Environmental Policy at Healy Pharmaceuticals

Brewer's Dilemma

Exhausted, Jeremy Brewer leaned against the ceiling support column in the company-provided changing room. Around him, regular members of the night shift crews were showering and changing into their street clothes. The laundry bin was overflowing with another day's worth of uniforms: white for production workers, gray-green for maintenance and support personnel. The uniforms each had a label with the employee's name, department number, and locker location. Many had stains in a variety of sizes and colors.

Brewer had just completed the third night of his incineration orientation. As part of a corporate task force investigating waste management at Healy Pharmaceuticals, Brewer had decided to acquire first-hand knowledge of the company's waste handling operations. His most recent stint, with the hazardous liquid incineration department at the Timpe production site, certainly gave him plenty to think about. Three nights of monitoring incinerator control boards, picking up melons and tankers, and trying to sort out the complicated regulatory procedures associated with hazardous waste were more than enough.

It seemed obvious, at least to Brewer, that there was plenty of excess capacity in the Timpe incineration operation. During his three-night shift, only one of the two incinerators was in use, and the nightly inspection of the hazardous liquid waste storage tanks involved less than half of the available tanks. "If the incineration operations at our other sites, especially the Clifton site, are anything like this, then my model could save the company a lot of money," Brewer thought to himself.

He knew better than to voice his opinion out loud, at least in the locker room surrounded by hourly personnel. Healy's personnel-centered culture made it difficult to sell proposals on their financial merits alone. His boss's comment at the end of the last task force meeting also made Brewer wary of pushing his results too hard. He could still imagine how stupid he must have looked, jaw slack, blank stare on his face, as he tried to come up with an answer to the question, "How do you know the model works?" If his own manager was skeptical about the linear program's ability to provide an optimal solution, he could only imagine how the corporate executives would react.

Healy Pharmaceuticals and the Pharmaceutical Industry

The pharmaceutical industry can be partitioned roughly into three components: research-based pharmaceutical firms that conduct extensive research and new drug development; generic pharmaceutical manufacturers that make large quantities of prescription medications that no longer have patent protection; and consumer product manufacturers that make all types of over-the-counter drugs that do not require a prescription. The importance of effective and efficient manufacturing operations varies according to the type of firm.

Healy Pharmaceuticals is a well-established research-based pharmaceutical company that competes on the basis of innovative drugs it discovers and develops through its research division. Throughout most of the twentieth century, Healy's product portfolio enabled its detailers[1] to successfully hard-sell the company's products to physicians. The pseudo-monopoly created by patent protection and the specific application of each particular drug resulted in low price elasticity for most pharmaceutical products. Up until the mid-1980s, Healy routinely raised prices to cover increased costs of research, development, and manufacturing.

The nature of competition in the pharmaceutical industry began to change in the late 1980s and early 1990s, however, as Health Maintenance Organizations (HMOs) and citizens' action groups such as the American Association for Retired Persons demanded cost containment in all facets of health care provision. Because many senior citizens paid for pharmaceuticals directly from their own pockets (as opposed to having the drug costs covered by insurance), political attention often focused on pharmaceutical price increases. By 1993, most drug companies pledged to limit price increases, on average, to no more than one or two percentage points above the CPI. Healy is included in this group.

HMOs brought additional price pressure to bear by creating restricted formularies, lists of approved drugs that their doctors could prescribe (Preferred Provider Organizations (PPOs) also use a formulary approach). Formulary managers considered not only a drug's therapeutic efficacy (the primary concern to the physician making the prescription decision) but also the cost of the drug and the willingness of the pharmaceutical firm to negotiate attractive supply arrangements. Since not being on a formulary meant no sales, most drug companies decided that negotiating with formularies was a good business decision. Healy was late in making this decision, and in fact was the lowest-rated drug company for service to HMOs. Recent efforts, however, have significantly improved Healy's relationships with managed care organizations. Although margins on individual products are lower, the company has maintained or increased its volume of sales to these organizations.

Healy's Organization and Culture

Figure 1 depicts Healy's organizational structure. The company markets four types of products: human health pharmaceuticals, animal health care products, plant care products (herbicides and fungicides), and medical and diagnostic devices. The first segment, human health pharmaceuticals, provides over 60% of Healy's sales and 80% of Healy's profits. Healy focuses its research and development on a limited number of therapeutic classes and organizes sales and marketing efforts around these therapeutic classes as "business units" (see Figure 1).

Figure 2 provides more detail regarding Healy's manufacturing organization, which reports through the North American Operations division. The manufacturing organization

[1] A "detailer," in the pharmaceutical industry, is a sales representative who makes direct calls on the drug prescriber and "details" the benefits of his or her company's products. Until recently, hospital and private practice physicians were the detailers' targets (as opposed to those who actually purchase the drug, the patients).

consists of line operations, divided into bulk pharmaceutical production and fill-finish operations, and staff functions such as environmental services and supply chain management. Food and Drug Administration requirements mandate that the manufacturing and quality control organizations *not* report through the same management chain, so the quality control personnel serving manufacturing sites have solid line relationships to the corporate office. The other regulatory compliance staff in the manufacturing organization (e.g., environmental and health and safety) has a dotted line reporting relationship with the corporate regulatory affairs office. Healy has also chosen to keep the technical services (engineering and scientific support for manufacturing) organization on a solid-line relationship with the research division and a dotted-line relationship with manufacturing.

Pharmaceutical production typically involves production of the active drug substance in "bulk" quantities of powders or liquids followed by the transformation of the bulk substance into appropriate dosage forms (pills, capsules, vials for injection, etc.). Bulk production might require several steps, each involving a chemical synthesis and purification of the resulting compound. These steps could take place all in the same equipment, in different equipment within the same building, in different buildings at the same site, or even at completely different sites. The choice of equipment depended on the required capabilities, the volume of product desired, equipment availability, cross-contamination concerns, and tax considerations. Bulk production operations generated significant amounts of waste, particularly contaminated organic solvents[2] that were used to hold the drug substances in solution during synthesis.

