No-Drain-Disposal Policies - A Hindrance or Not

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Introduction

A major problem that universities are facing is the disposal of hazardous waste from laboratories. Chemical waste from UC Berkeley laboratories is most commonly disposed of in landfills or through the sewers. Federal and state regulations define which chemicals can be disposed of in landfills and how to properly package that waste before its burial; whereas, local municipal utilities regulate which hazardous materials can be disposed of through the sewers (for further information, see the Introduction to the Inventory Section).

Unfortunately, with the rising cost of chemicals and more stringent regulations regarding types of chemicals that can be discarded into the landfills and sewers, Berkeley, like many other universities, may be forced to adopt new methods to reduce the amount of waste deposited into the drains by the laboratories. One method that would reduce the amount of waste going into the sewers is to ban drain disposal of all chemicals. Instead, the chemicals would be collected in containers, redistilled by the labs or an outside agency, and reused by any department requiring the chemical, or would be disposed of as hazardous waste. This no-drain-disposal policy would not only save departments money by reducing the quantity of chemicals ordered each month, but also would reduce the chances of waste from the University contaminating soil and groundwater (from waste seeping through defective pipes).

But before establishing a no-drain-disposal policy, the campus must analyze its waste stream to see if such a policy would be feasible. Therefore, it is the goal of this paper to identify types and amounts of chemicals that are currently being disposed of through the sewers, to discuss the challenges that Berkeley would need to address if a no-drain-disposal policy is implemented on the campus, and to discuss ways to meet those challenges.

Past Studies

Few studies have been made regarding the types and amounts of chemicals that are disposed of through the drains, because chemicals in the sewage are thought to be removed

from the effluent eventually by evaporation, decomposition by bacteria, or the sewage treatment process. One study (Jolly, 1983), however, discussed the disposal practices of a few departments on the Berkeley campus. This study found that these departments dispose of certain chemicals through the drains on a regular basis.

Background

The federal Resource Conservation and Recovery Act (RCRA), Hazardous and Solid Waste Amendments (HSWA), Clean Water Act (CWA), California's Porter-Cologne Act (PCA), and East Bay Municipal Utilities District (EBMUD) restrictions outline the hazardous waste management program of the state of California (discussed in detail in the Introduction to the Inventory Section). Congress designed RCRA, HSWA, and CWA to protect human health and the environment from the potential hazards of waste disposal; to conserve energy and natural resources; to reduce the amounts of waste generated, including hazardous waste; and to ensure that wastes are managed in an environmentally sound manner (EPA, 1986). The state implemented PCA as an effective way to meet CWA's water quality and permitting requirements. EBMUD's standards (Figure 1), however, were

Substance	Concentration not to Exceed
ARSENIC	2 mg/l
CADMIUM	1 mg/l
CHLORINATED HYDROCARBONS (total identifiable)	.5 mg/l
COPPER	5 mg/l
CYANIDE	5 mg/l
IRON	100 mg/l
LEAD	2 mg/l
MERCURY	.05 mg/l
NICKEL	5 mg/l
OIL and GREASE	250 mg/l
pH not less than	5.5
PHENOLIC COMPOUNDS	100 mg/l
SILVER	1 mg/l
TOTAL CHROMIUM	2 mg/l
ZINC	5 mg/l

Key:
mg/l = milligrams per liter

Figure 1. 15 Substances EBMUD Allows Down the Drain.

Source: Belk, pers. comm., 1988

designed not only to aid their wastewater treatment facility, Special District 1 (SD1), in meeting the water quality requirements defined by their permit, but to prevent harmful effects to SD1's biological secondary treatment.

SD1 processes wastewater by primary and secondary treatment. The influent is chlorinated, filtered during the bar screens and grit chamber process, more particles settled out in the primary sedimentation tank, and the waste decomposed further by bacteria contained in the secondary clarifier tank. Finally the treated effluent is dechlorinated by sulfur dioxide and sent out to San Francisco Bay. If the untreated influent contains high levels of certain chemicals or salt, or has a pH greater than 9 or less than 6, the bacteria needed for the secondary treatment would be destroyed by the wastewater (EBMUD, pers. comm., 1988). Although the campus labs dispose of many types of chemicals down the drain that can interfere with the treatment process, EBMUD and campus officials currently are not concerned with the possibility of the University's waste stream destroying the bacteria.

