Loch Katrine & Loch Lomond Pilot Plant

investigating feasibility of blending waters of two lochs

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A major component of the 'conjunctive use' plan for Glasgow is to increase the supply flexibility of the system and maximise the output of Balmore WTW. Consequently, a pilot plant study was undertaken on behalf of East and West of Scotland Water to investigate the feasibility of feeding Balmore WTW with Loch Katrine or blends of Loch Katrine and Loch Lomond water and to establish the necessary process requirements.

At the time of the tests, Balmore WTW received a pumped raw water supply from Loch Lomond. Costs savings in the order of £0.5 million per annum could be generated by taking a gravity supply from Loch Katrine by cross connecting the Loch Lomond and Loch Katrine aqueducts.

An initial jar test programme showed that Loch Katrine and blends of Loch Katrine and Loch Lomond water could be effectively coagulated and flocculated. Pilot plant trials were necessary to confirm that dircct filtration of the waters at Balmore WTW would be effective.

Description

During the study, which was undertaken by *Mott MacDonald,* the pilot plant was configured to simulate the existing filter design and operation at Balmore WTW. An hydraulic loading rate of 5m/h was used, equivalent to the works' maximum design filtration rate.

The pilot plant had four independent filter streams. Each stream could be supplied with either Loch Lomond or Loch Katrine water or a blend of the two. This arrangement allowed investigation of different coagulant doses, coagulation pH and polymer doses for a wide range of blended waters.

The plant consisted of the following key components:

* constant head columns;
* flow control valves and flow meters:
* chemical dosing & flocculation systems;
* four anthracite/sand rapid gravity filters;
* headloss manometer board;
* backwash system.

Operation

The pilot plant was operated over a continuous period of 14 months, between January 2001 to April 2002.

As at Balmore, the coagulant and polyelectrolyte used were aluminium sulphate and *Wisprofloc A*. Saturated lime solution was used to modify the pH of the coagulant dosed water.

A total of 158 runs were carried out to investigate the treatment of Loch Katrine water and its blends with Loch Lomond Water under all seasonal variations in raw water quality. On these, 116 were defined as warm weather runs and 42 as cold weather runs. For each blend different dosing regimes were investigated to optimise filter performance using a range of coagulant and polymer doses with variations in coagulation pH. Generally, each of the four columns was operated at a different pH level; during the same run to maximise the data collated.

Results

The pilot plant results showed that Loch Katrine water and blends of Loch Katrine with Loch Lomond water could be treated at

Filters *(courtesy Mott MacDonald).*

Balmore WTW by coagulation, flocculation and direct filtration. The higher the percentage of Loch Katrine Water in the blend, the more lime was required to achieve the optimum pH. This is attributed to the lower alkalinity of Loch Katrine Water.

