Bevan McKenzie

From:	Mellish, Charles <Charles.Mellish@stantec.com>
Sent:	Monday, 19 November 2018 10:08 a.m.
To:	Bevan McKenzie
Cc:	Rodger Oakley
Subject:	Riverton water: Soda Ash Dosing to soften water
Attachments:	180917-127-286492-01.xlsx

Hi Bevan,
The results are based on using the 14 September 2018 results for ex sandfilter and NF plant treated water. Using the blending function, the blend quality was used to estimate soda ash dose.

The method looks at the response to the chemical dose by first adding soda ash, adjusting pH and then elevating the temperature. Initially, softening to 40mg/L caused positive scaling index, and softening to 30mg/L reduced the scaling risk further, after elevating the temperature.

The results were:

- Initial softening causes a slight risk in corrosive properties in the network to the houses before temperature is increased in jugs and hot water cylinders;
- Acid is needed to manage the pH delivered to the network, producing slightly corrosive water;
- Elevating the temperature increases scaling risk;
- Softening can be adjusted to suit the network corrosion but limit scaling.

The results of the two softening estimates are recorded in the attached spreadsheet. Soda ash dose is provided for each estimate. The trial needs an additional step to adjust pH prior to heating the water.

- Revised trial steps:
    - Use dosing pump to feed cold water
    - Dose soda ash into feed water
    - Measure pH and add acid to stabilise pH below 8
    - Elevate water to 65°C
    - Test water quality after heating tank to see if alkalinity declined – confirms scaling occurred or not

The alternative using lime provides similar results to that of soda ash. I working on site today and tomorrow but will check emails if you have any questions and can call when I have time.

Regards
Charles

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From: Mellish, Charles
Sent: Tuesday, 16 October 2018 4:28 PM
To: Bevan McKenzie <bevan.mckenzie@southlanddc.govt.nz>
Subject: RE: Riverton water

Hi Bevan,
The notes below respond to the comments/ queries you had in your previous email.

- Precipitation potential of zero causes no deposition or dissolution
- Positive values reflect over-saturated water that result in scaling
- Negative values are under-saturated and dissolve calcium from concrete

I have noted that while acidity is unchanged at 90°C when I modelled the pH correction, the addition acidity changes the precipitation potential. I have checked lime and soda ash dosing of the NF treated water as a basis and then added carbon dioxide to reduce pH, but each time the precipitation potential is negative after pH correction.

While the theoretical assessment shows that there shouldn't be scaling, it isn't clear why, with negative precipitation potential, scaling occurs, as it is observed.

It would be best to do a trial on water at 90°C. The trial should be easy to set up a small dosing pump to feed water and add soda ash with a canteen hot water cylinder and the electrical cost to keep heating the water.

- Use treated water to network at ambient temperature from plant
- Elevate water sample to 90°C and check pH
- Confirm water test results of water sample to check whether reduction in pH occurs and whether this shows scaling is likely to occur
- Based on this determine a soda ash dose
- Run a trial by:
  - Use dosing pump to feed cold water
  - Dose soda ash into feed water with separate dosing pump
  - Maintain water at 90°C
  - Dose soda ash to trial feed water and observe whether scaling is observed
  - Test water quality after heating tank to see if alkalinity declined – confirms scaling occurred or not

I have site meetings in the morning and may only get back to the office later in the afternoon, but can call first thing Thursday to discuss.

Regards
Charles

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From: Bevan McKenzie <bevan.mckenzie@southlanddc.govt.nz>
Sent: Friday, 5 October 2018 1:51 PM
To: Mellish, Charles <Charles.Mellish@stantec.com>
Cc: Oakley, Roger <Roger.Oakley@stantec.com>
Subject: RE: Riverton ex WT Plant pH handheld Oct 17 - Oct 4 2018

Hi Charles
Thanks for sending through

The precipitation potential after adding CO2 is calculated at -5.41 mg/l CaCO3
Is this not going to lead to scaling at this level given the RAW water precipitation potential is -7.43 mg/l CaCO3?

What is the ideal value for the precipitation potential? Is that valve zero?

Attached is the completed comparisons of the pH of water leaving the plant and towards the Rocks end of the reticulation. The pH differences are probably in the no more than what the instrument is capable of measuring.

The time spent is acceptable thanks.

What is the next steps.

1) more testing the same parameters? Any others
2) Start to up trail testing of soda ash and CO2
3) Anything else?

