Disposal of toxic and industrial liquid waste in the city of Harare, Zimbabwe

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DISPOSAL OF TOXIC AND INDUSTRIAL LIQUID WASTE IN THE CITY OF HARARE, ZIMBABWE

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Disposal of industrial liquid waste, specifically of wastes which, due to their content, could not be put to sewer. Historically these wastes were either admixed with domestic refuse or deposited into a separate area.

In the early 1970s, admixture of domestic waste and liquid industrial waste provided a low-cost disposal system. Problems arose with the admixture of various liquids, the creation of ponds, the difficulties in backfilling, particularly in the rains, and their close proximity to residential areas.

The by-laws contained no provision whereby the Amenities Department could refuse industrial waste, liquid or solid, and no charge was made for disposal. Certain sections of Industry made it quite clear that they felt Council was obliged to take without question whatever Industry chose to give them.

Within the then Amenities Department and the City Engineer's Department it was admitted that qualified control was necessary, but little transpired until 1976 and 1977, when attempts were made to dry diatomaceous earth slurry on drying beds at Western Sewage Works. Though initially successful, they were discontinued as impractical, mainly through a lack of liaison.

In 1973, industrial liquid waste disposal and its impact on the disposal site along the Mukuvisi River made a move to some other site necessary. The possibility of using Campbells Quarry off Hatfield Road as a solid waste disposal site had been raised in 1972. The site was initially accepted, but turned down later because of the possibility of seepage. However, under pressure of necessity and lack of funds for other sites or methods of disposal, the quarry was used first for industrial solid waste, but by 1977 it was also being used for liquid waste disposal.

The final depth of twenty metres of this old granite quarry were filled with soap and fat wastes, tannery waste, acid sludge from mineral oil refining, metal plating waste, garage waste, plus much else. A backfill of wood waste and boiler ash was attempted. Much of this backfill was burnt away in July, 1981, when the "hole" caught fire.

Liquid disposal to this site had been stopped some two weeks before the fire, following seepage through an ash retaining wall on the western edge of the hole. The edge was strengthened and backfilling began with plant financed by Council, through a special grant of $25 000. ($100 = £74,14 August, 1981).

Although by 1981 efforts had been made to seek for and survey alternative sites, few sites were available for solid waste, and none for liquid waste disposal. The possibility of admixing or ponding on the Kelvin Road disposal site was ruled out mainly for reasons of smell, but further pollution of the Mukuvisi and the general problems posed by scavenger control weighed against this disposal method.

A temporary site was found off Austin Road in Workington, the site of Council's disused Western Sewage Disposal Works. This site had been so effectively demolished by the contractor that no brick stood on another, no tank or pond was left unfilled. However, the area was known to have a level of reasonably impervious clay which it was felt aided the prevention of seepage and the pollution of the nearby stormwater canal.

Ponds were dug, the first to a depth of one metre, a width of ten metres and a length of sixty metres. This was filled in two weeks with the admixture as before, and a second larger pond was excavated. This admixture of liquids into ponds could not be maintained for long; both land and money for ponds were limited.

The question of separation and treatment of liquids was no longer a matter for speculation, but one of immediate practical necessity, particularly so after attempts to acquire a further quarry site were turned down. With no other site available, this small site had to deal with an average of 150 000 litres per week of liquid waste as well as the prospect of rain. The Chief Chemist and the Noxious and Toxic Wastes Officer worked to devise a series of ponds with specific uses.

Earth removed from the existing two ponds was compacted into a double-ended ramp 60 m. long, 20 m. wide and 2 m. high. Two ponds 6 m. x 10 m. x 1,5 m. deep were cut in this and two sections of 75 mm.

steel pipe with valves inserted to provide outlets. It was intended that these ponds be used for garage waste containing water, silt and oil. Oil and silt interceptors are required on garage foul-drainage systems from vehicle wash and parts cleaning bays. The valves were to drain off water to an adjacent area either to soak away or evaporate. As the separated oil level was reached it was intended that the oil be drummed for possible sale. This oil has found a ready market with one of our local manufacturers as a furnace fuel.
Adjacent to the area created to contain the water from the garage waste, a small pond was created to receive those aqueous wastes which did not contain significant quantities of oil and which might, with safety and benefit, be mixed. Such wastes as printers ink, resins, some chemical wastes, acidic and alkaline wastes and food manufacturing waste were permitted to mix and dry together.

Four shallow 0,3 m. deep ponds, 10 m. x 15 m., were created to accommodate the liquid diatomaceous earth from one of our oil/soap manufacturers, the expectation being that evaporation could provide the answer by allowing each pond a week to fill and two weeks to dry before being dug out. In the event, the rains put paid to this idea although the ponds have since proved fairly effective in the dry weather.