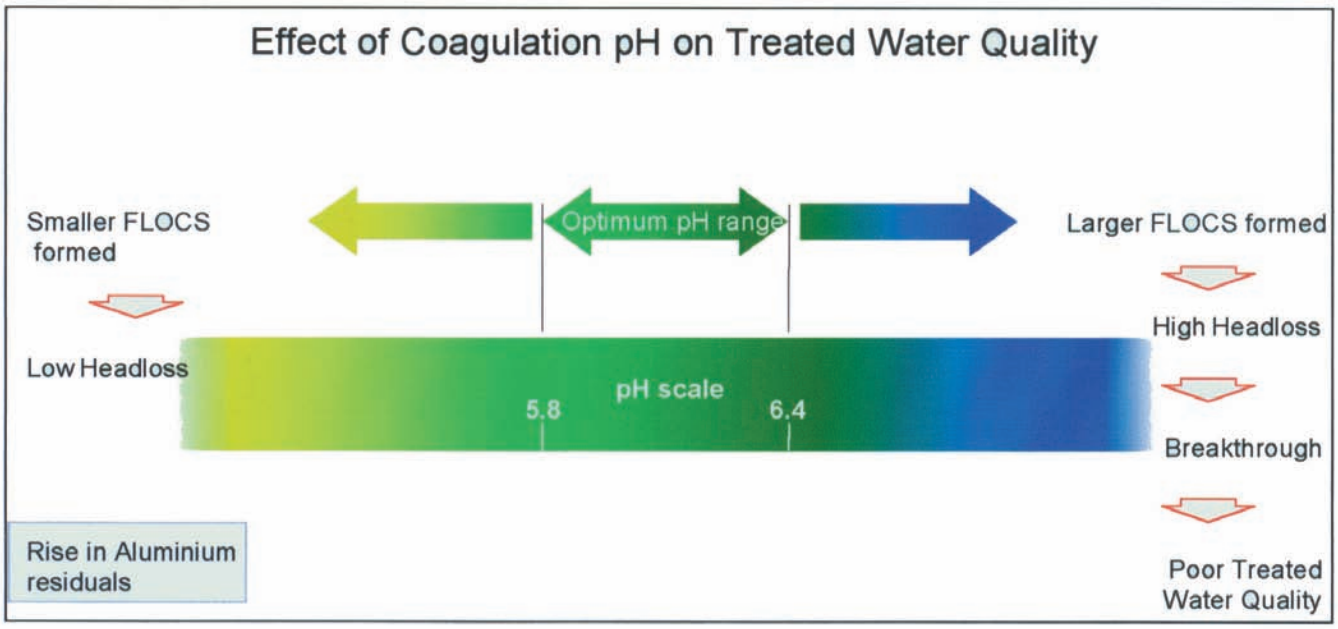
The optimum treatment conditions for a blend with a high percentage of Loch Katrine Water were found to be:

* 16mg/l alum (as $Al_2)(SO_4)_3$ .21H_2O);
* coagulation pH between 5.8 and 6.4;
* lime dose between 2.0 and 6.0mg/l;
* polyelectrolyte dose between 0.5 and 1.0mg/l *Wisprofloc A*.

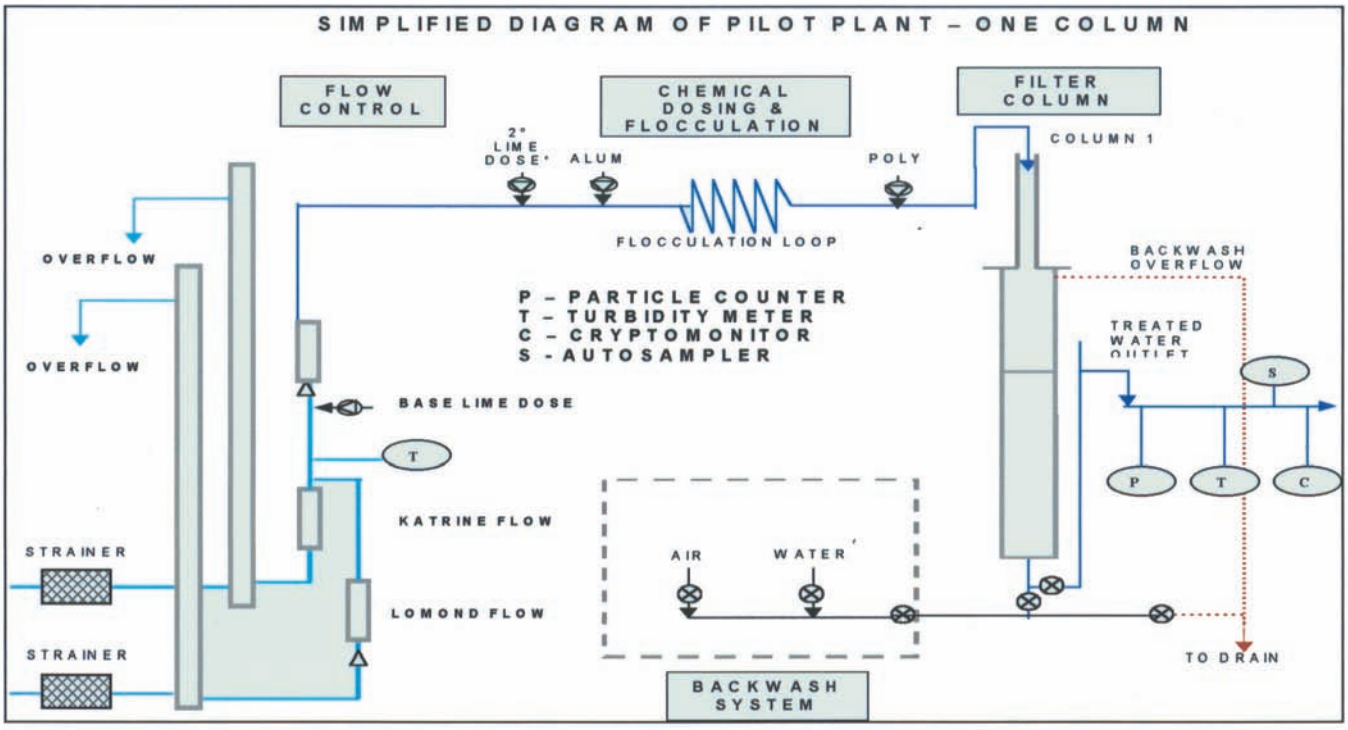
At this alum dose, acceptable treated water quality could be achieved with run times in excess of 24 hours, ,and headloss development of less than 2.5m. At higher alum doses similar performance could only be achieved over a narrower pH range.

