.

**Potential impacts on surface water features**

Rick: One of the key recommendations is to look at the impacts of the

hydraulic relations happening, which can be done quite easily.

**Assessment of Monitoring Bore Hydrographs: S4MB**



Increase in water level of 0.5m or more observed

**Potential Impacts on Surface Water Features in Recharge Areas**


- > A potential impact not considered is lateral transmission of pressures along coal seams (and interburden) into the areas where these units outcrop/sub-crop east of the site.
- > Depending on the nature of the connection there may be an impact on stream flow in these creeks
- > Impact is likely to occur more quickly than vertical impacts to the valley floor
- > A first step is to understand the nature of the connection (if any) between groundwater and the creeks where they overlie the recharge areas.

**Characterisation of vertical hydraulic conductivity**

Rick: There is no distinction between vertical and horizontal hydraulic conductivity in the PB report. The reason why this is important is when the numerical model starts they will need to make some assessment of what the  $K_v$  and  $K_h$  is. The fact that the report is silent on that you are leaving up to the numerical modellers who will know less about the system to make a judgement here. It would be normal in the report to discuss why the lab test results differ. I suggest that this should be done at an earlier stage not a later stage. The Packer Tests tend to be on a larger scale so these differing results are absolutely normal but should be discussed whether they will be using only their results or a combination of both. The report also doesn't state whether the lab tests used  $K_v$  or  $K_h$  data for their 'lab permeability' results.

**Characterisation of vertical hydraulic conductivity (1)**

- > Reports currently don't address distinction between vertical ( $K_v$ ) and horizontal ( $K_h$ ) hydraulic conductivity
- > Most results are  $K_h$ , what  $K_v$  values will be used in model? (model results likely to be sensitive to  $K_v$ )
- > Range in results for 4 units is large – what will be used in the model?
- > How will differences in results between slug tests and packertesting / lab testing be handled?



**CCC: When looking at the tests (pack/slug). So slug tests are when they pull the water out and see how long it takes to recharge?**

Rick: Yes, that's right.

**CCC: Why are there such large variations?**

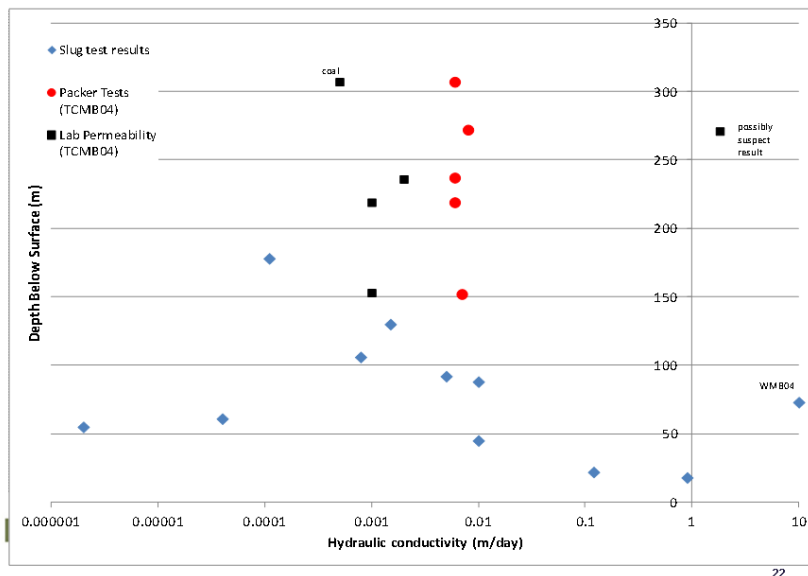
Rick: It is normal for large variations in the slug test, but what is causing the extremity results (e.g. 10, 0.000001) need to be explained in the report. Normally a conceptual model would discuss how this is going to be used and the distinction between the results needs to be made.