Healy has a very paternalistic culture, manifest in white shirts and dark suits at corporate headquarters, the plethora of formal procedures for all corporate affairs, and its attitude toward its employees, particularly the hourly workforce. Healy is most proud is its long-standing policy of not laying off employees during economic downturns. The founder's grandson, who was Chairman during the Great Depression, had employees repaint factory equipment and buildings rather than lay them off. This policy meant that Healy retained employees whose jobs were eliminated by technology or exogenous economic factors until they were able to find a new permanent position within the company.[3] Not replacing employees who left or retired was the only effective way Healy management had to reduce employment levels.

The Bulk Manufacturing Sites

Healy's production operations are located at three major sites in the continental United States. The Inty site is a sprawling complex which houses pilot plant facilities, bulk and

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[2] An "organic" solvent is a liquid substance based on atoms of carbon in which other organic molecules dissolve. Examples are alcohols (ethanol, for example) and ketones (such as acetone). One very effective solvent (in that many complex organic molecules dissolve in it) is methylene chloride. The EPA lists methylene chloride as a hazardous substance and carcinogen given long-term chronic exposure (www.osha.gov/Publications/Osha3144.pdf). Many Healy processes use methylene chloride as their primary solvent. An "aqueous" solution is one in which water is the primary solvent.

[3] At the time of this case, each bulk manufacturing site had a "surplus" pool of from 10 to 30 hourly employees. Before it could hire a new person, a site had to clearly demonstrate that no member of the surplus pool could adequately perform the job in question. On a day-to-day basis, members of the surplus pool filled in for vacationing employees and completed low-priority (and often low-skill) projects around the site.

fill-finish production, and all corporate offices. Bulk production volumes at the Inty site are relatively small because of the developmental nature of much of the work done there. Timpe, an hour's drive from Inty, is the company's primary development and small-scale production site. The first buildings at the site were built before World War II, and the site is proud of its reputation as stubborn and slow to change. Timpe's total annual budget (excluding costs for research and development activities) was approximately $175 million. The Clifton site (annual budget approximately $225 million), an hour and a half from Inty in a different direction, is only 25 years old and is the corporate showcase. Clifton houses large-scale production for human and animal health products, and is typically the initial pilot site for programs such as total quality management. Timpe and Clifton were loath to follow the advice or learn from the experience of each other.

Healy also operates production facilities in Puerto Rico, as do most pharmaceutical firms because of the favorable tax treatment of contribution that such operations generate.[4] Mayo and Caro are Healy's two production sites in Puerto Rico; neither is as large or complex as the domestic sites. Technical resources from Timpe and Clifton often travel to Puerto Rico site to provide support.

Bulk Site Performance Measurement

The Vice President of Manufacturing evaluates the bulk manufacturing sites on several financial and nonfinancial measures. Each site has a target level of "absorption," or the amount of its expenses that the accounting system assigns to product inventory. The higher the volume of activity at the site, the better off it will be in terms of its corporate scorecard.

Each site uses a normal costing system. In such a system, actual expenditures for direct materials and direct labor are assigned to each unit of a particular product. Each unit also "absorbs" a predetermined amount of indirect costs, or overhead.[5] The predetermined amount is calculated by dividing the total budgeted overhead expense for a particular activity (such as liquid hazardous waste incineration) by the *practical capacity* of the operation. Practical capacity is defined as the maximum amount of material that could be processed or produced given normal production rates and reasonable expectations of uptime.[6] The predetermined rate for incineration of one gallon of primary waste, for example, might be $10/gallon.[7] If a batch of Product X produces 1000 kg of Product X and 10,000 gallons of primary waste, the incineration cost that a kilogram of Product X

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[4] Recent changes to the tax code eliminated the tax benefits of locating in Puerto Rico.

[5] Any costs associated with manufacturing that are not classified as direct materials or direct labor are manufacturing overhead costs. Examples include process technicians, production supervisors, depreciation on equipment, indirect materials such as oil, cleaning rags, and office supplies, and environmental compliance costs (including waste treatment).

[6] *Ideal* capacity is the maximum amount that could be processed or produced assuming 100% uptime and maximum operating rates. Practical capacity accounts for planned downtime (e.g., preventive maintenance) and breaks for operators, among other things.

[7] This number is for the example only, and is not intended to reflect the actual overhead rate for incineration at any of Healy's bulk sites.

absorbs would be [10,000 gallon * $10/gallon] / 1,000 kg = $100 of incineration costs per kg of Product X.

Healy's cost system, therefore, assigns overhead costs to inventory only when batches of product are produced. If the budgeted demand for the services of a given operation is less than its practical capacity, the annual budget reflects the costs that are not expected to be absorbed in a line item called "Idle Plant." A site's "Idle Plant" expense each month included the expenses charged to income each period that could not be deferred in inventory because of the activity level. Plant managers were responsible for reducing expected idle plant costs each year and for managing the budgeted idle plant costs (as well as the budgeted "absorbed" costs) within each year.

The Environmental Regulatory Climate

The 1980s and 1990s saw an exponential increase in the amount and complexity of environmental regulations, and consequently, in the costs required for compliance. The 1970 Clean Air act specified the maximum amounts of materials that could be vented to the atmosphere, while the 1977 Clean Water Act specified the allowable levels of contaminants in a plant's wastewater discharge to sewers or waterways. Two other acts, the 1976 Resource Conservation and Recovery Act (RCRA)[8] and the 1980 Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, or "Superfund") mandated the treatment and disposal procedures for liquid and solid wastes that contain "hazardous" compounds (those on a specific list or that meet certain criteria). CERCLA was further defined in 1986 with the Superfund Amendments and Reauthorization Act (SARA).[9] See Figure 3 for a summary of these major environmental statutes.

In addition, the Superfund act instituted a regime of *joint and several liability* for producers and disposers of hazardous waste. Under a joint and several liability regime, should some sort of remediation be required due to improper handling of hazardous waste, any single contributor to the contaminated site could be held financially liable for *all* cleanup costs, regardless of the contributor's culpability in the contamination event or the contributor's portion of the waste processed at the contaminated site. Healy, as well as most major pharmaceutical firms, has been named a "Principally Responsible Party" for at least one Superfund site and is therefore at risk for a joint and severally liable ruling.

