27 July 2012

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Dear John,

RE – Consistency Review – Aluminium Monitoring and Discharge Management

It is understood that the Bulk Water Alliance (BWA) has received advice from ALS Global on the likely aluminium leaching into water passed through the cement-lined pipeline, and the likely issues this may have on the receiving waters in Burra Creek and the Googong Reservoir.

It is further understood that BWA is seeking advice from the Environmental Representative on the consistency of the recommendations of the ALS Global report in relation to the Approved Project, and the need, if any, for documentation changes related to water discharge and quality monitoring.

REVIEW OF DOCUMENTATION

Consistency Review for Changes to the Mini Hydro

As background to the current Consistency Review (CR), the CR for proposed changes to the mini hydro, which included a CO2 dosing structure, was reviewed. That CR made reference to advice received by ALS at the time relating to likely impacts on aluminium leaching from the passing of water (and in particular the holding of water for extended periods of time) through the pipeline. The following recommendations were made in that report:

- Monitoring for soluble aluminium be included in the Stream Flow and Water Quality Monitoring Sub Plan (SF&WQMP) to ensure levels of aluminium in water discharged from the project do not exceed acceptable levels for Burra Creek.
- The revised SF&WQMP be submitted to the NSW Office of Environment and Heritage (OEH) and NSW Department of Infrastructure and Planning (DPI).
- Details of the proposed CO_2 dosing system, including advice received from Dr Mueller in regards to the likely impacts of CO_2 dosing on water quality, be made publically available.

Actions by Bulk Water Alliance to address the recommendations of the Mini Hydro Consistency Review

To progress the first recommendation above, the Bulk Water Alliance commissioned further analysis to identify suitable monitoring requirements for soluble aluminium to be included in the Stream Flow and Water Quality Monitoring Sub Plan during the Commissioning phase and the first 12 months of operation. The second recommendation is superseded by this Consistency Review and the recommendations below.

The third recommendation has been addressed.

Letter of Advice (31/5/12) from ALS Global

A letter of advice to BWA was prepared by ALS Global which discusses dissolved aluminium levels and makes a number of recommendations. In relation to the current consistency review, I note the following

- The ANZECC guidelines for dissolved aluminium are noted to be 0.055mg/L (for 95% level of protection) or 0.15mg/L (for 80% level of protection) if pH levels are above 6.5. It is noted that the guidelines recognise some deficiencies in the data and approach.
- The letter makes note that toxicity data for aluminium on aquatic species is limited, and makes reference to a study from the US EPA on toxicity to fish species. It is noted that the LC50 range for dissolved aluminium levels was found to be great, from 3.6mg/L to ~80mg/L very little is known on toxicity levels for aquatic species. A number of other trigger levels are referenced for irrigation and stock/domestic use.
- Based on water quality monitoring conducted in 2012, the existing dissolved aluminium levels in Burra Creek have been found to be as high as 1.17mg/L at a pH between 6.3 and 8.4, which is greater than the ANZECC guidelines. Hence it is assumed the natural level of dissolved aluminium is higher than the ANZECC guidelines.
- Whilst samples of the cement lining have been taken to test for aluminium leaching in the laboratory, there is no information currently available on likely leachate. ALS Global is current testing for this.

The letter makes a number of recommendations, specifically for:

- Management of the release of water currently in the pipeline, to minimise dissolved aluminium discharge concentrations into Burra Creek.
- Additional laboratory analysis for aluminium leaching.
- Discharge management during the commissioning phase of the project.
- Preliminary discharge management measures during the operational phase of the project, at least until further data is available from the testing currently being conducted.
- Additional monitoring parameters for sampling at the discharge point and downstream in Burra Creek.

Letter of Advice (16/7/12) from GHD

A further letter of advice was received from GHD (GHD acquired ALS Global since initial advice of 31/5/12) to clarify and update the advice provided on 31/5/12. This advice included the laboratory results from the leachate -monitoring of cement lining samples taken from the pipeline, as well as further clarifying appropriate flow rates for discharging of water with elevated aluminium levels. The advice included a table (Table 2) which details flow regimes and water treatment to be adopted for specific aluminium readings in discharge waters for both the commissioning and operational phases of the M2G project.

