THE IMPORTANCE OF SANITARY REFUSE HANDLING IN FLY CONTROL

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THE PUBLIC HEALTH PROBLEM

Large sums of money, good management, and engineering principles have greatly improved the quality of milk and public water supplies. However, until the last few years, little attention has been given to refuse handling, particularly the planned and economical sanitary storage, collection, and disposal of food wastes – garbage. These wastes provide food for flies, cockroaches, and domestic rats, and often create disagreeable odors and nuisances. If refuse is left accessible to insects, rodents, birds, dogs, and other animals, there is a constant danger of pathogenic organisms being transmitted to humans.

In Hidalgo County, Tex., it was proved that a reduction of the fly density lowered the number of cases of diarrheal diseases (1). Flies may also transmit typhoid fever, cholera, yaws, and possibly many other diseases (2). The fly's body surface, especially the hairs on its feet and legs, is ideal for picking up and carrying filth. The fly regurgitates and deposits feces while feeding on sputum, human excrement, garbage, or human food. Certain species of blowflies have been found to carry over 3,500,000 bacteria per specimen, with 8 to 10 times as many bacteria found inside as on the surface of the fly (3). Flies are annoying to animals as well as to humans, and are responsible for yearly economic losses of several million dollars to the livestock and dairy industries (4).

Although this discussion stresses fly control, the points considered are applicable to rat control as well. The importance of refuse handling in both insect and rodent control is expressed in two well-known Public Health Service manuals:

"The elimination of fly breeding sources through a sound program of environmental sanitation is of prime importance in all fly control operations. The principles of good sanitation apply whether the program is operated on a community-wide basis or in an individual industry, farm, or household...The extent of fly breeding in garbage may be held to a minimum only when all three operations – storage, collection, and disposal – are properly coordinated and executed." (4)

"Good sanitation practices may comprise from 50 to 75 percent of the activity required to free an area of rats. Proper sanitation, consisting chiefly of adequate refuse storage, collection, and disposal practices, is believed by most authorities to be the most effective measure available for controlling rats. In any given area, it is useless to try to reduce the rat population if garbage and rubbish are everywhere available to the rats." (5)

Exposed rubbish is a fire hazard, and it provides harborage for rats, allowing them to live and reproduce where food, especially garbage, is available. Domestic rats, with their fleas and other ectoparasites, may transmit plague, murine typhus fever, salmonellosis, Weil's disease, and rat-bite fever (5). In addition, the loss to the public is estimated at $250,000,000 per year just to feed rats in the United States; and fowls, grain, and other valuable food and merchandise they destroy may amount to 10 times this figure (6). This estimated economic loss ranges from $1.60 to $16.00 per person per year.

Exposed rubbish such as open cans and bottles catch and hold water in which mosquitoes may breed. These mosquitoes are pests to both man and animals, and certain species are carriers of diseases such as dengue and yellow fever (2).

Mr. J. C. Dawes, Ministry of Health, London, points out that it is possible that the wind may spread some disease organisms from exposed garbage (7), and that "In Great Britain raw garbage is known to be a carrier of virus of foot and mouth disease and, in the past, large numbers of infected cattle and hogs have had to be slaughtered as a result...raw garbage is also known to be a carrier of the virus of fowl pest, and is capable of transmitting other diseases as well." (8)

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Insect and rodent control projects sponsored by Federal, State, and local health departments are now emphasizing this neglected municipal responsibility – sanitary refuse handling – and in many communities it has been found that planned, sanitary handling of refuse costs little more than the customary insanitary handling. For example, a city (population 28,000) in Tennessee which recently converted its method of disposal from the "open dump" to a sanitary landfill, reported: "Cost data show that collecting, hauling, and complete disposal is costing 4% less per load than the cost of collecting and hauling to the open dump." (9) Improved sanitary handling may, in some cases, significantly increase refuse costs, but health officials must realize and in turn inform the public of the benefits that will be derived.

TERMINOLOGY

The terms used in discussing household and other wastes vary from one community to another, and to avoid confusion the definitions given in *Refuse Collection Practice* (10) are used by the Public Health Service as well as by many State and local health departments. Some of these simplified definitions are:

1. **Wastes** – Unwanted solid, liquid, and/or gaseous materials.
2. **Refuse** – Solid wastes (including garbage and rubbish).
3. **Garbage** – Wastes resulting from the handling, preparation, cooking, and consumption of food.
4. **Rubbish** – Refuse other than garbage and ashes (tin cans, bottles, papers, cardboard, and similar materials).
5. **Refuse storage** – The temporary premises storage of garbage and rubbish by the householder or business establishment.
6. **Refuse collection** – The removal of refuse from temporary storage points to disposal sites by municipal forces, contractors, or others.
7. **Refuse disposal** – The burying, dumping, incineration, or other means used to dispose of garbage and rubbish.
8. **Refuse handling** – The storage, collection, and disposal of solid wastes, primarily garbage and rubbish.

