WASTEPLAN MODEL IMPLEMENTATION FOR NEW YORK STATE

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WASTEPLAN MODEL IMPLEMENTATION FOR NEW YORK STATE

Final Report

Prepared for

**THE NEW YORK STATE
ENERGY RESEARCH AND DEVELOPMENT AUTHORITY**

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1769-ERER-MW-92

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First printing: July 1995

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ABSTRACT

WastePlan is a computer software tool that models solid waste quantities, costs, and other parameters on a regional basis. The software was developed by the Tellus Institute, a non-profit research and consulting firm. The project's objective was to provide local solid waste management planners in New York State responsible to develop and implement comprehensive solid waste management plans authorized by the Solid Waste Management Act of 1988, with a WastePlan model specifically tailored to fit the demographic and other characteristics of New York State and to provide training and technical support to the users. Two-day workshops were held in 1992 to introduce planners to the existing versions; subsequently, extensive changes were made to the model and a second set of two-day workshops were held in 1993 to introduce planners to the enhanced version of WastePlan. Following user evaluations, WastePlan was further modified to allow users to model systems using a simplified version, and to incorporate report forms required by New York State. A post-project survey of trainees revealed limited regular use of software. Possible reasons include lack of synchronicity with NYSDEC planning process; lack of computer literacy and aptitude among trainees; hardware limitations; software user-friendliness; and the work environment of the trainees. A number of recommendations are made to encourage use of WastePlan by local solid waste management planners.

KEY WORDS: WastePlan, solid waste, computer modelling, regional planning.

ACKNOWLEDGEMENTS

The New York State Association for Solid Waste Management would like to acknowledge the individuals and organizations that contributed to this project:

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SUMMARY

In 1992, the Energy Authority contracted with the New York State Association for Solid Waste Management (the Association) to distribute a personal computer-based modelling software program called WastePlan to local solid waste management officials throughout New York State, and to train them in the fundamentals of using the software. The Association, in turn, contracted with the Tellus Institute, developers of the software, to modify WastePlan for New York State users, and to conduct a series of workshops for local solid waste management officials. The New York State Department of Environmental Conservation (NYSDEC) provided support to the Association and carried out the tasks assigned to the Association under its contract.

In designing the project, the Association evaluated results of other states' experiences with WastePlan, particularly Michigan. The project design was constructed to minimize the problems Michigan encountered.

Initial workshops were held in 1992 to introduce users, primarily representatives of local solid waste management planning units, to WastePlan. Approximately 80 people attended, including staff from New York State agencies, solid waste management planning units, an academic institution (Rochester Institute of Technology), and a consultant representing a planning unit. Of the 80 attendees, 30 percent represented various New York State agencies, NYSDEC predominantly; a little more than one percent each were consultants and academic institutions, respectively; 50 percent represented county or multicounty planning units; and the remaining 17.5 percent represented planning units for a single municipality, largely Long Island towns. Of the county/multicounty planning units, 60 percent could be characterized as rural; 7.5 percent as suburban (environs of New York City); and 32.5 percent as urban.

Following the initial round of workshops, the Association, through its subcontractor, the Tellus Institute, improved and modified the software for New York State users. Improvements included the developing of three distinct default data sets that are incorporated into WastePlan and reflect New York State's general demography. This demographic classification included an upstate rural area, an upstate urban area, and a downstate area exclusive of New York City. The software was also modified to incorporate time changes over a planning period, improve capital stock (equipment) vintages, transportation costs and routing, and improvements in report formats. The contract also required the Association to implement a toll-free telephone number to connect the user directly to the Tellus Institute for technical assistance.

After these initial improvements and modifications were finished, the Association held a second round of workshops early in 1993 to introduce the enhanced version of WastePlan. After this second round of workshops, user dissatisfaction and disinterest caused the Association to modify its second year workplan to address their concerns. To assess WastePlan from a user perspective, the Association conducted two separate pilot demonstration projects with two local solid waste management planning units. As a result, a number of suggestions and proposed modifications were compiled and presented to the Tellus Institute that included developing a simplified version of the WastePlan model, and incorporating reports required from local solid waste management planning units by NYSDEC. The modified version was distributed to users in early 1995.

After the contract's tasks were finished, the Association conducted a program evaluation survey in May 1994. Approximately 100 representatives from local solid waste management planning units who had attended one or more of the WastePlan workshops in 1992 and/or 1993 were sent a questionnaire. The survey results revealed a low level of use among those surveyed; however, a majority said the most recent changes would help them use it in the future.

There are a number of reasons why WastePlan was not as broadly embraced by the local solid waste management planning community in New York State as anticipated, including:

- Limited computer literacy of many users;
- Limited synchronism with the NYSDEC's planning process;
- Hardware limitations;
- User-friendliness of the software; and,
- The nature of the users and their jobs.

While the State cannot undertake actions to counter all of these obstacles, several promising steps are being considered. These include:

- Continuing technical assistance with the various municipal planning units by the NYSDEC staff;
- Expanding the potential to use WastePlan as a reporting tool by municipalities for NYSDEC compliance reports;

- Encouraging the use of WastePlan as a tool for fine-tuning existing solid waste management programs rather than as a means of planning new ones;
- Allowing consultants to use WastePlan on behalf of municipalities who have staff time and computer capability constraints.

WastePlan has potential as a modelling tool for New York State's local solid waste management community. As users receive the more user-friendly version of WastePlan that incorporates the NYSDEC-required report forms, the number of local solid waste management planning units using WastePlan is expected to increase.

Section 1

INTRODUCTION

Integrated solid waste management requires careful quantitative analysis of a wide range of options. WastePlan, a computer model created specifically to perform these analyses, allows planners to simulate the economic and physical characteristics of their waste stream and collection, processing, and disposal processes. The WastePlan model was developed and is owned by the Tellus Institute, a research and consulting firm. The model is marketed to states and large municipalities such as New York City. States that purchase the model have the right to let any municipality within the state use the model free.

For several years before this project, the NYSDEC assisted municipalities to plan integrated solid waste management systems. NYSDEC's intention was to provide municipalities with a standardized planning tool that would consider local conditions and needs while examining a variety of systems. NYSDEC selected WastePlan to meet those needs, and planned to purchase and adapt it to New York State conditions; however, due to State budget constraints, approvals for this project were not obtained.

Discussions between the Association and the NYSDEC led the Association to propose working with the Energy Authority assisted by the NYSDEC. Discussions with the Energy Authority and the NYSDEC resulted in this project.

The Association can deliver technical assistance because it is primarily composed of representatives from local solid waste management planning units and can reach a wide audience of local solid waste management planning officials. This made the Association ideal to implement WastePlan in New York State.