1.2 CONSISTENCY WITH THE MINISTER'S APPROVAL

The below consistency review has been conducted to determine whether:

1. Any aspect of the Approved Project is in conflict with the discharging of dissolved aluminium and in particular:

a. Whether commissioning, although not strictly part of the operational phase of the project, is carried out in accordance with the Stream Flow & Water Quality Monitoring Plan (SF&WQMP), and
b. Whether the discharging of dissolved aluminium is consistent with the adaptive management approach outlined under the SF&WQMP for the commissioning phase and first 12 months of operation of the Approved Project

2. Whether the implementation of the recommendations made by ALS Global and GHD are consistent with the Approved Project

Assessment of Environmental Documents in relation to consistency

A review of the environmental documents which form part of the Approved Project was conducted for the Mini Hydro CR. That review did not find any inconsistencies with aluminium release from the project. A subsequent review of the environmental documents has further found that there is no conflict between the documents and the recommendations made by ALS Global. In particular, a review of the SF&WQMP sections 5.2 and 7.3 which outline the adaptive management approach for the project, has identified that discharge of aluminium during commissioning and the first 12 months of operations in accordance with the recommendations made by ALS Global and GHD, and subject to addressing the recommendations below, is considered to be consistent with the Approved Project.

Assessment of Conditions of Approval in relation to consistency

No Conditions of Approval specifically refer to, or relate to, dissolved aluminium levels in the discharge water. Several Conditions of Approval require the preparation of monitoring and management plans for the operational phase of the project. In particular, the SF&WQMP (refer Condition of Approval 3.2) specifically relates to "monitor and manage the impact of the project on the waterways into which any extracted Murrumbidgee River water is discharged" and is therefore considered to be the appropriate condition under which commissioning and operation of the project are carried out. None of these conditions are affected by the implementation of the recommendations. No other Conditions of Approval could not be met through the implementation of the recommendations.

Assessment of Statement of Commitments in relation to consistency

None of the Statements of Commitment specifically relate to dissolved aluminium levels in the discharge water. No Statements of Commitment could not be met through the implementation of the recommendations.

CONSISTENCY REVIEW

A review of consistency issues is presented in Table 1.

Table 1 Consistency review

Consistency Question	Discussion	Response
Would the introduction of the proposed change, either by itself or in association with any other proposed change, result in any Condition of Approval (other than Condition of Approval 1) not being met?	The activities proposed by the recommendations would not result in any of the CoA's not being met.	No
Do the proposed changes, considered together, result in a radical change to the approved project as a whole?	The overall Approved Project is not affected by the proposed implementation of the recommendations. The requirement to monitoring and treat for aluminium in the discharge waters are considered a routine commissioning and operational aspect of the pipeline, and in no way radically changes the Approved Project.	No
Do the proposed changes, considered together, result in a substantive change to the objectives and functions of the approved project as a whole?	The objective of the Approved Project is to provide water security to the ACT. The function of the Approved Project is to construct and operate a water pipeline from the Murrumbidgee River to Burra Creek. The proposed implementation of the recommendations below are required to meet this objective, and would not alter these objectives or functions.	No

Consistency Question	Discussion	Response
Does any single proposed change considered separately (or, as relevant, in association with any other proposed change) result in a substantive change to the objectives and functions of that element of the approved project which is to be modified and in so doing, does not help to better satisfy any other Conditions of Approval?	The proposed implementation of the recommendations below would not alter the project objectives or function. Conversely, they are required to meet the project's objectives.	No
Does any single proposed change result in any change in impact of such nature or scale (including impact on different people to those who were affected by the approved project) that it would be unreasonable not to make public?	With the proposed implementation of the recommendations below, the quality of the water discharged is consistent with that predicted by the EA. The aluminium monitoring and treatment recommendations are expected to only apply during the early stages of project operation (and commissioning), and would not change, in the long term, the nature or scale of the project. No specific public consultation/notification is considered necessary. Notwithstanding that, the proposed recommendations would require changes be made to the Stream Flow & Water Quality Monitoring Sub Plan. This plan, once updated, would be available to the public. It is, therefore, recommended that some level of public notification, through the ERG, be undertaken before the plans are updated (see below).	No

CONCLUSION AND RECOMMENDATIONS

Based on the review above, I advise that in my opinion, the proposed implementation of the recommendations are required to allow the project to commission and operate and therefore meet the objectives and function of the Approved Project.

