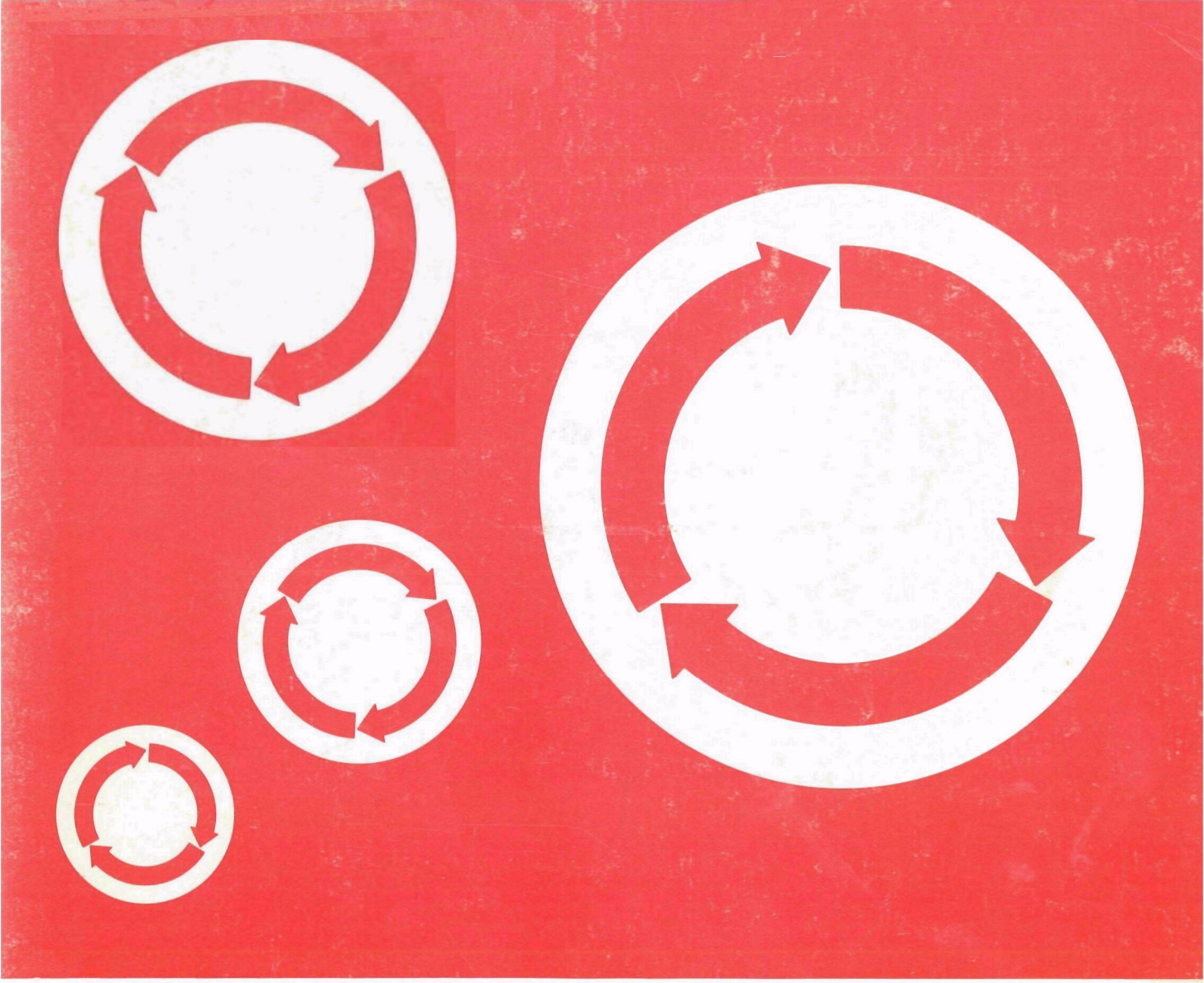

Summaries of Solid Waste Management Contracts

SUMMARIES OF SOLID WASTE MANAGEMENT

CONTRACTS

July 1, 1965—June 30, 1970

This publication (SW-5.3) was compiled by
HUGH H. CONNOLLY

U.S. ENVIRONMENTAL PROTECTION AGENCY
1972

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Requests for technical information related to specific contracts should be addressed to the Office of Solid Waste Management Programs, U.S. Environmental Protection Agency, Washington, D.C. 20460 Requests for published information should be addressed to Solid Waste Management Publications Distribution, Cincinnati, Ohio 45268, or to the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

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FOREWORD

THE CONTRACT MECHANISM is an integral arm of the Office of Solid Waste Management Programs of the U.S. Environmental Protection Agency.* Technical investigations are conducted by the Office's own staff. But this staff cannot be the size required for carrying on all the research and studies needed for solutions to the Nation's problems of managing its solid wastes. While capabilities of universities and other nonprofit organizations are being tapped through research grants as well as other types of grants,[1-3] contracts make it possible to use the accumulated practical experience and trained staffs of business and professional consultants.

Contracts are administered by means of regular written reports and oral discussion on a basis comparable to the review of work performed within the Office itself. This helps to ensure that the contract research fully meets the study intent. At the same time it keeps the Office staff informed on research progress and findings as they develop.

It is also important that the research world and the public at large learn of the results of contract investigations. Although a full report on each contract is usually published upon conclusion of the work, there is a legitimate demand for publication of prospectuses of the contracts and any information that can be made available on contract progress.

The present compilation is intended to satisfy that need. It contains abstracts on contracts undertaken from the beginning of activities conducted with funds appropriated under the Solid Waste Disposal Act. In the initial stages, many of the subjects for study were suggested by applicants and led to unsolicited contracts. As more detailed information was developed, it became easier to pinpoint gaps in our solid wastes knowledge and, therefore, to utilize contracts that are directed toward meeting these deficiencies.

The variety and extent of subject matter defy easy characterization and can be judged only by a look at the table of contents. The contracts described in this publication, as well as other contracts planned, hold great promise of extending the field of knowledge on solid waste management and, at the same time, of promoting a fruitful business–government partnership.

—SAMUEL HALE, JR.
Deputy Assistant Administrator
for Solid Waste Management

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* As this report was written before the current organization took effect, the Office is referred to as the Solid Waste Management Office (SWMO) throughout the remainder of the publication.

[1] LEFKE, L. W., A. G. KEENE, R. A. CHAPMAN, and H. JOHNSON, *comps.* Summaries of solid waste research and training grants—1970. Public Health Service Publication No. 1596. Washington, U.S. Government Printing Office, 1971. 134 p.

[2] SPONAGLE, C. E., and P. L. STUMP. Solid waste management demonstration grant projects—1971; for grants awarded during the period June 1, 1966—June 30, 1971. Public Health Service Publication No. 1821. Washington, U.S. Government Printing Office, 1971. 247 p.

[3] TOFTNER, R. O., D. D. SWAVELY, W. T. DEHN, and B. L. SWEENEY, *comps.* State solid waste planning grants, agencies, and progress—1970, report of activities through June 30, 1970. Public Health Service Publication No. 2109. Washington, U.S. Government Printing Office, 1971. 26 p.

CONTENTS

SUMMARIES OF SOLID WASTE MANAGEMENT CONTRACTS

July 1, 1965—June 30, 1970

THIS IS A COMPENDIUM of contract projects supported by the Solid Waste Management Office (SWMO) and its predecessors since the passage of the Solid Waste Disposal Act of 1965. The purpose of the publication is to inform interested readers of the variety of contracts being supported in such a way that information developed from this activity can be made quickly available and disseminated to those persons who can best use the information. We hope that the publication may stimulate prospective contractors to conceive new approaches that through research and development will lead to an advancement of technology and to better methods of solid waste management.

The Solid Waste Disposal Act of 1965, as amended by the Resource Recovery Act of 1970, directs the Secretary of the Department of Health, Education, and Welfare (functions transferred by Reorganization Plan No. 3 to the Administrator, Environmental Protection Agency) to conduct and encourage—and to cooperate with and assist appropriate public authorities, agencies, and institutions; private agencies and institutions; and individuals in the conduct of: (1) research, training, demonstrations, surveys, and other studies relating to adverse health and welfare effects caused by solid wastes; (2) operation and financing of solid waste disposal programs; (3) reduction of the amounts of such waste and unsalvageable waste materials; (4) development and application of new and improved methods of solid waste processing and materials and energy recovery; (5) identification of solid waste components and potential recoverable materials and energy.

In carrying out the provisions as directed, the Secretary is authorized to: (1) collect and make available, through publications and other means, the results of such research and other activities; (2) cooperate with public and private agencies, institutions, and industries in the preparation and conduct of such research and other activities; (3) make grants-in-aid and contracts with public or private agencies, institutions, and individuals for research, training, surveys, and demonstrations.

Any grant, agreement, or contract made or entered into is to contain provisions effective to ensure that all information, uses, processes, patents, and other developments resulting from any activity undertaken pursuant to such grant, agreement, or contract will be made readily available on fair and equitable terms to those industries utilizing methods of solid waste disposal and to industries engaged in furnishing devices, facilities, equipment, and supplies to be used in connection with solid waste disposal.

The summaries, arranged alphabetically by contractor, represent the efforts made to carry out this contract authority. One can readily see that there is no single approach applicable to the wide variety of solid wastes produced and that, as the concept of solid waste management has developed, so has the scope of our contracts. The characteristics of solid wastes are continually changing through product innovation, industrial process modification, and changes in living habits of the general population. Storage, collection, transport, processing, utilization, and disposal practices must continually be modified to keep pace with these changes.

Research contracts are used to implement the efforts directed by the Solid Waste Disposal Act of 1965 and the Resource Recovery Act of 1970. The contract mechanism makes it possible to support projects for which neither staff nor equipment is available. This mechanism permits the national program to utilize specialized facilities, organizations, and capabilities wherever they may exist. A contract may be a separate project in itself or may complement in-house research.

Solicited contracts are awarded to qualified contractors who submit the best proposals in response to advertised requests as they appear in the *Commerce Business Daily*. This competitive mechanism is used to ensure that the work required will be performed in the most economical manner by those best qualified.

Profit and nonprofit organizations desiring to perform research within the scope and intent of the Solid Waste Disposal Act are invited to submit proposals for consideration. All proposals submitted are evaluated for technical contribution and program relevancy, and compete with other proposals, both solicited and unsolicited, for priority funding.

A format, selected to enable the reader to become aware of the actual content of resultant publications, includes the objectives, the approach used, and a summary of progress where available.

PUBLIC HEALTH RELATED TO SOLID WASTE

CONTRACT NO. PH 86-66-151

CONTRACTOR
Aerojet-General Corp.
1100 West Hollyvale Street
Azusa, Calif. 91702

COST: $58,414
PROJECT START: June 1966
PROJECT END: January 1967

PROJECT DIRECTOR
Thrift G. Hanks

OBJECTIVE: To obtain a thorough and consistent listing and evaluation of health problems reported to be associated with solid waste disposal by identifying the relationships between human health and solid waste management.

APPROACH: The contract was primarily concerned with those relationships resulting in disease processes. A survey of the technical world literature was made: (1) to identify types, sources, disease processes, and occupational descriptions; (2) to accumulate data and establish identifiable relationships; (3) to note and tabulate significant conclusions and recommendations; (4) to provide an annotated bibliography of related survey literature; (5) to organize and publish a survey report on the public health aspects of solid waste handling and disposal.

SUMMARY OF PROGRESS: A report on the comprehensive literature survey, *Solid Waste/Disease Relationships,* was published. In this report each postulated solid waste/disease relationship is presented as follows: (1) a general statement on the disease under consideration; (2) a postulation on its association with wastes; (3) the evidence found in the literature supporting this postulation; (4) discussion of the evidence; (5) conclusions relative to the disease/waste association and to possible projections of the observations; (6) recommendations for research or other action.

HANKS, T. G. *Solid waste/disease relationships; a literature survey.* Public Health Service Publication No. 999-UIH-6. Washington, U.S. Government Printing Office, 1967. 179 p.

IDENTIFICATION PROGRAM FOR SOLID WASTE RESEARCH

CONTRACT NO. PH 86-67-126

CONTRACTOR
Aerojet-General Corp.
Life Science Division
1100 West Hollyvale Street
Azusa, Calif. 91702

COST: $19,025
PROJECT START: May 1967
PROJECT END: August 1967

PROJECT DIRECTOR
Thrift G. Hanks

OBJECTIVE: To develop a system for assigning priorities to selected research and development projects related to solid waste and public health problems.

APPROACH: A study of solid waste/disease relationships revealed research needs in a number of important areas. A detailed evaluation and assignment of priorities to those areas, however, was beyond the scope of that study. This research program was designed to select the most important topics from that report and to develop a series of task descriptions for specific research and development projects. Cost estimates as well as work statements, a description of the specific problem and its background, and an outline of a program devoted to its solution were included for the 10 most important projects.

SUMMARY OF PROGRESS: The final report on a solid waste research identification program has been accepted. The report, designed for in-house use, describes in detail the rationale and methods used, the various ratings obtained, conclusions, recommendations, work statements, and a basic research program outline.

TRAINING COURSES FOR PUBLIC WORKS OFFICIALS

CONTRACT NO. PH 86-66-146

CONTRACTOR
American Public Works Assoc.
1313 East 60th Street
Chicago, Ill. 60637

COST: $86,523
PROJECT START: June 1966
PROJECT END: August 1968

PROJECT DIRECTOR
Robert D. Bugher

OBJECTIVE: To develop a package of training courses for those operators, managers, and public works officials concerned with various aspects of solid waste management that can be used to broaden solid waste training throughout the Nation.

APPROACH: A comprehensive blueprint for the training of personnel in the field of solid waste management was to be prepared. This would include fully developed courses previously tested in pilot programs, a fully developed curriculum tailored to existing needs. and well developed teaching methodology including instructions for the use of training aids. Consideration was to be given to the educational backgrounds, work experiences, and career goals of operating officials, the requirements and responsibilities of the positions, and the socioeconomic and technical trends most likely to alter the function of operating personnel.

SUMMARY OF PROGRESS: Course outlines were prepared and pilot courses conducted in six major cities on: (1) incinerator plant operation; (2) sanitary landfill operation; (3) solid waste management; (4) refuse collection; (5) solid wastes technology; (6) solid waste management policy.
Copies of the course packages are available for review at SWMO offices in Cincinnati, Ohio and Rockville, Maryland. No publication is planned.

COMPILATION OF SOLID WASTE LEGISLATION

CONTRACT NO. CPE 70-118

CONTRACTOR
Autocomp Inc.
Autocode Division
7910 Woodmont Ave.
Bethesda, Maryland 20014

COST: $141,840
PROJECT START: June 1970
PROJECT END: January 1972

PROJECT DIRECTOR
Carl P. Fisher

OBJECTIVE: State and territorial legislation will be searched for applicability to solid wastes. Photocopies of the relevant laws will be made, indexed, and cross-indexed in sufficient detail for layman use. A compendium will be prepared from the applicable laws for publication.

APPROACH: All legislation of the 50 States, the District of Columbia, and the territories of American Samoa, Guam, Puerto Rico, and the Virgin Islands will be searched for applicability to solid wastes. This includes enabling legislation, direct prohibitions, and direct authorizations. Legislation may be found in such widely separated portions of the codes as those dealing with agriculture, health, labor, highways, industry, water, and air. Examples of legislation to be covered include laws regarding storage, collection, transportation, processing, vehicles, demolition materials, animal and vegetation wastes, as well as wastes from households and commercial and industrial establishments. Included also are the general nuisance laws, zoning regulations (to the extent codified). rule-making authorizations to State agencies or local or regional jurisdictions, all insofar as they pertain to the management of solid wastes.

Once located, the State and territorial laws will be checked with *Shepherd's Citator,* or the equivalent, to assure their currency as of the date of the contract. Laws that have been repealed will be eliminated, and new acts or amendments will be included up to the date of the contract.

The compendium will be by State or territory and will consist of abstracts of the particular provisions organized on a uniform subject matter basis.