**CCC: My understanding is that you would want it to be closer to the Packer Test results. What about the 'possibly suspect result'?**

Rick: The 'possibly suspect result' is, in my opinion, absolutely normal because there are many factors that may have impacted on this (e.g. a spoiled sample). I wouldn't be concerned about this or draw any

conspiracy theories about it, but how the conceptual model uses this data needs to be defined. A discussion of this is very important so that they can provide recommendations to the numerical modellers. In many ways the conceptual model is imperative because it is the driver for the other models.

## Characterisation of vertical hydraulic conductivity (2)



### Characterisation of vertical hydraulic conductivity (3)

- > Compared to other areas, values appear typical of hydraulic conductivity for the given rock type
- > How will tendency for point tests to underestimate regional vertical hydraulic conductivity be addressed?
- > Use of other regional data to supplement local data set should be considered (but may not be appropriate)

SKM

### Characterisation of discharge processes

- > **Alluvial aquifers** – agree primary mechanism likely to be baseflow (ET also important, probably secondary)
- > **Shallow rock units** – agree primary mechanism likely to be discharge to alluvium
- > **Interburden confining units** – within study area, vertically variable (up and down). Down catchment expected to be upwards (to shallow rock/alluvial sed) – in vicinity of Gloucester
- > **Coal seams** – agree primary mechanism likely to be discharge to shallow rock (and indirectly to alluvial aquifers) down catchment - in vicinity of Gloucester

SKM

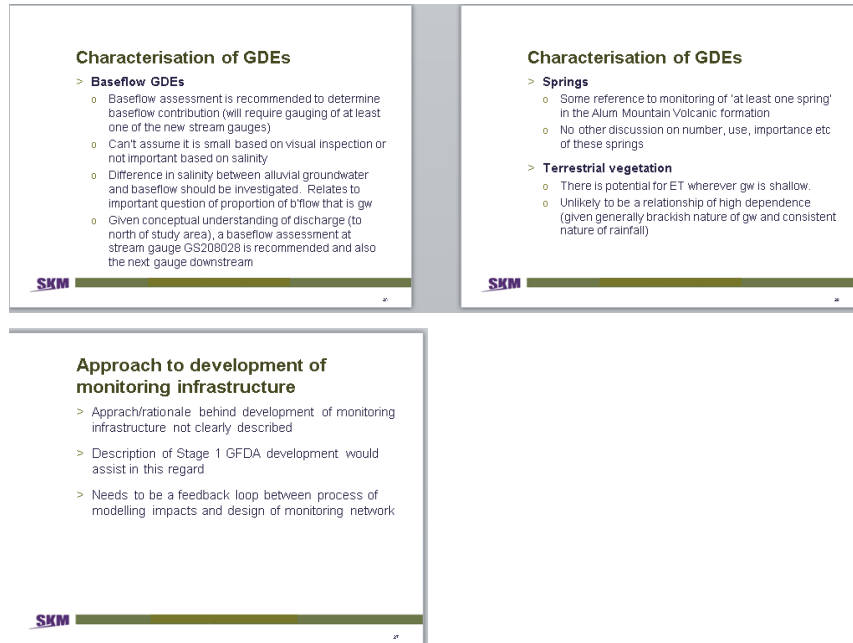
### Characterisation of discharge processes

Rick: the discharge factors are all about the effects. These terms seem to me to be feasible – I'm left with the question in my mind that, when you have a basin flowing into this particular area, the geological maps suggest that these come from the surface and whether this would impact other areas. We want to know what the 'down valley' effects are and this is not covered in the report.

### GDE's

Rick: What we want to know from this is how the surrounding environment is going to be impacted. The major dependent environmental aspects are rivers and springs. A baseflow assessment

of what is being impacted would be useful to understand how the groundwater systems impact on the environment in Gloucester.



The image shows three presentation slides from SKM. The top two slides are side-by-side, and the third is below them on the left.