Regards
Bevan

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From: Mellish, Charles [mailto:Charles.Mellish@stantec.com]
Sent: Thursday, 4 October 2018 7:26 p.m.
To: Bevan McKenzie
Subject: RE: Riverton ex WT Plant pH handheld Oct 17 - Oct 4 2018

Hi Bevan
The calcs show that the 33mg/L soda ash is required to stabilise the water and 4mg/L carbon dioxide can be used to adjust the pH to 8. I have copied the text that explains the use of the Taylor-Caldwell diagram as background.

Setting up a lab trial with water heated to 90°C allows measurement of pH at the elevated temperature as well as monitoring scaling.

The attached spreadsheet is a copy of the original lab results and then the data from the calcs on water stability and dosing needed to stabilise and adjust pH of the water. A larger number of previous test results are needed to confirm the dose required to stabilise the water noting that soda ash doesn't increase calcium and so the results show the water is impacted by acid dose for pH adjustment. As we discussed, adding lime may not be that great given the climate and moisture in the air in Southland.

From: Bevan McKenzie <bevan.mckenzie@southlanddc.govt.nz>
Sent: Thursday, 11 October 2018 10:02 AM
To: Mellish, Charles <Charles.Mellish@stantec.com>
Subject: Riverton water

Hi Charles
Thanks , please look at it next week. We are getting pressure to resolve this.
I assume we have to does soda ash first and the CO2
Is there a time delay required between dosing the each? How long?

Regards
Bevan

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From: Mellish, Charles [mailto:Charles.Mellish@stantec.com]
Sent: Thursday, 11 October 2018 10:39 a.m.
To: Bevan McKenzie
Subject: RE: Riverton ex WT Plant pH handheld Oct 17 - Oct 4 2018

Hi Bevan,
Apologies for my lack of response – the week has become somewhat busier than expected. I will look at the water quality as initially I was looking at providing a marginal dose to soften but at the expense of not stabilising the water with calcium. If we look at the theoretical water condition and then assess softening, that completes the picture.

I will have time early next week to work through that and give you a call to discuss.

Regards
Charles

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We shouldn't loose sight of the NF plant optimisation that is needed to agree a final solution.

I have spent a day's time on the analysis and hope that is acceptable.

Regards
Charles

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Treatment of Water for Hot Water Systems
Industrial and domestic water is often required at temperatures well above ambient, say up to 90°c. (Waters in boilers are not considered here). This requirement creates the following chemical problem: to what state should a water be treated at ambient temperature so that at an elevated temperature it is neither undersaturated nor too oversaturated with respect to $CaCO_3$. This type of problem can only be solved using equilibria chemistry. Analytical solutions are complex and tedious. However, by means of the graphical inter-relationships between the equilibrium values of Ca, Alkalinity, Acidity and pH (as depicted in the Modified Caldwell-Lawrence Diagram) a simple and rapid means of obtaining solutions is available. Application requires that the values be known for the equilibrium constants $K1$, $K2$, Kw and Ks at the different temperature conditions.

These relationships were only verified up to 40°C for Kw and 80°C for Ks. However, values of these constants Langelier, 1946, and Powell et al, 1945 and Hamer et al, 1961, accept that the values of the equilibrium constants can be extrapolated from the empirical expressions. Langelier states that using extrapolated values for the constants at 100°C the predicted pH values at 100°C are within 0,05 pH units of the true values.
For our purposes the K values at elevated temperatures given by the empirical equations will be accepted as satisfactory.

Considering equilibrium between carbonic species in the aqueous phase, the Caldwell-Lawrence diagram requires knowledge of two of the parameters Alkalinity, Acidity or pH to define the value of the third, If one has measurements for two of these parameters at the high temperature, estimation of the third value from the diagram is straightforward. However, normally the values of Alkalinity and pH only are available at ambient temperature. It is therefore necessary to enquire whether it is possible to obtain values for two of these parameters at the elevated temperature from the measured values at ambient temperature.

-----Original Message-----
From: Bevan McKenzie <bevan.mckenzie@southlanddc.govt.nz>
Sent: Thursday, 4 October 2018 12:21 PM
To: Mellish, Charles <Charles.Mellish@stantec.com>
Subject: Riverton ex WT Plant pH handheld Oct 17 - Oct 4 2018

Hi Charles
Attached is a copy of the pH tests for the riverton water supply There is still some tests to add and the times, but I thought I would send them in the interim.