SUMMARY OF PROGRESS: All territorial and State legislation has been indexed and checked to assure its accuracy to date of contract, and Phase I has been completed with submission of State-by-State volumes containing photo copies of existing legislation. Plans have begun for the development of the format and organization of the compendium —Phase II of the contract.

STATUS OF SOLID WASTE PROCESSING

CONTRACT NO. PH 86-66-160

CONTRACTOR
Battelle Memorial Institute
Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201

COST: $57,265
PROJECT START: June 1966
PROJECT END: February 1967

PROJECT DIRECTOR
Richard B. Engdahl

OBJECTIVE: To assemble all available information on solid waste processing in order to provide a concise reference useful to those concerned with the development of new and improved processes.

APPROACH: Information on the reliability of the processes, performance data, economic factors, and range of pertinent commercially available equipment and devices was obtained by surveying and examining existing technical processes and techniques. This included both industrial and municipal applications with evaluations as to applicability to solid waste treatment. The general processes considered were: (1) densification and size reduction; (2) separation; (3) recovery and utilization; (4) chemical processing. Special problems such as health hazards and environmental pollution were to be examined.

SUMMARY OF PROGRESS: A report on the status of unit operations and processes for solid waste disposal has been accepted. The report summarizes the present status of methods now or recently in use for the disposal and utilization of solid wastes. The report shows that, although a few aspects of solid waste processing are well developed, the availability of economic methods for most solid waste problems is scarce or nonexistent. The summary is organized under four general headings into which the study is divided.

ENGDAHL, R. B. *Solid waste processing; a state-of-the art report on unit operations and processes.* Public Health Service Publication No. 1856. Washington, U.S. Government Printing Office, 1969. 72 p.

EVALUATION OF SOLID WASTE PROCESSING

CONTRACT NO. PH 86-67-265

CONTRACTOR
Battelle Memorial Institute
505 King Avenue
Columbus, Ohio 43201

COST: $76,650
PROJECT START: June 1967
PROJECT END: October 1968

PROJECT DIRECTOR
Robert F. Testin

OBJECTIVE: To investigate, evaluate, and document separation and recovery equipment, processes, and techniques that have potential application in the areas of solid waste separation and utilization.

APPROACH: The investigation involved a study to establish the range of expected characterization of solid wastes, including total amounts, and physical and chemical properties. A literature survey, solicitations to manufacturers, and analyses of existing reclamation and disposal plants were used to compile a list of equipment and techniques and to assess their applicability to various types of solid wastes. For each unit process considered, appropriate operating information was compiled, and effects of input characteristics on capital and operating costs and the output products and any synergistic or antagonistic effects of various processes on one another were assessed. Information was obtained to define process capabilities, reliability, economics, availability of commercial equipment, and special operational problems. Appropriate mathematical, statistical, and economic methods were used to develop capital and operation cost relationships as functions of input and output characteristics.

SUMMARY OF PROGRESS: The final report has been accepted. The expected characteristics of solid wastes, including the amounts and physical and chemical properties, have been tabulated. Through literature surveys, solicitations from manufacturers, and analyses of existing reclamation and disposal plants, the list of techniques and equipment and processes to the solid waste field has been assessed. Process capabilities, reliability, economics, availability of commercial equipment, special operational problems, and health hazards have been defined. Using appropriate mathematical, statistical, and economic methods, capital and operating cost relationships have been developed. Feasible combinations of processes or equipment have been suggested.

DROBNEY, N. L., H. E. HULL, and R. F. TESTIN. *Recovery and utilization of municipal solid waste; a summary of available cost and performance characteristics of unit processes and systems.* Public Health Service Publication No. 1908. Washington, U.S. Government Printing Office, 1971. 118 p.

MANAGEMENT STUDY—THE PRINTING AND PUBLISHING INDUSTRY

CONTRACT NO. CPE 69-6

CONTRACTOR
Battelle Memorial Institute
505 King Avenue
Columbus, Ohio 43201

COST: $73,484
PROJECT START: May 1969
PROJECT END: January 1971

PROJECT DIRECTOR
Rufus C. Short

OBJECTIVE: To study and evaluate the solid waste management practices of the publishing and printing industry, SIC 271, 272, 273, and 275.

APPROACH: Information and data will be collected on the following items of the publishing and printing industry on a national basis: (1) total number of industrial plants, employment, capital value of the plants, and quantities and types of products produced; (2) past development and production patterns within the industry indicating present trends, new technology, and future development; (3) flow diagrams for the basic production processes; (4) location of the industries with particular notation of production centers in the country; (5) identification of the quantity (weight) and quality (character) of solid waste generated; (6) correlation of solid waste production with a readily available universal parameter of the plant; (7) identify and analyze the current storage, collection, and disposal practices of the industry; (8) amount of money being spent for storage, collection, treatment, and disposal of solid waste for the industry; (9) analysis of the future trends of solid waste management within the industry and factors that might influence them, such as reuse, etc.

The methodology to collect the information and data will consist of a literature review and a variety of different types of field interviews. Following the data collection phase, the information will be analyzed and evaluated.

SUMMARY OF PROGRESS: Prior to beginning data collection, a literature review was carried out, plants were grouped by SIC numbers and location, and an interview guide was developed. Data collection was followed by an analysis phase, and a preliminary draft of the final report was submitted. Review of the draft is nearly complete, and a final report will be printed.

DISMANTLING RAILROAD FREIGHT CARS

CONTRACT NO. PH 86-67-100

CONTRACTOR
Booz, Allen Applied Research Inc.
4733 Bethesda Avenue
Bethesda, Md. 20014

COST: $50,000
PROJECT START: March 1967
PROJECT END: December 1967

PROJECT DIRECTOR
Dale M. Butler

OBJECTIVE: To encourage the development of new and improved methods of railroad car dismantling and salvage operations that permit reuse of waste materials without presenting environmental problems.

APPROACH: On-site observations and interviews with key personnel were used to study current operating practices of railroad car dismantlers throughout the country, and to summarize information on proposed new techniques. Feasibility studies on new techniques that promise acceptable pollution control and economic practicality were investigated. A system for rating proposed car dismantling systems in order to select the best method for prototype development was undertaken.

SUMMARY OF PROGRESS: A final report containing the findings, conclusions, and recommendations has been accepted.

In effect the study was a pilot application of the systems approach to the difficult and complex problems presented by pollution and effective resource utilization. Many aspects of developing technology were investigated including new forms of explosives, high-speed water jets, cryogenic brittlizing agents, and advanced methods in wood utilization. Two approaches were suggested for prototype development: a system of cutting wood from railroad cars using high-pressure, manually operated water jets, and a system of using the car itself for an incinerator with a stack installed directly on the car to control effluent emissions.

BUTLER, D. M., and W. M. GRAHAM. *Dismantling railroad freight cars; a study of improved methods with application to other demolition problems.* Public Health Service Publication No. 1850. Washington, U.S. Government Printing Office, 1969. 32 p.

TECHNICAL-ECONOMIC STUDY OF SOLID WASTE DISPOSAL

CONTRACT NO. PH 86-66-163

CONTRACTOR
Combustion Engineering, Inc.
New Products Division
1000 Prospect Hill Road
Windsor, Conn. 06095

COST: $156,375
PROJECT START: June 1966
PROJECT END: November 1967

PROJECT DIRECTOR
Elliot D. Ranard

OBJECTIVE: To obtain data on: (1) disposal costs for municipal and industrial solid wastes with the additional costs that will be required to meet disposal standards which prevent land, water, and air pollution; (2) relative importance of such variables as technical developments, population movements, living habits, etc., that affect the composition and quantity of solid wastes; (3) reliable techniques and models for predicting collection and disposal facility needs.

APPROACH: Through surveys and personal interviews in selected U.S. cities, in-depth studies on municipal and industrial solid waste practices were undertaken in order to obtain installed capacity of refuse disposal facilities, estimates of the production of industrial solid wastes, and projections for generation and capacities in selected areas to 1975. Mathematical models to predict requirements for waste reduction facilities and refuse production were developed. The contractor also analyzed the problems relative to a refuse sampling and information system and gathered and analyzed data to describe the operational situations and information input and output.

SUMMARY OF PROGRESS: A four-volume report was accepted by the SWMO, and selected sections were published. *Municipal Inventory* presents surveys made of various cities to obtain data on amounts and types of waste generated, with a mathematical model for the Nation that predicts future amounts of solid wastes that will be generated. *Industrial Inventory* presents results of a survey of 23 industries indicating the disposal techniques used. *Information System* emphasizes the need for a solid waste information system to aid municipalities in planning refuse disposal plants. *Technical-Economic Overview* presents an overview of waste management systems based on in-depth interviews in a selected number of cities.

COMBUSTION ENGINEERING, INC. *Technical-economic study of solid waste disposal needs and practices.* Public Health Service Publication No. 1886. Washington, U.S. Government Printing Office, 1969. [705 p.] (Distributed by National Technical Information Service, Springfield, Va., as PB-187 712. 700 p.)

ADDITIONAL PUBLICATIONS RESULTING FROM CONTRACT NO. PH 86-66-163

BACHER, J. H., and E. D. RANARD. Use of mathematical planning models to predict incineration requirements. In *Proceedings, 1968 NationalIncinerator Conference*, New York, May 5-8, 1968, American Society of Mechanical Engineers. p. 1-11.

COHAN, L. J., and J. H. FERNANDES. Potential energy-conversion aspects of refuse. Paper presented at the Eighty-eighth Winter Annual Meeting of the American Society of Mechanical Engineers, Pittsburgh, Nov. 12-17, 1967. 7 p.

FERNANDES, J. H. Incinerator air pollution control. In *Proceedings, 1968 National Incinerator Conference,* New York, May 5–8, 1968, American Society of Mechanical Engineers. p. 101–116.

KALIKA, P. W. The effects of variations in municipal refuse on some incinerator design parameters. Paper presented at the Eighty-eighth Winter Annual Meeting of the American Society of Mechanical Engineers, Pittsburgh, Nov. 12–17, 1967. 10 p.

KALIKA, P. W. Influence coefficients to relate municipal refuse variations to incinerator design. In *Proceedings, 1968 National Incinerator Conference,* New York, May 5–8, 1968, American Society of Mechanical Engineers. p. 154–170.

FEASIBILITY OF INCINERATION—JET ENGINE TECHNOLOGY

CONTRACT NO. PH 86-67-259

CONTRACTOR
Combustion Power Company, Inc. (formerly Aerospace Commercial Corporation)
Stanford Industrial Park
2625 Hanover Street
Palo Alto, Calif. 94304

COST: $138,164
PROJECT START: June 1967
PROJECT END: June 1968

PROJECT DIRECTOR
Richard D. Smith

OBJECTIVE: To determine the technological and economic feasibility of a system of solid waste incineration that utilizes waste heat to generate electric power through a jet turbine.

APPROACH: Engineering studies were conducted as necessary to investigate use of a standard jet engine to receive the cleaned gases from the incineration of solid wastes. Separate studies were required to determine the effects of chemical composition, products of combustion, and heating values. In addition, surveys were conducted on shredders, preheat feeders, and separators to obtain equipment suitable for use with the refuse combustor.

SUMMARY OF PROGRESS: A technical abstract on the feasibility study was reviewed. The results of the study indicated that the project is technically feasible and economically attractive. An additional contract to conduct key subscale experiments for several components of the jet turbine incinerator was awarded [see: Subscale experiments on the model 400 combustion power unit (CPU–400), Contract No. PH 86–68–198.]

SUBSCALE EXPERIMENTS—CPU-400

CONTRACT NO. PH 86-68-198

CONTRACTOR
Combustion Power Company, Inc.
1346 Willow Road
Menlo Park, Calif. 94025

COST: $2,179,381
PROJECT START: June 1968
PROJECT END: January 1971

PROJECT DIRECTOR
Richard D. Smith

OBJECTIVE: The objective of this contract is to build and test subscale models of various combustor and particle collector devices to obtain necessary information for final design for the CPU–400 system. The CPU–400 system makes use of a gas turbine powered by waste heat from incineration of refuse for the purpose of generating electricity.

APPROACH: The contractor will investigate the design parameters of continuous flow incineration by a fluidized bed combustor. The investigation requires the design, fabrication, and testing of two different fluid bed combustors; (1) a large (8-ft. diameter) bed operated at low pressure which will determine the refuse feed and distribution problems; (2) a small (12-inch diameter) high-pressure (60 to 100 psia) bed to determine heat release rates, combustion products, etc. The contractor will also investigate three different particle collection devices—an electrostatic precipitator, a mat filter, and an inertial separator—to determine the best device (or combination of devices) to be used for the CPU–400.

SUMMARY OF PROGRESS: The electrostatic precipitator and the inertial separator tests showed that both items are feasible to use at CPU–400 pressure and temperature conditions. The mat filter concept tested was found not to be feasible because of difficulties encountered in its cleaning.
The 12-inch fluid bed experiments have indicated that high pressure fluid bed combustion of municipal solid waste is feasible and capable of heat release rates in excess of 500,000 Btu/ft^3/hr. Design and fabrication work was completed on a large-scale fluidized bed combustor along with solid waste handling equipment which is required for a continuous flow operation. Testing of this combustor and appurtenant handling equipment is now in progress.

CPU-400 PROGRAM MANAGEMENT AND SYSTEMS ENGINEERING

CONTRACT NO. CPE 69-100

CONTRACTOR
Combustion Power Company, Inc.
1346 Willow Road
Menlo Park, Calif. 94025

COST: $283,103
PROJECT START: August 1968
PROJECT END: October 1970

PROJECT DIRECTOR
Richard D. Smith

OBJECTIVE: To provide program management for the component developments by various subcontractors and to investigate the CPU–400 as a total system. The results of this investigation, combined with the results of the key subscale experiments, will be combined to refine the preliminary design for the CPU–400 to the point where detailed design work may be started.

APPROACH: Overall management for the CPU–400 will be provided. A systems design study will be conducted on five subsystems of the CPU–400: solid waste handling, hot gases, turbo-electric, controls, and residue handling. Materials corrosion, exhaust gas contamination, and acoustics studies will be made. Turbine compatibility tests will be defined and economic applications studies will be undertaken.

SUMMARY OF PROGRESS: The design of the CPU–400 has been updated in both the solid waste handling and hot gas subsystems. The provision for unshredded storage has been eliminated in the solid waste subsystem, and the combustor configuration has been changed from 3 combustors all piped into the system to 2 combustors with a spare on hand. The total CPU–400 system has been identified as having 19 different components, and preliminary specifications have been made for each component. Materials corrosion studies were performed by analysis of several different alloys after prolonged exposure to incinerator fly ash. All metals tested showed corrosive attack; the alloy which performed best was Inconel 625. Exhaust gas contamination studies indicate that HCl and SO_x can be suppressed by limestone injection into the bed. Acoustic surveys on shredder and turbine installations demonstrated the need for sound suppression to be considered in the design. Applications studies showed additional CPU–400 uses such as desalinization, sludge incineration, and activated char production.

SYSTEMS ANALYSIS OF SOLID WASTE DISPOSAL

CONTRACT NO. PH 86-67-254

CONTRACTOR
Cornell Aeronautical
Laboratories, Inc.
Post Office Box 235
Buffalo, N.Y. 14221

COST: $98,515
PROJECT START: June 1967
PROJECT END: March 1969

PROJECT DIRECTOR
Edwin W. Roth

OBJECTIVE: To develop a mathematical model for determining the overall costs and effectiveness of alternate waste disposal systems within a regional solid wastes system.

APPROACH: The contractor will collect and analyze existing regional data, identify indirect social costs, and establish a realistic range of constraints on deleterious effects. With this data and related background information, a mathematical model of politically realistic regional solid waste systems, which computes overall costs and performance, will be formulated. The major output of the study will be a first definition of a model or simulational method and its implementation. The model will be used to prepare a program for future work centered around comprehensive utilization of the developed model with an expansion and refinement of the model structure.