REFUSE STORAGE

From the public health viewpoint the proper storage of refuse, particularly garbage, at the doors of homes, restaurants, and markets is the most important part of refuse handling. Proper storage of refuse cannot be accomplished, however, unless adequate collection service is provided so containers will not overflow with garbage and rubbish. Refuse storage is the responsibility of the householder and business establishment and can be accomplished only through education – convincing all citizens that flies, rats, and disagreeable odors at their doorsteps are unhealthy and undesirable.

The cost of a good 20-gal. hot dipped galvanized corrugated steel refuse container with a tight-fitting lid is only about $3.00 or $4.00, but often the most difficult job is to get householders to place their refuse inside the can and replace the lid. This is particularly true at homes and business establishments where many people use the same refuse containers and no one assumes the responsibility of keeping them and the storage site clean.

Uncovered garbage cans and garbage scattered on the ground attract flies and provide excellent breeding media. Such exposed garbage also provides the necessary food for large rat populations. Wet garbage which sticks in the bottom or on the

Refuse storage need not be unsightly.

side of a container after it is emptied may produce hundreds of flies at the householder's back door. Providing a simple elevated stand (which will not harbor rats) for refuse containers keeps dogs from tipping them over and keeps the cans dry, preventing corrosion. Draining and wrapping garbage in several thicknesses of paper before placing in the cans greatly reduces fly breeding, prolongs the life of containers, makes them easier to keep clean, and reduces unpleasant odors. The wrapping of garbage is being stressed on all fly control projects, and can be accomplished only by an informed and educated public.

Topeka, Kans., was selected in 1948 as one of several cities which the Public Health Service, together with State and local health departments, would operate fly control projects for the purpose of learning more about fly habits and their role in the transmission of disease. At Topeka, as well as at other fly control projects, considerable emphasis is being placed on environmental sanitation. Improved refuse storage, collection, and disposal; elimination and regular cleaning of animal pens; and improved handling of industrial wastes is a part of the daily operations. Civic organizations did most of the actual promotional work. Newspapers, radios, and fly control pamphlets were used in the sanitation and educational program. Refuse collection schedules, types of containers required, and the local refuse ordinance were publicized. Personal interviews with householders were used as a follow-up to eliminate or correct insanitary conditions and practices. Excellent results were obtained by working through public grade schools. Pamphlets, describing the biology of the fly, its breeding habits, and pointing out the necessity for proper storage of garbage and rubbish, were distributed to school children for them to take home and talk about.

During the week of July 17-23, 1949, a campaign was conducted to improve insanitary storage conditions at households and business establishments. An active civic organization contacted all firms selling garbage containers and persuaded them to participate in the week's advertising program. During 3 days of this week all refuse containers were inspected by 22 health department personnel, and red warning tags placed on about 10,000 unsatisfactory containers. This included leaky cans or those with no lids and unapproved containers such as bins, boxes, and tubs. The red tags were of the shipping type which could be wired to unsatisfactory containers and had a removable stub for health department records. A list of unsatisfactory items was printed on the tags and the applicable deficiencies checked on inspection. A request for providing a standard fly-tight metal can to replace the old or missing container was also printed on the tag. This sanitation educational and information program to improve garbage storage conditions was very successful, and "adequate premises storage" was raised from about 30 percent to 90 percent, with 7,500 to 8,000 new refuse containers sold by local merchants during this week. Such a campaign for adequate storage containers, together with a concentrated effort to stress sanitary refuse handling throughout the year, has proved to be very effective in reducing fly breeding at the householder's door.

REFUSE COLLECTION

As previously stated, proper storage of refuse cannot be accomplished unless adequate collection service is provided. In many cities, refuse is collected from the better residential areas several times a week, whereas the substandard homes receive little or no collection service; collection routes may not have been planned properly; and refuse nuisance complaints may consume much of the time and effort of health department personnel. Detailed planning, scheduling, and publicizing of collection routes and proper use of equipment will give the community better service as well as a cleaner environment.