The following recommendations are made:

- That monitoring for dissolved aluminium be undertake to ensure the levels for discharge during the commissioning phase and during the first 12 months of operation of the Approved Project be in accordance with the ALS and GHD advice of 31/5/12 and 16/7/12 respectively.
- The Stream Flow & Water Quality Monitoring Sub Plan (SF&WQMP) should be updated to include the information contained within Table 2 of the advice received from GHD on 16/7/2012 and then submitted to the NSW Office of Environment and Heritage (OEH) and NSW Department of Infrastructure and Planning (DPI) within 12 months of operations commencing (refer Condition of Approval 3.2(g)), and once approved, placed on the project's website.
- The ERG should be advised of the proposed implementation of recommendations by GHD, and the proposed changes to the SF&WQMP.

Yours sincerely,

Erwin Budde
Independent Environmental Representative

nghenvironmental

APPENDIX A LETTERS OF ADVICE FROM ALS AND GHD

31ST May 2012 OUR REF: 5065-M2G-2012-002

Bulk Water Alliance
M2G site office, Angle Crossing Rd
Williamsdale NSW 2620

Attention: John Turville
M2G Land and Compliance Manager
John.Turville@bwa.actew.com.au
Ph: 02-62752369

Dear John,

Re: ALUMINIUM IN M2G PIPELINE DISCHARGE

1 Introduction

ALS has been requested to provide information and advice on the potential impact of aluminium in the water release from the M2G pipeline into Burra Creek. There is potential for the discharge to exceed the ANZECC (2000) recommended guideline levels for aluminium in aquatic ecosystems as indicated in Table 3.4.1of 0.055mg/L for 95% level of protection, or 0.15mg/L for 80% level of protection at pH levels above 6.5. As indicated in the guideline, the trigger levels in the table are based on a statistical distribution approach and it recognises deficiencies in the data and approach (ANZECC, 2000, p3.4-2). Several references acknowledge that free aluminium ions (Al^{3+}) are toxic to a range of aquatic organisms.

The level of pH in the discharge can be reduced by carbon dioxide dosing near the outlet and has been incorporated into the pipeline design. There is currently no mechanism for reducing the aluminium loading in the discharge effluent. Materials that will react with aluminium are natural turbidity and dissolved organic carbon present in the stream water, or added material such as clay.

This report provides an overview of the potential impacts and includes information from a literature search on the environmental effects of aluminium. Recommendations are made as to the discharge of water containing levels of aluminium above the ANZECC (2000) guideline level.

2 Environmental impact of Aluminium in water

Some background information for aluminium in the environment is as follows:

- aluminium is the most common metal in the earth's outer crust constituting approximately 8% by weight (Driscoll, et al., 1990);
- it occurs primarily as inert aluminosilicate minerals (Wauer et al., 2004);
- aluminium in streamflow rapidly hydrolyses (the aluminium combines with hydroxide ions in water) into various forms depending on the pH (Sparks, 2003);
- the speciation that occurs in water is principally dependent on pH but is also dependent on other available ions in solution (eg. sulphate, phosphate), dissolved organic carbon and suspended particulates (NEHF, 1998);
- the processes of natural aluminium mobilization are extremely complex and have been the basis for much research (Sposito,1996).
- other metals (Fe, Cd, Cu, Pb, and Zn) may also need to be considered when assessing toxicity from sediments to biota in streams (Besser, 2007)

From Sparks, 2003 the various species of aluminium can be seen in Figure 1:

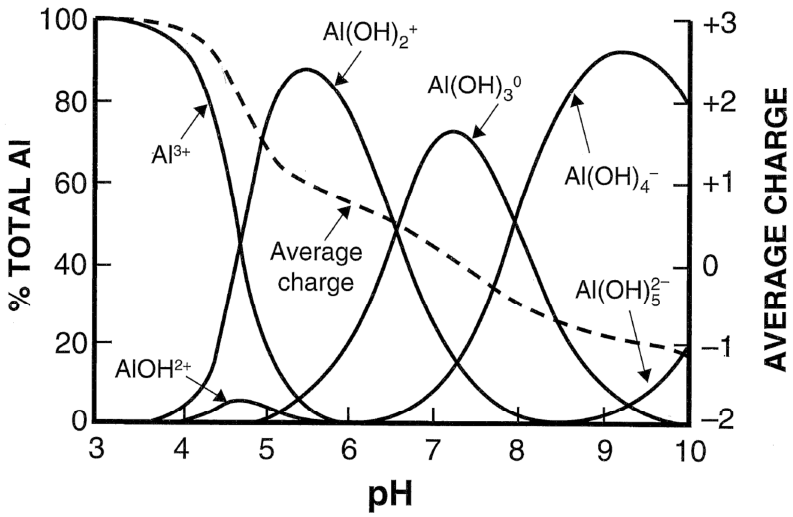

Figure 1: Soluble aluminium species versus pH.