SUMMARY OF PROGRESS: A final report has been printed. It discusses systems analysis of regional solid waste management, the structure of regional solid waste management systems evaluation, a facility choice model as an aid in regional solid waste management decision making, and various facts about the Buffalo Standard Metropolitan Statistical Area (SMSA), which was the empirical base for the study.

MORSE, N., and E. W. ROTH. *Systems analysis of regional solid waste handling.* Public Health Service Publication No. 2065. Washington, U.S. Government Printing Office, 1970. [294 p.]

OCEANIC DISPOSAL OF SOLID WASTES

CONTRACT NO. PH 86-68-203

CONTRACTOR
Dillingham Corporation
Applied Oceanography Branch
11803 Sorrento Valley Road
San Diego, Calif. 92121

COST: $76,646
PROJECT START: June 1968
PROJECT END: August 1970

PROJECT DIRECTOR
David D. Smith

OBJECTIVE: To determine the nature and magnitude of present oceanic disposal practices and to investigate their current or potential hazards to public health.

APPROACH: Information from the Corps of Engineers District Offices provided background information on marine disposal operations in their respective areas of control. This led to a series of interviews with waste producers, disposal operators, and pertinent municipal, State, and Federal agencies in: Seattle, Portland (Oregon), San Francisco, Los Angeles, San Diego, Galveston, Texas City, Houston, Port Arthur, Beaumont, New Orleans, Pascagoula, Mobile, St. Petersburg, Charleston, Norfolk, Baltimore, Philadelphia, New York, and Boston.

The information collected was compiled, summarized, and evaluated by a team of marine biologists, oceanographers, and sanitary engineers to provide the current "state of the art" of oceanic disposal of solid wastes and industrial sludges by barges off U.S. coastal cities.

SUMMARY OF PROGRESS: The entire study has been completed and a report submitted. Information in the report is very helpful in assaying the magnitude of and some of the problems associated with disposing of solid wastes and industrial sludges at sea. While the report deals only with those wastes being barged, it nonetheless fills an information gap and outlines specific conclusions that will assist the SWMO in accomplishing its goals.

SMITH, D. D., and R. P. BROWN. *Ocean disposal of barge-delivered liquid and solid wastes from U.S. coastal cities.* Public Health Service Publication No. 2113. Washington, U.S. Government Printing Office, 1971. 119 p.

PATHOGENS AND INDICATOR ORGANISMS IN REFUSE-SLUDGE COMPOSTING

CONTRACT NO. PH 86-67-112
PH 86-68-143

CONTRACTOR
East Tennessee State University
Department of Microbiology
Johnson City, Tennessee 37601

COST: $81,550
PROJECT START: June 1967
PROJECT END: May 1969

PROJECT DIRECTOR
William L. Gaby

OBJECTIVE: Phase I—To study the occurrence and persistence of pathogens and indicator organisms in refuse-sludge composting. Phase II—To study the survival of pathogens and indicator organisms in refuse-sludge composting by the windrow method.

APPROACH: Methods were selected and developed to permit a quantitative study of recovery of pathogens and indicator organisms during the processing of municipal refuse-sewage sludge mixtures. The first phase was devoted to investigation of the occurrence of pathogenic organisms in raw refuse and sewage sludge and their survival through the composting process. The second phase covered the insertion of certain pathogens into the composting refuse-sludge mixture and determining their survival by the examination of samples withdrawn at various successive stages of the composting process.

SUMMARY OF PROGRESS: During Phase I, determinations were made on raw or partially digested sludge, refuse, and refuse-sludge mixtures for the following: total bacterial counts at 35° C and 55° C for aerobes and anaerobes, total coliforms, *Escherichia coli,* salmonella, staphyloccoci-coagulase positive, *Streptococcus faecalis,* enteroviruses, pathogenic fungi, and human and animal parasites. A total of 602 samples was collected from 30 windrows, refuse, sludge, and refuse-sludge mixtures. These samples were taken when the windrows were laid down, at various intervals during the process, and on the terminal day (49 to 56 days).

In all, 1,137 samples of bacteria, fungi, parasites, and viruses were inserted in 24 windrows during Phase II. In conformity with the previous work, the samples were planted at various positions within the compost and withdrawn at intervals during the process. The studies showed that pathogen destruction is achieved in the central mass of windrows of refuse-sludge mixtures during normal composting where temperatures remain between 140° F and 160° F for about 20 days. The windrows were turned eight or nine times in the 35 to 42 days on the field in order to subject all material to the high temperatures. It was concluded that properly managed windrow composting with raw or partially digested sewage sludge will result in a product that is safe for agricultural or gardening use. Proper management consists of maintaining the moisture content between 50 and 60 percent by weight, turning with sufficient frequency to maintain aerobic conditions, and carefully preparing windrows before turning to insure thorough mixing. Pathogens in compost do not represent any greater risk than other activities in which man participates. It is not planned to publish the report on this contract because the information is intended primarily for use by the SWMO.

COMPOSTING DEWATERED SEWAGE SLUDGE

CONTRACT NO. PH 86-67-103

CONTRACTOR
The Eimco Corporation
537 West Sixth South
Salt Lake City, Utah 84103

COST: $67,695
PROJECT START: March 1967
PROJECT END: July 1968

PROJECT DIRECTOR
J. L. Boyd

OBJECTIVE: To study the composting of dewatered sewage sludge using a "mechanical type" composter in order to provide a means of processing the sewage sludge and other organic types of sludge into an end product that is odor free, devoid of insect life and pathogens, easy to handle, and useful for agricultural purposes.

APPROACH: Using facilities at Salt Lake City's sewage treatment plant, a pilot plant was constructed by Eimco Corporation. Thickened sludge was dewatered on a vacuum filter and conveyed to the mechanical composter, which was equipped with stirring, aerating, sampling, and measuring devices. Tests were conducted to determine: (1) the limits of moisture content of sludge cake; (2) necessary recycle ratios; (3) processing capacity for the sewage sludge in terms of volume and time; (4) required air; (5) temperature in various parts of the composting mass; (6) chemical and physical composition of the final product; (7) influence of varying feed rates; (8) limits of batch feeding; (9) composition of gas evolved from the composting mix; (10) influence of chemicals used for sludge conditioning before vacuum filtration. In addition, under a subcontract, the University of Utah School of Medicine made studies on the destruction of pathogenic bacteria, fungi, cysts, and viruses in the composted material.

SUMMARY OF PROGRESS: Characteristics of the mechanical composted dewatered sewage sludge have been observed and recorded. Weight, volume, moisture, and solids reduction have been observed at several retention times. Conspicuous effects appeared to be that of drying (80–88 percent reduction in water), effective destruction of the organic matter by the thermophilic organisms, and the destruction of pathogenic organisms inoculated into the system. Routine observations have been made on temperature at various places throughout the composter, the thoroughness of mixing of the material, the rate of gaseous emissions, and the identification of some of these gases. Various relationships have been established between the rate of air flow into the compost material, the recycling rate, the mixing of the material, and the composting temperature. The final report has been published.

SHELL, G. L., and J. L. BOYD. *Composting dewatered sewage sludge.* Public Health Service Publication No. 1936. Washington, U.S. Government Printing Office, 1970. 28 p.

OCCUPATIONAL HEALTH IN SOLID WASTE MANAGEMENT

CONTRACT NO. CPE 70-114

CONTRACTOR
Enviro-Med Inc.
Suite 316
7946 Ivanhoe
La Jolla, Calif. 92037

COST: $34,826
PROJECT START: June 1970
PROJECT END: April 1972

PROJECT DIRECTOR
R. J. Hasterlik

OBJECTIVE: The study will analyze solid waste management systems to determine if useful conclusions can be drawn on the nature, causes, and frequencies of accidents to employees engaged in solid waste handling. Based upon this, the contractor will develop a plan for conducting a broad-based, detailed study that would provide statistically valid information applicable to the entire solid waste industry.

APPROACH: The contractor will conduct on-site investigations of the records of six solid waste management systems to determine and compile the information available on the nature, causes, and frequencies of employee accidents resulting from the handling of solid waste over the past four years. The information sources shall include both the public and private sectors of the solid waste industry. The sources sampled will include two solid waste handling systems each servicing populations of over 500,000, two systems each servicing populations of 200,000 to 400,000, and two systems each servicing populations of 20,000 to 100,000.

In addition to reviewing these records, the contractor will study the records for the past four years of State, county, or municipal health departments, workmen's compensation boards, insurance companies, and other agencies with records relating to the occupational health of employees within the solid waste handling systems included in the study.

Analysis of the data will attempt to draw conclusions about the nature and rates of accidents as they may be related to employee age, level of education, physical condition, training, safety programs, and similar factors.

It is hoped that the comprehensive study, which the contractor will plan, can define major problem areas or conditions that account for high accident rates and severity. If the pilot study indicates that meaningful information is not likely to be available on a national scale, the feasibility of other data-gathering methods will be investigated.

SOLID WASTE MANAGEMENT ANNUAL FILM REPORT

CONTRACT NO. CPE 69-111

CONTRACTOR
Stuart Finley, Inc.
3428 Mansfield Road
Falls Church, Va. 22041

COST: $187,975
PROJECT START: June 1969
PROJECT END: November 1972

PROJECT DIRECTOR
Stuart Finley

OBJECTIVE: To develop film reports on solid waste research, development, and demonstration activities to serve the Bureau's basic responsibility for improving solid waste management practice in the United States through dissemination of technical information.

APPROACH: Two separate 16-mm, color, sound, motion picture films will be produced each year that document selected planning, demonstration, research and training grants, and research contracts—all funded by the SWMO.

One of the films is to be designed primarily for showing to solid waste management professionals, including but not limited to managers, planners, and technicians, as well as public officials. This film will be 45 minutes in length and more technically oriented than the second film.

A 23-min film will be designed to produce an interesting, logically developed story to inform the lay public entertainingly about the most recent advances in solid waste management.

A 15-min color film to explain "Mission 5000" will be prepared for use in meetings or on television specials. Six sets of four 60-sec. TV spots for use in explaining and eliciting public support for "Mission 5000" will be developed.

SUMMARY OF PROGRESS: *The Stuff We Throw Away,* 22 min in length, and *What's New in Solid Waste Management,* 37 min in length, both 16-mm motion pictures with sound and color, are completed. Copies of the films can be borrowed from the National Medical Audiovisual Center (Annex), Station K, Atlanta, Georgia 30324. Order numbers are M-2048-X and M-2049-X, respectively. Prints may be purchased from the contractor for $200 and $300, respectively. The "Mission 5000" materials are in production and will be provided on a pre-set delivery schedule.

Films tell the story. Washington, U.S. Government Printing Office, 1971. Flyer. 6 p. Reprinted 1971. [Addendum inserted.]

DEVELOPMENT OF HOUSEHOLD REFUSE GRINDER

CONTRACT NO. CPE 70-115

CONTRACTOR
Foster-Miller Associates, Inc.
135 Second Avenue
Waltham, Mass. 02154

COST: $78,692
PROJECT START: June 1970
PROJECT END: December 1971

PROJECT DIRECTOR
John S. Howland

OBJECTIVE: This is a two-phase project. Phase I will establish the background data required before a refuse grinder can be developed. Phase II will provide preliminary design and specifications, with approximate costs, for the refuse grinder and the proper safety controls with the capacity to macerate typical household refuse and inject it into a typical sanitary sewer.

APPROACH: Phase I. The contractor will determine if the average sanitary sewage system will be overloaded by the increase of solids (both dissolved and suspended) from the grinder process. If the sewers can handle the additional solids, the contractor will determine the maximum solids content and average particle size of the incoming refuse that can be easily transported by the sewers. From this research, a range of effluent solids content will be determined and used as a basic design criterion of the grinder. Work will be performed on a model gravity sanitary sewer system having roughness coefficients similar to existing sewer lines and with capabilities for variable slope and flow and means for injecting and extracting refuse. Tests run on this apparatus will define minimum flow rates for various refuse concentrations, the maximum refuse volume that can be transported, and types of material expected to be deposited in sewer lines. Modified sewage flow to the treatment plant will be characterized in terms of chemical constituents and possible biological effects. Existing treatment processes will be surveyed, and recommendations made for their improvement should they prove inadequate. Design criteria most applicable for a household grinder will be developed. Particular emphasis will be placed on safety devices, modifications necessary to household plumbing, and appropriate slurry concentrations. The study will also include cost/benefit analyses for grinders capable of grinding different types of wastes.

Phase II. Work on this phase will be contingent upon successful completion of Phase I. Only after a proper review of the first phase results and on an authorization to proceed will the contractor begin the preliminary design and specifications for the grinder.

ABSTRACTING AND OTHER SERVICES

CONTRACT NO. PH 86-67-182
PH 86-68-194

CONTRACTOR
Franklin Institute of the State of Pennsylvania
Benjamin Franklin Parkway
Philadelphia, Pa. 19103

COST: $328,727
PROJECT START: June 1967
PROJECT END: July 1971

PROJECT DIRECTOR
Alec Peters

OBJECTIVE: To screen, acquire, abstract, index, and prepare for publication selected patents from the United States and foreign countries covering the period from 1945 to 1969, and to prepare annotated bibliographies of refuse collection and disposal literature for the years 1964 through 1970. Also included is preparation of manuscripts for annotated bibliographies for the years 1964 through 1969 and a world patent bibliography on solid waste management for the years 1945 through 1969.

APPROACH: Compilation of patents will include only those patents covering significant technological advances in the field of solid wastes. One copy of each patent will be arranged by subject category and by accession number, and a suitable table of contents will be included. The work dealing with the annotated bibliographies will include document selection, checking for accuracy, depth of coverage, accession number, grouping by category, typing, proofreading, and indexing in order to submit the material for publication by the SWMO.

SUMMARY OF PROGRESS: Approximately 12,000 abstracts have been prepared and submitted. Many of the abstracted articles will appear in the annotated bibliographies for the years 1964 through 1970.

CONNOLLY, J. A., and S. E. STAINBACK. *Solid waste management; abstracts from the literature—1964.* Public Health Service Publication No 91-1964, Supplement G. Washington, U.S. Government Printing Office, 1971. 280 p.

VERIFICATION OF BIBLIOGRAPHIC CITATIONS

CONTRACT NO. CPE 70-135

CONTRACTOR
Franklin Institute of the State
of Pennsylvania
Benjamin Franklin Parkway
Philadelphia, Pa. 19103

COST: $20,516
PROJECT START: June 1970
PROJECT END: June 1971

PROJECT DIRECTOR
Alec Peters

OBJECTIVE: To verify 2400 bibliographic citations from contracts, grants, and research studies sponsored by the SWMO.

APPROACH: The accuracy and completeness of every element in each citation will be verified and then restyled in accordance with the SWMO *Mechanics of Style* manual. Three steps for source location will be used. If a source cannot be located for verification in three steps, the reference will be deemed unverifiable. Verified references will be retyped in the format specified by the manual on an IBM Magnetic Tape Selectric Typewriter (MTST) and proofread. Error-free hard copy MTST printouts and the MTST tape cassettes will be submitted to the SWMO.

PUBLIC AWARENESS DEVELOPMENT PROGRAM AND CASE STUDY

CONTRACT NO. CPE 70-122

CONTRACTOR
General Behavioral Systems, Inc.
Del Amo Financial Center
Torrance, Calif. 90503

COST: $79,573
PROJECT START: June 1970
PROJECT END: August 1971

PROJECT DIRECTOR
Barry Jensen

OBJECTIVE: To develop a survey questionnaire for measuring public awareness and knowledge of current solid waste practices, problems, and solutions. An educational program will be designed to increase this awareness level. The questionnaire will be administered in one city, the educational program carried out, and then the survey taken again.

APPROACH: In the development of the questionnaire, particular attention will be paid to stratification and sampling procedures that have a high probability of yielding representative results. The procedure for selecting a proper sample will be described in a manual; the method for analyzing and interpreting the results will also be included. An interviewer's instruction manual for administering the questionnaire will be prepared. The information and education program will be described in a separate report. A case study report will be written for the city in which the attitudes were measured before and after the educational program in the study.