Are you in the office at the moment, t I would like to call you and talk over what you sent though.
Let me know a time that would suit you.
Thanks
Bevan

Your message is ready to be sent with the following file or link attachments:

Riverton ex WT Plant pH handheld Oct 17 - Oct 4 2018

Note: To protect against computer viruses, e-mail programs may prevent sending or receiving certain types of file attachments. Check your e-mail security settings to determine how attachments are handled.

[cid:imagef22840.GIF@df7d1935.4d9bc95f]<http://www.southlanddc.govt.nz> Bevan McKenzie Project and Programme Manager Southland District Council PO Box 903 Invercargill 9840
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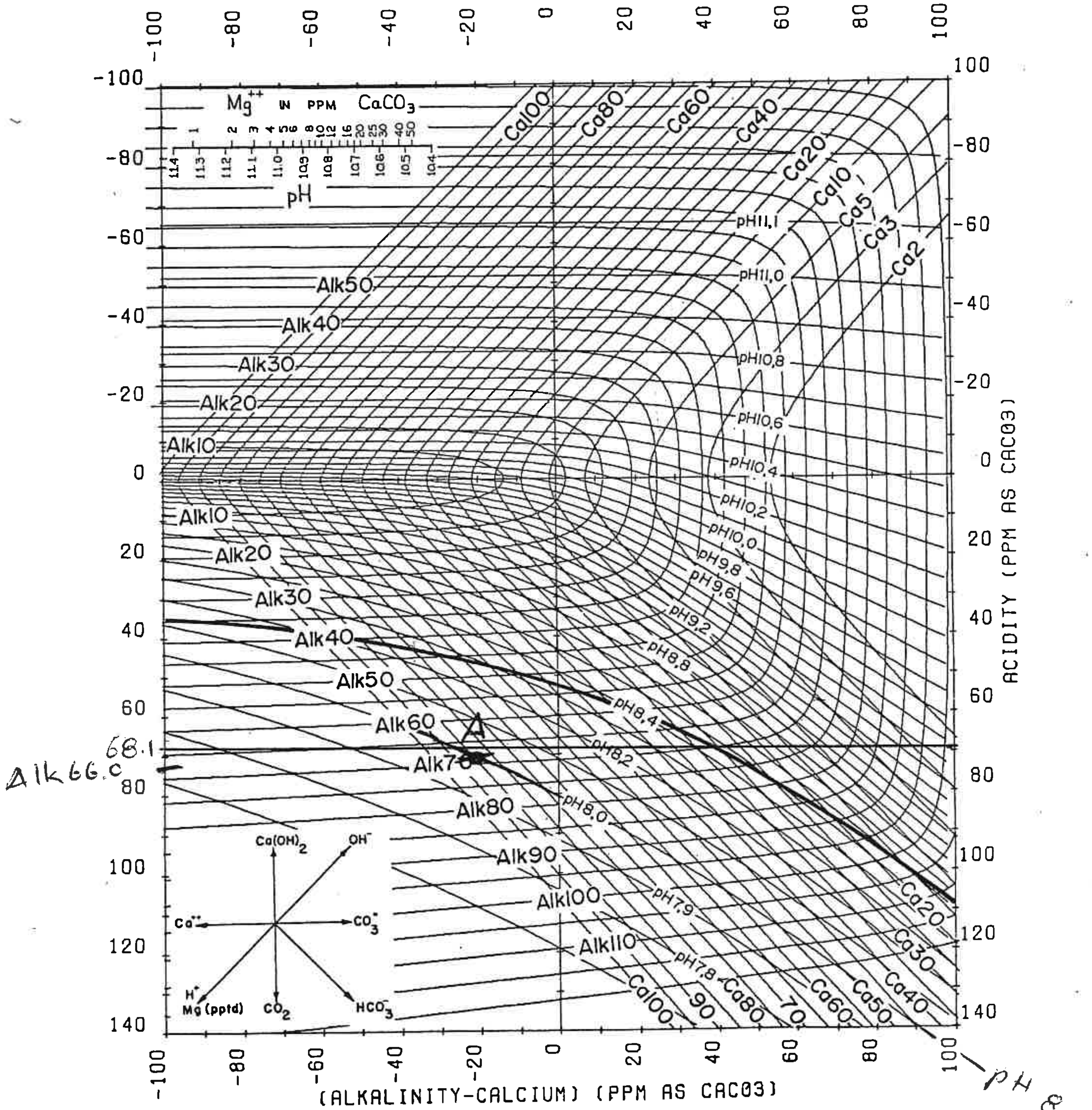
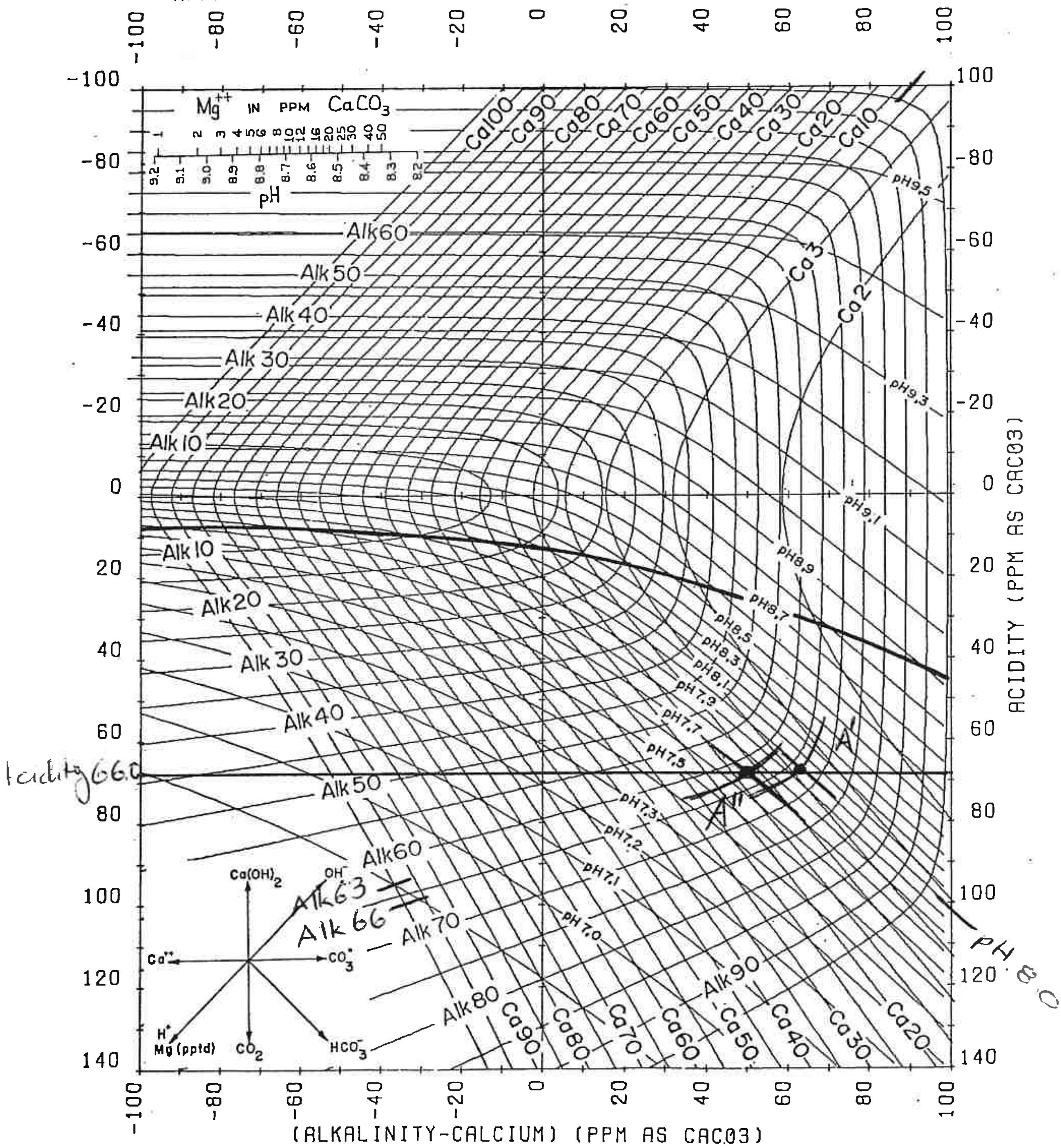
IONIC STRENGTH= .0010 TEMPERATURE (DEGC)= 25.0

