THE DEVELOPMENT OF THE GREATER DETROIT RESOURCE RECOVERY PROJECT

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ABSTRACT

An 850,000 ton/year refuse-to-energy facility, in the planning process since the mid-1970's and under construction since the spring of 1986, will dispose of the majority of the residential and commercial solid waste generated in Detroit. Employing a refuse-derived fuel system with dedicated waterwall, spreader stoker type boilers, the plant will produce steam for the downtown district heating system and surplus electric power, both to be sold to The Detroit Edison Company. The facility will be publicly owned by the Greater Detroit Resource Recovery Authority, specially created for this project, and constructed and operated by Combustion Engineering, Inc. (C-E). Construction of the project is being financed from proceeds of a $438 million bond issue. The paper describes the project; discusses salient technical, economic, and institutional features; presents highlights from the planning and development process; discusses construction progress to the time of the paper; and reviews important issues and lessons learned.

INTRODUCTION

Development of the Greater Detroit Resource Recovery Project (Project) is very much the story of a major U.S. city working to find an acceptable long-term opportunity for the management of its solid waste disposal needs. The Project has also moved forward in the context of Detroit's "renaissance" under the administration of Mayor Coleman A. Young, with the revitalization of the riverfront area, numerous major construction activities to revitalize and modernize the City, and the successful focus on fiscal management to enhance the City's credit and put it into a strong budgetary position.

The Project, although expected to be more expensive initially than landfill as the primary disposal method, is viewed as providing long-term economic stability and predictability: it means there is an assured disposal site for much of the City's waste well into the twenty-first century; and the City will avoid facing high market-driven disposal fees during an impending "Garbage Disposal Crisis." Southeastern Michigan is an area of projected shortfall in available landfill capacity by 1990, not unlike many locations in the northeastern United States and elsewhere. It is worth noting that the resource recovery facility (Facility) site is within the City, about three miles from the major downtown business area, very much in keeping with the City's desire to manage its own needs in a responsible fashion.

Features of the Project that make it of interest include:

(a) an existing big city involvement and perspective;
(b) the district heating system steam market;
(c) the institutional relationships with public authority ownership and private full-service contracts;

(d) with an installed capacity of approximately 4,000 tons/day (tpd) of refuse, the fact that this will be one of the largest waste-to-energy plants built to-date;

(e) the sheer size of the bond issue that was required; and

(f) the decade-long planning and development process; and in particular the nature of some of the more important obstacles, issues, and events that contributed to the protracted period before groundbreaking.

PROJECT DESCRIPTION

General

The Project includes a resource recovery facility (Facility), which is under construction on a 17.5 acre site near the intersection of two major interstate highways within the City, 3.1 miles of steam lines connecting the site with the Central Heating System (CHS) operated by The Detroit Edison Company (DECO), at two of its existing steam plants, and electrical transmission lines for export of power, also to DECO. Once the Facility is on-line and has demonstrated its reliability, it is anticipated that at least one of DECO's steam plants will cease operation. It is noteworthy that DECO will purchase all of the energy exported from the Facility either as steam or electricity, and thus load following and boiler turndown capabilities are not critical issues.

The general location of the Facility in the Detroit area is shown in Fig. 1, while Fig. 2 displays the site and steam line routing within the City. Figure 1 also indicates the location of existing solid waste transfer and disposal sites in the area. The fact that one of the existing transfer stations is very near the Facility site enhances the desirability of the site from a traffic and neighborhood impact point of view.

The various contracts and agreements between and among the Project participants are presented in Fig. 3. The Authority, as owner, is responsible for providing the site, adequate landfill arrangements, financing, and waste supply. The operator and full-service contractor, is responsible for design, construction, operation, and maintenance of the Facility and sale of recovered steam, electricity, and materials.

The planned operating level of the Facility of 850,000 tpy will be provided by 650,000 tpy which is collected by the City, primarily from residences, plus additional waste either from commercial sources within the City or from other municipalities. It is estimated that in excess of a million tpy of processible solid waste are generated from all sources with the City. Tonnage estimates are based on City weight records for the residential component combined with estimating factors for the commercial component (see Ref. [1]). No specific composition studies were performed for the Project, beyond visual observation at transfer stations in the City. However, in the context of ongoing planning to establish the long-term transfer station and landfill relationships with the Project, the Authority and the City are exploring ways to remove unprocessible or troublesome constituents from the waste stream prior to reaching the Facility.

The Facility contains three refuse-derived fuel (RDF) processing lines and three boilers; any two processing lines in combination with any two boilers are capable, with normal availability, of exceeding the planned annual throughout requirement. The air permit provides that no more than two boilers operate at any given time; based on the specific plant design and certain assumptions regarding emission levels and normal operations, this corresponds to approximately a million tpy of raw refuse.

Thus, there is a substantial amount of redundancy and excess capacity. The conservative design reflects several factors, including:

(a) The need to satisfy the backup requirements which will enable DECO to retire existing facilities on the Central Heating System.

