IV. Technology Assessment/Evaluation of Alternatives

A. Waste Reduction

The most obvious and direct measure in reducing the solid waste management problem is to minimize the amount of solid waste that is currently being generated. Waste reduction is the first and most preferred solid waste management method listed in Chapter 70 of the Environmental Conservation Law (ECL). A major goal of the New York State Solid Waste Management Plan is to reduce the total amount of solid waste produced in the state by 10% by the year 1997.

Generally, waste reduction can occur in one of two ways, either producing products containing less waste material altogether or producing products in which the potential waste material can be reused. A further method to reduce the economical and environmental impacts of solid waste management, is to manufacture potential waste stream components with lower levels of toxic substances. This results in a more environmentally benign product making it safer to recycle, burn or landfill by reducing potential toxic emissions to the air, land or water.

There are a number of waste reduction methods including reduction in product packaging, placing deposits on containers, banning certain materials, imposing taxes on packaging, modifying consumer purchasing habits, developing economic incentives through a fee based structure and instituting commercial and industrial waste reduction programs. A description of these waste reduction methods is presented below.

1. Product Packaging Reduction. Wrappings and packaging used during the shipment and marketing of products are typically used only once and then thrown away. This segment of the solid waste stream, which represents approximately 1/3 of the total solid waste stream, is an area in which great improvements have been made in recent years, but where many more positive changes are possible. Most manufacturers, without some sort of economic incentive or legislative mandate, do not consider the impact of solid waste disposal of their packaging during the design or manufacture of their products.

The Northeast Source Reduction Council is an organization created by the Coalition of Northeastern Governors (CONEG) formed to bring together representatives from government, industry, business, and non-profit organizations, to develop regional,
long range policy recommendations for volume reduction involving packaging waste. Additionally, the council was set up to draft legislation aimed at the reduction of toxins such as lead, cadmium, and mercury in both packaging and products. The council was also charged with establishing quantifiable goals for packaging reduction, minimization and percentages for recyclability and recycled content consistent with the preferred packaging guidelines. They were also charged with developing, within six months, a detailed action plan for implementation of preferred packaging guidelines. Finally, the CONEG Governors directed the council to begin a source reduction consumer education program with priority being given to educating legislators and public decision-makers about the benefits and advantages of source reduction in product packaging.

Model legislation developed by the Northeast Source Reduction Council was passed by the New York Legislature in the spring of 1990 as Chapter 286 of the Laws of New York. The laws mandate a gradual reduction in the concentration of certain toxic substances over a three year period starting in January 1992. Additional substances may be added to the list by recommendations from NYSDEC.

In addition to reducing the concentration of toxins, the Source Reduction Council established the following packaging hierarchy to reduce the overall volume of packaging wastes:

- Eliminate packages not necessary for the protection, safe handling, or function of the package contents.
- Reduce package or packing material if reduction does not result in a net increase or cause negative health, environmental or solid waste impacts.
- Design and manufacture packages to be returnable, refillable, and/or reusable.
- Where the preceding actions would lead to negative health, environmental, or solid waste impacts, the objective will be first, to promote the design and manufacture of recyclable packages and packaging materials, and second, to promote the design and manufacture of packaging containing recycled materials.

The Source Reduction Council is currently working on detailed standards to define specific parameters for the above hierarchy. These standards will eventually be incorporated into a standardized labeling system for environmentally safe packaging. A consumer education program will also be initiated after development of the packaging standards.
There are also organizations that have been recently formed to develop standardized labels for environmentally friendly packaging and products. National non-profit organizations, such as Green Seal, evaluate the total environmental impact of consumer products. Products deemed environmentally friendly by Green Seal will be awarded a "Green Seal" of approval, which can be placed on labels by the manufacturer. Products awarded the Green Seal will be authorized to bear the symbol for a designated period of time, after which the product will need to be re-evaluated. According to the group, products bearing the Green Seal will enjoy strong marketing advantages. Surveys commissioned by Green Seal reveal that a majority of American consumers prefer to purchase products which cause less environmental damage than others.

Another group, Green Cross Certification Company, has already awarded its seal of approval to more than 50 brand name paper, wood and plastic products ranging from toilet paper to fireplace logs. The standardized labeling system mentioned above may also include the new official New York State recycling emblems and standards for reusable, recyclable and recycled products. The NYSDEC, in March 1990, re-issued a proposed 6NYCRR Part 368 regulation establishing these emblems. The emblems will be used to make consumers aware of environmentally friendly packaging and products. The proposed emblems are shown in Figure VI-1.

2. **Deposit Containers.** Economic incentives are one of the most effective methods for encouraging participation in recycling/waste reduction programs which, by their nature, require additional effort from consumers. The New York State Returnable Container Act of 1983 is a prime example of this. It forces consumers to think of their containers as a reusable resource instead of something to discard. Initially glass, plastic and aluminum soft drink and beer containers were addressed by the Act. Wine coolers were added in 1988 and is expected to direct an additional 22,000 tons away from the state's annual solid waste stream. Overall, this law has resulted in a 5% reduction in the state's solid waste generation.

Even with the nickel deposit for New York State containers, the CCSWMD has found significant quantities of deposit containers being discarded at the milling station. Results from the CCSWMD's 1990 solid waste composition study show that nearly 55% of the total aluminum being discarded is in the form of deposit containers. Obviously one method to increase public participation rates is to increase the amount of deposit for the container. Chemung County plans to take economic advantage of this situation with the onset of the MRF operation. All deposit containers will be separated at the MRF as a redemption center in order to increase the revenue potential for such recycled products.
"Recycled" emblem as proposed in 6 NYCRR Part 368

"Recyclable" emblem as proposed in 6 NYCRR Part 368

"Reuseable" emblem as proposed in 6 NYCRR Part 368

SOURCE: New York State Department of Environmental Conservation
Division of Solid Waste
State Solid Waste Management Plan, 1989/90 Update

PROPOSED
NEW YORK STATE
RECYCLING EMBLEMS

FIGURE IV-I
MARCH, 1991

FAGAN ENGINEERS
Environmental Consultants
Additional volumes could be intercepted from the waste stream by expanding the Returnable Container Act to include such containers as liquor and wine bottles, fruit juice glass containers and vegetable juice cans, etc.

3. **Material Bans.** Some municipalities have banned certain non-biodegradable materials, such as plastics and polystyrene, from being sold in their area. This method prevents the subject material from being utilized and hence becoming part of the solid waste stream. However, based on the existence of limited local bans, this procedure is not considered a significant waste reduction approach. Nationally, few material bans have been enacted. One recent ban is found in the Federal Clean Air Act of 1991 which terminates the production of fully halogenated chlorofluorocarbons (CFC's) by January 1, 2000. By July 1992, EPA must promulgate standards mandating the recycling and disposal of such substances. The standards must prohibit anyone who maintains, services, repairs or disposes appliances (such as refrigerators) from venting or releasing CFC's to the atmosphere. Within five years of enactment, the venting of any environmentally harmful refrigerant substitute is prohibited. This regulation will directly affect the white goods recycling operation at the CCSWMD’s Lake Street solid waste complex. Currently, the CCSWMD is determining required facilities and local laws to comply with these new federal regulations.

4. **Packaging Taxes.** Packaging taxes or fees is another type of waste reduction incentive. They give the manufacturer incentive to reduce the amount of packaging for a given product or force the manufacturer to subsidize the cost of solid waste management associated with that packaging. This tax system can be scaled according to the recyclability of the material or by the percent of recyclable or reusable materials contained in the packaging.

In the spring of 1990, the New York State Legislature failed to pass a proposed packaging tax, designed to provide an incentive for production of recyclable packaging. Obviously, the successful implementation of this waste reduction approach requires state and/or federal legislation. Local municipalities, other than supporting such legislative efforts at the state or federal level, have little control over effectively implementing a packaging tax.

5. **Modifying Consumer Purchasing Habits.** Implementing legislation regulating the packaging and reducing the toxic characteristic of goods is a significant component for a source-oriented waste reduction program. However, the long-term goal of the county will be to re-orient public thinking in a more environmentally conscious direction. In addition to re-educating the present consumer population, young people, just entering the formal education phase of their life, need to be instilled with an environmental awareness of sound solid waste management practices. With a
comprehensive education approach toward the environment in general and solid waste in particular, hopefully our children and grandchildren will be considered productive members of a environmentally conscious society where consumer oriented wasteful attitudes are replaced with concern for preservation of our natural resources.

The New York State Department of Education, with assistance from the NYSDEC and other state agencies, is developing a solid waste management core component for the seventh grade science, technology and society curriculum. It will consist of classroom instruction on the various aspects of solid waste management, plus hands-on experience through appropriate solid waste experiments. This component will be required learning for all seventh grade students throughout New York State within three years.

Additionally, the NYSDEC is currently compiling information on solid waste educational curricula available from other states, municipalities, and organizations. The NYSDEC will assemble this information into a publication which will contain examples of the curricula available from other sources, and information on how to obtain it. This publication will be made available to New York educators who are interested in teaching their students about waste reduction, reuse, and recycling.

Consumer education programs should emphasize the following methods for waste reduction and reuse:

A Waste Reduction

☐ Buy only products which will really be used.

☐ Buy durable products.

☐ Use alternatives to paper products such as cloth napkins and diapers and glass plates, that can be reused.

☐ Don't buy disposable products such as razors and lighters.

☐ Buy large size containers of items which are usually less expensive on a per unit basis.

☐ Encourage stores to sell unpackaged merchandise such as fruit, vegetables and clothes.

☐ Purchase less toxic products for the household.
Write your congressperson to develop legislation to eliminate economic incentives in the form of reduced mailing rates for junk mail. According to a study done in New Jersey and released in August 1990, statistics show the average person receives 31 pounds of junk mail per year.

Avoid buying products that are excessively packaged.

B Reuse

- Buy and use reusable and refillable containers, such as glass milk bottles and canvas shopping bags.
- Buy recycled products.
- Repair, rather than replace, where possible.
- Pass on usable or repairable items to friends, charities or trade schools.
- Reuse building materials, or give to someone who can.
- Practice yard waste composting and lawn mulching of grass clippings when feasible.
- Rent infrequently used items, rather than purchase them.

The net long range result will be to re-orient consumer's purchasing decisions to increase demand for goods meeting the new packaging/durability criteria and to steer them away from disposable goods.

Purchasing habits have already been effected by legislation such as the Returnable Container Act and by disposal fees based on the amount of waste to be disposed of. Such a system is in-place now at the Chemung County Milling Station and Landfill as discussed below.

6. **Economic Incentive Through A Fee Based Structure.** A major economic incentive to reduce waste generation is the implementation of a fee based structure in which solid waste disposal charges are based on the amount of solid waste being disposed. Currently, this structure is being utilized in Chemung County with weigh scales located at both the milling station and landfill. The CCSWMD has taken this concept
and expanded it by providing economic incentives for recycling with no tipping fee charges being imposed for recyclables delivered to the MRF. However, any shortfall in the MRF operation (expenses and debt service payment less revenue from the sale of recyclables) including those revenues lost by not charging for the recyclables (which are currently being generated in the form of a tipping fee at the milling station) will be paid for by the remaining solid waste tipping fees levied against non-recyclables.

This plan will have a significant impact on the cost of waste disposal. When it was first envisioned while the MRF was being planned, it was estimated that the 1989 solid waste tipping fees would ultimately have to be increased from $30 per ton to between $50-$55 per ton. Currently, the tipping fee is $40 per ton with another increase being planned for the beginning of 1992.

This tipping fee structure will provide additional future economic incentives for Chemung County residents to both recycle and reduce the quantity of their residual waste stream requiring disposal. One potential drawback of this fee structure is the inherent economic incentive it provides for illegal dumping of solid waste. The CCSWMD recognizes this fact of life and is currently coordinating with the County Environmental Management Council, the County Sheriff's Department and the County Legislature to develop necessary legislation and funding to curb the potential increase in illegal solid waste disposal throughout the county.

7. **Commercial And Industrial Waste Reduction.** Many commercial and industrial facilities have already initiated their own waste reduction programs. They have analyzed the financial benefits of minimizing waste disposal expenses and found it was in their own best interests to reduce both the amount of waste produced and its toxicity. Studies indicate, however, that much more could be done to reduce such waste volumes. In 1990, the CCSWMD estimated that in excess of 23,000 tons of solid waste will be disposed of at the Chemung County Milling Station from commercial sources, of which over half of that volume is paper. More than 80% of this paper is composed of cardboard and office paper. As previously indicated, commercial and industrial facilities currently recycle some 15,000 tons of potential solid waste annually. However, it is evident that there is the potential for the commercial and industrial sector to significantly increase their quantity of wastes that could be removed from the solid waste stream. Cardboard volumes can be reduced by limiting over-packaging, and by re-use of boxes for shipping and storage. Offices can minimize office paper waste by encouraging two-sided copying wherever possible and by minimizing internal mail.

Other industrial wastes occur as a result of the manufacturing process. Methods for reducing these wastes are generally not only environmentally advantageous, but also
result in reasonable payback periods for the recycling or waste reduction equipment. These practices can include:

- Good housekeeping practices including waste segregation, improved operation and maintenance, inventory controls, and spill/leak prevention.

- Input substitution or input material modification by replacement of a material used in a process or product with a non-toxic, less toxic, recycled, or recyclable material.

- Technology modification resulting in waste reduction by improved controls, process redesign, process modification, and equipment changes.

- Product reformulation in which an end product is substituted with one that is more durable or requires a less toxic production process or a process that produces less waste.

- Lightweighting which involves the substitution of lighter and fewer materials for traditional packaging or product materials.

In some cases, the waste product of one industry may actually be sought by another. The Northeast Industrial Waste Exchange of Syracuse, New York, is an organization set up to assist in bringing waste producers and waste users together. The exchange publishes a quarterly listing of waste for sale and waste wanted. The exchange also assists in industrial waste audits, minimizing waste production and finding markets for remaining waste.

Hospitals and other health-oriented facilities are large users of disposables such as diapers, gowns, food service ware and medical instruments. These institutions could conduct audits to determine what items could be economically replaced with reusable ones, or whether some items need be purchased at all. Prisons, government offices, churches, educational, and other institutions could conduct similar surveys to minimize waste production by a careful review and analysis of their current operations resulting in the generation of solid waste.
B. Recycling and Reuse

With the eminent completion of the MRF, Chemung County continues its tradition of a proactive approach to solid waste management. This section discusses the recycling system structure in Chemung County as well as other approaches which were considered but not utilized in this structure. Criteria for selection of materials to be recycled, selection of material separation methodologies, collection system options, public education and enforcement approaches for recycling, and processing alternatives for material recycling facilities are also addressed.

Because of its very nature and purpose, the practice of recycling materials, that would otherwise be discarded and become part of the solid waste stream, is obviously environmentally beneficial. Very costly landfill space is saved by returning discarded goods to service, either directly or through a reclamation and remanufacturing process. The recycling process requires the use of energy and land, but in such small amounts that they are considered inconsequential when compared to the benefits of reducing our demand on natural resources and saving valuable landfill volume.

1. Materials To Be Recycled. The CCSWMD's Comprehensive Recycling Analysis (See Appendix C) discusses the criteria used to designate which components of the solid waste stream were selected as potential recyclables. After researching the marketing aspects of various potential recyclables with material buyers and with other municipalities, and after consultation with various recycling specialists, Chemung County decided to develop their recycling program around two major recyclable groups, namely paper and commingled containers. The components of these groups are listed below.

| ☐ glass (three colors) | ☐ cereal boxes |
| ☐ newsprint | ☐ office and computer paper |
| ☐ junk mail | ☐ aluminum containers |
| ☐ ferrous | ☐ appliances |
| ☐ cardboard | ☐ plastic bottles and containers (all rigid plastics) |
| ☐ magazines | ☐ five-cent deposit containers |
| ☐ ceramics | ☐ non-ferrous metal |
| ☐ office paper |

In addition to this list, large household appliances will be processed in the white goods building, adjacent to the milling station. The CCSWMD also currently accepts,
at the milling station, waste oil (four gallons or less) and automobile batteries (no more than four). A composting facility to recycle yard wastes (leaves and grass only) is currently in the planning stage for Chemung County.

2. **Alternative Sorting Approaches.** In order to prepare the recyclables for market, they must first be separated or sorted from the solid waste stream. The form that this sorting takes greatly impacts the efficiency and processing requirements of the recycling program. Separation of each item to be recycled can occur entirely at the source, entirely at the MRF, or partially at both places.

Source separation, in its purest form, calls for complete separation of each recyclable from the waste stream and from each other by the generator. This approach requires a much greater effort by the consumer, because one has to separate out all the products listed previously and either deliver them to the transfer station in separated form or, if curbside pickup is available, set them out in pre-sorted form involving a variety of containers. The advantages and disadvantages are listed below.

**Advantages Of Complete Source Separation Programs**

- The processing requirements at a central processing facility is greatly reduced because the separation of the recyclables is accomplished by the generator. However some processing is still required for efficient shipment to markets such as paper balers, plastic or metal balers, glass crushers, can flatteners, etc.

- Curbside collection personnel or transfer station attendants can more readily perform quality control operations for source separated materials as compared to commingled materials. This makes it easier to detect potential contaminants.

- Breakage of glass is not a significant concern because it has already been sorted by color.

**Disadvantages Of Complete Source Separation Programs**

- Curbside collection of source separated recyclables is significantly more expensive because costly special compartmentalized trucks are required; labor costs increase with more material handling requirements; and unloading compartmentalized trucks takes much longer to prevent contamination of the source separated materials.
A source-separation based transfer station requires more area than a commingled-based one because common tipping floors and conveyors cannot be utilized efficiently.

A detailed source separation program is not convenient to the homeowner due to the number of containers that must be utilized. This inherently reduces the number of items that can be effectively recycled, or greatly reduces the public participation rate which also limits the total quantity of recycled materials.

Because many of the recyclable materials are not processed, the market and revenue potential for such materials will be reduced. For example, glass will not be in a furnace ready cullet form, and hence must eventually be further processed including crushing, removal of contaminants etc.