In order to comply with the increasingly complex web of environmental regulations, Healy maintains corporate and site staffs of environmental regulatory experts, environmental engineers, and disposal technology experts. The resources work in concert with scientists developing new products and manufacturing departments producing current products to keep Healy in compliance with all applicable regulations. The primary waste disposal technologies are wastewater treatment, fume capture and incineration, liquid and solid

[8] Each Healy site operated under its own RCRA permit. These permits, renewed every ten years, specified the operations to be conducted at the site, the types of environmental programs and treatment facilities at the site, and the sources of all types of waste streams.

[9] http://www.epa.gov/superfund/index.htm

waste incineration, and landfill. Healy has invested in capital equipment for all of these technologies, with the exception of landfill. The increasing expenditures in the late 1980s on end-of-pipe treatment equipment led Healy management to investigate ways to reduce capital investment and annual operating costs associated with environmental compliance.[10]

The SWAMP Project

Vice President for Manufacturing Alvin Wade wanted alternative approaches for managing the company's waste streams and the costs associated with each strategy. In particular, Wade wanted to make sure Healy was making the best use of its existing capital resources so that it could avoid or delay as long as possible additional expenditures. Wade also wanted to know the costs and benefits of utilizing external providers of waste disposal services.

Wade commissioned a task force of engineering and environmental professionals to develop these alternatives. The group adopted the name SWAMP (Strategic Waste Analysis and Management Plan) and began accumulating data regarding Healy's waste treatment operations. The members of SWAMP were: Brewer, based at Timpe but with responsibility for corporate-wide waste minimization activity; three engineers on technical career tracks, experts in waste treatment technologies such as incineration and wastewater treatment;[11] two regulatory experts from Corporate Environmental Affairs; and two engineers from the Corporate Engineering group. The Clifton, Puerto Rico, and Inty manufacturing sites were not directly represented on the team.

The initial meetings of the SWAMP team left Brewer dazed and frustrated. The other members were clearly skilled engineers and project managers with little experience thinking on the corporate level. Brewer struggled to encourage them to determine explicitly what questions needed to be answered in order for the team to fulfill its charter. His head swam with discussions of how to obtain treatment capacities, operating costs, and waste volumes. He thought to himself, "How do they expect to translate the vast quantity of data they are setting out to collect into information which will enable Healy to select its waste management strategy?"

As Brewer listened to the discussion during SWAMP meetings, he realized that it might help to approach Healy's waste treatment problem from the perspective of each individual treatment technology. Any waste stream that could be sent to the wastewater treatment plant would be sent there, since it was the least expensive and most politically acceptable method of disposal. Other waste streams, however, had to be incinerated or otherwise disposed of, since they contained materials that would either damage the wastewater treatment process[12] or were classified as "hazardous" by the Environmental Protection

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[10] Recent regulatory updates to RCRA also mandate that companies explicitly establish waste reduction programs and goals.

[11] These "Technology Center" engineers report to Timpe's Manager of Environmental Operations. They have dotted line relationships to the Manager of Corporate Environmental Engineering and serve all Healy sites as technical experts.

[12] A wastewater treatment plant is essentially a series of holding tanks, each with a complement of microorganisms that feed on the organic materials in the wastewater (they are often particularly fond of fermentation process

Agency and therefore prohibited from a treatment system that discharged back to the environment. These technological and regulatory constraints created a natural partitioning of the waste disposal strategy problem, one that made modeling the process more straightforward.

Since it would never make sense to treat the vast quantities of wastewater anywhere other than the plants' own treatment systems, Brewer decided to focus on the hazardous waste streams, and in particular on the liquid incinerable waste streams. He began to learn about the incineration process and regulations, and decided to spend some time working on-shift in the Timpe incineration department to become familiar with the technology and operational requirements.

Hazardous Liquid Incineration[13]

As he relaxed after the third night on-shift, Brewer mentally reviewed what he had learned so far about Healy's liquid incineration needs and capabilities. Liquid incinerable waste streams are classified in one of two ways. Primary waste is mostly organic solvent, while secondary waste is mostly water with low levels of organic solvents (aqueous waste). Healy only incinerated waste streams after attempting to recover any usable organic solvents in the company's Solvent Recovery operations. Some waste streams contained various contaminants that made recovery impossible, and even recoverable waste streams always left some unusable residual material after the recovery process.

A liquid incinerator is essentially a large oven made of refractory brick, cylindrical in shape, with various pieces of fume control equipment attached. Modern incinerators are computer-controlled, and routine operations are handled from a control room set apart from the incinerator. The incinerator is "fired" using natural gas, after which liquid waste is fed to the incinerator to be burned. Combustion of primary waste produces enough heat to sustain the incineration process without supplemental fuel. Combustion of secondary waste, however, requires supplemental fuel (typically natural gas) to keep the process going (secondary waste is, after all, mostly water). It is possible to minimize natural gas expenses by burning primary and secondary waste together in the proper proportions.

The incineration departments at the various sites were staffed 24 hours a day throughout the year. Incinerator operators also performed other functions, such as picking up full waste containers (either tanker trailers or smaller containers known as "melons") from production areas and leaving empty containers in their place. Operators empty the full containers into large storage tanks near the incinerator; the liquid waste remains in the storage tanks until it is burned.[14] The incinerator operators' duties also included regular inspection of the storage tanks and their spill containment facilities. With current and

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residues). Many organic and inorganic chemicals, however, are poisonous to these microorganisms, and waste streams containing such materials must be disposed of in other ways.

[13] Incinerators are a particularly politically sensitive waste treatment method. At the time of the case there was significant national press coverage of the attempts of an Ohio municipality to permit a new incinerator near an elementary school. EPA Administrator Carol Browner declared a moratorium on permits for new incinerators in May of 1993.

[14] RCRA requires that liquid waste not be stored longer than 90 days, so the incineration operations also had to manage the documentation of when waste was transferred to and from the storage tanks.

foreseeable production volumes, none of Healy's sites was in danger of running out of liquid waste storage space.