APPROXIMATE TDS(PPM)= 40



IONIC STRENGTH= .0025 TEMPERATURE (DEGC)= 90.0

APPROXIMATE TDS(PPM)= 100



Bevan McKenzie

From: Bevan McKenzie
Sent: Wednesday, 3 October 2018 3:03 p.m.
To: Ian Evans
Subject: Riverton water hardness - causing scaling
Attachments: Taylor-Caldwell.Diagram_Temperature_Precipitation.pdf

Ian
FYI
Bevan

From: Mellish, Charles [mailto:Charles.Mellish@stantec.com]
Sent: Tuesday, 2 October 2018 5:11 p.m.
To: Bevan McKenzie
Cc: Rodger Oakley; Norquay, Kirsten; Ian Evans
Subject: RE: Riverton water hardness - causing scaling

Hi Bevan,
The response of the water hardness to temperature is discussed in the text by Lowenthal high-lighting the problem that the water characteristics are known at ambient temperature and not at 90°C.

Water chemistry remains constant apart from pH and subsequently precipitation of calcium carbonate. The blend delivered to town has a negative precipitation potential, implying that calcium carbonate will dissolve out of AC pipes and concrete.
Observations are showing though that scaling is occurring and this is caused by pH change causing scaling but the amount of scaling should be low, rather than dramatic. The attached charts show stability for 25°C and 90°C and used a drop in pH to 7.7 to show how precipitation would be estimated = 3mg/L. It is dependant on pH change in the hot water systems and nobody can be sure whether this occurs or not, but shows that pH change causes the observed response.

Apart from the contractual performance requirements of the NF contract, in the short term scaling needs to be addressed – with NF plant performance being resolved, softening can be amended to suit future treated water quality. Soda ash in your case would be the preferred chemical rather than lime softening. Your intention to do bench scale jar tests would help resolve the chemical dosing requirements. If I generate a table with precipitation potential analysis and chemical required to stabilise/ soften, we can discuss a trial methodology on Thursday when I am back in the office.

Regards
Charles

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From: Bevan McKenzie <bevan.mckenzie@southlanddc.govt.nz>
Sent: Wednesday, 26 September 2018 11:37 AM
To: Mellish, Charles <Charles.Mellish@stantec.com>
Cc: Oakley, Roger <Roger.Oakley@stantec.com>; Norquay, Kirsten <Kirsten.Norquay@stantec.com>; Ian Evans <ian.evans@southlanddc.govt.nz>
Subject: Riverton water hardness - causing scaling

Hi Mellish
Please find attached the PDF of the lab test results.
Please review, analyse and advise possible solutions to reduce the scaling that is occurring in electric jugs and hot water cylinder elements.

The town water sample is taken at the plant.

It has been suggested that we may be getting some calcium coming out of the AC pipes? What are your thoughts on this?
I could/ will get a few samples from the reticulation in 3 area of the town.

The NF manufacture is going to replace all the stage one elements.

Could you look at these test results and give us your initial thoughts and if we need to do any other testing,

On the day the test samples were taken
2.66 l/s (18.3 %) was by passing the NF plant and 11.99 l/s (81.7 %) running through the NF plant. Then both of these combine as water to town.
ORP going into NF 167, conductivity 153 ex NF
Water going into town was pH 7.4 and FAC 1.12

Regard's
Bevan

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From: Bevan McKenzie
Sent: Friday, 14 September 2018 11:12 a.m.
To: 'Mellish, Charles'
Subject: RE: Riverton water hardness - causing scaling

Hi Mellish
I am about to get water samples for these tests, for the Iron is soluble iron and total iron?

Thanks
Bevan

From: Mellish, Charles [mailto:Charles.Mellish@stantec.com]
Sent: Monday, 23 July 2018 12:14 p.m.
To: Bevan McKenzie
Cc: Rodger Oakley; Norquay, Kirsten
Subject: RE: Riverton water hardness - causing scaling