Refuse may be collected separately or together, depending on the method of disposal used. For example, if garbage is used for hog feed, separate containers for garbage and rubbish are required, and one pick-up is then required for the garbage and another for the rubbish. When refuse is collected separately, it is difficult to get citizens to keep all putrescible matter out of rubbish because of the trouble involved in washing tin cans and removing all food particles from paper. Combined collection is more convenient and economical (10).

Refuse should be picked up from alleys, when they exist, and the refuse containers placed within a few feet of the alley by the householder. If it is necessary that collectors operate from the street, and it is desired to keep collection costs at a minimum, each householder should be required to set his containers adjacent to the street curb. This is somewhat unsightly on collection days, but if adequate containers are provided, there should be little scattering of rubbish. The neces-

sary handling of the cans in placing them at the curb tends to make the man-of-the-house see that they are kept in better condition and that refuse is placed inside the can to facilitate handling. Some individuals may desire special service, and are willing to pay for the extra cost of having the collectors come on their premises to pick up refuse. The cost of such extra service should be accurately determined so as to equalize collection costs with other citizens.

Enclosed packer-type trucks are preferable for most refuse collections but, if only open trucks are available, they can be utilized in a sanitary manner by careful loading and by covering the refuse with tarpaulins to avoid scattering.

The minimum time required for flies to develop from eggs to larvae should be used as a basis for determining frequency of collection (4). It is usually recommended that garbage and combined refuse be collected at least twice a week in residential areas; even more frequent collection may be required during warm weather (11). Daily collections are usually made at business establishments due to the large amount of refuse accumulated each day, and such collections, especially in the larger cities, are often more conveniently made at night.

The cost of collection varies, depending on the length of haul necessary for disposal, the topography, street and alley lay-out and, as mentioned previously, the planning and management involved. A city (population 423,000) in Texas reports the following collection service in 1946 (12):

Residential areas – twice a week, businesses in residential areas – four times a week, and main business areas – daily. Eighty percent of the pick-ups were from alleys; and 20 percent were made by collectors going to the rear of the property and carrying the refuse to the street. The annual per capita operating cost was $0.98 for collection and $0.43 for disposal at six sanitary landfills located within the city limits.

The average citizen is probably more aware of refuse collection than any other public service. The collectors with their trucks are seen every few days by most citizens, and the caliber of those employed in refuse handling, the quality of their performance, and their attitudes and manners are closely related to the public's reaction to the municipal government. The American Public Works Association states:

"The importance of personal contacts between citizens and employees is perhaps nowhere greater than in the refuse collection service. It is here that the city, as an institution, or the policies of the city as such, make their impression on most citizens. Because in the eyes of the citizen every public employee represents the city, what any employee does is of vital importance to the maintenance of good public relations."

REFUSE DISPOSAL

In the past the "open dump" has served, in an inferior way, as the commonly accepted method of refuse disposal, particularly in many of the smaller cities and towns of the United States. As these cities grew and expanded, the land adjacent to open dumps became more valuable, resulting in a demand for sanitary refuse disposal. Flies, rats, and mosquitoes often migrate from such dumps to adjacent cities. Even when the open dump is located a sufficient distance from populated areas to prevent this migration, the cost of the long haul for collection vehicles may be increased to the extent that sanitary disposal could be provided for about the same cost.

There are several sanitary methods of refuse disposal. If a community provides satisfactory disposal, it has generally given attention to all phases of refuse handling – and storage and collection are usually carried out in a sanitary and economical manner. Actually, the refuse handling problem should be approached with an engineering viewpoint and should cover all phases of handling together, i.e., the storage, collection, and disposal.

Complete incineration is generally more feasible in large cities (over 100,000 people) where considerable quantities of refuse are produced, where sanitary landfill sites are not available nearby, and where financial resources are available to construct and properly operate incineration plants. However, provision must be made for proper operation to obtain complete burning of combustibles and for final disposal of noncombustibles and ash which amount to 15 to 50 percent by weight of the material burned (11).

One city of 218,000 people in Texas is building a modern incinerator in a central location (replacing two old inefficient incinerators) which will serve the central business district. In the residential areas, where disposal sites are available, several sanitary landfills will be used – thus keeping the haul required for collection vehicles to a minimum. The Superintendent of Waste Disposal Service of this same city reports that "disposal by sanitary fill can consistently be done for not more than one-

half the cost for incineration with present type (old) incinerators." Operating costs for a few months showed $1.12 per ton for incineration as compared to $0.38 per ton for sanitary landfill disposal (13). Generally, the complete cost for disposal by incineration – operation plus amortization of the original construction – ranges from $1.50 to $2.50 per ton of refuse (14).