The Data

With the help of other SWAMP members, Brewer compiled data regarding liquid incineration at Healy. Healy generated liquid incinerable waste at Timpe, Clifton, Inty, Mayo, and Caro. Table 1 contains the amount of waste each site expected to generate over the course of a year.[15]

Healy has incineration facilities at Timpe, Clifton, and Mayo. Timpe has two incinerators, one of which is somewhat more efficient than the other. Clifton has four incinerators, two of which cannot handle primary waste because of the temperature at which it burns. Timpe and Clifton can treat waste from any site. Mayo has one incinerator and handles waste from Caro and Mayo. Table 1 also contains information about each site's incineration capacities. Table 2 provides information about the staffing levels and budgets of the incineration operations of the three plant sites. The fixed costs represent expenses the site will incur no matter how much waste is burned at the site. Brewer realized, however, that corporate human resources policies, as well as regulatory requirements for continued monitoring of hazardous waste storage facilities even after they are no longer actively used, might interfere with Healy's ability to shed any of these fixed costs were incineration operations decommissioned at a given site.

Table 3 contains the incremental cost per ton to treat waste at each site.[16] Healy can also send its waste to a third-party waste management company, Extern, for a set rate per ton.

Transportation regulations prevent Healy from sending waste from the mainland to Mayo for incineration. Table 4 contains the cost per ton to transport waste from one site to another.[17]

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[15] Site engineers estimated expected waste volumes based on five-year production volume forecasts from Facilities Planning and current standard waste generation for a given production process.

[16] Site engineers, at the request of the SWAMP team, estimated the incremental costs of burning an additional ton of each type of waste at the site. The different teams of engineers did not use a standard process for calculating the estimates. Clifton, in fact, first proposed that the incremental cost for burning a ton of primary waste was essentially zero since the waste would burn itself if the incinerator were already running. The Timpe engineers accounted for average start-up and shutdown costs for each incineration run as well as any incremental costs during the run. They considered natural gas use and other utility consumption as well as incremental testing and collection costs.

[17] In his initial model, Brewer included costs for the increased liability exposure if Healy were to transport waste between plant sites. When he requested estimates of this risk from the Legal and Transportation areas, he received two responses. Transportation informed him that the probability of a spill on the road was essentially zero; while such spills do happen, they are so infrequent relative to the number of truck-miles given that any probability estimates are necessarily very small. Legal informed him that it was Healy's policy to refrain from making explicit estimates of such liabilities because of the potentially damaging claim of "prior knowledge" and failure to take appropriate safeguards in any lawsuits following a spill.

Table 1: Annual Site Waste Volumes and Capacities (Tons)

Site	Expected Waste Generation		Incineration Capacity	
	Primary	Secondary	Primary	Secondary
Timpe	1,183	1,705	6,032	17,871
Clifton	4,000	18,000	8,673	30,846
Inty	1,576	0	NA	NA
Mayo	630	490	694	1,239
Caro	100	0	NA	NA

Table 2: Incineration Operations Staffing and Budget Data

	Timpe	Clifton	Mayo
Department Head	1	1	1
Technician	1	1	1
Shift Supervisor (per shift)	1	1	1
Incinerator Operators (per shift)	3	6	2
Tank Farm/Collection Operators (per shift)	2	4	1
Annual fixed expense, including depreciation ($MM)	2	5	0.5
Book value of incineration equipment ($MM)	10	25	3

Additional Information

- Healy estimates average annual costs (including wages, benefits, and personnel administration costs) for various job levels to be $125,000 for department heads, $100,000 for shift supervisors, $90,000 for technicians, and $80,000 for production operators.
- Tank Farm and Waste Collection Operations would still be necessary even if the incinerator at a given site were decommissioned.
- RCRA permitting costs at a given site would likely decrease if the incinerator were decommissioned.

Table 3: Incremental Incineration Costs (Dollars Per Ton)

Site	Primary	Secondary
Timpe	104	104
Clifton	25	57
Mayo	235	435
Extern	100	100

Table 4: Transportation Costs (Dollars Per Ton)

From	To:	Timpe	Clifton	Mayo	Extern
Timpe		0	60	Infinite	83
Clifton		60	0	Infinite	65
Inty		60	60	Infinite	65
Mayo		550	550	0	550
Caro		550	550	60	550