Two other small ponds were created to accommodate tannery waste. These were effective but the company discontinued deliveries due to cost.

There remained two materials the nature of which constituted the Liquid Waste Disposal Site's biggest problem.

Acid Sludge from a re-refining process for mineral oil

Basically, concentrated sulphuric acid filtered through used engine oil. The acid sludge contains waste solids and some oil fractions. This is discharged into a skip holding 2 000 litres. Deliveries for disposal average three skips per week. This material thickens due to a polymer reaction and gives off sulphurous fumes which add considerably to the noxious and toxic nature of any mass with which it is admixed.

One of the two garage waste ponds was used to hold the deliveries of acid sludge. A test using some of this material seemed to indicate that it could be used to fuel Council's Bitumen Unit. The thickening of the acid sludge due to polymerization made this impracticable. Similarly, the draw-off valve proved ineffective when attempts to drain off and burn some of the material from the acid sludge-filled pond were made. This pond was backfilled and capped with boiler ash.

Having failed to deal with this material and not wishing to have a permanent acid sludge pond or to admix the sludge with other liquids, deliveries were redirected to Campbells Quarry. Here backfilling had continued to close in and cover the liquid waste, but there still existed a large area of hole. This provided a limited life site, an existing and relatively isolated one.

Whereas this first problem child was only delivered at an average rate of 4 to 8 000 litres a week, the second was a problem by sheer size.

Cotton seed acid oil A dark brown oil and water residue from edible oil manufacture. This liquid waste constituted the largest single waste disposed to the waste site - some 400 000 litres per month. On average 60% of the liquid waste delivered for disposal. It was to provide holding capacity for this waste that a further pond 40 m. x 60 m. x 1,5 m. was created. With the creation of this pond sufficient capacity for immediate needs was provided.

In September, 1981, with the introduction of a charge for liquid waste disposal ($1 per 100 litres), it was hoped to introduce a realistic disposal cost into the thinking of Industry and provide finance for future development.

Further methods of disposal were examined and actively pursued. Oily waste from the first and second ponds, and cotton seed acid oil from the third large pond were shown to be combustible. Due to the open nature of the burning tests, the temperature required for a clean burn was not obtained, and an unacceptable black smoke given off. The water content and low temperature caused the expansion and contraction of a water content bubbling effect across the oil surface which extinguished the flame. Where the burning continued, a crust of unburnt carbon gradually formed which also acted to extinguish the flame. An experimental incinerator was considered necessary.

Those liquid wastes containing high solids but little fat were capable of dewatering on either evaporation ponds or sand filter drying beds. From 1976 and perhaps earlier, diatomaceous earth slurry was the largest single waste of this kind, approximately 40 000 litres

per month being delivered throughout the period. In September, 1981, the company said it was their intention to dewater by filter-press; this process has been operational since October, 1982. The liquid waste disposal site continues to receive periodic loads of a similar waste from our other oil expressor.

Large consignments of tannery waste had been received containing various mineral and metallic salts, skinfibre, hair and fat. With the introduction of the disposal charge the company attempted to dry the waste in their own premises but the results were not very satisfactory. Delivered as dry waste to the Kelvin Road disposal site it was complained of as being too wet and smelly. The waste fat, skin and larger solids have been redirected for burial in the detritus trenches at Firle Sewage Works. The fibrous waste dries well in evaporation ponds and some possibilities for re-use either as fuel, humus, or in the creation of leather paper are being examined by the company and the department.

Council receives quantities of liquid waste from a food processing company. It is highly organic and has a solids content well in excess of Council's limits which may be put to sewer. Evaporation or filtration of this waste could prove satisfactory. The possibilities of burning the dried waste or using it as an animal feed are to be examined. By admixing this liquid waste in the Western Evaporation Pond with inks and solvents, it was found that no fly breeding took place in what was highly organic matter.

The problems posed by the cotton seed acid oil have been actively pursued with the company. Their use or sale of it as a fuel or fuel additive and the reduction of volumes delivered by the introduction of a dewatering process resulted, in June 1982, in a successful attempt to reduce volume.

By boiling off the acid oil and removing the water to sewer, the company has effectively reduced deliveries by 60%. The cotton seed acid oil presently delivered contains between 3 and 15% water by mass, as opposed to 60 to 70% previously. The water content varies with production throughput, where time and available plant require the curtailing of the dewatering process. It is envisaged that within the next two years the dewatered cotton seed acid oil will be used as a boiler fuel if not required in soap manufacture.

The question of volume reduction was first tackled as one of necessity at Western Liquid Waste Disposal Site. Deliveries as well as rain filled the first and seconds ponds to unacceptably high levels. The partial emptying of these ponds became vital to the life of the site during the latter part of the rains in March, 1982.