EFFECTS OF DISPOSAL SITES UPON PROPERTY VALUES

CONTRACT NO. CPE 70-133

CONTRACTOR
General Behavioral Systems, Inc.
Del Amo Financial Center
Torrance, Calif. 90503

COST: $99,958
PROJECT START: June 1970
PROJECT END: November 1971

PROJECT DIRECTOR
Barry Jensen

OBJECTIVE: To provide a basis for cost-benefit analysis of solid waste land disposal practices by: (1) designing a methodology for assessing the effect of land disposal sites on the value of surrounding real estate; (2) identifying the variables which determine the size of these effects; and (3) quantifying these findings, where possible, in terms of a model describing the relationship between landfill operations and changes in land and real estate values.

APPROACH: Twenty sample sites will be selected. There will be four inadequate sites (or dumps), 10 sanitary landfills that have been converted from dumps, and six sanitary landfills (as originally established). The areas around each site will be defined and data requirements, sampling procedures, real estate data collection procedures, and population sampling procedures will be developed. Data collection will include: (1) historical sales data, data on sales of comparable homes, or data used in other valuation methods to determine the effect of the sites on property values; (2) data on the factors associated with each site which may influence property values; and (3) data on other variables such as demographic and economic trends.

The data will be analyzed through: (1) a predictive study to develop a mathematical model to forecast the effects of solid waste land disposal sites on property values, using linear and nonlinear regression techniques; and (2) an analytical study to explain the relationships of the various factors affecting values for particular sites. Both a statistical modeling and case history approach will be used.

FACTORS INFLUENCING CITIZENS' ATTITUDES AND RESPONSES

CONTRACT NO. CPE 69-107

CONTRACTOR
General Systems Industries, Inc.
Del Amo Financial Center
Torrance, Calif. 90503

COST: $89,502
PROJECT START: May 1969
PROJECT END: October 1970

PROJECT DIRECTOR
Barry Jensen

OBJECTIVE: To investigate those psychometric factors that influence human behavior with regard to proposed solutions to solid waste systems, and to determine the present attitudes of citizens to these problems.

APPROACH: An attitude and opinion survey will be conducted that is representative of the entire population. The socioeconomic characterization of the respondents as well as identity of the participants initiating, supporting, opposing, and negotiating solid waste management decisions will be made.
Attitudes of citizens toward solid waste problems and their current solutions will be determined and related to background factors such as sex, age, occupation, and income. A determination will be made on how these attitudes change under the influence of new information, persuasive intervention, and incentives.
The successful and unsuccessful establishment of solid waste disposal sites and public opposition to the operation of existing sites will be examined through an analysis of public and private records of the decision-making process.

SUMMARY OF PROGRESS: A draft final report was submitted that contains a description of the data collection instruments used in the study, analysis of attitudes and opinions of people living up to three miles from disposal sites in 10 cities, estimates of the perceived seriousness of solid waste disposal problems, estimates of public and official knowledge of sanitary landfill operation, summaries describing actual solid waste operation in the 10 cities studied, analysis of organizations that have protested solid waste disposal operations in three cities, comparison of attitudes, opinions, and distance from site between people objecting to solid waste disposal operation and people not objecting, analysis of public officials' site selection decision-making processes in 10 cities, communication materials and demonstration of their use to influence public opinion. Review of this draft has been completed, and a final report is in preparation.

PHOTODEGRADATION OF CELLULOSE AND WASTE PAPER

CONTRACT NO. 68-03-0006

COST: $50,000 *
PROJECT START:
January 1971
PROJECT END: July 1972

CONTRACTOR
The Gillette Research Institute
1413 Research Boulevard
Rockville, Maryland 20850

PROJECT DIRECTOR
Geoffrey Frohnsdorff

OBJECTIVE: To determine the technical and economic feasibility of a photochemical pretreatment process that enhances the degradation of cellulosic wastes. Cellulose might then be more easily assimilated by various utilization processes.

APPROACH: The contractor will establish the conditions for sensitized photodegradation of waste cellulose. The cellulosic materials to be studied are cellophane, purified soft wood, kraft paper, and hydrapulped refuse. Specific environmental conditions to be established are—temperature, relative humidity, illumination, and the selection of a sensitizing photodegradation agent. The effect of this photodegradation process will be assessed by measuring certain physical and chemical properties and increased rates of biodegradation obtained in fermentation processes. This project, if successful, will provide relevant data on cellulose photodegradation to be used in the development of economical waste cellulose recycling processes.

* Federal share: $1,000
Contractor contribution: $49,000

OPERATION BREAKTHROUGH

CONTRACT NO. CPE 70-136

CONTRACTOR
Greenleaf/Telesca
1451 Brickell Avenue
Miami, Fla. 33131

COST: $64,506 *
PROJECT START: June 1970
PROJECT END: June 1971

PROJECT DIRECTOR
Bruce C. Pearl

* Funded by reimbursible Housing and Urban Development funds.

OBJECTIVE: To provide technical assistance to "Operation Breakthrough" of the Department of Housing and Urban Development (HUD).

APPROACH: The contractor will perform individual site analyses and determinations of site characteristics that will influence solid waste management systems. Possible techniques that may be used will be evaluated. These include existing methods as well as those which may be applicable when tried. Candidate systems that would be appropriate for "Operation Breakthrough" housing and which promise high chances of success will be developed. In conjunction with this, a procedure will be established that can be used for selecting a candidate system for each site, and each system-site combination will be assigned a priority ranking. After completing this work, the contractor will submit the findings of the study and a plan for a separate contract, which is expected to include such items as pilot scale testing, performance evaluation criteria, system installation, planning for operation and maintenance, and testing of the completed systems.

GREENLEAF/TELESCA. *Solid waste management in residential complexes.* Washington, U.S. Government Printing Office, 1971. [419 p.]

COMPOSTING TECHNOLOGY AND COMPOST UTILIZATION IN EUROPE

CONTRACT NO. PH 86-67-13

COST: $10,000
PROJECT START: August 1966
PROJECT END: June 1967

CONTRACTOR
Samuel A. Hart
720 Anderson Road
Davis, Calif. 95616

PROJECT DIRECTOR
Samuel A. Hart

OBJECTIVE: To investigate composting and other biodegradation techniques as practiced in Europe and to evaluate the utilization of the products.

APPROACH: Information and data were gathered by on-site investigation and personal interviews with key personnel. Comparative descriptions of plant processes, refuse handling techniques, and ways that compost is utilized from the various operations were obtained. Data were collected and analyses made of capital and operating costs for various processes and marketability of the products. In addition to the technical evaluations, the author considered related health aspects, areas of needed future research, and methods used to monitor processes.

SUMMARY OF PROGRESS: A report, entitled *Solid Waste Management/Composting; European Activity and American Potential,* was submitted in fulfillment of the contract. It contains detailed findings of the European survey and proposals for future American research and practice. Chapters are devoted to the survey of 14 European composting plants, compost utilization in Europe, European research in compost manufacture and use, the potential for composting and compost utilization in the United States, and recommedations for U.S. composting research. The report has been published and is available from the SWMO.

HART, S. A. *Solid waste management/composting; European activity and American potential.* Public Health Service Publication No. 1826. Washington, U.S. Government Printing Office, 1968. 40 p.

SOLID WASTES MANAGEMENT IN GERMANY

CONTRACT NO. PH 86-67-257

CONTRACTOR
Samuel A. Hart
720 Anderson Road
Davis, Calif. 95616

COST: $2,000
PROJECT START: July 1967
PROJECT END: August 1967

PROJECT DIRECTOR
Samuel A. Hart

OBJECTIVE: To observe and study German practices in solid waste management, research, and technology in order to determine their applicability in the United States.

APPROACH: Eight American engineers and scientists spent 2 weeks on a waste management study tour in Europe. After attending the Ninth Congress of the International Association of Public Cleansing technical meeting in Paris, they then toured Germany in order to evaluate garbage and refuse handling, and disposal facilities. The team visited the cities of Berlin, Munich, Rosenheim, Frankfurt, Schweinfurt, Düsseldorf, and Duisburg.

SUMMARY OF PROGRESS: A detailed report of the U.S. study team visit has been submitted in fulfillment of the terms of this contract. This report has been published by the SWMO and is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. The report discusses the findings of the study team under the general headings of characteristics and changes in European solid wastes, domestic refuse storage and collection, landfilling, composting, and incineration.

HART, S. A. *Solid wastes management in Germany; report of the U.S. Solid Wastes Study Team visit, June 25–July 8, 1967.* Public Health Service Publication No. 1812. Washington, U.S. Government Printing Office, 1968. 18 p.

CHRONICLE OF ACTIVITIES AND ACCOMPLISHMENTS IN SOLID WASTE MANAGEMENT

CONTRACT NO. CPE R-70-0016

COST: $5,008
PROJECT START:
February 1970
PROJECT END: June 1970

CONTRACTOR
John F. Holman & Co., Inc.
1346 Connecticut Avenue, NW
Washington, D.C. 20036

PROJECT DIRECTOR
John F. Holman

OBJECTIVE: To complete a comprehensive report on the progress of solid waste management since enactment of the 1965 Solid Waste Disposal Act (Public Law 89–272). Demand for information to be contained in this report has come from Congress, the SWMO, other government agencies, industry, and the public.

APPROACH: The report will be introduced with a statement of the solid waste problem. Background information will then be supplied, leading to a discussion of the 1965 Act itself. The SWMO will receive detailed coverage. Grants-in-aid programs, contracts, in-house operations (R&D, technical services, training, information, etc.), Regional Office activities, and liaison operations with other Federal agencies will be described.

Initiating a national effort to improve solid waste management. Washington, U.S. Government Printing Office, 1971. 107 p.

FEASIBILITY STUDY — DISPOSAL OF POLYETHYLENE PLASTIC WASTE

CONTRACT NO. PH 86-67-274

CONTRACTOR
IIT Research Institute
10 West 35th Street
Chicago, Ill. 60616

COST: $63,485
PROJECT START: June 1967
PROJECT END: September 1968

PROJECT DIRECTOR
Gene Zerlaut

OBJECTIVE: To determine by laboratory and pilot testing the feasibility of alternate methods of disposal of polyethylene plastic wastes.

APPROACH: This project is being conducted by the staff of Polymer Research at Illinois Institute of Technology Research Institute, and is being carried out in two phases as follows:

Phase I will be a literature survey covering: (1) plastic reclamation; (2) present methods of plastic disposal; (3) basic properties of resins and components; (4) analytical and identifying methods for resins, components, and degradation products; (5) possible modifications of present plastic disposal methods; (6) the use of stress cracking to reduce plastic waste bulk; (7) plastic waste disposal products and their effect on air and waste pollution.

Through laboratory and pilot testing, the feasibility of alternate methods of disposal of polyethylene plastic wastes will be determined as Phase II. Economics, safety, ease of operation, and other factors governing potential community acceptance of alternate methods will be carefully evaluated.

SUMMARY OF PROGRESS: As the first phase of this project, a very thorough literature search was conducted, the results of which were summarized in detail in the final report. In the second phase of the project, experimental studies were made to determine the feasibility of alternate methods of disposal of polyethylene plastic wastes. Despite the difficulties incurred by the inertness of polyethylene plastic, these experiments showed that chemical treatment can modify the mechanical, thermal, and biochemical properties of the material in such a way as to facilitate its ultimate disposal. Of particular importance were the findings that oxidative treatment of polyethylene by acids and nitration by red fuming nitric acid resulted in pronounced embrittlement of this otherwise flexible plastic, lowered the heat of combustion of the plastic, and enhanced its utilization by bacteria (Pseudomonas).

GUTFREUND, K. *Feasibility study of the disposal of polyethylene plastic waste.* Public Health Service Publication No. 2010. Washington, U.S. Government Printing Office, 1971. 45 p.

CONVERTING SOLID WASTE MATERIALS INTO YEAST

CONTRACT NO. PH 86-67-204

CONTRACTOR
Ionics, Inc.
65 Grove Street
Watertown, Mass. 02172

COST: $30,000
PROJECT START: June 1967
PROJECT END: February 1968

PROJECT DIRECTOR
Daniel L. Brown

OBJECTIVE: To determine whether various kinds of solid wastes—mixed and unmixed—can compete as sources of yeast for animal protein additives and other uses, and whether the size of the probable market for yeast warrants developing processes for the conversion of solid wastes.

APPROACH: An economic evaluation of the overall concept of converting solid waste materials into yeast was made. The study included economic consideration of solid wastes as raw material, including questions of abundance and stable supply, locational cost and costs of preparation, ease of hydrolysis, and chemical composition of hydrolysate. Various types of solid wastes investigated included mixed municipal wastes, waste paper, and agricultural process wastes.

SUMMARY OF PROGRESS: The final report, containing six sections with appendices, was published. The report includes a comparative discussion of the economic feasibility of using waste newsprint, bagasse, and mixed refuse as raw materials in the production of yeast and protein additives. Suggested hydrolysis and fermentation processes for these raw materials are presented, and the costs of production are compared with those for soy, cotton seed, fish, and animal protein. Included also is a discussion of the market demand for any large quantities of yeast from solid waste.

MELLER, F. H. *Conversion of organic solid wastes into yeast; an economic evaluation.* Public Health Service Publication No. 1909. Washtington, U.S. Government Printing Office, 1969. 173 p.

INCENTIVES FOR SOLID WASTE MANAGEMENT

CONTRACT NO. CPE 70-017

COST: $2,492
PROJECT START:
January 1970
PROJECT END: March 1970

CONTRACTOR
International Research and
Technology Corporation
1225 Connecticut Avenue, NW
Washington, D.C. 20036

PROJECT DIRECTOR
Robert U. Ayres

OBJECTIVE: To provide a working plan articulating a one-year and a five-year strategy in regard to regulatory and economic alternatives that would produce positive changes in solid waste management through "incentives."

APPROACH: Two action plans will be developed setting forth, respectively, a one- and a five-year planning program for the development of regulatory and economic incentives for improving solid waste management. The plans will concentrate, first, toward increasing reuse of substances or objects otherwise discarded, and second, to encourage improvement in the form or characteristics of substances or objects to be discarded, or the circumstances of their disposition. Priorities will be designated among the goals to be achieved and the programs for achieving them. Estimates of time and cost will be developed for each procedure that is identified.

SUMMARY OF PROGRESS: A report, setting forth the one-year and five-year plans, has been prepared for use by the SWMO.

INCENTIVES FOR TIRE RECYCLING AND REUSE

CONTRACT NO. CPE R-70-0047

CONTRACTOR
International Research and
Technology Corporation
1225 Connecticut Avenue, NW
Washington, D.C. 20036

COST: $52,000
PROJECT START: June 1970
PROJECT END: June 1971

PROJECT DIRECTOR
Robert U. Ayres

OBJECTIVE: To perform a thorough analysis of the total tire cycle, evaluating separately each major industry segment. Strategies to be applied to the entire system to improve recycling and reuse will be developed.

APPROACH: An overall narrative and graphic model of the total tire cycle will be prepared. A detailed flow and process chart defining the scope of current operations and techniques will be developed for each major relevant industry segment. A decision-logic approach will indicate where and by whom key decisions are made. Particular attention will be paid to barriers that affect decisions related to recycling. A number of strategies designed to improve recycling will be formulated. These strategies will have applicability to the total tire system and may include such factors as economic incentives, regulatory actions, education, and research and development. Each one will then be evaluated from an overall model approach so that the best strategy can be selected. Study will thereafter focus upon administrative and legislative needs for implementation of the recommendations.

THE COST OF MUNICIPAL INCINERATION

CONTRACT NO. PH 86-68-184

CONTRACTOR
Louis Koenig Research
Route 10, Box 108
San Antonio, Tex. 78213

COST: $34,971
PROJECT START: June 1968
PROJECT END: February 1970

PROJECT DIRECTOR
Louis Koenig

OBJECTIVE: To obtain comparative cost and engineering audits of municipal incineration as actually incurred and actually practiced in order to obtain data upon which to project the cost of future incinerator installations.