Figure 1: Healy Organization

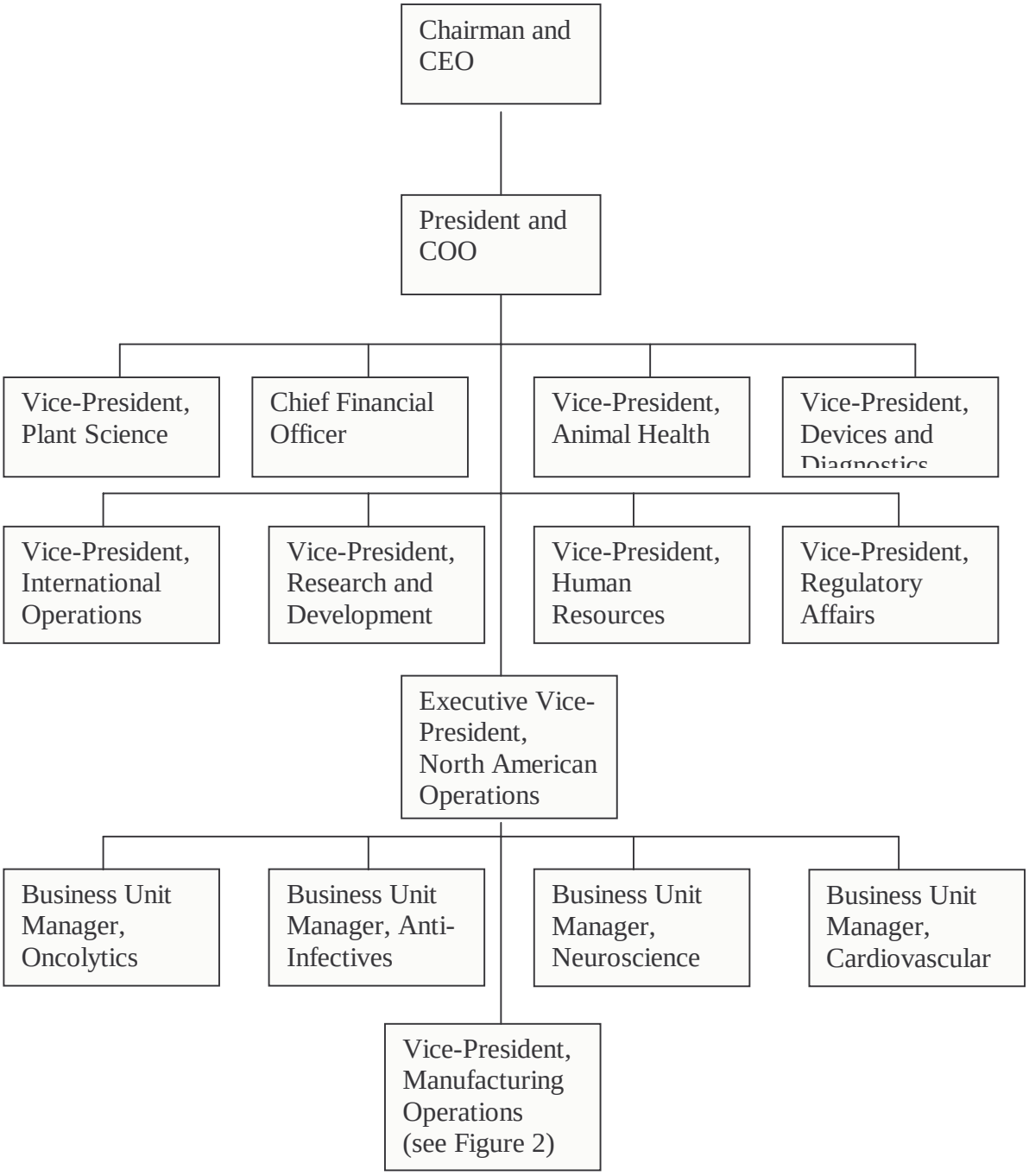

Figure 2: Healy Manufacturing Organization

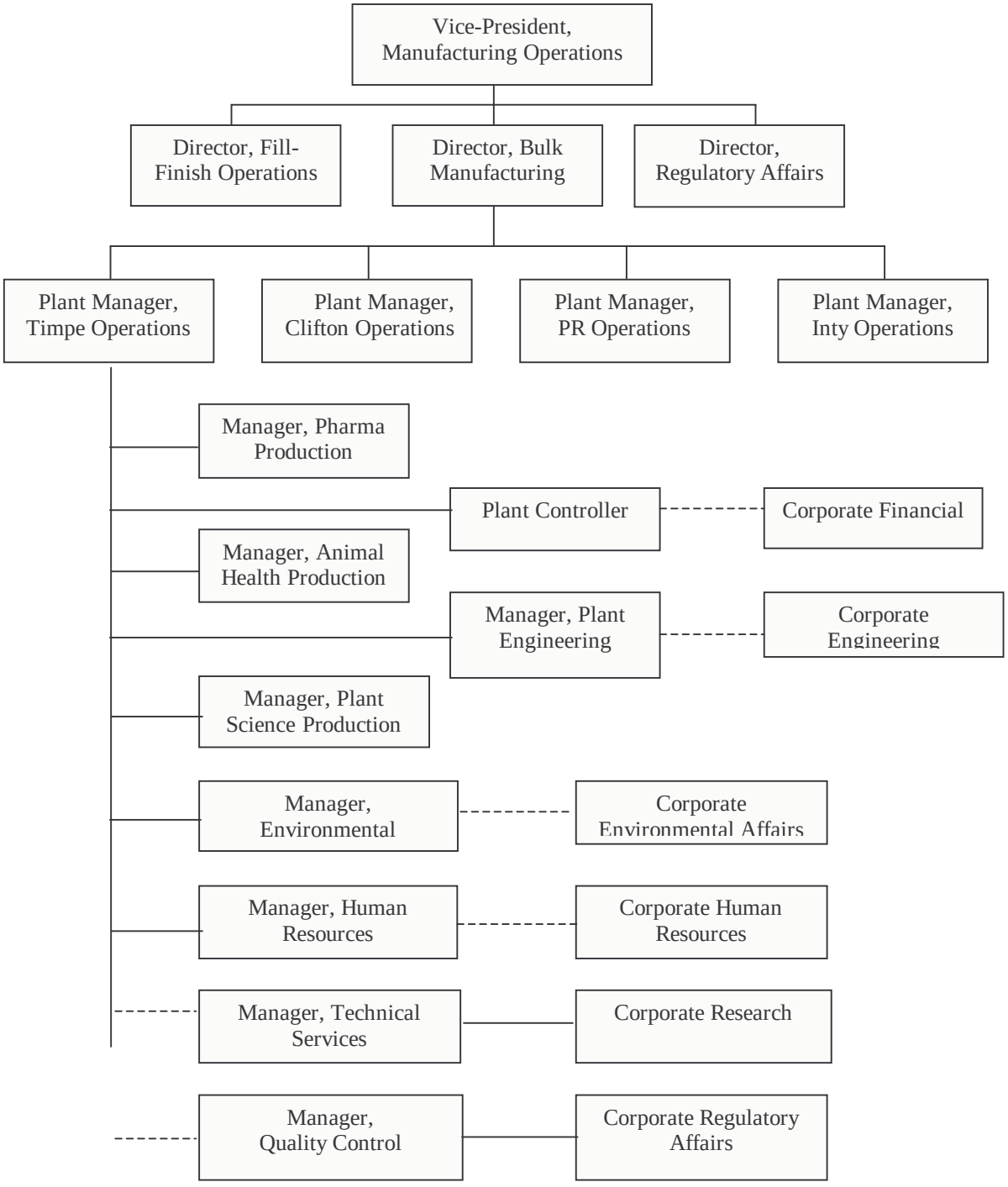

Figure 3: Summary of Major Environmental Statutes[18]

RCRA (1976) Overview

RCRA (pronounced "rick-rah") gave EPA the authority to control hazardous waste from the "cradle-to-grave." This includes the generation, transportation, treatment, storage, and disposal of hazardous waste. RCRA also set forth a framework for the management of non-hazardous wastes.

The 1986 amendments to RCRA enabled EPA to address environmental problems that could result from underground tanks storing petroleum and other hazardous substances. RCRA focuses only on active and future facilities and does not address abandoned or historical sites (see CERCLA).