Jolly (1983) found that some departments on the UC Berkeley campus dispose of acids, alcohols, acetone, formaldehyde, glutaraldehyde, toluene, and neutralized salts regularly through the drains (Figure 2). Chemicals that can be poured safely into the drains are organic compounds, organometallic compounds, decomposed alkyllithiums and aryllithiums, non-toxic inorganic salts, and neutralized acids and alkalis, providing that quantities of these chemicals are limited to a few hundred grams or milliliters and flushed with excess amounts of water (NRC, 1983). NRC (1983) notes that for organic compounds drain disposal should not include hydrocarbons, halogenated hydrocarbons, nitro compounds, mercaptans, and most oxygenated compounds that contain more than five carbon atoms. Other exclusions are explosives, such as azides and peroxides, and polymers that could form gels in the piping system (NRC, 1983). These disposal practices are not believed to pose a threat to SD1's treatment process because these chemicals are disposed of in dilute concentrations, which are further diluted by the effluent in the sewers. In other words, the campus doesn't dispose of quantities of chemicals large enough to disrupt SD1's secondary treatment process. However, the University should be concerned with the disposal practices of its lab personnel because of the potential for soil and groundwater contamination, and the possibility that regulations will become increasingly stringent over time.

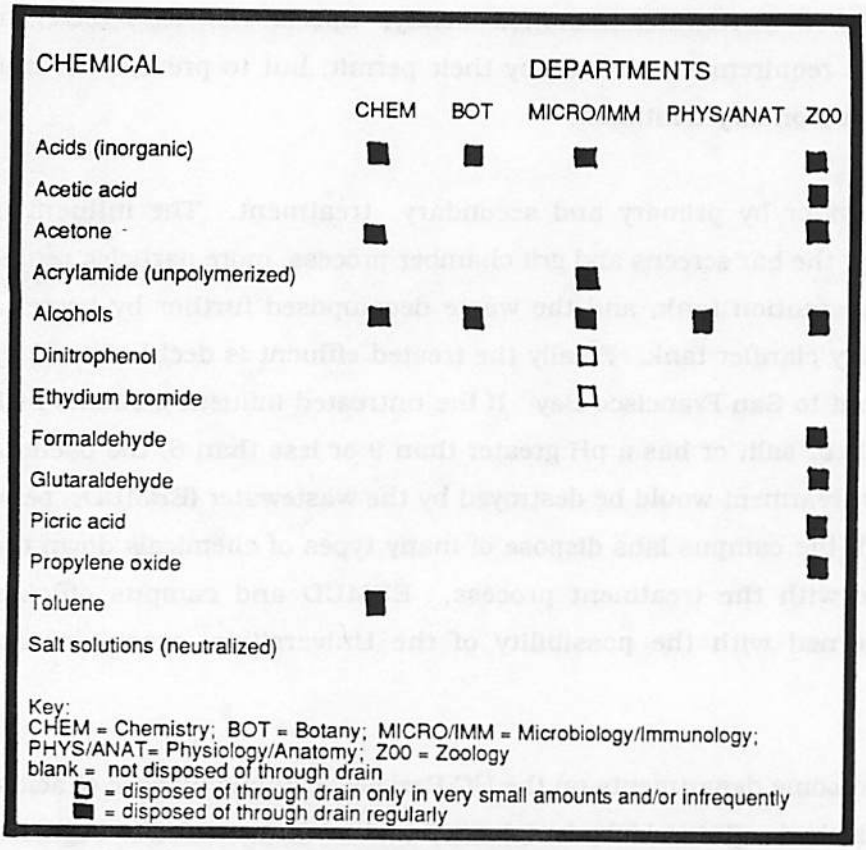

Figure 2. Drain Disposal Patterns on the UC Berkeley Campus.