Of note from the plot is that:

- when pH is below 4.7 Al^{3+} predominates and is soluble;
- when pH is between 4.7 and 6.6 $Al(OH)_2$ and $Al(OH)_2^+$ are dominant;
- in the pH range from 6.5 to 8.5 the aluminium is dominated by $Al(OH)_3$ which readily precipitates as a flocculant, meaning the aluminium settles out of solution on its own;
- above pH 8 the aluminate $Al(OH)_4$ anion dominates and aluminium is again soluble.

Within the environment the most toxic form of soluble aluminium which can be taken up by plants and fish is $Al^{3+,}$ which only dominates with pH below 5. In general, few problems are observed if pH remains above 5 (Pierzynski et al., 2005).

The ANZECC (2000) aluminium trigger level for short-term (<20 years) water use in agricultural irrigation is 20mg/L (Table 4.2.10, p 4.2-11), and for livestock drinking water it is 5mg/L (Table 4.3.2, p 4.3-5).

The bioavailability of aluminium is strongly dependent on its availability to be absorbed, which is determined by its solubility (NEHF, 1998). Therefore the primary aim in reducing any potential impact from aluminium is to reduce the dissolved component by allowing it to combine with natural organic matter (principally tested by measuring True Colour as an indicator of dissolved organic matter) and suspended material (turbidity) and precipitating out.

From a human health perspective aluminium has long been considered a candidate as a neurotoxin and contributing to the cause of Alzheimer's disease. It appears to be one of the main reasons for the World Health Organization and water supply authorities specifying low levels of aluminium in drinking water.

The availability of toxicity data for aluminium on aquatic species appears limited. The United States Environmental Protection Agency has produced a document on "Ambient Water Quality Criteria for Aluminium - 1988". It undertook toxicity tests on various aquatic plants and animals using aluminium chloride or aluminium sulphate. A summary of some of the toxicity limits are given in Table 1. It generally indicates that when pH becomes alkaline the toxicity is minimised.

Table 1: Toxicity of aquatic animals (USEPA, 1998)
Note: LC50 is the concentration at which a 50% probability exists that the species shall die after a predefined period of exposure, varied from 48-96 hrs. for fish.

Species	pH	LC50 aluminium level (mg/L)
Cladoceran (<24hr)	7.68	3.69
Stonefly (nymph) *Acroneuria sp.*	7.46	22.6
Midge (larvae) *Tanytarsus dissimilis*	7.71	79.9
Rainbow Trout (juvenile) *Salmo gairdnari*	7.31	14.6
Rainbow Trout (juvenile) *Salmo gairdneri*	8.17	>24.7
Yellow Perch (juvenile) *Parco flavescens*	7.55	>49.8
Brook Trout *Salvelinus fontinalis*	6.5	3.6
Green algae *Chlorella vulgaris*	7.5- 7.8	1.5-2.0 (incipient inhabition)

3 Results

Water samples have been collected at various times within Burra Creek, from the water source used to pressure test the pipeline (McDonald's dam), and from the pipeline scour valve.

The results are given in Table 2 and provide the following observations:

- Surface water in Burra Creek has dissolved aluminium from the native area location (BUR 1 Tinderry Nature Reserve) which precipitates out during low flows by the time it reaches the M2G discharge point. This appears to be due to the high alkalinity and pH which is consistent with bicarbonate interaction. During high flows the dissolved and total aluminium in Burra Creek naturally increases to high levels (refer 4 March 2012 results).
- The high dissolved aluminium from the scour valve occurred from an extended period of detention time in the pipe. The high dissolved aluminium level of 3mg/L was 90% of the total aluminium measured (3.3mg/L), and with a pH of 9.6 indicates it was predominately the soluble aluminate species $Al(OH)_4^-$. This aluminium level is below the limit for livestock or irrigation use but above the guideline for aquatic ecosystems. A reduction of pH to below 8.5 and with the high alkalinity and some turbidity would change the speciation to $Al(OH)_3^0$ which would readily precipitate out.