The Association found that other states' experiences with WastePlan might be useful. The Association reviewed a critical study of how WastePlan was implemented in Michigan¹, and designed this project to avoid Michigan's pitfalls. The Association considered several issues that contributed to the poor reception WastePlan received in Michigan: a more intelligent interface was developed that gave users the ability to more quickly and easily begin using the model; several default data sets were developed; the manual was extensively revised to make it as user-friendly as possible; a toll-free number for expert technical assistance was provided; and, the state regulatory agency, NYSDEC, was involved in distributing the model, and in associated training and technical assistance.

1. Meyer, G., Sandberg, B., & Stanton, T. WastePlan Software Adoption and Implementation. Fourteenth Annual Madison Waste Conference, Sept. 1991.

Section 2

PURCHASE AND DISTRIBUTION OF EXISTING MODEL

The first task accomplished under this Contract was the purchase and distribution of the existing WastePlan software under the license agreement with the Tellus Institute, subcontractor for this project. The WastePlan software was developed by the Tellus Institute, a Boston-based, non-profit research and consulting firm. As agreed under the Contract, the WastePlan software program was licensed to the Energy Authority in March 1992, authorizing the Energy Authority to distribute the software and supporting documents to public sector agencies in New York State. The distribution of the existing WastePlan software (Version 92.0) was accomplished at the first round of workshops (see Section 4) in order to ensure appropriate training, as it was believed that the training was an important and integral part of understanding WastePlan. The software was distributed to local government officials, members of non-profit associations, and state agency personnel in New York State through the NYSDEC under the licensing agreement with the Energy Authority.

The license agreement stipulates that the Tellus Institute shall provide to the Energy Authority any new enhancements or modifications to the software at no additional charge for three years from the date on which the original enhancements to the model described in Task #4 (see Appendix B) were made available. As such, WastePlan users will be entitled to any updated versions of the software that are developed until the beginning of 1996. The Energy Authority will have the discretion of deciding whether to distribute such updates, if any, to users.

Section 3

PREPARATION OF NEW YORK STATE-SPECIFIC DATA FOR THE MODEL

During the initial brainstorming for this project, the Technical Advisory Committee organized by the Energy Authority decided that the Tellus Institute should prepare and distribute a New York State-specific written data report, describing solid waste generation, collection, and processing/disposal systems. The decision to construct New York State-specific default databases was made, in part, to address one of the problems identified in a paper presented at the Fourteenth Annual Madison Waste Conference in September 1991 entitled, WastePlan Software Adoption and Implementation, that described Michigan's implementation of WastePlan. In that study, the authors concluded, "Several Default Data Sets should be available for use, so that communities can begin WastePlan analysis as easily as possible with default data that fairly accurately depicts their community."

Tellus subsequently developed default databases for three separate regions of New York State: upstate rural; upstate urban, including Buffalo, Syracuse, and Rochester; and downstate suburban, including Westchester, Nassau, and Suffolk counties. The databases reflect economic, physical, and demographic characteristics of these three regions. The information was based on Tellus studies, on New York State-specific data supplied by State and local agencies, data developed for other WastePlan users, and data from local solid waste management plans representative of each of the three demographic units. These databases are intended to provide users with a reasonable starting point for local application of WastePlan.

While participants at the training sessions were strongly encouraged to use these databases, they were advised to apply their own respective county/city generation rates and collection program costs to accurately simulate their systems.

The default databases are accessed by the WastePlan user under the "Projects" menu. The upstate rural environment default database is called NYRURAL; the upstate urban default database is called NYURBAN; and the downstate suburban environment, exclusive of New York City, is called SUBURBAN.

Section 4

INITIAL TRAINING SESSIONS

Two rounds of two-day training sessions were held during the contract period. The first round began in June 1992, and concluded that August. This first round covered the 92.0 version of WastePlan. To be available to as many planning units as possible, locations for training were selected at Albany, Ithaca, Buffalo, and Westbury. WastePlan was introduced followed by simplified problems that were solved individually or in groups. The problems illustrated the uses of WastePlan, data requirements of the software, and familiarized users with the basic features of the software. Examples of how WastePlan had been used in other locations were presented. Approximately twenty people attended each session; about eighty people were trained, including staff from New York State agencies, solid waste management planning units, an academic institution (Rochester Institute of Technology), and a consultant representing a planning unit. Of the 80 attendees, 30 percent represented various New York State agencies, predominantly from NYSDEC; a little more than one percent each were consultants and academic institutions, respectively; 50 percent represented county or multicounty planning units; and the remaining 17.5 percent represented planning units for a single municipality, largely Long Island towns. Of the county/multicounty planning units, 60 percent could be characterized as rural; 7.5 percent as suburban (environs of New York City); and 32.5 percent as urban. At the end of each session, participants were asked to complete an evaluation form, the results of which are given in Appendix C.

The workshops involved a great deal of coordination between the Association and the Tellus Institute. The Association was responsible for selecting training sites, securing the necessary agreements, advertising the workshop, registering participants, and providing logistical support, such as maps and lodging for participants unfamiliar with the area.

Since the training sessions involved hands-on use of WastePlan, training sites had to meet stringent requirements: A minimum of 20 computers with 386 microprocessors and five to ten megabytes of free random-access memory, and a computer screen projector. The costs to rent a personal computer laboratory ranged from free (Nassau County Board of Cooperative Educational Services in Westbury, and the IBM offices in Albany) to \$1,500 at the University at Buffalo. While a great effort was made to ensure the hardware would run the software before each workshop, minor technical difficulties did occur that required workshop time to correct. With the exception of the training session locations in the Capital District, it was not practical to visit other computer laboratories in the State before the training sessions.

The Tellus Institute brought a minimum of two, sometimes three, instructors for the training sessions. While one instructor was teaching, others would help on a one-by-one basis. The workshops were attended by the WastePlan Training Coordinator for the Association and occasionally other staff from the NYSDEC.

To defray costs and ensure that participants were attending in "good faith," the Association charged a \$50 registration fee for the workshop, that included lunch and refreshments for both days. A few would-be participants said that the fee prevented attending. The Association waived or reduced the fee for hardship cases.

An agenda for the first training session, a list of participants, registration form, questionnaire, graphic summary of the evaluations, and other information, is attached to this report as Appendix C.

Section 5

FURTHER DEVELOPMENT OF WASTEPLAN SOFTWARE

To meet the needs of New York State WastePlan users, the software was extensively revised and enhanced. Based on earlier discussions with the NYSDEC, the Tellus Institute identified four priority areas for software enhancement: better treatment of capital stock vintages; the ability to analyze and evaluate program changes over time; the analysis of transportation costs and routing issues; and, finally, improving reporting.

Procedural revisions increased the user-friendliness of the program, including pull-down menus, pop-up lists, using a mouse, "help" screens, and an on-screen "road map" outlining the data structure. Subsequent revisions have minimized assumptions about waste management practices, and provided greater flexibility to the user.