Source: Jolly, 1983, p. 296

One of the biggest problems EBMUD has to work with is the infiltration of rainwater through deteriorated pipes and improper storm drain connections (EBMUD, pers. comm., 1988). For a typical year, approximately 25 percent of the wastewater treated is infiltrated rain water and untreated overflows total about 180 million gallons (0.5% of annual flows) (EBMUD, 1986). Detergents and untreated wastes in sewers may upset soil conditions enough to cause shrubbery to die from a small seepage of effluent (Fullman and Schuldener, 1981). A small seepage of waste could also cause damage by contaminating ground water. In the City of Berkeley, there exist approximately 557 wells (Romanucci, 1983). At one time, these wells pumped an average of 473,820 gallons per day. Although these wells aren't in use today (not since the construction of the Mokelumne aqueduct), they could be a major source of water in case of a disaster or a severe drought that interrupted regular services (Romanucci, 1983).

History has shown that hazardous waste regulations are becoming more stringent over time as agencies learn more about our environment and the effects chemicals have on our environment. For example, less than twenty years ago hazardous waste regulations were nonexistent. Now many statutes regarding hazardous waste management have been

implemented by federal, state, and local governments. Moreover, not long ago liquid waste could be buried in landfills provided the material was packed according to certain guidelines. By the year 1990, all liquid waste will be banned from landfills. Finally, a few environmentally - conscientious organizations are lobbying to raise current water pollutant discharge standards. If these standards are raised, EBMUD will probably lower the concentrations of chemicals they allow facilities, like the University, to dispose of through the drains. With hazardous waste regulations constantly changing, the campus must begin to research new policies, such as UC Davis' no-drain-disposal policy, in order to respond to and be able to cope with tomorrow's drain disposal challenges.

For over 14 years, UC Davis' Environmental Health and Safety (EH&S) Department has collected all the waste generated by their laboratories. The waste is sent to recycling agencies, treatment areas, or industries which burn the waste for supplement fuel (Foreman, pers. comm., 1988). Any lab wishing to dispose of innocuous solutions (e.g. buffers, salt solutions, protein solutions, etc.) through the drains must apply for a waiver. After the application is completed, an EH&S technician discusses extra lprocedures the employees must perform before the solution can be deposited into the sink. Generally, at UC Davis chemical solutions do not go down the drains. Solutions which are deposited into the drains are strictly regulated by campus officials.

Methodology

Information regarding amounts of chemicals that are disposed of through the drains was obtained by interviewing 21 professors and graduate students from seven departments and the College of Chemistry. Although sampling from drain lines would have provided more accurate information, this method was discarded for two reasons. First, an analysis of this sort should be performed over a reasonable length of time, beyond the scope of this paper, in order for the data to be legitimate. And secondly, it was felt that this procedure would be met with much opposition by department officials.

Questions regarding drain disposal (Figure 3) were part of a general questionnaire written by the inventory group (see Introduction to the Inventory Section for further information). Placing drain disposal questions on the inventory questionnaire allowed the students conducting inventories to ask the labs about their disposal practices. Unfortunately, inventory students were not able to interview many labs for two reasons. First, the majority of labs were inventoried before the completion of the general

1) Please list the wastes that you usually dispose of through drains?

2) For each chemical, please approximate monthly amounts.

Figure 3. Disposal Questions.

questionnaire. Second, after the completion of the questionnaire, it was not used if a student was inventorying a lab alone (inventory required a great deal of time). Despite these drawbacks, however, four professors from three departments were interviewed by the inventory group.

During the spring semester, initial contact was made to departments' business offices. We wanted department officials to be aware of our questionnaire, and we needed guidance to find interviewees. Most of the business offices directed us to pamphlets distributed to graduate students describing current research projects. Through this source, we interviewed two graduate students working in labs located in the Life Science Building (LSB). Another department located in LSB directed us to four interviews by supplying us with the names of the graduate students in charge of the labs. Finally, the College of Chemistry's business office director allowed us to leave questionnaires with the Graduate Office's secretary. Seven of these questionnaires were returned, answering the question regarding the types and amounts of chemicals poured into the drains each month.

The final source used to obtain interviewees was the campus' EH&S waste disposal pick-up sheets. We tried to interview persons who often called EH&S. From this source, we obtained three interviewees from a department in the College of Letters and Sciences and one interviewee from the School of Public Health.