APPROACH: Data will be collected on those elements of available plant information that make up the cost of incineration. The unit investments, pertinent design factors, and various other components of incinerator cost will be statistically analyzed from selected model type plants. The data and information obtained will provide public officials, planners, economists, etc., with the level of costs to be anticipated and the ranges and central tendencies to be expected in wholesale studies of solid waste economics.

SUMMARY OF PROGRESS: A final report was submitted and is available for review in the SWMO in Rockville, Maryland. No publication is planned.

MANAGEMENT STUDY—THE ELECTRICAL HOME APPLIANCE INDUSTRY

CONTRACT NO. CPE 69-4

CONTRACTOR
Louis Koenig Research
Route 10, Box 108
San Antonio, Tex. 78213

COST: $31,720
PROJECT START: May 1969
PROJECT END: May 1971

PROJECT DIRECTOR
Louis Koenig

OBJECTIVE: To study and evaluate the solid waste management practices of the electrical home appliance industry, SIC 363.

APPROACH: Information and data will be collected on the following items of the electrical home appliance industry on a national basis: (1) total number of industrial plants, employment, capital value of the plants, and quantities and types of products produced; (2) past development and production patterns within the industry indicating present trends, new technology, and future development; (3) flow diagrams for the basic production processes; (4) location of the industries with particular notation of production centers in the country; (5) identification of the quantity (weight) and quality (character) of solid waste generated; (6) correlation of solid waste production with a readily available universal parameter of the plant; (7) identification and analysis of current storage, collection, and disposal practices of the industry; (8) amount of money being spent for storage, collection, treatment, and disposal of solid waste for the industry; (9) analysis of the future trends of solid waste management within the industry and factors that might influence them, such as reuse.

This data and information will be gathered by a literature review and personal interviews. The final phase of the project will consist of data evaluation and analysis.

SUMMARY OF PROGRESS: Information was gathered on the total number of plants, location, employment, capital value, and production. The contractor developed a questionnaire to be used for data collection from a selected group of establishments, and a sampling (interview) plan. Liaison was established and support was promised from the Association of Home Appliance Manufacturers and the Gas Appliance Manufacturing Association.

HEALTH EFFECTS OF AIR POLLUTION RELATED TO SOLID WASTES

CONTRACT NO. PH 86-66-129

CONTRACTOR
Benjamin Linsky
1360 Anderson Avenue
Morgantown, W. Va. 26505

COST: $3,000
PROJECT START: May 1966
PROJECT END: October 1966

PROJECT DIRECTOR
Benjamin Linsky

OBJECTIVE: To obtain a thorough evaluation of the relationships of air pollution, health, and solid waste disposal practices.

APPROACH: An in-depth literature search, including law literature and judicial findings, was conducted on health-related aspects of air pollution and solid wastes. The information obtained was used to integrate current knowledge about solid wastes, air pollution, and the relationships of air pollutants originating from solid wastes to various health problems.

SUMMARY OF PROGRESS: A report entitled "Health Effects of Air Pollution Related to Solid Waste" was submitted in fulfillment of the contract. The findings included in the report are in four general subject areas: (1) general and specific information on solid waste management problems; (2) specific solid waste disposal methods; (3) air pollutants both as they relate to solid wastes and in general; (4) the health effects of air pollution resulting specifically from organized and disorganized solid waste handling and disposal. Fifty-two specific health effects are included. The report is intended for SWMO use. No publication is planned.

INCENTIVES FOR PLASTIC RECYCLING AND REUSE

CONTRACT NO. CPE R-70-0048

CONTRACTOR
Arthur D. Little, Inc.
Acorn Park
Cambridge, Mass. 02140

COST: $99,356
PROJECT START: June 1970
PROJECT END: May 1971

PROJECT DIRECTOR
Jack Milgrom

OBJECTIVE: To perform a thorough analysis of the entire plastics cycle, evaluating separately each major industry segment. Strategies for application to the total system to improve recycling and reuse will be developed.

APPROACH: An overall narrative and graphic model of the plastics cycle will be prepared. A detailed flow and process chart defining the scope of current operations and techniques will be developed for each major industry segment. A decision-logic approach will indicate where and by whom key decisions are made. Particular attention will be paid to barriers that affect decisions related to recycling. A number of strategies designed to improve recycling will be formulated. These strategies will have applicability to the total plastics cycle and may include economic incentives, regulatory actions, education, research and development, etc. Each one will then be evaluated from an overall model approach so that the best strategy can be selected. Study will thereafter focus upon administrative and legislative needs for implementation of the recommendations.

MANAGEMENT STUDY — THE DRUG INDUSTRY

CONTRACT NO. CPE 69-7

CONTRACTOR
Litton Systems, Inc.
Environmental Systems Center
3641 Santa Rosa Road
Camarillo, Calif. 93010

COST: $85,276
PROJECT START: May 1969
PROJECT END: July 1971

PROJECT DIRECTOR
Ralph Sullivan

OBJECTIVE: To study and evaluate the solid waste management practices of the drug industry, SIC 283.

APPROACH: Information and data will be collected on the following items of the drug industry on a national basis: (1) total number of industrial plants, employment, capital value of the plants, and quantities and types of products produced; (2) past development and production patterns within the industry indicating present trends, new technology, and future development; (3) flow diagrams for the basic production processes; (4) location of the industries with particular notation of production centers in the country; (5) identification of the quantity (weight) and quality (character) of solid waste generated; (6) correlation of solid waste production with a readily available universal parameter of the plant; (7) identification and analysis of current storage, collection, and disposal practices of the industry; (8) amount of money being spent for storage, collection, treatment, and disposal of solid waste for the industry; (9) analysis of the future trends of solid waste management within the industry and factors that might influence them, such as reuse, etc. All data and information will be gathered by means of a literature review and field interviews. The final phase of this project will be data analysis and evaluation.

SUMMARY OF PROGRESS: The literature review, numerical structuring of the plants by SIC groups, and statistical sample sizing for field interviews were completed. Liaison was established with the Pharmaceutical Manufacturers Association and, with their assistance, a draft of the questionnaire was developed. The field interview format was tested at three plants and revised. About 50 percent (16) of the plant interviews have been completed. Case study style write-ups have been prepared on all visits. Information will show solid waste quantities, types, and management practices. The individual plant studies, together with data about the industry, will be the basis for the final report. A preliminary draft report has been received and is undergoing SWMO review.

MOTION PICTURE ON SOLID WASTE DISPOSAL

CONTRACT NO. PH
OS-DQ-66-109

CONTRACTOR
County Sanitation Districts of
Los Angeles County
Solid Wastes Engineering
Section
2020 Beverly Boulevard
Los Angeles, Calif. 90057

COST: $10,500
PROJECT START: June 1966
PROJECT END: September 1968

PROJECT DIRECTOR
John D. Parkhurst

OBJECTIVE: To use audiovisual media for communicating basic knowledge of sanitary landfilling techniques and guidelines for accepting disposal of urban solid wastes.

APPROACH: Locations and descriptive narratives were chosen to describe successful landfill techniques. Sections of the film are devoted to site selection, equipment requirements, climate influences, operating procedures, topography and soil conditions, storm drainage, final contour planning, and ultimate use of the completed fill.
While much of the film concerns deep filling —landfills of 200 tons per day capacity or greater—much of the information can, with judgment, be applied to smaller facilities. Designed for technical audiences.

SUMMARY OF PROGRESS: A 16-mm motion picture film in color with sound, 24 minutes in length, entitled *Sanitary Landfill: One Part Earth to Four Parts Refuse,* was submitted in fulfillment of the contract. The film covers all aspects of landfill planning and operation. Copies of the film (Order No. M-1740-X) can be borrowed from:

National Medical Audiovisual Center
(Annex)
Station K
Atlanta, Georgia 30324

and purchased for $97.75 f.o.b. Washington from:

Capital Film Laboratories, Inc.
470 E Street, S.W.
Washington, D.C. 20024

Supporting publications include a promotional flyer and a written version of the film narrative.

PRODUCTION OF EDIBLE PROTEINS FROM CELLULOSIC WASTES

CONTRACT NO. PH 86-68-152

CONTRACTOR
Louisiana State University
Department of Chemical Engineering
Baton Rouge, La. 70803

COST: $74,230
PROJECT START: June 1968
PROJECT END: October 1970

PROJECT DIRECTORS
Claydon D. Callihan
Ralph W. Pike

OBJECTIVE: To construct a pilot plant which will handle various cellulosic substrates and which will aid in evaluation of the technical and economic feasibility of continually producing single cell protein by fermentation of cellulose-containing wastes.

APPROACH: The process is designed as a continuous operation in which cellulosic wastes are ground, chemically treated, and continuously sterilized with the sterile cellulose slurry fed to a fermenter whose selected organisms degrade and metabolize the cellulose. The microorganisms and undisgested cellulose are then directed to a harvesting section where the single cell protein is separated from the growth media and dried. Methods for the complete evaluation of the yields from any substrate; the residence of time in the reactor required by any particular pretreatment; the aeration and nutrient requirement for the most economic growth rates; the BOD and COD demands of the feed and product; and the equipment to determine the best harvesting techniques for the microorganism grown on the cellulose substrate complete the pilot assembly.

SUMMARY OF PROGRESS: A pilot plant has been constructed at the National Aeronautics and Space Administration's Mississippi Test Facility, Bay Saint Louis, Mississippi. In conjunction with the pilot unit, a chemical and microbiological analytical laboratory has also been established. The fermentation unit is capable of carrying out any liquid phase fermentation, aerobically or anaerobically, using any organism, on either a batch or continuous basis. The fermentation unit is one of the more flexible-instrumented units in the United States. Complete facilities for cell separation and harvesting are also available.

The pilot unit has been operational since approximately September 1, 1969. The initial operation of the pilot unit has utilized sugar cane bagasse as the cellulosic substrate. The single cell protein produced is a light brown to yellow powder having a crude protein content of from 50 to 60 percent.

A comprehensive report describing the pilot plant construction, initial start up, and initial pilot runs has been submitted in fulfillment of the terms of this contract.

CALLIHAN, C. D., and C. E. DUNLAP. *Construction of a chemical-microbial pilot plant for production of a single-cell protein from cellulosic wastes.* Washington, U.S. Government Printing Office, 1971. 126 p.

PILOT DATA ACQUISITION AND ANALYSIS SYSTEM

CONTRACT NO. CPE 70-131

CONTRACTOR
Martin-Marietta Corporation
Orlando Division
P.O. Box 5837
Orlando, Fla. 32805

COST: $67,845
PROJECT START: June 1970
PROJECT END: June 1971

PROJECT DIRECTOR
James Gillean

OBJECTIVE: To develop a pilot-scale data network in order to test and evaluate alternative data acquisition and analysis systems, thus providing a foundation for the implementation of a complete network. The data processing system will analyze and report the information that it receives as input, with computer programs remaining flexible so that modifications and new requirements can be easily included.

APPROACH: Data of five types (legislation, administration and management, solid waste generation, characterization, and solid waste management systems) will be considered. The contractor and SWMO personnel will gather data of the last three types from at least one, and not more than three, Standard Metropolitan Statistical Areas. Forms, procedures, and sampling schemes will be developed. Solid waste will be separated into the following categories: metal products, glass products, paper products, food wastes, textiles, plastics, rubber, leather, wood, yard wastes, and inerts. Output definition will be initiated in three areas: generation and characterization, collection, and disposal. The computer programs to be developed will be compatible with the IBM 360-50 system and, in general, with computer systems accepting punch card and magnetic tape inputs.

PACKAGING MATERIALS AND WASTE DISPOSAL

CONTRACT NO. PH 86-67-114

CONTRACTOR
Midwest Research Institute
425 Volker Boulevard
Kansas City, Mo. 64110

COST: $67,368
PROJECT START: March 1967
PROJECT END: December 1968

PROJECT DIRECTOR
Arsen J. Darnay, Jr.

OBJECTIVE: To determine the present packaging material mix and its relation to disposal of the materials. To project the trends in packaging materials types and volumes to the year 1976 together with their potential technical and economic effects on disposal. To suggest means of effecting changes in packaging technology and use so as to mitigate the problems of disposal.

APPROACH: A product-by-product analysis of packaging materials, covering historical development and a 10-year forecast (to 1976) of material composition and configurations, competitive relations, industry sources and factors affecting the markets, quantities consumed, and quantities reclaimed, reused, or disposed of as waste, was undertaken. Attempts were made to describe the technological and convenience factors affecting packaging materials development and packaging waste generation problems to give an analysis of packaging material disposability in terms of combustibility, compactibility, degradability, return for reuse, and salvage. Means for alleviating the waste disposal problems arising from the projected 1976 volumes and types of packaging materials were also developed and evaluated.

SUMMARY OF PROGRESS: The final report discusses the outlook for packaging materials and solid waste management in 1976 in terms of the base year 1966. Separate sections are devoted to major packaging material categories. The relative disposability of the different packaging materials are considered, and alternative policies and devices for mitigating the solid waste problems arising from the use of packaging materials are discussed.

A contract supplement called for a study of nonpackaging paper in solid waste management, and a report on this subject has been published.

DARNAY, A., and W. E. FRANKLIN. *The role of packaging in solid waste management, 1966 to 1976.* Public Health Service Publication No. 1855. Washington, U.S. Government Printing Office, 1969. 205 p.

FRANKLIN, W. E., and A. DARNAY. *The role of nonpackaging paper in solid waste management, 1966 to 1976.* Washington, U.S. Government Printing Office, 1971. 76 p.

SALVAGE MARKETS FOR RECOVERABLE SOLID WASTE MATERIALS

CONTRACT NO. CPE 69-3

CONTRACTOR
Midwest Research Institute
425 Volker Boulevard
Kansas City, Mo. 64110

COST: $123,331
PROJECT START: May 1969
PROJECT END: May 1971

PROJECT DIRECTOR
Arsen J. Darnay, Jr.

OBJECTIVE: To provide an economic evaluation of the marketing of recoverable solid waste material.

APPROACH: The contractor will define, evaluate, and project the markets for recoverable solid waste materials. An investigation of the market prospects for materials recovered or reclaimed from solid wastes will emphasize three major areas: the structural framework of the market; the influence of prices, price differential, and price volatility on market prospects; and an assessment of the quantitative requirements for recoverable materials. Within municipal operations, data will be sought on salvage quantities, revenue, and costs of present operations. The secondary material markets, including the roles of private enterprise and of nonprofit organizations, will be researched. The technical processes available or required for the separation, recovery, or preparation for resale or reuse will be reviewed. Paper, metals, glass and ceramics, organic materials, and several miscellaneous items will be examined in detail. The study will concentrate in four regional markets and 10 cities.

The contract was amended to provide for two interim reports on special aspects of recycling for SWMO guidance in preparing internal decision documents on possible legislative recommendations. The two areas covered were beverage containers and paper products. The amendment provided additional funds and an extension of time. A further time extension was given to cover the new standard SWMO review procedures.

SUMMARY OF PROGRESS: The two interim reports referred to above were completed in April 1970. All field and research work called for under the contract is complete, and the main report in preliminary draft form has been submitted. A questionnaire to elicit information for a catalog of municipal salvage operations was mailed out in August 1970 to mayors of cities of 10,000 and over, and the results will be recorded in an appendix to the report. A preliminary draft report has been received and is undergoing review.

FIVE-YEAR PLAN FOR RESEARCH AND DEVELOPMENT

CONTRACT NO. EHS-C-71-0002

CONTRACTOR
Midwest Research Institute
425 Volker Boulevard
Kansas City, Mo. 64110

COST: $112,580
PROJECT START: August 1970
PROJECT END: November 1971

PROJECT DIRECTOR
Arsen J. Darnay, Jr.

OBJECTIVE: The objective of this contract is to create a total plan for basic research and applied research and development to bring about new and improved technological and economic systems for reduction of the amount of solid waste generated, increased amounts of solid waste recycled, and new and improved systems for storage, collection, processing, and disposal. The end-product of the contract will be used as a tool by the SWMO to implement research and development in the areas of emphasis identified through the program-planning system.