INCORPORATING TIME CHANGES

WastePlan was modified to project detailed analysis of cost patterns. The new version distinguishes between existing and new equipment, allows for the phase-in of new programs (with, for example, gradually increasing participation rates), and can simulate construction of new facilities or buy new collection vehicles at designated years in the future. A waste reduction scenario may now, for example, show a gain in net present value due to postponing the need to build an expensive new facility. In the previous WastePlan version, only the landfill module distinguished between existing and new capacity.

BETTER TREATMENT OF CAPITAL STOCK VINTAGES

In addition to the items previously mentioned, the enhanced version of WastePlan calculates inflation on all future costs, and buys replacement equipment at the appropriate future prices.

TRANSPORTATION COSTS AND ROUTING

A transportation option was added to WastePlan to route different communities' collected waste stream components (recyclables, compostables, and garbage) to different facilities. For each routing, transportation costs per ton of waste can be entered. With this option, WastePlan can re-calculate

total system costs under a variety of user-defined transportation routings to identify the least-cost transportation scenario. In the previous version, transportation costs appeared only in the cost calculations for local collection vehicles, and in summary form in the transfer station module.

IMPROVEMENT IN REPORT FORMATS

Unlike the single, lengthy reporting format in the 92.0 version, WastePlan 2.05 and its successors allow users to select from a menu of report options, offering a wide range of reporting detail. Data reports can be generated from each data entry screen, summarizing the data entered in that screen. All reports can be viewed on screen, printed, or saved on disk. In addition, graphics capability allows on-screen or printed summaries. Other changes have also been made:

First-year Calculation Option

This new feature in WastePlan allows the user to run calculations the first year of the report period alone to save time on complex scenarios. This feature minimizes calculation time if, for example, the user is only interested in single-year snapshot results or in evaluating initial modelling assumptions.

Customized Naming

The enhanced version of WastePlan allows the user to customize the labels for program titles, sector categories and facility names. This feature was added for those who felt that solid waste systems in different areas often use unique terminology.

These changes offered users better data-management that requires less time to use with greater flexibility.

Section 6

SECOND TRAINING SESSIONS

The second round of training ran from late January to mid-March 1993, in Stony Brook, Buffalo, Troy, and Syracuse. A two-day session format was again used, with workshops located around the State. The second round was designed to introduce users to WastePlan - Version 2.05. During the sessions, the old and new versions were compared. Simple exercises were practiced and the New York State default data set was distributed and discussed. Approximately 70 people attended, of which 38 percent represented New York State agencies, predominantly NYSDEC; 46 percent represented county or multicounty planning units; 14 percent represented municipalities that are planning units (primarily Long Island towns); and two percent represented Cornell Cooperative Extension. Of the county/multicounty planning units, 70 percent represented rural areas of New York State; 26 percent represent upstate urban areas; and four percent represented suburban planning units in the environs of New York City. Of the planning units that consist of individual municipalities, all represent suburban (downstate) areas. Many people who attended the first round of training attended the second. An agenda, list of participants, summary of the evaluations, and other information appears in Appendix D.

As with the first round of training, the Association was responsible for securing suitable computer laboratories for the hands-on workshops (with a minimum of 20 work stations), advertising and organizing the workshops, and registering participants. A \$50 registration fee defrayed lunch and refreshment costs for two days.

Those who attended only the first round of training sessions received updates to the software, including the final version (2.20), along with the revised User Guides and the New York State Default Data Report.

After the second round of training sessions the Tellus Institute produced a Final Report which appears in Appendix E.

The Final Report summarized the Institute's work with the Association. The report says that "very few participants who attended the first set of training sessions actually used the older WastePlan version. Apparently, with the knowledge that a newer version was to be released within the year, most participants simply waited to attend the second round of training sessions. The number of

participants who indicated that they planned to use WastePlan in the near future was difficult to determine because they still needed time to become familiar with the software and how it fit in with the Department of Environmental Conservation's (DEC) planning process."

Section 7

MODEL UPDATES AND USER SUPPORT

As agreed under Contract, the Tellus Institute provided technical support to New York State users for one year from the last training session, March 18-19, 1993. This support was primarily a toll-free telephone number that allowed users to get advice and information directly from Tellus. Use of the hotline number was minimal. The service continued on a trial basis until May 31, 1993 when it was terminated. The Tellus Institute supported New York State WastePlan users via regular telephone, facsimile, and mail, and continued to assist the Association. For example, Tellus, in conjunction with the Association, delivered a presentation on WastePlan at the annual meeting of the New York State Association for Reduction, Reuse, and Recycling in Saratoga Springs in June 1993. Tellus has provided the Association, which in turn has provided the Energy Authority, all revisions to the WastePlan model and supporting information developed for other clients, as required under the contract. The final version of the software delivered under the contract is Version 2.20.

As a result of an evaluation of the WastePlan project in the spring of 1993, the Association, in concurrence with the Energy Authority, redirected the focus of the second year of the contract. Instead of expending resources on additional training sessions and promotion of WastePlan at various conferences and seminars where solid waste management professionals gather, the WastePlan project was revised to develop a more user-friendly, useable product for the solid waste management community and to still promote its use at Association training courses and conferences. The majority of the resources for the second-year effort were focussed on three, inter-related areas: pilot demonstration projects; user-friendly modifications; and incorporation of DEC Compliance Report forms.

PILOT DEMONSTRATION PROJECTS

The Association organized two pilot demonstration projects with local solid waste management planning units in the Capital District of New York State. The first pilot project began in the summer of 1993 with the Eastern Rensselaer County Solid Waste Management Authority. During the course of this pilot demonstration project, staff worked with the Eastern Rensselaer County Solid Waste Management Authority (ERCSWMA), an upstate rural planning unit, to construct a WastePlan model from the ground up. This approach allowed Association staff to fully understand the model development process, and better evaluate the software from a user-friendly perspective.

The second pilot project was held with Schenectady County, an upstate urban planning unit, in the fall of 1993. The project took less time because Association staff had benefitted from the first pilot project.

Both projects yielded usable WastePlan models and information to improve WastePlan. The demonstration project with ERCSWMA yielded valuable information because it was the first project in which the Association worked with actual local data to model a solid waste management system. This project was particularly fruitful because a great deal of care was exercised in constructing the model to not shortcut any aspects. As a result, much was learned about the process of learning and using WastePlan as well as discovering where improvements could be made to the software, particularly in user-friendly interfaces. In both demonstration projects, the glitches and areas for improvement discovered and recorded during the work became the basis for the user-friendly software modifications proposed to the Tellus Institute that appear in Appendix F.

USER-FRIENDLY MODIFICATIONS

The proposed modifications and recommendations catalogued during the two pilot demonstration projects became the basis for the first of two requests made to the Tellus Institute to update WastePlan. While many of the proposed modifications were relatively minor, one was not: The Association requested the Tellus Institute to explore the possibility of a simplified model analogous to the simplified 1040 tax form. The Tellus Institute subsequently developed this model, called WastePlan BASIC. Users have the option, at the beginning of a modelling session, to use either WastePlan BASIC or WastePlan ADVANCED. A user can upgrade a WastePlan BASIC model to WastePlan ADVANCED, but not the reverse.