(b) The relationship between the level of comfort on the part of the operator and the high level of guarantees (as discussed subsequently in this paper in sections pertaining to Facility Construction and Operation) and dollar liabilities by the operator that were essential to accomplishing the Project's financing as well as to reaching agreement on the Construction and Operations Agreements with the Authority; the dollar exposures are unusually large compared with other resource recovery projects in part because of the size of this endeavor.

(c) A long-standing vision on the part of the City — that predates the permit limitation — that the excess capacity is a very valuable asset that in the long run will be in great demand and will potentially represent added revenues, or cost savings, to the City.

The Facility and Its Operation[1]

Major equipment and components associated with the Facility include: components for weighing, receiving, and shipping; equipment for materials handling and transport; materials processing equipment, includ-

[1] This section has been adapted and updated from Ref. [1].

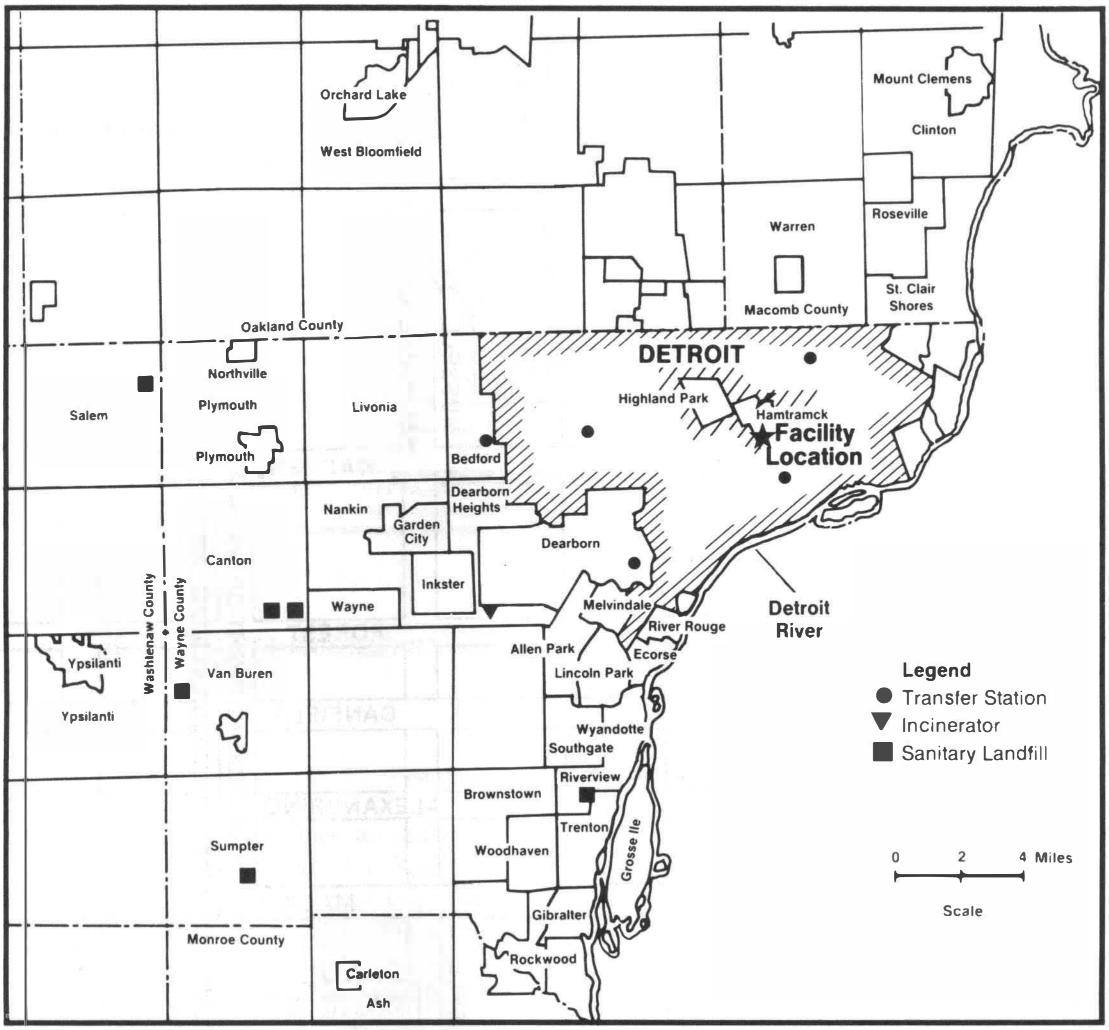

FIG. 1 PROJECT AREA MAP

ing shredders, magnetic separators, trommels, and cyclones; storage provisions for refuse, RDF, recovered ferrous metal, and process and ash residue; boilers and associated equipment; turbine-generator and auxiliaries; air pollution control equipment; cooling tower; electrical switchyard and transmission line; and underground steam line. In the following description, certain design details are intentionally omitted where they may be considered proprietary by C-E or are currently still subject to modification.

The Facility has two operational parts, the RDF processing plant and the power generating plant, which are connected by a set of conveyors that transport RDF from the former into the latter. Figure 4 is a schematic diagram intended to illustrate the layout of the major equipment.