In addition to residential source separation, similar programs must also be established for commercial, institutional and industrial generators of recyclable materials. For larger facilities, detailed source separation should not be a significant problem when compared to small businesses with limited space available for waste and recyclable storage. Currently, the CCSWMD has established a very successful office paper recycling program with over 6,500 office employees, school children, etc. participating. However, to the extent that these facilities generate other potentially recyclable materials, they will have to expand their source separation program to accommodate such material recycling needs.

Another recyclable sorting alternative would be to continue to collect unsorted solid waste. This method is the exact opposite of source separation. Mixed solid waste is collected without having been separated, and is sorted later at a central processing facility. This method, although simple and inexpensive from a collection standpoint, results in a smaller amount of materials that can be potentially recycled due to the obvious contamination problems of mixing this material with other household garbage. This "separation" method has not been widely utilized in the United States. However, there are some limited applications associated with solid waste composting systems. This typically involves magnetic separation of the ferrous component together with possibly a manual sort of glass before the material is shredded and composted. In order to meet the state's ambitious goal of 40% recycling by 1997, this recyclable sorting/collection system is not considered feasible for Chemung County.

A third sorting alternative for separating recyclables from the waste stream is called commingled source separation. Commingled sorting is a combination of source separation and mixed waste separation. In this approach, the waste generator
A third sorting alternative for separating recyclables from the waste stream is called commingled source separation. Commingled sorting is a combination of source separation and mixed waste separation. In this approach, the waste generator separates the recyclables from the mixed waste stream, but not from each other. Often municipalities will provide each household and commercial establishment within their service area with a single container for holding these recyclables. The unsegregated recyclables will be deposited in their own receptacle at the transfer station or, if applicable, at curbside along with the rest of the solid waste. These "commingled recyclables" are then further separated at a processing facility.

Many municipalities have adopted this approach to sorting or separation of their recyclables. It has many advantages over the complete source-separation approach and is generally considered to be more implementable with good citizen participation rates resulting in greater quantities of materials that are recycled.

**Advantages Of Commingled Separation Programs**

- Commingled separation is relatively simple to institute and does not significantly alter the generator's current waste storage practice. A minimum amount of education is required for the generator, so they are more likely to participate. These factors result in higher participation rates with the resultant increase in the amount of potential waste that is recycled.

- Collection costs are reduced when compared to a more complete source separation program. Typically the only sorting required for the recyclables is paper materials from the commingled containers. Hence highly specialized collection vehicles are not required.

- Unloading time at the MRF is greatly reduced with only two basic separations - paper products dumped on the paper tipping floor and commingled containers on the commingled container tipping floor.

- Because these commingled materials require processing at a MRF, the resultant end products can become more marketable (i.e. furnace ready glass cullet) and hence will generate greater revenues for the recyclables.
Disadvantages Of Commingled Separation Programs

- A disadvantage of this approach is that during the collection process, glass is more likely to be broken and hence is more difficult to separate by color.

- Commingled separation, by the nature of the collected materials, will require a centralized materials recycling facility to separate and process the recyclables. Such facilities are expensive to construct and operate and generally, the revenues from the marketed recyclables, do not cover the total costs for the MRF.

Based on the aforementioned factors, the CCSWMD has selected the commingled approach to source separate recyclable materials. The CCSWMD will provide each household in the county with a 17 to 20 gallon blue recycling container. These blue boxes will be used by the homeowners to store commingled containers as previously discussed. All caps and lids must be removed. All containers must be free of food waste and rinsed out. However, labels do not have to be removed. On the scheduled waste collection day, the blue box will be put out at the curb with the other solid wastes. Newspapers should be put in paper bags (not tied) as shall magazines and placed on the blue box. Cardboard should be cut or folded into bundles (not tied) and placed next to the blue box. The remaining solid waste must be placed in clear garbage bags. During wet weather, residents will be asked to keep the paper products for the following good weather collection day.

For those areas with curbside pickup, the recyclables bin and garbage bags are placed at curbside on pick-up night. If even a small number of recyclables have been produced by a particular household during that week, the bin is still placed at curbside partially full. If the bin is not present, no waste will be picked up at that residence. The non-recyclables will remain at curb side. Also if recyclable materials are evident in the clear garbage bags, the garbage will be left at the curbside and the generator will receive a warning or a ticket.

Consumers have the option of bringing their waste to transfer stations. Recyclables and bagged solid wastes are put into their respective bins. A fee is charged for the non-recyclable waste, but not for the recyclables.

As previously noted, the commingled separation approach to recyclables collection will require a centralized processing facility for these materials. Even though CCSWMD’s MRF will result in a net operational cost to Chemung County, the district believes that this is the most efficient method to ensure compliance with the state’s recycling goal of 40% of the total waste stream by 1997.
3. **Collection Of Solid Waste.** The collection of solid waste refers to the action of gathering solid waste from the generators and transporting it to its subsequent destination. That destination may be a recycling center, a solid waste processing station or a landfill. In Chemung County, only construction and demolition debris and certain industrial wastes are hauled directly to the landfill by the generator. All other wastes and recyclables are hauled to CCSWMD's solid waste complex off Lake Street.

There are two principal methods generally used to gather and deliver the solid waste (both recyclable and non-recyclable) to central processing or disposal locations. The first is curbside collection by professional solid waste collectors. They gather the solid waste from each generator on a regularly scheduled basis, and deliver to one of the above mentioned facilities. The second approach involves delivery of solid waste to a central or rural transfer station, or to one of the above facilities, directly by the generator.

The service area for the CCSWMD is exclusively Chemung County. No other areas outside the county are served by the CCSWMD at this time. As previously mentioned, the CCSWMD does not manage the collection of solid waste nor does it intend to directly manage the collection of recyclables except for the development of local rules and regulations governing the same.

Weekly residential curbside solid waste collection is available throughout the county. Within the City of Elmira, residents pay for curbside pickup through taxes. The city, in turn, provides for the municipal collection of solid waste for residential customers only. All commercial businesses within the city must contract with private haulers for solid waste collection. In other areas of the county, residents generally have the option of contracting with private haulers for curbside pickup, or delivering the solid waste to one of four transfer stations or directly to the milling station. At the transfer stations, residents pay for the disposal of refuse only and not for their recyclables.

During the fall, additional collection of leaves is performed in the City of Elmira, and other municipalities. Residents simply rake the leaves along the side of the street for removal by the municipality.

Some municipalities also hold annual spring trash pickup days for large bulky items such as white goods, furniture, bed springs, tree or shrub prunings etc. Due to recent regulations requiring complete separation of C&D wastes by the CCSWMD together with attendant disposal cost increases, some towns have disbanded their spring trash pickup program. Others, such as the City of Elmira, have instituted a drop-off program in the spring. For an approximate four to six week period, roll-offs
are rotated around certain sections of the city whereby residents can drop-off their spring trash.

Based on a revenue comparison, very little solid waste is hauled directly by homeowners to the CCSWMD's four transfer stations. The vast majority of the solid waste is collected via municipal or private curbside collection programs for delivery to the milling station off Lake Street. The majority of collections are on a weekly basis. One notable exception to this rule would be for commercial or industrial wastes where collection frequency is determined on an "as-needed" basis.

In order to ensure that recycling is taking place, the CCSWMD will update their rules and regulations to require that recyclables be placed out with the solid waste for curbside collection. Obviously this new regulation will impact how solid waste and recyclables are collected throughout the county. The CCSWMD will not be involved in the selection of the particular type of collection equipment to be utilized by haulers to convey recyclables to the MRF. Rather, the district will simply require that all paper wastes be deposited on the westerly tipping floor and all commingled containers be dumped on the easterly tipping floor. The CCSWMD will also require that for delivery of commercial recyclables, office paper be separated from other newspaper and cardboard on the tipping floor.

Although the type of collection equipment for recyclables will not be overseen by the CCSWMD, a description of the various types of equipment available to the local haulers is presented below.

Due to New York State's recycling goals, many solid waste collection entities have had to augment their collection equipment in order to serve the recycling needs of their customers. Consequently, in recent years, solid waste collection equipment has been developed that is more and more specialized with respect to differing applications associated with solid waste and recyclables. Generally, this equipment falls into one of the following categories:

- Single-compartment, non-compacting trucks
- Single-compartment trailers
- Multiple-compartment trucks
- Multiple-compartment trailers
- Single-compartment compactor trucks

The choice of collection vehicles is strongly influenced by the approach to source separation used. A program based on pre-sorting by generators or on sorting by
collection personnel requires multiple-compartment collection vehicles, while a program based on commingling does not.

Single compartment, non-compacting trucks and trailers are the simplest and least expensive type of vehicles. A wide range of trucks fall into this category, including pickups, stake bodies and dump trucks. While the capital investment and maintenance on one of these vehicles is relatively low, there are a number of serious disadvantages listed below:

✦ In most cases, these vehicles are the open top type resulting in the recyclables being exposed to the elements. Paper products, in particular, suffer quality degradation when exposed to precipitation.

✦ Because no compacting equipment is installed on these vehicles, their payload is considerably less than a comparably sized compaction vehicle would be.

✦ There is no way to keep refuse and recyclables separate because, by definition, there is only one compartment in this type of vehicle. Of course, single compartment trucks perform adequately if collection of recyclables and refuse occurs on alternate days or if this truck is being utilized following the solid waste truck.

Single compartment trailers are often used in a commingled type of curbside collection program. In areas where curbside collection of commingled recyclables has been introduced, these trailers can be an economical alternative to replacing existing waste collection vehicles. The trailers can be used to haul the commingled recyclables, while the trucks can continue to perform their original function of collecting solid waste. Only one compartment is required because the recyclables are not separated from each other. Even in this type of usage, a single divider in the trailer would be desirable for segregating paper products from commingled containers.

Multiple compartment trucks are the most common type of recyclable collection vehicle currently in operation throughout the country. The number of compartments are determined by the type of source separation being performed and the number of recyclables being separated. The minimum number of compartments for commingled source separation is three, which are for paper products, commingled containers and non-recyclables. The maximum number of compartments is limited only by the size of the truck and the required size of each compartment. Of course, the compartments do not need to be all the same size. A composition study of the actual waste stream can aid in the sizing of compartments for new equipment.
Multiple compartment trucks come in many different and innovative forms. Most load from the side to provide better access to the compartments, which are usually arranged front to rear. In some trucks, recyclables are deposited directly into bins by the workers and in others, a small hopper on the side of the truck is filled which in turn lifts the waste to the top of the truck and dumps into the bin. The advantage of the hopper style of truck is that the workers don't have to lift the recyclables high. A third style actually lifts the generators' receptacle to the top of the truck for dumping directly into a bin. This type incorporates no provisions for recyclables inspection by collection personnel.

Different methods of unloading are employed by different manufacturers. Multiple compartment trucks need to be configured so that each compartment is capable of being dumped independently of the others. One of two basic methods are used in the majority of vehicles, side dumping or rear dumping. With side dumping, each compartment rotates laterally, separate from the others. One side is opened and, as the compartment rotates, the recyclables spill out the open door. In visits to various MRF's, problems were noted with side dumping of the paper fraction. Bridging problems, particularly associated with corrugated materials, were found to be significant.

Rear dumping vehicles have compartment dividers that are hinged at the top. The body of the truck elevates similarly to a dump truck, and the most rearward compartment divider is released, emptying the corresponding compartment. To dump the next compartment, both the divider corresponding to that compartment and the rearward divider are released, allowing the recyclables to pass through the rear section out of the truck. Each successive compartment is dumped similarly, with all dividers being released to empty the forward-most compartment.

Multiple compartment trailers provide the exact same service as multiple compartment trucks. They are sometimes used to collect recyclables behind a single compartment solid waste truck. One advantage that compartmentalized trailers have over trucks is their relatively low initial cost. Many communities, when first initiating a recycling program, will elect to use trailers for containment of recyclables during the establishment of the program or until their existing collection equipment requires replacement. When towed by a compactor truck, the trailer usually needs to be unhooked before the truck can be unloaded.

Single compartment compaction trucks have been used by many municipalities for years for collection of municipal solid waste. Their usefulness for collecting recyclables is restricted by the fact that they have only a single compartment, but their compaction features are still useful when used to gather a single type of recyclable.
One combination that has proven effective for collection of recyclables is to collect commingled recyclables with a single compartment compaction truck towing a single or multi-compartment trailer. Items from the paper segment of the recyclable stream are deposited in the truck, while the trailer is used to haul the commingled container component. By compacting the paper, a greater volume can be collected before emptying. However, on many collection routes, the use of large trailers may be so cumbersome that the labor costs per ton of recyclables preclude their use. If the compaction truck is used to gather recyclables containing metal or glass, the hydraulics are sometimes modified to provide a lower degree of compaction in order to minimize glass breakage and bending of metal components around other recyclables.

4. **Public Education And Enforcement**. Public education is an important and integral part of any recycling program, and is an integral part of a successful enforcement program. An informed public, because it understands the advantages of recycling, will demonstrate a higher participation rate and practice better quality source separation than will a public who is just told "you have to do this, or else." Attitude plays an important role in a "quasi-voluntary" program such as source separation recycling.

Recycling education usually involves one of two general educational schemes, namely re-educating disposal-oriented persons to the benefits of recycling and reuse, and educating young people about recycling who have yet to develop adverse solid waste generation habits. Obviously, the first type of education involves a greater segment of the population than the second.

The CCSWMD plans three major changes in the way residents and businesses process their solid waste and recyclables during 1991. The first is that both solid waste and recyclables must be visible. This can be accomplished by the use of clear plastic bags or by placing the materials in a trash can or dumpster with no bagging. Next, recyclables must be prepared to the District's specifications. The CCSWMD will only request those items that are routinely recyclable by the residents and businesses. (For example service stations will not be required to wash out quart oil containers to recycle the plastic containers. If a service station used 50 or 100 quarts of oil per day, it would be an unreasonable request to ask that each container be washed with soap and water). Finally, recyclables must be separated properly (i.e. that recyclables are not mixed with the solid waste and conversely, that the solid waste not be mixed with recyclables).

After a year long informational and educational campaign, there are two basic methods of enforcement of these changes. One is to hire "Recycling Police" that actually drive around and inspect solid waste and recyclables at curbside and at the
rear businesses. The second method is have the haulers "reject the material at curbside if the material is not prepared properly. In turn if the haulers do not properly "enforce" the new recycling policies, the CCSWMD will not allow the haulers to use the County's disposal facilities.

Over the past 24 months, an extensive recycling public education program has been conducted by the Recycling Manager of the CCSWMD. Components of the program have included:

- Numerous presentations at schools, senior citizen groups, church organizations, service organizations (Kiwanis, Lions, Rotarians, Ladies Auxiliaries etc.), professional organizations (professional engineers society, Chemung Co. legal secretaries etc.), youth groups (4-H Club, Junior Achievement, Chemung Co. High School Student Councils), village and town boards, environmental groups (Chemung County Environmental Management Council, Chemung County Environmental Action Coalition, Trout Unlimited), the Chemung County Legislature and representatives of Steuben, Tioga and Tompkins Counties.

- Guest on numerous broadcast talk shows including WBNG TV, WENY Radio "Voice Of The People", WENY TV "Close Up", WETM TV "Community Focus" and "Public Affairs", WIQT Radio "Current Affairs" and "Saturday Talk Show", WLEZ Radio "Morning Show".

- Development of an extensive radio and TV advertising campaign including numerous public service announcements and paid advertisements.

- Coordination with local news media in the form of press conferences, facility tours, letters to the editor and guest columnist articles featuring the County's future recycling program.

- Audio-visual presentations at such local public gatherings as the Chemung County Fair, Village and Town Community Day celebrations, Rotarian trade shows, etc.

- Coordination with local waste haulers, City of Elmira, Arnot Mall representatives etc. regarding specific collection aspects of the recycling program.

- Coordination with numerous business and institutional representatives regarding the development of an office paper recycling program which
currently has 240 commercial/institutional and industrial participants involving some 6,500 + people.

Coordination with supermarket managers towards the sale of reusable canvas bags in local area supermarkets in lieu of discardable plastic or paper bags.

Development, printing and mailing throughout the county of a biannual newsletter highlighting accomplishments and future planned recycling initiatives.

Development of a "We Mean Business" flyer for commercial establishments including a mass mailing (3,300+) in March, 1991 for every business, factory and office operating in Chemung County.

Development of a public flyer for homeowners explaining the "do's and don'ts" of recycling. This flyer will be attached to all recycling containers when they are delivered to individual residences throughout the county during 1991.

Coordination with the Chemung County Chamber of Commerce for a June, 1991 business seminar on commercial recycling.

Once the recycling program is underway, future public educational efforts will be focused on increasing public participation rates and enhancing the quality of materials to be recycled. This will be accomplished through a variety of the aforementioned public education methodologies (public service announcements, flyers, presentations, guest editorials etc.) with emphasis on extolling the benefits of recycling and summarizing the recycling achievements in comparison to the CCSWMD's recycling goals. If quality control is found to be a problem, additional information in the form of detailed instructions as to the type and preparation of acceptable recyclable materials will be developed and communicated to the general public via appropriate outreach programs.

Past experience indicates that the vast majority of solid waste generators will voluntarily participate in a recycling program as soon as it is implemented. After January 1, 1992, the voluntary recycling program will become mandatory. Those who refuse to source separate may be subject to suspension of waste collection services and fines.

Suspension of waste removal services, or refusal to pickup solid waste containing recyclables is normally an effective method for ensuring cooperation from non-participants, especially when alternative methods for trash disposal are not available.
The biggest potential problem with this approach is that some people may allow garbage to accumulate, causing attendant odor, rodent, aesthetic and public health problems. Hence an aggressive enforcement program is necessary to ensure all solid wastes generated in the county are being properly and legally managed.

The CCSWMD, as part of this plan, will formulate new rules and regulations which will require source separation of recyclables and the use of clear plastic bags for solid waste. These regulations will also have provisions for civil penalties if they are not properly adhered to by solid waste generators. If recyclables are not properly separated (i.e. recyclables are seen within the clear plastic bags mixed with other solid wastes), they will be tagged by the hauler and left at the curbside indicating the reason for rejection. If repeated violations occur or if an accumulation of solid waste is left at the curb, a ticket will be issued by a County Sheriff’s deputy who oversees enforcement of the CCSWMD’s rules and regulations.