Additional information was obtained from a questionnaire that was distributed by the College of Chemistry. Two personnel commented about the College's drain disposal problems.

Data

Most of those interviewed deposited acetone, acids, alcohols, and neutralized salt solutions into the drains (Figure 4). Graduate students from three departments disposed of

CHEMICALS	DEPARTMENTS							
	A	B	C	D	E	F	G	H
Acetone	2L-4L	1L-2L	—	8L	—	175ml-200ml	—	—
Acids	100ml	1L	—	200ml	*	2L	100ml-3L	4L-8L
Alcohols	12L	250ml-75L	5L-10L	—	1ml - 100ml	—	100ml	2L-10L
Alkanes	---	500ml-2L	—	—	—	—	—	—
Bases	---	*	—	—	—	—	100ml	—
Buffers	---	*	—	—	*	—	—	—
(Halogenated) Hydrocarbons	---	500ml	—	—	*	—	—	—
Polyenes	---	*	—	—	1ml	—	—	—
Protein Solutions	---	---	---	---	---	---	100ml	—
(Neutralized) Salt Solutions	---	*	2kg-4kg	—	*	—	80gm-200kg	450kg-500kg
Trace Metals	---	*	—	—	*	—	—	—

Key:
L= liters; ml= milliliters; kg= kilograms; gm= grams
* = amount disposed of not given

Figure 4. Estimated Monthly Minimum-Maximum Drain Disposal Amounts by Chemical Families.

alkanes, bases, buffers, halogenated hydrocarbons, polyenes (i.e. compounds containing more than one double bond), protein solutions, and trace metals in small quantities. The estimated amount of chemicals disposed of each month varied not only from department to department, but also from person to person within the department.

As little as 175 milliliters (ml) of acetone, for example, was disposed of by lab workers from Department F. Yet from Department D, as much as 8 liters (L) of acetone is poured down the drains by lab personnel. Alcohol was deposited into the drains in the largest quantities, up to 75 L per month, by Department B. On the other hand, Department E disposed of this chemical in the smallest quantities, as little as 1 ml. Finally, a graduate student from a Department G lab deposited into the sink approximately 80 grams (gm) of

salt each month. But another interviewee from Department C disposed of approximately 4 kg of salt solutions per month.

Variations within the department occured between the maximum and minimum monthly disposal amounts of acetone in Department A and Department B, acids in Department H, alcohols in Department C, and salts in Department B. The maximum amount is twice the minimum monthly disposal quantities for those chemicals. The greatest difference between the minimum and maximum disposal amounts appeared within Department B. One interviewee from this department reported depositing an estimated amount of 250 ml of alcohol, whereas another reported disposing of 75 L into the drains.

Besides the variations in amounts of chemicals disposed of in the drains by labs, variations occurred according to the types of chemicals labs pour down the drains as waste (Figure 5). Although 21 lab employees were interviewed, 27 different chemicals were

CHEMICALS	
ACETONE	NITRIC ACID
ACETIC ACID	PHENOL
BUTYL ACETATE	POTASSIUM CHLORIDE
CARBON TETRACHLORIDE	POTASSIUM HYDROXIDE
CHLOROFORM	POTASSIUM PHOSPHATE
CYCLOHEXANE	PROPANOL
DICHLOROMETHANE	PROTEIN SOLUTIONS
ETHANOL	SODIUM BICARBONATE
HEXANE	SODIUM CHLORIDE
HEXATRIENE	SODIUM HYDROXIDE
HYDROCHLORIC ACID	SULFURIC ACID
ISOPROPANOL	TOLUENE
MAGNESIUM CHLORIDE	UREA
METHANOL	

Figure 5. Partial Monthly List of Chemicals Disposed of Through the Drains.

reported as waste. Figure 5 is a partial list because workers who reported disposing of trace metals and buffers did not give the names of waste during the interview. Therefore specific types of trace metals and buffers were not included in the list.