Supplemental objectives of the contract are to re-evaluate economic and technical factors relative to certain other major Office contract efforts, and to provide specific planning in connection therewith.

APPROACH: The contractor will:

a. Survey and evaluate the results of completed research carried out through: (1) research grants, (2) demonstration grants, (3) research contracts, (4) intramural research, and (5) other related research.

b. Review the results of broad policy studies addressing the problem of solid waste management.

c. Using the operating research and development matrix and systems-analysis approaches, develop a time-sequenced, comprehensive, resource-sensitive plan for identifying, plotting, and sequencing the research and development requirements and steps to be taken at various scales in the overall research and development effort.

d. Provide a detailed PERT-type working diagram charting the time- and resource-sequenced steps.

e. Provide estimates of costs in dollars and manpower associated with each element of the plan.

f. Provide a mechanism for appropriate updating and extension of the plan.

g. Suggest the mode of funding most suitable for each element of the plan.

h. Provide an up-dated evaluation of the economic and technical factors related to the CPU-400 concept.

i. Develop a recommended program for testing the CPU-400 pilot model.

MICROBIOLOGICAL QUALITY OF PRODUCTS FROM RENDERING PLANTS

CONTRACT NO. PH 86-67-20
PH 86-68-126

CONTRACTOR
University of Minnesota
College of Veterinary Medicine
St. Paul, Minnesota 55455

COST: $60,265
PROJECT START: August 1966
PROJECT END: June 1969

PROJECT DIRECTOR
Benjamin S. Pomeroy

OBJECTIVE: To determine health-related differences in the microbiological quality of products from various types of rendering plants and factors responsible for such differences.

APPROACH: During the first year studies were made in four plants selected on the basis of plant construction, plant sanitation, type of animal waste products used, and by-products manufactured. Bacteriological examinations were made on finished products with particular attention to samples collected during various processing stages. In addition, the operational feasibility and costs of adjustments necessary to eliminate salmonellae organisms in finished products were to be evaluated. The effects of various plant designs and operational factors were considered as they relate to the microbiological quality and safety of rendering plant products. A new contract emphasizing controlled laboratory investigation to determine minimum and optimum conditions for growth of potential pathogens in rendered materials with an evaluation of the more complex automated plants is now underway.

SUMMARY OF PROGRESS: The final progress report indicates that rendered products are often contaminated with salmonellae and enterpathogenic strains of *Escherichia coli.* The studies revealed, however, that the pathogens often could not be correlated with visual observation of plant sanitation and that contamination of products in larger plants with more complex, difficult-to-clean equipment was more frequently observed.

LOKEN, K. I., K. H. CULBERT, R. E. SOLEE, and B. S. POMEROY. Microbiological quality of protein feed supplements produced by rendering plants. *Applied Microbiology,* 16(7): 1002–1005, July 1968.

LOKEN, K. I. Sanitation and thermal destruction of salmonellae in feed and feed ingredients. Presented at the course, Epidemiology and Control of Salmonellosis, Trenton, April 24, 1968. 7 p.

SOLEE, R. E., K. I. LOKEN, and B. S. POMEROY. Monitoring animal, fish, and poultry by-products for the presence of salmonella. St. Paul University of Minnesota. mimeo. 11 p.

SOLEE, R. E., K. I. LOKEN, and B. S. POMEROY. The application of sanitation in rendering plants. St. Paul, University of Minnesota. mimeo. 31 p.

SOLID WASTE REMOVAL FROM HIGH-RISE RESIDENTIAL STRUCTURES

CONTRACT NO. PH 86-66-171

CONTRACTOR
National Academy of Sciences
National Research Council
Building Research Advisory Board
2101 Constitution Avenue, NW
Washington, D.C. 20418

COST: $10,000
PROJECT START: June 1966
PROJECT END: June 1967

PROJECT DIRECTOR
Robinson Newcomb

OBJECTIVE: To undertake systems analysis of on-site refuse systems and establish a protocol for a study relating to the development of acceptable methods of refuse disposal that will lead quickly to improvements in on-site refuse collection and disposal systems for high-density residential developments.

APPROACH: The protocol was developed by the appointment to the Building Research Advisory Board of an *ad hoc* committee composed of scientific, professional, and technical authorities. The committee met regularly to develop a firmly established protocol for the study with provisions for follow-up reviews in order to evaluate the advantages and disadvantages of the several systems proposed for waste disposal. The committee's responsibility covered the following areas: (1) selection of equipment to be installed and studied; (2) determination of kinds of data to be obtained; (3) establishment of an experimental program for years II and III; (4) provision of guidance to Committee staff; (5) review and analysis of data collected; (6) preparation and approval of all reports—complete with conclusions and recommendations—emanating from the study, including interim reports covering the efforts of each of the first two years, and a final phase-I report due at conclusion of the third-year effort.

SUMMARY OF PROGRESS: A final report was accepted in June 1967 containing the requested protocol for undertaking a research program for on-site solid waste removal from high-rise residential structures. The report contains a detailed description of the problem, and from a long list of selected problems, proposes four areas for intensive study covering the "life-cycle" of solid wastes from generation to disposal. Recommendations have been accepted and research is currently under way under Contract No. PH 86-67-167 to carry out the required research program. Information from the report is available through the Office of Information, SWMO.

ON-SITE REFUSE STORAGE, COLLECTION, AND REDUCTION SYSTEM FOR HIGH-RISE RESIDENTIAL STRUCTURES

CONTRACT NO. PH 86-67-167

CONTRACTOR
National Academy of Sciences
Building Research Advisory Board
Division of Engineering
2101 Constitution Avenue, NW
Washington, D.C. 20418

COST: $398,078
PROJECT START: June 1967
PROJECT END: September 1971

PROJECT DIRECTOR
William A. Cosby

OBJECTIVE: To continue the study and evaluation of equipment and techniques for handling solid wastes from high-rise multifamily structures. Concurrent investigation of three concepts for handling and processing of refuse located close to the source of waste will be made. These are: incineration, compaction, and wet pulverization.

APPROACH: Collection of data and assessments will include the following: (1) quantity and composition of refuse generated by tenants both before and after processing by the newly installed refuse-handling equipment; (2) quantity and composition of waste flowing through the building sewer line of one test structure in terms of volume and such factors as pH, solids, phosphates, nitrogen, BOD, COD etc.; (3) inhabitants' ages and numbers; (4) costs associated with newly installed equipment including capital investment and operating, maintenance, general, and administrative costs; (5) environmental conditions associated with newly installed equipment such as its contribution to air pollution, vermin and insect infestation, odor level, noise level, contribution to building sewer line, and to the aesthetic level of the conditions maintained; (6) equipment effectiveness, requirements, and limitations. In addition, a survey will be conducted within several municipalities of the nation to obtain: (1) additional data for evaluation and comparison with the results obtained from investigations at the test site under this contract; (2) an inventory of equipment now in use or available for on-site handling of refuse.

SUMMARY OF PROGRESS: An agreement was reached with the Public Housing Authority, New Haven, Connecticut, regarding the use of three housing authority structures for the purpose of carrying out the field laboratory research. Data was collected on "as is" conditions, including the extent of contribution to air pollution by existing gas-fired, flue-fed incinerators; personnel and power requirements; costs; efficiency and effectiveness: owner/tenant/custodian-janitor acceptance of existing systems; weight, volume, and composition of generated refuse; and degree of vermin infestation associated with existing systems. The collection of data on the composition and volume of waste flowing through structural drainage lines will begin after garbage grinders are installed.
The following systems have been installed: an incinerator system in one structure, a system of the compactor type in a second structure, and a wet pulverizer system in a third structure. Preliminary plans are being prepared for investigations to be carried out, first without the use of garbage grinders and then with garbage grinders.

NATIONAL ACADEMY OF SCIENCES—NATIONAL RESEARCH COUNCIL. *Collection, reduction, and disposal of solid waste in high-rise multifamily dwellings.* Rockville, Md., U.S. Environmental Protection Agency, 1971. (Distributed by National Technical Information Service, Springfield, Va., as PB 197 623. 169 p.)

FEASIBILITY OF RECOMMENDATIONS IN NAS–NRC PUBLICATION

CONTRACT NO. PH 86-67-240

CONTRACTOR
National Academy of Sciences
National Research Council
Division of Engineering
2101 Constitution Avenue, NW
Washington, D.C. 20418

COST: $140,580
PROJECT START: June 1967
PROJECT END: January 1969

PROJECT DIRECTOR
John C. Kohl

OBJECTIVE: To obtain advice on the relevance to the work of the Bureau of Solid Waste Management of the recommendations in the NAS-NRC publication *Waste Management and Control* (1966), along with advice on research needed for developing indices and parameters for implementation of a systems concept.

APPROACH: An *ad hoc* Committee on Solid Waste Management was established within the National Research Council's Division of Engineering, for correlating environmental needs, particularly those related to air and water pollution, with solid waste disposal. The committee advised on: (1) the feasibility of the recommendations of the NAS-NRC report *Waste Management and Control* as they relate to the handling and disposal of solid wastes, including those from urban, industrial, and agricultural sources, and residues resulting from liquid and gaseous waste systems; (2) whether other courses of action similar to the above are feasible or should be studied; (3) a priority rating for the feasible courses of action under (1) and (2) above, and the estimated costs of implementing these actions; (4) criteria for the selection of demonstration sites for actual studies or demonstrations of the recommendations; (5) research and development efforts in the solid waste field which are necessary for developing the required indices and parameters for implementation of a systems concept.

SUMMARY OF PROGRESS: The final report covering the work performed during the contract has been published. The contract resulted in a set of recommendations with far-reaching implications for individuals and government at all levels.

NATIONAL ACADEMY OF ENGINEERING–NATIONAL ACADEMY OF SCIENCES. *Policies for solid waste management.* Public Health Service Publication No. 2018. Washington, U.S. Government Printing Office, 1970, 64 p.

PROGRAM FOR REGIONAL SOLID WASTE MANAGEMENT SYSTEMS

CONTRACT NO. PH 86-67-290

CONTRACTOR
National Association of Counties Research Foundation
1001 Connecticut Avenue, NW
Washington, D.C. 20036

COST: $212,950
PROJECT START: June 1967
PROJECT END: June 1970

PROJECT DIRECTOR
Bernard F. Hillenbrand

OBJECTIVE: To provide local governmental leaders with nontechnical comprehensive guides that explore all aspects of solid waste management and will assist local government in the development of regional solid waste management systems.

APPROACH: The work is divided into three phases and covers a 3-year period. The initial phase was concerned with the development of management and informational tools in order to develop a national concept of comprehensive regional solid waste management systems that will help guarantee environments favorable to health and assure the preservation of natural beauty. A series of community action guides for solid waste management systems have been developed and distributed covering: (1) legislation, (2) management approaches, (3) planning, (4) organization, (5) construction and operations, (6) financing, (7) types of assistance available, (8) communication methods and techniques, (9) staffing requirements, and (10) plans of action.

In phase two a national workshop on solid waste management was planned, developed, and conducted. Attendees at the workshop reviewed drafts of the guides and were helped to understand the urgency of the need for local governmental agencies to initiate comprehensive and operational systems. This National Solid Wastes Management Workshop was held in September 1968.

Phase three will encompass the planning, development, and conduct of 20 regional solid waste management institutes to acquaint governmental agencies with the action guides.

SUMMARY OF PROGRESS: Final guides were distributed through the *American County Government* magazine. The guides have been reprinted, and single copies are available from the SWMO. Multiple copies are available from the Government Printing Office.

Twenty regional solid waste management institutes were held throughout the U.S. to acquaint public officials with the guides and the concepts of good solid waste management. Over 1,500 individuals attended these institutes. The project was completed June 30, 1970.

NATIONAL ASSOCIATION OF COUNTIES RESEARCH FOUNDATION. *Guidelines for local governments on solid waste management.* Public Health Service Publication No. 2084. Washington, U.S. Government Printing Office, 1971, 184 p.

DIGEST OF ORDINANCES AND A MODEL ORDINANCE

CONTRACT NO. CPE 69-114

COST: $35,024
PROJECT START: June 1969
PROJECT END: September 1970

CONTRACTOR
National Association of Counties Research Foundation
1001 Connecticut Avenue, NW
Washington, D.C. 20036

PROJECT DIRECTOR
Mel D. Powell

OBJECTIVE: To prepare a digest of 100 local ordinances to enable political, legal, and technical personnel to understand and compare a variety of approaches to solid waste management. A model solid waste ordinance will be developed to serve as a guide to good practice so that cities and counties can make their own decisions by comparing the examples and the model.

APPROACH: The contractor will collect approximately 400 city, country, and regional ordinances from various sources. These will be categorized according to focus of regulation, i.e., collection, storage, disposal, or all three. A balance will be maintained among ordinances regulating privately and publicly operated systems covering rural, suburban, and urban areas, and among the various States. The 100-ordinance digest will illustrate the following major areas: (1) general statement of policy and purpose, along with definitions; (2) location and extent of administration responsibility; (3) legislative scope; (4) provision for enforcement.
A model ordinance will be developed and formulated to identify essential characteristic elements. Its format will parallel that of the digest.

SUMMARY OF PROGRESS: The digest of ordinances is complete and was typed on tape for delivery in September 1970. A draft of the model local ordinance was furnished in April 1970 for guidance to the SWMO in preparing a model for publication.

MANAGEMENT STUDY—THE FOOD PROCESSING INDUSTRY

CONTRACT NO. PH 86-68-138

CONTRACTOR
National Canners Association
1950 Sixth Street
Berkeley, Calif. 94710

COST: $57,120
PROJECT START: June 1968
PROJECT END: August 1971

PROJECT DIRECTOR
Walter A. Mercer

OBJECTIVE: To obtain basic information on the national, geographical, and seasonal distribution of solid wastes generated in the food canning industry, with an evaluation and descriptions of current methods, techniques, and costs in the management of such wastes. The information obtained will help in determining the relative magnitude of disposal problems related to this source and enable factual and equitable efforts toward the development of recycling, utilization, and disposal methods.

APPROACH: Current agricultural and industrial census reports, records and reports of various national and state food processing organizations and associations, and selected publications were searched to obtain and summarize available information. In addition, detailed interviews were conducted at selected food processing plants to collect information on specific processes and process streams. Data were obtained on individual food products and food product classes, time of production, and volume of waste generated, characteristics of the waste solids, cost of the processing or disposal, environmental problems created, and the plant operations giving rise to the quantity and characteristics of the solid wastes generated. The information obtained is being organized and compiled for use by agencies responsible for planning and integrating solid waste management systems.

SUMMARY OF PROGRESS: The returned solid waste questionnaires have been analyzed and used as a guide in selecting the remaining site visits. Site visits were selected on the criteria of geographical location, commodity importance, and degree of disposal difficulty. The questionnaire phase, site survey, and data compilation are all complete, and a draft preliminary report has been received.

SINGLE-USE ITEMS IN HEALTH CARE FACILITIES

CONTRACT NO. CPE 69-102

CONTRACTOR
National Sanitation
Foundation
2355 West Stadium Boulevard
P.O. Box 1468
Ann Arbor, Mich. 48106

COST: $5,175 *
PROJECT START: October 1968
PROJECT END: May 1969

PROJECT DIRECTOR
Tom S. Gable

OBJECTIVE: To define problems in the use and disposal of single-use items in hospitals, laboratories, professional offices, and similar health care facilities and present possible solutions.

APPROACH: A conference was held at the National Sanitation Foundation, Ann Arbor, Michigan, to review the entire matter of the project objectives. Existing laws and regulations and literature pertaining to single-use items were reviewed and compiled. The conference reviewed the various types of single-use items presently in use.

SUMMARY OF PROGRESS: The conferees were public health and other regulation officials; representatives from hospitals and other health care facilities; manufacturers of single-use items, pharmaceuticals, and packaging materials; and others having a special knowledge of single-use items or of their use and disposal.

During the conference, sessions having representation from each group or discipline were held to discuss their interrelationship to the problems and possible solutions for disposal of single-use items in health care facilities.