The list of user-friendly modifications originally proposed to the Tellus Institute, and their response appears in Appendix F.

The major recommendation was to simplify the user interface with the software using prompts and other guides. The Tellus Institute responded that while the idea seemed sound, programming WastePlan to track the steps a particular user makes--particularly when a user backtracks and starts over--would require enormous programming, memory, and expense. Given the small benefit that might be derived, and given our next suggestion to create a simplified version of WastePlan, we agreed with the Tellus Institute's recommendation. This suggestion resulted, successfully, in the creation of WastePlan BASIC, a simplified version of WastePlan that requires less data input while sacrificing minimal modelling accuracy.

INCORPORATING DEC REPORT FORMS

The third, and final aspect of the model update process was to incorporate certain data-intensive forms required of all solid waste management planning units by the NYSDEC. The Association proposed that the Tellus Institute incorporate, within the structure of WastePlan, two DEC reports required under 6 NYCRR 360-15.12: The Waste Generation/Disposal Inventory, and the Recyclables Generation/Management Inventory. The Association anticipated that incorporating both forms would provide an incentive for users at the planning unit level to use WastePlan and simplify compliance reporting, since WastePlan would assist the user in generating and reporting the required data. NYSDEC could use WastePlan to aggregate and report the information Statewide. Such information could be used to forecast trends in solid waste generation, for instance.

Local solid waste management planning units will be required to submit compliance reports to the Department of Environmental Conservation beginning March 1, 1995. The Department will also advise all the solid waste management planning units of the incorporation of these reports into WastePlan, and the updated software, which includes these forms, will be available to all planning units. Copies of both forms appear in Appendix G.

Section 8
PROJECT MANAGEMENT

The contract required the Association to form a team consisting of two key New York State Department of Environmental Conservation employees and one member of the Association's Board of Directors to manage this project including, but not limited to promotional and logistical support for all training sessions described in the Contractor's proposal, on-going training beyond that provided in Task 3 and Task 5, and a program evaluation and final report.

The team that managed this project included James E. Close, Solid Waste Management Specialist for the Bureau of Facility Management, Division of Solid Waste, Department of Environmental Conservation; and his supervisor, Thomas J. Lynch, P.E., Environmental Engineer, also at the Department of Environmental Conservation. Mr. Close implemented the WastePlan project from beginning to end. Mr. Lynch provided direction and supervision whenever needed. David A. Blackman, P.E., represented the Association as a member of the Board of Directors, and served as the official WastePlan Project Manager. Michael J. McTague and Penelope A. Cioffi, Bureau of Facility Management, assisted in the pilot demonstration projects.

Section 9

CONTINUING TRAINING AND USER SUPPORT

The contract required the Association to provide technical support to New York State users of the WastePlan model for at least one year after the last training session. As explained in Section 7, "Model Updates and User Support," the second year of the contract was radically re-directed in form and substance. Instead of only focussing resources on continued training and promotion, the Association, with the concurrence of the Energy Authority, directed its efforts, with the assistance of the Tellus Institute, to developing a more user-friendly WastePlan model that would, hopefully, achieve greater user acceptance within the solid waste management planning community. These efforts were described in Section 7.

The Association continued promoting WastePlan at its spring and fall meetings, as well as setting up a demonstration and display at the Annual Conference of the New York State Association for Reduction, Reuse, and Recycling. The toll-free telephone number continued to operate past May 1993, but was finally discontinued because of limited usage. During the second year, and beyond, the Association and the Tellus Institute have continued to provide technical support to users.

Section 10

PROGRAM EVALUATION

Program evaluations usually take place at the end of a project or study; the Association conducted program evaluations throughout this project.

After both training sessions participants were asked to complete a workshop evaluation form. Responses varied considerably, and seemed to depend in part on the degree of computer experience. Those who had little or no computer experience were generally less satisfied than those who had moderate or extensive computer knowledge. The latter group felt they had received a good introduction that would be useful. Evaluations of the first and second workshops appear in Appendices C and D, respectively.

Overall, as the training sessions progressed, it became clear that the material covered during the sessions had to remain very straightforward and simple. Familiarizing trainees with the program was a substantial task in itself (i.e., moving about the menus, inputting data, deleting data, etc.), and proved to constitute the majority of time spent instructing during the sessions.

During the second round of workshops on the enhanced version of WastePlan, it was apparent that there was some dissatisfaction with the software, the training, or both. This led the Association to investigate the level of usage of the software by those who had participated in the workshops, and to seek to determine what improvements, if any, were needed in order to deliver a more useful and user-friendly product to the solid waste planning community in New York State.

Based on our interviews and correspondence with users following the second set of workshops, the Association suspected that WastePlan was not being extensively used by the people who had received the training and the project was redirected.

PROGRAM EVALUATION SURVEY

The Association conducted a post-project survey in May 1994. The survey was sent to more than 100 planning unit representatives who had attended at least one WastePlan workshop; 29 responses were received. The responses appear in Appendix H, and some results are graphically displayed. The survey also gave respondents an opportunity to respond, in narrative, to open-ended questions. These responses are also incorporated in Appendix H.

These conclusions can be drawn from the surveys:

- The majority of respondents believe a computer software modelling tool is useful and necessary to their job.
- The majority of respondents have not used WastePlan to model their system.
- Most respondents learned about WastePlan from either the Department of Environmental Conservation or the Association.
- Those who have used WastePlan used it to model "generation" scenarios the most; "collection" scenarios the least.
- Of those who attended both workshops, most felt that the enhanced version was easier to use and more useful.
- The majority of respondents who had not used WastePlan were not sure if they would use it in the future.
- The majority of those who have been WastePlan users plan to continue to use it.

Computer Literacy

The target audience for the WastePlan software may not have had the minimum degree of computer literacy necessary to sustain an interest in WastePlan after the workshops. During the first round of workshops, the registration form asked the registrant what degree of familiarity they had with respect to micro-computers; the registrant was asked to check one of three boxes (novice; somewhat knowledgeable; very knowledgeable). The responses showed a fairly high proportion of those attending considered themselves novices. While the Tellus Institute directed training for those with little or no computer experience, novice attendees are least likely to return to their office and use the software.

Limited Synchronism with NYSDEC Planning Process

Many participants at the workshops said they had less need to use WastePlan because their solid waste management plans were completed. Correct or not, the impression that the value of

WastePlan lay only in its development of a local solid waste management plan may have led many recipients of the WastePlan software to not use it. It is worthwhile noting that it was originally anticipated that the NYSDEC's contract to purchase WastePlan would be approved in a timely manner to coincide with the local solid waste management plan development process.