The electrically driven household garbage grinder is becoming more popluar because of the convenience to the housewife. It provides her with an easy way to get rid of garbage in the sink – the place where most of it first accumulates. Studies on the household garbage grinder indicate that its operation is dependable; that properly designed sewers can handle this additional macerated garbage; that the volume of sewage flow is increased only about 1 percent; and that, with more digester capacity, "food wastes are amenable to treatment in plants conventionally used today without difficulty." (15) Also, the cost of the grinder and its installation, which runs about $175 for individual installation, can be cut in half if large-scale or community-wide installation is arranged.

One estimate of the amount of refuse produced per person per day is 2 lb. with about ½ lb. being garbage and 1½ lb. being rubbish (15). The home grinder eliminates collection and disposal of garbage only. Other arrangements must be made for removing rubbish. However, most of the public health problem will be eliminated by getting rid of the putrescible part of refuse; and if all food wastes are removed from the rubbish, less frequent collection will be necessary. This will result in a saving in the cost of collection service, and make refuse handling less obnoxious for the collectors.

In many cities in the United States garbage is partially disposed of by feeding to hogs. The U.S. Department of Agriculture, however, recommends that garbage used for animal feed be preserved as carefully as human food, and that it be cooked before being fed to hogs to prevent the spread of trichinosis and other diseases (16). The feeding of raw garbage to hogs is regarded as the primary factor in the high incidence of trichinosis, and studies have indicated that an average of one person in six in the United States has some trichina infection (14). If garbage is to be used for hog feed, it is the responsibility of the municipality concerned to see that it is not mishandled. Only about 50 or 60 percent of most garbage is actually consumed by hogs; and this uneaten portion, together with the hog excrement, creates an insanitary condition unless removed frequently and disposed of in a sanitary manner. The Department of Agriculture has a mimeographed bulletin dated February 1943, *Feeding Garbage to Hogs*, which includes sections on methods of feeding and essential sanitary conditions (17). The Division of Sanitation of the Public Health Service also contemplates a joint study to determine satisfactory methods for feeding food wastes to hogs.

When care is taken to see that water supplies are not being contaminated, and other sanitary practices are followed, the upper few feet of earth has proved to be a safe place for small towns and farms to dispose of human excrement through the use of sanitary pit privies and septic tank tile fields. Likewise, both garbage and rubbish are even more satisfactorily and economically disposed of by burial. This method of disposal is known as the "sanitary landfill" and refers to the disposal of refuse by properly compacting it and covering with earth frequently enough to eliminate odors, smoke, and disease-bearing insects and rodents. In contrast, an "open dump" may be defined as a disposal site where refuse is dumped over a bank, into a ditch, or in the open with no attempt made to cover it with earth.

Since World War II, and prior to that time in England, many cities and towns in the United States have used the sanitary landfill method of refuse disposal. It is not always the best method, but in many cases has proved to be the answer to safe, economical refuse disposal – particularly in cities and towns with less than 100,000 people.

For example, a city of 28,000 people in Tennessee reports the sanitary landfill which they operated was so located that it was possible to haul 36 percent more refuse with the same equipment and crew previously used to haul to an open dump. The City Manager also stated that several invitations have been received from citizens to use their unimproved property for a sanitary landfill to save them the expense of filling and grading (9).

Probably no two sanitary landfills are operated exactly alike, but the three principles involved in ideal operation require that (18): (1) refuse be well-compacted in about 1-ft. layers, (2) each cell not exceed 6 or 8 ft. in depth, and (3) the entire fill be sealed with proper cover frequently enough to eliminate insects, rodents, and odors.

The site for a sanitary landfill should be located within or very near the area served. By

Sanitary trucks placing refuse for spreading and compaction. (Inset) Refuse being covered. Note proximity to residential area. *(Photos courtesy International Harvester Company)*

planning and scheduling the collection service, based on time and motion studies, manpower and equipment costs for collection can be reduced to a minimum. It has been found that about 1 acre of land per year is required for each 10,000 people when refuse is well-compacted to a 6-ft. depth (11). The amount and availability of proper cover for a seal should be considered along with other items such as the cost of the site, availability of access roads and bridges, and avoidance of heavy traffic. The possible future use of disposal sites should be studied, since the area may be later utilized for recreation, open storage, auto parking, or other use involving light loading.

