CONTRACTING METHODS AND RISKS IN FEDERAL REMEDIATION PROJECTS

by

Peter K. Sherrill

B.S., United States Military Academy at West Point
(1981)

Submitted to the Department of Civil and Environmental Engineering in Partial Fulfillment of the Requirements for the Degree of

MASTER OF SCIENCE
in Civil and Environmental Engineering
at the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

September 1994

© 1994 Peter K. Sherrill
All rights reserved

The author hereby grants to MIT permission to reproduce and to distribute publicly paper and electronic copies of this thesis document in whole or in part.

Signature of Author...
Department of Civil and Environmental Engineering
August 2, 1994

Certified by...
Fred Moavenzadeh
Director, Henry L. Pierce Engineering Laboratory
Thesis Supervisor

Accepted by..
Joseph M. Sussman
Chairman, Departmental Committee on Graduate Studies

Barker Eng
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
OCT 06 1994
LIBRARIES

CONTRACTING METHODS AND RISKS
IN FEDERAL REMEDIATION PROJECTS
by
Peter K. Sherrill

Submitted to the Department of Civil and Environmental Engineering in partial fulfillment of the requirements for the Degree of Master of Science in Civil and Environmental Engineering, Massachusetts Institute of Technology, September 1994

ABSTRACT

This thesis examines contracting methods used by the U.S. Army Corps of Engineers (USACE) in federal remediation projects. USACE's current approaches require a lengthy selection and approval process, thereby, not providing timely remediation of hazardous waste sites. Also, risks for all parties are not attenuated in the best way using current contracting arrangements. This thesis analyzed two projects with ongoing remedial action. The first was the Baird & McGuire Inc., Superfund site located in Holbrook, MA. USACE is accomplishing remediation of the site in three phases and is using fixed priced contracts for each phase. As a comparison, the second project researched was the Army Material Technology Laboratory (AMTL) located in Watertown, MA. This site differs from the first in that a cost type contract is being used and the contaminants detected included both hazardous wastes and low-level radioactive wastes.

Both projects were analyzed from an owner's perspective to determine the most appropriate contracting strategy for that specific project. Based upon the analysis, a contracting mechanism was developed for federal remediation projects that would expedite cleanup and better attenuate the risks of parties involved. The proposed method suggested a Design-Build team as the most appropriate organization. This contracting strategy uses a fixed price contract for the construction of remediation facilities and cost plus fixed fee for the actual remediation of the contaminants themselves. Additionally, it mandates contracting with one entity for total site remediation at each federal installation.

Adopting the recommended approach will expedite remedial action since USACE will only go through the contractor selection process once. Also, the contracting methodology proposed will place the burden of risk on the party that controls the risk and, therefore, is most appropriate to it.

Thesis Supervisor: Fred Moavenzadeh
Title: Director, Henry L. Pierce Engineering Laboratory

ACKNOWLEDGEMENT

I would like to thank the following people for their assistance in this thesis and throughout my time at MIT. My thesis advisor, Dr. Fred Moavenzadeh, for his assistance and insight. The United States Army, for my assignment as instructor for Army ROTC at MIT which led to the opportunity to pursue a graduate degree. LTC Wellman and LTC Creel, for their great assistance and allowing me the time to attend required courses. My parents, for their love and lifelong encouragement. Finally, to my fiance, Donna, for her understanding, support, and undying belief in my abilities over the past two years.

AUTHOR

The author, Peter K. Sherrill, is a Major in the U.S. Army Corps of Engineers. Following his graduation from the United States Military Academy at West Point in 1981, he was commissioned in the U.S. Army. During his thirteen year career he has served as a platoon leader, assistant brigade operations officer, engineer staff officer, company commander, battalion training officer, and battalion civil engineer in combat and combat heavy engineer units in the United States, Germany and Iraq. Currently, he is assigned as a technical instructor for Army ROTC at MIT. He will marry Miss Donna M. Salvucci on August 20, 1994.

TABLE OF CONTENTS

CHAPTER 1

Introduction

The Nation's commitment to environmental restoration has been manifested over the last three decades by visible public concern. This concern stems from the increasing number of sites requiring remedial action and the timeliness of cleanup operations. Department of Defense installations are the most noticeable of the increasing number of sites requiring remedial action. This trend will continue due to the down sizing of the military and the corresponding base closures. As a result, the Federal government, at all levels, has initiated numerous legislation and programs to restore the environment. Billions of dollars have been and will continue to be expended on programs to identify restoration needs, develop plans to meet these needs, and initiate remedial action.

The U.S. Army Corps of Engineers (USACE) plays an active and vital role in the remediation of Hazardous, Toxic, and Radioactive Wastes (HTRW) sites. USACE is the contracting and construction agent for the Department of Defense, Department of the Army and the other Federal agencies that own HTRW projects. Due to public concern, pressures have mounted for increased USACE performance in this field. Congress has mandated development of new contracting strategies to move HTRW projects rapidly from initial studies through remediation. In the development of alternative contracting methodologies, attenuation of associated risks must also be considered.

Chapter 2 describes society's increased environmental awareness and its moral responsibility to later generations to clean up the environment. The chapter discusses the impact society's concern has on education and the political scene. Also presented in this chapter, is the U.S. Army's commitment towards stewardship of the environment. Lastly, an analysis of the environmental remediation market is outlined.

Chapter 3 is the first of two that studies a project that has ongoing remedial action. This chapter contains analysis and evaluation of the Baird & McGuire, Inc. Superfund site focusing on the soils incineration portion of the remediation effort. USACE is using a fixed price contract for all aspects of remediation action. The role and importance of the EPA and USACE and the funding for the cleanup are discussed. An overview of the site's history and contaminants detected in the groundwater, soil, and sediment is provided. Discussed next are alternative remediation technologies considered and the contractor selection process. The current status of the project, contract structure, and associated risks and concerns are reviewed. Lastly, the project is analyzed from an owner's perspective to determine the most appropriate contracting methodology for this site.

Chapter 4 examines the Army Material Technology Laboratory (AMTL) project. Department of the Army owns this installation which has also been designated a Superfund site. The same method of analysis used for the Baird & McGuire project is used for the AMTL site. This site was selected for analysis as a comparison since it differs from the Baird & McGuire project in three ways. The first is in contract type with remediation at AMTL being accomplished through the use of a cost type contract. Secondly, AMTL not only has hazardous waste requiring remedial action, but also low-level radioactive waste. Lastly, funding for this project is provided by the

Department of the Army since the site is a military installation.

Based on the analysis of the two aforementioned projects, Chapter 5 provides a recommendation for federal remediation projects which will expedite remedial action and better attenuate the risks of all parties involved. Also, presented is a brief overview of a recently initiated USACE contracting mechanism. Finally, suggestions for further research are offered.

CHAPTER 2

Environmental Consciousness

"One in four Americans now live within four miles of a Superfund site"[1]

Society today is more than ever aware of its environment. The past environmental abuses, accidental or intentional, are not accepted practices and will not be tolerated by this nation's population. As our society progresses and modernizes the natural by product is waste. However, the past practices of disposal, such as dumping directly into the soil or water supplies, are no longer accepted. The public now requires responsible disposal and clean up of hazardous waste sites. Society's views have vastly changed from a decade ago. This chapter will provide an indication of the importance of environmental stewardship from a moral, educational, political, and governmental, specifically the Department of the Army, aspect. Also, this chapter will describe a viable market in environmental remediation work for the long term future.

2.1 Philosophical Foundation

Individuals have a moral obligation to preserve their environment for future generations. This responsibility can be divided into three distinct components. The first is equal opportunity in which every individual, including those yet to be born, have the inalienable right to equal opportunity for self determination and pursuing self interests. The second component asserts that our actions and inactions determine the identity of persons in the

---

[1] Bruce Van Voorst, "Toxic Dumps: The Lawyers' Money Pit," Time Magazine, September 13, 1993, p. 64.

future. Lastly, there exists an intergenerational contract that dictates we are liable to future generations for our actions. Of the three components of moral responsibility, society has control over the latter only. People do not have the ability to control the identification of persons in the future either by our actions or inactions. With the dynamics existing in today's world, our socio-economic institutions will adjust accordingly to survive. Future generations will then be afforded the opportunity to learn from our successes and failures and build upon them.[2] Therefore, it is incumbent upon all of society to be stewards of our environment through a moral obligation to future generations. We are required to leave to future generations the same opportunities left open to us by our forefathers. Society's moral responsibility dictates the clean up of hazardous waste sites to afford future generations with a clean environment to live in.

2.2 Impact on Education

As previously stated, society is better educated and more conscious of its environment. This is evidenced by a national Earth Day activities being observed 21 -22 April of each year. Of particular interest is the increase in the number of graduate students throughout the nation pursuing degrees in environmental engineering. From 1989 to 1992, the enrollment in approximately 100 environmental

---

[2] Alex Christopher Dornstauder, Hazardous Waste Remediation and the US Corps of Engineers: Facilitating Technological Innovation Through Construction Management. Thesis submitted to the Department of Civil and Environmental Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts, May 1991.

engineering programs nationwide has increased 25%.[3] More intriguing is the fact that it is not just the lure of job opportunities in this field, but the fact that environmental consciousness is a deeply ingrained ethic. "We have a generation of students who grew up in a world where environmental things mattered."[4] The interest in this academic field illustrates the importance of environmental thinking in our society today. These students are not fanatical environmentalists, but are pursuing this academic major as a way to help society, thereby fulfilling their own moral responsibility.[5]

2.3 Impact on Political Arena

Increased public awareness of the environment has impacted the political scene. Winning elections in today's society is predicated on a number of issues, one of which is environmental legislation and its enforcement. One of the planks of President Clinton's platform for his election campaign was an increased emphasis on environmental issues which helped in winning the election. Vice President Gore authored a "green" bestseller titled Earth in the Balance. Several environmental leaders, including Interior Secretary Bruce Babbitt, hold key administration positions.[6] However, the administration is under attack from many environmental groups who perceive inaction on the administration's part with respect to their campaign

---

[3] Betsy Wagner, "The Greening of the Engineer," U.S. News & World Report, March 21, 1994, p. 90.

[4] Edward Rubin, Professor of Environmental Engineering and Science, Carnegie Mellon, "The Greening of the Engineer," U.S. News & World Report, March 21, 1994, p. 91.

[5] Ibid, p. 91.

[6] Betsy Carpenter, "This Land is My Land," U.S. News & World Report, March 14, 1994, p.65.

promises. The League of Conservation Voters gave President Clinton a D for environmental budget and a C- for delivery on their recent environmental report card.[7] All elected officials are held responsible for environmental issues more so today than in any other time in history. Inaction by governmental officials, real or perceived, will be detrimental to their reelection bid.

2.4 Importance of Environmental Issues to the Military

The United States Army is committed to environmental stewardship. The Secretary of the Army has clearly outlined this philosophy to the Congress and to the Army leadership.

> Our vision is simple: The Army will be a national leader in environmental and natural resources stewardship for the present and future generations.[8]

His strategy is based on four pillars: compliance, restoration, prevention and conservation. The Chief of Staff of the Army, General Gordon Sullivan has echoed this sentiment.

> Environmental degradation is one of America's pressing problems as we approach the 21st century. Air and water pollution, depletion of water supplies, deforestation and hazardous waste sites

---

[7] "Environmentalists Feel a Presidential Letdown, "Boston Globe, April 21, 1994, p. 1.

[8] Honorable Togo D. West, Jr. and General Gordon R. Sullivan, A Statement on the Posture of the United States Army Fiscal Year 1995, presented to the Committees and Subcommittees of the United States Senate and the House of Representatives, Second Session, 103d Congress, February 1994, p. 70.

cleanup are just a few of our Nation's problems.[9]

To address these important environmental issues, General Sullivan has stated that the Army is committed to a course of action that will meet current responsibilities and improve the environment for future generations.[10] The Chief of Engineers has reiterated this line of thought. He has gone further to state that Army units in the field must increase their knowledge of the environmental limits on training. Training must be planned to avoid environmental damage and where damage does take place it is the Army Engineers responsibility to repair damages quickly.[11]

2.5 Environmental Remediation Market in General

An analysis of the environmental remediation industry can be accomplished using the five competitive forces concept developed by Michael Porter. The components are entry of new competitors, threat of substitutes, bargaining power of buyers, bargaining power of suppliers, and the rivalry among existing competitors.[12] As indicated in the subsequent paragraphs, the market holds opportunities for firms desiring to enter.

2.5.1 Threat of New Entrants

The threat of new entrants is based on barriers to entry and the reaction from existing competitors. The major barriers to be examined are capital requirements and

---

[9] General Gordon R. Sullivan, Army Focus 93: Moving Out to the 21st Century, September 93, p. 39.

[10] Ibid, p. 39.

[11] Lieutenant General Arthur E. Williams, "From the Chief of Engineers," Engineer Officer Bulletin, February 94, p. 1.

[12] Michael Porter, Competitive Advantage, pp. 4-5.

cost disadvantages independent of scale. Environmental remediation is a new and rapidly expanding market. There is no absolute set of approved technological methods. Firms desiring to use low risk and approved technological processes may easily enter the market. The amount of capital to accomplish entry is relatively low. However, firms entering the market with innovative technologies, the risks are increased, therefore, the costs are greater. A lack of cost disadvantages independent of scale exists in the market. No important proprietary process technologies, process expertise, or design characteristics kept proprietary through patents or secrecy exist. Due to these reasons the threat of entry is deemed high.[13]

2.5.2 Rivalry Among Existing Competitors

The intensity of rivalry among current competitors is determined to be low. The market is still new and, therefore, there is a substantial backlog of work to be accomplished. Also, low exit barriers exist due to the lack of specialized assets, low fixed costs to exit, and loose strategic interrelationships between segments.[14]

2.5.3 Substitute Products

No threat of substitute products exists. With the market in its early stages, no clear cut technological solutions are available that would entice clients to switch processes.[15]

---

[13] Michael A. Rossi, The Department of Defense and Construction Industry: Leadership Opportunities in Hazardous Waste Remediation Innovation. Thesis submitted to the Department of Civil and Environmental Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts, September 1992, p. 62.