Hardware Limitations

The enhanced version of WastePlan required significantly more random-access memory (RAM), hard-disk space, and processing speed to run efficiently than the earlier version. Some workshop participants said their hardware would not run the enhanced version.

User-Friendliness

The enhanced version of WastePlan, while delivering more modelling capability to the user, also increased the complexity of the program.

The Nature of the Users and their Jobs

Many of the workshop participants were solid waste management officials from small, rural counties; as such, they often wear more than one hat and, in many instances, have little free time to devote to developing a WastePlan model. To investigate that hypothesis, we asked the following questions in the program evaluation survey. Not surprisingly, the results (which are by no means conclusive or definitive) show a slightly higher tendency for rural survey respondents (Question No. 3) to indicate that they have not used WastePlan. As for "why," the number of responses elicited in Questions 9A and 9D do not provide definitive conclusions to support the hypothesis. The following responses illuminate the differences between those who labelled themselves as "rural," "upstate urban" and "downstate."

Question No. 2: "Would you describe your job as one in which a computer software tool for modelling solid waste management is useful and necessary?"

	<u>YES</u>	<u>NO</u>	<u>NO RESPONSE</u>	<u>NUMBER OF RESPONSES</u>
Rural:	68%	26%	6%	19
Upstate Urban:	44%	56%	0%	9
Downstate:	100%	0%	0%	3

Question No. 3: "If your answer to '2' is 'yes', have you used WastePlan to model any aspect of your local solid waste management system?"

	<u>YES</u>	<u>NO</u>	<u>NO RESPONSE</u>	<u>NUMBER OF RESPONSES</u>
Rural	16%	63%	21%	19
Upstate Urban:	22%	33%	45%	9
Downstate:	0%	100%	0%	3

Question No. 9B: Number of survey respondents who indicated that they do not plan on continuing to use WastePlan because they do not have the time and/or inclination to learn how to use it:

	<u>AFFIRMATIVE RESPONSE</u>	<u>NO RESPONSE</u>	<u>NUMBER OF RESPONSES</u>
Rural:	11%	89%	19
Upstate Urban:	22%	78%	9
Downstate:	0%	100%	3

Question No. 9D: Number of survey respondents who understand how to use WastePlan, but who indicated that they do not plan on continuing to use WastePlan because they have not had the time and/or opportunity to use it:

	<u>AFFIRMATIVE RESPONSE</u>	<u>NO RESPONSE</u>	<u>NUMBER OF RESPONSES</u>
Rural:	16%	84%	19
Upstate Urban:	33%	67%	9
Downstate:	67%	33%	3

RESULTS AND ACCOMPLISHMENTS

While many local solid waste management officials have not extensively used WastePlan, project accomplishments include:

- It brought the local solid waste management planning units together in a forum where useful information could be exchanged.
- It gave planning units the ability to model their solid waste management systems, whether or not they took advantage of it.

- It created a small, possibly growing group of planning units that use WastePlan on a regular basis; based on the program evaluation survey, five planning units (22 percent of responses) said they have used WastePlan. Three of the five respondents indicated they were "rural" planning units; the remaining two indicated they were "upstate urban" planning units.
- It demonstrated that WastePlan could be applied and could work in diverse settings in New York State.
- By incorporating the NYSDEC-required compliance reports, WastePlan is in the best possible place to recruit future users.
- It demonstrated conclusively that WastePlan could be applied in diverse environments and produce usable, useful models. Both pilot demonstration projects showed that WastePlan can, with sufficient time and attention to data input, produce models that accurately reflect and model the economics and waste flux of a region.
- The Michigan study referenced earlier concluded that WastePlan use by local solid waste planners was slow to materialize. They suggested that this problem could be mitigated or overcome by improving the model so the user interface is more intelligent. While this project was not undertaken with an express mandate to address this or the other Michigan study's recommendations, the project did, nevertheless, address this problem by making several user-friendly modifications which improved the user interface.
- The Michigan study also recommended that several default data sets should be available for use, so that communities can begin WastePlan analysis as easily as possible with default data that fairly accurately depicts their community. One of the initial tasks of the Tellus Institute was to develop three distinct default data sets reflecting the rural, upstate urban, and downstate regions of New York State.
- The Michigan study also suggested that better training materials should be developed, including an extensive tutorial with examples of major types of analyses. Not having a copy of the manual used in the Michigan study, it is difficult to compare and contrast the quality of that early manual with the extensively revised and re-written version that now exists. During the course of this project, the manual was extensively reviewed and comments and suggestions for improvement sent to the Tellus Institute. The product that now exists is a significant improvement over the first manual distributed at the first round of training.

- The Michigan study also postulated that "perhaps the most appropriate WastePlan users are solid waste management consulting firms and the solid waste industry itself, and not staff at SWMPA's" [solid waste management planning authorities]. The Michigan authors go on to say, "Certainly, making the software available for a fee through more commonly used distribution channels would greatly facilitate identification of the group of potential early adopters who might champion WastePlan use, if they are out there." The results of this project certainly lend weight to this premise; this project put a considerable amount of effort into encouraging local solid waste management planning unit officials to learn and use WastePlan, but few availed themselves of the opportunity to use it for reasons discussed elsewhere. The easy answer would be to conclude that the money spent on training the local planners could, perhaps, have been better spent on one-time grants to interested planning units to hire a consultant who, for a fee, would undertake a WastePlan analysis for the community. However, because part of the grant monies would go to overhead and profit, a local planning unit would get more if they undertook a WastePlan analysis themselves. A consultant would be more likely, due to budget constraints, to use the default data rather than actual planning unit data; therefore, the analysis may be less thorough and accurate than an analysis undertaken by the planning unit itself. Furthermore, after the grant monies were spent, a consultant would likely charge the planning unit for each iteration that it runs using the model; a planning unit trained in the use of WastePlan can use it at any time to run different scenarios at no external cost.
- The Michigan study also asked, "Is there not enough interest and political will for SWMPA's to do comprehensive, detailed planning?" In New York, that interest was very much alive and well, particularly when New York State offered planning units several million dollars beginning in 1989 to undertake comprehensive solid waste management planning. Unfortunately, the peak level of interest did not coincide with the implementation of this project, the result being that, when this project was finally implemented, in March 1992, most of the planning units in New York State had already completed their solid waste management plans, or were substantially underway. With this in mind, the Association did not try to "sell" WastePlan as, strictly, a tool to enable planning units to develop solid waste management plans with, but as a tool to help them "fine-tune" their plans, and to analyze and evaluate specific aspects of their plans such as recycling, and the comparative economics of different collection programs.