Incineration of the fatty matter had proven to be impracticable. Dry material in the form of cotton seed hull had failed to soak up sufficient surface oil, or sink to form a solid mass, which might be removed. However, at the edges of these ponds where several loads of hull could compact, it was found that water was permitted through to a hole dug in the hull, whilst the hull prevented the oil and fatty matter from penetrating to this pumping hole. What had happened was the separation of the solids, water and oil within these ponds. The water had a highly organic content, and the surface oil seal created conditions similar to those in an anaerobic pond or septic tank. The active organic content in the water meant that under the surface crust of fat, the oil was being agitated. It was realized that any attempt to drain the water must be carefully monitored for oil content, if put to sewer.

The draining and emptying of the first pond was agreed. Water from this pond was to be pumped into the second pond. Plant and vehicles were brought in, and as the water was pumped out at one end, earth and hull were mixed with the oil and solids at the other. These mixed solids were dug out and taken to the solid waste site.

Pumping the second pond was done to sewer. Its size, and the lack of plant and finance meant that no removal of fats by admixture of dry solids was attempted. The pond level was reduced by 0,5 m. or approximately 1 200 000 lt. of water put to sewer. The third pond was reduced by a similar amount a month later. This third pond had received only materials delivered from edible oil/soap manufacturers, i.e. cotton seed acid oil, gum residues, interceptor wastes and some diatomaceous earth slurry.

The second and third ponds were re-filled by November, 1982, mainly with cotton seed acid oil and have proved incapable of being pumped to sewer due to their high oil/fat content.

The mineral oil refinery acid sludge, which had been deposited in the back-filled Campbells Quarry until August,1982, was added to the refilling of the second pond. This simply added to the speed of fill, and final closure of the large ponds

at Western in November, 1982.

Addressing ourselves to the problem of the disposal of "acid sludge", a number of methods have been investigated.

Neutralisation, which the company regards as too expensive, but which could give Council an acceptable waste for disposal continues to be a last resort.

Incineration, admixture with other materials, a straight disposal to land with the addition of lime, are alternatives used elsewhere in the world. Selling the waste acid back to be used in fertilizer is apparently a non-starter. Incineration has been tried by Council, and should the present experimental incinerator prove successful in burning the acid sludge, the company have offered a material in a holding tank, which would break up any polymerisation thus giving the Department a thin liquid to burn.

Admixture with asbestos concrete waste has been found practicable in New Zealand. There, a company of the same group contracts to combine their acid sludge with asbestos concrete slurry from a nearby plant. This is not possible here since the asbestos fibre waste from the local company is both dry and has no concrete content. Acid sludge has been admixed experimentally with boiler ash, cotton seed hull, and dried diatomaceous earth waste. With none of these local wastes did it form more than a partial amalgam.

Disposal to land with the addition of lime is unacceptable. The consequences of large deposits of acid sludge can neither be assessed nor easily controlled.

Since November, 1982, the acid sludge and all the edible oil and soap wastes have been admixed with dry waste deposited at Council's new solid waste site at Pomona. Hopes have been expressed that the sulphurous content of the acid sludge may combine with the ironstone content of the soil. It must be stressed that the disposal of acid sludge by adding it to landfill is very short term. This admixture of materials is considered as regrettable but necessary, since alternative disposal methods are yet to be found or become operative. The liquid waste is being backfilled load by load and cover applied immediately; smell is thus eliminated. There are risks of both surface and sub-soil water contamination but these appear minimal in the present disposal area.

Council has constructed a small incinerator, two evaporation ponds, two sand filter drying beds and a garage oil and water separator at the Southern Sewage Works off Cripps Road. Preliminary tests and experimental loads have already been examined, and the facility should begin to provide further answers to liquid waste disposal in December, 1982.

Since September, 1981, it has been part of the function of the Noxious and Toxic Wastes Officer to assist in the disposal of chemical wastes. A number of these have fallen into the category of reusable materials.

Outdated herbicides and insecticides have been collected and used by Divisions within the Department. By increasing the dosing rates they have been effective, and saved Council funds.

Waste acid containing ferrous sulphate has been utilized in separating the mineral oil from the water of garage wastes. The same material was used to render waste cyanide innocuous by the creation of ferrous salts.

Companies wishing to rid themselves of old or spoilt stocks of copper, sulphur and mercuric compounds have been found companies willing to buy these "wastes" or to take them at no cost for re-use.

It can be fairly said that Council's approach to the disposal of liquid waste, and indeed to all hazardous materials, is now a positive one. That facilities for disposal should be improved is undeniable, and given time, finance and expertise Council, in co-operation with Industry, will provide them.