combine with the sulphuric acid present. It should not have more than one per cent. as total iron. An excess of bases over the amount required to combine with the total acid present is a necessity and is a point that is overlooked in the purchase of alum by most municipalities.

Table No. 1.—Analysis of Filter Alums Offered for Sale in Ontario and Used 1916-1917

Source of Filter Alum (Municipality)	Al_2O_3	SO_3	Basicity ratio	Fe_2O_3	FeO	Insoluble matter	NH_3
Toronto, July 13th, 1917	19.5	38.6	.138	0.375	0.34	trace	.....
Toronto, Aug. 8th, 1917	19.5	37.6	.015	0.4	0.37	0.4	.....
Perth	19.4	40.6	.06	0.275	0.23	0.079	.....
St. Thomas	19.3	39.0	.10	0.4	0.37	0.1	.....
Toronto, Sept. 12th, 1917	19.3	32.2	.3	0.46	0.41	0.056	.05
Dundas	18.8	43.3	.02	0.3	0.25	trace	.03
Toronto, July 24th, 1917	18.7	38.9	.011	0.4	0.37	trace	.04
Toronto, July 31st, 1917	18.7	41.2	.025	0.5	0.47	trace	.....
Haileybury	18.7	38.0	.01	0.3	0.28	0.1	.03
Toronto, Aug. 31st, 1917	18.64	33.7	.25	0.58	0.53	0.07	.028
Lindsay (lump)	18.56	38.2	.128	0.47	.....	0.2	.....
Renfrew	18.2	38.6	.098	0.35	0.31	0.075	.....
Cobourg	18.2	36.3	.16	0.3	0.27	0.05	.....
Toronto, Sept. 19th, 1917	18.1	33.0	.24	0.58	0.54	nil	1.1
New Toronto	17.9	32.7	.022	0.40	0.05	6.4	.....
Toronto, Sept. 12th, 1917	17.9	32.9	.23	0.45	0.40	0.08	.028
Iroquois Falls	17.8	32.0	.286	0.58	0.57	0.24	.05
Orillia	17.7	37.9	.094	0.35	0.345	trace	.....
Stratford	17.7	38.3	.08	0.3	0.26	trace	.....
Lindsay (ground)	17.6	38.7	.06	0.495	.....	0.25	.....
Kitchener	17.5	39.8	.01	0.3	0.22	0.1	.....
Toronto, Sept. 27th, 1917	17.4	32.9	.21	0.45	0.43	0.23	.....
Toronto, July 10th, 1917	17.2	38.0	.059	0.3	0.27	trace	.....
Toronto	17.0	38.5	.035	0.3	0.21	0.1	.....
Toronto, Aug. 2nd, 1917	16.9	36.6	.089	0.45	0.42	0.1	.....
Weston (ground)	16.48	32.7	.14	0.01	0.005	0.16	.....
Niagara-on-the-Lake	15.8	37.2	.01 free acid	0.5	0.4	trace	.026
Weston (lump)	14.0	33.2	1.1	0.04	0.03	0.12	.....
Dunnville	12.8	35.5	0.1	trace	trace	trace	4.5
Maximum of each part	19.5	43.3	.300 free acid	.58	.57	6.4	4.5
Minimum of each part	12.8	32.0	1.1	trace	trace	nil	nil

NOTE.—Aluminium Sulphate should be judged and purchased on its water soluble aluminium content and on the excess of $Al_2O_3H_4$ over what is required theoretically to combine with sulphuric acid. Estimated on the basis of 17% Al_2O_3 at 2 cents per pound, an alum, 19.5% Al_2O_3, is worth ⅓ cent more, which is equivalent to a discount of 16½ per cent., and an alum 12.8% Al_2O_3 is worth ½ cent less and represents a loss of 25%. The 12.8% Al_2O_3 referred to was purchased at 5 cents per pound, and the loss was at least 1¼ cents per pound irrespective of the original high cost.