Regardless of the type of earth-moving equipment used at the sanitary landfill, it must be operated and maintained by competent personnel. The training and instructions given the equipment operators often determine whether the disposal site will be operated as a sanitary landfill or merely as a "covered dump."

The main shortcoming of the sanitary landfill method of disposal is that improper operation may revert the site to a covered dump, resulting in only limited insect and rodent control, untidiness, erosion of cover, and surface cracking. Also, collection trucks may become bogged down in wet weather unless a road cover is used or an alternate "wet-weather" sanitary disposal site is made available at all times. Scavengers may interfere with the operations unless properly managed; and, if drainage is not properly planned, the seepage from fills may contribute to pollution of adjacent streams. However, it is obvious that most of these shortcomings are due to poor operation.

There are several advantages to a well-operated sanitary landfill. Primarily, (1) it is economical, and (2) insect and rodent breeding is eliminated. It is economical because all refuse can be stored and collected together, the length of haul of collection trucks is often reduced, operating costs are low, cost of equipment is not excessive, equipment may sometimes be used for other purposes, and this method of disposal may be quickly

organized and put into use. Old open dumps may be covered, useless land may be reclaimed, several disposal sites may be used simultaneously, and variations in amount and type of refuse affect operation only to a minor extent.

Due to differences in topography, cover, available equipment, necessary drainage, and other factors, sanitary landfill operations vary somewhat. Many modifications may be made, particularly in small towns of only a few thousand people. For instance, it is often practical and economical for small communities to contract for and have a trench excavated in advance to handle several months' accumulation of refuse. A small bulldozer, even a motor grader or laborers with hand shovels, can then compact the refuse and cover it frequently enough to maintain sanitary disposal. Wheel-type tractors are not recommended; but if nothing else is available, an improvement can be made over the open dump.

However, to be successful – and obtain rat and fly control, eliminate odor, smoke, and nuisance – this disposal method must be given proper attention and operated as an engineering project.

CONCLUSIONS

It is suggested that the direct responsibility for refuse handling be given to the public works department if the health department is allowed to actively assist, advise, and assume their responsibility for this public service.

Two good reasons why many health officials do not desire to accept direct responsibility for refuse handling are:

1. The public works, or similar department, is best qualified to purchase and maintain collection and disposal equipment since it usually has the necessary shop facilities, mechanics, and operators.
2. It is not desirable to include this part of the municipal budget within that of the health department inasmuch as refuse handling is primarily an operating or service-type function.

The health department does have a public responsibility of seeing that sanitary refuse handling is carried out. Therefore, this department should provide technical assistance for those phases affecting the health of the community.

The health department is the logical one to carry on the necessary educational and information program. Sanitarians, nurses, and other health department personnel can do much to improve refuse handling and sanitation in the community through their contacts with citizens. These workers enter homes and business establishments and can emphasize the importance of proper storage, as well as point out the need for sanitary collection and disposal. The health department should insist that refuse collectors be paid a sufficient salary to attract good workers, that collectors realize the importance of good public relations, and that complaints on refuse handling be courteously and competently received and answered.

Inasmuch as there are also other city departments interested in refuse handling, it may be desirable to organize an advisory board from available city officials representing the various fields of interest. Such a board could be composed of the superintendent of public works, the health officer, and other city officials such as the city manager, the city engineer, the fire chief, chief of police, and the superintendent of the planning or zoning board. Individual board members could then be called upon for advice concerning their particular interests in refuse handling. The superintendent of public works, with the assistance of the health officer, should then operate and administer the program as defined by the advisory board.

It can readily be seen that the cost of sanitary refuse handling varies greatly, although combined collection with sanitary landfill disposal – which is the most economical – should not be more than about $2.00 to $3.00 per person per year. The direct cost to each householder for refuse containers and a stand at his residence should not be more than $1.00 or $2.00 per year.

Although a good sanitary refuse handling program should be accomplished largely through education and cooperation of the public, it should be backed up by a good refuse ordinance or sanitary code. It would be impossible to prescribe a detailed ordinance covering storage, collection, and disposal that would be suitable for all communities. Each town or city presents a somewhat different problem, and the State health department concerned will be of assistance in preparing such an ordinance. *Refuse Collection Practice* (10) contains a good general discussion on "Provisions of Typical Refuse Collection Ordinances" suggested by the American Public Works Association.