5. **Material Recycling Facilities.** A material recycling facility, or MRF, is a facility designed to further separate, or process source separated recyclables in order to meet the quality control requirements of a particular market or end-user. MRF’s do not separate recyclables from the solid waste stream.

MRF’s are designed and operated to sort, clean and densify source separated recyclables by manual and mechanical means for subsequent transport and sale. They may utilize sophisticated separation and processing equipment to separate the recyclable stream into several fractions, including ferrous metals, glass, aluminum, plastics, a variety of paper products and a non-recyclable or residue fraction. A MRF will usually include an enclosed building with a paved receiving area, lights, heat, plumbing and adequate space for processing and storage. The facility is staffed to operate equipment and manually sort certain recyclables prior to their processing. Two basic operations generally occur at a MRF, namely sorting and processing/cleaning. Sorting is a necessary component of a commingled MRF operation, as is being constructed for Chemung County. Both manual and mechanical sorting is generally found at a MRF as summarized below:

**Manual Sorting**

- Glass by color (i.e. clear, amber and green).
- Plastics by type (i.e. PET, HDPE, etc.)
- Paper by grade (i.e. newsprint, magazines, corrugated, office paper, etc.)
- Contaminants separated from the recyclable materials. This generally occurs at a feed conveyor or on the tipping floor.
Mechanical Sorting

- Trommel screens to pass larger sized recyclables (paper, aluminum and plastics) while dropping out smaller materials (metals, glass, ceramics, grit).
- Magnetic separators to separate ferrous materials from non-ferrous commingled recyclables.
- Air classifiers and ballistic separators to sort light recyclables (paper, aluminum and plastics) from heavier materials.
- Eddy currents to separate aluminum from other commingled containers.
- Optical sorters to sort glass by color.

A more detailed discussion of these various mechanical sorting equipment systems is presented below:

- **Air Classifier** - Recyclables can be separated based on the relative weights of materials; the air classifier uses gravity to sort materials according to this principle. Four basic types of air classifiers exist: air knife, rotary drum, vertical system and horizontal system. In all cases, a stream of air is used to separate materials such as paper, aluminum and light plastic from the heavier fractions of waste. A schematic of a typical air classifier for commingled recyclable containers is included in Figure IV-2.

- **Ballistic Separator** - Another type of classifier which can separate two or three recyclable streams simultaneously is the ballistic separator. In this system, the commingled recyclables are carried up a conveyor belt at an inclined angle, allowing the lighter materials to travel up the belt, and the heavier materials to fall back.

- **Screens** - Screens are designed to separate commingled materials by size. The most commonly used screen is called a rotary trommel screen. A trommel consists of a cylindrical rotating chamber with holes. Smaller-sized particles such as glass, dirt and other small contaminants pass through the holes and are removed. Larger particles such as metals and plastics generally will be carried along on the screen for further processing. The primary purpose of trommels for commingled recyclables is to clean the recyclable stream of dirt and other small contaminants rather than to sort the recyclables per se.

- **Magnetic Metal Separator** - This device uses magnets to separate ferrous from non-ferrous commingled containers. A ferrous metal separation and
FIGURE IV-2
AIR CLASSIFIER SCHEMATIC
N.T.S.

FAGAN ENGINEERS
Environmental Consultants
processing system which is the type being installed at the Chemung County MRF is shown in Figure IV-3.

- **Aluminum Separators**  Aluminum separation usually takes place along with plastic separation, as these two components are light and can be readily separated by air. Another aluminum separation method, called an “aluminum magnet,” currently is in use in only a few facilities, including one operated by New England CRINC at the Rhode Island MRF in Johnston, Rhode Island. The process involves the generation of a magnetic field known as an eddy current around a rotating drum. When a non-ferrous conducting material enters this field, it is deflected by the eddy currents. The method has limitations because the deflection is dependent upon the geometry and size of the object being deflected. In Rhode Island, the process is used to separate aluminum cans from other commingled containers.

- **Optical Sorting**  This process separates glass based on the light-reflective properties of the glass. The glass must be in the range of 1/4 to 3/4 inches in diameter, and is passed along a vibrating feeder where a sensor measures the optical reflectivity of the glass. A blast of compressed air then separates the glass from the rest of the commingled stream. Optical sorting separates glass from non-glass particles at an efficiency of 99%; it also separates colored from clear glass. The processing rate varies from one half ton to fifty tons per hour. However, most MRF’s in operation today do not utilize this high technology equipment. Rather, most glass separation by color involves manual sorting at a picking station.

The second basic operation which occurs in a MRF is processing and/or cleaning of the separated recyclable materials. This step is utilized to enhance the marketability of the end product or to increase the cost-effectiveness of shipping the product to end users. Both of these factors increase the net revenue potential for the recyclable material. The following equipments falls in the “processing” category: balers, can flatteners, glass bottle crushers and granulators. A more detailed description of this equipment which is used to process recyclables is presented below.

- **Baler** - A baler is a compaction device that crushes material into small rectangular blocks, reducing it in volume and making it uniform in shape for easy storage and shipping. Balers are versatile because they can process several types of materials and can be designed for specific components of the recyclable stream, including aluminum, paper, and plastics. A wide variety of capacities and bale sizes are available, most with varying degrees of compaction or partial bale capabilities. Automatic bale tying is usually available.

- **Can Flattener** - By crushing or flattening cans, the number of cans transported per shipment is greatly increased. The largest can crushers
process thousands of cans an hour. Some can crushers have special features, such as a pneumatic conveyor that automatically feeds the cans into a truck. An aluminum can crusher with pneumatic conveyor is depicted schematically in Figure IV-4.

- **Glass Bottle Crusher** - Most crushers simply crush the glass to reduce volume. Mechanical bottle crushers are preferred to manual crushing because they are more efficient and less dangerous for personnel. Some models have attached screens or trommels to remove caps, rings or other aluminum contaminants. A glass crusher of the type to be used in the Chemung County MRF is shown in Figure IV-5.

- **Granulator** - Granulators are generally used to reduce the volume of plastics. Some also remove impurities, usually by means of an air classifier that operates on the principle of sedimentation to sort materials.

6. **Chemung County's MRF.** When the CCSWMD evaluated technologies associated with MRF processing systems, it had a number of factors to consider. The first consideration was whether to go with a very basic low technology system which involved primarily the sorting of recyclables but very little equipment for processing such materials, or to go with a more moderate to high technology approach involving material processing. Certainly there are many pros and cons for each approach not the least of which are cost considerations. One of the overriding considerations in not selecting a low technology approach was the CCSWMD's concern for a glut on the market of marginally processed recyclables caused by government mandated recycling programs. The CCSWMD felt that a more properly processed recyclable material could better ensure long term markets for such materials. The underlying fear was that if the supply of low level recyclables far outstrips the future demand for such materials, they could ultimately be considered waste products if no future markets for these secondary resources materialized.

The next significant consideration made by the CCSWMD was whether it should design its own processing system or utilize an existing private system that has an experienced track record. On the one hand, a custom built MRF could be designed for Chemung County taking into account, the best features of various MRF systems currently in operation throughout the country. However, this approach would result in the inevitable growing pains and setbacks associated with a "first of its kind system".
FIGURE IV-4
ALUMINUM PROCESSING SCHEMATIC
N.T.S.
FIGURE IV-5
GLASS CRUSHING SCHEMATIC
N.T.S.

FAGAN ENGINEERS
Environmental Consultants
More importantly, the CCSWMD was concerned about initially securing reasonable markets for a system which does not have an extensive track record. Management staff and the engineer for the CCSWMD visited a number of operational MRF's throughout the country. Based on a review of potential recyclables in the county's waste stream, throughput capacity needs, site constraints associated with constructing a new MRF adjacent to the existing milling station and building system cost estimates, a site plan was finalized for a 25,000+ square foot MRF facility at the Lake Street solid waste complex. Bids were then solicited from pre-selected MRF system developers who had the capability of manufacturing, installing and operating the processing equipment. The firms, Resource Recovery Systems, Inc. and New England CRINC were pre-selected based on their experience in producing a high quality, readily marketable product. Based on a detailed review of the bids, the CCSWMD selected RRS to provide and install the processing equipment for the MRF. However due to the CCSWMD's "can do" attitude including its 18-year experience in operating the adjacent milling station, the district opted to operate the MRF facility itself rather than entering into an operational contract with RRS. Currently, the CCSWMD is evaluating marketing contracts for the recyclable materials including a subcontract to RRS. The cornerstone in selecting the RRS technology is its successful track record over the past ten years of developing strong and secure markets for its recyclable end products. A more detailed description of the CCSWMD's MRF follows.

Commingle, source-separated recyclables collected at the curbside will enter CCSWMD's solid waste complex off Lake Street with other solid waste trucks for weighing on the scales. As shown on Figure IV-6, the trucks hauling recyclables will then travel around the MRF facility in a clockwise manner for entry onto the two tipping floors, one for commingled paper and the other for commingled mixed containers, both located at the north end of the building. Market-ready recyclables are shipped from the bulk bins and the loading dock at the south and west ends of the MRF building.

Commingle, source separated paper recyclables are deposited on the paper tipping floor by the various recyclable haulers. The tipping floor attendant inspects the load and separates out any oversized or obviously non-recyclable pieces and sets them aside for later processing. Loads with high portions of contaminated or non-recyclable components will be rejected and must be removed by the hauler. A small bobcat loader then pushes the pile of paper into the conveyor receiving pit, where the main paper feed conveyor elevates these recyclables to the paper sorting booth. Inside the booth, the paper recyclable stream is separated manually, by the sorters, into the three basic components: cardboard, magazines and contaminated residue. The fourth component, newspapers, is negatively sorted and falls to the tipping floor just beyond the paper sorting platform. The other manually sorted components are
dropped through chutes into their own respective bins, separated by vertical concrete walls. When one of the bins is full, the material from the full bin is pushed over to a second receiving pit for the feed conveyor to the paper baler. The material exits the baler in baled form with ties, for subsequent loading directly onto a trailer parked at the adjacent loading dock, or for short term storage adjacent to the paper tipping floor. Paper shipments for business recycling programs will not be allowed on the paper tipping floor to be mixed with other paper recyclables. Instead, such paper shipments will be stored in sorted form via jersey barriers which are located adjacent to the paper baler receiving pit for direct baling when sufficient stockpiles warrant processing of these paper components.

Recyclable commingled containers are dumped and inspected on the MRF’s easterly tipping floor in a manner similar to that for the recyclable paper (see Figure III-8 for MRF floor plan and equipment layout). This material consists of glass, ferrous and non-ferrous cans and a variety of rigid plastic containers. From the floor, the mixed container recyclable stream is pushed into the commingled containers receiving pit, where the main feed conveyor for this line elevates the material past an inspection station. The sorter at this first station sorts out deposit containers for redemption under the state’s bottle bill as well as large pieces of scrap metal and other potential contaminants that the processing equipment is not designed to handle.

The remaining mix of glass, cans, and plastics is carried by the cleated feed conveyor to the air classifier, where the aluminum and plastic containers are blown off the conveyor onto a sorting grate. This grate allows aluminum containers to pass through into the aluminum flattener/blower system, and causes the plastic containers to roll off onto a separate plastics conveyor. The aluminum is flattened to save shipping space and is blown directly into the back of an aluminum trailer for storage and ultimate shipment to an aluminum manufacturing facility. Sorters at the plastics conveyor separate plastics into one of three overhead 10 cubic foot plastic bins with a negative sort for remaining mixed plastics. When full, the contents of a bin are run via a conveyor to the nearby paper baler which in turn bales and ties the plastic for shipment via trailers parked at the loading dock located at the westerly side of the MRF.

The remaining recyclable stream, consisting of glass, ferrous metal cans and residue, next passes over the magnetic separator located on the end of the main feed conveyor. The magnetic separator discharges all ferrous metal cans to the tin can processor where they are flattened and slit into three inch wide or less strips and conveyed to an outside storage bin. Again the tin can flattener is used to increase the transportation efficiencies to end users. The slitting machine is used to increase the marketability of the tin cans since such slit pieces are more amenable to detinning operations.
The other components of the remaining recyclable stream drop onto the main sorting conveyor, where they pass in front of the glass sorters. The commingled sorters (both plastic and glass) are housed in a heated and air conditioned booth inside the MRF, where they sort recyclable glass by color and plastics by type of basic material. The clear, amber and green glass is dropped into its corresponding chute, which guides the glass into the top of one of three glass crushers. The glass crushers are constructed with an integral revolving trommel, which sorts the crushed glass by size, partially cleaning the labels and removing all the metal ring contaminants from the glass. The crushed glass cullet passes from the trommel to a conveyor, which discharges the cullet to external storage bins. The particles and impurities cleansed from the cullet by the trommel drop onto a residue conveyor which eventually discharges to the residue dumpster located in the southwest corner of the MRF.

It should be noted that these proprietary glass crushers, manufactured by RRS, produce a furnace ready cullet which can be delivered directly to the nearby Anchor Glass manufacturing plant located within one mile of the MRF. As a relative comparison regarding the enhanced marketability of the MRF's glass cullet, the nearby Central Recycling Co-Op, which is a regional redemption center for bottle bill containers serving a six county area, ships its glass cullet to New Jersey for processing before it can be shipped to glass manufacturing plants such as the nearby Anchor Glass plant.

After removal of the glass, the residue remaining on the sorting conveyor drops off the end of the conveyor into the residue screening trommel. Usable residue fragments are directed by this trommel to an aggregate crusher which reduces the size of this residue so that it can be used in a "glassphalt" paving process. The aggregate crusher, like the previous glass crushers, incorporates a trommel to separate out unusable contaminants. The contaminants go to the residue dumpster, while the "aggregate" cullet is conveyed to an external storage bin. All recyclable process residue is ultimately collected in trash roll-off containers for shipment to the adjacent mill station tipping floor for ultimate conveyance and disposal to the county's landfill.

C. Composting

Composting takes advantage of, and accelerates the natural process of, decay of organic matter to produce a stable, humus-like substance suitable for use as a mulch or soil conditioner. It is a biological method of solid waste management that processes and stabilizes the organic waste fraction through aerobic decomposition. There are three main
solid waste groups which are usually processed by means of composting. These are yard wastes, municipal solid wastes and sewage sludge. Differing technical approaches are utilized in composting these different materials. Although all technologies basically employ the same biological process, the individual techniques are better suited for the processing of one particular class of organics. For example, windrow composting is better suited to yard waste processing than sewage sludge, because of odor control problems associated with composting sewage sludge.

Presented in this section is a general description of composting technologies. Specific information is also presented regarding yard waste composting, municipal solid waste composting and sewage sludge composting as they apply to CCSWMD's integrated solid waste management system. Finally a discussion is presented regarding other compost related considerations such as sludge landspreading.

1. **Description Of Composting Technologies.** In relation to solid waste management, there are five basic composting technologies in use today. These include windrow systems, aerated static pile systems, in-vessel compost units, co-composting and simplified backyard composting systems. A more detailed discussion of each of these technologies is presented as follows.

a. **Windrow Systems**

Windrows are formed as long piles of compostable materials, usually approximately 12 to 15 feet wide and 4 to 6 feet high. The rows are kept moist and turned over to aerate the system and help control the temperature of the composting mass. This promotes uniform decomposition, and ensures that all the material decomposes at a satisfactory rate. In order to mitigate adverse environmental impacts, most windrow sites are paved. Depending on the type of material being composted and the size of the operation, windrows maybe open to the elements or enclosed.

In the past, windrows have been successfully utilized to compost yard waste, sewage sludge and municipal solid waste. Due to the inability to control odors or to maintain optimum compost conditions, most large windrow operations employ an enclosure of at least the active composting stage while the more inactive or curing stage maybe exposed to the elements.

For small yard waste systems, front-end loaders can be used to periodically turn and aerate the windrows. For larger systems, special windrow machines are utilized. These machines move longitudinally over the windrows whereby the composting material is efficiently turned to enhance aerobic conditions and accelerate decomposition. These machines use augers or conveyors to overturn and mix the contents of the windrows.

IV-34
b. **Aerated Static Pile**

This composting method is typically utilized to control odors generated during the composting of sewage sludge. The first procedure is to mix the sewage sludge with woodchips or some other acceptable bulking agent. A system of pipes is constructed and connected to blowers. The bulked sludge is then formed into piles over the pipe. Air is then drawn through the pile via the vacuum mode of the blower. Exhaust air is typically filtered through a pile of previously composted material for odor control. The composting mass is usually covered with a foot or two of stabilized compost material to help maintain temperatures in the pile and to also control odors. The microbes that metabolize and decompose the organic waste need oxygen to prevent excessive heat buildup and remove moisture from the piles. Although this system requires less area than the windrow system, little mixing and partial size reduction occurs during the compost process and moisture addition is difficult. Capital and operating costs are relatively low for this technique, since little equipment other than a blower system is necessary.

c. **In-Vessel Composting**

The in-vessel compost process utilizes mechanical equipment which accelerates decomposition by providing a well mixed material. Furthermore, such systems can be readily adjusted to control the flow of air and water to help maintain optimum compost conditions. Most of these systems are enclosed and computer-controlled to further monitor and control the decomposition process. Compared to windrow or static pile composting, in-vessel composting requires less labor, and provides better odor control. Capital and operating costs are relatively high, and the abrasive nature of the compost can cause excessive wear on mechanical equipment. Because the waste is retained in the vessel for only a few days, it leaves the vessel only partially composted and has to be finished by windrow composting. Most of these systems are modular and generally have been primarily used to compost sewage sludge. A variety of different in-vessel mechanical equipment is employed including agitated bed systems, silo systems, tunnel systems and enclosed static pile systems.

d. **Co-Composting**

Co-composting is generally defined as the simultaneous composting of two or more diverse waste streams, typically mixed municipal solid waste and sewage sludge. Co-composting of municipal solid waste with sludge is best handled in
an enclosed system because of the potential for odors and the need for leachate collection and surface runoff control. Sludge can also be mixed with chipped yard wastes. These mixtures will typically accelerate the compost process because sludge is rich in nitrogen and moisture content while the other wastes have both a high organic content and are bulky in nature thereby enabling good air passage with the resultant ease in establishing aerobic conditions. These mixtures generally can meet optimum carbon to nitrogen ratios for composting with ratios in the 20:1 to 30:1 range. Co-composting of municipal solid waste, in particular, requires a stringent program to remove household hazardous waste, which not only can interfere with the composting process but also can contaminate the finished compost product thereby greatly reducing its market potential.