Refuse is received and is processed into RDF by shredding to a particle size of 6 in. or less; magnetic separation to recover ferrous metals for sale; and screening to remove dirt, glass, and other noncombustibles. Collection vehicles dump from ten elevated bays onto a storage floor 15 ft below, and directly onto the floor from five lower tipping locations for larger transfer vehicles. There are 4000 tons of refuse storage up to the level of the tipping bays, and additional storage above this level is possible. Crawler dozers in the storage area spread and compact the refuse and feed a front-end loader which, in turn, loads the refuse

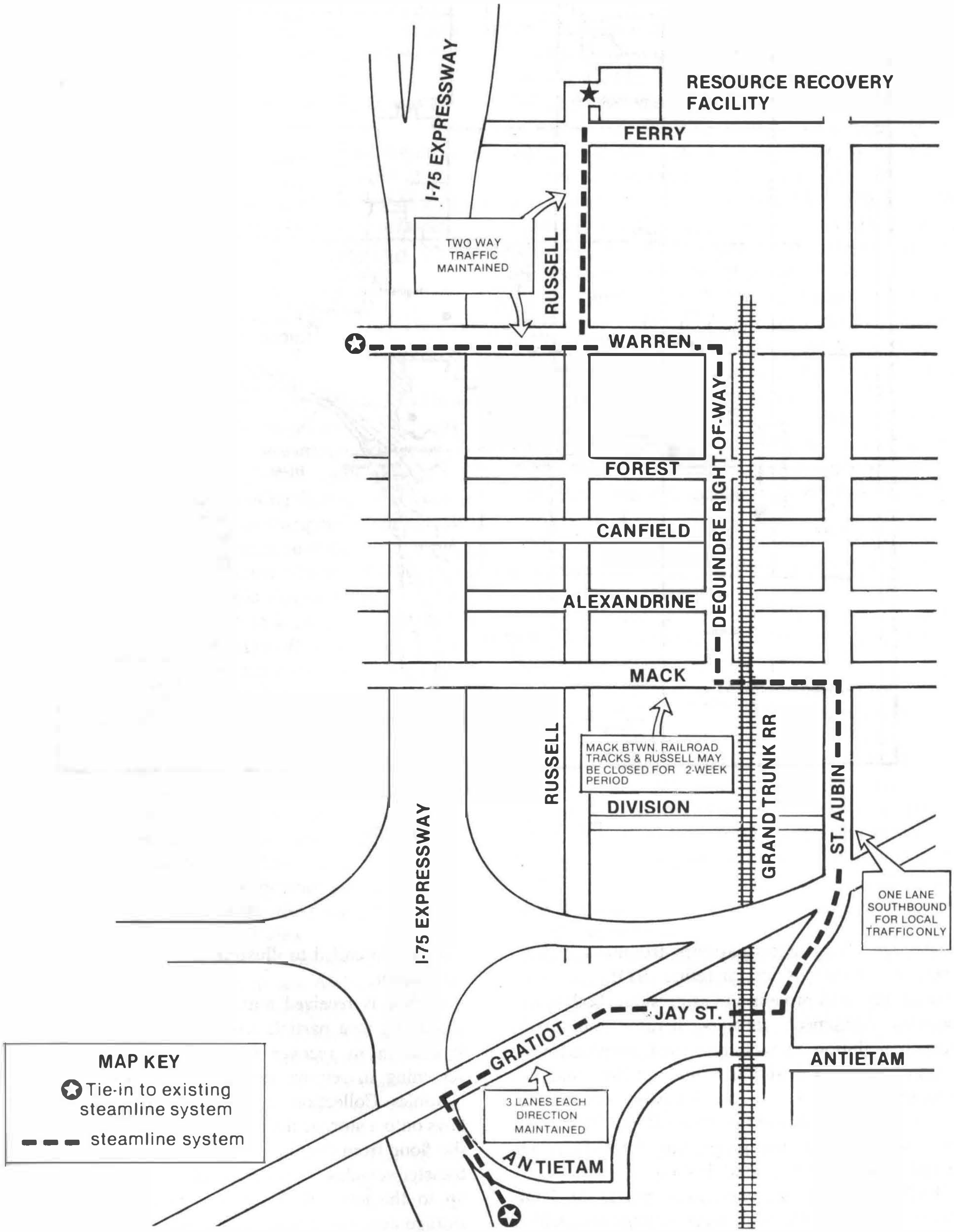

FIG. 2 DETROIT RESOURCE RECOVERY FACILITY ROUTING OF STEAM SUPPLY LINE

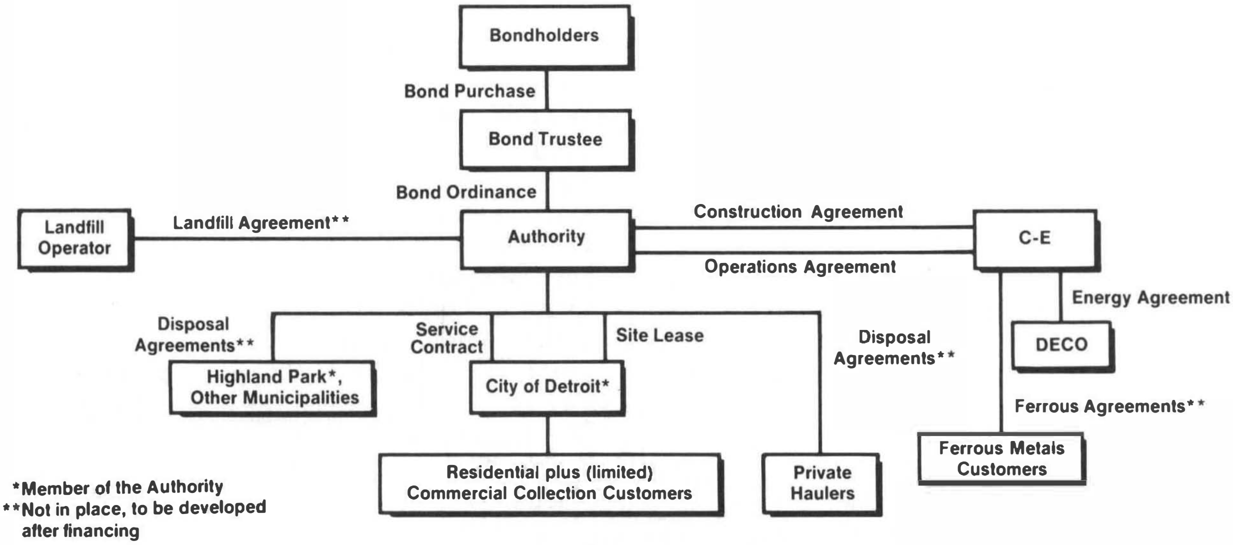

FIG. 3 PROJECT PARTICIPANTS AND THEIR CONTRACTUAL RELATIONSHIPS

onto one of three steel apron conveyors: each being the start of a processing line.

The three identical processing lines are each designed to handle 100 tons/hr (tph) of refuse. Two processing lines will be operating for 16 hr a day. The other line is for redundancy. From every 100 tons of refuse, the system yields approximately 76 tons of RDF, 14 tons of noncombustibles, 7 tons of ferrous metals, and 3 tons of moisture (lost). This breakdown was used for conceptual design purposes, and is not a C-E guarantee. However, there are specific guarantees for steam, electrical production, and ferrous metal recovery, as described later in this paper. Note, in this regard, that the operator is not guaranteeing material recovery quantities, waste or fuel heating value, or ash composition other than combustibles content.