Effect of coagulation pH on treated water quality

A low pH generally resulted in smaller floc formation and, although treated water quality was poor at the beginning of the run, long run times could be achieved. A sharp increase in aluminium residuals occurred when the pH dropped below about 5.7, or with large pH variations. Peaks in aluminium residuals also corresponded closely with peaks in particle counts.

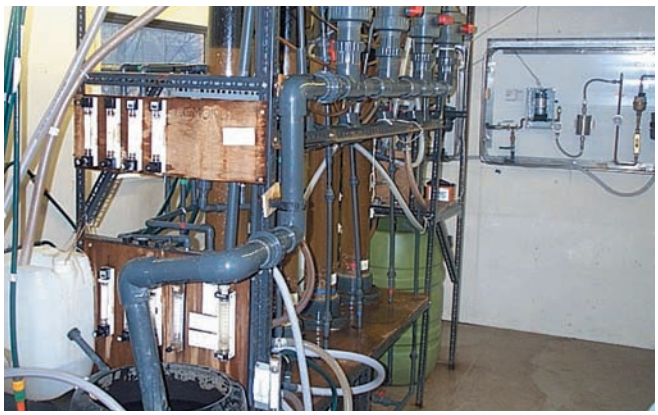


(courtesy Mott MacDonald).



Simplified diagram of pilot plant *(courtesy Mott MacDonald).*

Pilot plant *(courtesy Mott MacDonald).*



Overview inside of pilot plant *(courtesy Mott MacDonald).*

High pH values resulted in the formation of larger flocs and better initial filtered water quality. However, these flocs rapidly clogged the filters, caused high headloss development, overloading of the filters, then shearing of the flocs within the bed and breakthrough.

Poor colour removal was observed at a coagulation pH above 6.6 and below 5.4.

Thus control and stability of the coagulation pH (dosed water) was bound to be crucial for the formation of a filterable floc and hence good treated water quality.

pH level and pH stability were found to be more critical when treating Loch Katrine Water or blends containing a majority of Loch Katrine water. These waters have less buffering capacity than Loch Lomond water and are more sensitive to small variations in chemical dose. More careful control is therefore required for coagulant and lime addition.

Conclusion

In conclusion, the trials undertaken at the pilot plant demonstrated that Balmore WTW could treat Loch Katrine water and blend the Loch Katrine and Loch Lomond water requiring only minor modifications to the daily operation of the plant. In addition, a blend should be easier to treat than Loch Katrine water alone.

Performance since completion

Loch Katrine water was first supplied to Balmore WTW in September 2002. The works have successfully treated both 100 per cent Katrine water and blends of Loch Katrine and Loch Lomond water. The blend ratio usually applied is 2:1 Loch Katrine to Loch Lomond. ■

Note on the authors: Elizabeth Price is with Mott MacDonald; Frank Stone and Alex Cochrane, Scottish Water.

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