There are widely varying types of co-composting systems on the market. They differ in important aspects such as pre-processing requirements, the volume of residuals, the quality of the resulting compost, the period to compost and cure the end product, post-processing requirements for various end market users etc. Most of the co-composting systems involve shredding as a pre-processing step. In the case of municipal solid waste, this can be preceded by magnetic separation of ferrous materials and trommels to drop out the glass component.

As siting problems continue to plague resource recovery systems and regional landfills, co-composting of municipal solid waste and sewage sludge is coming under closer scrutiny by municipalities as a method to reduce the volume of residual waste requiring landfilling while producing an end product that may have some market revenue potential to help offset operational costs.

e. **Backyard Composting**

As part of an overall municipal solid waste management program, householders should be encouraged, where feasible, to compost their own yard wastes in their own yards. Obviously the householders, attempting to manage their yard waste in this manner, must have adequate outdoor space for the compost bin or pile.

Backyard composting is an excellent method of diverting grass clippings, leaves, tree trimmings and some kitchen wastes (without meat, bones or fatty foods) from the municipal solid waste collection system. A mixture of materials makes the best compost for plants. Backyard composting produces valuable material for mulching and mixing with soil to nourish flowers, vegetables, trees and shrubs or for establishing turf for new lawns.

IV-36
Community benefits to backyard composting include savings on collection and disposal of the diverted waste. However, composting requires some effort on the part of the householder, and information on the proper methods for backyard composting should be obtained from a local Cooperative Extension office or library. In addition, a brochure is available from DEC entitled "Easy Backyard Composting." This type of information should become a future focus of the CCSWMD Recycling Manager's public education program.

2. **Yard Waste Composting.** As previously indicated, the most advantageous yard waste composting system is an individual backyard operation. Such operations divert yard waste from more costly to manage municipal collection and disposal systems. However, many householders cannot or will not participate in a voluntary backyard compost plan. Hence municipal yard waste composting systems are becoming more prevalent due to the need to divert this relatively benign and bulky waste from our solid waste stream and thereby save valuable landfill space.

According to the CCSWMD's 1990 solid waste composition study, approximately 12% of the milling station waste stream in the summer consisted of grass and leaves. During this same period, this study found that over 15% of the C&D waste stream consisted of brush and grass. Although these quantities vary seasonally, a county operated yard waste compost system could divert significant quantities of this material from disposal at the landfill. In anticipation of the need to develop a yard waste compost system, the CCSWMD constructed a yard waste transfer station located due east of the milling station at the county's solid waste complex off Lake Street.

A number of important design considerations must be finalized before the yard waste compost system can be implemented for Chemung County. The primary design consideration is siting. Two obvious sites have been previously considered by the CCSWMD. The preferred site is located at the adjacent sludge drying beds of the county's Lake Street sewage treatment plant. These beds were abandoned a few years ago with the installation of new sludge dewatering equipment. Although this site is potentially available from the Chemung County Sewer District No. 1 plant, it is located in the Newtown Creek floodway. Given current floodplain mapping of Newtown Creek, it does not appear that floodproofing these facilities, for use as a yard waste compost operation, is technically or economically feasible given compensatory flood storage requirements. However, it should be noted that this floodplain mapping was completed prior to the construction of the Sullivanville Dam which is located upstream on Newtown Creek.
Currently Chemung County and the City of Elmira are co-sponsoring a floodplain remapping study of Newtown Creek to determine the flood control benefits associated with the new Sullivanville Dam. The hydrological study, being performed by USDA's Soil Conservation Service, is currently being completed and coordinated with FEMA's floodplain mapping contractor. Once this remapping study is available, sometime this year, the CCWMD will be able to determine if it is feasible to flood proof the sludge drying beds for use as a yard waste compost site. From a transportation standpoint, this site is ideally situated in conjunction with the adjacent yard waste transfer site. Another advantage to this site is the existing drains beneath the drying beds which drain to the sewage treatment plant. There are, however, limitations to this site. The site itself is relatively constrained and probably is not large enough to store composted materials requiring a one or two month curing period. Although the site should be sufficient to handle the diversion of yard wastes from the existing milling station waste stream, it may not be able to handle the potential future influx of yard waste materials should the NYSDEC rescind its exemption of municipal leaf collection "storage" areas which currently exist throughout the county. Finally, due to the location of the nearby Mark Twain Motel located off Lake Street (with the history of past law suits regarding odors from the sewage treatment plant), a yard waste compost operation at this site would likely be enclosed by a pole barn structure. Such an enclosure would be designed to protect the compost operation from inclement weather conditions while also providing better odor control emissions for this facility. This facility would likely be operated utilizing the aerated static pile method which is more conducive for confined areas together with inherent odor control features. Curing of this composted material could take place at any number of suitable sites such as the county landfill complex, the City of Elmira's yards (where leaves from the city are currently "stored") or other nearby open space areas which are adequately separated from developed areas.

A second alternate site would be the Chemung County landfill complex. This site is advantageous if it is coupled with a C&D wood waste recycling operation. Chipped wood waste diverted from the C&D waste stream could be utilized as a bulking agent for the yard waste compost operation. This site would also be amenable to composting larger yard waste volumes. However since the majority of open space at the landfill has been recently converted for use as erosion control siltation traps, this plan may require clearing and grading hill areas above the landfill expansion site or acquiring nearby adjacent lands which may be more suitable from a site development aspect. Due to the local concerns for groundwater protection at the landfill, it would be necessary to pave and probably enclose at least the active portion of the compost process. An open pole barn structure would likely be suitable employing the windrow compost process. Given the presence of three front-end loaders at the landfill, these machines would likely be utilized to turn the windrow piles thereby reducing initial capital expense. However, based on operational experience, labor
requirements and the total volume of yard waste to be recycled, it is possible that future compost needs may necessitate the use of a more efficient windrow turning machine. Since the CCSWMD will likely compost in excess of 3,000 cubic yards of yard waste annually, a Part 360 permit would be required for such a system.

Ideally yard waste compost, if properly processed after composting by use of a screen to recycle wood chips and a shredder to improve the texture of the material, could be directly marketed as a revenue generator. Potential end users would include nurserymen, landscape contractors, garden centers, the general public, municipal park operations, etc. If insufficient markets exist for this material or if the cost of post-processing exceeds the revenue generated from the sale of this material, the CCSWMD can readily use this material as a soil conditioner/topsoil substitute for its ongoing landfill closure activities or as a source of daily cover for the landfill operations.

3. Municipal Solid Waste Composting. Composting can divert a significant portion of the solid waste stream from disposal, since approximately 40-60% of municipal solid waste is organic in nature and hence potentially compostable. Organic components of the municipal solid waste (MSW) stream capable of being composted include food waste, all types of paper waste including newspaper and magazines, corrugated and non-corrugated cardboard, textiles and wood wastes. In the 1990 solid waste composition study, the total organic fraction of the summer waste stream being disposed at the milling station exceeded 60%. For the Chemung County operation, pre-processing or sorting of the solid waste stream is not necessary due to the presence of both the MRF and milling station. The current milled waste stream, which is being landfilled at the CCSWMD facility in Lowman is very amenable to composting.

However, there are a number of considerations which preclude the short term feasibility of implementing a municipal solid waste compost operation for Chemung County. The first concern is siting. Although the compost process will greatly reduce the total volume of waste to be landfilled, there will still remain between 30-60% of the total waste stream which must be landfilled. Based on material handling considerations alone, this fact would dictate that the compost operation be sited at the county's current landfill complex. However, there is not sufficient land at the current site to accommodate a municipal compost operation which would be significantly larger than the aforementioned yard waste compost operation. Hence additional lands would have to be purchased adjacent to the existing landfill operation.

Another significant factor impacting the design of an MSW compost system is the scale or design capacity for this system. Obviously when the CCSWMD opens the MRF
operation, they will remove a significant portion of the county's currently
compostable waste stream through the recycling of yard waste, newspaper,
cardboard, magazines, office paper and junk mail. Simply put, the more successful
the MRF operation is (which the county has already made a major commitment to),
the less viable and cost-effective a municipal compost operation would be especially
in light of the fact that the projected landfill site life is estimated at some 25-years with
the implementation of the MRF operation.

Another significant factor which weighs against the foreseeable implementation of a
municipal compost operation is the capital cost required to construct such a facility.
In order to provide adequate environmental controls for this operation, the compost
facility itself would be enclosed. Hence the building cost, land acquisition cost, site
preparation, engineering siting and permitting fees, processing equipment, etc.,
would be significant. It is doubtful that the increase in landfill site life could come
close to offsetting these initial capital cost requirements.

Because of the limited amount of experience with MSW composting, and because of
the wide variation in MSW composition, initial capital costs can only be estimated.
Estimates of these initial capital costs fall into the range of $50,000 to $75,000 per ton
per day of design capacity. Operation and maintenance costs can run $35 to $45 per
ton, depending on amount of pre-processing required, composition of the MSW and
the type of processing performed. Monroe County, New York, in a feasibility study,
recently estimated a capital cost of $75 million for an 1800 ton per day facility.
Operation and maintenance costs were estimated at $18 million per year. This works
out to $42,000 per ton per day of design capacity for capital costs, and $38 per ton
for operation and maintenance costs, based on a five day work week.

However, it should be emphasized that Chemung County does have some unique
conditions which are amenable to municipal solid waste composting. These are the
MRF, which will recycle and divert a portion of the current non-compostable waste
stream (i.e. glass, metal, plastic and aluminum containers), and the milling station
which already processes a significant portion of the waste stream in a form that is
readily conducive to the compost process. Hence, it is recommended, that after the
MRF has been in operation for a period of at least two years, a detailed composition
study be made of the remaining solid waste stream being processed at the milling
station. Such a composition study will provide the basic data to conduct a realistic
cost-effective analysis associated with composting the remaining municipal waste
stream. Finally, it should be noted that such an analysis should take into account the
limited revenue potential of composted municipal waste. Due to the obvious
contamination problems with non-compostable materials, most municipal solid waste
compost will be suitable for landfilling with the advantage of little need for cover
seeking alternative methods for processing and disposal of sewage sludge generated by their wastewater treatment plants. Hence, the number of communities that have begun sludge composting operations in the last six years has risen dramatically in the state.

There are many inherent benefits associated with a sewage sludge compost. For example, the nutrient content, particularly nitrogen and phosphorus, is high. The microbial content is also very high. These factors, together with the compost's inherent moisture retention capability, makes it a valuable soil conditioner or amendment as a topsoil replacement. However, there is one significant concern regarding the utilization of sludge compost. That is the quality of the material related to its heavy metal content. The state's Part 360 regulations pose strict concentration limits for heavy metals associated with marketing sludge compost. These same regulations pose strict limitations on sludge heavy metal concentrations associated with landspreading sludge for agricultural utilization purposes.

Currently, the Chemung County Sewer Districts operate two sewage treatment plants, one off Lake Street adjacent to the CCSWMD's milling station/MRF complex, and the other off Milton Street on the City of Elmira's southside. Both treatment plants employ a trickling filter solids contact treatment process that collectively generates some 10,000 tons of anaerobically digested sludge each year. After a two stage digestion process, the sludge is dewatered in filter presses prior to hauling to the Chemung County landfill. The dewatered sludge generally falls in the 20% to 30% moisture content range.

In the past, heavy metals concentrations in both sludge waste streams have exceeded the Part 360 sludge landspreading limits. Presented in Table IV-1 is a summary of the existing sludge quality generated by the Chemung County Sewer Districts' two sewage treatment plants. Analysis of this table indicates that the sludge quality from both plants is improving. This improvement is likely the result of the district's enhanced enforcement of its industrial pretreatment ordinance over the past two years. The Lake Street sludge still has a minor problem with cadmium and zinc. Also, the copper levels are only marginally acceptable. The Milton Street sludge has shown a dramatic improvement in its heavy metal quality over the past year with only copper and cadmium exceeding the compliance limit for landspreading. However, it should be noted that the cadmium concentration in the Milton Street sludge is still exceedingly high with a dry weight concentration some five times the acceptable limit. Furthermore, from a public health standpoint, cadmium is the heavy metal of greatest concern because it can find its way into the food chain and bioaccumulate in the kidneys and liver of humans. For marketing of compost to the general public for use on food chain crops and other agricultural or horticultural uses (Class I compost), the cadmium concentration is further restricted to no more than 10 ppm.
Table IV - 1 - Current Heavy Metal Concentrations In Chemung County Sewage Sludge*

<table>
<thead>
<tr>
<th>Heavy Metal</th>
<th>Part 360 Landspreading &amp; Class II Compost Limit</th>
<th>Milton St. STP 1/91</th>
<th>Milton St. STP 1/90</th>
<th>Lake St. STP 8/90</th>
<th>Lake St. STP 2/90</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cadmium</td>
<td>25</td>
<td>126</td>
<td>276</td>
<td>26.4</td>
<td>33.7</td>
</tr>
<tr>
<td>Chromium</td>
<td>1000</td>
<td>683</td>
<td>1640</td>
<td>146</td>
<td>163</td>
</tr>
<tr>
<td>Copper</td>
<td>1000</td>
<td>1170</td>
<td>2050</td>
<td>950</td>
<td>1000</td>
</tr>
<tr>
<td>Lead</td>
<td>1000</td>
<td>224</td>
<td>391</td>
<td>289</td>
<td>283</td>
</tr>
<tr>
<td>Mercury</td>
<td>10</td>
<td>0.8</td>
<td>4.2</td>
<td>-</td>
<td>2.3</td>
</tr>
<tr>
<td>Nickel</td>
<td>200</td>
<td>111</td>
<td>221</td>
<td>33.8</td>
<td>32.4</td>
</tr>
<tr>
<td>Zinc</td>
<td>2500</td>
<td>1580</td>
<td>3080</td>
<td>2510</td>
<td>1360</td>
</tr>
</tbody>
</table>

* All concentrations in mg/kg dry weight.

Obviously based on the existing sludge quality, the Chemung county sewage treatment plants do not produce a sludge that would be marketable based on regulatory restrictions associated with compost quality. Hence, the feasibility of building an expensive in-vessel or static pile sludge compost system is not considered viable at this time when the compost product could not generate revenues to offset operational and capital expenses. Furthermore, with the county landfill having adequate volume to meet the project county-wide solid waste disposal needs over the next 25 years, the need for a more expensive sludge management alternative does not exist.

Since sludge composting is not considered feasible due in part to existing heavy metal problems, so to would co-composting this sludge with either yard waste or MSW. A potential long term co-composting alternative that could be feasible would entail the
composting of the better quality Lake Street sludge with yard wastes. However this alternative should not be evaluated until the CCSWMD selects a final site for its yard waste compost operation. Ideally, after the CCSWMD has a few years of operational experience with yard waste composting, including a more detailed evaluation of potential markets and revenue projections, it will be in better position to evaluate more fully the advantages and disadvantages of a yard waste and municipal sludge co-compost alternative.

5. **Other Compost Related Considerations**. As indicated in Chapter III, the CCSWMD has successfully demonstrated the reutilization of digested and dewatered municipal sludge as a topsoil replacement for final cover systems on both Area 3 and Area 5 portions of the landfill. Old, better quality sludge generated during the construction of the expanded Milton Street sewage treatment plant, has been mixed in a ratio of one part sludge with two parts of sandy silt subsoils (lake bed deposits). This mixture was then spread by a bulldozer some six-inches thick followed by seeding and mulching. The resultant luxuriant grass growth helps to minimize erosion problems with the final cover while maximizing evapotranspiration potential with the attendant decrease in leachate generation potential.

The above landspreading procedure is similar to that of utilizing a finished sludge compost product without incurring the capital and operational expense of composting. However based on current sludge quality concerns, all of the sludge presently being produced by the Chemung County Sewer District's is being landfilled in the dual lined cells. Over the past few years, the CCSWMD has been coordinating with the sewer districts in order to improve the quality of the sludge such that it will be acceptable for future landspreading projects. As shown on Table IV-1, significant progress has been made recently as reflected in the reduced heavy metal concentrations particularly for the Milton Street plant.

Analysis of the Lake Street sludge shows that it is very close to the Part 360 heavy metal limits for landspreading. Currently, another confirmatory heavy metal analysis is being run on this sludge. If these results confirm the recent past analyses, the CCSWMD plans to submit a landspreading permit for use of this sludge as a topsoil substitute for final cover systems that are currently planned on the side slopes for Area 3 and the entire existing C&D fill area. This permit application will likely require a variance for the cadmium concentrations and potentially also for copper and zinc. However, the CCSWMD feels that such a landspreading permit should be granted by DEC based on the following considerations:

- The sludge quality is very close to the existing DEC limits for landspreading based on agricultural utilization practices.
This will be a one time application on the final cover system involving no agricultural utilization. Hence there is no possibility that heavy metals could enter the human food chain.

Past sludge landspreading practices at the landfill have demonstrated the benefits of this sludge recycling/reutilization method in the form of grass growth, erosion control, moisture retention and attendant increase in evapotranspiration potential.

Beneficial use of this material will save valuable landfill space and hence increase the site life potential of the landfill.

There are no potential surface runoff problems as all surface runoff at the landfill is tributary to either the existing siltation pond or the adjacent old canal bed, neither of which are connected to a receiving stream.

D. **Waste-to-Energy**

In order to reduce solid waste volumes and offset disposal costs, a number of municipalities throughout the country have resorted to burning the combustible portion of their waste stream to produce energy. This process still results in an ash residue which must be landfilled, but in a much smaller volume when compared to the volume of the raw solid waste. Combustion can reduce solid waste volume by 95% and solid waste weight by 75%. Most of the solid waste incinerators involve reclaiming energy from the waste via the direct utilization of steam or the generation of electricity for conveyance to the electrical grid system. Some systems process a refuse derived fuel (RDF) as a supplemental feed stock to coal fired electrical generating stations. These technologies used in waste-to-energy (WTE) processes are described below.

