APPENDIX 2, DETERMINING THE OPTIMAL DOSE THROUGH A JAR TEST.

Procedure for undertaking a jar test;

1. Make up 1% alum solution

- A 1% alum solution is formed by dissolving 10 grams of granular alum into 1 litre of clean water (mix in less than 1 litre then make up to the final volume). This solution will be referred to as a 1% Oxfam Alum Solution. (To allow measurement by volume to be interpreted as a weight: 1 litre of granular alum weighs 1100 grams and then by use of measuring cylinder in the Oxfam code FMT kit) A baseline alum solution concentration is as follows:

1% Oxfam Alum Solution = 10,000 mg/1 (10,000ppm) Alum Solution

2. Collect equipment for jar test, (as in Oxfam code FMT kit):

- Turbidity is best recorded on a turbidity meter to enable fine distinctions to be made between similarly turbid water.
- The Turbidity tube, Oxfam code FTT does not provide accurate readings, but is probably all that is available.

Equipment required;

- 6 No.1 litre jar (beakers)
- Turbidity meter or turbidity Tube
- Timer or stopwatch
- Pipette or fine measuring cylinder
- Litre measuring cylinder
- Supply of 1% Oxfam Alum Solution
- Raw water sample container (at least 6.5 litres)
- Dining fork for stirring

3. Dose Jars

- Pour appropriate quantities of 1% Oxfam Alum Solution and raw water into test jars to produce the desired concentrations of coagulant.
- Initial starting concentrations of Oxfam Alum Solution in test jars is recommended as 50, 60, 70, 80, 90, 100 mg/1 (i.e. 5, 6, 7, 8, 9, 10 ml of 1% Oxfam Alum Solution for each litre of raw water).

4. Stir Jars

- Stir briskly with a fork for a time equivalent to the transit time in the system. Periodically stir each jar to ensure that a "whirlpool depression" is continuously visible on the centre of each test jar's water surface.
- Stir gently for a time equivalent to the residence time of the flocculation tank (typically approx. 30 mins). Periodically stir each jar to keep the emerging flocs gently moving, they should be visible in the water of every beaker, moving gently.

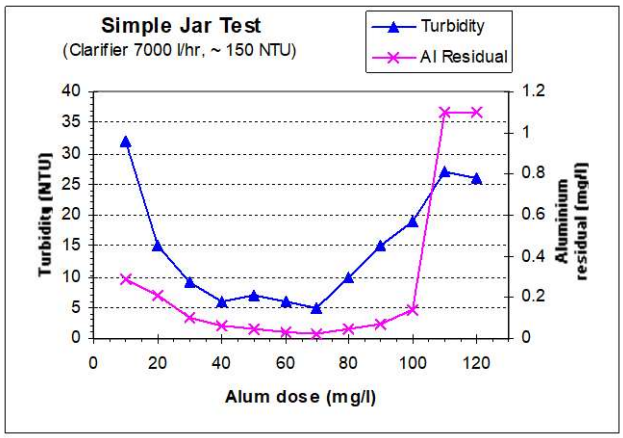
5. Monitor Turbidity

- Allow to briefly settle and then carefully take water samples from the top of each jar to measure turbidity.
- Take turbidity readings for each jar before commencing the test and then at test run times of 2.5, 5, 10, 15, 25 and 40 minute intervals, which requires 6 jars of each concentration to be made up.

6. Plot Results (refer to graph)

- Plot the turbidity results on an X-Y graph with Turbidity in NTU as the Y-axis (vertical) and Alum Dose in mg/1 as the X-axis.
- Produce graphs on the same X-Y axes, one for each "test run time" interval (6 No.)

- The graph with a regular profile (typically "bucket shaped") and which also contains the lowest turbidity value on the Y-axis should clearly indicate the optimum coagulant concentration.
- If the highest or lowest concentration tested appears to be the optimum value, repeat the jar test for further coagulant concentrations which induce this value in the middle of the range of concentrations tested



7. Uncertain Results

- Repeat the test to eliminate experimental error. Check all calculations and graph plots.
- Test pH value of the raw and product water to determine if pH adjustment is necessary. The jar test can be used to find the lime or acid dosing rates required. The resulting range of pH values should extend from 4.5 to 8.5. After stirring, flocculation and sedimentation, the optimal pH value is determined from the samples.
- If pH needs to be raised, lime should be added to keep the pH within the optimum range of 6.5-7.5 for aluminium sulphate use. Alternatively, if no lime is available or for highly alkaline waters, use extra alum to compensate, but monitor alum carry over in treated water (using comparator in Oxfam code FMT kit).
- Try water treatment making a best guess for coagulant levels on the evidence available.

Dosing rates

Once the optimum dose has been established, it is then necessary to determine the actual dose rate, i.e. the rate at which aluminium sulphate solution is put into the water stream. In addition, the total volume of solution that is required for the tank, which clearly depends upon tank size. The table below should give some guidance on this.

Although the jar test is conducted using a 1% solution, dosing should be made using 10% aluminium sulphate solution. This concentration may need to be raised if large volumes of water need dosing or lowered if very small quantities of aluminium sulphate solution are being used such that the rate of dosing is outside the range of the flow meter on the solution side doser. However, it should be noted the while good quality grade aluminium sulphate will dissolve into water at concentrations of up to 20%, where aluminium sulphate is purchased in country and it is a poorer grade, it may be that solubility will be lower than 10% and this should be taken into account.

For a 10% alum solution

Req. dose of alum	Dose rate per $10m^3$ /hr of water flow	Dose rate per $50m^3$ /hr of water flow	Dose rate per $100m^3$ /hr of water flow
30 mg/l	3 l/hr	15 l/hr	30 l/hr
150 mg/l	15 l/hr	75 l/hr	150 l/hr

The rate of water flow (and thus solution flow) will be greatest at maximum pump output. Details of pump output, which depends upon pumping head are given in the pumping manual, but as a guide the following maximum outputs for pumps at very low pumping heads are possible:

PR2	28 m^3/hr,
P2	38 m^3/hr
P4/P4H	90 m^3/hr

Example

The optimum dose rate for a water to be treated has been determined by jar test to be 30mg/l. A suction side doser is to be used with an Oxfam P2 pump, which is pumping into an Oxfam T70 tank, where coagulant assisted sedimentation will occur. What flow rate should be set on the suction side doser and what total volume of alum solution is required?

A P2 pump will pump at max 38 m^3/hr at zero head, so dose rate of alum will have to match this water flow rate. From the table above for a dose of 30mg/l, a dose rate of 3 1/hr is required for a 10m^3/hr, i.e. 11.4l/hr for the P2 pump operating under these conditions. This will require the appropriate adjustment of the needle valve on the suction side doser and this should be set to achieve this flow by estimating the rate of discharge from the coagulant vessel on a volume basis.

The T70 tank has an effective volume of 70m^3 and will require around 21 litres of 10% alum solution to dose the tank.