* Total cost was $20,700. Additional financial support:
$5,175 Health Facilities Planning and Construction Service, U.S. Public Health Service;
$10,350 Manufacturers of Single-Use Items, Containers, and Packaging Materials.

AIRBORNE EMISSIONS FROM MUNICIPAL INCINERATORS

CONTRACT NO. PH 86-67-62
PH 86-68-121

CONTRACTOR
New York University
College of Engineering and Science
Research Division
University Heights
New York, N.Y. 10463

COST: $80,000
PROJECT START:
December 1966
PROJECT END: April 1970

PROJECT DIRECTOR
Arrigo Carotti

OBJECTIVE: To investigate and determine the kinds and quantities of emissions that are discharged from incinerators in the process of incinerating municipal solid waste.

APPROACH: Gaseous effluents were sampled from the stack discharges of municipal incinerators in the New York City metropolitan area. These samples were analyzed to determine chemical composition and variations in composition. Sampling of stack effluents during each of the four seasons permitted determination of possible seasonal variations. An analysis of effluents from the same incinerator was made as often as necessary to collect detailed data on all possible materials emitted, with identification and quantification of specific organic compounds; effluents potentially toxic to humans received special attention. Sampling and analyses were done on effluents from three other municipal incinerators different in construction and design. In all cases data were recorded on: (1) average general composition of the refuse feed; (2) the incinerator operating conditions; (3) total gaseous effluents discharged; (4) rate of discharge of the stack effluents; (5) composition of the quench water and residue.

SUMMARY OF PROGRESS: A literature survey and data review on airborne emissions from municipal incinerators has been completed and submitted to the SWMO. This Phase I report contains the annotated bibliography of the literature surveyed, a summary report of the present knowledge on airborne emissions from municipal incinerators, and recommendations for further study. A final draft report containing detailed findings from the Phase II investigation has been reviewed by the SWMO and returned to the Contractor for final editing and transfer to magnetic tape prior to publication. The published report will contain information and present data on the sampling apparatus and analytical procedures, and will discuss results from the seasonal variations, incinerator comparison, and the detailed analysis of stack effluent studies. In addition, the final report is expected to contain several recommendations for further study.

FIELD EVALUATION OF SANITARY LANDFILL TECHNIQUES

CONTRACT NO. CPE 70-104

COST: $19,920
PROJECT START:
January 1970
PROJECT END: December 1972

CONTRACTOR
Northern Kentucky Sanitation Company
P.O. Box 126
Walton, Ky. 41094

PROJECT DIRECTOR
Fred Stallard

OBJECTIVE: To provide the heavy equipment required for: the construction and maintenance of roads; the necessary excavation, compaction, and covering during the periodic construction of test cells; all site preparation for the facilities necessary for the operation of a land disposal research site.

APPROACH: The contractor will provide the equipment and operators for the construction of an access road, test cells of waste, and other facilities necessary for the operation of a land disposal research site. All planning and supervision of construction will be done by the staff of the Land Disposal Section, Division of Research and Development, SWMO. Property leased by the Government from the contractor will be used.

The work will be done by the contractor at times mutually agreeable to the contractor and the Government representative. The contractor will also provide services in the case of fire or other emergency occurrences within a reasonable period of time.

During the period of the contract, SWMO staff will be conducting research studies to develop basic design criteria for sanitary landfills. This contract provides for the heavy equipment necessary in the construction and operation of the facility.

SOIL INDEX PROPERTIES OF COVER MATERIAL

CONTRACT NO. PH 86-68-196

CONTRACTOR
H. C. Nutting Company
4120 Airport Road
Cincinnati, Ohio 45226

COST: $13,550
PROJECT START: June 1968
PROJECT END: June 1971

PROJECT DIRECTOR
Gerard Roberto

OBJECTIVE: To determine the index properties of cover material from sanitary landfills within the United States in order to develop guidelines for the safe and efficient operation of sanitary landfills in different geographical locations.

APPROACH: Soil samples will be analyzed and classified according to the Unified Soil Classification System. The number of tests to be performed will depend on the initial test results, soil variations per sample, and soil variations per landfill. The soil descriptions will be included as part of the test results.

SUMMARY OF PROGRESS: Laboratory investigation of the soil engineering properties of cover material collected from 56 sanitary landfills at various geographic locations has been completed. The laboratory investigation consisted of classification tests, combined mechanical analysis test, and standard compaction test. Twelve of these sanitary landfills were also visited to study present placement procedures and to obtain more detailed information. Knowledge of the soil engineering properties along with additional information to be obtained will enable us to determine those parameters which are significant in the evaluation of the applicability of any soil as a cover material.

PATENT SEARCH OF ON-SITE REFUSE HANDLING DEVICES

CONTRACT NO. PH 86-67-95

CONTRACTOR
Stephen B. Olmsted
2881 West Ritchie Parkway
Rockville, Md. 20850

COST: $1,750
PROJECT START: March 1967
PROJECT END: May 1967

PROJECT DIRECTOR
Stephen B. Olmsted

OBJECTIVE: To obtain a thorough and consistent inventory and catalog of potential refuse handling devices.

APPROACH: Over 3 million patents were searched for devices that were related to solid wastes. Patent examiners were consulted and selected patent lawyers were questioned regarding specific devices for solid waste handling.

SUMMARY OF PROGRESS: A detailed report covering the classes searched, a list of the U.S. and foreign patents found and notes for future searches were submitted to the SWMO in fulfillment of the contract. The list of patents has been collated in 12 subject folios with the patents arranged by date of issuance. Three hundred and sixty-one U.S. and 62 foreign patents were found to be of value. The patents show means of performance and not the many adaptations. The report is available for SWMO use. Publication of the entire patent search is not planned; however, selected patents were published in a single volume, which is available from the SWMO.

CONNOLLY, J. A., *ed. Abstracts; selected patents on refuse handling facilities for buildings.* Service Publication No. 1793. Washington, U.S. Government Printing Office, 1968. 320 p.

COST/BENEFIT RELATIONSHIPS IN SOLID WASTE LITTER

CONTRACT NO. CPE 70-123

CONTRACTOR
Resource Management
Corporation
7315 Wisconsin Avenue
Bethesda, Md. 20014

COST: $38,491
PROJECT START: June 1970
PROJECT END: October 1971

PROJECT DIRECTOR
Robert Davis

OBJECTIVE: To collect and document available information and data on solid waste litter. Conclusions on the magnitude of the costs and benefits associated with such litter will suggest areas of highest payoff for further analysis. Protocol development for a complete study of this type will also be performed.

APPROACH: First, a literature survey with documentation will be prepared. This will include a secondary source search in selected Federal and State agencies with particular attention to collection costs, quantities, and property values. After an overview of costs and benefits has been made, the relevant data will be tabulated and reduced. Conclusions will then be drawn on the magnitude of costs and benefits associated with litter. Finally, recommendations and a protocol development for a complete study will be prepared.

EVALUATION AND COMPARISON PROCEDURE FOR SANITARY LANDFILL EQUIPMENT

CONTRACT NO. CPE 70-116

CONTRACTOR
SCS Engineers
4014 Long Beach Boulevard
Long Beach, Calif. 90807

COST: $25,000
PROJECT START: June 1970
PROJECT END: June 1971

PROJECT DIRECTOR
E. T. Conrad

OBJECTIVE: The purpose of this contract is to develop a detailed set of procedures whereby various pieces of sanitary landfill equipment can be evaluated. There will be no actual evaluation or comparison in this study.

APPROACH: A complete equipment and accessory catalog will be developed, as well as a listing of the various combinations of equipment that can be studied. Price information and a wide range of equipment sizes will be included. Tasks and relevant field conditions for sanitary landfill operations will be investigated, with particular attention paid to operating characteristics necessary for defined tasks. Economic factors will also be considered.

From this information, detailed instructions and forms for equipment evaluation will be prepared. The costs of the proposed testing program will be estimated. In addition, the contractor will compile a list of organizations capable of performing the equipment evaluations and comparisons.

GOVERNMENT POLICIES AFFECTING SOLID WASTE GENERATION AND RECLAMATION

CONTRACT NO. EHS-C-71-0106

COST: $42,768
PROJECT START:
January 1971
PROJECT END: March 1972

CONTRACTOR
SCS Engineers
4014 Long Beach Boulevard
Long Beach, Calif. 90807

PROJECT DIRECTOR
Robert P. Stearns

OBJECTIVE: To identify those Government regulations, controls, and policies which have an effect on the generation and/or reclamation of solid wastes, and to determine how the Federal Government, in carrying out its various programs, might be utilized to lessen national solid waste management problems.

APPROACH: The project includes two phases. During Phase I the contractor, through extensive literature reviews and interviews with governmental and non-governmental agencies, will identify those Federal agencies which have the greatest interface with solid waste generation and reclamation. Based upon the results of Phase I, the SWMO will select twelve of the identified agencies to be studied in more depth during Phase II. The final report of the work will contain the findings of the in-depth investigation, and make recommendations as to the manner in which the agencies might contribute to reducing solid waste management problems throughout the nation.

SUMMARY OF PROGRESS: Phase I of the work has been completed and the report submitted to the SWMO. The investigation and interviews for Phase II are now underway and scheduled for completion during October 1971. A final report of the work will be submitted during March 1972.

DECONTAMINATION AND COMBUSTION OF ORGANIC PESTICIDES AND CONTAINERS

CONTRACT NO. CPE 69-140

COST: $34,251
PROJECT START: June 1969
PROJECT END: April 1970

CONTRACTOR
Foster D. Snell, Inc.
29 West 15th Street
New York, N.Y. 10011

PROJECT DIRECTOR
M. S. Weinberg

OBJECTIVE: To investigate the necessary conditions for proper decontamination and combustion of organic pesticides by investigating (1) selected oxidizers and combustible binding agents, and (2) combustion characteristics and requirements for container composition.

APPROACH: Each mixture of pesticide and selected combustion aid will be investigated to determine the temperature and rate at which it burns. Combustion gases from this procedure will be examined for degree of conversion to carbon monoxide, carbon dioxide, water, and intermediate organics. Also, binding agents will be applied to such mixtures prior to combustion to test for prevention of mechanical entrainment of the pesticide in the flame convection currents.

Combustion temperatures and characteristics, including completeness of consumption, for common container types will be determined. Based on these studies, requirements for combustible pesticide containers will be developed.

Work done under this contract will be coordinated with and augmented by work being done at Mississippi State and Oregon State Universities.

SUMMARY OF PROGRESS: A report entitled, "Organic Pesticides and Pesticide Containers, A Study of Their Decontamination and Combustion" has been submitted in fulfillment of the contract. It includes tables and figures which characterize the combustion studies performed on some nine representative pesticides. Based on this data, a method of packaging pesticides was recommended so that safe disposal by combustion would be possible. It was suggested that pesticides be packaged in some combustible material using polyethylene as an inner liner. The polyethylene acts as a binder to ensure that the flame residence time is long enough for total combustion of the pesticide.

PUTNAM, R. C., F. ELLISON, R. PROTZMANN, and J. HILOVSKY. *Organic pesticides and pesticide containers; a study of their decontamination and combustion.* Rockville, Md., U.S. Environmental Protection Agency, 1971. (Distributed by National Technical Information Service, Springfield, Va., as PB-202 202. 175 p.)

AIR CLASSIFICATION PROCESS TO SEPARATE SOLID WASTE MATERIALS

CONTRACT NO. PH 86-68-157

COST: $35,038
PROJECT START: June 1968
PROJECT END: February 1970

CONTRACTOR
Stanford Research Institute
333 Ravenswood Drive
Menlo Park, Calif. 94025

PROJECT DIRECTOR
Lester P. Berriman

OBJECTIVE: To obtain a preliminary determination of the technical feasibility of utilizing air classification to process or treat selected types of nonhomogenous, dry, solid wastes.

APPROACH: A detailed test program was developed, based on the characteristics of the wastes selected and on the purposes for which air classification might be employed for processing these wastes. Appropriate experiments were conducted using an experimental pilot-scale air classifier modified to facilitate the handling of solid materials. Five different types of waste were tested with the study limited to the technical aspects of the air classifier operation. The experiments were designed to determine both the limitations and the advantages of the air separation processes.

SUMMARY OF PROGRESS: Completed experiments on the small-scale (2″ x 4″) air classifier indicated that dense materials such as metals, glass, rubber and plastics, and light fines such as dust could be effectively separated from pulverized, dried solid waste. The size of the experimental apparatus prevented the separation of the various paper fractions. The contract was extended to provide construction of a larger column (6″ x 8″), and test results with this apparatus indicated it was technically feasible to sort cardboard and paper fractions from municipal solid waste, though the particle sizes used in the experiments were not optimum for the column throat size. Additional experiments on the larger column were successful in classifying compost to remove plastics, metals, and glass particles.

A draft of the final report was submitted, and review of this draft has been completed. The report is undergoing final preparation for printing.

MANAGEMENT STUDY—THE POLYMER PRODUCTION INDUSTRY

CONTRACT NO. PH 86-68-160

CONTRACTOR
Stanford Research Institute
333 Ravenswood Drive
Menlo Park, Calif. 94025

COST: $63,280
PROJECT START: June 1968
PROJECT END: June 1970

PROJECT DIRECTOR
Chester W. Marynowski

OBJECTIVE: To assess the polymer waste disposal problem and to evaluate alternative approaches to polymer waste utilization.

APPROACH: Personal interviews were used to obtain information on: (1) the sources, amounts, and forms of polymer wastes generated; (2) the availability of selected organic wastes that could be combined with the polymers to make some disposal methods more feasible; (3) disposal methods in use or under investigation. Important technical factors of alternative disposal methods were thoroughly evaluated and each proposed method was rated technically against established performance criteria. Most of the research and development was directed toward the disposal of polyethylene and polyprophylene wastes.

Recommendations will be made on the best disposal methods capable of immediate industrial application. The disposal process with the highest potential for economic solution will be developed and demonstrated through the pilot-plant stage to obtain data for the designs and preliminary cost of industrial units.

SUMMARY OF PROGRESS: A report entitled *Disposal of Polymer Solid Wastes by Primary Polymer Producers and Plastics Fabricators* was submitted in fulfillment of the contract. It contains information on the nature and extent of the problem in the United States for that segment of the plastics industry representing the largest product tonnage—the production and fabrication of the principle thermoplastics. It also presents technical and economic information on the polymer waste disposal methods in actual use, and evaluates alternative approaches to the polymer solid waste problem. The report is undergoing final preparation for printing.

MARYNOWSKI, C. W. *Disposal of polymer solid wastes by primary polymer producers and plastics fabricators.* Washington, U.S. Government Printing Offiice, 1972. 92 p.

CHAR FROM SOLID WASTES AS AN ADSORPTION MEDIUM

CONTRACT NO. CPE 70-129

COST: $51,180
PROJECT START: June 1970
PROJECT END: November 1971

CONTRACTOR
The Board of Trustees
Stanford University
Room 239, Encina Hall
Stanford, Calif. 94503

PROJECT DIRECTOR
Rolf Eliassen

OBJECTIVE: Char produced from municipal solid wastes will be characterized in terms of parameters now used to describe activated carbon. Such char will be evaluated in terms of its effectiveness as an absorption medium. The economic feasibility of solid waste char utilization versus alternative methods of treatment will be investigated.

APPROACH: Char from solid wastes will be characterized on a laboratory scale using parameters currently employed for activated carbon. New parameters and methods will also be developed. The effectiveness of char produced from solid waste of varying composition, with and without activation, will be investigated. Process design data will be developed from laboratory and literature data. The economic feasibility analysis will be based upon laboratory data related to production, activation and reactivation handling, utilization, storage, and ultimate disposal costs.

ENGINEERING STUDY OF A ONE-MAN COLLECTION SYSTEM

CONTRACT NO. PH 86-67-248

CONTRACTOR
Ralph Stone and Co., Inc.,
Engineers
10954 Santa Monica Boulevard
Los Angeles, Calif. 90025

COST: $80,200
PROJECT START: June 1967
PROJECT END: June 1968

PROJECT DIRECTOR
Ralph Stone

OBJECTIVE: To obtain basic information about various types of collection systems and to provide a comparative analysis of one-man systems and other established collection techniques in order to determine if a one-man system can improve the efficiency of operation from a financial standpoint and the reduction of hazards and nuisance problems.