Most WTE techniques utilize direct combustion of the incoming solid waste, while some, as mentioned above, manufacture fuel from the waste to be burned at a later time in a more controlled environment. All new WTE systems are subject to very stringent air quality regulations and will require sophisticated air emission controls and ash residue management systems to protect both the public health and the environment. The new 6 NYCRR Part 219 state regulations for incinerators require that new facilities have additional pollution controls, operate at more efficient rates and higher temperatures and be monitored by properly trained operators. These regulations, for the first time, set limits for dioxin emissions. Emissions from a properly designed and operated waste-to-energy facility, using state-of-the-art pollution controls, should not significantly increase public health risks or adversely affect the environment. The steam or electricity generated in a
facility is marketed under the Public Utilities Regulatory Policy Acts (PURPA) program. Under this program, a local utility company must purchase the electricity and steam produced by the WTE facility.

There are numerous WTE technologies in varying stages of development. The six technologies discussed in this section—mass burn, modular, RDF, fluidized bed combustion, biogasification and pyrolysis—have had varying degrees of implementation at full scale operational levels. In the following sections, WTE technologies are discussed in order of this experience and overall utilization throughout the county.

In mass burn, modular, RDF and fluidized bed facilities, waste is combusted at high temperatures and heat is recovered by a boiler. The key components of a combustion facility include:

- waste storage and handling;
- waste feeding;
- combustion;
- steam and electricity generation;
- air pollution control; and
- ash residue handling.

The combustion of waste occurs in four stages: namely drying in which the moisture is evaporated from the waste; devolatilization in which the combustible volatiles are released from the waste; ignition in which the volatiles are ignited in the presence of oxygen; and combustion of fixed carbon in which the volatile matter is completely combusted and the fixed carbon is oxidized to carbon dioxide.

In contrast to the above combustion technologies, pyrolysis uses heat in an oxygen-deficient or oxygen-free atmosphere to decompose organic wastes physically and chemically into a gas or liquid energy product. Biogasification is another non-combustible process by which organic matter is decomposed anaerobically (in the absence of oxygen) and without the addition of heat, to generate a methane gas product.

Due to the lack of operating history, the fluidized bed combustion, biogasification and pyrolysis technologies cannot be considered proven technologies for mixed municipal solid waste management in New York State. Included in Appendix D, is a listing of Resource Recovery projects in New York State as of August 1990. Their operational or planning status, type of combustion or resource recovery process are presented in this appendix.
Mass Burn. Mass burn systems are the most common of all WTE plants. In a mass burn system, the solid waste is typically fed directly into the combustion chamber by an overhead crane and chute. Most components of an MSW stream can be utilized as fuel in a mass burn facility. The only pre-processing normally required before burning is to separate out bulky or hazardous materials. The waste falls either onto a grate or a rotary combustor and burns to produce steam which is used to run generators. The overhead cranes are also used to thoroughly fluff and mix the refuse to loosen it and improve its firing quality. After combustion is complete, the ash residue is removed from the bottom of the unit for final disposal.

Mass burn systems are designed with moving grates used to mix the solid waste to ensure complete combustion. They are designed to move the burning waste through the furnace while agitating it, so that when removed at the end of the burning process, only ashes remain.

The air required for combustion in a mass burn system is supplied by fans or blowers through openings in the furnace from below the grates (under-fire air) and above the grates (over-fire air). Under-fire air initiates combustion and supplies oxygen to the waste burning on the grates. Over-fire air mixes with volatile gasses given off as the waste burns and causes ignition and combustion of the gases. Residual or bottom ash is removed from the furnace bottom by a conveyor and cooled by spraying or quenching with water. In most cases, fly ash, composed of the particles suspended in the gas stream and removed by air pollution control equipment, is combined with the bottom ash for ultimate waste disposal.

There are three major types of mass burn furnaces, namely waterwall, refractory and rotary kiln as shown on Figures IV-7, IV-8 and IV-9 respectively. In a waterwall furnace, energy is recovered by a closely-spaced steel tube furnace lining which forms a continuous wall around the combustion chamber. In a refractory furnace, energy is recovered by a convection-type waste heat boiler installed at a point after the combustion chamber. Of the two, the waterwall furnace is more efficient and economical and provides higher heat recovery efficiencies than refractory-lined furnaces. Waterwall furnaces have almost completely replaced refractory lined furnaces in current system design.
FIGURE IV-7
MASS BURN WATERWALL FACILITY
N.T.S.

SOURCE: USDOE, 1988

FAGAN ENGINEERS
Environmental Consultants
The rotary kiln furnace is a modification of the refractory lined furnace. Solid waste is fed to a primary combustion chamber where it is pre-dried and ignited. Burning is completed in a refractory-lined rotating furnace. The combustion chamber contains a cylindrical compartment constructed of grating that rotates about a near-horizontal axis, similar to a trommel. The rotating action of the furnace mixes the refuse, allowing better combustion and causing the materials to move throughout the furnace. The anticipated heat recovery rate from a rotary kiln furnace is comparable to a waterwall furnace, namely in the range of 65 to 70 percent.

The quantity of energy recovered in a mass burn facility is related to the type of furnace employed. On average, approximately 500 to 600 kilowatt hours (kwh) of electricity are generated per ton of refuse; steam is produced at an average rate of approximately three to four pounds per pound of solid waste. In both cases, these averages represent net energy output after internal energy needs to run the facility are taken into account.

Commercially available mass burn units range in size from 100 to 1000 tons per day (TPD). Typical designs consist of multiple furnaces to achieve total burn capacity and provide better operational reliability and flexibility. The Part 360 regulations require a minimum of three units per facility to ensure designed-in operational reliability. The mass burn technology is utilized for larger facilities, usually in excess of 400 TPD. The largest facility permittable by law is 3,000 TPD. Most mass burn facilities are field erected, but prefabrication of major components often occurs in the factory.

A mass burn facility can also be designed for co-generation of steam and electricity. Mass burn furnaces, especially the refractory-lined type, have been used for co-disposal of municipal solid waste and sewage treatment plant sludge. An 18 to 36 month construction period is usually required for a mass burn facility.

The most advanced of the mass burn furnaces is the waterwall furnace which employs advanced stoker design, combustion control, uniform air flow and state-of-the-art air pollution control equipment. Large scale, mass burn waterwall furnaces were first put to use in Europe in the 1950's. With many refinements which have been incorporated into the design, this largely European technology has been widely used throughout the world. There are currently more than 300 mass burn facilities operating in the U.S., Europe, Japan and South America. An on-line reliability rate of up to 90% has been reported for waterwall furnaces. A number of qualified vendors are licensed to market mass burn technology in the United States.

The capital cost for mass burn facilities typically ranges from $100,000 to $135,000 per ton per day of design capacity. Estimated operating costs range from $25 to $35
per ton and tend to increase as plant size decreases. Estimated revenues from the sale of electricity are $30 per ton, assuming six cents per kilowatt hour (Kwh) and 500 Kwh per ton of waste. These costs do not include electrical generating plant or operation and maintenance costs.

2. **Modular Combustion Units.** Modular combustion waste-burning units, in contrast to the larger scale mass burn units, are relatively small-scale WTE. They are typically comprised of single or multiple pre-designed and factory manufactured modular combustion units that are assembled on site. Modular combustion units can be operated as a single unit or with multiple modular units operating together.

In modular facilities, refuse is dumped on the tipping floor and loaded into the feed hopper with a front-end loader or bulldozer. Typically, waste is fed to the furnace intermittently with a horizontal hydraulic ram. Some modular systems have grates similar to those employed in field-erected installations. Figure IV-10 illustrates a typical modular WTE system.

Modular waterwall furnaces are controlled-air, fully oxidizing furnaces. These furnaces have good combustion efficiency with respect to ash residue quality, since there is greater reduction in the organic or volatile matter of the ash with a modular furnace. However, because of the low-cost design of the feeding and mixing mechanisms, combustion efficiency is lower than mass burn waterwall furnaces. The thermal efficiency of this system is approximately 50 to 60 percent. Electrical generation rate for modular facilities is approximately 400 to 450 kwh per ton of waste burned. Steam production ranges from two to three pounds per pound of solid waste.

In a modular starved-air system, there are two combustion chambers. In the primary chamber, partial pyrolysis of the waste reducing the peak combustion rate and producing incompletely burned residues. In the secondary chamber, the partially pyrolyzed products are burned with excess air and an auxiliary fuel burner. The thermal efficiency of this system is also approximately 50 to 60 percent. Air emissions from this system are relatively clean and less likely to contain particulate matter in the exhaust. This is due to the fact that less air is introduced into the primary chamber. Consequently, less flue gas moving at a lower velocity exiting the chamber is available to entrain particulates.

Modular waste-to-energy facilities currently in operation range in size from 50 to 120 TPD. Modular systems can handle most waste streams without preprocessing except for removal of large bulky items. However, modular facilities usually are not cost-effective when compared to mass burn facilities for system capacities greater than 400 TPD.
FIGURE IV-10
MODULAR WASTE-TO-ENERGY
FACILITY
N.T.S.

SOURCE: USEPA, 1987

EE FAGAN ENGINEERS
Environmental Consultants

IV - 52
A modular system can be constructed in 12 to 18 months, roughly one-half the time for a mass burn system. Modular systems will reduce solid waste volume by 85-90% and weight by 50-60%. The use of multiple modular units allows for flexibility of design and operation.

A number of modular systems have been in operation since the 1970's. Most currently operating systems are the dual chambered starved air type. However, not all of these systems accept mixed municipal waste and many were designed for homogeneous industrial wastes. The simple design of modular systems is more suitable for smaller energy and steam generating systems. Reliability and environmental performance of these smaller units quite often is a function of the operator's skill as opposed to larger systems with greater automatic operational controls. Hence on-line reliability of modular furnaces is slightly less than that of mass burn furnaces. Available data indicates that the operating life of a modular incinerator is also shorter than a mass burn incinerator.

Capital costs of a modular WTE facility are significantly lower than for a mass burn facility. However, operation and maintenance costs are higher. Estimates for capital costs range from $75,000 to $90,000 per ton per day of design capacity and $30 to $40 per ton for operating costs. Estimated revenues from the sale of electricity are $24 per ton, assuming six cents per kilowatt hour (kwh), and 400 kwh per ton of waste.

3. Refuse-Derived Fuel. Refuse-derived fuel (RDF) is the end result of a solid waste processing system in which the combustible portion of the solid waste stream is separated out and reduced to a uniform size suitable for incineration. Most of this combustible portion is organics and plastic materials. This pre-processing (sorting and refining) of waste enhances its' fuel value and also creates the opportunity for recycling materials such as glass and ferrous metals. This materials recovery also results in fewer boiler operating problems and a reduction in the volume of incinerator residue that must be landfilled. The sorting of this waste could be integrated into a MRF to further minimize pre-processing costs.

The well developed technology used for burning solid fuels such as coal and wood is generally applicable to RDF-based facilities. However, coal and wood are very homogeneous and easily combustible. RDF is heterogeneous and therefore more difficult to burn, necessitating careful design of an RDF furnace. Combining RDF with coal or wood also requires some modifications of the boiler.

There are currently three general types of RDF being produced on a commercial basis: coarse, fluff and densified. These RDF's differ in the degree of material
processing involved. Mechanical processing of coarse RDF typically consists of single stage shredding, separation and removal of organics and metals, and screening to remove inorganic particles. Fluff RDF involves additional stages of shredding, separation and screening to produce a higher fuel value. Densified RDF is produced by compacting RDF into pellets or briquettes. Even within these three classifications, RDF varies widely with respect to material density, particle size, time required for combustion, moisture content and presence of noncombustibles such as glass, dirt, metals, etc.

Coarse RDF, because it undergoes the least amount of processing is the cheapest fuel to produce. Coarse RDF, however, displays problems associated with impurities such as large residue accumulation in the ash. Furthermore, it produces the least amount of heat per weight of fuel of the three types of RDF mentioned previously.

Additional processing is required to produce fluff and densified RDF. Fluff RDF is made by performing additional size reduction and classification on coarse RDF, to the point where no particle is larger than one cubic inch. Densified RDF requires the most processing as it is manufactured by compressing fluff RDF into pellets or briquettes.

Because of its density, densified RDF is the most economical RDF to store and transport. A major advantage of this RDF system is its ability to store the fuel indefinitely so that no energy source will be dependent on a constant stream of incoming waste, as is the case with mass burn and modular combustion units. Another benefit of this material is its ability to mix directly with lump coal for feeding to a stoker boiler with only a minimum of modifications necessary.

Other variations of RDF include dust RDF and wet RDF. Dust RDF involves treating fluff RDF with an embrittling agent - sulfuric or hydrochloric acid - and then pulverizing it. However, the addition of sulfuric acid increases sulfur dioxide emissions in combustion. Efforts to commercialize dust RDF have been unsuccessful. In wet RDF systems, solid waste is wet-ground in large hydropulpers, similar to those used to pulp wood into paper, to produce a slurry. The light organic fraction is separated from the heavy fraction in a hydraulic centrifuge. The light fraction is then dewatered by vacuum equipment and fired in the furnace. Commercial applications of wet RDF in Hempstead, New York and in Dade County, Florida, have been discontinued due to various emissions and operational problems.

Generating energy from waste with an RDF system involves two steps. Processing waste to obtain fuel and using the fuel to generate heat. Therefore, there are two major components to the RDF system: the RDF processing system and the RDF fired furnace. Design criteria for both components must be considered when evaluating
this WTE alternative. In general, approximately 0.5 to 0.7 pounds of RDF can be produced from each pound of solid waste.

Four basic processes are involved in the processing of an RDF product, namely size reduction, separation, materials recovery and densification. Figure IV-11 illustrates two processing facilities utilized for the production of RDF. Size reduction is usually the first step in the RDF manufacturing process. The waste is reduced in size and broken up for subsequent separation. Flail mills and hammermill shredders are commonly used for size reduction. In the separation step, trommels, disc screens, vibrating screens and air classifiers can be used to separate non-combustibles. The remaining fraction of the waste stream is a product called the light fraction which is rich in combustible materials. This light fraction, or RDF, can be used directly or undergo further processing.

In the materials recovery step the heavy fraction, ferrous metals, non-ferrous metals and glass, can be further separated by magnetic separation, screening, and air classification. Densification is the fourth step in some RDF processing systems. RDF is usually densified if it is to be stored for extended periods or transported off-site to an industrial user. Densified RDF is produced by compacting the light fraction into pellets or briquettes. When integrated with a MRF, the order of some of these steps may be modified to facilitate early removal of non-combustibles and recyclables.

RDF can be used for energy production by co-firing with fossil fuels in industrial or utility boilers, or as the sole or primary fuel in a dedicated RDF boiler. The latter approach is more common since it allows for the design of a furnace that can specifically handle the characteristics associated with the burning of RDF.

RDF can be burned in grate burning systems, suspension-fired systems, fluidized bed systems or a combination thereof. Grate burning systems are similar to mass burn and modular systems where the waste is combusted as it travels through the furnace. In suspension-fired furnaces, the fuel is burned in suspension; there is no burn-out grate for completion of combustion or for removal. To ensure complete combustion, only high quality "fluff" RDF fuel can be used in this type of furnace. In fluidized bed systems, RDF is mixed in the furnace with an inert material (sand) and circulated until complete burnout is achieved.

A properly managed RDF facility can enhance the effectiveness of a recycling program by intercepting an additional organic material before it is landfilled. Any solid waste stream will be reduced in volume and size if part of it is burned.

The capacity of an RDF facility will depend on its two major components: the RDF processing facility and the furnace. Typically, the design capacity of RDF facilities is
PROCESS FLOW SCHEMATIC (HAVERHILL, MA)

PROCESS FLOW SCHEMATIC (PALM BEACH, FL)

FIGURE IV-11
RDF PROCESSING FACILITIES
N.T.S.

SOURCE: WASTE AGE, APRIL 1989

FAGAN ENGINEERS
Environmental Consultants
modular system can be constructed between 600 and 2000 tons per day (TPD). An RDF plant below the 600 TPD capacity is not as cost-effective when compared with a mass burn facility because of the high costs associated with the front-end processing requirements.

An overall volume reduction of 90 to 92 percent can be expected from an RDF facility with a corresponding weight reduction of 80-85 percent. These reductions will depend on two major factors: the composition of the raw municipal waste and the materials recovery that takes place during fuel processing.

An RDF boiler is approximately 10% more efficient than a mass burn waterwall furnace. This is due to the fact that RDF is a more homogeneous material than raw municipal solid waste. Furthermore, inert materials have been removed from the RDF prior to the burning stage. However, the energy requirements for the entire RDF system are greater than any other combustion process. Even so, after internal usage conditions, approximately 500-525 kwh of electricity can be generated per ton of combusted RDF. Steam availability is two to three pounds per pound of combusted RDF.

Commercial RDF facilities were started in the 1970's when the energy crisis emphasized the need for energy conservation and materials recovery. Early RDF technologies had problems with high amounts of ash, slagging in the boiler, and fouling the grates, incomplete combustion and excessive exhaust emissions. Explosions linked to volatile materials in the incoming MSW have also plagued some RDF facilities. Most of these early facilities have now shut down, including the Monroe County Resource Recovery Facility in Rochester, NY.

Most RDF facilities currently in operation utilize the fluff RDF process. Experience has shown that burning RDF fuel alone results in a more reliable system than mixing RDF with other fuels. Other past problems have been overcome by adding a sorting conveyer to the incoming waste stream to eliminate incompatible components (i.e. potential explosives, illegal industrial wastes, etc.) and by the addition of air classification and screening to eliminate non-combustibles. Recent RDF facilities have overcome all of the problems inherent in the early RDF systems, and are now operating successfully. The mass burn system, however, has a better track record and has been around much longer, so some municipalities still tend to favor mass burn over RDF.