Refuse drops from the apron conveyor onto a slow-moving, horizontal drag flight conveyor where it is inspected for hazardous components and nonprocessible items. It is expected that there will be one picker per line with a TV camera monitor. The pickers are protected from potential explosions, etc., by being located in enclosed stations, with positive air pressure, and would not ordinarily handpick any items while the conveyor is moving. The horizontal conveyor feeds the primary shredder, which is a low horsepower flail mill that breaks open bags and coarse shreds the waste to about a 6–12-in. particle size by the action of a set of hammers attached to a horizontally rotating shaft. Each shredder is designed to handle 100 tph, is isolated in a room with poured concrete walls and a blow-away roof vent, and is served by an air sweep system connected to a baghouse for continuous ventilation of the shredder and for dust control. The system will have sufficient air sweep to control the lights fraction of the RDF.

The output of the flail mill passes under a rotating drum magnet, which should remove 90% of the ferrous metals in the waste. All conveyors following the flail mill are rubber belt conveyors. The ferrous stream then undergoes air classification, where loose combustibles are separated and returned to the process line, followed by a ferrous densification step.

The process stream after magnetic separation splits and enters two trommels, the primary separators, each of which is a rotating screen inclined at about 5 deg. from the horizontal, and each of which has a first stage with smaller holes and a second stage with relatively larger holes. The trommel design, along with the rest of the processing line, is based on operating experience with similar equipment at the processing facility in Madison, Wisconsin. Unders from the first stage, primarily dirt and grit, are conveyed to a trailer for subsequent transport to landfill. Second stage unders are conveyed to another trommel, the secondary separator, which further separates fine particle sizes (through small holes) from what is at this point RDF, which in turn is conveyed to the RDF storage area which has a capacity of 3600 tons.