RECOMMENDATIONS

With the completion of this project, the question "Where does WastePlan go from here in New York State?" suggest these possibilities:

- If the NYSDEC, or other State agency, can continue to provide technical assistance to the planning units, the audience of WastePlan may continue to grow, even without further carrots or sticks.
- To encourage use by additional local solid waste management planning units, WastePlan could be modified to provide more user-friendliness.
- The marketing strategy for WastePlan could be redirected; instead of marketing it as a tool to assist planning units to prepare or fine tune their solid waste management plans, it could be marketed to smaller entities, such as individual municipalities, as a public works tool for fine-tuning collection programs or estimating the size and cost of transfer, composting and recycling facilities; the proper approach in this instance might be to allow consultants to use it on behalf of municipalities whose own staff find themselves hampered due to time constraints.
- WastePlan's potential as a reporting tool for local solid waste management planning units to the NYSDEC could be expanded beyond the two compliance reports currently incorporated.
- WastePlan could be used as a Statewide planning tool by the NYSDEC or the Legislative Commission on Solid Waste to plan regionally or Statewide.
- The Michigan study rhetorically asked whether the model was simply given to the wrong group of people or pushed through an inappropriate distribution channel? New York State's approach to the dissemination of WastePlan was to intensively train each of the local solid waste management planning units to use the software. Given the limited adoption of the software, a more effective approach might be a "circuit-rider" approach in which one or two people with a high degree of WastePlan expertise travel from planning unit to planning unit modelling the solid waste management system for each planning unit. In this case, all planning units end up with a model, but may lack the training to do it themselves, unless they avail themselves of the opportunity to learn the software while the expert is present. Given what was learned at the pilot demonstration projects, we believe that a typical planning unit model can be constructed in about one week's time; therefore, with one expert working the State, all the 64 planning units (excluding New York City) could be modelled in about two years. The cost of hiring a single "expert" for two years (the length of this project) at a salary of \$40,000-\$50,000 (excluding fringe benefits) would have been comparable to the training and promotion costs of this project.

- WastePlan should be given a chance to work. The Michigan authors, incisively enough, ask whether "our expectations are too high and consider how to measure success for the WastePlan project. Does the process of innovation diffusion just simply require more effort, time, money, etc. than we anticipated? If the ratio of real users to licensees is 1 to 10 after two years, is that a success or a failure?" We echo this conclusion; it is unrealistic to expect users to emerge, fully developed, after only two relatively brief training sessions. The long view needs to be taken in analyzing the success of this project. As such, it would be appropriate to re-evaluate the success of the use of WastePlan in New York State in another two to three years.

With the completion of this project, it is also appropriate to ask, "What can other states learn from the New York experience?" Some recommendations:

- Other states should evaluate the need for WastePlan on the local level before committing resources on extensive training of local planners and solid waste management officials. WastePlan should directly benefit the entity which undertakes the modelling effort.
- It may be more realistic for the state to learn to use WastePlan itself, and then apply it on a local or regional level as needed. Where local solid waste officials wish to learn WastePlan, a train-the-trainer approach, using a cadre of highly motivated and computer literate local solid waste management officials might prove productive. With this approach, resources are not squandered on those whose aptitude or interest in learning WastePlan is minimal, or on one-shot, one-time training courses.
- The state's role should be to promote WastePlan and identify how the local solid waste management official can use it.

CONCLUSIONS

While this project did not succeed in making WastePlan an active and integral part of every local solid waste management planning effort, it did set the stage for more users by providing a computer software tool designed specifically to serve the needs of New York State's solid waste management planning units.

The NYSDEC will continue to encourage the potential of a wider WastePlan audience by providing continuing user support and by encouraging planning units and others to use WastePlan for reporting and for solid waste management planning. The extent of these efforts will be dictated by NYSDEC staff availability and resources.

APPENDIX A

General Information about WastePlan

WASTEPLAN

The Integrated Solid Waste Management Planning Tool

What is WastePlan?

WastePlan is a user-friendly, microcomputer-based modelling tool for use in solid waste management planning. This planning tool was purchased from the Tellus Institute by the New York State Energy Research and Development Authority (NYSERDA) for distribution by the New York State Association for Solid Waste Management (NYSASWM) to municipalities, County governments, and other public sector entities involved in solid waste management planning in New York State.

WastePlan BASIC

WastePlan BASIC provides solid waste planners and public works officials with the flexibility to model solid waste management systems that are fairly simple and do not require extensive data input. This version of WastePlan is for use by small municipalities without extensive solid waste management activities (i.e., no public collection fleets, etc.).

WastePlan ADVANCED

WastePlan ADVANCED requires substantially more data input than its "basic" counterpart. However, because it includes more detailed components and variables that are integral parts of more complex solid waste systems, it provides a more realistic simulation of a solid waste program.

How Can I Get A Copy of WastePlan?

Copies are available to New York State municipalities without charge.

Contact: Division of Solid Waste
New York State Department of
Environmental Conservation
50 Wolf Road
Albany, NY 12233-4016
518-485-5856

ATTN: Mr. James E. Close

WastePlan ADVANCED "Road Map"

WastePlan BASIC "Road Map"

WASTEPLAN AT A GLANCE

● CREATE A PROJECT

System Menu; Projects Screen

Create a new Project; It is easier to copy data from an existing project, such as the Default Project, than to create one from scratch.

● SET THE FORECAST PERIOD AND SELECT THE UNITS

Projects Menu; Project Configuration Screen

Choose the first, middle and last years of the Forecast Period and Select the desired Unit Set; If desired, define a new Unit Set in the Units screen in the System menu.

● CREATE A SET OF ECONOMIC ASSUMPTIONS

Projects Menu; Economic Assumptions Screen

Create one or several sets of Economic Assumptions to be used in both Collection and Facility Scenarios.

● CREATE AND DEFINE WASTE STREAMS

Project Menu; Waste Definitions Screen

Create as many waste streams as will be needed. Define different waste streams for generators based on widely divergent types of waste, rather than for generators with streams of different waste compositions.

● CREATE WASTE GENERATING SECTORS AND WASTE COMPOSITIONS

Generation Menu; Sectors Screen

- Name a Generation Scenario
- Define Generation Locations
- Define Categories for each Location
- Define Sectors for each Category

Locations are distinguished by different physical characteristics, political divisions, or any characteristic that leads to unique collection program characteristics.

Categories are differentiated along the lines of waste streams; define a different Category for each different waste stream.

Sectors are created for different waste compositions; create a unique Sector for every different waste composition within a Category.

- Define Activity Units

Activity Units are the activity to which waste generation can be attributed or assigned. Example include: households, persons, employees, \$1000 of sales, etc.

For each Sector:

- assign an Activity Unit
- assign numbers of Units and Annual Growth Rates;
- assign Generation Rate of waste per Activity Unit and Annual Growth Rates
- create and assign Waste Compositions for each Sector.

● CREATE COLLECTION BUILDING BLOCKS AND COLLECTION PROGRAMS

Collection Menu/Programs Screen

For each Collection Program:

- Select the Program Type
- Name the Collection Program
- Create a Program Cost page
- Create a Diversion page
- Create a Vehicle Page
- Create a Collection Efficiency page
- Create a Container page
- Enter in first year for Program Costs
- Enter in first and last years for Program Operation

Program Costs: To buy vehicles for program, make sure "Y" is entered on this screen at bottom.