Furthermore, all interviewees, except those from the College of Chemistry, remarked that proper hazardous waste disposal and management training are not given by the

departments. The College of Chemistry has made the greatest effort in the area of hazardous waste management training by publishing a guide, "Who Does It and Where To Find It," that all employees are required to read. Despite the College of Chemistry's outstanding hazardous waste management program, improvement is needed in training personnel about proper drain disposal. As a response to improvements still needed by the College of Chemistry, one interviewee claims,

> There's a basic skepticism among lab personnel that materials are correctly disposed of. Most of our chemical waste is organic solvents which are currently dumped down the drain and out into the bay. We would be happier if UC would dispose of them by high-temperature incineration.

Another person comments,

> Many things are washed down the drain in the College of Chemistry including hydrocarbons, halogenated hydrocarbons, reactive inorganics, toxic metals, etc. Such practices would never be tolerated in industry.

Currently, the only information given about drain disposal in "Who Does It and Where To Find It" is mentioned in a section that employees are not required to read as a measure to prevent floods:

> When flushing anything down the drain, use an abundant amount of water. Satisfy yourself that whatever was flushed down the drain will be so dilute that it cannot corrode the drains or harm the environment (Chemistry, 1987).

Discussion

Some chemicals that were mentioned as being regularly disposed of in drains by Jolly (1983) were not mentioned by the interviewees. Discrepancy between the two studies, however, should be expected because the same labs were probably not interviewed and labs usually have a number of students working - each with a different disposal practice.

The amounts disposed of probably will not pose a problem as long as the waste is in very dilute concentrations and is treated by a wastewater facility. But any waste seeping out of pipes can accumulate to levels in soil and water that could cause harm to plants, animals, and humans. Potential problems, however, will occur if the campus tries to enforce a no-drain-disposal policy.

The data show that many different types of chemicals are currently being deposited into

the drains. Therefore, if the campus collects their waste, lab employees must have a knowledge of chemical compatibilities and be willing to take time from research to list all waste placed into collection containers. Yet, many lab workers have little knowledge of compatible chemicals or time to keep track of the waste that they generate each day. Once the waste is collected, storage will be another problem because labs have limited amounts of space, and the campus cannot store waste for more than three months. Finally, a no-drain-disposal policy will be ineffective without strong enforcement. This policy may not be looked upon kindly by labs.

Collection of Waste: If chemicals are not allowed to be disposed of through sewers then they must be collected by the departments or labs. The data show that many different types of chemicals are put into the drains by a small sample of employees. Containers collecting waste must be properly labelled in order to prevent any accidents from occurring during the redistillation process. Separation of waste by chemical compatibility, however, would still be essential to the process of waste collection, since certain chemicals when mixed can cause toxic fumes or explosions. Unfortunately, some lab employees do not have the knowledge or time to devote to separating chemicals by their compatibility. The knowledge can be solved easily by supplying labs with references that list compatible chemicals. But there is no easy solution to make employees take time from the research and class work in order to list all waste being deposited into the containers.

Storage: Storing the accumulating waste in a designated area is another major obstacle to overcome. Most of the labs are very small and cramped at the present time. There is not much room in the labs to store additional bottles containing waste for recycling or off-campus destruction. For example, the College of Chemistry uses a great deal of mercury. The storeroom usually waits until it has collected about 5 lb -10 lb of mercury before sending it to a recycling agency. A storeroom worker stated that sometimes it takes 2 - 3 months before enough mercury has been collected for redistillation. With labs disposing of quantities as little as 1 ml, a great deal of time (more than 3 months) may be required in order for the labs to collect enough waste for redistillation. Hazardous waste regulations state, unfortunately, that waste cannot be stored on a facility for more than 3 months. Any facility storing waste for more than 3 months must be permitted as a Storage, Treatment, and Disposal (STD) facility. The University does not want to be permitted as a STD facility because these facilities are governed by more regulations. Berkeley has to deal with enough regulations as a hazardous waste generator.

Enforcement: The final problem would be enforcement of the no-drain-disposal policy. If University officials don't punish violators, the no-drain-disposal policy will be ignored by almost everyone. Therefore, the campus will need to support lab workers reporting on violators (each other), send a department (or a person) to perform surprise inspections, and shutdown labs which constantly violate the policy. These tactics will probably be met with great opposition from lab personnel. No one will be comfortable with or support a policy that will require lab workers to look over their shoulders for hallway spies.