To insure quality in aluminium sulphate and to make an appreciable saving, the municipalities using chemicals and filtering their water should combine with each other and either manufacture their own aluminium sulphate or purchase it by annual contract according to the proposed specifications from one of several manufacturers. Without introducing the economic aspects of the question, the benefits to be derived from this co-operation are most apparent when the municipalities realize that manufacturers can give them exactly what they require with possibly a reduction in the cost of manufacture, provided the quantities and dates of shipment are reasonably apparent in the annual contracts. Until such action is taken the purchasing agent for each municipality should be instructed, even when buying small quantities of aluminium sulphate, to secure one which fills the following specifications:—

Table No. 2.—Estimate of the Present Use of Alum for Water Purification in Ontario

Municipality	Pounds alum used per annum	Water gallons pumpage per annum	Water pumpage per 24 hours	Pounds alum used per 24 hours	Estimated grains alum per imp. gallon
Abitibi Pulp and Paper Mills, Iroquois Falls	14,400	94,900,000	260,000	40	1.1
Amherstburg (projected)	.....	.....	750,000	106	1.0
Arnprior	300	146,000,000	400,000	52	1.5 (not in use)
Chatham	40,000	474,300,000	1,300,000	110	0.6
Cobourg	13,000	3,723,000	1,002,000	36	0.26
Dundas	17,155	117,530,000	322,000	47	1.1
Dunnville	6,000	182,500,000	500,000	15	0.2
Haileybury	45,000	73,000,000	200,000	125	4.4
Kitchener	14,600	261,250,000	312,000	40	0.9
Lindsay (under construction)	58,000	.....	1,152,000	160	1.0
New Toronto	64,000	.....	1,250,000	175	1.0 to 0.75
Niagara-on-the-Lake	3,400	73,000,000	200,000	9.5	0.33
Ojibway (projected)	50,000	.....	1,000,000	140	1.0
Orillia	45,600	200,750,000	700,000	125	1.38
Oshawa (in construction)	22,800	159,610,533	438,000	62	1.0
Perth	18,000	200,000,000	500,000	50	0.7
Renfrew	9,660	371,500,000	1,017,882	26.5	0.35
St. Thomas	5,400	622,744,480	1,815,820	150	0.58
Stratford	25,000	372,700,000	10,264,640	69	0.49
Toronto	1,600,000	10,950,000,000	30,000,000	4,384	1.1
Weston	3,600	55,000,000	175,000	10	0.4

Specifications for Filter Aluminium Sulphate

The basic aluminium sulphate shall be in lumps from one-half to two inches in diameter and shall contain not less than 17 per cent. water soluble aluminium calculated as Al_2O_3. It shall have one-half to one per cent. of Al_2O_3 in excess of the amount theoretically required to combine with the sulphuric acid present. It shall not contain more than seven to ten per cent. insoluble matter in cold water and not more than one per cent. total iron.

Provided that a proper grade of bauxite filling the required specifications for alum-making is used, manufacturers should not find it difficult to supply aluminium sulphate according to the above specifications.

In paper mills, or for other industries where the pure article is needed, it is essential to use a sulphate of alumina containing not more than one-tenth to one per cent. insoluble matter in cold distilled water. For water purification, however, a refined alum is not necessary, and, in fact, it is not nearly so active a coagulant as alum containing a fairly high percentage of insoluble matter.

Table No. 2 is an estimate of the present use of alum and the dosage administered in the several municipalities operating rapid sand filters. It is to be observed that quantities greater than 2.5 grains per gallon and less than 0.5 grains are either excessive and wasteful, promoting corrosion in water service pipes and fittings, or inadequate, permitting insufficiently treated water to pass through filters.

Table No. 3 is a rough forecast of the use of alum in the province, mention being made only of the municipalities using alum at the present time. This table may be of interest to industries in a position to manufacture alum, or capable of supplying an equally satisfactory substance for the use of water purification plants. The number of municipalities employing rapid sand filtration should, in a few years, be considerably increased and the amount of alum used in the province for water treatment will be about 1,500 tons per annum.

Table No. 3.—Forecast of Use of Filter Alum in Ontario

Year.	Estimated pounds of alum used.
1916	1,891,115
1920	2,220,725
1925	2,673,610
1935	4,560,381

This decided increase in alum consumption, together with the problem of a suitable quantity of alum at a nominal cost, makes it highly desirable to consider the practicability of manufacturing filter alums within the province.

At the present time there is only one firm, to our knowledge, manufacturing alum in Canada. Most of the filter alum used in Ontario is imported either from Great Britain or the United States. A plant for making alum to coagulate water was recently built at the Columbus Water Purification Works, Ohio. According to Charles P. Hoover (Journal of American Waterworks Association,