[14] Ibid, p. 61.

[15] Ibid, p. 62.

2.5.4 Bargaining Power of Buyers

The bargaining power of buyers is considered to be high. This is due to the stringent rules and regulations the EPA has in place. EPA reviews every aspect of the remediation phase, thereby, exerting leverage on the firms.[16]

2.5.5 Bargaining Power of Suppliers

Suppliers exert little influence on the competitors. The value added for competing firms is in the area of service and expertise, not raw materials or subcontractors.[17]

2.5.6 Environmental Construction Forecast

In addition to analyzing the five competitive forces in play, the forecast for environmental construction work also illustrates opportunity for firms desiring to enter the market. F.W. Dodge, division of the McGraw-Hill's construction information group predicts that environmental construction will advance 4% in 1994.[18] William Anderson, Executive Director of the American Academy of Environmental Engineers, states "Environmental engineering will continue to offer employment for as long as the eye can see."[19] He predicts that if the standards hold (which most experts agree will only become more stringent), by the year 2000, the U.S. expects to spend 2.65 of its GNP on pollution prevention and clean up. This represents a 13% increase

---

[16] Ibid, p. 63.

[17] Ibid, p.64.

[18] F.W. Dodge, "Construction Forecast Predicts 9 Percent Increase in 1994," Civil Engineering News, December 1993, p. 1.

[19] Wagner, p. 91.

when compared to the amount expended in 1992.[20] Hazardous waste clean up alone is expected to grow 16% by 1996.[21]

2.6 Military Market

The opportunity for environmental remediation work on current and former U.S. Army installations and property is enormous. The Base Realignment and Closure Commission 93 (BRAC 93) closed 350 installations within the United States and abroad.[22] With the continuation of down sizing the U.S. Army, additional base closures will be conducted in the future. As bases are closed, the Corps of Engineers (USACE) is an active player in the clean up of hazardous waste sites in order for these formerly used sites to be turned over for public use.[23] The Department of Defense has continued to have substantial growth in the number of installations included in the Installation Restoration Program (IRP). Table 2.1 provides a summary of installations and sites included in the IRP.

---

[20] Ibid, p. 91.

[21] Dana Hawkins, "Salary Survey," U.S. News & World Report, November 1, 1993, p. 109.

[22] West, Jr., p. 7.

[23] LTG Arthur E. Williams, "From the Chief of Engineers," Engineer Officer Bulletin, January 1993, p. 1.

Table 2.1 IRP: Summary of Installations and Sites[24]

	ARMY	NAVY	AIR FORCE	DLA	TOTAL
# OF INSTALLATIONS	1,144	290	332	34	1800
# OF SITES	10,603	3,258	4,474	460	18,795
# OF ACTIVE SITES	4,216	2,481	3,191	270	10,158
CLOSED OUT SITES	5,944	615	1,010	75	7,644

Currently, the U.S. Army owns or leases 12 million acres of land. Of those listed in table 2.1, there are 30 installations and 13 formerly used defense sites on the National Priority List (NPL) and 10,600 suspected contaminated sites. As can be clearly seen from the above information, there is a huge backlog of work currently; and the amount for the future will increase as additional bases are closed and new sites reported.

The military budget further indicates an optimistic market in the future for Department of the Army (DA) remediation of its installations and sites. The total clean-up funding allocated to Department of Defense in FY 92 was approximately $2 billion. This included a supplemental appropriation of $610.2 million for accelerating clean-up. DA's allocation was approximately $700 million.[25] President Clinton's annual budget request to Congress on February 7, 1994 provides further support that the environmental remediation market for DA has a

[24] Defense Environmental Restoration Program, Annual report to Congress for Fiscal Year 1992, April 1993, p. 7.

[25] Ibid, p.1.

promising outlook for the future. The budget request included $3.3 billion for the Army's FY 95 Civil Works Program. Of this amount, $427 million is directed toward environmental activities. This is an increase of approximately $15 million over that contained in the FY 94 budget. The $427 million is divided into five categories: mitigation - $82 million; restoration - $106 million; protection - $73 million; programmatic activities - $131 million; and coastal wetlands - $35 million.[26] The requested increase for environmental activities depicts the administration's priority and indicates that this will continue in the future.

2.7 Chapter Summary

The public today is more concerned with its environment than ever before in history. This is a priority for Americans. Society's environmental consciousness impacts on its youth by encouraging their pursuit of higher education in this field. Government officials are acutely aware of the environmental issues and what inaction on their part may mean to reelection bids. The U.S. Army highest leadership has committed itself to the stewardship of the environment. Without a doubt, society has accepted its moral responsibility to clean-up and maintain the environment in order to afford the same opportunities left to us by our forefathers for the future generations to come.

Environmental problems however do exist. There are vast opportunities for firms to enter the remediation market. Focusing even further, Department of the Army

---

[26] "Clinton Releases FY 95 Budget," United States Corps of Engineers Engineer Update, Vol. 18, No. 3, March 1994, p. 1.

offers immense opportunities for designers, engineers, and contractors. The number of installations and sites requiring restoration continue to increase, although not by leaps and bounds as in the past. With additional base closures on the horizon, the number will grow. Funding has been set aside for this remediation effort. The request for the next fiscal year's budget has increased the amount to be allocated for the Army's environmental activities compared to the previous year.

CHAPTER 3

Baird & McGuire, Inc. Superfund Site

This case study concentrates on the ongoing cleanup of the Baird & McGuire, Inc. site. The site is a Superfund site located in Holbrook, MA, approximately 14 miles south of Boston. Figure 3.1 depicts the location of the site within the town of Holbrook. The 20 acre site is bounded by South Street to the south and west. Mear Road bounds the site to the north and the Cochato River abuts it to the east. The cleanup operations consists of construction systems to treat more than 200,000 tons of contaminated materials. These systems include a groundwater treatment plant, an on-site soils incinerator, and dredging operations of the Cochato River for the contaminated sediment. The case study will discuss each aspect of the cleanup but will focus on the current ongoing phase, soils incineration. It will also provide a recommendation as to an appropriate contracting method for the Baird & McGuire remediation project.

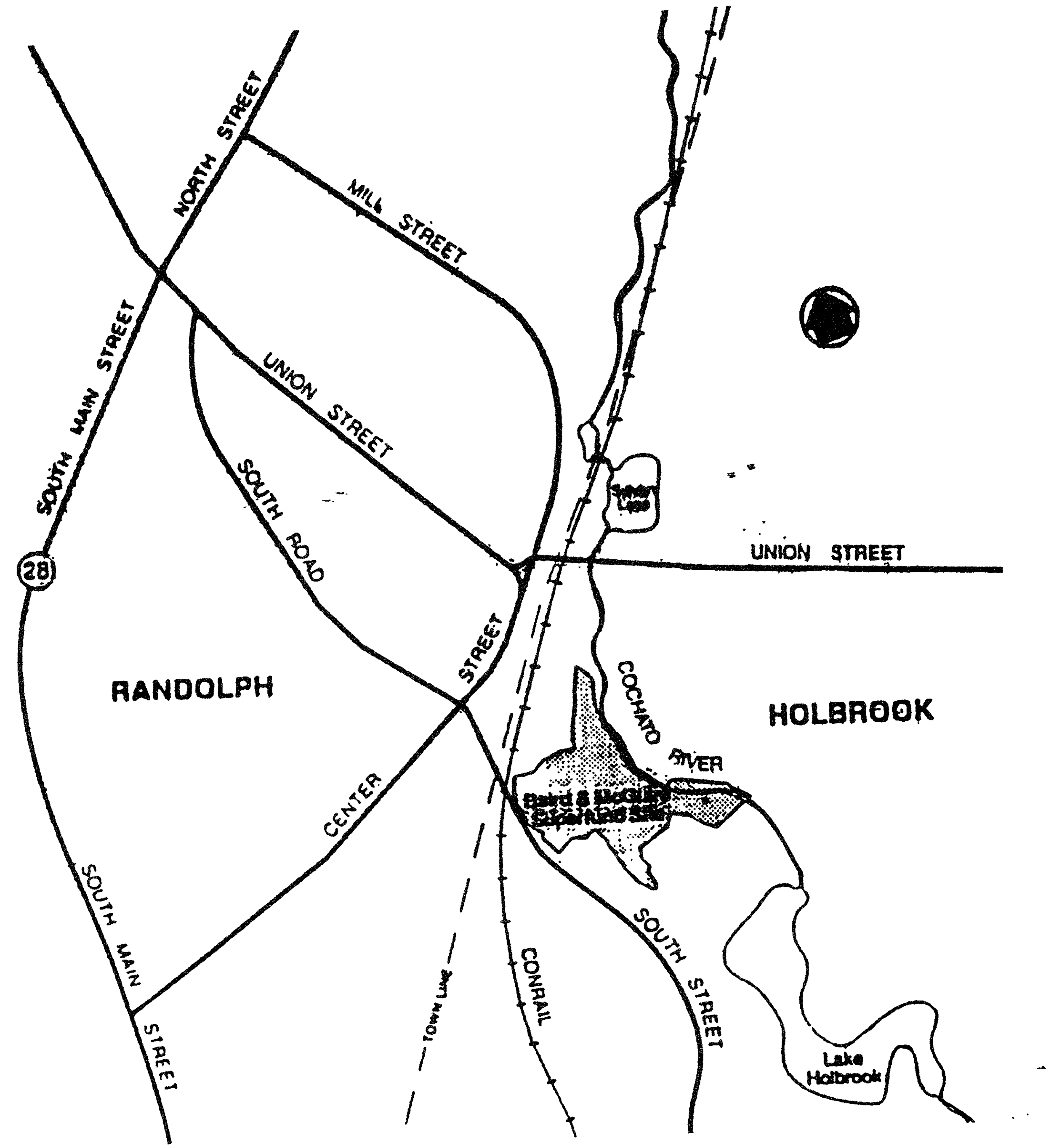
3.1 Federal Remediation Projects

3.1.1 EPA's Involvement[27]

Between 1957 and 1983, Baird Realty Company, Inc. was the owner of the site on record. In 1983, the title transferred to Baird & McGuire, Inc. Cameron M. Baird was the President and Treasurer of Baird & McGuire, Inc. His brother, Gordon, acted as the Chairman of the Board.

[27] Summarized from United States Environmental Protection Agency, Superfund Record of Decision: Baird & McGuire, MA, September 1986, pp.4-5.

Figure 3.1


NORTH STREET
MILL STREET
SOUTH MAIN STREET
UNION STREET
SOUTH ROAD
28
UNION STREET
STREET
RANDOLPH
COCHATO RIVER
HOLBROOK
CENTER
SOUTH MAIN
STREET
TOWN LINE
CONRAIL
SOUTH STREET
Lake Holbrook

The EPA first became involved with Baird & McGuire during the period 1954 to 1977. During this timeframe, the company was fined at least 35 times for numerous violations of the Federal Insecticide, Fungicide and Rodenticide Act of 1947. In August 1982, EPA's contractor, Ecology and Environment, Inc. scored the site on the Hazardous Ranking System. The site was proposed for inclusion on the National Priorities List (NPL) in October 1982. This made the site eligible for federal Superfund cleanup funds. Currently, the site ranks 14 out of a total of 888 current or proposed sites on the NPL.

Heavy rains in March 1983 caused a breach of a creosote lagoon and as a result a pollutant was released which presented an imminent or substantial threat to the public health or environment. EPA responded with an immediate removal action under CERCLA guidelines. This removal action consisted of removal of approximately 1000 cubic yards of contaminated soils, construction of a clay cap, installing a groundwater interception/recirculation system, and erection of limited fencing. The town of Holbrook, on May 2, 1983, revoked Baird & McGuire's permit to store chemicals on-site and ordered the company to dismantle its existing storage facilities. As a result of this order, Baird & McGuire ceased its operation. EPA conducted a second removal action in July 1985 due to site sampling detecting the presence of dioxin in surficial soils. The second removal effort consisted of installing 5700 feet of fencing and performance of extensive soil, groundwater, surface water, and air sampling to better delineate the extent of dioxin contamination.

3.1.2 Cleanup Funding[28]

The United States of America, on behalf of the Administrator of EPA, filed a cost recovery action in October 1983. They were seeking reimbursement for costs expended by the EPA for the removal action and expected expenditures during the remedial action. The complaint named Baird & McGuire, Inc., Baird Realty Company, Inc., Cameron M. Baird, and Gordon M. Baird as defendants. The EPA identified these defendants as the sole Potentially Responsible Parties (PRPs). The PRPs early on stated they lacked the financial assets required to conduct the remedial actions and that they were not liable. As a result, EPA determined that the PRPs were unable financially and unwilling to implement the full remedy for the site. Settlement negotiations were initiated and to date are still ongoing. Due to the lack of financially viable PRPs and the requirement for immediate response to protect the public welfare and environment, EPA decided to fund the clean up itself while settlement negotiations are continuing. This site is, therefore, funded 90% with Superfund monies and 10% through state funding.

3.1.3 The Role of the U.S. Army Corps of Engineers

The United States Army Corps of Engineers (USACE) are the Nation's engineers. This organization has a long history of supporting both peacetime and wartime construction needs. The Corps' involvement and working relationship with their industry counterparts are unparalled. USACE has developed an expertise in value engineering through its supervision of the contracting, management, and construction of the Nation's dams and locks, defense infrastructure, and overseas bases. Due to

---

[28]Ibid, pp. 17-18.

its wide range of work, the Corps may have more organizational lessons learned than most of the large construction corporations.

USACE's current role has changed little from its historical one. They remain the primary construction organization for the U.S. Army, the Department of Defense, and the Federal government. What has changed is its increased involvement in the environmental arena. The Corps' recent and ongoing management of wetlands, combined with its history of waterway infrastructure management, gives it problem solving experience and expertise beyond that of any other federal agency. This has effectively brought together the construction industry, environmental services, the EPA, state and local government, and public interests.[29]

The remedial actions required for the Baird & McGuire site were valued at much greater than $5 million. Also as stated earlier, EPA took the lead in funding the clean up of the site. In an EPA fund-lead cleanup, that is in excess of $5 million, USACE manages the design and construction.[30] For these stated reasons, USACE is the contracting agent and construction manager, at no risk, for the Baird & McGuire site.