Many local health departments (or other city departments charged with refuse handling) spend much time and money answering nuisance complaints. Often a good share of these are refuse complaints. Studies of the inspection services of

two eastern city health departments were made in 1940 and 1941, and a tabulation of all complaints showed that refuse complaints made up nearly one-half the total in one city and about one-fourth in the second city (19). Improved refuse handling would, in many cases, relieve troublesome nuisance complaints, allowing local health departments to concentrate on other public health activities.

Cooperation in the city or community is a matter of public education, and the extent of this cooperation will determine the success or failure of a good refuse program. A well-organized, informative, educational-sanitation program stating the economic advantages and the health aims and benefits will provide this necessary cooperation. This cannot be accomplished with a 1-week campaign, but must be a continuing day-to-day activity.

Several tools are now available or are being prepared to assist local communities with their educational-sanitation activities. These include:

1. A manual on *The Control of Domestic Flies*, by J. H. Coffey and H. F. Schoof, FSA, PHS, CDC.
2. An environmental sanitary survey form to be used in obtaining information on the basic sanitary factors for a given area.
3. An educational-sanitation operations outline for a typical city or town with a June to September fly breeding season.
4. A series of 14 pamphlets covering refuse handling and fly biology.
5. A set of about 40 2- by 2-in. slides with a detailed outline on sanitary landfill operations to be used as a basis for talks to local officials and civic organizations.
6. A set of 14 suggested press releases on fly control and sanitation.
7. A list of available films on environmental sanitation and fly control.

This material should provide interested cities and communities with a sound basis for future fly control programs.

REFERENCES

1. Watt, James, and Lindsay, Dale R.: Diarrheal disease control studies, I. Effect of fly control in a high morbidity area. Pub. Health Rep. 63(41): 1319-1334 (1948).

2. American Public Health Association: The control of communicable diseases in man. Pub. Health Rep., Reprint No. 1697. (Revised 1950).

3. Hall, David G.: The blowflies of North America. The Thomas Say Foundation, Baltimore, Md. (1948).

4. Coffey, J. H., and Schoof, H. F.: The control of domestic flies. FSA, PHS, CDC, Atlanta, Ga. (1949).

5. Fehn, Clyde F., and Kinney, Alfred R., Jr.: Rat-borne disease prevention and control. FSA, PHS, CDC, Atlanta, Ga. (1949).

6. Phelps, Earle B., and Tiedeman, Walter D.: Public Health Engineering, vol. II. The food contact. John Wiley and Sons, Inc., New York. Chapman and Hall, Ltd., London, England. (1950).

7. Dawes, J. C. (Ministry of Health, London): British experience in the collection and disposal of refuse. Reprinted FSA. (Undated).

8. Dawes, J. C. (Ministry of Health, London): The storage, collection, and disposal of domestic refuse (including garbage) in the U. S. Reprinted FSA. (January 19, 1950).

9. What does your city pay for refuse disposal? Drott Manufacturing Corp., 3841 W. Wisconsin Ave., Milwaukee 8, Wis. (Undated).

10. Refuse collection practice. American Public Works Association, Chicago, Ill. (1941).

11. Spencer, C. C.: Recommended wartime refuse disposal practice. Pub. Health Rep. Supplement No. 173.(1943).

12. Brinkley, G.C.: How Dallas' sanitary fill program works. The American City. 60(7):125 (1946).

13. Lacy, R. R.: A study of the sanitary fill at Fort Worth, Texas, Parts I and II. The American City. 61(5):161, and 61(6):84-85 (1946).

14. Van Derwerker, Ralph J.: Sanitary landfill versus incineration. FSA, PHS, Division of Sanitation, Washington 25, D.C. (March 2, 1950).

15. Foster, William S.: An objective view of garbage grinders. The American City. 65(11): 110-111 (1950).

16. Rockey, J. W., and Simmons, J. W.: Sewage and garbage disposal on the farm. U. S. Department of Agriculture Farmers' Bulletin No. 1950. (Revised 1946).

17. Zeller, J. H.: Feeding garbage to hogs. U. S. Department of Agriculture, Bureau of Animal Industry. Mimeographed A.H.D. No.71 (Revised 1943).

18. Construction and maintenance of sanitary landfills for refuse disposal. Georgia Department of Public Health, Refuse Collection and Disposal Service. (Undated).

19. Pond, M. Allen: Nuisance complaints and municipal health department practices. Pub. Health Rep. 60(14):381-388 (1945).