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In the shoes of a community group:

not a happy outcome for the mine proponent

Proposals for brownfield mine developments typically include a re-investigation of the lease and its multi-faceted relationship to the environment. Imagine the consternation when the proposals are released for public review and they are then widely criticised on technical grounds. The technical aspects say of geological structure, surface geology, groundwater disposition, or unrepresented old workings, might be thought to be beyond question – settled. Accordingly they receive scant new attention or inappropriate upscaling or conceptualisation. Geological formation testing may be done perfunctorily ("got to satisfy the reporting criteria"), or improperly ("got to show some samples and numbers") and is often accompanied by broken or low level analysis or synthesis ("A here, A there, therefore continuous between").

The proponent can be better advised by including an arm's length peer review of all major aspects preferably from the early investigative stages. But especially this review should be undertaken during preparation of the final report and should check for: misuse of technical terms. For example, names of geological units; lack of rigour; poor sampling recording or reporting technique; data holes; unexplained aspects (are they being hidden?) and general deficiencies. "Yes", it costs more. But, undertaking this process – from a community perspective looking in – should enhance the quality of the work, reduce grounds for criticism and support the proponent's contention that they thoroughly understand the site.

As far as possible, one of the early duties of the local manager and the overarching consultant engaged to steer a proposed development through the approval stage, is to identify critical aspects in the development assessment process. These would include those that are:

- the most controversial,
- the most technically difficult,
- the most vulnerable (in terms of harm to the project),
- the most easily criticised, and,
- the most personal (to the community).

It's likely that these will cross-over all aspects of the proposed development from excess traffic and noise to the protection of plant species or aquifers or surface water flows. The matters related to the environment are generally the most technically difficult, probably also contain the greatest areas of risk or vulnerability to the project's success, and are the most easily criticised – everyone has a viewpoint.

The proponents can enhance their proposal's pathway to approval success, with a significant reduction in community or regulator antagonism, by either having their inputs reviewed or making sure they re-evaluate their work – from the outside looking in. Aspects of some recent cases involving the author are presented to demonstrate this approach.

In Case H, the collection, location and movement of groundwater at the soil-rock interface (clays and gravelly clays over shale) was important. In some parts of the site the groundwater was clearly present and probably driven by seasonal rainfall events and directed by the topography; at other places this ephemeral water was absent. The natural processes initiated the development of shallow groundwater systems with diffuse seepage. The presentation of these facts about how the site worked was insufficient to stop a nearby neighbour complaining that: "Within two hours after watering her vegetable garden she observed seepage in the face of her driveway cutting 10m further downhill". So much for deep infiltration and groundwater movement of the order of 10 centimetres per year!

The regulator assessors forgot that the development situation had been referring to percolation at depth (about 1 – 1.2 m), the lady was directing a concentrated water flow to a small, disturbed plot – on the surface, the nearby cutting provided an obvious sink and location for groundwater emergence, and accordingly the length and style of flowpath was completely different to that to be encountered in the development. All that emerged before the soil/rock disposition at the neighbour's was even investigated for its similarity to that in the development area. The proposal review should have stressed that the soil-rock and groundwater situation was considerably variable over the geological unit, and that negative aspects had been exacerbated by historic land development.

In technical aspects, everyone can have an opinion and a large number of experts from a great range of disciplines, or knowledgeable locals, can be brought into play. Before considering what the opposing experts have to say, don't forget that there will be some who are automatically hostile to the development in the first instance. Their underlying objections may be philosophical (no more mines!), emotional (save the wombats!), or personal (my groundwater supplies will be affected). These experts will typically be closely associated with community opposition groups; their presentations will be highly focussed, may be highly illustrated, full of anecdotes, and often draw the long-bow by citing references or half-baked studies or opinions to support their position. They often lose perspective but they cannot be taken for granted.

The ideas and data raised by these objectors must receive close, immediate and definite attention; they should be considered piece by piece and a considered response to each matter developed. If the opponents are immediate neighbours of the proposed development, their properties must be inspected and diligent understandings made of their geoscientific and environmental relationship to the development.