HSWA (pronounced "hiss-wa")—The Federal Hazardous and Solid Waste Amendments are the 1984 amendments to RCRA that required phasing out land disposal of hazardous waste. Some of the other mandates of this strict law include increased enforcement authority for EPA, more stringent hazardous waste management standards, and a comprehensive underground storage tank program.

CERCLA (1980) Overview

Congress enacted the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly known as Superfund, on December 11, 1980. This law created a tax on the chemical and petroleum industries and provided broad Federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment. Over five years, $1.6 billion was collected and the tax went to a trust fund for cleaning up abandoned or uncontrolled hazardous waste sites. CERCLA:

- Established prohibitions and requirements concerning closed and abandoned hazardous waste sites
- Provided for liability of persons responsible for releases of hazardous waste at these sites
- Established a trust fund to provide for cleanup when no responsible party could be identified

The law authorizes two kinds of response actions:

- Short-term removals, where actions may be taken to address releases or threatened releases requiring prompt response.
- Long-term remedial response actions that permanently and significantly reduce the dangers associated with releases or threats of releases of hazardous substances that are serious but not immediately life threatening. These actions can be conducted only at sites listed on EPA's National Priorities List (NPL).

CERCLA also enabled the revision of the National Contingency Plan (NCP). The NCP provided the guidelines and procedures needed to respond to releases and threatened releases of hazardous substances, pollutants, or contaminants. The NCP also established the NPL.

[18] Source: http://www.epa.gov

Figure 3 (continued)

SARA (1986) Overview

The Superfund Amendments and Reauthorization Act (SARA) amended the CERCLA on October 17, 1986. SARA reflected EPA's experience in administering the complex Superfund program during its first six years and made several important changes and additions to the program. SARA:

- Stressed the importance of permanent remedies and innovative treatment technologies in cleaning up hazardous waste sites
- Required Superfund actions to consider the standards and requirements found in other State and Federal environmental laws and regulations
- Provided new enforcement authorities and settlement tools
- Increased State involvement in every phase of the Superfund program
- Increased the focus on human health problems posed by hazardous waste sites
- Encouraged greater citizen participation in making decisions on how sites should be cleaned up
- Increased the size of the trust fund to $8.5 billion.

SARA also required EPA to revise the Hazard Ranking System (HRS) to ensure that it accurately assessed the relative degree of risk to human health and the environment posed by uncontrolled hazardous waste sites that may be placed on the NPL.

Environmental Policy at Healy Pharmaceuticals
Teaching Note

Overview
Healy Pharmaceuticals explores the attempts of a pharmaceutical manufacturer to understand and optimize its handling of hazardous waste. The case provides opportunities to discuss the following topics:

- Linear programming and constrained optimization
- Environmental regulatory compliance
- The value to a corporation of human resources policies and environmental treatment policies
- The introduction of new analysis tools to a business setting
- The effect of management accounting procedures and performance measurement on incentives and decision-making

The natural flow of case discussion inevitably leads to at least some discussion on all of these topics. The instructor can focus the discussion on areas of particular interest by assigning appropriate questions for analysis prior to discussion.

Pedagogy
Healy Pharmaceuticals has been taught at both the undergraduate and MBA level. For undergraduate students, more specific assignment questions and a little more assistance with developing the model are usually necessary. Excel Solver is the typical optimization package.

Students are usually assigned (in groups) to represent one of the following: Timpe Plant Operations, Clifton Plant Operations, or Corporate Environmental. Class typically begins with a presentation by one of these groups recommending a specific plan for treating Healy's liquid incinerable hazardous waste, including which incineration operations remain open and where specific waste is treated.

Representatives of the other perspectives then respond to the initial recommendations. This can occur through guided discussion regarding the assumptions, costs, and benefits of the proposal. Other groups often present alternative recommendations with different costs and benefits.

In order to ensure that specific issues come up during the discussion, it is possible to ask one group to respond to a direct question about the issue and then ask others to respond.

Potential Assignment Questions

Assume the role of Brewer (or a Clifton engineer, or a Corporate Environmental staff member) and analyze the case from his perspective.

1. What waste treatment plan, given all available incineration operations, provides the lowest annual (incremental) operating cost?

2. What waste treatment plan, given the opportunity to close specific plant site incineration operations, provides the lowest annual incremental costs (considering the plant-specific incremental fixed costs of operating the incineration facility)?

3. What concerns do you have about implementing the waste treatment plans you develop in Questions 1 and 2?

4. How will representatives of the other plant sites and of corporate headquarters react?

5. What is the out-of-pocket cost to Healy Pharmaceuticals of a corporate policy to use only internal treatment facilities?

6. What is the out-of-pocket cost related to hazardous liquid waste incineration to Healy Pharmaceuticals of the corporate no-layoff policy?

Analysis

1. What waste treatment plan, given all available incineration operations, provides the lowest annual (incremental) operating cost?

The first step in the analysis is to develop and solve a linear program to minimize the incremental operating costs of treating the company's expected liquid incinerable hazardous waste. This analysis ignores the fixed costs associated with incineration operations and personnel at each site.[19]

The objective is to minimize the incremental costs to treat the waste. The costs involve the actual burning of the waste and the transportation of the waste if necessary. Each decision variable represents a combination of waste generation site (5 possible sites), waste type (2 types, primary and secondary), and waste treatment site (4 possible sites). There are therefore 5 x 2 x 4 = 40 decision variables. We can eliminate 13 due to the lack of creation of a waste type at a site (e.g., Inty does not produce secondary waste) and due to the legal restriction on transporting waste from the mainland to Puerto Rico. Exhibit TN–1 shows the decision variables and the costs associated with each.

Exhibit TN–2 depicts the linear program for minimizing the incremental operating costs of liquid incinerable hazardous waste treatment. The program has the following components:

[19] It is, of course, possible to include these fixed costs in the optimization program through integer programming. This technique is beyond the scope of the classes in which the case has been used and so is not included in this Teaching Note.

Objective Function
The objective function is a minimization of the sum of the treatment cost for each decision variable times the amount of each decision variable in the treatment plan.

Capacity Constraints
There are constraints on the amount of primary and secondary waste that each treatment facility can handle. The linear program requires articulation of six capacity constraints to ensure that the treatment plan does not overload a particular facility.