The angle of the trommels can be adjusted in the

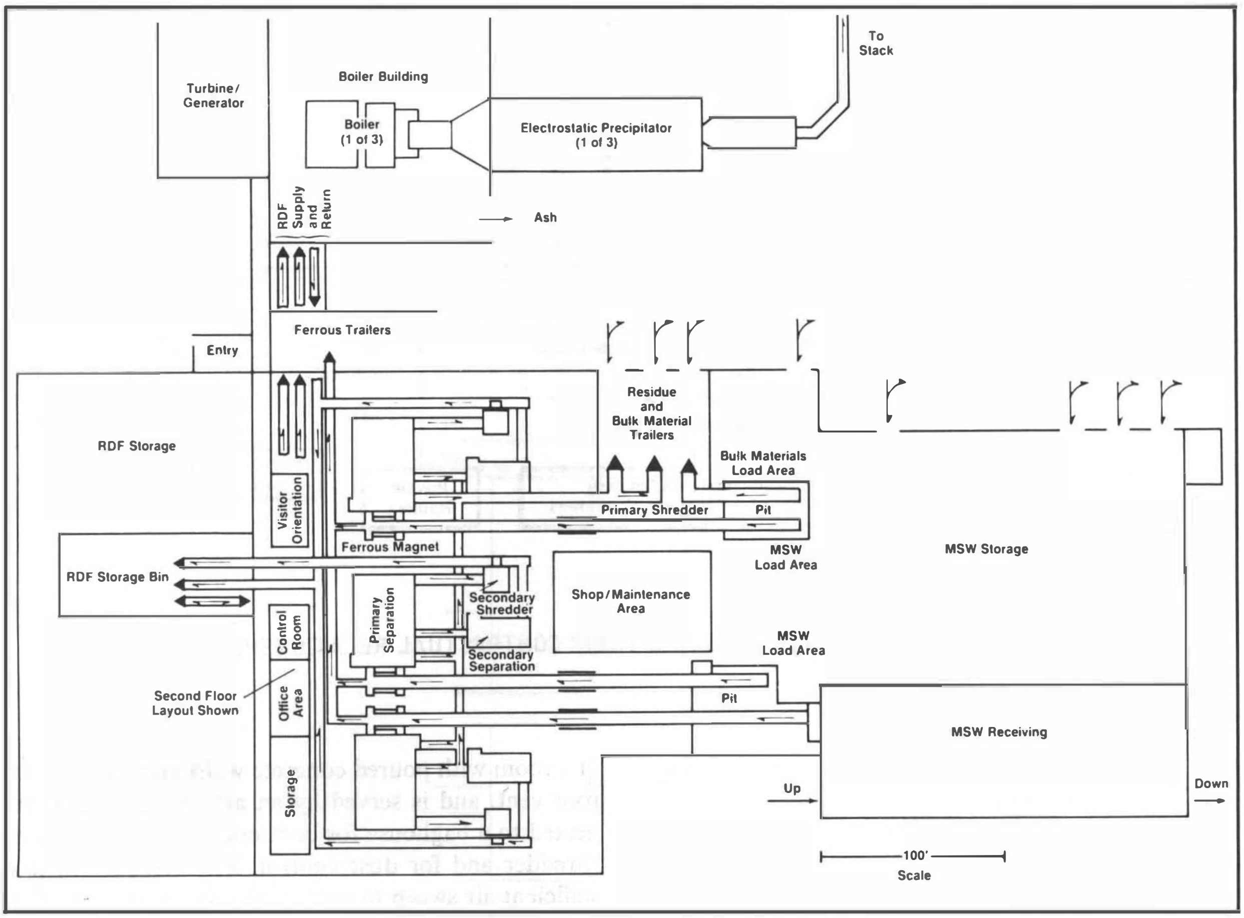

FIG. 4 MAJOR EQUIPMENT LAYOUT FOR DETROIT FACILITY

field to improve their screening efficiency. They are also constructed to permit the easy replacement of each screening stage separately, in case different hole sizes are warranted.

Two outfeed apron pan conveyors meter RDF to the power-generating plant and discharge it onto rubber belt conveyors leading to the boilers. Each of the three identical units is a C-E VU-40 travelling grate waterwall boiler designed to produce 343,450 lb/hr of steam at 825°F (approximately 440°C) and 900 psig, when burning RDF at about 46 tph.

After passing through the various sections of the boiler, the flue gases are controlled via a five-field electrostatic precipitator (ESP) to a particulate emission level of less than 0.019 grains per dry standard cubic foot corrected to 12% carbon dioxide. The ESP design is quite conservative based on the Specific Collection Area, which is higher than that for most ESPs for waste-to-energy facilities. It may also be of interest that the air pre-heater is downstream of the ESP. The fly ash is moistened and conveyed, along with the bottom ash, which has undergone a wet quenching process, to the ash storage building.

Steam from the boilers drives a single multi-stage controlled extraction condensing turbine-generator rated at 65 MW, with four uncontrolled extraction ports for feedwater heating. Part of the steam flow will be extracted for export to the Central Heating System, while the remainder will be condensed for electricity sales. The Facility includes a closed-loop wet cooling tower, and both cooling water and boiler make-up water will be from City supplies. The expected total make-up water quantity is approximately 530 million gallons per year.

Construction Agreement

The Construction Agreement embodies the obligations and responsibilities of the Authority and C-E related to the design, engineering, construction, start-up, and testing of the Facility. C-E agrees to design and construct the Facility in accordance with set Technical Specifications; within a guaranteed period of 36 months from financing to commercial operation; and for a Contract Price that is fixed subject to agreed upon escalation indices and certain pass-through items. Both the price and schedule are subject to adjustment under certain conditions, including changes in law. However, it is important to note that C-E otherwise assumes the risk of Force Majeure during construction, in return for which the Authority assumes corresponding risks during the operating period.

The following Acceptance Criteria are identified in the Agreement:

(a) Design Capacity:

(1) annual capacity of 850,000 tpy, and

(2) capacity of 40,000 tons during a consecutive 14-day period, and 55,000 tons during a consecutive 21-day period.