In Case S, the proponent had engaged a large consultancy to perform its community liaison – to gather the facts of contention, listen to the concerns, and more. When you read their report – or at least the publicly available parts, one would think that everyone had been consulted, their properties had been inspected as necessary, and consideration given to their concerns (and more latterly by others – a position developed). But it wasn't so. A visit by an independent reviewer for the community found that two key properties adjoining the development hadn't been inspected (permission had been refused). True, the proponent's representative had convened a public meeting and everyone had been invited to 'have a say', and a couple of properties were visited then and others were audited by the senior consultant. The report to the regulators and community was actually false. The proponent's reviewer should have identified the inadequacies here.

This matter was raised publicly by the community. The proponent immediately inspected the two missed farms; groundwater seepage features (and several bores) that had been missed were noted. How embarrassing! What a poor reflection on the proponent and its advisers

who claimed that all had been done to consult with the community. A senior staff member for the proponent had commented that since the dip of the strata was away from the neighbour, that that landholder wouldn't be affected by groundwater losses, or contributory flows into his property.

What an unfortunate comment! Whilst groundwater flow frequently mimics the topography, and this is an initial analytical position for understanding fractured rock flow or alluvial aquifers, it frequently isn't so. Stratigraphic disposition frequently controls flow since it aligns itself with the lithology, except that there can be marked heterogeneity with facies changes. But, geological structure and the gross heterogeneity of strata composition can be more important; and can be further enhanced when topography, perhaps a deep river gorge, or a stream meandering around the development's perimeter, is imposed. There doesn't always have to be a sub-regional watertable. Some strata behave as confined aquifers almost immediately below the soil or the weathered zone: and geological structure (other than dip) is often the key driver in providing new groundwater pathways, interconnection between aquifers, or leakage from aquifers to aquitards.

Clearly one must mostly assess the big picture; what on average does the groundwater flow pattern look like; are there specific, local variations, or are there other discrete (like flow along a fault), or regular (like joint-aligned seepage paths), patterns that are present. But it's unwise to assume that groundwater flow behaves regularly until the evidence is there to show it. Why can't a farmer two kilometres up the stratigraphic dip of the proposed minesite, and even if topographically lower, be affected? Did you bother to put a couple of strategic piezometers in to measure any longer term affects and also to develop the potentiometric surface understandings for the whole development?

In Case S, the proponent's own groundwater modelling showed that on the farm in question, between two and three kilometres from the proposed pit top, the groundwater surface in a layer of rock which eventually underlies the development will be drawn down! Okay, the amount of drawdown will be small, it will be some time before it occurs and its assessment is subject to all the difficulties and shortcomings of the groundwater modelling: but this is hardly a robust, forgiving position for the proponent. Their own adviser's work defeats the utterances of a senior staff member. Technically, publicly, and most likely in future fact – they're wrong. A consequence of this small drawdown effect will be that gully seeps, vital to supporting the farmer's stock in times of water shortage, will dry-up. This lack of understanding by the proponent, on several levels, is a clear case of alienating the community and plays into the hands of any critic who says the work lacks rigour or understanding; it certainly shows a lack of empathy with the mine's immediate neighbour.

Could another approach have been better? In the first instance, making sure that everyone was spoken to would have helped – it's not a flippant, window-dressing exercise. Mapping the farm's groundwater seeps and shallow groundwater systems would demonstrate active and comprehensive investigations of both the issues generally, and the immediate surrounds. Establishing a couple of extra piezometers in considered locations, even in strata initially thought to be unaffected, would show comprehensive study; but this would also help in the experts' studies overall. The groundwater modelling can't fully proceed without field-based data and understandings, and the more of these the better – good numerical groundwater models are data-hungry beasts! Yes, it costs more – drilling and establishment costs, future monitoring costs; but it's a cost worth bearing to show comprehensive evaluation and commitment. These activities reflect the notion of standing back and looking in to the proposal.

For Case S, if the above ideas had been followed, several favourable outcomes would have occurred. The community negativity would have diminished. The proponent would have attained a technically better job in terms of the groundwater modelling and general development evaluation: a source of criticism would have 'gone away' and a plan to deal with the matter could have been formulated. In this case, as for other landholders around the proposed mine, there are consequences. The proponent addressed some of these; a reviewer should have made sure that this was one was addressed. The effects noted here are both to the environment and a person's livelihood. In a case where the proponent does not own the land each of these effects has a heightened significance - controversial, vulnerable and personal aspects related to the development.