Quantity Constraints
Environmental regulations prevent the long-term storage of waste. The treatment plan, therefore, must ensure that all waste generated is treated. The linear program requires articulation of eight quantity constraints to ensure that all of Healy's waste is treated. Since the objective is cost minimization, the optimization software will return zero as the value of each decision variable unless minimum treatment quantities are specified.

Non-Negativity Constraints
Often inferred, these constraints are necessary to prevent the treatment plan from including large negative quantities (which would, of course, create negative terms in the objective function and lower its value).

Exhibit TN–3 contains a summary of the Excel Solver output for the baseline linear program. The minimum annual operating cost is $1,938,615, all Healy treatment facilities remain in operations, and Healy does not send any waste to the external treatment option.

2. *What waste treatment plan, given the opportunity to close specific plant site incineration operations, provides the lowest annual incremental costs (considering the plant-specific incremental fixed costs of operating the incineration facility)?*

Without resorting to integer programming, the most straightforward way to address this question is to create a simulation spreadsheet that allows you to "open" and "close" plant incineration facilities by entering a zero or one into a specific cell. The simulation then calculates the costs associated with fixed assets and personnel depending on whether a given site is open or closed. You must also run the linear program with any closed plant site's capacities set to zero to obtain the annual operating costs.

Exhibit TN-4 provides a snapshot of the simulation for the scenario in which all three Healy incineration facilities remain open (i.e., the baseline case). Exhibit TN–5 provides a summary table of the simulation results for the possible facility scenarios. The option for Healy with the lowest annual operating costs is to close its facilities and rely on the external treatment option.

3. What concerns do you have about implementing the waste treatment plans you develop in Questions 1 and 2?

There are several possible concerns regarding implementation of any of the waste treatment plans that differ from Healy's current practice of incinerating all waste at the site that generated it. They include:

- Quality of the input data. The model, just like any other, is subject to the garbage-in, garbage-out phenomenon. The reluctance of Clifton engineers to provide cost information and the differences across plant sites in reported unit costs of incineration are signals that this may be a real concern.
- Effect on plant site performance measures. Transferring waste incineration from one site to another will change the level of absorption at a given plant site and affect the site's "idle plant" metric.
- Risk of shipping hazardous waste. The negative publicity from a spill, either along the highway in the US or on the ocean between Puerto Rico and the mainland, would be significant.
- Possible future need for incineration capacity. Once Healy decommissions an incinerator that capacity is probably gone forever (unless the EPA changes radically). Future pharmaceutical demand, however, is not expected to create huge amounts of waste.
- Employee morale. Employees whose incineration jobs disappear will wind up in the site's surplus pool, always an uncomfortable role and one that bears a little stigma.
- Litigation risk. Using the external treatment option exposes Healy to the joint and severally liable legal regime that governs environmental regulatory enforcement (Superfund). The potential liability to Healy for the external treatment option's mistakes, or the mistakes of other customers of the external treatment option, is inestimable but probably very large.

4. How will representatives of the other plant sites and of corporate headquarters react?

The discussion here typically centers around each site's incentives to keep its incineration operation open, regardless of what is best for Healy overall.

5. What is the out-of-pocket cost to Healy Pharmaceuticals of a corporate policy to use only internal treatment facilities?

I model the costs of this corporate policy as the difference between the annual cost to treat liquid incinerable hazardous waste solely at the external treatment option ($8.2 million) and the lowest annual cost that does not require the external treatment option ($12.3 million, treating all waste at Clifton). So the (minimum) cost of the corporate policy is $4.1 million per year. We can consider this to be the insurance premium Healy pays to avoid the joint and severally liable litigation risk.

6. *What is the out-of-pocket cost related to hazardous liquid waste incineration to Healy Pharmaceuticals of the corporate no-layoff policy?*

I model this cost as the difference in the *required* personnel costs between the annual operating costs of the lowest-cost option (Clifton treats all Healy's waste) and the personnel costs of the current situation. This amounts to approximately $2.8 million per year. The company purchases employee morale and loyalty with this money.

Other Issues

Inevitably, someone raised the possibility of Healy selling its incineration capacity to other firms (i.e., Healy becomes a contract waste incinerator). This is a good idea for the students to raise but it is unworkable because:

- Healy's site-specific RCRA permits are written to allow Healy to treat only waste generated at its own sites. Healy would have to obtain new RCRA permits to treat waste generated at other facilities; this process would be very expensive and, given the EPA's position on new incinerators, approval is not certain.
- Healy is not in the business of treating waste but rather of developing and producing pharmaceuticals. Taking on incineration business could easily distract managers at Healy sites from their core responsibilities.

Exhibit TN–1
Decision Variables and Associated Costs

Variable	*Source*	*Type*	*Treated At*	*Burn Cost ($/ton)*	*Trans. Cost ($/ton)*	*Total Cost ($/ton)*
Q_1	*Timpe*	*Primary*	*Timpe*	104	0	104
Q_2	*Timpe*	*Primary*	*Clifton*	25	60	85
Q_3	*Timpe*	*Primary*	*Extern*	100	83	183
Q_4	*Timpe*	*Secondary*	*Timpe*	104	0	104
Q_5	*Timpe*	*Secondary*	*Clifton*	57	60	117
Q_6	*Timpe*	*Secondary*	*Extern*	100	83	183
Q_7	*Clifton*	*Primary*	*Timpe*	104	60	164
Q_8	*Clifton*	*Primary*	*Clifton*	25	0	25
Q_9	*Clifton*	*Primary*	*Extern*	100	65	165
Q_{10}	*Clifton*	*Secondary*	*Timpe*	104	60	164
Q_{11}	*Clifton*	*Secondary*	*Clifton*	57	0	57
Q_{12}	*Clifton*	*Secondary*	*Extern*	100	65	165
Q_{13}	*Inty*	*Primary*	*Timpe*	104	60	164
Q_{14}	*Inty*	*Primary*	*Clifton*	25	60	85
Q_{15}	*Inty*	*Primary*	*Extern*	100	65	165
Q_{16}	*Mayo*	*Primary*	*Timpe*	104	550	654
Q_{17}	*Mayo*	*Primary*	*Clifton*	25	550	575
Q_{18}	*Mayo*	*Primary*	*Extern*	100	550	650
Q_{19}	*Mayo*	*Primary*	*Mayo*	235	0	235
Q_{20}	*Mayo*	*Secondary*	*Timpe*	104	550	654
Q_{21}	*Mayo*	*Secondary*	*Clifton*	57	550	607
Q_{22}	*Mayo*	*Secondary*	*Extern*	100	550	650
Q_{23}	*Mayo*	*Secondary*	*Mayo*	435	0	435
Q_{24}	*Caro*	*Primary*	*Timpe*	104	550	654
Q_{25}	*Caro*	*Primary*	*Clifton*	25	550	575
Q_{26}	*Caro*	*Primary*	*Extern*	100	550	650
Q_{27}	*Caro*	*Primary*	*Mayo*	235	60	295