The Omaha District, USACE contracted for design through the traditional approach. At the time Baird & McGuire was designated a hazardous waste site, USACE's expertise in the remediation work was limited to two of its forty districts. The Omaha and Kansas City Districts of

---

[29]Rossi, p. 31-33.

[30]Erickson, Randall L., Environmental Remediation Contracting, Wiley Law Publications, 1992, p.16-17.

the Missouri River Division of the Corps headed the Army's remediation efforts through a centralized program. These two districts, initially had the only staffs with expertise in this field. Each district was responsible for the design and construction work in one-half of the EPA regions (Figure 3.2). Omaha hired and supervised professional A/E firms to do all the design work. The Omaha District then transferred the plans, specifications, and construction contracts to the closest Corps' district for engineering and construction management.

During 1990, the Corps changed from a centralized method of controlling design and construction to a more decentralized system. Currently, USACE has eleven regional contracting offices. The decentralized system provides smaller firms a greater opportunity to obtain work. Also, this system increases the opportunity to gain additional environmental remediation expertise throughout the Corps.[31]

3.2 SITE HISTORY[32]

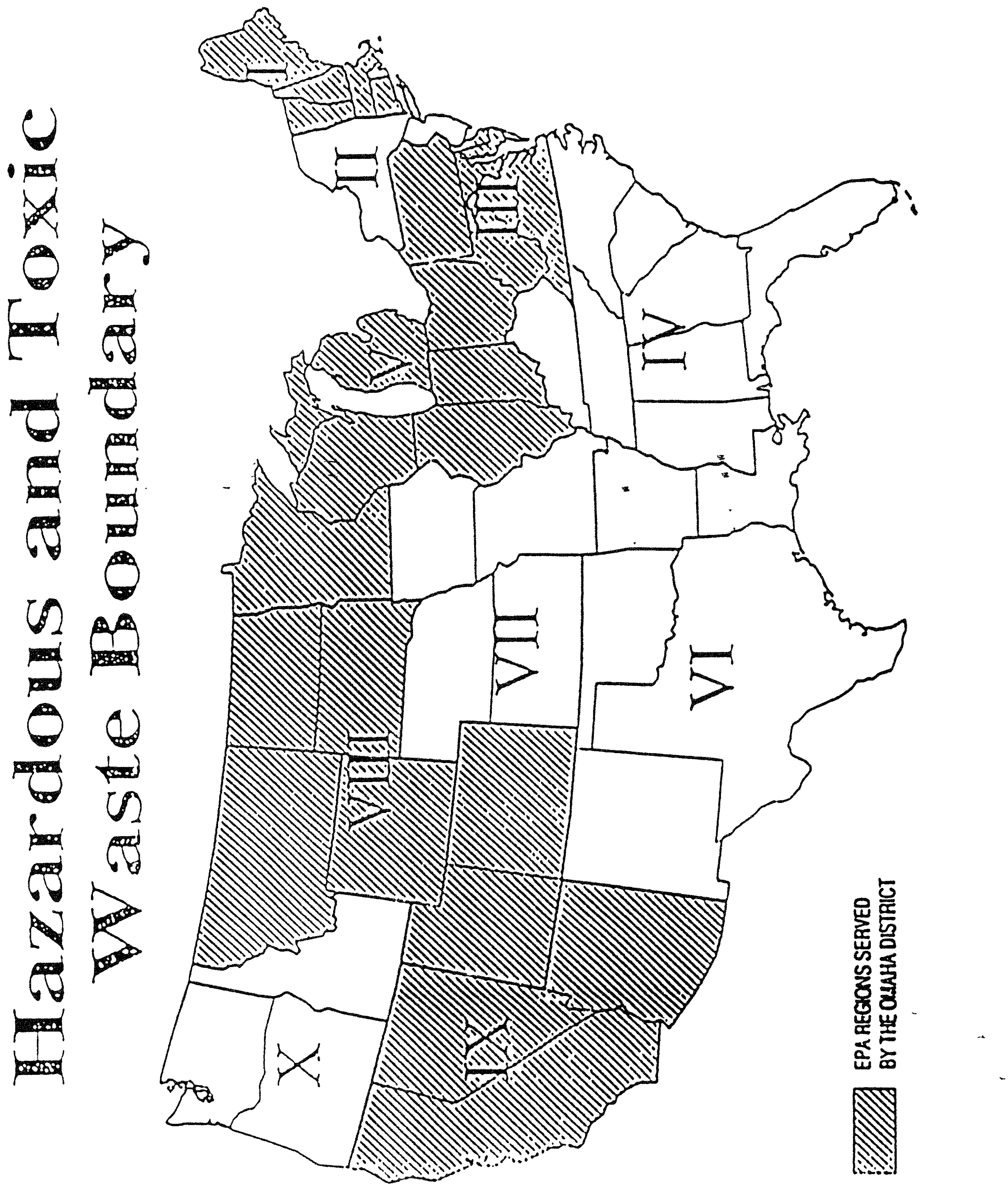
Eight of the twenty acres comprising the site were owned by Baird & McGuire, Inc. The company started its operation in 1912 and during the past 70 years, it operated a chemical manufacturing and batch facility on the property. The firm's activities included mixing, packaging, storing, and distributing a variety of products. These products included herbicides pesticides, disinfectants, soaps, floor waxes, and solvents. The original facilities consisted of a laboratory, storage and

---

[31]Ibid, p. 17.

[32]U.S. Environmental Protection Agency, "The Baird & McGuire Site Construction Update," Countdown to Cleanup, Vol. 2, Fall 1993

Figure 3.2

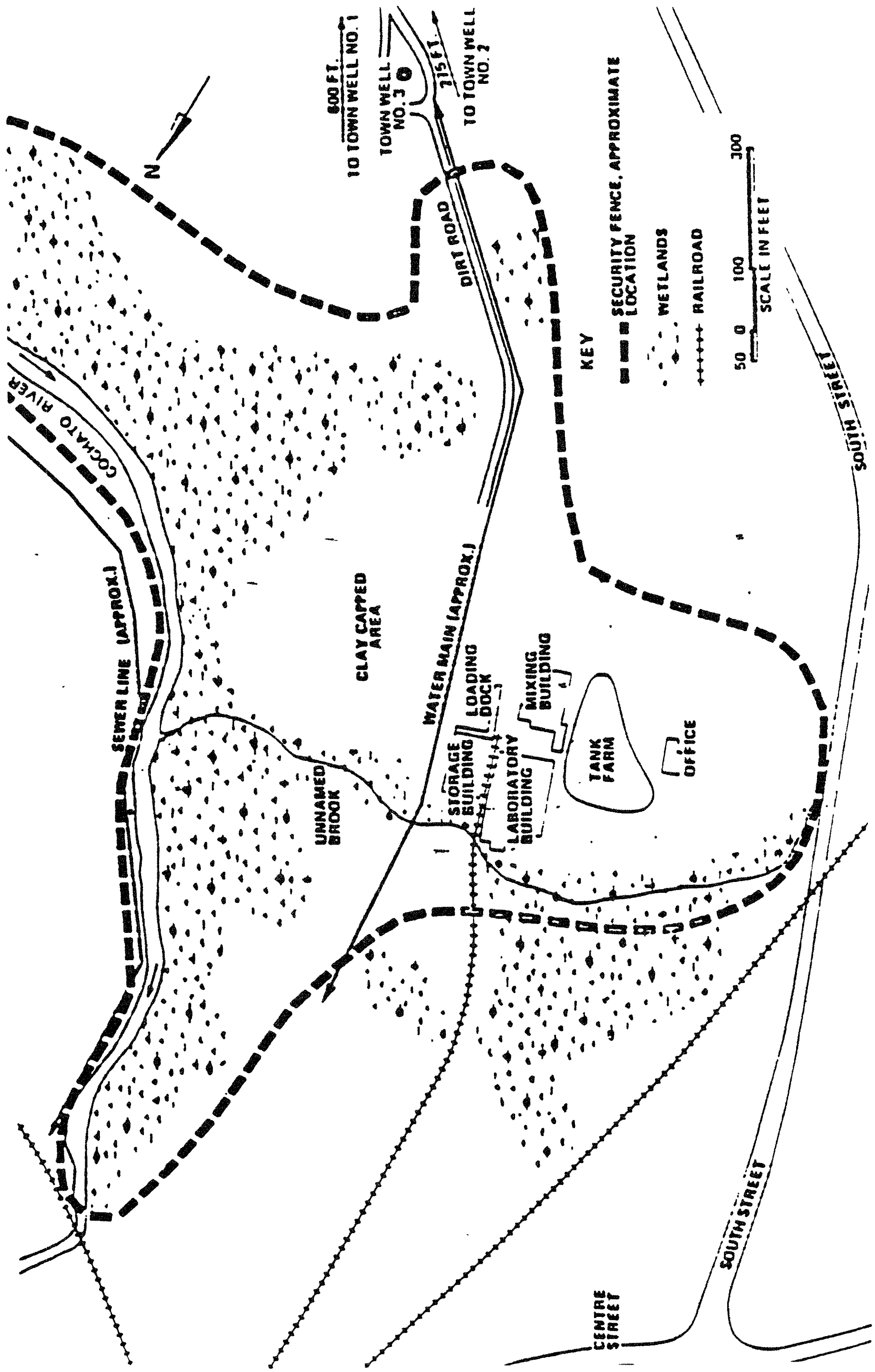

Hazardous and Toxic
Waste Boundary
I
II
III
IV
V
VI
VII
VIII
IX
X
EPA REGIONS SERVED
BY THE OMAHA DISTRICT

mixing buildings, office buildings and a tank farm. Figure 3.3 shows the site layout and various facilities during the time Baird & McGuire was at full operation. Baird & McGuire stored its raw materials at its tank farm and piped these materials to its laboratory and mixing facilities. Also, raw materials were stored in drums on site. Waste disposal methods included discharging directly into the soil, a nearby brook and wetlands, and gravel pit (since covered and sealed). Underground disposal systems were also used for waste disposal.

In 1982 the site was placed on the Environmental Protection Agency's (EPA's) Proposed National Priorities List (NPL) and became eligible for federal Superfund cleanup funds. Baird & McGuire, Inc. stopped its operation on this site in 1983. The EPA conducted removal actions after a waste lagoon overflowed near the Cochato River, spreading contaminants. In 1985 a second EPA removal action was implemented after dioxin was discovered in site soils. A Remedial Investigation (RI) was completed on the 20-acre soils, groundwater, and surface water in 1986. In 1989, additional investigations were conducted that addressed the contamination in the Cochato River environment which included wetland restoration. Record of Decisions (RODs) were completed in 1986, 1989 and 1990 based on the previously mentioned RIs.

The EPA, through the Omaha District, U.S. Army Corps of Engineers (USACE) contracted with the design firm of Metcalf & Eddy for the design of the remediation effort. The design, civil engineering in nature, provided performance specifications that defined the limits and depth of excavation, layout for the treatment facilities,

Figure 3.3


N
600 FT.
TO TOWN WELL NO. 1
TOWN WELL NO. 3
215 FT.
TO TOWN WELL NO. 2
KEY
SECURITY FENCE, APPROXIMATE LOCATION
WETLANDS
RAILROAD
50 0 100 300
SCALE IN FEET
DIRT ROAD
COCHATO RIVER
SEWER LINE (APPROX.)
CLAY CAPPED AREA
WATER MAIN (APPROX.)
LOADING DOCK
MIXING BUILDING
STORAGE BUILDING
LABORATORY BUILDING
TANK FARM
OFFICE
UNNAMED BROOK
SOUTH STREET
SOUTH STREET
CENTRE STREET

elevations, and criteria for performance standards.[33] Upon completion of the design, the Omaha District transferred contracting and construction responsibility to the New England Division (NED), USACE.

Under NED supervision, construction of systems to treat the contaminated materials began in 1990. NED awarded Barletta Engineering of Rosindale, Massachusetts a contract to construct and operate a groundwater treatment plant valued at $13.9 million. The plant was completed in 1992. The soils incinerator contract, with capital costs of $57.9 million, was awarded in 1992 to OHM Remediation Services, Inc., which had a local office located in Hopkinton, Massachusetts. In 1993, the Cochato River sediment dredging contract, valued at $750,000, was awarded to Site Remediation Services, Inc. of East Windsor, CT. However, NED is currently reviewing this contract since the offeror underbid an independent government estimate by $500,000. Each firm responding to the advertisement underwent pre-qualification screening to ensure competency and previous experience. With an underbid on such a magnitude, NED is concerned that even though Site Remediation Services passed the pre-qualification screening, the firm may not have the necessary experience and/or competence to undertake this type of work.

3.3 Characterization of Contaminants[34]

3.3.1 SOILS

During the Remedial Investigation (RI), 73 soil samples were taken and analyzed. 217 additional soil

[33] Henry, Fred, Contract Specialist, Contracting Division, Omaha District, U.S. Army Corps of Engineers, Omaha, Nebraska, interview of May 12, 1994.

[34] ROD, September 1986, p. 10-15.

samples were taken during the RI Addendum field programs. The site was not homogeneous in terms of geology, soils, hydrology or contamination. Therefore, the site was divided into eleven distinct zones and samples were taken from each zone.

Areas with the highest levels of soil contamination included the tank farm, under and around buildings, and under the capped portion of the site. Soils in outlying areas, such as the north and south wetlands, were determined to be less contaminated than soil in plant and cap areas.

Volatile organic compounds (VOCs), dioxin, polynuclear aromatic hydrocarbons (PAHs), organic compounds, pesticides, and inorganic chemicals including lead and arsenic were detected. Migration of these contaminants was via storm water runoff, ground water, and surface water. The RI determined that the site soils were the source of the ground water contaminants.

3.3.2 GROUNDWATER

The principal contaminants detected in the groundwater were similar to those found in the site soils. Infiltration of precipitation through the contaminated soils has been determined to be the main source of groundwater contamination. The contaminated groundwater is leaving the site in a plume originating at the former tank farm. It is believed that the groundwater discharge is partially responsible for the contaminants in the river sediment and the adjoining wetlands. Although the intercepter/recirculation system currently in operation at the site has significantly reduced the migration of contaminants, the plume may continue to migrate further.