This same proposal is likely to affect the groundwater and stream flows of other neighbours. Thus automatically the degree of community concern or hostility has been multiplied. Accordingly, the proponent needs to be extra diligent and rigorous in the investigation and wider examination of the issues. Having identified the difficulties and effects, the proponent provided solutions, for example, the provision of capturing groundwater likely to flow into the pit and diverting it as a surface water supplement to a nearby stream and/or farm; or abstraction of other groundwater from the lease and providing it to an affected landholder or the environment. Both are viable options and can be made to work satisfactorily.

The prime difficulties that arose in relation to these proposals were technical. The offset water supply for the environment was short-lived (basically pit diversions were only required during the mining). The post-mining effects can be greater than the during-mining effects. The outcome could be to leave the community 'high and dry'. Further, the groundwater likely to accumulate in the infilled pit will probably vary detrimentally in chemistry from that before mining (not necessarily an unusual situation), but might not that water also be partially abstracted for resupply?

It is not sufficient to say that these matters will be progressively addressed during the mine development. The community, if it's to be at all accepting of the development, needs to see, feel, and be convinced that there is a sound compensatory plan where needed. If the volumes are short - there's an issue (check the calculations in the first instance); if longevity of supply is not guaranteed – there's an issue; and if the chemistry is changing – how will that be dealt with (technical discussion). These matters can be difficult to solve, are certainly costly for the proponent – particularly post-mining. A reviewer should have picked-up on these aspects and drawn the proponent's attention to their insufficient preparation, making sure they were vigorously addressed to the extent possible at the outset. They weren't. Consequently various consultants could criticise these aspects and present alternative calculations and analyses, thus exposing the proponent's lack of rigour and consideration.

In Case S, there were also failures to understand the site geology particularly the geological structure. This aspect wasn't even meaningfully addressed and it severely influenced groundwater flow. The variances of the stratigraphy weren't properly mapped or addressed either, nor were the extents of old-workings and their relationship to the new site. These are all points of potential criticism and they were criticised. They would have been easily addressed by the proponent's reviewer demanding a complete, large-scale geological map of the site and its immediate surroundings and requiring attention to mapping and analysing the structure as well as rigour in presentation and analysis. This might cost a little more, but relatively less than enduring technical criticism after releasing the report.

It's very common for initial geological mapping to not be updated. In the case of brownfield sites, it's easy to assume that the geology is known – settled. It's not so! The surface geology can and frequently does vary within a few hundred metres – likely because of some structural feature overlooked or unmapped or unknown. In Case G, a company discovered a whole new coal seam in an on-lease location where it wasn't thought to be and a new pit will evolve. Extensive exploration programs will typically lead to enhanced 3D model improvements, assessment of new pits and resources. But, where are the maps and evaluative cross-sections which would be used by a groundwater modeller to understand the site and develop their model? Where's the translation and checking of the subsurface back to the surface? [In the matter noted here, this failure led to considerable geometric difficulties in establishing the groundwater model surface. Up-to-date geological maps, groundwater seepage mapping, and structural analysis could have been fed 'straight-in' to the modelling process with a reduced cost; but more importantly with a resultant greater precision than that of the consultants who eventually had to do it.]

In Case S there was an important matter regarding flows in the boundary river system – an absolutely crucial aspect of the proponent's development. The major concern was that mining would lead to a loss of river flow. Rivers, in fact the whole stream pattern, commonly develop/s in response to geological structure or along a stratigraphic contact. It therefore behoves the geoscientists reporting on the site to consider structure at least initially in trying to characterise and understand a site. If the matter of river flows (typically a very strong matter of community concern) is vital to the proposal, then it would surely follow that extra effort would be made to fully evaluate it. For instance, gauge the streams above and below the development; look harder at how the river/stream relates to the development, and not just what's in the stream but what are it's bed characteristics; what's the coupling of river to bedrock (conductance for groundwater modelling); and investigate whether the alluvial deposits are as extensive as they look, and what's their nature? Failure to review all these modest, and fundamental things opens the door to criticism. It might be that opponents will discuss your findings, but they can't say that you didn't investigate or consider the obvious relationships. It's a matter of doing more, thinking beyond the usual and being sure in the case of a brownfield site that all these aspects really have been documented.