**Slide 1: Characterisation of GDEs**

- > **Baseflow GDEs**
  - o Baseflow assessment is recommended to determine baseflow contribution (will require gauging of at least one of the new stream gauges)
  - o Can't assume it is small based on visual inspection or not important based on salinity
  - o Difference in salinity between alluvial groundwater and baseflow should be investigated. Relates to important question of proportion of flow that is gw
  - o Given conceptual understanding of discharge (to north of study area), a baseflow assessment at stream gauge GS20028 is recommended and also the next gauge downstream.

**Slide 2: Characterisation of GDEs**

- > **Springs**
  - o Some reference to monitoring of 'at least one spring' in the Alum Mountain Volcanic formation
  - o No other discussion on number, use, importance etc of these springs
- > **Terrestrial vegetation**
  - o There is potential for ET wherever gw is shallow.
  - o Unlikely to be a relationship of high dependence (given generally brackish nature of gw and consistent nature of rainfall)

**Slide 3: Approach to development of monitoring infrastructure**

- > Approach/rationale behind development of monitoring infrastructure not clearly described
- > Description of Stage 1 GFDA development would assist in this regard
- > Needs to be a feedback loop between process of modelling impacts and design of monitoring network

**CCC: There was no indication in the report that there was a biological entity in the groundwater system reliant on baseflow. In your opinion should things like, bacteria, be looked at here?**

Rick: All groundwater systems have bugs in them (microscopic stygia fauna) that flow into the streams, sustaining their health. We don't know if it is a major process here and I would suggest that we shouldn't look into this further because it is such a minor impact. I don't think that microscopic fauna is going to be a major factor. My opinion is that the vague references to springs need to be thought about a lot more.

**CCC: I think the springs are important here, the people find them hugely important in times of drought.**

Rick: Of course, and that's why I make the point that this shouldn't be vaguely looked at. From a hydrogeological point of view I cannot find what the problem is here. The major problems here are baseflow to rivers and springs.

**CCC: During very dry times, we have to draw water from wells.**

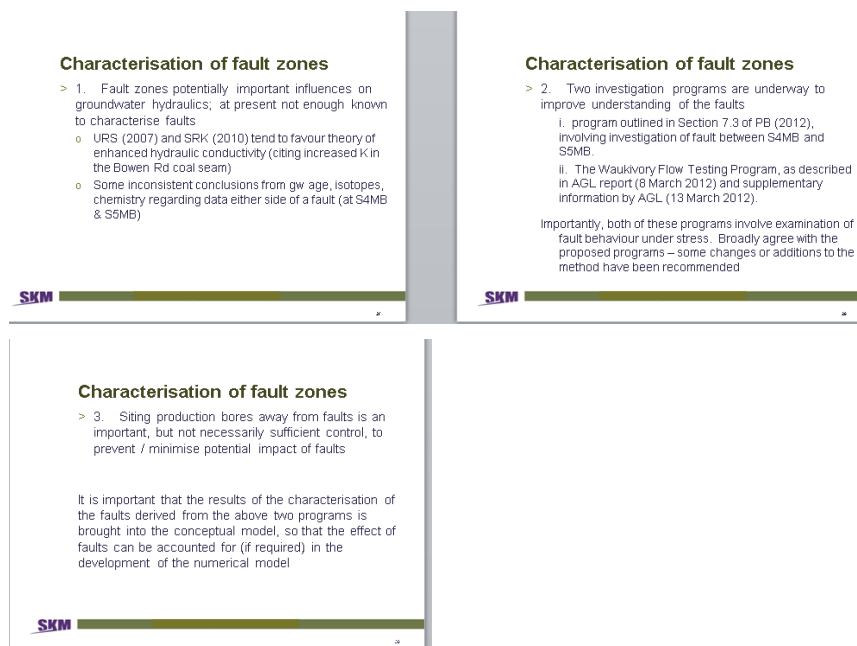
Rick: I have talked about this later on.