Function Keys: F1-Help, F2-Roadmap, F3-Create New, F4-Edit, F5-Delete, F6-Select, F7-Number, F8-Deselect, F10-Exit

- If vehicles are to be amortized for period other than vehicle lifetime, enter years in "Term of Loan" field.
 - If only participants are to receive containers, enter "Y" in this field.
- Diversion: Participant percentage defines how many will participate in Collection Program.
- Vehicles: If program will use existing vehicles, enter annual loan payment on each vehicle.
- Create Collection Program Building Blocks so that they can be used by many programs, if possible.

● **CREATE COLLECTION SEQUENCES**

Collection Menu/Sequences Screen

Each Collection Sequences will handle the waste from one or more Generating Sector. Name the Collection Sequence so that its name describes the Collection Programs it comprises. Select the desired programs from the Collection Program list boxes. If any programs are to make use of existing vehicles, number them here using the F7 function key. Design Collection Sequences to be as widely applicable as possible.

● **CREATE A COLLECTION SCENARIO**

Collection Menu/Collection Scenario Screen

Name a Collection Scenario and select the Generation Scenario to which it will apply. Select a set of Economic Assumptions.

Select the first Location in the Generation Scenario, and the first Category in the Location. Then, for each Sector in the Category select a Collection Sequence. Repeat for all Sectors, Categories and Locations in the Generation Scenario, until every Sector is associated with a Collection Sequence.

● **CREATE PROCESSING TECHNOLOGIES AND PROCESSING FACILITIES**

Facility Menu/Facilities Screen

For each Facility:

• Select the Facility Type;	• Select either Fixed Fee or Detailed Costs for Facility;
• Name the Facility;	• Describe Capital and Operating Costs (if required); and
• Define as either a New Facility or Existing Facility;	• Describe Area & Operations; (and, for landfills only);
• Create Processing Technology;	• Describe Closure and Long-Term Costs.
• Create Bypass Diversion page (if needed);	
• Assign Preprocessor (if needed);	

● **CREATE EXPORT OPTIONS**

Facility Menu/Export Screen

• Name the Export Option	• Enter the per ton cost

● **CREATE A FACILITY SCENARIO**

Facility Menu/Facility Scenario Screen

• Name the Facility Scenario;	• For each Program of each Program Type, select a Facility to which the program's collected wastes are to be delivered;
• Select the Collection Scenario from which waste is to be processed;	• Assign a Shipping cost for transporting waste <u>TO</u> the facility (if any);
• Select (or create) a set of Economic Assumptions;	• Repeat for all Programs, Program Types and Sequences in the Collection Scenario;
• Select the first Collection Sequence in the Collection Scenario;	• Route Overflow/Bypass and Transfer/Residue from each Facility.

Keyboard Commands: ESC, F10-Exit; TAB, SHIFT+TAB,-Move Through Screen; CTRL+^Letter, ALT+^Letter-Scroll

"WastePlan Software"

Gary Prince

Tellus Institute

Boston Massachusetts

Presentation at 8th Annual Conference on Solid Waste Management and Materials

New York City

January 29, 1992

The Tellus Institute has developed a software model which evaluates different solid waste management strategies. WastePlan operates on any IBM compatible computer. WastePlan was designed to facilitate the development of solid waste management scenarios. Within one framework, WastePlan models the generation, collection, and reduction, recovery, and disposal of any number of waste materials and waste streams. Subject to computer limitations, any number of generating sectors (such as high or low density residential, commercial, industrial, or other sectors) can be modelled with any number of collection programs, disposing at any number of intermediate or final disposal sites. Over 300 variables are included in the program including material densities, operating costs, capital costs, interest and inflation rates, and other variables.

The model is structured to reflect the solid waste hierarchy used by solid waste planners. Source reduction programs are modelled first, followed by recycling and composting, then resource recovery, and finally landfills. Each of these separate management options can be described in the program with a full range of collection systems and disposal facilities.

The model is readily usable for regional analysis. Any number of regional combinations can be tested and current, constant, or the net present value of different system options will be reported. The model provides full reporting on labor, capital, and physical costs associated with any management option. The software also provides full summary reports comparing different management strategies.

The model is designed for sophisticated "what-if" questioning. Unlike models based on spreadsheet format, WastePlan can accommodate a large number of program options, and the user can readily and quickly change any assumption in the model. Sensitivities, such as different assumptions about economic growth, waste generation, waste composition, recycled materials prices, and/or other variables, can be quickly computed as well. Calculating the effect of these changes is done in real time so that the user can see the results of program changes quickly. The "what-if" capabilities of WastePlan make it ideal for solid waste planning where some of the data may be uncertain and it is useful to identify the cost boundaries of various management approaches.

WastePlan software has been adapted for statewide or regional use by Michigan, Ohio, New York, Delaware, Illinois, Maine, Tennessee Valley Authority, and in numerous other locations around the country. The model has also been tested at Universities around the country including Cornell, Purdue, Michigan State, Yale, and others. It has proved useful in

these locations in modelling local and regional solid waste management system, and in evaluating the costs of different management strategies, such as curbside recycling, composting, mixed waste processing, incineration, and other options.

The Tellus Institute has used the model to evaluate different system options for the New York City Department of Sanitation as part of the preparation of that City's Generic Environmental Impact Statement and Solid Waste Plan. Each of the City's 59 sanitation districts were modelled and different collection and facility scenarios tested to determine the most efficient and economical management strategy for the City as a whole. For the Regional Plan Association, the model has also been used by the Tellus Institute to evaluate management options in the 31 county region surrounding New York City. This region has a population of over 20 million persons with widely different solid waste management systems and objectives. The model was able to identify capacity needs within the region, the quantities and composition of waste which must be managed, and the avoided costs of different management options as well as the impact on both diversion and disposal systems from failing to implement mandated source reduction goals.

In the course of developing and applying WastePlan in various states, the Tellus Institute has developed an extensive database on waste generation, composition, collection, and disposal costs. This data covers a wide variety of economic and demographic situations as well as management approaches throughout the country.

There are four major interactive programs in WastePlan Plus: Waste-Stream Definitions, Waste-Stream Generation, Collection, and Facilities. The structure is illustrated in figure 1 at the end of this paper.

Waste Stream Definition The first program defines the individual waste components that make up each of the waste streams (including residential, institutional, commercial, industrial and any other desired waste streams such as medical waste, construction and demolition waste, etc.) It then defines the physical characteristics of each of these components, including their density (lbs/cu.yd), the heating content (btus/lb), ash content (%), ultimate analysis (% oxygen, hydrogen, carbon, nitrogen, chlorine, etc) and metal content (parts per million). This program also allows the identification of each waste stream component to be handled by a particular recycling program, composting program, resource recovery program, or landfilling program.