The plume originates at the Baird & McGuire facility and extends east towards and to a limited extent beyond the Cochato River. This plume runs beneath those soils which received the bulk of contamination from the company's disposal practices previously discussed. The core of the contaminated plume is characterized by levels of total base/neutral and acid extractable organics exceeding 10,000 ppb. Also, levels of total aromatic and chlorinated volatile organics exceeding 1000 ppb and 100 ppb, respectively, were detected. The southern portion of the plume is skewed somewhat more than what would be expected. This may have been caused by residual effects of pumping from the South Street well field or by hydrogeologic factors.

3.3.3 SURFACE WATER

The RI detected no site related contaminants. The contaminants were effectively trapped in the Cochato River sediment and were not migrating down river. The fish that are contaminated with pesticides are located in the Sylvan Lake to the north of the site. Signs are posted warning individuals fishing in the lake not to eat the fish that are caught.

3.3.4 SEDIMENTS

VOCs, organic compounds, and pesticides, including DDT and chlorade, were detected. The highest levels of contamination was located on site and within 500 feet down river of the Superfund boundary fence. The RI revealed that the contaminants may migrate further down river during major storms when the river is the most turbulent. Also, PAHs were found in the tributaries which indicated additional sources of contamination in the Cochato River watershed.

3.4 Selection of Treatment Technologies[35]

The Record of Decision signed in 1986 divided the cleanup of the Baird & McGuire site into four operable units or phases. These operable units are:

1) Remediation of groundwater.

2) Remediation of the soil.

3) Remediation of the sediment in the Cochato River.

4) Establishment of an alternative water supply to replace that lost as a result of the Baird & McGuire industrial activities. Operable units are used by the EPA when the cleanup of a site can be conducted more efficiently by identifying distinct components of the remediation effort and addressing each individually.

The overall cleanup levels required at the Baird & McGuire site reduce the risks at the site to at most a one in 10,000 chance of one additional cancer occurrence as a result of exposure to residual contamination after cleanup. Currently it is not possible to reduce site risks to zero (0). Table 3.1, below, however, illustrates that the remediation effort will reduce the risks presented by the site to one hundred times below the levels that would exist were the site left untreated.

[35]U.S. Environmental Protection Agency, "The Baird & McGuire Site Construction Update," Countdown to Cleanup, Vol. 1, April 1992.

TABLE 3.1[36]

Risk for cancer in the U.S. (American Cancer Society):	1 in 3
Risk of additional cancer occurrence currently posed by:	
Drinking contaminated groundwater from the site:	1 additional incidence of cancer
Playing in certain site soil:	2 additional incidence of cancer
Risk of additional cancer occurrence posed after site is cleaned up:	1 additional incidence of cancer

3.4.1 Groundwater

The 1986 ROD focused on groundwater (Operable Unit #1) and soil (Operable Unit #2) contamination. The ROD established the extraction and on-site treatment of groundwater as the treatment technology for the remediation of groundwater. This technology called for the contaminated groundwater to be pumped from six extraction wells located on the site to the groundwater treatment plant (GWTP). The GWTP contains processes to remove solids, metals, and organic contaminants. The metals are removed in two stages. Arsenic is removed by precipitation at a relatively neutral pH in the first stage. In stage two other metals are removed at a higher pH. The metallic sludge produced during the metallic removal process is then dried and transported to an off-site disposal facility. Upon removal of the metals from the groundwater, most of the organic contaminants are removed using a biological treatment process. This process consists of micro-organisms eating the organics in the presence of oxygen.

[36]Countdown to Cleanup, Vol. 1, April 1992, p.5.

The biological sludge created is then dried and disposed of in the on-site incinerator or in an off-site landfill. Following this procedure, the groundwater is pumped to a sand filtration system where more solids are removed. Carbon adsorption columns are the last step in the process to remove any remaining organic compounds. The treated groundwater is then reinjected into the aquifer.[37] Figure 3.4 depicts the entire groundwater treatment process. Upon completion of the GWTP facility, the contractor will operate it for one year. Also, the contractor will accept transfer of up to 100 gpm of surface water for treatment from the Operable Unit #2 operations.[38]

3.4.2 Soils

As stated in the section above, the 1986 ROD also established the treatment technology for the on-site contaminated soil. Accordingly, contaminated soils would be treated using on-site incineration. The type of incinerator, rotary kiln, was selected in part on its ability to meet the cleanup standards and the nature of site contaminants. The performance specifications delineated for this treatment technology are to maintain a minimum of 99.99% destruction and removal efficiency of all organic contaminants, except for dioxins and furans for which 99.9999% destruction will be required. Soil will be excavated to a depth approximately one foot below the seasonal low groundwater table. The water table will be artificially lowered using a series of wells and pumps in order to excavate below the water table.

Approximately 200,000 tons of contaminated material

---

[37]U.S. Environmental Protection Agency, "The Baird & McGuire Site Construction Update," Countdown to Cleanup, Vol 2., Fall 1993, p. 2.

[38]Acquisition Plan, Baird & McGuire Superfund Site, p. 1.

will be treated. This will include approximately 193,000 tons (142,000 cubic yards) of soil and building foundation material; 2,000 tons of trees, shrubs, and roots removed during clearing and excavation; and 5,000 tons of other combustible materials including the contents of the remaining site buildings, and remains of previously demolished buildings. Figure 3.5 depicts the operation of the incinerator.[39]

3.4.2.1 Concerns About Incineration

The source document for the establishment of treatment technology, 1986 ROD, contained the characterization of contaminants. The ROD, in establishing the technology to be utilized, selected approximately 106 target compounds to be treated. In selecting the technology, it was determined these contaminants could be destroyed and others could be destroyed in the process. However, two metals, lead and arsenic, could possibly present problems.[40]

Lead - is a naturally occurring metallic element found in all parts of the environment, including air, food, soil, and water. During a variety of daily activities, such as drinking and eating, humans are exposed to lead. The typical air concentration of lead in the environment is approximately 0.1 to 2.0 ug/m^3.

Arsenic[41] - Arsenic is also a naturally occurring metallic element found almost everywhere in the environment. The average person consumes approximately 45 ug/m^3 of different forms of arsenic every day. Except at

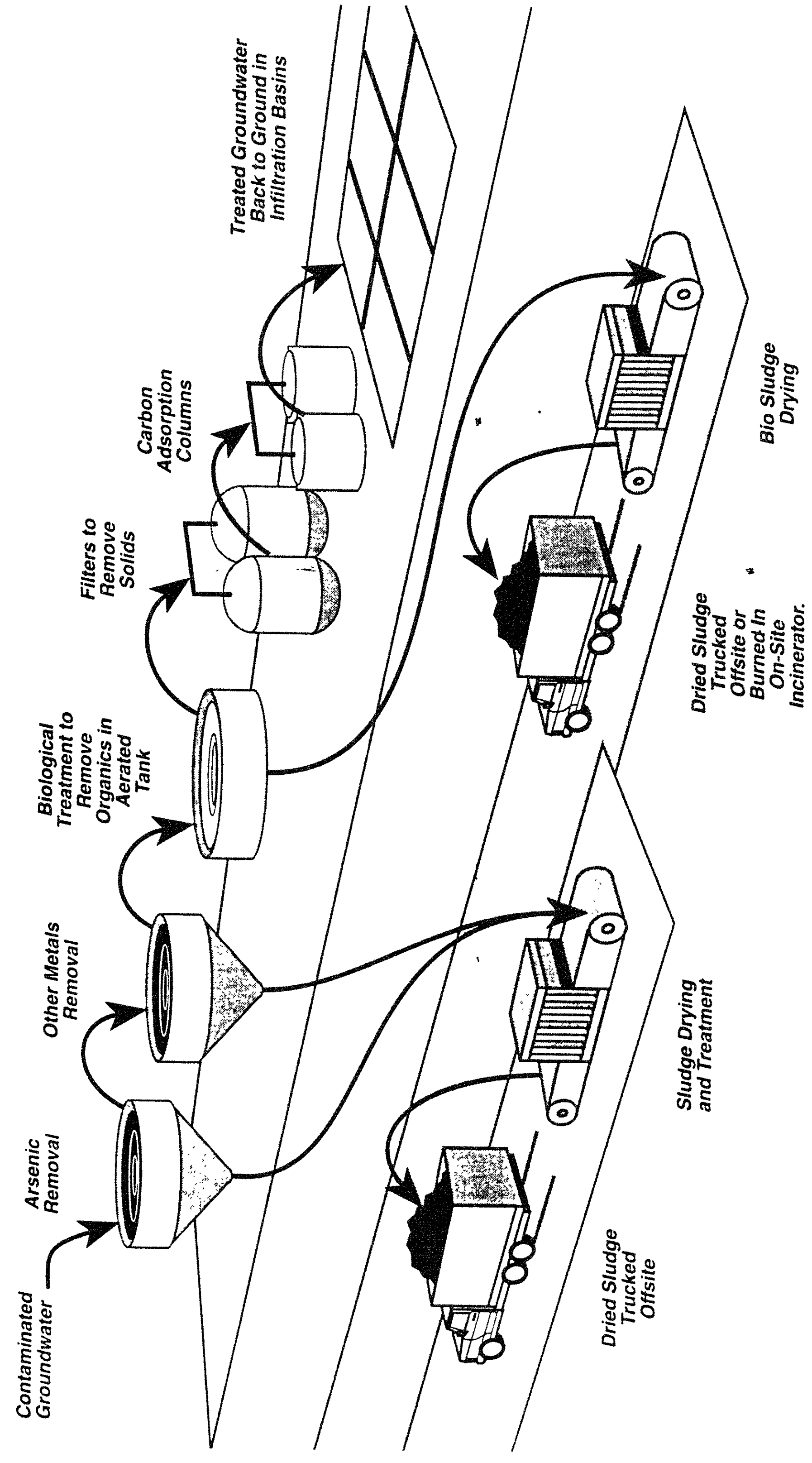
---

[39]Countdown to Cleanup, Vol. 2, Fall 1993, p. 4.

[40]Henry, interview of May 12, 1994.

[41]Ibid, p.7.

Figure 3.4


Contaminated Groundwater
Arsenic Removal
Other Metals Removal
Biological Treatment to Remove Organics in Aerated Tank
Filters to Remove Solids
Carbon Adsorption Columns
Treated Groundwater Back to Ground in Infiltration Basins
Dried Sludge Trucked Offsite
Sludge Drying and Treatment
Dried Sludge Trucked Offsite or Burned In On-Site Incinerator.
Bio Sludge Drying

high exposure levels, it does not have a strong tendency to accumulate in the body and is routinely processed by the kidneys and excreted in urine.

EPA Plan to Limit Emissions[42] - In selecting soil incineration technology, the EPA set a limit on arsenic release from the incinerator so that the potential increased cancer risk from incinerator operation is held to no more than one in one million. The Baird & McGuire incinerator emission standard for arsenic dictates that no more than 0.004 ug/m^3 of arsenic will be measurable at any point in the environment. By meeting the stricter arsenic standard, all metals in the soils will be kept below the allowable emission levels and will not be of significant concern during incineration.

3.4.2.2 Soil Contamination Treatment Options

Public health and environmental objectives for the site included:

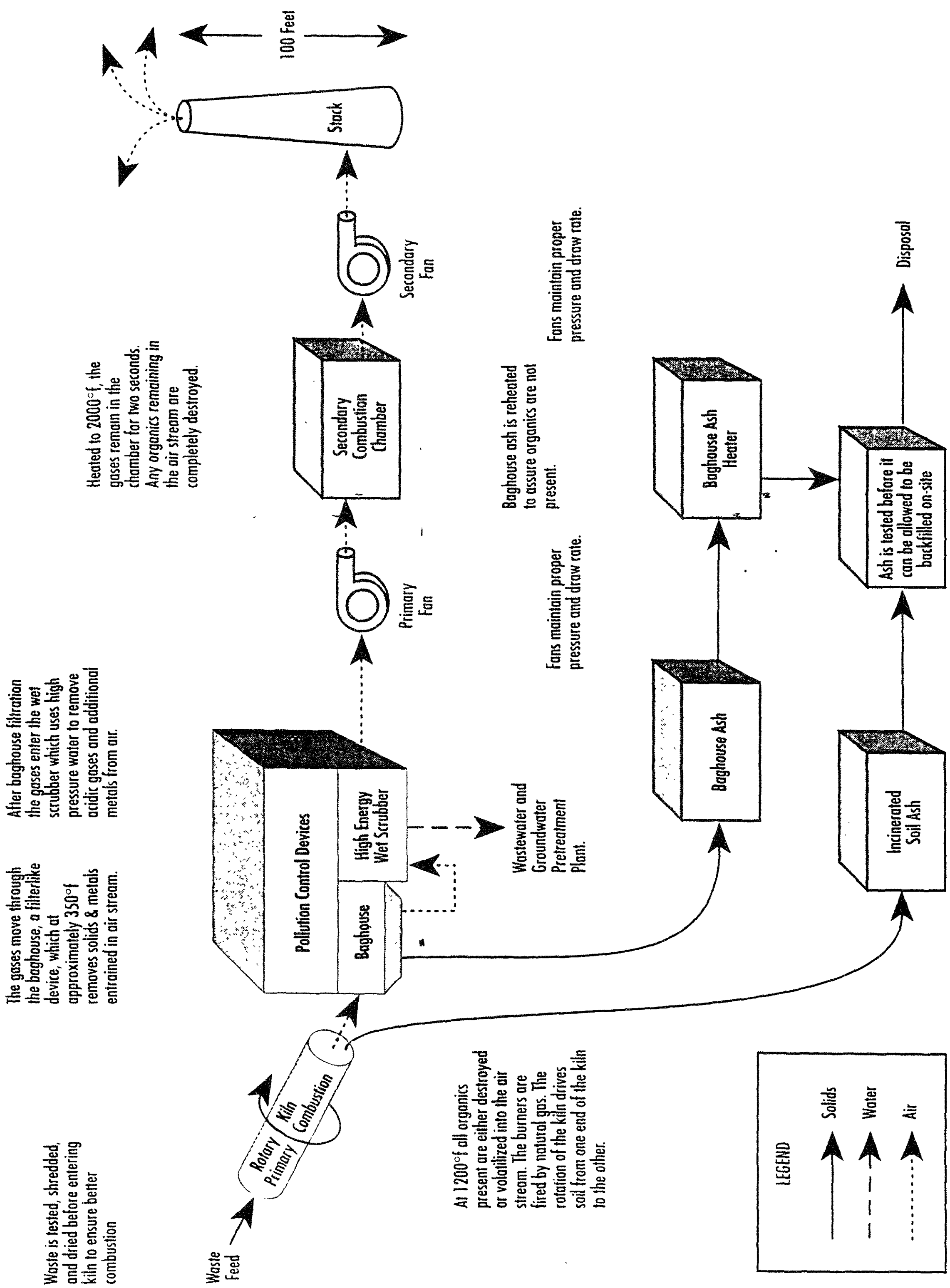
- Minimizing risk for humans of direct contact with contaminated soils and sediment.
- Protection of surface waters from future migration of contaminants.
- Minimizing long-term management and/or maintenance requirements.