**CCC: Can you give us some context on the importance of salinity in this groundwater issue?**

Rick: The quality of the groundwater that comes out is pretty brackish quality and it is not that useful. In most CSG projects the impact is on farmer bores because they use the groundwater frequently but here the groundwater quality is not all that useful and less of a problem. But I have recognised that there is a data gap there.

## Fault zones

Rick: There is an inconsistency in the report which I have drawn out and we need a conceptual model that draws on all of the data not just general data. In most cases the fault zones tend to seal and reduce the conductivity – they reduce flow and constrain impacts and make them narrower. That doesn't mean to say that some faults are like this all the time. It seems to be that it is quite possible that you could get high conductivity in the fault zone and that the impacts are not what you expect them to be. It could result in impacts occurring in a different location and different speeds. The report says that there needs to be more work.



The image shows three SKM presentation slides. The top two slides are side-by-side, and the third is centered below them. Each slide has a title 'Characterisation of fault zones' and a list of points.

**Slide 1 (Top Left):**

**Characterisation of fault zones**

- > 1. Fault zones potentially important influences on groundwater hydraulics, at present not enough known to characterise faults
  - o URS (2007) and SRK (2010) tend to favour theory of enhanced hydraulic conductivity (citing increased K in the Bowen Rd coal seam)
  - o Some inconsistent conclusions from gw age, isotopes, chemistry regarding data either side of a fault (at S4MB & S5MB)

**Slide 2 (Top Right):**

**Characterisation of fault zones**

- > 2. Two investigation programs are underway to improve understanding of the faults
  - i. program outlined in Section 7.3 of PB (2012), involving investigation of fault between S4MB and S5MB
  - ii. The Waukvory Flow Testing Program, as described in AGL report (8 March 2012) and supplementary information by AGL (13 March 2012).

Importantly, both of these programs involve examination of fault behaviour under stress. Broadly agree with the proposed programs – some changes or additions to the method have been recommended

**Slide 3 (Bottom Center):**

**Characterisation of fault zones**

- > 3. Siting production bores away from faults is an important, but not necessarily sufficient control, to prevent / minimise potential impact of faults

It is important that the results of the characterisation of the faults derived from the above two programs is brought into the conceptual model, so that the effect of faults can be accounted for (if required) in the development of the numerical model

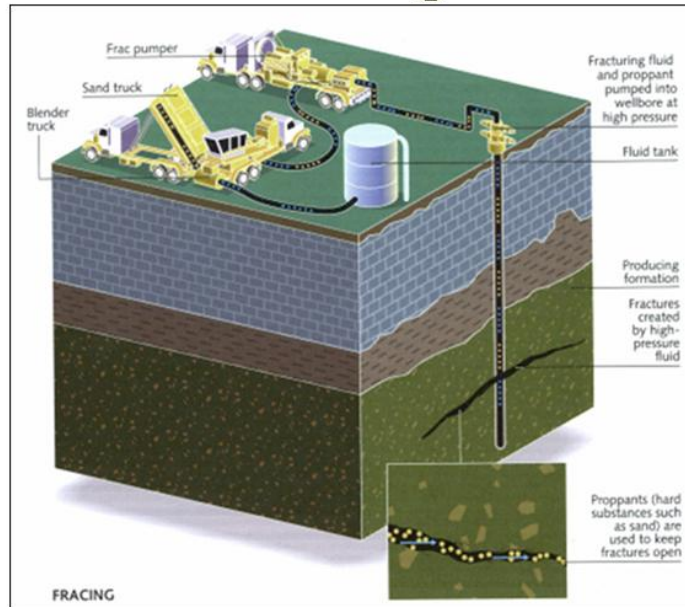
## CCC: How far could these faults run?

Rick: You could easily get a pressure transmission line at a couple of hundred metres. I've not seen any evidence of this happening here, there are lots of faults but they are not to a large scale. The jury is still out here and there is much more work required on faults.