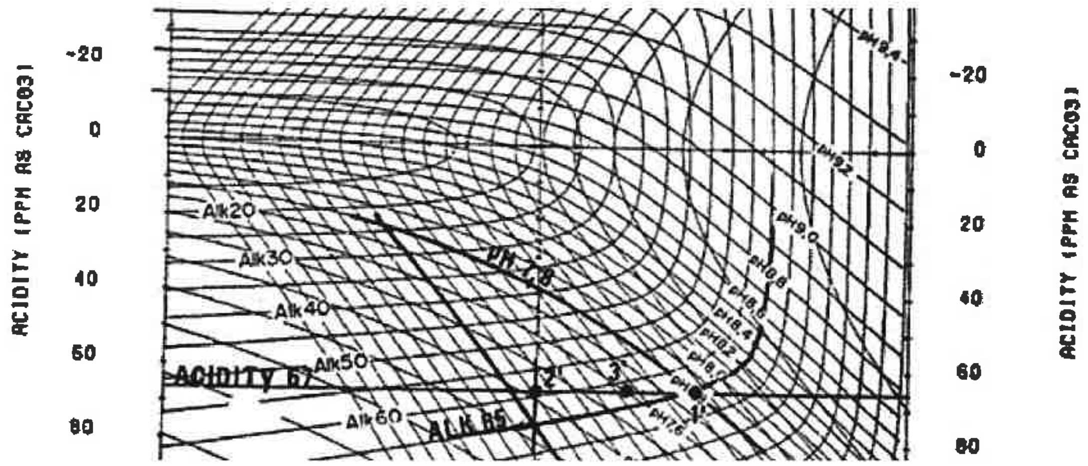
Hi Bevan,
As discussed this morning, we can assist with the scaling problem. The tests required to determine the water stability are:

- pH
- Temperature
- Sodium
- Magnesium as $CaCO_3$
- Calcium as $CaCO_3$
- Chloride
- Sulphate
- Conductivity, TDS and ionic strength
- Total alkalinity
- Silica
- Iron

If you have historical water quality data, I can check those now or wait until the new results are available.

With regard the determination of water stability at 90°C, one has to use total species concentration, alkalinity and acidity that are temperature independent – measurement is normally done at 25°C. The condition at 90°C, is determined using the alkalinity and acidity to determine the pH; that allows $CaCO_3$ precipitation to be estimated; and the saturation state found using Modified Caldwell-Lawrence diagrams.

The example below shows the final saturated state dropping from 65 to 58ppm as $CaCO_3$, precipitating 7ppm at 90°C.



The water quality data will allow the current water conditions to be checked at elevated temperatures.

Adding carbon dioxide lowers pH by adding acidity, which can be considered, but we need to determine water stability, and effects on pH to cause precipitation with temperature increase. Possible chemical conditioning options are salt addition -- sodium ions are used to replace the calcium and magnesium ions to soften water, to the detriment of taste.

Once water quality data is available and scaling potential estimated, we can discuss solutions to the problem.

Regards
Charles

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Historical parameters used to check relative stability of water using an empirical measure of LSI or RI.

Langelier Index Definitions

LSI (Carrier)	Indication
-2,0<-0,5	Serious corrosion
-0,5<0	Slightly corrosive but non-scale forming
LSI = 0,0	Balanced but pitting corrosion possible
0,0<0,5	Slightly scale forming and corrosive
0,5<2	Scale forming but non corrosive

Ryznar Indication Definitions

RI	Indication
4.0 – 5.0	Heavy scale
5.0 – 6.0	Light scale
6.0 – 7.0	Little scale or corrosion
7.0 – 7.5	Corrosion significant
7.5 – 9.0	Heavy corrosion
> 9.0	Corrosion intolerable

From: Norquay, Kirsten
Sent: Sunday, 22 July 2018 7:41 PM
To: Mellish, Charles <Charles.Mellish@stantec.com>
Cc: Oakley, Roger <Roger.Oakley@stantec.com>
Subject: FW: Riverton water hardness - causing scaling

Charles, if you're still not flat out, can you give Bevan a ring (see his email below)? I've been on leave (Bevan would have got my out of office this week) and busy with workshops, site visits + follow up for the DCC waste futures project this week.

Thanks!
Kirsten

From: Bevan McKenzie [mailto:bevan.mckenzie@southlanddc.govt.nz]
Sent: Tuesday, 17 July 2018 4:00 p.m.
To: Norquay, Kirsten <Kirsten.Norquay@stantec.com>
Cc: Oakley, Roger <Roger.Oakley@stantec.com>
Subject: Riverton water hardness - causing scaling

Hi Kirsten
Could you give me a call to discuss Hardness levels at Riverton.
I asked Roger to recommend a Water Scientist last time he was down, to look at the chemical make-up of the water as we are getting scaling (hot water elements and the inside of Jugs, at a hardness level of about 58 -59
36 ex the NF currently
Is there any chemical dosing? eg lowering the pH) that may help the scaling at hot water temperatures.

Regards
Bevan

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