The EPA considered five different alternatives to accomplish the above stated objectives: (1) No action; (2) Off-site treatment or disposal; (3) Alternative that would exceed established standards; (4) Alternatives that did not meet standards; and (5) Options that attained standards.

In its evaluation of these five alternative treatment methodologies, the EPA considered four factors. The first factor considered was whether an off-site dioxin treatment

[42] Ibid, p.7.

Figure 3.5


Waste is tested, shredded, and dried before entering kiln to ensure better combustion
Waste Feed
Rotary Primary Kiln Combustion
At 1200°f all organics present are either destroyed or volatilized into the air stream. The burners are fired by natural gas. The rotation of the kiln drives soil from one end of the kiln to the other.
The gases move through the baghouse, a filterlike device, which at approximately 350°f removes solids & metals entrained in air stream.
After baghouse filtration the gases enter the wet scrubber which uses high pressure water to remove acidic gases and additional metals from air.
Pollution Control Devices
Baghouse
High Energy Wet Scrubber
Wastewater and Groundwater Pretreatment Plant.
Primary Fan
Fans maintain proper pressure and draw rate.
Heated to 2000°f, the gases remain in the chamber for two seconds. Any organics remaining in the air stream are completely destroyed.
Secondary Combustion Chamber
Secondary Fan
Fans maintain proper pressure and draw rate.
Stack
100 Feet
Baghouse Ash
Baghouse ash is reheated to assure organics are not present.
Baghouse Ash Heater
Incinerated Soil Ash
Ash is tested before it can be allowed to be backfilled on-site
Disposal
LEGEND
Solids
Water
Air

or disposal facility existed due to the presence of dioxin detected in the soil. Secondly, the EPA kept in mind that 66% of the contaminated soil ares were located within the 100 year floodplain. Also, 44 % of the contaminated soil areas were classified as wetlands. Lastly, the fact that underlying bedrock was fractured and carried contaminated groundwater was used in the EPA's decision making process.

No-Action/Limited Action - This particular alternative consisted of demolishing the Baird & McGuire building; maintaining site fencing; covering contaminated soil with clean soil; discontinuing the groundwater recirculation system; and periodic environmental monitoring. The cost of this option was $940,000. The EPA rejected this proposal on the basis that the risks associated with the site after these actions would still be present at unacceptable levels. Another reason for rejection of this option was the long-term (30 years) requirement for quality monitoring of groundwater and surface water.[43]

Off-Site Treatment or Disposal - The EPA rejected this proposal on the basis that no off-site facilities permitted to treat or dispose of dioxin contaminated materials existed at the time in the United States.[44]

Exceeding Standards Option - It was not possible to develop an option that would exceed all applicable, relevant or appropriate requirements. This was due to the extent of the contamination at the site and background contamination present in surrounding areas.[45]

---

[43]ROD, September 1986, p. 21-22.

[44]Ibid, p. 20.

[45]Ibid, p. 20.

Not Attaining Standards Option (Landfilling) - The EPA entertained possible utilization of three landfill alternatives. Principal components of these three alternatives included:

1) Excavation of between 100,000 and 250,000 cy of contaminated soil.

2) Disposal of the soils in a hazardous waste landfill constructed on-site.

3) Installation of an impermeable cap over the former creosote lagoon.

4) Capping of portions of the Cochato River.

5) Operation of a GWTP on-site for between ten and sixty-five years.

6) Monitoring the site for at least thirty years.

No treatment of soils or sediment would occur, nor would any contaminants have been removed. Cost for the three different landfill alternatives ranged between $14.7 and $18 million depending on the quantity of soil excavated. These alternatives did not meet EPA's objectives since contaminated soil and sediment would have remained on-site. The EPA also rejected this approach due to the required lengthy period of monitoring and maintenance of the cap.[46]

Attaining Standards - Two alternatives were considered that met the established standards. The first option prescribed a RCRA Cap to be constructed. Contaminated soil was excavated to a four foot depth and then transported to a location on site. At this location, the contractor would construct a cap meeting RCRA approved design criteria. This is a proven and known technique and is capable of being constructed. The EPA rejected this option based on the fact that large quantities of contaminated wastes would remain on site and the possibility of contact with the

---

[46]Ibid, p. 22-25.

groundwater. Also, bearing on the decision to reject this option was the long-term (38 years) to treat the groundwater.

The second method that achieved standards was soil incineration. This option called for excavation of approximately 200,000 cubic yards of contaminated soil. An on-site incinerator is used to thermally decompose the contaminated soil. The EPA elected this technology since it was a known and proven method that met all regulatory requirements. There would be no interim storage of wastes and no permanent loss of wetlands. Also, the estimated time to treat the groundwater was ten years which was substantially less than any of the other alternatives.[47]

3.5 Soil Incineration Contract

3.5.1 Acquisition Plan

The phase of the remediation effort that is currently being executed is the soil incineration work. As stated previously, this is the focus of this case study and will provide insight into the contracting aspect of remediation of hazardous waste sites. NED estimated the contract for this portion of the remediation work to be in excess of $60 million and designated the contract as service in nature versus commodity. Thus, an acquisition plan was required to be prepared.[48] The plan proposed a request for proposal with source selection procedures. The awarding of the contract was made to the firm determined to be in the best interest of the government in accordance with the predetermined source selection plan.

---

[47]Ibid, p. 30-32.

[48]Federal Acquisition Regulation, part 7.103, February 1992.

3.5.1.1 Scope of Work[49]

The scope of work for the remediation contaminated soil included the following:

1) Site preparation: activities consisted of but were not limited to clearing, grubbing, and construction of roadway.

2) Excavation: excavation and dewatering of contaminated soils from the excavation zone.

3) Thermal destruction unit: construction, trial burn, and operation of an on-site thermal destruction unit.

4) Air monitoring: monitoring at the stack, excavation zone, support zone, and fence line.

5) Wetlands restoration: restoration of wetland areas impacted by excavation.

3.5.1.2 Risks

Technical - The technical risk associated with this phase of the total remediation effort concerns the attainment of performance levels established by the EPA. These performance levels were discussed in section 3.3 of this chapter. The EPA and NED both were of the opinion that incineration would attain the level of safety required. Incineration is a proven technology. Rotary kiln, infrared and fluidized bed mobile units have been used primarily at Superfund sites. The destruction and removal efficiency achieved for waste streams typically exceeds 99.99%.[50] Although the effectiveness for metal contamination is an issue, the stricter arsenic limits established will ensure all other metals will be kept below the allowable emission levels and will not be of

---

[49]Contract DACW45-92-C-0047, OHM Remediation Services, Baird & McGuire Superfund Site, March 30, 1992.

[50]Camp, Dresser & McKee, MIT course 1.972, Environmental Restoration Engineering, Department of Civil and Environmental Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts, Spring 1992.

significant concern during incineration.

Cost[51] - The Corps chose to advertise a contract that was firm fixed price with fixed unit prices for the incineration portion of the remediation of the site. By adopting this type of contract, the risk is borne by the contractor. USACE, however, perceived that the overall cost risk was minimal since the contaminants are known and a good estimate of the quantities was accomplished. Other elements of the work are clearly identifiable and can be fixed as lump sum. Possible cost risk that the Corps foresaw that would increase the cost included: inability to meet incineration specifications, a change in incineration standards, differing site conditions, and third party liability if EPA did not indemnify the contractor.

Performance Bonding - FAR 28.103-1 states that agencies shall not require performance and payment bonds for other than construction contracts. This contract for incineration was categorized as a service contract. Therefore, NED did not require a performance bond of the contractor. FAR 28.103-2 lists situations that may require a performance bond of the contractor to protect the government's interests. The situations requiring a bond in this instance did not apply.

The risk the New England Division (NED), USACE had to bear revolved around the issue of contractor default with no performance bond to compensate reprocurement costs. NED took into consideration this issue by full and effective use of the Source Selection Process. By doing such, it provided the government the opportunity to select the best

---

[51]Acquisition Plan, Baird & McGuire Superfund Site, March 10, 1992, p. 3.

qualified of all proposing firms. Also, NED attenuated the risk by paying milestone payments for work actually completed. The upcoming trial burn is the first milestone. Additionally, a portion of the milestone payments is retained until the contracting officer's representative approves the work accomplished.

The funds saved by forgoing performance bonds will be available to reprocure the remainder of work in the event the contractor defaults. Historically, costs of bonding hazardous treatment of waste work has been substantially above that normally incurred with conventional construction work. USACE estimated the performance bond for the Baird & McGuire site would have been 10% of the total cost.[52]

Payment Bonding - Generally, a payment bond is required only when a performance bond is required of the contractor or if it is in the best interest of the Government.[53] The work to be accomplished at the site is performed in a heavily unionized part of the country. There is a concern that sub-contractors and suppliers might not get paid and the only recourse to NED is litigation. Also, the project is important and highly visible. Therefore, USACE, in the best interest of the government, required a payment bond of the contractor.[54]

3.5.2 Source Selection Procedure

The Source Selection procedure adopted by NED appointed a contracting officer as the source selection

---

[52]Acquisition Plan, p.4.

[53]Federal Acquisition Regulation, 28.102-2, February 1992.

[54]Acquisition Plan, p.5.

authority. A Source Selection Evaluation Board (SSEB) was established consisting of a board chairman, technical representatives from Omaha District, USACE, EPA, Missouri River Division, USACE, and NED. All the representatives were chosen for their expertise and experience in environmental remediation. A request for proposal invited firms to evaluate site conditions during scheduled pre-proposal conferences and propose an appropriate incineration technology. The primary evaluation factors used to rank proposals were technical, firm's experience and capabilities, and cost.[55]

3.5.3 Contractor Selection

3.5.3.1 Firms Responding to Request for Proposals

There were twelve firms that responded to USACE's RFP:[56]

1) IT
2) OHM Remediation Services
3) EBASCO
4) Weston
5) Chemical Waste Management
6) Thermo Cor, INC
7) AWD Technologies
8) Davis-Allis JV
9) Halliburton NUS
10) IDM/MRK
11) D&C Construction
12) ALCON Demolition

Of these twelve, the last three firms listed were deemed to

[55] Acquisition Plan, p.6.

[56] Source Selection Board - Selection Justification, On Site Incineration, Baird & McGuire Superfund Site, RFP DACW 45-90-R-0065, March 19, 1992, pp.2-5.

be outside of the established competitive range due to a failure to provide the required information.[57]

3.5.3.2 Technical Data and Past Project Experience

Of the two lowest price/cost proposals, OHM Remediation Services was viewed as being above Davy-Allis JV, Inc. in several elements. In the area of safety and health, OHM was seen as having more experience which was critical to community relations and to community safety and health. D-A JV had proposed to staff a significant project position, Health and Safety Technologist, with alocal sub-contractor. Another area in which OHM's proposal ranked above D-A JV was in air modeling and monitoring. This area was also critical to community relations and safety and health. OHM developed a very thorough description of its sub-contractor management procedure in the management plan portion of the proposal. It proposed the use of major sub-contractors limited to three specialized areas of analytical services for soil and water analysis; air modeling and monitoring; and restoration of uplands and wetlands. OHM would accomplish all other areas of the project as the prime. OHM proposed to hire only a small number of laborers, equipment operators, and incinerator operators to supplement its own personnel. OHM had considerable experience in the area of contracts undertaken as a prime contractor for hazardous waste treatment which aided in scoring above D-A JV. OHM has 22 years of environmental remediation experience in over 12,000 projects. These projects include numerous ones that were multi-million dollar projects. Of particular interest to

---

[57]Memorandum for File, Record of Evaluation for RFP# DACW 45-90-R-0065, On Site Soil Incineration, Baird & McGuire Superfund Site, March 20, 1992, p.5.

USACE, was the fact that OHM at the time was the largest HTRW remediation contractor within Engineering News Record's list of top 20 in the May 1991 issue.

Davy-Allis JV was viewed as the next best of the two lowest price/cost proposals. One factor that contributed to its lower scoring was their proposal to use seven sub-contractors specializing in the areas of: trial burn plan and permitting; air modeling; analysis laboratory services; stack emissions monitoring; and uplands and wetland restoration. Additionally, the firm proposed to staff some significant project positions with local individuals including a construction scheduler, a quality control inspector, and an air modeling technician. The use of a large number of sub-contractors was perceived to have a high potential for causing coordination problems in work schedules. Another factor that played a part in D-A JV coming in second to OHM was the incorporation of a number of significant changes to their original proposal in response to statements of clarification developed by the SSEB. These changes included design of the thermal destruction unit, additional analytical laboratory services, and a completely different dewatering system.[58]

3.5.3.3 Other Contributing Factors

OHM selection as the contractor for the soil incineration phase was enhanced by some other important considerations. One consideration was the previous experience OHM had with trial burn procedures using their infared incinerator. The fact that OHM was not adding lime to the incinerator feed was also a contributing factor. OHM was only one of two firms to respond to the RFP that

[58]Source Selection Board - Selection Justification, pp.1-2.

scored above 90% of the total points allowed. After rescoring the best and final offers, OHM scored 916 out of 1000 points as compared to IT Corporation's 918. D-A JV scored 846 which earned a ranking of number six. OHM's price proposal was $57.8 million versus $75.9 million IT had proposed. USACE determined that the point difference after rescoring was insignificant when compared to the vast difference in price/cost data.[59] Table 3.2 shows the Competitive Range scores.