## Hydraulic Fracturing

Rick: One thing I have noted is that if the fracturing goes wrong they can induce more vertical conductivity impacts (Kv). And clearly that is to be avoided. The other key problem is poor well construction practices. This has nothing to do with fracing, but if you have abandoned wells it can have an impact on vertical conductivity. The report is silent on this matter but I am not saying that this is an issue here.

# Hydraulic fracturing



Source: www.corridor.ca/

## Hydraulic fracturing

- > "Contextual comments" on potential risks associated with hydraulic fracturing in Gloucester Valley
  - > Two mechanisms to induce connection / cross-contamination between aquifers:
    - o Poor well construction practices (vertical pathways in and around bore casing)
    - o Vertical fracture propagation in target formation creating preferred pathways to overlying/underlying units
- Both of these mechanisms results in increased Kv, which, if extending into the 'shallow rock aquifers' / 'interburden confining units' in the upper 200m will increase leakage.

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## Under-reaming

- > Process of enlarging the diameter of the hole beneath the end of the cemented casing - to increase surface area and increase gas liberation
- > If no seal between slotted casing intervals then process of under-reaming can connect individual coal seams and intervening aquifers (if under-reaming between multiple coal seams)
- > However, in Gloucester Basin groundwater chemistry of coal seams is similar, therefore cross migration of water within coal seams therefore not significant



SKM

## Under-reaming

Rick: Under-reaming should be ignored in this instance.

## Seepage monitoring

Rick: We could do a little bit more but possibly not as much is required.

## Seepage monitoring

- > Stratford 1 and 3 dams do not have any observation bores for detecting seepage. If construction techniques or liners were the same as for the Tiedman dams, then the Tiedman monitoring is considered a sufficient indicator of dam performance
- > If different construction techniques or liners have been used in the Stratford dams, then consideration should be given to installing a monitoring bore down-gradient of one of the Stratford dams.

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## Conclusion (1)

- > In general conceptualisation broadly considered appropriate, however this review recommends further work
- > Issues with conceptualisation fall into categories of connectivity between deep/shallow systems, recharge & discharge processes, characterisation of vertical K and specific improvements to the conceptual model.
- > Most important improvements to conceptual model relate to its spatial coverage, definition of model boundaries and need for a water balance.

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## Conclusion

### Conclusion (2)

- > Apparent that not all available information has been used to develop the conceptual model, incorporation of additional data will enhance conceptualisation.
- > Review has highlighted the importance of not drawing conclusions regarding the developed hydrogeological system based on observations from natural condition.
- > Currently insufficient information to characterise hydraulic behaviour of faults. Given potential importance to gw flow, the two proposed programs are important activities to fill this knowledge gap.

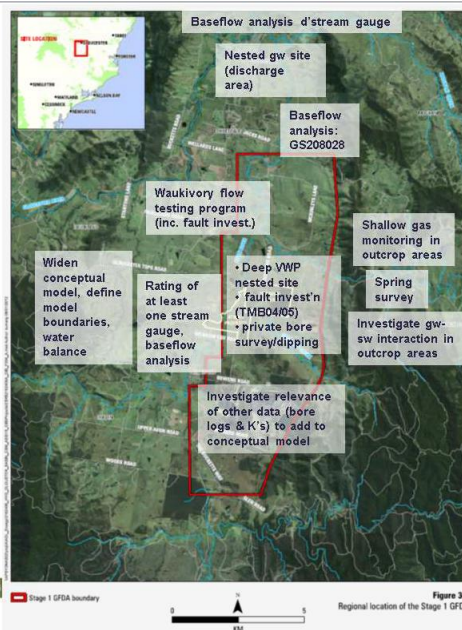
### Conclusion (3)

- > None of the criticisms presented in this review considered to be issues that cannot be readily addressed or the conceptual model revised to take account of the comments.
- > The review has not identified any issues which necessarily indicate the project represents a high or unacceptable risk from a hydrogeological impact perspective at the conceptual model stage, BUT it is the role of the numerical modelling to assess impacts.