The capital and operating costs of RDF system are closely comparable to other types of WTE systems. RDF furnaces can be smaller because a significant portion of the waste stream has been removed in the RDF fuel production process. However
potential savings from this smaller furnace size are offset by the costs associated with the RDF processing system.

Capital costs for an RDF system range from $110,000 to $140,000 per ton per day of design capacity. Estimated operating costs of an RDF system range from $30 to $40 per ton. These operating costs can be offset by the sale of electricity or steam and by the sale of materials recovered in the RDF production process stage.

4. **Fluidized Bed Combustion.** Fluidized bed combustion of MSW is a relatively recent development in RDF technology. This specialized design utilizes a cylindrical refractory-lined shell with a bed of sand. Coarse, fluff or densified RDF is injected into the bed of sand from the side, while the sand is being expanded and held in a dynamic suspended state by air pressure from underneath. The sand bed is expanded to 30 to 40 times its original volume. Because of the complete mixing that occurs in the furnace, excess air requirements are minimal. Complete combustion is possible by controlling retention time of the waste in the furnace. Careful control of air pressure prevents waste from floating above the combustion zone. The energy recovery unit may be an integral part of, or separate from the combustion chamber. Figure IV-12 shows a typical fluidized bed furnace.

Ash resulting from this combustion is continuously removed from the bed by the upflowing exhaust gasses. Ashes and a small amount of sand are removed from the exhaust by a pollution control system. Sand loss is typically 5% of total for every 300 hours of operation, and must be periodically replaced. Non-combustibles must also be periodically purged from the furnace by either temporarily reducing the fluidizing air pressure and thereby reducing circulation long enough to allow them to settle, or by incorporating into the design a circulating combustor which separates these non-combustibles out automatically.

Energy recovery in the form of steam may be accomplished in several ways. Boiler tubes may be installed directly in the bed which also acts as a bed cooling media or, in some cases, a waste heat boiler may be installed in the exhaust downstream of the furnace. This configuration is typically employed in fluidized bed incinerators that burn commingled fuels such as sewage sludge and RDF and in systems where the facility has been retrofitted for the combustion of RDF. The most modern and efficient means of generating steam in an RDF-fired fluidized bed boiler is installing the fluidized bed within a waterwall furnace.

Fluidized bed combustion systems have been used extensively for sewage sludge disposal. Municipal waste must be processed into an RDF-type fuel in order to be used in a fluidized bed furnace. Fluidized bed combustion facilities utilized for burning municipal waste to recover energy exist in Japan. A facility in Duluth.
FIGURE IV-12
FLUIDIZED BED FURNACE
N.T.S.

SOURCE: USEPA, 1979

FAGAN ENGINEERS
Environmental Consultants

IV - 59
Minnesota, burns a combination of shredded waste and sewage sludge. No facilities utilizing this technology exist in New York State.

While the use of fluidized bed furnaces for sludge, wood and coal combustion is common, the technology is still being refined for municipal solid waste applications and hence limited operational data is available to predict long term reliability and system costs. Experience to date indicates a need for a reliable air classification or sorting system to prevent oversized objects from jamming the fuel injection system. Preliminary capital costs can be estimated by multiplying the design tonnage per day times $200,000 per ton. Operating costs are estimated at $45 per ton. These estimates include the RDF processing system costs.

5. **Pyrolysis**. Pyrolysis is a form of RDF technology which, unlike the contemporary RDF process which produces solid fuel pellets, produces a combustible gas or liquid hydrocarbons from an anaerobic, or oxygen free waste decomposition process. These fluids are then burned to produce electricity. The products of pyrolysis may include hydrogen, methane and carbon monoxide. Pyrolysis also produces solids, including a carbon-rich residue and non-combustible materials such as glass and metals.

The products of pyrolysis depend on many factors. The most important of these are the type of carbonaceous solids in the waste, the operating temperatures of the system, the heating rate and the type of equipment used. Temperatures below 1000 °F and slow heating favor production of char and oxygenated gases. Temperatures above 1500 °F and rapid heating favor production of flammable gases. In the past, pyrolysis has been used to produce coke from coal and charcoal from wood. As in fluidized combustion, a pyrolysis system requires front-end RDF preparation of MSW.

The application of pyrolysis for MSW is relatively new and can be traced back to about 1968. The major components of a typical system are storage facilities for municipal solid waste, a feed system, a front-end-RDF system, a pyrolytic reactor, a product cleaning or treating system, a product collection and storage system and a solid, liquid and gaseous by-product and residue removal system. Various types of pyrolysis systems have been marketed. Figure IV-13 shows a schematic for two such pyrolysis reactors.

There are no commercial, full scale MSW pyrolysis system’s operating successfully. Pyrolysis has been used for many years for coal gasification and to produce methanol, acetic acids and turpentine from wood. However, more research and development are required to make this technology a viable alternative for municipal solid waste management. Several companies attempted development of MSW pyrolysis systems in the 1970's, with little success. Currently, no full scale municipal
FIGURE IV-13
PYROLYSIS REACTORS
N.T.S.

SOURCE: USEPA, 1979

FAGAN ENGINEERS
Environmental Consultants
solid waste pyrolysis facility exists in the U.S. Preliminary estimates of capital costs for pyrolysis facilities are approximately $150,000 per ton per day of capacity. Operating costs range from $35 to $45 per ton.

6. **Biogasification.** Of all the WTE technologies described herein, biogasification is the only one that requires no direct input of energy in the form of heat. Biogasification takes advantage of the natural process of anaerobic decomposition of organics and the subsequent flammable gases given off by this process. The process involves three major steps. First, MSW undergoes extensive pre-processing, which includes size reduction, classification into separate light and heavy fractions, and preparation of the light fraction into a well mixed "feed" slurry. Next, the feed slurry is placed into airtight anaerobic digesters where fermentation occurs over a 5 to 30 day period. During fermentation, microorganisms break down cellulose and other complex compounds to produce methane and carbon dioxide. Methane is recovered from the digester, and the residue is either incinerated for additional heat recovery, or is landfilled.

These digesters contain mechanisms that continuously stir the feed stock, allowing decomposition to occur over a relatively short period of time. The actual decomposition process is similar to that occurring in MSW landfills. Figure IV-14 shows a typical biogasification process system.

A facility based on biogasification can only utilize the organic fraction of the waste stream. In general, about 50 percent of the waste stream is organic matter. Approximately 50 percent of organic solid waste fed into the digester is converted to gas. The remainder requires further processing or disposal. Furthermore, the system requires large quantities of water for processing and generates large quantities of liquid and solid waste which must be further treated or disposed. This system also generates a filter cake with high heavy metal concentrations. Plant material, though organic in nature, is not readily biodegradable and thus not suitable for biogasification without pre-processing. On the other hand, sewage sludge is readily biodegradable.

A 100 TPD demonstration project in Pompano Beach, Florida, has operated successfully since 1978 and is the only large-scale system operating in this country. More research and development is needed before the biogasification process can be considered a reliable solid waste management alternative.

One major drawback to this process is that, although a usable gas is produced by the process, very little reduction in waste volume is accomplished so landfill savings are limited. Furthermore, gas production is reduced at temperatures below 50°F, thereby making it a less desirable technology in colder climates. Additionally, a by-
product of this process is a highly contaminated liquid fraction which requires wastewater treatment prior to reuse or disposal. Due to the limited experience with these systems, total solid waste management system cost estimates are not available with this technology.

7. Waste To Energy Considerations For Chemung County. A number of factors impact the feasibility of the CCSWMD implementing a WTE facility to handle the long term solid waste disposal needs of the county. These factors include evaluation of the waste stream including the effect on the solid waste characteristics after the county implements its MRF operation; environmental and siting concerns; potential long term energy users; and cost impacts based on the appropriate type of WTE technology.

a. Solid Waste Analysis

A recent siting controversy for the proposed Broome County WTE centered around the capacity needs of the facility. A key issue was the future quantity and combustibility characteristics of Broome County’s waste stream after recycling systems are fully operational in the service area. At issue is the fact that implementation of an aggressive recycling system can divert significant combustible quantities from the solid waste stream thereby impacting the heating content of the waste, the systems capacity, capital cost and potential revenues for a WTE facility.

A solid waste stream composition study was performed during the summers of 1989 and 1990 on incoming solid waste at the Chemung County both the landfill and the miloing station. The resulting report for 1989 is included as Appendix E. Examination of this 1989 report reveals that 39% of the total waste stream consisted of various paper materials. Organics comprise another 23% of the total waste stream while other burnables (i.e. plastics, etc.) total another 14%. Hence 76% of the residential and commercial solid waste stream is considered combustible. Burnables compose 78% of the residential and commercial waste stream by volume. When one considers the ash residue from incineration, it is estimated that approximately 70% of the current solid waste disposal volume in the landfill could be saved by implementing a WTE system. This landfill savings estimate is based on the assumption that the burnable solid waste volume would be reduced 90% by incineration.

Table IV-2 summarizes all solid waste available in Chemung County with potential fuel value for an RDF WTE plant, before the removal of any waste through recycling. The remaining available solid waste after recycling which could be used as fuel, is summarized in Table IV-3. In both cases, available
## Table IV-2
SUMMARY OF THE ENERGY VALUE OF CHEMUNG COUNTY'S SOLID WASTE STREAM WITH NO RECYCLING (TONS)

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| 50,920,890 |
| 50,920,890 |
| 50,920,890 |
| 50,920,890 |
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| 50,920,890 |
| 50,920,890 |
| 50,920,890 |
| 50,920,890 |
| | 50,920,890 |

**ESTIMATED KWH/TON***

| 3.37 | 3.39 | 3.42 | 3.45 | 3.41 | 3.17 | 3.03 | 2.88 | 2.93 | 2.95 | 3.08 | 3.3 |

**ESTIMATED CAPITAL INVESTMENT & $10,000/yr**

| $1,258,516 | $1,329,835 | $1,353,044 | $1,371,267 | $1,380,113 | $2,010,262 | $2,362,297 | $2,314,742 | $2,456,453 | $2,617,533 | $2,752,978 | $3,541,191 | $4,551 |

**ESTIMATED ANNUAL REVENUE FROM SALE OF ELECTRICITY**

| ($1,770,023) | ($1,785,037) | ($1,800,051) | ($1,815,066) | ($1,840,081) | ($1,865,106) | ($1,890,131) | ($1,915,156) | ($1,940,181) | ($1,965,206) | ($1,990,231) | ($2,015,256) | ($2,040,281) |

**ANNUAL OPERATING EXPENSES & $50/TON**

| $1,062,014 | $1,071,022 | $1,080,031 | $1,089,040 | $1,098,050 | $1,107,062 | $1,116,072 | $1,125,081 | $1,134,090 | $1,143,101 | $1,152,112 | $1,161,122 | $1,170,133 |

**ESTIMATED ANNUAL SALVAGE VALUE & DISCARD COSTS**


**ESTIMATED PRICE FOR SALE OF ELECTRICITY ($/KW-H)**

| 0.00430 | 0.00447 | 0.00511 | 0.00569 | 0.00647 | 0.00723 | 0.00800 | 0.00876 | 0.00953 | 0.01030 | 0.01107 | 0.01184 | 0.01262 |

**NET ANNUAL INCREMENTAL REVENUE**


**NET ANNUAL COMBINED REVENUE**

| $560,507 | $575,538 | $590,568 | $605,598 | $620,628 | $635,658 | $650,688 | $665,718 | $680,748 | $695,778 | $710,808 | $725,838 | $740,868 |

* VALUES TAKEN FROM 1990 SOLID WASTE COMPOSITION STUDY AND ADJUSTED FOR ESTIMATED POPULATION INCREASE.
** INITIAL POPULATION FIGURE TAKEN FROM 1990 CENSUS AND ESTIMATED ACCORDING TO THE ESTIMATED GROWTH RATE FOUND IN THE NOVEMBER 1990 COMPREHENSIVE RECYCLING ANALYSIS.
*** MINIMUM ESTIMATED VALUES TAKEN FROM NWSCS PUBLICATION "GURPINE TECHNOLOGY ASSESSMENT SOLID WASTE MANAGEMENT".

SOURCES: 2.
JUNE 1990, RE CAPS.
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</tr>
</tbody>
</table>

**Estimated Capital Investment**: $330,300

**Estimated Price for Sale**: $1,389,055

**Estimated Annual Revenue from Sale of Electricity**: $1,770,023

**Estimated Annual Operating Expenses @ $30 / TON**: $1,062,074

**Estimated Annual Dividend in Landfill Costs**: $560,007

**Net Annual Incremental Revenue**: $312,313

**Net Annual Cumulative Revenue**: $620,007

*Values taken from 1990 solid waste composition study and adjusted for estimated population increase.

**Initial population figure taken from 1990 census, and expanded according to the estimated growth rate found in the November 1989 comprehensive recycling analysis.

***Maximum estimated values taken from Wisconsin public health assessment of solid waste management, June 1990, p.1 chapter.

---

*From WDEP "SCHEDULE OF LONG RUN AVOIDED COSTS" for a PRIMARY PRODUCER, 1998.

***Assuming $2/TON landfill fee and 10% volume reduction from incineration.
solid waste has been expressed in terms of megawatt potential and daily
tonnage in order to compare the required facility sizes. Estimates of capital
and operating costs and revenues from sale of electricity and avoided
landfilling costs are also shown.

The basis for the impact on projected solid waste generation rate and
recyclables estimates is shown in Table IV-4. For analysis purposes, solid
waste with fuel potential has been separated into three general categories,
namely recyclables, semi-recyclables and non-recyclables. The recyclables
category lists components which, in addition to their value as a fuel, possess
qualities which render them likely to be removed from the solid waste stream
via the MRF. The semi-recyclables category is composed of the various organic
waste types, of which some are recyclable through a yard waste composting
system. Items with no current value as recyclables, but which have potential
value as fuel are listed under non-recyclables.

The as-received energy value of 3,173 kwh per ton of waste as calculated in
Table IV-5, represents the raw energy value of the solid waste stream before
boiler efficiency and internal use factors are subtracted. Because of the
potential for wide variations due to individual boiler designs, operating
efficiencies and variations within the solid waste stream, a conservative figure
of 500 kwh per ton of solid waste, taken from the DEC publication Generic
Technology Assessment Solid Waste Management, June 1990, was used.

The calculated energy value of 3,173 kwh per ton of solid waste compares
favorably with the 2,754.2 kwh per ton calculated by Energy Unlimited for the
Evaluation of Refuse Derived Fuel Utilization for the A & P Plant Boiler Facility
in Horseheads, New York, performed (under sub-contract to O'Brien & Gere
Engineers, Inc.) for the Chemung County Solid Waste Disposal District in
1977.

The energy potential analysis was performed for both cases, with and without
recycling, for a 20 year period. Any sizing of a WTE facility must consider both
the initial and projected solid waste volumes involved. Table IV-2 shows that if
a WTE plant were to be constructed with no recycling and operated for a 20
year period receiving all burnable solid waste available in service area, it
would have to be sized to accommodate the projected year 1993 design solid
waste volume. For this arrangement, a 3.45 megawatt generating plant would
be required. It is assumed that the required 10% reduction in solid waste by
the year 1997 would still apply.
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<tr>
<td><strong>POPULATION</strong></td>
<td>95,195</td>
<td>96,003</td>
<td>96,810</td>
<td>97,618</td>
<td>98,425</td>
<td>99,233</td>
<td>100,040</td>
<td>100,848</td>
<td>101,655</td>
<td>102,463</td>
<td>103,270</td>
<td>107,308</td>
<td>111,345</td>
</tr>
<tr>
<td><strong>TOTAL SOLID WASTE VOLUME</strong></td>
<td>121,027</td>
<td>122,054</td>
<td>123,080</td>
<td>124,107</td>
<td>125,128</td>
<td>119,749</td>
<td>117,571</td>
<td>115,392</td>
<td>116,316</td>
<td>117,240</td>
<td>118,164</td>
<td>122,794</td>
<td>127,404</td>
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<tr>
<td><strong>RECYCLABLES</strong></td>
<td>23,014</td>
<td>7,205</td>
<td>5,816</td>
<td>4,987</td>
<td>4,154</td>
<td>4,222</td>
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<td>4,324</td>
<td>4,358</td>
<td>4,529</td>
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<tr>
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<tr>
<td><strong>TEXTILES</strong></td>
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<td><strong>TIRES</strong></td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td><strong>TOTAL MRF RECYCLING</strong></td>
<td>0</td>
<td>14,574</td>
<td>28,029</td>
<td>29,756</td>
<td>30,002</td>
<td>30,248</td>
<td>30,494</td>
<td>30,741</td>
<td>30,987</td>
<td>31,233</td>
<td>31,479</td>
<td>32,710</td>
<td>33,940</td>
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<td><strong>TOTAL COMPOSTING &amp; C&amp;D</strong></td>
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<td>14,574</td>
<td>28,029</td>
<td>29,756</td>
<td>30,002</td>
<td>30,248</td>
<td>30,494</td>
<td>30,741</td>
<td>30,987</td>
<td>31,233</td>
<td>31,479</td>
<td>32,710</td>
<td>33,940</td>
</tr>
<tr>
<td><strong>TOTAL RECYCLING &amp; COMPOSTING</strong></td>
<td>0</td>
<td>14,574</td>
<td>28,029</td>
<td>29,756</td>
<td>30,002</td>
<td>30,248</td>
<td>30,494</td>
<td>30,741</td>
<td>30,987</td>
<td>31,233</td>
<td>31,479</td>
<td>32,710</td>
<td>33,940</td>
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<tr>
<td><strong>% OF TOTAL WASTE RECYCLED</strong></td>
<td>37.1%</td>
<td>49.0%</td>
<td>59.9%</td>
<td>61.1%</td>
<td>60.3%</td>
<td>59.4%</td>
<td>58.5%</td>
<td>57.4%</td>
<td>57.8%</td>
<td>57.8%</td>
<td>57.8%</td>
<td>57.8%</td>
<td>57.8%</td>
</tr>
</tbody>
</table>

* - INITIAL POPULATION Figure TAKEN FROM 1990 CENSUS, AND EXPANDED ACCORDING TO THE ESTIMATED GROWTH RATE FOUND IN THE NOVEMBER 1989 COMPREHENSIVE RECYCLING ANALYSIS.