(b) Steam Production: minimum of 5770 lb of steam at 900 psig and 825°F/ton of refuse having a heat content of 4600 Btu/lb (i.e., the steam production guarantee is adjusted for heating value of the refuse).

(c) Electricity Generation: generate at least the guarantees stated below for the three specified operating conditions; also, a maximum in-plant electricity consumption of 74 kWh per ton is guaranteed;

	Turbine Throttle Flow (lb/hr)	Process Steam Flow (lb/hr)	Guaranteed Electrical Output (kW)
(1) Maximum Export Electricity	686,900	100,000	63,930
(2) Maximum Export Steam	686,900	510,000	27,538
(3) Average Conditions	560,000	300,000	33,215

(d) Recovered Materials: minimum 90% recovery efficiency for magnetic ferrous metals. The test procedure requires, if necessary, multiple passes of a magnet over the test samples at the discretion of the Authority's Consulting Engineer who also will visually inspect the area downstream of the magnetic separator to ensure that the ferrous metal magnet is working properly.

(e) Combustible Loss: no more than 10% of the heat content of the refuse shall be removed in the recovered ferrous or residue.

(f) Environmental Regulations: comply with all applicable permits.

Test procedures for the following tests are described to demonstrate achievement of the Acceptance Criteria: a 14 day Capacity and Minimum Energy Quantity Test, a Ferrous Metal Recovery Test, an Air Emissions Test, and a Turbine-generator Efficiency Test. The Capacity Test determines the Facility's ability to process the 40,000 tons guarantee, while at the same time producing the guaranteed Minimum Energy Quantity of 5770 lb of steam per ton of refuse processed. The Minimum Energy Quantity is adjusted if the refuse heating value differs from 4600 Btu/lb.

The acceptance and liquidated damage provisions are somewhat complicated, and will not be fully described here. Basically, C-E must meet the environmental requirements and otherwise pass at 94% or better, to be accepted subject to payment of damages; in this event, C-E has a continuing obligation to improve performance and may recover the damages if it so demonstrates. At less than 94%, the Facility is not accepted and there is a 1-year extension period (also subject to extension up to two additional years for limited causes), during which C-E pays the expenses of the Authority as damages. If, after the extension period the Facility still has not passed at the 94% level or higher, the Authority may terminate the Agreement and obtain liquidated damages.

The $438 million bond issue is based on a total construction cost of approximately $276 million, of which $193 million is the base Contract Price and $32 million is an estimate for the steam line and electrical interconnection, both as of December 1984, and the balance is for the pass-through costs, contingency, and an allowance for escalation through the construction period.

The steam line itself represents a sizable project, in the $30 million range. While on a "cost-plus" basis when considered a pass-through cost external to the guaranteed Contract Price, in fact the steam line is being constructed under several lump sum bids, corresponding to different sections of the route, and the work is being supervised and monitored very closely in the field for cost control.

Operations Agreement and Service Contract

The Operations Agreement specifies the obligations and responsibilities of C-E as operator, the City, and the Authority during the operation of the Facility after

TABLE 1 PROJECT HISTORY

PROJECT HISTORY	
1975	Resource Recovery Task Force Established by the City
	Ten Resource Recovery Sites Identified
	Qualifications Submittals Received from 24 Firms Reflecting Wide Range of Technologies
1976	Request for Proposals Issued (two alternative sites and energy markets)
	Three Proposals Received and Evaluated
1977	Simultaneous Discussions with Two Proposers
1978	C-E Selected as Preferred Contractor
	State Solid Waste Management Act Passed
	Preferred Site and Energy Customer Identified
1979-1980	Contractual, Financing, and Environmental Permitting Issues Addressed
1981	Michigan Environmental Impact Statement (EIS) First Published
	Solid Waste Management System Evaluation Prepared
	Memorandum of Understanding Reached with DECO
1982	High Interest Rates put Project on Hold
	Permit Caucus held with Regulatory Agencies
1983	Updated EIS Prepared
	Permit Applications Submitted
	Numerous Meetings and Efforts to Formulate Financing and Security Measures; Proposed State Legislation
1984	Greater Detroit Resource Recovery Authority Established
	EIS Addendum Prepared; Project Approved by Michigan Environmental Review Board
	Permits Secured
	Service Contract Approved by City Council
	$500 Million of Adjustable/Fixed Rate Bonds Issued and Warehoused
1985	Contract Negotiations Completed
	Presentations to Letter-of-Credit Banks and Bond Rating Agencies
1986	Bonds Remarketed to Provide $438 Million Construction Financing; All Fixed Rate
	Commencement of Construction (May)
1986-1989	Detailed Design, Construction, Start-up, and Testing

acceptance. The initial term is approximately 20 years. The operator warrants that the Facility will be capable of processing 850,000 tpy each year, 40,000 tons in 14 days, and 55,000 tons in 21 days, and will pay compensatory damages for failure to process all processible refuse delivered up to the guarantee levels. Note, also, that the process line redundancy provides assurance to C-E and the Authority that the throughput requirements will be met, irrespective of the inevitable uncertainty about the precise waste stream composition. The Authority has no minimum waste delivery commitment, but does guarantee that the operator's share of energy revenues will be at least the amount corresponding to 510,000 tpy.