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## Recommendations for Further Work



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SINCLAIR, KIM

Stage 1 GFDA boundary

Figure 3-1  
 Regional location of the Stage 1 GFDA

### Recommendations for Further Work – Field Work (High Priority)

- > Fault investigations
- > Stream gauge rating
- > Nested monitoring site in Gloucester area
- > Investigate gw-sw process of creeks over recharge areas
- > Deep WWP (nested) site
- > Shallow gas monitoring site in coal seam outcrop areas
- > Confirm method of abandonment of exploration bores

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### Recommendations for Further Work – Field Work (Moderate Priority)

- > Investigate sources of baseflow to Avon River
- > Water level loggers installed in TMB04 & TMB05
- > Dependent on dam construction technique etc, install bores downgradient of Stratford dams
- > Private bores be surveyed and dipped
- > Surveying of springs

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### Recommendations for Further Work – Desk Based (High Priority - 1)

- > Develop conceptual model of fault behaviour (post-field investigations)
- > Conceptual model to account for major structural changes related to faults
- > Define model boundaries. Expand boundaries of conceptual model.
- > Conduct water balance
- > Use currently available bore data to improve spatial coverage of conceptual model

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### Recommendations for Further Work – Desk Based (High Priority - 2)

- > Additional analysis of existing K data (Kv, differences in K for different methods, define representative values for 4 units, consider relevance of other K data)
- > Baseflow separation be undertaken for the Avon River downstream of Waukivory Creek gauge, and downstream gauge if one within 10-15km
- > Baseflow separation be undertaken for the gauge(s) which is rated
- > Update conceptual model once all of above complete

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**Recommendations for Further Work  
– Desk Based (Moderate Priority)**

- > Analysis of water levels with barometric effect removed
- > Consolidation of conceptual model (e.g. between the three reports)

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Rick:

- ▶ The major things are the conceptual model and the need to do a water balance.
- ▶ Not all of the valid information has been completely used in the report – to develop a holistic conceptual model all data needs to be used.
- ▶ None of these criticisms are implying a fatal flaw, but rather that one would need to use them to improve the report.
- ▶ Has divided the recommendations into field work and desk work (high – moderate priority) – as per the slides
- ▶ The importance of the springs should be done in areas where gas extraction would occur. More clarification on the impacts and the importance needs to be stated in the report.
- ▶ The fundamental point is that when this stuff is done then one would update the conceptual model before leading into the numerical model stage.

**Michael: Rick, what do you think is going to change from now and the release of the final draft?**

Rick: The only major change would be for me to try and clarify or rephrase the content of my review. I will look at any further comments and I would consider those points in the next draft.

**CCC: The questions sent already. Are they going to be answered today?**

Rick: I haven't had time to look at them so I can give you a brief answer now. (There were five questions).

▶ **Question 1**

I note the report is labelled as being by Sinclair Knight but I understood it is a report by Ric Evans only. Is there some point in doing this? Is it to give it greater standing? or what?

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**A:** If you employ me you employ SKM. The client knows that there are not any issues there. In that sense I don't think there is a conflict of interest here. In the original scope I addressed my conflicts of interest. SKM is about being very professional and that these conflicts of interests are important and we are very conscious of that.

▶ **Question 2**

I am confused by the Overview comments in Section 4. Some of the bullet points on page 8 (1st, 4th, 5th) do not appear to be supported by the findings of the review generally. I believe other members will raise this more fully but issues discussed included that the breakdown into 4 basic hydrostratigraphic units is too constrained in lateral extent and depth as acknowledged in section 5. This always has been and remains a serious flaw in all investigations undertaken by AGL to date. The inadequate assessment of faults compounds the whole issue involved here.