Around the mine in Case G some structural aspect clearly caused the development of sharp bends in the river. An examination of exploration data couldn't indicate the underlying cause; detailed surface mapping and structural analysis needed to be done. Other than protecting the future development from a potential difficulty, undertaking such work shows a comprehensive approach to understanding the site; it removes an area of potential conflict from a hydrologist or geomorphologist who might have easily deduced an altered flow pattern or river structure. The investigation of obvious topographic anomalies, and then considering and commenting on them in development reports, will show outsiders that the proponent is the steward of its lands; it understands the site and has taken time to consider it. Once again a small extra cost, an activity typically outside the usual approach, one that's probably overlooked because "the river's already been looked at". Take time to understand the whole site/lease and how nature's parts work together; avoid areas of potential critical evaluation by investigating the 'bleeding obvious'.

Yes, implementing these ideas will cost a little more. No, it doesn't all have to be done at once. Yes, it's more than the regulator asked for. No, it's never enough for the community. Yes, it could easily aid your bottom line because you understand the site, have considered potential issues and difficulties and at least made a preliminary assessment; and it reduces your negative cost in the face of the community, and exposes you to reduced technical criticism. On balance, it's likely that you have more to gain through being more thorough, mounting rigorous investigation and research techniques and taking time to understand your development's neighbours or environmental context, than doing less, or resting on the laurels of a previously understood or operational site.

The other approach that should be considered is more proactive. The proponent is advised to engage an arm's length, independent reviewer. The reviewer should be seen as both a member of the project team – at the level of the overarching consultant, but also the project team assessor. For this reason they would ideally be independent of the main contractors involved in the project investigation and assessment. In some instances there may be limited scope for their additional involvement, for example in data analysis or site supervision, if necessary because of personnel shortages or the consultant's relevant site experience.

The reviewer needs to be engaged at an early stage and their role clearly defined. Their primary role is to ensure that investigations for the project and supportive studies do not leave gaps in the data obtained and analysed. Further that those data and analyses are robust, that the methodologies used are properly explained and that shortcomings in them, or shortfalls in data collection, are reported. The final reporting and proponent's effort is not to flee from data absence or difficulties, but to identify the gap, consider it and either plug it or otherwise deal with it. The reviewer therefore needs to be commissioned with authority to recommend changes (probably extensions) to the degree of investigations for example the case of extra piezometers in possibly unaffected strata, or extra river gauging.

The reviewer isn't expected to be an overall expert in each sub-discipline, rather they work with and across the roles and interests of the proponent, the overarching consultant, and the sub-consultants without obstruction to bring a completeness to the work. Especially they should work from the perspective of the community looking in. Their work will reduce areas of technical criticism and community angst.

Good practice in numerical groundwater modelling requires that the model and its methodology be peer reviewed. This practice for such a key component that is ideally used for predictive analysis should continue. In some instances the modeller provides inputs to the project team/consortia to make sure that the necessary data steps or considerations are acquired/given. This is useful and is certainly embodied in the reviewer's role, but may also be seen as an adjunct.

The ideal course for the reviewer's role can't always be met. Often times project planning and investigations are very well advanced, drill rigs have long since gone and extra piezometers can't be emplaced; the groundwater modelling is just about finished – what then? Certainly, don't fail to engage the reviewer for the final report. In this instance the primary purpose is to look for gaps – data, methodologies, things undone. If there's a matter of community consultation, this can be addressed.

If diagrams are missing, incomplete lacking in information or just genuinely inadequate there's time to do or redo them. It's amazing how many diagrams are presented without north points or reference grids or scales or scale bars, even titles and/or are not referenced in the text. Simple, basic matters that make navigating the text easy, make the obvious links needed, and show that the consultant/reporter cares about the proponent and the quality of effort made. Geological maps taken from the state's records, or official aerial images, don't belong to the proponent – you need to acknowledge the source; but more importantly check that they are the latest version, or is their date identified if they are purporting to illustrate some particular feature. Is there a record of geological units; have any of these been updated or even eliminated since the brownfield was first green? Do the comments and use of descriptive geological or geographical terms and stratigraphic names by consultant A, perhaps the hydrologist, match those by consultant B, perhaps the groundwater modeller? Are deficiencies in the groundwater modelling properly identified and discussed? Check it.

In the penultimate task, the proponent and/or its reviewer need/s to step back and think as a community member. They should look from the outside in and consider where they would attack this proposal: the proponent can be better prepared to deal with likely criticisms.

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