TABLE 3.2[60]

FIRMS	ORIG PTS TECH/EXPER	ORIG PRICE $ MILLION	RESCORED TECH/ EXPER	BAFO PRICE $ MILLION
IT CORP	536/381 TOT: 917	$81.9	541/377 TOT: 918	$75.9
OHM	529/368 TOT: 897	$64.4	537/379 TOT: 916	$57.8
EBASCO	499/376 TOT: 875	$68.0	508/381 TOT: 889	$67.7
WESTON	502/358 TOT: 860	$81.6	508/358 TOT: 866	$78.7
CHEMICAL WASTE MANAGE-MENT	481/374 TOT: 855	$59.3	494/374 TOT: 868	$58.6
THERMO COR, INC	461/370 TOT: 831	$70.8	468/370 TOT: 838	$69.7
AWD TECHNO-LOGIES	501/323 TOT: 824	$70.8	468/370 TOT: 838	$69.7
DAVY-ALLIS JV	480/342 TOT: 824	$49.8	504/342 TOT: 846	$49.3
HALLI-BURTON NUS	462/300 TOT: 762	$72.0	473/306 TOT: 779	$72.0

[59]Ibid, p.3.

[60]Ibid, p.4.

3.5.3.4 SELECTION JUSTIFICATION

OHM Remediation Services was awarded the soil incineration contract at a value of $57.8 million. IT Corporation did not present a proposal that demonstrated technical superiority over OHM's which would reasonably justify the payment of $18 million difference in price between the two best and final offers. Davy-Allis proposed a price which was $8.5 million less than OHM's. However, the 72 point difference (32 technical and 34 experience) between D-A JV and OHM demonstrates that OHM has superior experience and technical expertise which made it significantly more advantageous to justify payment of a higher price. The SSEB expressed concern over the fact that D-A JV had loaded a considerable amount of their costs into the trial burn activities which constituted approximately two-thirds of the cost. This was not a reason to reject the proposal but did make it suspect.[61]

3.6 CURRENT SITUATION

The Environmental Protection Agency (EPA) is the owner in this case study. The United States Corps of Engineers (USACE) role in the cleanup effort is as a construction manager not at risk, i.e. as a consulting agency to EPA. USACE's primary focus is overseeing the efficient construction of remediation facilities, contract awarding, and quality assurance. Viewing the total cleanup effort, the organization is seen as multiple primes. USACE, however, divided the remediation project into three phases titled operating units (OU). OU #1 is the treatment of groundwater and construction of a groundwater treatment facility was completed in 1992 and is currently operational. OU #2 is the incineration of contaminated soils. This phase is presently on-going with the contract

[61]Record of Evaluation, p. 6.

awarded in 1992 and construction of the incinerator being accomplished during 1994 as this case study is being written. Currently the status of the project is 35% actually completed as compared to 38% scheduled. The trial burn date was scheduled for May 25, 1994, but is being delayed on a weekly basis by three to four days each week. OU #3 is the dredging of the Cochato River with the contract being awarded late in 1993. Taking each OU separately, the contract method used is general contractor. This case study focuses on OU #2 which is the only phase currently under construction.

3.6.1 Status of Soil Incineration Contract

USACE used the traditional approach with respect to contract scope. As pointed out previously, the design was accomplished by Metcalf and Eddy which was awarded the contract by the Omaha District, USACE. Responsibility for the construction of remediation facilities was transferred from the Omaha District to the New England Division, USACE (NED). The contract for the soils incineration was awarded in 1992. The organization is general contractor with OHM Remediation Services, Inc. as the general contractor. A firm fixed price contract was awarded in the amount of $57.8 million. The contract was awarded through competitive bids from pre -qualified firms.

As of June 1994, several modifications have been made to the original contract which increases the contract amount to $76 million with two more years left to complete the project. The modifications of significance included the following. (1) Purchase of pollution liability insurance by the contractor. The contract required OHM to purchase pollution liability insurance ($5 million per loss/$5 million total for all losses and $100,000 self-insured retention). The insurance protects OHM against any third party liability which results from a release of any harzardous substance or pollutant or contaminant if such release arose from OHM's response action activities. The interesting aspect of this modification was that OHM was reimbursed for the cost of the insurance purchase - $690,000. (2) Construction of incineration and stabilization buildings to house the mobile incinerator and associated facilities could not begin until unsuitable foundation subgrade soils were excavated and suitable off-site materials were used to backfill. The cost of this modification was $675,000. (3) The northern limits of the incineration/stabilization area required extension. Originally, OHM was going to use only 95% of the 2.25 acre area and estimated the extension to be worth $697,000. USACE agreed to $220,000. (4) Further characterization of levels of soil contamination to determine additional limits of soil remediation increased the original contract amount by $150,000. (5) Installation of nine new monitoring wells was negotiated to cost $110,000. (6) The original specifications did not address measures to limit VOC emissions. OHM was required to furnish and install carbon filter sets on the filter system at a cost of $50,000. (7) Indemnification of OHM against any liability, not compensated by insurance or otherwise, which results from a release of any hazardous substance or pollutant or contaminant if such release arises from OHM's response action activities. Thus, risk of liability is borne by EPA and USACE with this modification for any amount above the insurance OHM purchased and was reimbursed for.

The previously stated changes account for approximately $2 million of the $18 million increase in contract price. Accounting for the other $16 million increase in price was the additional quantity of soil that required incineration discovered by the additional characterization of contaminants.

3.6.2 EPA/USACE's Concerns with Contract Structure

The most obvious fault of the current contract structure is in the total cost of the project. The contract was originally awarded in the amount of $57.8 million. Presently, with all modifications, the contract amount has increased to $76 million. The contract called for the project to commence in 1992 and to be completed in 1996. With an additional two years left until completion, the project has already incurred a 30% cost overrun. This negates a major advantage a firm fixed price general contractor contract which is knowing the price of a project prior to the start of construction.

Another problem identified with this contracting method stems from the pressures to increase the contract value. A definite adversarial relationship has been created between OHM and the EPA and USACE. Both EPA and USACE feel that OHM underbid the project in order to win the contract. Therefore, the modifications are perceived as OHM's attempt to increase revenues and profits on the project. Adding to the causes of the adversarial relationship is the fact that OHM is behind schedule and appears to be cutting corners in order to get back on schedule. An example is a recent attempt to change a foundation design without the approval of USACE. OHM has been asked to present USACE with information that shows that their design meets or exceeds the original design specifications. If not, OHM will have to rip out their foundation and construct a new foundation according to the original specifications. These types of issues are contributing to an increasingly adversarial relationship.

The other problem of note is the issue of quality. As OHM falls further behind schedule, their quality checks become less frequent. This is in order to compress the construction schedule in an attempt to get back on schedule. USACE's quality assurance inspections have revealed that OHM has not conducted its required quality control inspections. Requirements to perform these "missed" quality control inspections are further delaying the project.[62]

3.7 Contractor Point of View

3.7.1 Fixed Price Contracts

Generally, the Federal government is risk averse and desires to alleviate itself of all and any risks. Fixed price contracts are the best way to place the burden of risk on another entity. With this type of contract the burden of risk is on the contractor. The government will opt for this type of contract arrangement when it deems the scope of work to be clearly defined and delineated.

The contractor, at the time of advertisement, has two options - to bid or not to bid. He must determine if enough information exists on which to prepare a good estimate of the costs of work to be done. The onus of providing information about the history of the site, its uses, and what contaminants were used during the site's operation rests with the responsible party(ies). There are times when the site has a long history, involving different and various users, and a wide range of materials. This creates a situation where it is difficult to discern what type of contaminants were used or where the contaminants were disposed of on-site. With a lack of information or

---

[62]Project Update Meeting, Baird & McGuire Superfund Site, Holbrook, MA, April 13, 1994.

incomplete data, the firm fixed price bidding process is difficult for the contractor.

Fixed price contracts are competitively bid. This creates another risk for the contractor. If complete or substantially complete information is known, the contractor must bid competitively to win the contract and must assure himself a profit within his bid. For the most part there is a lack of complete information. Contractors, therefore, attenuate the risk by incorporating large premiums within their bids. Another method of attenuation is to submit bids with qualifications. Qualifications to bids address items that, should they occur, will entail a change of scope and the contractor will be reimbursed for costs incurred and profit. However, the need to be competitive often mitigates against the use of these measures.

3.7.2 Profit

Remediation of hazardous waste sites is a business and those working in this market must make a profit to remain in this field. Contractors, when submitting bids on fixed price contracts, realize that site information is never complete. Even though the scope of work may be well defined and a good characterization of site contaminants accomplished, there always exist uncertainties. This is where contractors attenuate their risks. Knowing that uncertainties exists, contractors will bid on the advertised scope of work. Their strategy is to make their profit on changes to the scope of work. Modifications to the original contract will reimburse the contractor for costs incurred and will also include a reasonable profit margin.

3.7.3 Liability

This is a risk that all contractors face while remediating hazardous waste sites. They must insulate themselves by purchasing pollution liability insurance, if it is available in the first place. This is extremely expensive which requires the firm to be financially sound. An alternative is for the contractor to be indemnified by the EPA. Recently, EPA is getting away from indemnification since the availability of insurance is increasing.

3.8 RECOMMENDED CONTRACTING METHOD[63]

3.8.1 ORGANIZATION

Chris Gordon developed a systematic approach to selecting an appropriate contracting arrangement that best suits a project and an owner. The initial step in the selection process is choosing an appropriate organization to conduct the project. The process begins by eliminating organizations that do not meet the needs of the project or the owner. The owner must evaluate three types of characteristics, or drivers, to eliminate inappropriate organizations. The owner first assesses the project's characteristics to eliminate obvious inappropriate organizations. This step includes evaluating time constraints a project may have, the need for flexibility due to changes, value of pre-construction services from the contractor to the project, the degree to which an owner desires interaction during the design phase, and financial constraints.

Next, the owner's characteristics are assessed to further narrow the remaining appropriate organizations if more than one is identified by the project drivers. Owner

[63]Adopted from Christopher Gordon's Compatibility of Construction Contracting Methods with Project and Owners, thesis submitted to the Department of Civil and Environmental Engineering, Cambridge, MA, September 1992.

characteristics, or drivers, include construction sophistication, the owner's current capabilities, how risk averse the owner is, and other restrictions placed on the owner from external sources. Assessing the market's characteristics is the final step in determining an appropriate contract organization for the project and owner. Market characteristics include availability of appropriate contractors, current state of the market, and the package size of the project.

The contract or how the owner will pay the contractor is the next step in the contracting arrangement selection process. The decision should be based on risk allocation. To do make this decision, the owner must first assess the risks involved. Once risks are assessed, the owner should allocate these risks to those who control it and, therefore, are more appropriate to bear the burden of the risk.

The final step of the process, award method, is choosing a method to select a contractor. The methods include competitive bidding, multi-parameter bidding, and negotiation.

3.8.1.1 PROJECT DRIVERS

TIME CONSTRAINTS - With the continual and increased public and political pressure to remediate sites quickly, Superfund sites such as Baird McGuire require fastracking. In this case study, construction was originally scheduled to be completed in four years. The current status is 38% actually completed compared to 45% scheduled. The trial burn for the incinerator was scheduled to take place on May 25, 1994 but is likely to be delayed due to the construction of a foundation for the exhaust hood using a design not approved by USACE. As of July 1994 the trial burn has not yet been accomplished and has been rescheduled for August 1994. Negative public sentiment will increase if further delays take place. Also, the fact that contaminants slowly migrate over large areas with time, requires speed in the remediation effort. Therefore, timely site remediation is an important factor.

FLEXIBILITY NEEDS - The size and complexity of this project favors flexibility during the construction process. The changes and uncertainties associated with this project are evidenced by the previously discussed modifications concerning new monitoring wells and further soil characterization requirements. Therefore, flexibility is an important driver.

PRE-CONSTRUCTION SERVICE NEEDS - The complexity of remediating the Baird McGuire site requires pre-construction services. Although USACE has an abundance of expertise in-house, remediation of hazardous waste sites is not its sole mission. Therefore, advice on remediation technologies and design are required in order to identify and utilize the most appropriate remediation method.

DESIGN PROCESS INTERACTION - Interaction during the design process is a definite requirement. Site remediation is a new and evolving area of construction activity. USACE desires interaction to monitor methods and technologies that will be used. This is evidenced in this case study by the Corps' requirement for an air quality model of possible emissions from the trial burn prior to the actual burn taking place. Also impacting on the interaction issue is the public concern for safe remediation technologies.

FINANCIAL CONSTRAINTS - No outside financing is required. EPA is funding this project through Superfund monies. Additionally, the Commonwealth of Massachusetts is providing 10% of the funds required to clean up the site. Therefore, sufficient funds are available for this project but must be economically utilized.

CONCLUSIONS - There are six contracting arrangements from which to choose, based on either a fixed price or a cost reimbursable contract, as applicable: general contractor, construction manager, design-build team, multiple prime contractors, turnkey team, and build-operate-transfer team. Based on the above analysis of the five project drivers, the controlling factors are:

- Need for fast-track schedule
- Need for flexibility during construction
- Requirement for pre-construction services
- Need for design interaction
- No requirement for outside financing

The evaluation of project drivers indicated that the most appropriate organizations for the Baird & McGuire project are (a) General Contractor on a reimbursable basis; (b) Construction Manager; or (c) Design-Build team on a reimbursable basis.

3.8.1.2 OWNER DRIVERS

CONSTRUCTION SOPHISTICATION - USACE possesses a very knowledgeable organization that has been involved in construction and its administration for a long period of time. However, environmental remediation is a new and evolving field in which USACE has limited experience and expertise. USACE is decentralizing its operations and will in time possess expertise in this field throughout its various district offices.