Waste Stream Generation The second program then generates each of the waste streams defined in the Definitions Program by first identifying the demographic and/or economic activities that are responsible for producing each of the waste streams. Once this activity unit or waste-stream "driver" is identified, the amount of waste currently generated by each of these units is specified. The total waste quantity is then calculated by multiplying the activity units by the waste-generating factor. The composition of the waste is then calculated using generator specific waste-composition information.

Within each waste stream any number of generating sectors can be described. For example, the total residential waste stream can be divided into the smaller waste streams produced by different housing and density strata, or by different geographical regions. The total overall commercial waste stream can be divided into as many different commercial sectors (e.g. retail, food store, eating and drinking establishments, motel and hotel, wholesale, etc.) or households for which data exists. For each substream, the waste-generating unit (e.g.

employees), the waste-generating factor (e.g. lbs/activity unit/day), and the composition of waste produced by that strata are identified, and then the total level of activity (e.g., total employment) in that strata is specified. WastePlan Plus then takes the results of each substream and aggregates them into a total waste-stream quantity and composition analysis.

Finally, to forecast changes in the waste streams over the defined planning period, the user can define annual percentage changes in both the waste-generating factors and in the number of waste-generating units. Similarly, changes can be forecast for each waste stream's composition for the beginning and end years and a mid-point (often an inflection point) over the planning period. Such composition changes are linearly interpolated between years.

Collection Once the waste streams have been generated, the collection systems are modelled. First, the physical and financial characteristics for the range of collection equipment (trucks and containers) that might be used in the various systems for collecting each waste stream are described as are general economic assumptions (various inflation and interest rates, worker salaries or availability, working days per year, etc). Combinations of equipment are then selected to model the effect of various alternative collection systems. Source reduction programs can also be described and modelled for any waste generating sector. For collection systems requiring the active participation of the waste generators (e.g. source-separation recycling or composting programs) participation and capture rates are defined for each material identified in the Generation Program. Initial base year capture and participation rates for any given program can be modeled to increase to any selected plateau year, at which point the respective program achieves its maximum diversion. Specific collection system characteristics, such as crew size, collection efficiency, average miles from the route to the given facility, miles traveled per hour and collection frequency, set-out frequency, compaction ratio, administrative costs, etc, are then defined for each collection program. The Collection Module calculates by material, tons collected in any one program, the number of vehicles and containers required to collect the given waste stream, and annualized capital and operating costs of each collection program. These figures are reported for each year of the program, with WastePlan Plus tracking existing equipment and replacing it if it reaches its life-expectancy.

Facilities Once all the waste streams have been collected, they are routed to the facility Module, which contains economic and technology data for each of the potential facilities that are evaluated in the plan. Any collection program can be routed to deliver its waste to any processing facility; any waste at any processing facility can be transferred to any other facility. The user describes the physical and financial characteristics of all current and planned facilities to be used in the development of the plan. Facilities can be designed to begin or end operations at any point during the planning period, with any length for the construction period. The facilities modeled by Wasteplan encompass the spectrum of facilities that could accept any waste stream. These include: any manner of transfer stations with and without material recovery; any manner of recycling facility from residential drop-off or buy-back to MRF to commercial dump and sort facilities; any manner of windrow or in-vessel composting facility with or without material separation; any manner of incinerator with or without material separation; and any type of landfill. For each facility, WastePlan Plus calculates: tons recovered and tons processed, by material; operating and amortized capital costs by category; revenues; and residue generated. Residue, and any tons not handled by a facility due to capacity restrictions, are routed to the next appropriate facility(ies), as determined by the user. All information is reported for each year and reflects the economic assumptions made by the user and payment schedules that reflect the scheduled purchase of replacement capital.

Scenario Development Once the data for waste streams, collection systems, and processing/disposal facilities is loaded, **WastePlan Plus** quickly produces all economic and quantity information for the overall scenario. Alternative scenarios, in which either specific assumptions are changed or in which entirely different collection and/or processing/disposal facilities are considered, are easily developed and provide an important and powerful tool in analyzing both sensitivities and the efficacy costs and benefits of alternate systems. Scenarios can be run separately or in batch mode.

Model Output The **WastePlan Plus** model will produce, depending upon the complexity of the scenario and the level of detail requested by the user, output reports of 50 to 60 pages or more. These outputs will include:

- a detailed description of the quantities and composition and physical properties of the waste streams generated both in aggregate and by subsectors;
- a description of the physical requirements, e.g. the numbers and types of collection vehicles used for each program, and the basic land, building, and equipment requirements for each type of facility;
- a summary of all costs, including total and per-ton capital and operating costs for each type of waste-management program, and for the overall scenario.

WastePlan Plus also produces summary reports that provide the total cost of each waste management scenario and each subsystem component, the total and proportionate tonnage handled by each subsystem component, and overall and subsystem per-ton costs. **WastePlan Plus** also provides present value calculations for any or all scenarios.

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graph TD
    Root[WASTE STREAM COMPONENTS, SYSTEMS, SERVICES, POLICIES]
    
    Root --- Residential[WASTE STREAM]
    Root --- Commercial[WASTE STREAM]
    Root --- Composting[COMPOSTING COLLECTION]
    
    Residential --- Deposition[Deposition]
    Residential --- ResidentialCollection[Residential Waste Collection]
    Residential --- ResidentialRecycling[RECYCLING COLLECTION]
    
    ResidentialCollection --- CommercialWasteCollection[Commercial Waste Collection]
    ResidentialCollection --- CommercialWasteRecycling[Commercial Waste Recycling]
    
    ResidentialRecycling --- Satellite[Satellite]
    ResidentialRecycling --- CurbsideRecycling[Curbside Recycling]
    ResidentialRecycling --- DropoffRecycling[Drop-off Recycling]
    
    Commercial --- CommercialCollection[COMPOSTING COLLECTION]
    Commercial --- CommercialRecycling[COMPOSTING COLLECTION]
    Commercial --- CommercialComposting[COMPOSTING COLLECTION]
    
    CommercialCollection --- BulkCompost[Bulk Compost Collection]
    CommercialCollection --- BaggedComposting[Bagged Composting Collection]
    CommercialCollection --- DropoffComposting[Drop-off Composting Collection]
    
    CommercialRecycling --- BulkCompost2[Bulk Compost Collection]
    CommercialRecycling --- BaggedComposting2[Bagged Composting Collection]
    CommercialRecycling --- DropoffComposting2[Drop-off Composting Collection]
    
    CommercialComposting --- BulkCompost3[Bulk Compost Collection]
    CommercialComposting --- BaggedComposting3[Bagged Composting Collection]
    CommercialComposting --- DropoffComposting3[Drop-off Composting Collection]
    
    CommercialCollection --- TransferStation[Transfer Station]
    CommercialRecycling --- TransferStation2[Transfer Station]
    CommercialComposting --- TransferStation3[Transfer Station]
  
```