APPROACH: The overall refuse collection evaluation was accomplished by a comprehensive study of the available one-man-operated equipment and its use in comparison with two-man- and three-man-operated collection vehicles. A thorough inventory of collection equipment suitable for one-man crew operation was made, and a municipal survey involving field studies within a number of selected communities that employ various types of collection systems provided a comparative analysis between one-man systems and others as related to technical feasibility, economic applicability, and operational practicability, including the human factors, of one-man collection systems.

SUMMARY OF PROGRESS: The results of the project were published in a report entitled *A Study of Solid Waste Collection Systems Comparing One-Man with Multi-Man Crews* (SW-9c). Single copies are available from the SWMO and multiple copies from the Government Printing Office.

RALPH STONE AND COMPANY, INC. *A study of solid waste collection systems comparing one-man with multi-man crews; final report.* Public Health Service Publication No. 1892. Washington, U.S. Government Printing Office, 1969. 175 p.

MANAGEMENT STUDY—THE AUTOMOTIVE ASSEMBLY INDUSTRY

CONTRACT NO. PH 86-68-212

CONTRACTOR
Ralph Stone and Co., Inc.,
Engineers
10954 Santa Monica Boulevard
Los Angeles, Calif. 90025

COST: $69,287
PROJECT START: June 1968
PROJECT END: September 1970

PROJECT DIRECTOR
Ralph Stone

OBJECTIVE: To obtain basic technical information concerning the quality and quantity of solid waste generated by the automotive assembly industry in order to identify real or potential problems of solid waste management.

APPROACH: Analyses will be made of storage and collection practices with emphasis on system efficiency, economics, and aesthetics. The waste generated will be characterized to identify real or potential problems in disposing of solid wastes by current disposal methods, and an analysis will be made of past, present, and future trends of the solid wastes generated with special or possible emergency management problems identified. The solid waste production will be correlated with a readily available and universal parameter of the automotive assembly industry.

SUMMARY OF PROGRESS: The final report, dealing with the industry structure, its processes and products, the methods and procedures used in the study, data analysis, and conclusions, has been submitted to the SWMO for review and clearance. The report contains the results of an AMA survey, 70 plant visits, and mail-out questionnaires to plants and corresponding municipalities. The results are presented as qualitative and quantitative data related to industrial solid wastes generated in the automobile industry. Review is complete, and the report is undergoing final preparation for printing.

MANAGEMENT STUDY—THE CHEMICAL INDUSTRY

CONTRACT NO. CPE 69-5

CONTRACTOR
The Travelers Research Corporation
210 Washington Street
Hartford, Conn. 06106

COST: $114,664
PROJECT START: May 1969
PROJECT END: June 1971

PROJECT DIRECTOR
John E. Yocom

OBJECTIVE: To study and evaluate the solid waste management practices of the industrial chemical industry, SIC 281.

APPROACH: Information and data will be collected on the following items of the industrial chemical industry on a national basis: (1) total number of industrial plants, employment, capital value of the plants, and quantities and types of products produced; (2) past development and production patterns within the industry indicating present trends, new technology, and future development; (3) flow diagrams for the basic production processes; (4) location of the industries, with particular notation of production centers in the country; (5) identification of the quantity (weight) and the quality (character) of solid waste generated; (6) correlation of solid waste production with a readily available universal parameter of the plant; (7) identification and analysis of current storage, collection, and disposal practices of the industry; (8) amount of money being spent for storage, collection, treatment, and disposal of solid waste for the industry; (9) analysis of the future trends of solid waste management within the industry, and factors that might influence them, such as reuse, etc.
The data and information will be gathered by a literature review, a questionnaire mailed to a selected group of industrial plants, and field interviews. The final phase of the project will consist of data evaluation and analysis.

SUMMARY OF PROGRESS: The survey portion has been completed; 28 plant visits were conducted and 250 replies to the mail-out questionnaire contained useful data. Preliminary analyses have been made as well as summaries showing coverage and data layouts. Information on the industry, its process, and its solid waste management practices will be drawn together with the quantitative data from the survey and plant visits to form the final report. A preliminary draft report has been received and is undergoing SWMO review.

NEW CHEMICAL CONCEPTS FOR WASTE PLASTIC UTILIZATION

CONTRACT NO. PH 86-68-206

COST: $99,929
PROJECT START: June 1968
PROJECT END: February 1970

CONTRACTOR
TRW Inc.
One Space Park
Redondo Beach, Calif. 90278

PROJECT DIRECTOR
Robert S. Ottinger

OBJECTIVE: To determine by computer simulation whether waste plastics can be converted to economically significant products by reactions with various reagents in a high-temperature reactor.

APPROACH: Computer programs simulating chemical reactions between waste plastics, namely polyethylene, polystyrene, and polyvinylchloride, and various reagents such as oxygen, water, hydrogen, ammonia, and others selected on the basis of cost, availability, and estimated reactivity with the selected plastics, were used to obtain information as to the thermodynamic and kinetic properties of the reactions. All of the necessary information was collected and placed on the program input tapes. The analysis was conducted by: (1) calculating rapidly and inexpensively the product distribution for a broad range of initial compositions and temperature and pressure conditions; and (2) examining the outputs for economically significant product concentrations and potentially harmful air or water pollutants. Further calculations were made to quantitatively determine the effects of the reaction conditions on the concentrations of important products. The data resulting from these analyses were used to develop relationships describing disposal costs, reactants used with the plastics, value of products and reactor complexity, and control capability requirements.

SUMMARY OF PROGRESS: The final report indicates that the system involving the application of heat in the absence of air appears most promising for the production of useful chemicals.

BANKS, M. E., W. D. LUSK, and R. E. OTTINGER. *New chemical concepts for utilization of waste plastics; an analytical investigation.* [Public Health Service Publication No. 2125.] Washington, U.S. Government Printing Office, 1971. 129 p.

BIODEGRADABILITY OF PLASTICS

CONTRACT NO. CPE 70-124

CONTRACTOR
Union Carbide Corporation
270 Park Avenue
New York, N.Y. 10017

COST: $75,803
PROJECT START: June 1970
PROJECT END: November 1971

PROJECT DIRECTOR
J. E. Potts

OBJECTIVE: To determine the effect of molecular weight, end-group composition, and polymer chain structure on biodegradability, and to determine the utility of the polymers containing biodegradable structures as packaging materials.

APPROACH: A series of samples of low- and high-density polyethylene, polystyrene, and polyvinylchloride will be synthesized and screened for biodegradability. A similar series of samples with metabolically active end groups on each polymer chain will be screened and evaluated for commercial applicability. The contractor will also investigate the development of biodegradable plastics containing mixtures of blocks, some of which are segments of polyethylene or polystyrene and some of which are structural units that are easily biodegraded. The latter will, in some instances, be biodegradable molecules acting as linking agents.

In addition, high molecular weight polymer samples will be pressed into plaques from which specimens will be cut and tested for degradation by fungi and bacteria.

MANAGEMENT STUDY—THE RUBBER INDUSTRY

CONTRACT NO. PH 86-68-208

CONTRACTOR
Uniroyal Chemical Division
Uniroyal, Inc.
Elm Street
Naugatuck, Conn. 06770

COST: $46,966
PROJECT START: June 1968
PROJECT END: March 1970

PROJECT DIRECTOR
Frank H. Roninger

OBJECTIVE: To obtain information and data on: (1) the quality and quantity of solid waste generated by the rubber industry; (2) the present state-of-the-art utilization of discarded rubber and rubber products; (3) the present practices, needs, and problems of solid waste management within the industry.

APPROACH: Questionnaires and interviews were used to obtain basic data on the rubber products, scrap rubber, and reclaimed rubber industry, and to determine the problems associated with each segment of the industry. The study must produce basic technical information concerning solid waste management within the rubber manufacturing and reclaim industries in a form that will help establish industrial solid waste guidelines and reference material for the industry, governmental agencies, and industries concerned with solid waste management. Separate studies are required to identify and evaluate the technical feasibility of various unique uses of waste rubber and to investigate and analyze the feasibility of various postulated means of broadening the market for scrap rubber.

SUMMARY OF PROGRESS: A report entitled *Solid Waste Management and Rubber Reuse Potential in the Rubber Industry* was submitted in fulfillment of the contract. Volume I contains data on solid waste management in the fabricated rubber products industry for 1968. Solid waste quantities are detailed for six categories of rubber products and five categories of solid waste type. Volume II contains information on waste rubber and its reuse, outlining the waste rubber disposal problem, the present areas of waste reuse with future trends, and potential future areas of collection and reuse. The reclaiming, retreading, and tire splitting industries are discussed. An analysis of the various methods of waste rubber collection and reuse along with specific conclusions and recommendations for further action is presented.

PETTIGREW, R. J., F. H. RONINGER, W. J. MARKIEWICZ, and M. J. GRANSKY. *Rubber refuse and solid waste management.* pt. 1 and 2. Public Health Service Publication No. 2124. Washington, U.S. Government Printing Office, 1971. 120 p.

PREDICTION OF SOLID WASTE CHARACTERISTICS

CONTRACT NO. PH 86-68-97

COST: $27,355
PROJECT START:
January 1968
PROJECT END: January 1969

CONTRACTOR
URS Research Corporation
155 Bovet Road
San Mateo, California 94402

PROJECT DIRECTOR
Myron B. Hawkins

OBJECTIVE: To develop a technique for predicting the characteristics of solid wastes in urban areas. The model to be developed will identify materials used and consumed by a given community and will use input/output techniques to determine the quantity of waste to be expected as well as its physical and chemical composition. This knowledge will enable sanitary engineers, public health officials, and others concerned with solid waste management to plan for future collection and disposal requirements.

APPROACH: Using available economic sources, the contractor collected, developed, and formulated selected standard data, descriptors, and functions for input commodities and activities in order to design and develop specifications for a basic waste prediction model. The model was tested manually in a relatively small community to evaluate its performance.

SUMMARY OF PROGRESS: The final report has been accepted for publication. The study consisted primarily of determining the availability of usable information and developing a preliminary prediction model for residential household solid wastes. This model was restricted to the prediction of present-day, short-residence-time wastes. Its performance was tested by comparing its predictions for a given locality with the results of an actual study of solid waste generation in that locality. The areas studied were in Jefferson County, Kentucky. Pertinent demographic data were collected and the solid waste quantities of various materials estimated by manual application of the prediction method. The results compared favorably with the measured values.

BOYD, G. B., and M. B. HAWKINS. *Methods of predicting solid waste characteristics.* Washington, U. S. Government Printing Office, 1972. 28 p.

SOLID WASTE PREDICTION MODEL

CONTRACT NO. CPE 70-117

CONTRACTOR
URS Research Corporation
155 Bovet Road
San Mateo, California 94402

COST: $134,700
PROJECT START: May 1970
PROJECT END: October 1971

PROJECT DIRECTOR
Myron B. Hawkins

OBJECTIVE: To develop and test a model for predicting the characteristics and quantities of solid wastes from commercial establishments, and to complete the development, programming, and testing of the residential waste prediction model produced under a previous study (Contract No. PH 86-68-97). This knowledge will enable sanitary engineers, public health officials, and others concerned with solid waste management to plan for future collection and disposal requirements.

APPROACH: The types and magnitude of the problems of solid waste generation in various commercial activities will be obtained by interviews, correspondence, and discussions with managers of actual establishments, refuse collectors, dump operators, investigators, representatives of trade associations, manufacturers, and personnel of the SWMO. Information will also be obtained from a review of studies of waste disposal operations and by means of rapid surveys involving personal observations of scrap piles, waste containers, etc.

Program development and model testing will include the following services: (1) identify sources and available detail of information regarding size, type, and location of various commercial establishments; (2) analyze data and develop a usable set of commercial activities that will be considered in the prediction model; (3) for each selected activity, develop a preliminary, semiquantitative material input-output waste model; (4) conduct investigations, surveys, and measurements to determine various critical factors and coefficients necessary to relate the size of the activity to the amount of each waste component generated; (5) collect, compile, and analyze information on changes in technology and practice that will affect waste generation by commercial activities, and develop modified waste generation coefficients; (6) adapt the general waste prediction model to handle the wastes generated by commercial activities that are found to be contributors; (7) establish computation specifications and develop computer programs for the commercial model; (8) assemble standard data blanks for the commercial model, and collect, evaluate, and collate as many standard activity and commodity descriptions as are pertinent to the test area, while converting data to the appropriate computer format; and (9) select a test area for the commercial waste study, run the waste prediction model for the test area, and evaluate results.

The following tasks relating to the residential solid waste prediction model are to be performed: (1) to conduct a statistical analysis on the significance of various parameters of the LIFE data (and the supporting source data) to provide bases for decisions on the selection of basic evaluation factors; (2) to review in detail the results of the earlier work on the residential waste reduction model (under Contract PH 86-68-97) and to establish the design of the short-residence-time (SRT) residential waste model; (3) to investigate data sources, analyze information, and complete the development of the SRT residential model; and (4) to investigate data and information sources, analyze possible approaches, and establish the detailed format for handling future waste in the residential model.

PIPELINE TRANSPORT OF SHREDDED SOLID WASTES

CONTRACT NO. CPE 70-132

CONTRACTOR
The Western Company
Research Division
2201 North Waterview Parkway
Richardson, Tex. 75080

COST: $17,373
PROJECT START: June 1970
PROJECT END: May 1971

PROJECT DIRECTOR
Gerald D. Hartsell

OBJECTIVE: To develop a detailed plan for the economic feasibility of transporting shredded refuse via pipeline.

APPROACH: This project is the first phase of a three-phase research program. Continuation into succeeding Phases II and III will depend on the results and recommendations generated from the first phase. *Phase I. Study and Design.* The initial effort will be to estimate equipment and testing costs as well as to outline a scope of work so that Phases II and III can be awarded on a competitive basis.

Phase II. Construction and Startup. The middle phase will entail the purchasing, fabrication, erection, and testing of all equipment and submittal of a detailed research plan with dates, accomplishments, and other scheduled activities to be used in Phase III.

Phase III. Test and analyses. The final effort will provide the data upon which the accompanying recommendations and conclusions will be based.

Phase I will consist of: (1) review of other programs and data that have been generated to take advantage of available information and to prevent duplication of effort; (2) development of a plan for awarding a contract on a competitive basis to study three transport systems—water and slurry pressure system, water and capsule pressure system, and water and slurry gravity system; (3) design of test apparatus and compilation of a list of materials to provide maximum data for an economic and uncomplicated operation; (4) economic analysis, comparing a typical pipeline transportation system for a city with a typical refuse truck transfer transportation system; and (5) preparation of a final report containing all data, program plans, designs, and economic analyses of the processes and their future potential for solving a major transport problem of solid waste management.

PROCEDURES FOR STATE AGENCY SURVEYS

CONTRACT NO. PH 86-67-12
PH 86-67-43

CONTRACTOR
William A. Xanten
3355 Military Road, NW
Washington, D.C. 20015

COST: $3,000
PROJECT START: July 1966
PROJECT END: November 1966

PROJECT DIRECTOR
William A. Xanten

OBJECTIVE: To obtain fundamental guidelines and procedures for State agency surveys to enable the attainment of established objectives as progressively and uniformly as possible.

APPROACH: Past survey forms and the types of information obtained by their use were examined. The personal experience of the investigators was used to modify and develop the required information.

SUMMARY OF PROGRESS: A report entitled "Codification and Data Gathering Surveys for State Planning Agencies" was accepted by the SWMO. This report proposes fundamental guidelines for in-depth data gathering surveys. Suggested forms to be used for basic data information on the general survey and site investigations of community solid waste practices were included. The report was prepared for use by SWMO personnel and will not be published or distributed.

SUBJECT INDEX

PROJECT DIRECTORS

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