But the data show that presently there is no standard campus practice regarding drain disposal of chemicals. Labs are pouring into the drains many variations of chemicals and amounts every month. Eventually, these disposal practices will catch up with us. Therefore the campus needs to take some kind of action today. Despite the problems, a no-drain-disposal policy could work if it is given additional help.

Recommendation

A no-drain-disposal policy is obviously not the sole answer. But with commitment and effort from officials, departments, and principal researchers to educate their labs, improve lab techniques, and share hazardous waste management ideas a no-drain-policy will work.

First, labs should educate their personnel about proper waste management. The College of Chemistry's manual contains a pink section which clearly explains the College Emergency Response Plan, Fire Prevention Plan, and waste disposal procedures. Anyone receiving a key to the building is required to sign a document stating that they read this pink section (Matteson, pers. comm., 1988).

Secondly, as important as education, time should be invested into proper lab technique. Chemicals are being disposed of through the drains because of sloppy technique (Chiladakis, pers. comm., 1988). One lab (see paper by Barnard, this report) that has spent a great deal of time on improving lab technique has not only reported disposing of very little or no chemicals down the drain but found that experimental errors are alleviated .

The College of Chemistry, also makes available to the researcher suggestions for waste prevention. The College suggests that research proposals should include a section stating the type of waste that will be generated by the experiment and the disposal method. This step will improve technique by helping the waste generator to know at the beginning of the

experiment what type of waste the researcher will be handling. Furthermore, if a no-drain-disposal policy is in effect, this step will facilate the labelling problem for the waste collection. The College further suggests replacing hazardous chemicals with non-hazardous synthetic ones and to downsizing the experiment . Small-scale equipment coupled with good analytic technique makes it possible for researchers to run experiments accurately and reduce the volume of chemical waste (College of Chemistry, 1987).

Moreover, departments should also invest in a drain-monitoring system for their own usage. Manual systems are lowered into the sewage stream to collect water samples. Some automatic systems can be used as a portable or permanent sampler. Monitoring will allow departments to keep track of the drain disposal practices of their labs. If high concentrations of a certain chemical are found, the department will know which labs need improvement on their techniques.

Investing in equipment will improve techniques by helping workers to withdraw chemical reagents from bottles accurately. Often workers pour chemicals from large containers into smaller ones, pipette from the smaller container, and discard the excess waste into the drain. Bottle dispensers (which come in all sizes to fit a variety of reagent bottles) and automatic pipettes create enough suction to withdraw material from containers accurately with the first attempt.

Thirdly, campus' officials should encourage labs to share good ideas with one another. A monthly or bimonthly bulletin should be circulated among departments and labs. This type of waste disposal bulletin could present questions and answers that lab personnel have about waste disposal, allow personnel to learn how other labs and departments are handling waste disposal problems, and allow labs or departments to advertise any over- and/or under-stocked chemicals. As an incentive to have departments and lab employees participate in the bulletin, the University could acknowledge outstanding efforts by presenting certificates at an annual banquet to individuals who contribute ideas, or small grants to the lab(s) which contributes the most useful idea at the end of each year.

Finally, if everyone puts work, effort, and commitment into making hazardous waste disposal management as their top priority, storage and enforcement will no longer be problems. Labs, floors, or departments could combine forces and coordinate a successful collection system. The system will collect, store, and ship the waste off-campus quickly, efficiently, and without accidents. As for enforcement, employees need not fear punishment because violators will not exist on the campus.

Conclusion

Hazardous waste management is a campus-wide problem, a problem complicated by extensive and changing regulations. This complication can create problems for employees who must deal with chemicals every day. These problems, however, could be reduced if the campus looks into implementing a no-drain-disposal policy. A policy stating that labs will no longer dispose of any chemicals into the drains (except with a few exceptions providing that these exceptions are monitored carefully). Although a no-drain-disposal policy will not be met without challenges, the policy will be a hindrance if we allow ourselves to be defeated by the problems. With hard work, commitment, and effort , Berkeley, like UC Davis, will be able to make the policy work with time.

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