A comparison of alkalinity versus dissolved aluminium from the Burra Creek results is shown in Figure 2 and indicates that dissolved aluminium precipitates out quickly as alkalinity increases. The pH ranged from 6.3 to 8.4. In the rain event of 4 March 2012 dissolved aluminium in Burra Creek (BUR 1) was 1.5mg/L but total aluminium was 10mg/L.

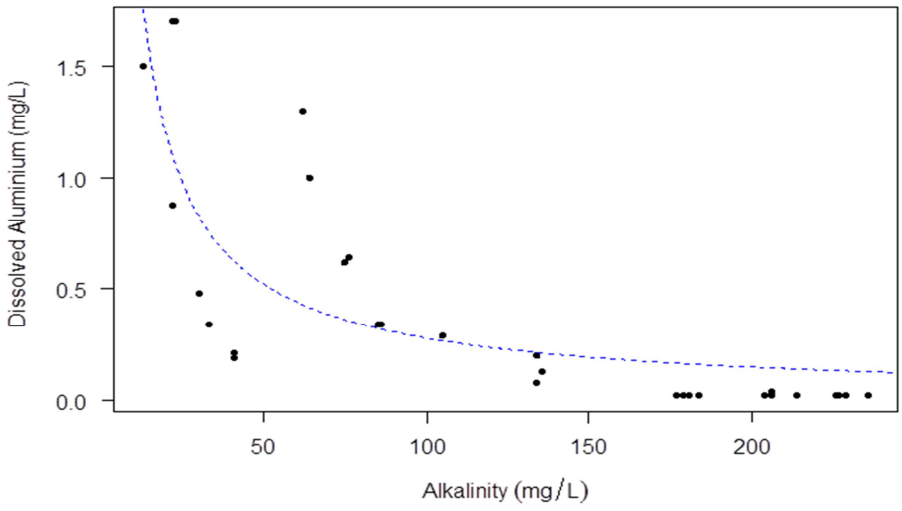

Figure 2: Plot of alkalinity versus Dissolved Aluminium for Burra Creek.

To assist in determining the ongoing potential for leaching of aluminium from the cement lined pipe into solution, a sample of the lining was tested for aluminium. The result indicates the cement lining is

8.9% (by weight) aluminium. ALS is currently undertaking tests of aluminium leaching from small samples of the cement lined pipe into Burra and Murrumbidgee raw water samples.

A fish survey was undertaken within Burra Creek in spring 2011 (Beitzel et al., 2011), and also in February 2012 (ALS). The surveys found no native species within the creek, which was dominated by introduced Eastern Gambusia (*Gambusia holbrooki*). and Redfin Perch (*Perca fluviatilis*) in the downstream reaches No data on aluminium toxicity of these species has been found, or for the Mountain Galaxias (*Galaxias olidus*) or Western Carp Gudgeon (*Hypseleotris klunzingeri*) which were the only native species found in the Queanbeyan River upstream of the Burra Creek confluence during recent surveys.

4 Discussion and Conclusion

Historical and current water sample results indicate Burra Creek naturally has high alkalinity, electrical conductivity and pH, which is due to the limestone geology within the catchment. During rainfall events there is significant sediment runoff which contains aluminium at moderate levels (measured at up to 1.7mg/L as dissolved Al, and 10mg/L total Al.). The occurrence of dissolved aluminium was also tested in a local farm dam (McDonald's Dam) at 0.96mg/L after a recent rainfall runoff event.

There is not expected to be any detectable affect from aluminium in the pipeline on aquatic species in Burra Creek through discharge of water held in the pipeline. The most likely effect of elevated aluminium levels due to discharges in Burra Creek may be a slight impairment to the growth of green algae. This could be seen as beneficial given the high nutrient loads that drive the excess growth during periods of low flow, increased water temperature, and increased sunlight as a result of recent riparian vegetation scour from storm events.

5 Recommendations

Given the water sample data to date, it is recommended that water from the pipeline is slowly discharged into Burra Creek (at less than 5ML/d, ideally closer to 1ML/d) or to the Murrumbidgee River (no flow limit required) as long as the pH is reduced to below 8.5 prior to discharge..

Although not imperative, a cautionary approach could be to defer the discharge of pipeline water into Burra Creek until flows are above approximately 2ML/d at the Burra Weir (410774), or released at a rate that does not exceed the flow in the creek such that dilution occurs. This may be difficult to control given the pipeline discharge is probably not designed for such a small release rate.