The Authority receives 88% of energy revenues up to 780,000 tpy processed, and 50% above this amount. The operator receives the balance. The Authority and operator share equally in recovered materials revenues.

The operator is required to operate and maintain the Facility for a fee which includes labor costs, other operating expenses, and specified pass-through costs. Labor and other expenses are set at guaranteed fixed base amounts which escalate according to agreed upon indices. The specified pass-through costs are utility and fuel expenses up to guaranteed usage limits, and required insurances.

The Operations Agreement also establishes the Authority's responsibility to provide for the Project's landfill needs.

A key feature of this agreement is the liquidated damages formulation, which is designed to make the Authority "whole" for failure of the operator to meet its performance guarantees. In this regard, the minimum steam and electricity guarantees, along with the capacity guarantees, carry over directly from the Construction Agreement, since both Construction and Operations Agreements contain common Technical Specifications. The damages formula takes into account the complexities of the possible operating scenarios for waste delivery, processing, and mixes of steam and power production. The formula also, in effect, accounts for changes in refuse heating value, ferrous metal quantities, and nonprocessible waste that may be delivered.

The Service Contract between the City and the Authority, among other provisions, provides that the City will deliver to the Facility or a landfill, as directed by the Authority, all waste collected by the City. The City also agrees to take all actions required to enable the Authority to secure sufficient landfill capacity. The formula tipping fee is set forth, which covers Authority expenses plus the net costs of the Project: the operating fee to C-E, debt service, and landfill costs, less the Authority's share of energy and material revenues.

As a backup security feature of the Project, which was required for financing and is applicable only under certain very narrow conditions in which the City is unable to meet its payment obligations, the Authority may collect user fees from City residents.

PROJECT HISTORY

Table 1 presents selected milestones and events during the decade-long planning and development process from the mid-1970s to the start of construction in May of 1986, extended to the projected start of operations in the early part of 1989.

In 1975 the City established a Resource Recovery Task Force led by the Department of Public Works (DPW) and with staff support from the City Engineering, Public Lighting, Law, and Finance Departments. Throughout the planning process, the Mayor's office was routinely kept informed of progress and at key decision points the Mayor was formally briefed by the Task Force and its consultants. It is an important factor in the ultimate success of the Project that the same mayor has remained in office.

Ten alternate resource recovery sites were identified and evaluated for suitability, and two were selected for further consideration. One was the current site. The other was located in the riverfront area adjacent to a power plant operated by the Public Lighting Department, which would serve as the energy customer if that site were chosen.

A Request for Qualifications was issued and 24 companies responded offering a range of technologies, including mass burn, RDF systems, pyrolysis processes, and other approaches. This was one of the early resource recovery procurement efforts in the U.S., and in this sense was a pioneering effort. The resource recovery industry had not yet "shaken out" unproven systems or those with limited operational experience, and there was also very little experience in this country with the contractual and financing aspects of this type of project.

A Request for Proposals was prepared and issued in 1976, including both DECO and the Public Lighting Department as potential energy customers at the respective sites, and three proposals were received and evaluated. Two were selected as finalists for further evaluation and initial negotiations, a mass burn system (employing the Martin technology, offered at that time by UOP, Inc.) and the RDF system subsequently selected. Both proposals were strong, and were considered on balance roughly equivalent in terms of technical evaluation criteria, the resulting net disposal cost to the City, and the technical and management capabilities of the proposers. The mass burn proposal was recognized as offering the more proven technology. However, the proposed RDF facility had the advantage of providing excess capacity and the potential for expanded operation and greater flexibility, assuming it performed up to expectations. Another key element that influenced the City's decision was the input from the City's financial advisor that the participation of C-E made the Project somewhat stronger financially. The ability to finance the Project was a major consideration and concern throughout the planning process.

The C-E design also was favorably reviewed in a separate evaluation sponsored by DECO. Starting in the 1978 timeframe, the Task Force's efforts focused on DECO as the preferred energy customer. While the Public Lighting facility remained a backup, at least until 1981 when a Memorandum of Understanding covering price and quantity issues was reached between C-E and DECO with the concurrence of the City, the DECO alternative appeared more favorable economically. The City also considers the Central Heating System a benefit to the downtown area, and thus the Project's potential contribution to the long-term viability of the CHS has been an important consideration for the City.

The period from 1979 to 1981 was characterized by contract negotiations involving the City, C-E, and DECO; a continuing review, in the context of progress in these negotiations, of the likely or preferred financing mechanisms; and discussions and background analyses to support the permitting process. A Michigan Environmental Impact Statement (EIS) was prepared, but was not officially released for review by the Michigan Environmental Review Board (MERB) due, in part, to the contractual issues that separated the City and C-E at that point and the possibility that the Project might not proceed.