**A:** I think I need to think about this a little harder and will address this in my next draft. In my view there are significant gaps, but they are not necessarily fatal gaps. However, if this goes into the numerical modelling then the significance of these gaps could be more of an issue. My problem is that PB see it as a yes or no, whereas my view is that everything has an impact, it's the degree that counts.

**CCC: is it possible to have a brief overview on the faults?**

Rick: yes, that's fine. I can write a paragraph about this and present it to you at the next meeting.

▶ **Question 3**

3. The review seems to ignore or play down the existence and importance of vertical flows. The statement that natural flow is dominant (in the natural state) takes us nowhere because this is normal in any situation, only unusual formations would be otherwise. The circumstances under CSG extraction are what is relevant and this needs much more analysis.

**A:** I am concerned because I believe that I have covered this in quite a lot of detail.

▶ **Question 4**

We remain concerned that groundwater ecosystems have not been properly addressed and see this as a serious deficiency and consider that the Phase 2 investigations fall a long way short of being a Comprehensive Groundwater Study as claimed.

**A:** I would have thought that in my report I addressed this very overtly and very clearly. When I read this I was surprised by this comment as I have written a lot on groundwater ecosystems and made it quite clear

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what I think of the of the processes and there are a whole lot of recommendations about it, so that it is addressed in a more serious way.

Michael: The person who originally asked this question is not present. (Directed to Ray who wasn't aware of the rationale behind the question.)

**CCC: there needs to be something in the PB report about groundwater dependent ecosystems.**

Rick: I have made recommendations about this aspect. I want to know what exactly, from a hydrogeological point of view, what your concerns are and what the issues are. From my point of view the only issue I can see are basewater flows and springs (surface water issues).

***CCC to state what their major concerns are from a hydrogeological point of view***

▶ **Question 5**

We are concerned that there has been no analyses of the computed impacts of the proposed CSG extraction and that terms such as high and unacceptable risk have not been defined or quantified in any way.

**A:** at the moment all we are doing is a conceptual model and trying to develop a better numerical model.

**CCC addressed that there was an inconsistency on Page 22 of the report.**

Rick: There is a typo there. I will need to find the details and respond to them. Thank you for that.

**Rick: will there be public meetings?**

Naomi: we haven't discussed this in detail yet but it would be very beneficial. It's on the agenda, yes, but the details are yet to be determined.

Rick: I would just ask you to consider what you would like out of this potential meeting. So that there is a clear message going out we need to discuss what we would like to achieve.

Michael: one of the goals should be a greater understanding.

***CCC discussed the potential topics that could be discussed – people are more in tune with the social than with the technical, however that there needs to be reinforcement of the purpose of the review.***

**CCC: Can you give us a feel for what is the length of the process will be for taking on your recommendations and then changing the conceptual model?**

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Rick: this would be up to AGL.

Naomi: I'm concerned if a timeframe is stated then this would be some expectation.

**CCC: it's just to get a feel.**

Rick: To give you an idea this is years away. Numerical modelling will take at least a couple of months. I don't believe that this is going to be nailed for quite a while because the speed of each of the required tasks is different.

**CCC: We haven't heard from AGL that they would do a numerical model?**

Toni: It goes without saying, it is written within the requirements, it is in our conditions of approval and would most certainly be done. It absolutely has to happen.

**CCC: Is it worth having something else in the newspaper from the CCC meeting, like last time? We received positive feedback on this.**

Michael: All I could say is that we held the meeting.

**CCC: I think it is beneficial. You need to be transparent with the community.**

Michael: that sounds very good then.

**CCC: Could you please explain the variation that AGL submitted for the project.**

Toni: There was a media report about the EPBC referral in the Newcastle Herald that was taken out of context. The variation submitted was simply to update the project description to accurately reflect the project as is being assessed. It is just a correction that we are seeking for the project description which has a hangover from the original Lucas Energy description. There have been no variations or changes to the project.

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**Next meeting**

Thursday 26<sup>th</sup> April, 10am.

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**Michael Ulph**

**GHD – Stakeholder Engagement**