** - EXISTING RECYCLING NOT ROUTED THROUGH MRF, ACCORDING TO 1990 SOLID WASTE COMPOSITION STUDY.

*** - INITIAL SOLID WASTE VOLUMES WERE TAKEN FROM THE 1990 CHEMUNG COUNTY SOLID WASTE COMPOSITION STUDY, AND EXPANDED ACCORDING TO THE ESTIMATED POPULATION GROWTH RATE AND PARTICIPATION FACTORS.
### TABLE IV-5
ANALYSIS OF BTU VALUE OF SOLID WASTE STREAM

<table>
<thead>
<tr>
<th>Recyclables</th>
<th>Annual BTU Value</th>
<th>BTU Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardboard &amp; Paper</td>
<td>23,614</td>
<td>7,990</td>
</tr>
<tr>
<td>Plastics</td>
<td>5,022</td>
<td>15,770</td>
</tr>
<tr>
<td>Semi-Recyclables</td>
<td></td>
<td>285,732</td>
</tr>
<tr>
<td>Food Wastes</td>
<td>7,380</td>
<td>7,300</td>
</tr>
<tr>
<td>Grass &amp; Leaves</td>
<td>20,340</td>
<td>8,600</td>
</tr>
<tr>
<td>Wood</td>
<td>296</td>
<td>8,400</td>
</tr>
<tr>
<td>Textiles</td>
<td>1,995</td>
<td>7,300</td>
</tr>
<tr>
<td>Tires</td>
<td>154</td>
<td>12,500</td>
</tr>
<tr>
<td>Total</td>
<td>59,001</td>
<td>638,702</td>
</tr>
</tbody>
</table>

| Avg. BTU/Ton               | 10,825,326       |
| Avg. KW-HR/Ton             | 3,173            |

{0.0002930711} KW-HR/ BTU
Table IV-3 shows the cost analysis for a WTE plant built and operated with a recycling program in place. The burnables separated out by the recycling program were removed from the waste stream prior to incineration and, thus, their BTU value is not taken into account. Furthermore, it is assumed that 100% of the wood, grass, and leaves will be recycled through composting. Other waste stream components are reduced by the recycled amounts cited in Table IV-4.

A WTE plant built to operate with the current recycling program would be only 30% as large as one built to operate without recycling. Based on this analysis, only a 1.02 megawatt WTE facility would be justified in conjunction with recycling in place in Chemung County. It is assumed that a WTE plant would not be sized simultaneously with the incorporation of a new recycling program. Hence, the initial three years of recycling, with their correspondingly low participation factors, should not be considered in this analysis.

Based on a review of the two theoretical waste streams shown in Tables IV-2 and IV-3, a graphical depiction of potential fuel removed through recycling is shown as Figure IV-15. As expected, the waste stream available without recycling increases slightly for three years until the volume reduction program for yard waste commences. The goal of 10% overall solid waste reduction by 1997 is indicated at the low point of this curve, where the annual potential fuel fraction of the waste stream totals approximately 50,000 tons. After this point, solid waste increases as a straight line in proportion to population. The waste stream available after recycling begins at the same 1990 value of 59,000 tons as in the previous curve, but drops off sharply as recycling begins. As the 80% participation factor is approached, the rate of decrease of available solid waste is reduced until 1997, when a minimum value of roughly 16,000 tons per year is reached. At that point, available solid waste increases in proportion to population.

b. Environmental And Siting Concerns

Similar potential environmental impacts are inherent to all major solid waste management facilities. Strict new regulatory requirements for the siting, design, and operation of these facilities, reduce the potential for such adverse impacts that have historically been associated with solid waste management facilities (litter, odors, groundwater contamination, gas migration, air pollution). WTE facilities, by their very nature, display greater negative environmental impacts in the areas of air quality and ash disposal than do other solid waste management facilities. The requirements contained in the 6
NYCRR Part 219 and Part 360 regulations assure that WTE emissions and ash residue will not pose an adverse threat to public health and the environment.

The most significant environmental concern for WTE facilities is air emissions. Specific parameters of greatest concern include particulate matter, acid gas (i.e. hydrochloric acid, sulfuric acid, sulfur dioxide and sulfur trioxide), inorganics (i.e. cadmium, chromium, lead, et al.), organics (i.e. polychlorinated dioxins, polychlorinated dibenzofurans, etc.), and nitrogen oxides.

To protect public health and the environment, New York State regulations impose stringent air emission limitations on new municipal solid waste incineration facilities. The NYSDEC designed the regulations with the intent that there should be no adverse environmental or health impacts associated with these facilities in accordance with the 6 NYCRR Part 219 and Part 360 regulations.

The Part 219 regulations set limits for particulate, acid gas and dioxin emissions. Nitrogen dioxide emissions must be controlled through best available control technology (BACT) in ozone attainment areas (areas that meet EPA ozone standards) or through lowest achievable emission rate (LAER) control in ozone non-attainment areas (areas that do not meet EPA ozone standards). These regulations also require thermal destruction of toxic organics and collection and removal of volatile contaminants. Furnaces must be designed to operate so that combustion gases reach 1800°F for at least one second. Facility design also must include auxiliary burners and must provide for a reduction in flue gas temperature to promote condensation of volatile contaminants.

The Part 219 regulations also require the monitoring of carbon dioxide and carbon monoxide in exhaust gases and establishes a combustion index to check on efficiency of combustion. A facility must demonstrate continuously that the 1800°F, one-second design requirement and flue gas temperature limits are being met. Finally, emissions testing is required from the stack. Reporting of results must be made to NYSDEC and the county health department. Continuous measurement of specific combustion gases and monitoring of operational parameters is also required.

In addition to the requirements of the Part 219 regulations, applicants for an air permit to operate a municipal solid waste incinerator will be required either under SEQR or under their permit application to include as part of the environmental impact statement, a health risk assessment. This quantitative
health risk assessment will provide the public with an up-front assessment of the health impacts from both regulated and unregulated air emissions from the proposed facility.

Another significant environmental concern from a WTE facility is management of the ash residue. Ash residue from a WTE facility consists of two different types: bottom ash and fly ash. Bottom ash, which comprises approximately 90% of the total ash, is the heavy residue remaining after combustion. Fly ash is a lighter, very fine residue that escapes the furnace with the exhaust gasses. Fly ash is removed from exhaust gasses by emission control equipment such as electrostatic precipitators. Both types of ash are usually combined for ease of disposal.

The major contaminants of concern in ash include metals and chlorinated organics. The metal contaminants observed in combined ash from a WTE facility are arsenic, barium, cadmium, chromium, lead, mercury, selenium and silver. Of these, lead and cadmium pose the greatest environmental concern. Major sources for lead and cadmium in solid waste are lead-acid and household batteries, consumer electronics and plastics. Chlorine atoms present in solid waste combine with carbon atoms and form chlorinated materials and polyaromatic hydrocarbons. The two major chlorinated organic contaminants of concern in the ash residue are chlorinated dibenzo-p-dioxins, and chlorinated dibenzofurans. Plastics and paper are common sources of chlorine in the municipal waste stream.

The NYSDEC takes the view that ash residue from municipal energy recovery facilities that burn household and non-hazardous industrial and commercial solid waste is exempt from regulation under the federal hazardous waste program (under Section 3001(i) of the Resource Conservation and Recovery Act). Nonetheless, the state’s Part 360 regulations essentially require a "cradle-to-grave" approach for ash residue management in WTE facilities. Ash residue from incinerators are required to be placed in lined landfills with leachate collection. This step-by-step management approach allows the state to monitor and control ash residues from its point of generation to the point of final disposal, thereby protecting human health and the environment from the potential dangers of mismanagement. This approach is formalized in a required ash residue management plan, which is prepared by the applicant and which will be an enforceable provision of the permit issued to operate the facility. The plan must describe the methods, equipment and structures that will be used to prevent the uncontrolled dispersion of ash residue. The plan must take into account potential pathways of human or environmental exposure including, but not limited to, inhalation, direct contact and
groundwater and surface water contamination. The management plan must also address the generation, handling, storage, transportation, treatment, disposal and/or beneficial use of ash residue. Since the CCSWMD already operates a Part 360 permitted, dual lined landfill with leachate collection facilities for disposal of its MSW waste, compliance with NYSDEC ash management regulations could be readily met.

Additional environmental impacts common to all solid waste management facilities, including WTE plants include potential surface and groundwater contamination, methane gas generation, adverse aesthetic/visual impacts, vector propagation, litter control, traffic disruption and noise generation. Relative to MSW landfills, WTE facilities do not pose significant management problems associated with protection of surface and ground water. Also due to the inherent stabilization of organic matter, WTE ash disposal pose few problems regarding methane gas generation and vector control. Litter control at a WTE facility will be similar to that being experienced at Chemung County’s milling station. Litter control at the landfill will obviously be facilitated if the district changed from a shredded MSW product to an incinerator ash. The other three environmental concerns, namely visual/aesthetic, traffic and noise are all potentially significant factors in the siting of a WTE facility in Chemung County.

In addition to the aforementioned environmental siting concerns, a number of other factors greatly influence siting of a WTE facility. These include traffic patterns for transporting solid waste to a WTE facility and the identification and location of an industrial user for most of the energy produced by a WTE facility. Another significant consideration relates to the location of the WTE facility and its potential for development as a regional facility serving the solid waste management needs of a multi-county area. A key assumption regarding the potential feasibility of implementing a WTE facility in Chemung County based on the fact that only a relatively small amount of solid waste is produced in the county (less than 300 TPD). At this scale, it would not be economical to produce energy to tie directly into the New York State Electric and Gas (NYSEG) electrical grid system. Rather, economics would dictate the need to find an industrial energy user which would thereby increase the efficiency and revenues of the overall WTE system.

c. Potential WTE Energy Users.

A waste-to-energy facility designed to exclusively burn the residual waste stream remaining after recycling in Chemung County would be inefficiently small for any proven WTE technology except the modular design. The 49 to
166 tons per day range presented in Tables IV-2 and IV-3 could better be utilized as either:

☑ Supplemental fuel for a co-fired furnace normally burning fossil fuel; or
☑ Fuel for a proprietary boiler located at an industrial site.

A third potential approach would be to investigate the feasibility of a much larger system serving a multi-county area such as Steuben County to the west, Schuyler County to the north and Tioga County to the east.

In 1974, O'Brien & Gere undertook a Resource Recovery Study for the Solid Waste District to determine the technical and economic feasibility of implementing an RDF system in Chemung County. As a result of this study, several potential users of the fuel supplement were identified, with NYSEG exhibiting the greatest potential.

The district had hoped to reach an agreement with NYSEG, who operates an existing coal-fired 87 megawatt electrical generation plant at the Hickling Station in nearby Steuben County just west of Big Flats. The district's interest was to retrofit the plant to burn coal together with an RDF supplement. However, NYSEG would not agree to this change for two reasons as stated below:

☑ The Hickling Station boilers, originally designed to burn anthracite coal, would require extensive modifications in order to burn RDF. NYSEG's policy with regard to the plant, was one of operational flexibility. Capital investment of the magnitude required to retrofit this plant, would limit NYSEG's ability to react to changing conditions within the economy.

☑ Co-firing RDF with coal would require that air emissions from the plant meet more stringent air quality standards. While NYSEG continually upgrades the facility to meet air emission requirements, they were not prepared to invest in the equipment required to meet the more stringent emission demands for RDF plants.

More recent discussions between Chemung County and NYSEG occurred in the mid-1980's regarding the abandonment of this facility as a coal fired generating station and replacement with a new mass burn facility to meet the
long term solid waste needs of a regional multi-county service area. The potential benefits of such a plan included:

★ Many of the siting issues raised by the siting of a new WTE facility would be somewhat modified since there already exists an energy production facility with existing truck traffic patterns for coal deliveries and ash disposal and a permitted air emission for the coal-fired station.

★ Due to its location directly off State Route 17 and mid-way between Elmira and Corning, the Hickling Station site is well suited as a potential regional WTE facility to serve not only Chemung County and southeastern Steuben County, but also Schuyler, Tioga and possibly even Tompkins Counties.

★ Although the existing coal fired furnaces would have to be replaced with modular mass burn units, capital cost savings would still result at this facility due to existing site development for truck traffic and electrical generating equipment including the electrical grid switch gear and transmission facilities.

As a supplemental fuel for the Hickling Station power plant, the fuel waste component of Chemung County's solid waste stream has limited value. Even with no recycling system in place, the fuel value of the waste stream could only provide roughly 4% of the fuel requirements of the plant. Given the large scale capital investment which would be required to retrofit Hickling Station coupled with the fact that two-thirds or more of the potential fuel will be removed form the waste stream through recycling, there appears to be no economical basis for pursuing the idea of co-firing solid waste with coal at the Hickling Station at this time.

Another potential WTE energy user that has been identified in the past is the Ann Page Division of the Great Atlantic and Pacific Tea Company (A & P) in Horseheads. When the A & P plant was built in the mid-1960’s, the 1.4 million square foot facility was the largest food manufacturing plant located under one roof in the country. Subsequent to O'Brien and Gere's resource recovery study, the Americology Division of the American Can Company conducted an independent market survey for the CCSWDD. This survey identified the A & P plant as a potential RDF user. Following preliminary discussions, A & P consented to cooperate in a detailed investigation of its facilities for adaptability to RDF utilization. A detailed on-site evaluation of the A & P
boilers and power plant was conducted for the district by Energy Unlimited, LTD under subcontract to O'Brien & Gere Engineers, Inc., in 1977.

The report concluded that there was sufficient RDF in Chemung County's waste stream to meet the heating requirements of the Horseheads A & P plant. The RDF would have been burned to produce steam used in their food processing operation. Implementation of an RDF system would require the construction of an RDF processing facility to separate the RDF from the waste stream, and modification or construction of some type of facility for burning the RDF. The 1977 O'Brien & Gere Report recommended construction of an RDF processing system at the CCSWDD's milling station as part of the overall WTE project. This system would incorporate an air classification system which would recover roughly 75% of the paper, organics, rags and wood from the waste stream, resulting in 50% to 75% of the milling station's solid waste stream being utilized as RDF. The system would also have recovered ferrous metals. The capital cost of this system in 1979 was estimated at $3,100,000, but was eligible for 50% New York State aid under the 1972 Environmental Quality Bond Act (EQBA). The CCSWDD was also eligible for an additional $370,000 in aid for modification of existing mill facilities, resulting in a total cost to the district of $1,180,000 for the proposed RDF recovery system. Operation and maintenance of the RDF processing system was anticipated to require an additional mechanic and two laborers be added to the mill facility staff. The total annual cost for the processing system including operation, maintenance and debt service, exclusive of the primary RDF burn facility, was estimated to be about $524,000 without state aid. With state funding, the annual cost of the recovery system was estimated at about $300,000.

In order to utilize this processed RDF in a WTE facility, the O'Brien & Gere Report listed alternatives based on input from the district, A&P personnel and conditions necessary to satisfy the requirements for resource recovery projects eligible for funding from the New York State Department of Environmental Conservation. Previous investigations performed as part of the Resource Recovery Study indicated that an RDF utilization project would require state aid in order to be economically viable in Chemung County. The greatest savings to the district and the RDF user would be realized under those alternatives receiving the greatest amount of state funds. Therefore, in order to maximize the amount of state aid and realize the greatest net savings from the overall RDF system, alternatives were developed with the CCSWDD assuming the greatest capital investments. Alternatives considered for additional investigation include the following:
Direct-firing the RDF into one of the existing boilers which would be retrofit to burn solids.

Utilizing a multiple hearth pyrolysis furnace located on A&P property to produce a combustible gas from the RDF, which in turn would be burned in an existing boiler modified to burn the pyrolysis gas.

Operation of a steam plant located off A&P property.

Utilization of a pyrolysis furnace located off A&P property.

Utilizing light and heavy fraction RDF in a pyrolysis furnace.

Co-burning of sewage sludge and RDF in a pyrolysis furnace.

Of the alternatives considered, the first two listed previously were found to be the most viable and were evaluated in detail. The other alternatives although technically feasible, were not evaluated in detail due primarily to system cost. Under the first alternative, direct firing of RDF into an existing A&P owned boiler, the district would haul processed RDF to a district owned and operated RDF receiving and storage facility, built on property leased from A&P. The district would sell RDF to A&P at a price competitive with oil. A&P would retrofit one of their existing boilers to utilize the RDF. A pneumatic conveyor would deliver the fuel directly from the storage facility to the boiler.

The estimated cost to the district for the receiving/storage area was $660,000 in 1979. This figure could be reduced by 50% to $330,000 if the maximum allowable state aid were available. Annual operation, maintenance and debt service costs were estimated at $148,000 per year, reduced to $87,000 per year after state aid. Capital costs incurred by A&P for boiler retrofit would total $1,060,000, with $300,000 annual operation, maintenance and debt service costs, in 1979.

If the second alternative had been adopted, the construction of a new multiple hearth pyrolysis furnace by the district along with receiving and storage facilities for the RDF, the brunt of the initial capital costs would be carried by the district. A&P would be responsible for modifying their existing boiler to
burn the combustible off-gas produced by the pyrolysis furnace. Again, the facility would have been built on land leased from A&P, but instead of selling the RDF to A&P, the product sold would have been the off gas.

Costs for the receiving and storage area would be the same as for the first alternative, but an additional capital investment of $1,320,000 would be required for the actual boiler facility, which would be reduced to $660,000 if state aid were made available. Annual costs for debt service, operation and maintenance would be $304,000, reduced to $227,000 with state aid.

Under the second alternative, A&P would incur a capital cost of only $264,000, roughly 25% of the estimated capital costs for alternative 1. The boiler modifications would have much less involved and therefore, less costly. No additional operation and maintenance costs were estimated, but debt service was calculated at $48,000 per year. Combined calculated costs for implementation of both RDF systems are represented in Tables VI-6 and IV-7. Costs and benefits are summarized in Table IV-8. Further progress toward development of an RDF with A&P was suspended with the closing of the plant. As of 1991, the A&P plant in Horseheads, New York remains unused.