As a complement to the resource recovery work, the DPW commissioned a study of its overall solid waste management practices. The resulting report, published in 1981, documented the existing collection, transfer, and disposal system and presented an evaluation of issues that need to be addressed in the transition to a system incorporating resource recovery as a major component. While certain results of the study were of value to the DPW at the time, the transition aspects were not pursued until the construction period was well underway.

While a specific date is not available, sometime in 1982 the Project in effect was put on-hold as high interest rates dramatically increased projected City tipping fees. The City at one point was on the verge of "deferring" resource recovery for several years, and pursuing landfill options in the meantime.

The 1983 and 1984, a major effort was made to get the Project moving again. The EIS process was resumed, with an update in 1983 to reflect the data in the permit applications (which were also submitted at this time) and an addendum in 1984 which addressed comments on the updated document; the EIS was formally approved by MERB.

Various public and private ownership and financing approaches were pursued, and the result was the establishment of the Greater Detroit Resource Recovery Authority with the ability to serve as owner and issuer of bonds. By the latter part of 1984 the major preconstruction permits had been secured and the Service Contract, described earlier in this paper, was approved by the City Council. These events set the stage for the initial financing of the Project, which took place on December 31, 1984. The funds were warehoused until such time as the remaining contracts were executed and the long-term financing put in-place. This milestone was achieved on May 5, 1986, when the bonds were remarketed to provide $438 million for construction financing. One interesting aspect of the 1986 financing is that two preliminary Official Statements were distributed: one for a combination of fixed rate bonds, and adjustable rate bonds backed by bank letters-of-credit; and a second for 100% fixed rate bonds. The latter approach was chosen — practically at the last minute — based on market conditions and risk considerations.

Construction progress from its commencement in May 1986 to the writing of this paper (Fall 1987) has been good. Work is proceeding according to schedule on both the Facility proper and the off-site steam line. Most of the equipment has been procured and is beginning to appear at the site. Underground piling is essentially complete and concrete foundations are in place for the boiler building and certain other portions of the plant. A substantial amount of steel is up, particularly for the boiler building. The stack is nearly complete. While some limited time has been lost due to weather, this has not been at all out of the ordinary.

CONCLUSION

The Greater Detroit Project illustrates a number of important features:

(a) The Project embodies a viable technology, which makes up for limitations in experience with a conservative approach toward capacity and redundancy.

(b) The institutional approach of public authority ownership and private full-service operation, can serve as a model for future projects where tax benefits and other considerations do not favor private ownership.

(c) Continuity in public and project leadership is fundamental to the success of as major and complex an undertaking as implementing resource recovery.

The Project also offers valuable lessons from its development process, as discussed below.

In reconstructing the Project's history, in which both of the authors personally participated throughout, it became apparent that the course of the Project was buffeted not only by the sheer magnitude and complexity of the undertaking, but also by outside events and circumstances. The period encompassed, for example, wide swings in interest rates and energy costs, as well as changes in tax law. It also covered a time of change, which is still ongoing, in the environmental regulation of resource recovery facilities.

Furthermore, a project delay caused initially by such events or circumstances tends to feed on itself. Some insight provided by the Detroit experience may be gleaned from the following observations:

(a) Decision-makers defer finalizing agreements or commitments until circumstances are more favorable, or at least more certain.

(b) Organizations also change with time; what can be mutually acceptable one year may be viewed as deficient the next; for a municipality this may relate to the political climate or to other competing priorities, for a private contractor this may involve company management criteria or relate to its activities elsewhere in the marketplace, and for a utility this may be a function its business outlook or management preferences.

(c) Renegotiation takes time, and other project development activities (notably those associated with financing in the case of Detroit) await the project again achieving essential agreement among the parties.

(d) All current environmental issues and concerns need to be addressed, analyzed, discussed in public forums, and in certain cases resolved in the courts; this can and does take considerable time, resources, and personal attention away from other aspects of project development, thereby slowing the pace of resolving other outstanding issues as well; and, the longer the delay, the more "new" issues of the day emerge, which must be addressed, etc.

These points are stated in a somewhat abstract form, because many of the details and specifics, while they undoubtedly would make considerably more interesting reading, are not appropriate to cite. Nonetheless, the message is important. Hopefully, this discussion and this paper will shed light on how and why projects can experience such lengthy delays. How this insight will enable other resource recovery projects to avoid similar pitfalls (with the common trait that delay feeds delay) is not clear, and the authors suspect that the appropriate approach and strategy will, in fact, be different in different circumstances.

REFERENCES

[1] Yaffe, H. J., et al. "The Greater Detroit, Michigan Resource Recovery Project Consulting Engineer's Feasibility Report." WESTON, May 5, 1986. Contained in the Project's Official Statement of same date.

[2] The authors also wish to acknowledge Mr. Norman P. Getz of Roy F. Weston, Inc. (WESTON), who provided useful comments to improve the paper.

SI UNITS

1 ton = 0.9072 metric ton (t)
1 acre = 4,047 m^2
1 btu/lb = 2,323.8 J/kg
1 in. = 0.0254 m
1 psig = 6,895 Pascal (Pa)
1 gr/dscf = 2.231 g/m^3 (at 25°C and 1 bar dry)
1 lb = 0.4536 kg