CURRENT CAPABILITIES - As previously stated USACE has a sophisticated construction organization. However, its experience and knowledge in the remediation of hazardous waste sites is limited. With the down sizing action taking place in today's Army, USACE is experiencing a reduction in staffing but the workload remains the same.

RISK AVERSION - USACE is risk averse. The Corps desires to know costs up front since as a public entity it must answer to the taxpayers. Therefore, USACE monitors contractors' costs and has design process interaction with many environmental consultant firms.

RESTRICTIONS ON METHODS/OTHER EXTERNAL FACTORS - The Federal Acquisition Regulation (FAR) clauses are the primary restrictions placed on public procurement. The FAR is further supplemented by DoD, Department of the Army and USACE, with each being increasingly restrictive. Specifically, FAR 9.507 establish minimum solicitation provisions and contract clause requirements that must be addressed. This clause precludes the use of design-build unless special approval is given.

External factors that are important include the use of small business and disadvantaged contractors for public work. The Davis-Bacon Act requires contractors to pay the prevailing union wage for the work being preformed. This is a major drawback if the union wages are higher than those of non-union wages in the local area. In compliance with this Act, the contractor must pay both union and non-union laborors the higher prevailing union wage. Thus, savings cannot be realized from the hiring of non-union laborors Also, higher prevailing union wages may cause a decrease in productivity since the labor force knows it will get paid higher wages for the same amount of work normally accomplished at lower non-union wages.

CONCLUSION - Upon analyzing these owner drivers, two of the organizations deemed appropriate to satisfy the project drivers can be eliminated. The construction manager approach is not cost effective for USACE since it has the capabilities to serve now and in the future as the construction manager on all of its projects. Contracting with another entity for this task only adds additional costs and does not serve the public's best interest. Due to the need for greater involvement when using a general contractor, and noting that USACE is experiencing reductions within its forces while total work requirements remain the same, the Design-Build team is the recommended organization.

Utilizing this type of an organization eliminates the requirement to go through the selection process for a separate Architect/Engineer (A/E) firm to accomplish the design aspect and expidites project completion. An A/E firm must be contracted for the project with a general contractor or construction manager type organizations. USACE then requires personnel to oversee both the design and construction phase. Using a design-build team, requires less of USACE's personnel for supervision and administration since the team accomplishes both phases, design and construction. Also, using a construction manager approach, USACE could be required to contract all subcontractors to accomplish the cleanup. Thus, a design-build team requires less involvement in terms of supervisory and administrative personnel for USACE. This advantage is in concert with the fact that USACE will experience a 12.5% loss of personnel in the near future. Additionally, a project's completion time is expedited since the separate selection process for an A/E firm to do the design is eliminated.

3.8.1.3 MARKET DRIVERS

AVAILABILITY OF CONTRACTORS - There are a sufficient number of contractors that are experienced in the environmental arena. Also, an adequate number responded to the request for bids for this project. Twelve firms responded to the Corps request for proposal for this project.

CURRENT STATE OF THE MARKET - Both the public and private sector are faced with remediation of hazardous waste sites. The forecast for environmental clean up work is to increase by 4% this year. The number of sites requiring remediation increases each year as remediation studies are completed. A long future exists in the environmental remediation field.

PACKAGING SIZE OF PROJECT - The Baird McGuire site was divided into three cleanup phases as previously stated. A different contractor was used or will be for each phase. This methodology further complicates an already complex situation. The possibility of conflict between contractors can be seen in the transfer of surface water for treatment from one operable unit to another. The Operable Unit #1 contractor (groundwater treatment) is required to accept transfer of up to 100 gpm of surface water for treatment from Operable Unit # 2 operations. A possible conflict between contractors arises if the transfer of surface water exceeds 100gpm. Will the OU #1 contractor accept an amount exceeding his cotractual commitment and, if so, how much more? Most likely USACE will be called on to resolve this possible dispute and will have to allocate additional funds to the groundwater treatment contractor in order for greater amounts of surface water to be accepted. This will increase the contract value which is not in the best interest of the taxpayer.

USACE uses contracts titled Preplaced Remedial Action Contracts (PPRAC) to resolve time critical environmental problems of federal agencies. This type of contract will be discussed in detail in the next chapter but is described here to show that OHM has the technological capability to do both groundwater treatment and incineration. PPRACs are organized to carry out a wide range of remedial actions including source control, groundwater remedies, removal actions, incineration, and low-level radioactive waste cleanup. Firms awarded these types of contracts must demonstrate their capability to do this range of remedial work anywhere in the United States. Some of the same firms that submitted bids for the soils incineration phase of the Baird & McGuire project have also been awarded PPRACs by USACE. These firms included WESTON, IT, and OHM.[64] On the basis of being awarded a PPRAC, OHM has demonstrated to USACE that they possess the capability to do both groundwater treatment and incineration. This proves there are firms capable of doing all aspects required for cleanup for a site. Therefore, it is recommended that one contractor be used for the total remediation effort required for a single site.

3.8.2 CONTRACT TYPE

3.8.2.1 RISK ALLOCATION

ASSESSING RISK - Due to the nature of remediation work, construction documents at the time of award can never be final and complete. Flexibility is a requirement throughout the duration of the project. The lack of final/complete plans creates financial risks. These risks are located in the distinguishable segment - characterizing

---

[64]Al Kam, Contracting Technician, Omaha District, U.S. Army Corps of Engineers, Omaha, Nebraska, interview of June 21, 1994.

the subsurface media, and the nature and extent of subsurface contaminants. Uncertainty always exists due to the various contaminants that can be isolated and their continual movement within the subsurface media. The other risk is liability which results from the release of hazardous substances, pollutants, or contaminants during the remediation efforts.

3.8.2.2 ALLOCATING RISK

FINANCIAL RISK - The capability to handle this risk is based on the power to control the risk. Due to the subsurface and contaminants uncertainty, USACE must bear this risk. However, the construction of the actual remediation facilities can be borne by the contractor since knowledge of construction cost is known. Therefore, the contract should be divided into: one for the facility or technique - fixed price; and one for the quantity of contaminants to be remediated - cost plus fixed fee.

LIABILITY RISK - Liability for accidental release of hazardous substances is a risk that must be borne by the parties involved in the site cleanup. The Corps and EPA approve the technology to be used by the contractor when the contract is awarded. Therefore, the contractor is obligated to utilize that method to remediate the site. The contractor does not control the risk of the selected method failing to achieve agreed to cleanup standards. The EPA and USACE must bear this risk since they control it.

Accidental releases may occur through the improper construction or operation of the incinerator. The contractor should bear this risk since he has control over this. Upon being awarded the incineration contract, the contractor had to demonstrate competency in construction and operation of an incinerator to USACE. Liability for poor construction, improper operation, or lack of maintenance of the incinerator rests with the contractor. The contractor should be required to obtain pollution insurance and then be reimbursed by USACE. This reimbursement should be a part of the cost plus fixed fee. To do otherwise would result in USACE being forced to accept bids with a sizeable risk premium included.

3.8.3 AWARD METHOD

Using design-build team requires trust since the success of the project rests with a single entity. Therefore, it is paramount that the design-build team be competent, experienced, and possess the expertise required for environmental remediation projects. Multi-parameters should be the award methodology versus awarding the contract solely on a cost basis. The parameters for awarding of contracts should be cost, time, and quality. Cost is still included since USACE is a public entity and answers to the taxpayers, but should not be the overriding factor in awarding a remediation contract. Contractors responding to the contract advertisement offer a cost proposal based on available information. Timeliness is a necessity due to the public awareness of the environment and the nature of contaminants in the subsurface media. Responding firms should present a work plan or schedule that best meets the remediation requirements of the project and minimizes the time required to acheive the cleanup objective. Quality of a company is essential in order to select the best firm that possesses the capability to clean up the site. The quality of the firm should be measured by a number of factors. These factors include staff qualification, past experience on similar projects, success rate on past projects, management plan, and financial stability of the firm. A firm rating high in these categories will assure USACE of obtaining a reliable, competent and efficient contractor that will achieve the Corps' cleanup objectives.

3.9 Recommendation for Baird & McGuire Site Contract Structure

The contracting arrangement for the Baird & McGuire project has already been established. The recommendations presented in the subsequent paragraphs reflect ideas on how the contract should have been arranged if there was an opportunity to start the project all over again. The concepts presented below are the author's method of better attenuating the associated risks if the project were to begin today.

Based upon the previous analysis and the lessons learned in this case, a design-build team organization is recommended for the contract organization. This will allow for an improved working relationship. Also, this concept provides the opportunity for the owner, contractor and A/E to interact during the key phase of design. A disadvantage to this organization is that the owner is totally dependent upon a single entity for the success of the project.

The contract should be firm fixed price for the actual construction of the remediation facility and cost-plus-fixed fee for the actual remediation of the contaminated soils. This approach best attenuates the risks for those involved. The burden of the risk is placed with the entity that has control of the risk. In this case, the Design-Build team has full control over the construction of the remediation facility and therefore, should bear that risk completely. The Design-Build team has no control over the amount nor type of contaminants to be remediated. The owner, in this instance USACE, is the most appropriate party to bear the cost of this risk.

A multiple parameter award method is recommended with the parameters being cost, time, and quality. As stated earlier, the success of the project rest with the Design-Build team. Therefore, the contract should be awarded on the basis of the quality of the team. Also, time is of an essence and should be included as a parameter for contract awarding. Due to the risk averse nature of USACE, cost is an important element in awarding a contract, but it should not be the overriding parameter.

Selection of a design-build team is critical to the successful completion of remediating a site. There are several capabilities and characteristics USACE should consider in the selection process of a design-build team. The first criteria for consideration is in-house capability. Does the firm have the capability to accomplish both design and construction or must it create a joint venture with an A/E firm to accomplish the work? In the author's opinion it is more advantageous for a single company to have design-build capability rather than use a joint venture. Joint ventures hold the possibility for conflicts due to the differences in nature of the two firms, their work methodologies, and their financial stability. Another important consideration is prior experience on successful projects. This experience must be on projects of similar size, scope, contaminants, and complexity. This will better enable USACE to select a firm that is best suited for a particular project. Also, financial stability of a company is an important consideration for USACE. The price of insurance and bonding is extremely high for remediation projects. A performance bond for the Baird & McGuire project, had it been required, was estimated to be 10% of the total cost. Cost of insurance for this project was approximately 10% of the total cost.

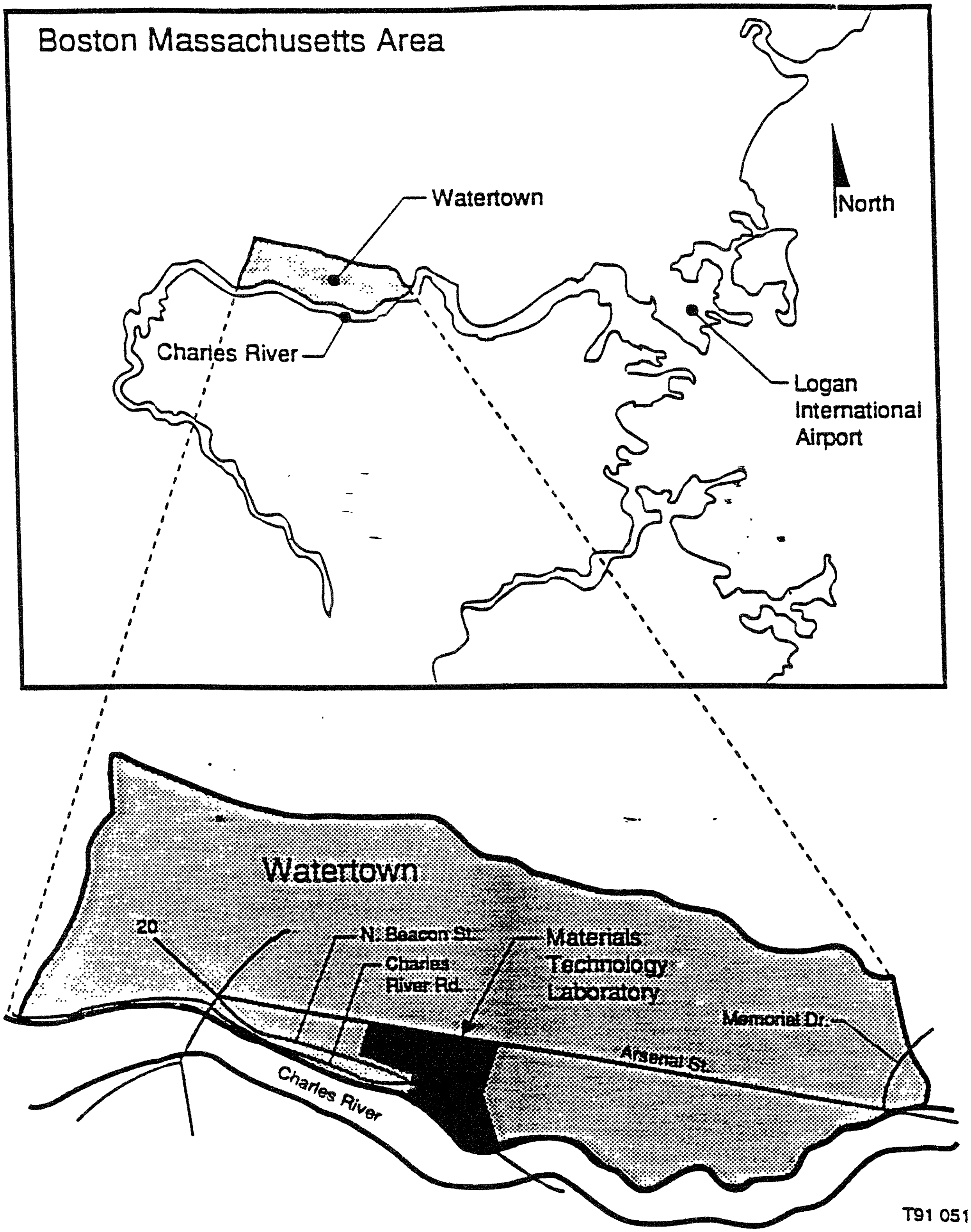
CHAPTER 4

Army Materials Technology Laboratory

This case study centers on the ongoing cleanup of the Army Materials Technology Laboratory (AMTL). The site is located in the town of Watertown, Massachusetts, on the north bank of the Charles River approximately 5 miles west of downtown Boston. Figure 4.1 is a map depicting the location of Watertown in relation to Boston. The active portion of the Army facility encompasses 36.5 acres. The AMTL site is bounded by a park and condominiums on Arsenal Street to the north. Commercial and residential areas exist on the west side of the site . A shopping mall and condominiums on Talcott Avenue abut the site on the eastside. North Beacon Street and the Charles River lie on the south side of AMTL. The cleanup operation currently ongoing consists of the remediation of radiological wastes and involves the decommissioning of the research reactor and nine buildings located within the AMTL complex.