Given the solid waste management system currently in place in Chemung County, including the new $4.5 million MRF and 25+ years site life permitted landfill, a WTE facility of any type does not appear to be cost-effective. The WTE concept, however, still remains a viable long-term alternative that may be feasible to implement some 10 to 20 years in the future. If, in the future, new facilities for electricity generation are implemented in the region, a WTE plant may be incorporated into the design. Currently, a new natural gas fired electrical and steam generating plant is planned for South Corning in Steuben County. No WTE capabilities are planned for this new facility.

With the commencement of the new recycling program in Chemung County, and the inevitable compliance of adjoining counties with the new state waste reduction/recycling goals, solid waste volumes will be difficult to predict and document for the next few years. Therefore, it is recommended that the CCSWMD conduct an update WTE feasibility study in five years, at which time more factual data will be available on:
TABLE IV - 6  
EVALUATION OF ANN PAGE BOILER FACILITY  
ALTERNATIVE 1

CCSWDD - Processes waste and hauls RDF to A&P, builds and operates pyrolysis furnace, RDF receiving and storage facilities on A&P site and sells off gas to A&P.

A&P - Retro-fits existing boiler to burn pyrolysis gas.

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<th>W/Aid</th>
<th>A&amp;P</th>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recovery System</td>
<td>$3,100,000</td>
<td>$1,180,000*</td>
<td></td>
</tr>
<tr>
<td>Pyrolysis Furnace</td>
<td>1,320,000</td>
<td>660,000</td>
<td></td>
</tr>
<tr>
<td>Receiving &amp; Storage Facilities</td>
<td>660,000</td>
<td>330,000</td>
<td></td>
</tr>
<tr>
<td>Boiler Retro-Fit</td>
<td>-</td>
<td>-</td>
<td>$264,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$5,080,000</td>
<td>$2,170,000</td>
<td>$264,000</td>
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</tbody>
</table>

| **Annual Costs:**    |         |       |     |
| Debt Service         |         |       |     |
| Recovery System      | $362,000 | $138,000 |     |
| Pyrolysis Furnace    | 154,000  | 77,000 |     |
| Receiving & Storage Facilities | 122,000 | 61,000 |     |
| Boiler Retro-Fit     | -       | -     | $48,000** |
| **Sub-total**        | $638,000 | $279,000 | $48,000 |
| Operation and Maintenance |         |       |     |
| Recovery System      | $162,000 | $162,000 |     |
| Pyrolysis Furnace    | 150,000  | 150,000 |     |
| Receiving & Storage Facilities | 26,000  | 26,000 |     |
| Boiler Retro-Fit     | -       | -     | -   |
| **Sub-total**        | $338,000 | $338,000 | - |
| **Total Annual Cost**| $976,000 | $614,000 | $48,000 |

* Assumes 50% aid for CCSWDD facilities plus an additional $370,000 in aid for the existing primary shredding facility.

** Assumes 18% fixed cost for amortization, interest, insurance and taxes.
TABLE IV - 7
EVALUATION OF ANN PAGE BOILER FACILITY
ALTERNATIVE 2

CCSWDD - Processes waste and hauls RDF to A&P, builds and operates unloading facilities and sells RDF to A&P.

A&P - Retro-fits existing Riley boiler for direct firing of RDF and operates boiler facility.

<table>
<thead>
<tr>
<th></th>
<th>W/O Aid</th>
<th>CCSWDD W/Aid</th>
<th>A&amp;P</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Capital Costs:</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Recovery System</td>
<td>$3,100,000</td>
<td>$1,180,000*</td>
<td></td>
</tr>
<tr>
<td>Receiving &amp; Storage Facilities</td>
<td>660,000</td>
<td>330,000</td>
<td></td>
</tr>
<tr>
<td>Boiler Retro-Fit</td>
<td></td>
<td>$1,060,000</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$3,760,000</td>
<td>$1,510,000</td>
<td>$1,060,000</td>
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</table>

| **Annual Costs:**   |         |               |      |
| Debt Service        |         |               |      |
| Recovery System     | $362,000 | $138,000      |      |
| Receiving & Storage Facilities | 122,000 | 61,000        |      |
| Boiler Retro-Fit    |         |               |      |
| **Sub-total**       | $484,000 | $199,000      | $190,000** |

| Operation and Maintenance |         |               |      |
| Recovery System           | $162,000 | $162,000      |      |
| Receiving & Storage Facilities | 26,000 | 26,000        |      |
| Boiler Retro-Fit           | 30,000   | 30,000        | $110,000 |
| **Sub-total**              | $218,000 | $218,000      | $110,000 |
| **Total Annual Cost**      | $702,000 | $417,000      | $300,000 |

* Assumes 50% aid for CCSWDD facilities plus an additional $370,000 in aid for the existing primary shredding facility.

** Assumes 18% fixed cost for amortization, interest, insurance and taxes.
| Table IV - 8  
EVALUATION OF ANN PAGE BOILER FACILITY  
ECONOMIC COMPARISON OF RDF ALTERNATIVES |
<table>
<thead>
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<tr>
<td><strong>Alternative 1</strong></td>
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<tr>
<td>W/O Aid</td>
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<tr>
<td>------------------</td>
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<tr>
<td><strong>Annual Reduction in Oil Costs to A&amp;P</strong></td>
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<tr>
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<tr>
<td><strong>Annual Reduction in Landfill Haul Costs to CCSWDD</strong></td>
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<tr>
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<tr>
<td><strong>Total Credits</strong></td>
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<tr>
<td>$974,000</td>
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<tr>
<td><strong>Annual Cost for A&amp;P to Burn RDF</strong></td>
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<td>$48,000</td>
</tr>
<tr>
<td><strong>Annual Cost for CCSWDD to Produce RDF</strong></td>
</tr>
<tr>
<td>976,000</td>
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<tr>
<td><strong>Total Cost</strong></td>
</tr>
<tr>
<td>$1,024,000</td>
</tr>
<tr>
<td><strong>Net Annual Savings Realized Through Joint Participation in RDF Utilization Project</strong></td>
</tr>
<tr>
<td>$312,000</td>
</tr>
</tbody>
</table>

* Based on anticipated oil price of $.44 per gallon in 1979

** Less cost of primary milling facilities
Impact of recycling or burnable waste residuals.

Long-term plans for Hickling Station by NYSEG.

Status of long-term plans/reutilization of A&P Plant.

Long-term needs of surrounding counties relative to potential implementation of a WTE facility.

A more detailed evaluation of the impacts of recent environmental (stack emissions) and cost concerns for WTE.

E. Landfill/Disposal

Landfilling is a solid waste disposal process in which the waste is spread and compacted in layers at a specially designed and prepared site, and covered with earth. The 6 NYCRR Part 360 regulations specify siting, planning and design, construction, operation, closure and post-closure requirements for MSW landfills, C & D landfills, industrial waste landfills, and WTE ash landfills.

Under current Part 360 regulations, there are exemptions for two types of landfills if no tipping fees are collected at these facilities presented below:

☐ A disposal site for "clean" fill consisting solely of asphalt, brick, concrete, soil and/or stone.

☐ A yard waste disposal site operated by a municipality for leaves, trees and stumps, and brush.

1. Description Of Technology. Environmental concerns relative to groundwater or surface water contamination, propagation of vectors, generation of uncontrolled explosive gases, aesthetic, and nuisance conditions such as blowing papers and odors have required that modern day sanitary landfills be properly sited and designed to mitigate the aforementioned environmental concerns. The major technological features of a properly designed and managed landfill include:
Siting in a hydrogeological setting conducive to landfilling (i.e. adequate depth to groundwater, relatively impermeable subsoils with slow groundwater flow patterns which will not affect an existing water supply aquifer as an aquifer that could be used as a potential future water supply source).

Construction of a dual composite liner system (see Figure IV - 16) with each composite liner system consisting of a combination of an impermeable soil liner directly beneath a geomembrane liner.

Construction of a leachate collection and removal system above the primary liner and a secondary leachate collection and removal system above the secondary composite liner to act as a leak detection system.

Construction of a final cover system (see Figure IV - 17) which is designed to properly vent landfill gas while minimizing the potential infiltration of precipitation into the solid waste, thereby contributing to the control of leachate generation.

Construction of a groundwater monitoring system around the perimeter of the landfill to allow comparison of upstream background groundwater quality with downstream monitoring wells to ensure no contaminated plume of leachate is escaping from the landfill.

Implementation of management controls to monitor incoming waste loads to ensure no hazardous or unpermitted industrial wastes are being accepted at the landfill.

Implementation of operational controls for proper drainage management and timely placement of daily, intermediate and final cover systems.

In addition to the aforementioned landfill design and management techniques, a properly designed landfill must also have a post-closure plan which specifies procedures which will be implemented to ensure no environmental degradation occurs after the landfill facility has been closed. This post-closure plan should identify a long-term groundwater monitoring well network, a landfill gas monitoring plan and a post-closure operation and maintenance plan to include:
FIGURE IV-16
DOUBLE COMPOSITE LINER SYSTEM
N.T.S.

SOURCE: NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
DIVISION OF SOLID WASTE
VEGETATION

6" TOP SOIL

MINIMUM 24" BARRIER PROTECTION LAYER

GEOMEMBRANE OR 18" SOIL BARRIER

FILTER FABRIC

GEOTEXTILE OR 12" SOIL GAS VENTING LAYER

CRUSHED STONE OR OTHER POROUS MATERIAL

GAS VENT RISER MINIMUM 1/ACRE

4% MINIMUM SLOPE

33% MAXIMUM SLOPE

SOURCE: NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
DIVISION OF SOLID WASTE

FIGURE IV-17
FINAL COVER
N.T.S.

FAGAN ENGINEERS
Environmental Consultants
Management and disposal of landfill leachate.

- Upkeep/maintenance of the final cover system including all drainage facilities, sediment traps and siltation ponds etc.

- Repair/replacement as needed of any final cover vegetation and/or cover system, leachate collection, drainage facilities, etc.

2. Alternatives To Conventional Landfill Technology. Potential alternatives to the landfill technology can generally be grouped into two categories. The first category involves processing the MSW in some form so that the residual waste will be more amenable to landfiling and hence may not require as strict controls or management when compared to disposal of MSW. The second group is a relatively recent technological innovation in which old landfills are mined to reprocess old abandoned "recyclable" components thereby creating potential landfill space for new or expanded MSW landfill operations.

One obvious alternative to a conventional landfill system is the Chemung County landfill operation itself. As previously mentioned, this facility has operated as a shredded waste landfill since its inception in 1973. A shredding or milling processing step occurs at the milling station off Lake Street. This shredding step results in a nominal four-inch size material which is much more conducive to landfiling. Since large bulky items are not normally encountered (one day each week, bulky items such as furniture, mattresses, etc. are bypassed around the shredder for transfer to the landfill), large landfill compaction equipment is not necessary. This greatly reduces the wear and tear on the landfill compaction equipment. Furthermore, in the process of shredding, the more putrescible garbage is more thoroughly mixed with the rest of the solid waste. The resultant shredded waste mixture does not attract or sustain rats and other vectors feeding off this waste. Although past studies have shown that daily cover operations could be reduced for shredded waste landfills, the CCSWMD maintains a vigilant daily cover operation to ensure that potential vector and odor problems do not arise at the landfill.

Another example of processing MSW prior to landfiling would be an MSW compost operation designed primarily for volume reduction as opposed to marketing a compost product per se. Landfiling an MSW compost that is contaminated with metals, plastic and other potential non-compostable materials will not require strict landfill controls as does conventional landfiling of MSW. This is due to the fact that the majority of the organics in an MSW compost will be stabilized through the aerobic decomposition of the waste. Hence, traditional daily cover requirements associated with the control of vectors and blowing papers, etc. would not be applicable with this
soil-like compost end product. If there is an adequate market for a compost end product, then post-processing of this waste via screening, shredding, magnetic separation, etc. would further reduce the volume of residual waste requiring final disposal via landfilling.

Landfill mining has been utilized on a few projects in the U.S. most notably in Florida. The concept is somewhat similar to an MSW compost operation except that instead of controlling the aerobic decomposition of MSW, one takes advantage of the natural decomposition process which occurs in old landfills. Excavation of an old "stabilized" waste landfill will allow the waste to be processed in order to remove potential non-compostable recyclables such as ferrous materials, plastics, glass, etc. If suitable, the stabilized organic material can be further processed as necessary to market the material as a compost product. Upon completion of the landfill mining, the old landfill site can be prepared, if site conditions are suitable, for a new landfill operation with modern liner and leachate removal facilities.

In theory, this alternative landfill technique has a number of positive environmental features. First, it involves the recycling of past discarded wastes. Second, the mining operation removes a potential environmental hazard as most of these old landfills have no liner and leachate collection system. Third, the re-establishment of a properly designed landfill not only provides a sound environmental method for future solid waste disposal, but it also minimizes landfill siting problems since the site's previous land use was a landfill.

It should be noted that most of the landfill mining operations have occurred in the southeastern United States where precipitation and temperature are fairly high compared to the northeast. Such conditions are more conducive to rapid decomposition of the organic fraction of the solid waste. However, experience at the Area 5 of the Chemung County landfill indicates a potential very slow decomposition process takes place especially if the final cover system is placed shortly after reaching design grades. Hence, any type of landfill mining of partially decomposed solid waste is not considered desirable from an environmental and employee safety viewpoint. Furthermore, the cost of such an operation would be prohibitive given the existing permitted capacity at the Chemung County landfill as presented below.

3. **Future Plans For The Chemung County Landfill.** As previously discussed, the CCSWMD has operated an MSW landfill in Lowman, New York which is located in the Town of Chemung, some eight miles southeast of downtown Elmira, since 1973. In 1987, the district completed landfill expansion plans for a 28-acre four cell expansion which is located approximately one-half mile north of State Route 17 and the nearby Chemung River.
As part of this expansion, detailed hydrogeologic investigations were conducted at the landfill to ensure that the proposed expansion site was not located over the Chemung River Valley aquifer. In order to provide adequate environmental protection, the NYSDEC construction permit called for the installation of a dual liner system consisting of a 24-inch impermeable soil liner and a 60-mil thick HDPE geomembrane liner. It should be noted that these liner requirements preceded the December, 1988 Part 360 regulations and hence they are not composite liners consisting of both a soil and geomembrane liner.

The liner system for the first two cells, each approximately six acres in area, have been completed with landfill operations currently taking place in Cell II. Construction of the third cell, which is upstream of Cells I and II, is scheduled to commence in 1991 and be completed by the end of the construction season in 1992. The fourth cell, which is not scheduled to be completed until later this decade, is not tributary to the first three cells. As such, construction of this cell will require a dual composite liner system be installed in accordance with the Part 360 regulations.

Based on the filling rate in the first two cells, it is estimated that the remaining life of the four cell landfill is 15 years. However, with the implementation of the MRF operation this year, it is estimated that recycling will increase the landfill site life to 25 years.

No major plans or changes to the permitted landfill expansion site is envisioned in the near future. However, as the landfill operation continues to fill above ground, blowing papers, caused by the predominant westerly winds, will continue to cause policing problems along the easterly border of the landfill. Currently, a farm operation is adjacent to the landfill on the east. During the 1985 siting study, this farm was one of the preferred sites for expanding landfill operations. However, the farm is in an agricultural district and the owner was not interested in selling his farm to the CCSWMD. The district, not wishing to exercise eminent domain proceedings, did not pursue purchase of this property. However, if it becomes available for purchase in the future, it is recommended that the district purchase this property to act as a buffer to its current operation. This land could also be utilized as a source of future cover material, and as a long-term consideration, it may be suitable for use as a future landfill expansion or compost site to meet Chemung County’s solid waste disposal needs well into the 21st century.

Recently, the CCSWMD has submitted first phase remediation plans for Area 3 of the landfill. This remediation involves the construction of a perimeter leachate collection system around the old landfill for drainage to a leachate pump station. The perimeter collection system is designed to intercept side slope leachate breakouts from this old fill area which currently drains to the existing siltation pond to the east. From the
pump station, leachate will be conveyed via a three-inch and six-inch dual containment force main to the existing leachate storage pond for eventual truck transfer to the Milton Street sewage treatment plant. Bids have recently been opened by the CC SWMD for this first phase remediation project. Upon review and approval by NYSDEC, this remediation work should commence during the Spring of 1991.

The proposed second phase of Area 3 remediation involves the upgrading of side slopes by construction of a new soil cap final cover system in accordance with NYSDEC Part 360 regulations. In order to restrict future leachate breakouts, a 60-mil VLDPE geomembrane liner would be constructed on the 12-acre plateau area on the top of Area 3. A leachate collection system would then be installed on top of the liner to also drain to the aforementioned leachate pump station. In order to provide a better draining top, as part of a final closure plan, the lined plateau portion of Area 3 would then be filled with C & D material before installation of a new final cover system. This third phase of the remediation/final closure plan is designed to provide a 10 - 15 year C & D landfill operation while ultimately minimizing long-term leachate generation potential from this site. Current plans of the CC SWMD call for the submission of a C & D landfill permit application package to NYSDEC this spring as part of the overall Area 3 remediation.

In conjunction with the aforementioned Area 3 remediation, the CC SWMD also needs to curtail operations at the existing C & D fill area located east of Area 3 and north of the existing siltation pond (see Figure III - 9). The capacity of this site will be exhausted by the end of 1991 at which time new C & D fill should be ready for operation on top of Area 3. Currently the CC SWMD is coordinating with NYSDEC Region 8 officials in Avon on a consent order regarding a compliance schedule for Area 3 remediation and final closure of the existing C & D site. Due to the amount of work necessary to prepare Area 3 for remediation in 1991, the final closure of the C & D site is not envisioned to begin until 1992.

Finally, as previously discussed in other sections of this report, new recycling and processing operations may also be implemented at the CC SWMD landfill site. Upon approval of a long-term C & D landfill permit by NYSDEC on top of Area 3, the district will evaluate in detail the implementation of a wood waste recycling system for C & D wastes. Also dependent on the results of the Newtown Creek floodplain remapping study, the CC SWMD may need to site a yard waste composting operation at the landfill complex. These evaluations will likely take place in 1991 for implementation by 1992.