Water samples should be taken from the discharge point and downstream at the Burra Weir as the discharge passes, for testing with the results able to direct future releases and operational management of the pipeline. Should dissolved aluminium levels of the water within the pipe be above 5mg/L with pH below 6, and minimal flow occurring in the Burra Creek receiving water, it would be helpful to canvass options of mixing the discharge with clay material off stream to reduce the amount of soluble aluminium entering the creek.

During the commissioning phase the dissolved aluminium level in the discharge should also be below 5mg/L, water samples taken within Burra Creek near the weir (410774) as the discharged water

passes, and again 24 hours after discharge ceases, to determine whether dissolved aluminium levels are being reduced within stream.

Without further detailed testing and analysis of aluminium leaching rates, it is recommended that during the operational phase of the M2G pipeline and pumping system any complete discharge of water that has remained in the pipeline for more than 2 weeks be followed by an equivalent volume (~10ML) of fresh water pumped through from Murrumbidgee River. This is to flush the stored pipeline water into the Googong Reservoir where dilution and turbidity would quickly reduce the dissolved aluminium fraction through precipitation.

6 Closure

We hope this report meets your expectations and requirements. Please do not hesitate to contact the undersigned on 02-62025421 or by email (norm.mueller@alsglobal.com) to discuss further.

Yours sincerely,

Norm Mueller
Manager Water Sciences, ACT
ALS Water Science Group

Date	10/1/12	30/1/12	1/2/12	2/2/12	3/2/12	14/2/12	15/2/12	21/2/12	29/2/12	4/3/12	7/3/12
Flow (ML/d) - 410774	1.3	3.5	1.4	5	5.5	1.7	6.3	21	81	651	115
BUR 1 -Native											
Diss. Al (mg/L)	0.21				0.19	0.34	0.48	0.88		1.5	
Tot. Al (mg/L)	Na				Na	Na	Na	3.4		10	
Alkalinity (mg/L)	41				41	33	30	22		13	
pH	6.7				7.4	7.0	7.3	7.1		6.6	
Turbidity	5.7				35	4.8	19	54		240	
BUR 1c – u/s M2G discharge											
Diss. Al (mg/L)	<0.02	<0.02			<0.02	<0.02	0.08	0.34	1.3		
Tot. Al (mg/L)	Na	0.097			Na	Na	Na	7.9	2.2		
Alkalinity (mg/L)	179	181			177	184	134	86	62		
pH	8.0	8.0			8.1	7.9	7.9	7.7	7.7		
Turbidity	6.5	6.3			6	6.2	20	260	61		
BUR 2a – d/s M2G											
Diss. Al (mg/L)	<0.02	0.02			0.04	<0.02	0.13	0.34	1.0	1.7	
Tot. Al (mg/L)	Na	0.54	0.02		Na	Na	Na	5.9	2.5	5.9	
Alkalinity (mg/L)	227	214			206	226	136	85	64	22	
pH	8.1	8.0			8.2	8.0	7.9	7.7	7.7	7.0	
Turbidity	7.7	18			15	7.7	53	200	59	130	
BUR 2b – d/s Weir											
Diss. Al (mg/L)	<0.02	<0.02			0.02	<0.02	0.2	0.29	0.64	1.7	
Tot. Al (mg/L)	Na	1.1			Na	Na	Na	1.9	2.2	6.2	
Alkalinity (mg/L)	226	236			229	226	134	105	76	23	
pH	8.2	8.1			8.3	8.3	8.0	7.9	7.9	7.4	
Turbidity	3.7	32			12	3.4	220	46	58	64	
BUR 2c – u/s London Bridge											
Diss. Al (mg/L)	<0.02					<0.02		0.62			
Tot. Al (mg/L)	Na					Na		2.5			
Alkalinity (mg/L)	204					206		75			
pH	8.3					8.4		7.9			
Turbidity	3.3					2.3		57			
MacDonalds Dam											
Diss. Al (mg/L)				0.29							0.96
Tot. Al (mg/L)				0.51							Na
Alkalinity (mg/L)				55							37
pH				8.2							7.3
Turbidity				15							25
Scour valve CH3500											
Diss. Al (mg/L)			3.0								
Tot. Al (mg/L)			3.3								
Alkalinity (mg/L)			104								
pH			9.6								
Turbidity			5.6								

Table 2: Water Quality sampling results

7 References

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16 July 2012

Bulk Water Alliance

Our ref: 23/14302/68399
Your ref: Meeting 12/07/2012

Attention: John Turville
Land and Compliance Manager

Dear John,

M2G: Aluminium level for pipeline discharge

This advice is to clarify and update advice given to the Bulk Water Alliance (BWA) in a letter dated 31 May 2012 by Water Sciences Group (our ref: 5065-M2G-2012-002) when part of ALS, now acquired by GHD.