Exhibit TN–2
Baseline Linear Program

Objective Function

Minimize Total Cost	=	Costs to Burn + Costs to Transport
	=	$\Sigma\ Q_i * C_i$, I = 1 to 27
	where	C_i is the cost ($/ton) to treat waste type i
	and	Q_i is the quantity of waste type i.

Subject to:

Capacity Constraints

Treatment Location	***Waste Type***	***Decision Variables Involved***		***Maximum Amount Treated***
Timpe	*Primary*	$Q_1 + Q_7 + Q_{13} + Q_{16} + Q_{24}$	≤	*6,032*
Timpe	*Secondary*	$Q_4 + Q_{10} + Q_{20}$	≤	*17,871*
Clifton	*Primary*	$Q_2 + Q_8 + Q_{14} + Q_{17} + Q_{25}$	≤	*8,673*
Clifton	*Secondary*	$Q_5 + Q_{11} + Q_{21}$	≤	*30,846*
Mayo	*Primary*	$Q_{19} + Q_{27}$	≤	*694*
Mayo	*Secondary*	Q_{23}	≤	*1,239*

The capacity constraints ensure that no incinerator treats more than it is capable of treating.

Supply Constraints

Generation Site	***Waste Type***	***Decision Variables Involved***		***Minimum Amount Treated***
Timpe	*Primary*	$Q_1 + Q_2 + Q_3$	≥	*1,183*
Timpe	*Secondary*	$Q_4 + Q_5 + Q_6$	≥	*1,705*
Clifton	*Primary*	$Q_7 + Q_8 + Q_9$	≥	*4,000*
Clifton	*Secondary*	$Q_{10} + Q_{11} + Q_{12}$	≥	*18,000*
Inty	*Primary*	$Q_{13} + Q_{14} + Q_{15}$	≥	*1,576*
Mayo	*Primary*	$Q_{16} + Q_{17} + Q_{18} + Q_{19}$	≥	*630*
Mayo	*Secondary*	$Q_{20} + Q_{21} + Q_{22} + Q_{23}$	≥	*490*
Caro	*Primary*	$Q_{24} + Q_{25} + Q_{26} + Q_{27}$	≥	*100*

The supply constraints ensure that all waste that Healy generates is treated at some incineration facility.

Finally, 27 non-negativity constraints are required (in Solver, this involves to checking the non-negativity option in the Options Dialogue Box).

Exhibit TN–3
Baseline Optimization Results

Solver provides the following output for this minimization problem:

Objective function value: $1,938,615 per year treatment cost

Q2	=	1183 tons
Q4	=	1705 tons
Q8	=	4000 tons
Q11	=	18000 tons
Q14	=	1576 tons
Q19	=	630 tons
Q23	=	490 tons
Q25	=	36 tons
Q27	=	64 tons

All other decision variables are zero.

Exhibit TN–4
Snapshot of Excel Simulation

Healy Pharmaceuticals Simulation Spreadsheet

Plant Site Conditions (1 = plant site open, 0 = plant site closed)

Timpe	1
Clifton	1
Mayo	1

Personnel Requirements Table

	T Open	T Closed	C Open	C Closed	M Open	M Closed
DH	1	0	1	0	1	0
Tech	1	0	1	0	1	0
SS	4	0	4	0	4	0
Op	20	8	40	16	12	4
Total	$2,215,000	$640,000	$3,815,000	$1,280,000	$1,575,000	$320,000

Position Costs

DH	$125,000
Tech	$90,000
SS	$100,000
Op	$80,000

Annual Depreciation Given Maintained Facilities

T Open	T Closed	C Open	C Closed	M Open	M Closed
$2,000,000	$200,000	$5,000,000	$500,000	$500,000	$50,000

One-Year Write-Down to Decommission Unused Assets

T Open	T Closed	C Open	C Closed	M Open	M Closed
$0	$10,000,000	$0	$25,000,000	$0	$3,000,000

Total Cost Summary

Incremental Operating Costs	$1,938,535

Plant Site Operating Costs

	Personnel	Depreciation	Write Down	
Timpe	$2,215,000	$2,000,000	$0	$4,215,000
Clifton	$3,815,000	$5,000,000	$0	$8,815,000
Mayo	$1,575,000	$500,000	$0	$2,075,000

Annual Operating Costs	$17,033,535
One-Time Costs	$0

Exhibit TN–5
Summary of Simulation Results

Option	Incremental Operating Costs	Personnel Costs	Facility Costs	Total Operating Costs	One-Time Costs	Extern Used?
All Open	$1,938,615	$7,605,000	$7,500,000	$17,043,615	$0	No
Mayo Closed	$2,850,673	$6,350,000	$7,050,000	$16,250,673	$3,000,000	No
Timpe Closed	$1,960,779	$6,030,000	$5,700,000	$13,690,779	$10,000,000	No
Clifton Closed	$4,572,587	$5,070,000	$3,000,000	$12,642,587	$25,000,000	Yes
Timpe Closed Mayo Closed	$2,306,780	$4,775,000	$5,250,000	$12,331,780	$13,000,000	No
Clifton Closed Mayo Closed	$4,962,107	$3,815,000	$2,550,000	$11,327,107	$28,000,000	Yes
Timpe Closed Clifton Closed	$4,822,024	$3,495,000	$1,200,000	$9,517,024	$3,500,000	Yes
All Closed	$5,211,544	$2,240,000	$750,000	$8,201,544	$38,000,000	Yes