I have reviewed the additional water quality data collected to July 2012 to provide recommendations for the water quality monitoring during commissioning and the following 12 months of operation, as attached.

If required, I shall be available to provide clarification or further advice during the commissioning phase and proving test.

Yours Sincerely,
GHD Pty Ltd

Norm Mueller
Principal Civil Engineer Hydrology
61 2 6113 3200

ADVICE FOR ALUMINIUM LEVEL IN M2G DISCHARGE DURING COMMISSIONING AND FOLLOWING 12 MONTHS OF OPERATION.

Construction for the Murrumbidgee to Googong transfer pipeline (M2G) has now been completed and the system is ready for the commissioning and proving test phase, prior to being considered operational. This letter provides advice for consideration on recommended aluminium levels for discharge while the system is commissioned and for the first 12 months of operation.

There is currently no dissolved aluminium trigger level within the Streamflow and Water Quality Monitoring sub plan (BWA, 2010) to the Operation Environmental Management Plan (BWA, 2012). Dissolved aluminium from initial leaching of the new pipe lining is expected to be a short term impact, however ongoing monitoring of aluminium levels are recommended for ongoing review of the water quality trigger levels under the OEMP.

There are different forms of aluminium hydrolysis reactions in water that are generally dependant on the pH, which has been explained in previous correspondence. We tested different water sources supplied by the BWA in early March 2012 including Burra Creek and Murrumbidgee River. Samples of the pipeline high alumina cement lining were added to the water samples to assess aluminium leaching after 3 months contact, to simulate water held within the pipeline. The results are shown in Table 1 and indicate pure water (by Reverse Osmosis) to be the most aggressive as there is no buffering capacity. Murrumbidgee River water was the least reactive creating low total aluminium levels with the majority of total aluminium remaining as the dissolved form in solution.

Table 1: Dissolved and Total Aluminium levels from pipeline lining leachate into different water sources.

Parameter	Date	RO water (pure)	MacDonald's Dam water	Burra Creek water	Murrumbidgee River water
Dissolved. Al.	12/06/2012	3.1	0.1	0.09	0.65
Total Al.	12/06/2012	6.0	5.7	4.9	0.90

The pH of water within the pipeline also increases over time from cement lining leachates, however this was not measured at the time.

RECOMMENDATION FOR COMMISSIONING AND FIRST 12 MONTHS

During the term of commissioning and proving test the pump systems shall be operated in various combinations and flow rates for various lengths of time. It is possible that there may be periods where the water is retained in the pipe for a period of days or weeks where potential aluminium leaching and pH increases may occur. During the first 12 months after commissioning the pumps are expected to be operated monthly and during this time water will also be retained in the pipe at low sag points. Leaching of contaminants from the pipe lining into the water is common to new water supply systems and will reduce over time.

Previous results for Burra Creek generally indicate dissolved aluminium from the upstream Tinderry Nature Reserve (refer location BUR 1 in the monitoring program) are precipitated out within stream and significantly reduced during transport down the creek due to interaction with organic compounds and fine sediments. Burra Creek is likely to be flowing above 5 ML/d in the coming weeks due to recent rains and a saturated catchment. Refer to Figure 1 for a flow plot of June and July 2012 at Burra Ck gauging station (410774).

Discharged water with dissolved aluminium values above ambient levels would precipitate out relatively quickly. Levels of aluminium below 5 mg/L with a pH above 6.5 are very unlikely to cause any environmental impact. Natural aluminium levels in Burra Creek can be high (9.3 mg/L total Aluminium on 1 March 2012, and 10 mg/L during an event on 4 March 2012). The pH in Burra Creek is also well above 6.5 with levels now generally at or above 8.0 and sometimes increasing to 8.5 in the lower reach during low flows.

Recommended water quality parameter levels during commissioning and the subsequent 12 months are given below:

- pH less than 8.5; dosing required if above 8.5
- turbidity less than or equal to 150 NTU
- dissolved aluminium at discharge point:
  <= 1 mg/L; pump as desired
  >1 mg/L and <= 5 mg/L; pump as desired and provide a minimum pipe flushing volume of 10 ML water with diss. Al at ≤1 mg/L at completion of a testing sequence (where pumps may be switched off for more than 5 days), or if >1 mg/L and <= 5 mg/L, discharge at <= 5 ML/day;
  >5 mg/L; release at <= 5 ML/d and add small amount of clay based material to discharge mixing chamber and maintain turbidity below 150 NTU.

The water quality parameters are summarised in Table 2:

Table 2: Dissolved aluminium levels for discharge during M2G commissioning

			Dissolved Aluminium Level at discharge point		
	Turbidity (NTU)	**pH**	**≤ 1mg/L**	**>1mg/L & ≤5mg/L**	**> 5 mg/L**
Murrumbidgee R Intake water	≤ 150	≤ 8.5	Pump as desired	Pump as desired	Do not pump
Burra Ck Discharge water	≤150	≤ 8.5 or dosed to reduce to below 8.5	Discharge as desired	Discharge as desired. Flush pipe with 10ML at ≤1mg/L diss.Al	Release at ≤ 5ML/d and add small amount of clay. Keep turb. At ≤150NTU. Flush pipe with 10ML at ≤1mg/L diss.Al

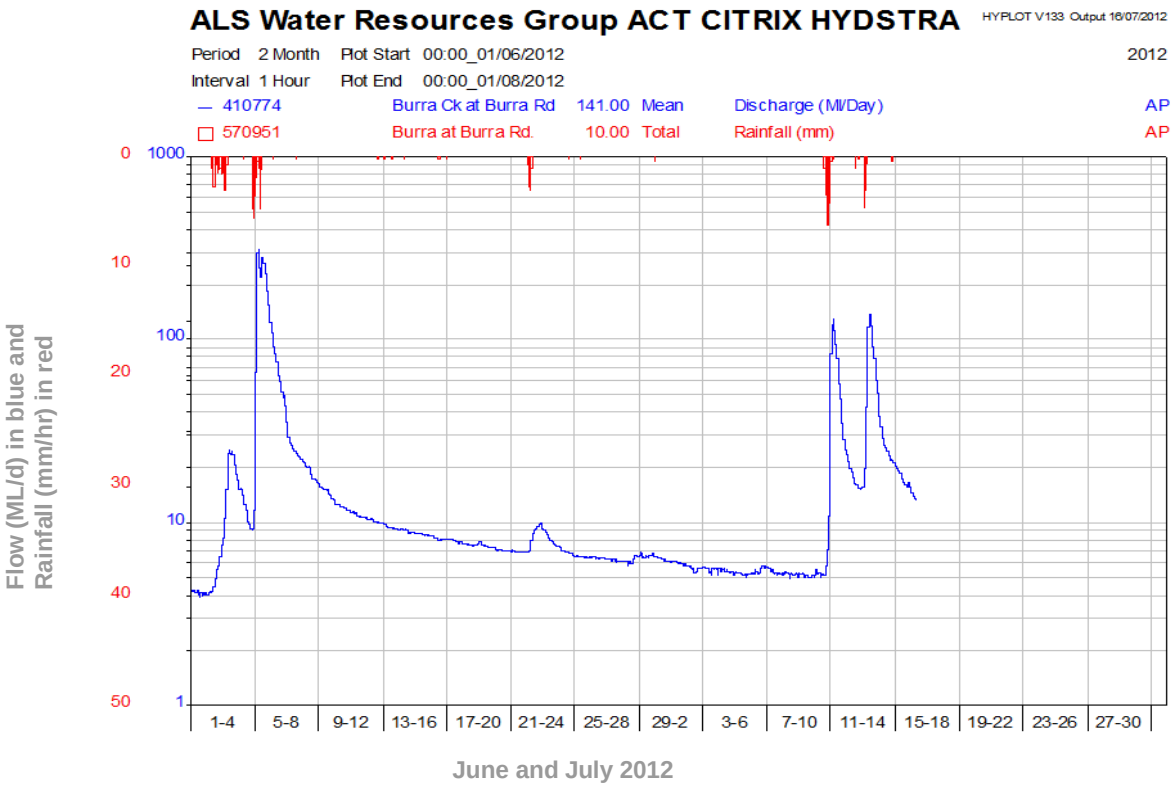

Figure 1: Burra Creek flow and rainfall plot June and July 2012 (to 16 July 2012).

I shall be also available to provide clarification or further advice during the commissioning phase.