The AMTL case study differs from the Baird & McGuire study in three ways. First, the responsible party for the contaminants is the Department of Defense (DoD), namely the Department of the Army. DoD has responsibility for the cleanup efforts under the Defense Environmental Restoration Program (DERP). Secondly, the nature of contaminants differs. As discussed in the preceding chapter, the contaminants discovered at the Baird & McGuire site were of a chemical nature. AMTL has mixed-wastes, chemical and low-level radioactive wastes. The third difference is the contract method adopted for remediation of the wastes. AMTL cleanup is being accomplished on a reimbursable basis, whereas the Baird & McGuire cleanup is being accomplished on a firm fixed price.

Figure 4.1



Boston Massachusetts Area
Watertown
North
Charles River
Logan
International
Airport
Watertown
20
N. Beacon St.
Charles
River Rd.
Materials
Technology
Laboratory
Memorial Dr.
Arsenal St.
Charles River
T91 051

The AMTL case study provides a brief overview to familiarize the reader with the DERP program and the U.S. Army Corps of Engineers' role in this program. The case study also addresses the various aspects of the cleanup of low-level radioactive wastes. The chemical contaminants, for which characterization is currently being completed, are also described. Finally, an analysis and recommendation as to an appropriate contracting method for site remediation is presented.

4.1 Defense Environmental Restoration Program

4.1.1 DERP Overview

The origin of federal environmental legislation in the United States can be traced to the Resource Conservation and Recovery Act (RCRA), passed in 1976. RCRA guidelines for hazardous waste disposal, however, did not include requirements to clean up past disposal sites. The first Federal legislation requiring cleanup of past hazardous waste disposal sites was the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), passed in 1980 and now known as Superfund. The Superfund was a $1.6 billion trust fund covering a five-year program. It was to finance the investigation of dump sites and identify those parties responsible for the cleanups. If it was unable to identify the responsible party or parties, the program itself would finance the site remediation.[65]

The Defense Environmental Restoration Program (DERP) was established in 1984 to promote and coordinate efforts for the evaluation and cleanup of contamination at Department of Defense installations. DERP consists of two components: (i) Installation Restoration Program (IRP) which investigates potentially contaminated DoD

[65]Rossi, Michael A., p. 13.

installations and formerly used defense sites (FUDS) for cleanup; and (ii) Other Hazardous Waste (OHW) Operations, which encourages research, development, and demonstration focused on improving remediation technology and reducing DoD waste generation.

The Office of the Secretary of Defense centrally manages DERP and the Deputy Assistant Secretary of Defense (Environment) provides policy direction and oversight. Each component of DoD (Departments of the Army, Navy, and Air Force) is responsible for accomplishment of its own program.[66]

The Superfund Amendments and Reauthorization Act (SARA) was passed in 1986. SARA provides continuing authority for the Secretary of Defense to carry out DERP in consultation with the U.S. Environmental Protection Agency (EPA). The President signed Executive Order 12580 on Superfund execution on January 23, 1987. This assigned responsibility to the Secretary of Defense for carrying out DERP within SARA and CERCLA guidelines.[67]

Former President George Bush, in October 1992, signed the Federal Facilities Compliance Act (FFCA) of 1992. The purpose of the Act was to clarify that federal facilities are subject to civil and administrative fines and penalties for violations of federal, state, and local laws dealing with the handling of solid and hazardous wastes. Through this Act, the EPA has a new and powerful enforcement mechanism over DoD's current practices and its Installation Restoration Program.[68] This aspect is noteworthy

---

[66]DERP Annual Report, summarized from p. 1.

[67]Ibid, p. 1.

considering the fact that the AMTL site was placed on the Superfund National Priorities List (NPL) on May 31, 1994. The EPA will now have veto power over cleanup plans and the public can play a more prominent oversight role.[69] The impact of EPA placing AMTL on the NPL and the EPA's increased scrutiny of remediation technologies will be discussed in more detail in a later section of this chapter.

4.1.2 DERP Funding

DoD's requirement for environmental restoration contracting is quite extensive. The enormity of the situation is found in Table 2.1. As stated in Chapter 2, the U.S. Army currently has more than thirty installations and 13 FUDs on the NPL and over 10,600 suspected contaminated sites. No Department of the Army IRP activity receives funding through Superfund monies. The Department of the Army obtains its funds for remediation of hazardous waste sites through the Military Construction, Army (MCA) program. The MCA process consists of three phases: programming, design, and construction. During the programming phase, the need for restoration work is submitted through appropriate organizational channels to Headquarters, U.S. Army. The goal is to establish project feasibility and outline the parameters for the project. The Army prioritizes its projects and Congress approves the Army's list of projects. Congressional approval and appropriation of funds mark the end of the programming

---

[68]Banaji, Darius, Contracting Methods and Management Systems of Remedial Action Contracts Within the U.S. Navy's Installation Restoration Program, thesis submitted to Massachusetts Institute of Technology, Cambridge, Massachusetts, September 1993, p. 16.

phase. The design phase can overlap with the programming phase since preliminary designs and estimates are required during the programming phase. Should Congress not approve a project, the design can be saved until approval is obtained.

The construction is the third phase of the process. This phase involves solicitation of bids from contractors, management of the construction contract, and final inspection and acceptance of the project. The U.S. Army Corps of Engineers cannot award a contract unless Congress approves and appropriates funds for the project. The entire MCA process commonly takes from four to five years (from project identification to final acceptance).[70]

4.1.3 The Role of the U.S. Army Corps of Engineers

USACE is the Army's contracting agent and construction manager, at no risk, for the DERP program. USACE's role in the AMTL project is one of management. They execute site investigations, characterization of contaminants, designs, and construction through contracts with civilian design and environmental services firms. Specifically, the Toxic and Hazardous Materials Agency (THAMA) at Aberdeen Proving Grounds, Maryland contracted EG&G Idaho, Inc. and Arthur D. Little, Inc. to accomplish the Preliminary Assessment/Site Investigation (PA/SI) at AMTL between 1988 and 1990.[71] THAMA has since been redesignated as the U.S. Army

---

[70]Simoneau, Craig L., Alternative Contracting Methods in the U.S. Army Corps of Engineers. Thesis submitted to the Department of Civil and Environmental Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts, June 1992, p. 16-17.

[71]Waskiewicz, Dennis, Program Manager, Army Material Technology Laboratory, New England Division, U.S. Corps of Engineers, Waltham, Massachusetts. Interview of June 6, 1994.

Environmental Center or AEC, still a part of the U.S. Corps of Engineers. AEC contracted with EG&G Idaho to prepare a decommissioning plan for AMTL's research laboratory and the plan was finalized October 1991.[72] In 1990, AEC contracted with Roy F. Weston, Inc. to accomplish two Remedial Investigations (RI) and a Feasibility Study (FS).[73] WESTON developed, as part of this contract, the Facility Decommissioning Plan completed in April 1992.[74]

The Omaha District, USACE contracted, through the traditional approach, with Stone & Webster for the design. Stone & Webster's design was directive in nature. It specified which facilities and locations within each facility required remediation and the level of cleanup required. Additionally, the design specified decontamination methodology to be employed based on type and amount of contaminants identified in the decommissioning plans previously stated.[75] In July 1992, Omaha District awarded the contract for decommissioning of the AMTL research reactor to Morrison Knudson (MK); and in August 1992, the contract for the decommissioning of the facilities, i.e., nine buildings. The responsibility for engineering and construction management was simultaneously transferred from the Omaha District to the New England Division, USACE.

---

[72]Decommissioning Plan for U.S. Army Materials Technology Laboratory Research Reactor, EG&G Idaho, Inc., October 1991.

[73]Phase 2, Remedial Investigation Report, Army Materials Technology Laboratory, Roy F. Weston, Inc., September 1993.

[74]Facility Decommissioning Plan, Army Materials Technology Laboratory, Roy F. Weston, Inc., April 1992.

[75]Contract No. DACW45-90-D-0029, Decommissioning, Demolition and Site Restoration of AMTL Research Reactor Radiological Facilities Watertown, MA, May 14, 1992.

4.2 Site History

4.2.1 Installation History

President James Madison established the Army Materials Technology Laboratory facility at the Watertown Arsenal in 1816. The facility was originally used for the storage, cleaning, repair, and issue of small arms and ordinance supplies. The mission expanded in the 1800s to include ammunition and pyrotechnics production; materials testing and experimentation with paint, lubricants, and cartridges; and manufacture of breech-loading steel guns and cartridges for field and siege guns. The mission, staff, and facilities continued to increase until after World War II. At this time the facility encompassed 131 acres comprising fifty-three buildings and structures, and employed approximately 10,000 people. Watertown Arsenal continued to manufacture arms until a downsizing operation was initiated in 1967. The Army completed the first materials research nuclear reactor at AMTL in 1960. It used the nuclear reactor actively in molecular and atomic structure research activities until 1970, then deactivated it.

At the time of draw down, much of the Watertown Arsenal property was transferred to the General Services Administration (GSA). The Army, in 1968, sold approximately 55 acres to the town of Watertown and the property was subsequently used for the construction of apartment buildings, the Arsenal Mall, and a public park and playground. The Army retained 47.5 acres of which 36.5 acres became known as the Army Materials and Mechanics Research Center (AMMRC). AMMRC was named a historical landmark by the Society of Metals in 1983. In 1991, the 36.5 acre parcel was declared a historical district.

AMMRC was renamed Army Materials Technology Laboratory (AMTL) in 1985. Currently, AMTL employs approximately 500 people and contains fifteen major buildings and fifteen associated structures. The current mission of AMTL is materials development, structural integrity testing, solid mechanics, lightweight armor development, and manufacturing testing technology.

In October 1988, Congress passed the Defense Authorization Amendments and Base Realignment and Closure Act (Public Law 100-525). In December 1988, the Secretary of Defense's ad hoc Commission on Base Realignment and Closure (BRAC) issued its final report that included a recommendation, subsequently approved by Congress, for the closure of 81 Department of Defense installations. The list included AMTL as a base to be closed.

The U.S. Army Toxic and Hazardous Materials Agency (THAMA) is responsible for the base closure program and initiated a closure program. The program consists of three stages or phases: preliminary assessment/site inspection (PA/SI), remedial investigation/feasibility study (RI/FS), and remedial actions. As discussed in the previous section of this chapter, the PA/SI was conducted by EG&G Idaho in 1987. EG&G conducted a field program in 1988, from which an RI report was developed. The firm, however, never submitted this RI to a state or federal agency and has remained an internal draft. It was found that chemical analyses for the 1988 sampling were not performed according to the THAMA Quality Assurance Program. Thus, these data could not be verified or validated by THAMA and are therefore considered insupportable. In 1990, Arthur D. Little, Inc. conducted resampling under contract to EG&G. The intent was to duplicate, to the extent possible, the 1988 effort, including resampling the 1988 sampling locations. However, resampling was not always possible. For instance, certain aqueous sewer samples could not be collected in 1990 since no flow was present at that time.

The EPA establishes protocols for the investigation and remediation of contaminated sites included on the EPA Superfund NPL. Often, sites not on the list, as with AMTL, are investigated using EPA protocols, to ensure a consistent, comprehensive approach to site cleanup. The type of investigation conducted using the EPA guidance is known as a RI/FS. In September 1993, WESTON, as directed by THAMA completed RI efforts to address issues raised by the closure and reuse of AMTL. These efforts include preparation of a Phase 1 RI report, performance of Phase 2 field investigation activities, and completion of a Phase 2 RI report. Also, WESTON has completed an FS draft report that is currently under review by appropriate regulatory agencies.[76]

4.2.2 Research Reactor History

The AMTL research reactor was the first nuclear research reactor designed to meet the needs of the research programs on materials for the U.S. Army Ordnance Corps. It was constructed at Watertown, MA during the late 1950s and 1960. The reactor achieved initial criticality on June 15, 1960, at a power level of 1 MW. Post-neutron tests consisting of shim rod calibrations, power calibration, temperature and void coefficients of reactivity measurements, and determinations of the worth of experimental facilities were conducted and completed by September 16, 1960. AMTL conducted various solid-state physics research programs and experiments at the 1-MW power level through June 1966. These programs were performed by the Army Materials and Mechanics Research Center. Also, several local institutions including Boston College,

[76]Remedial Investigation Report, AMTL, p.1-2.

Worcester Polytechnic Institute, University of New Hampshire, and Massachusetts Institute of Technology made use of the reactor for diffraction measurements and irradiations.

The reactor's license was amended in June 1966 to allow the power level to be increased to 2 MW to provide higher neutron fluxes for experiments. The power increased in 200 kW steps and all parameters were observed and measured for several hours at each step. In 1969, NRC updated the license from 2 MW to 5 MW. The power wattage increased in 1-MW steps to the maximum licensed level of 5 MW with no abnormal results observed during the power escalation.

Experiments similar to those previously described were planned, using the higher power level. Also, new experiments were conducted for advanced material and for research on and development and application of composite materials, improved metal alloys, and ceramics. These types of experiments were conducted on an irregular basis until the reactor was permanently shut down in March 1970. Information contained in operations reports of the U.S. Army Materials Research Agency Nuclear Facility covering the period June 1960 through March 1970, and reviews of the facility safety reports, indicated no fuel was breached during reactor operations or during fuel transfers between the reactor core and the annulus. The low levels of radioactivity and contamination found in the reactor vessel and on the reactor internal components attest to the fact that no fuel was breached.[77]

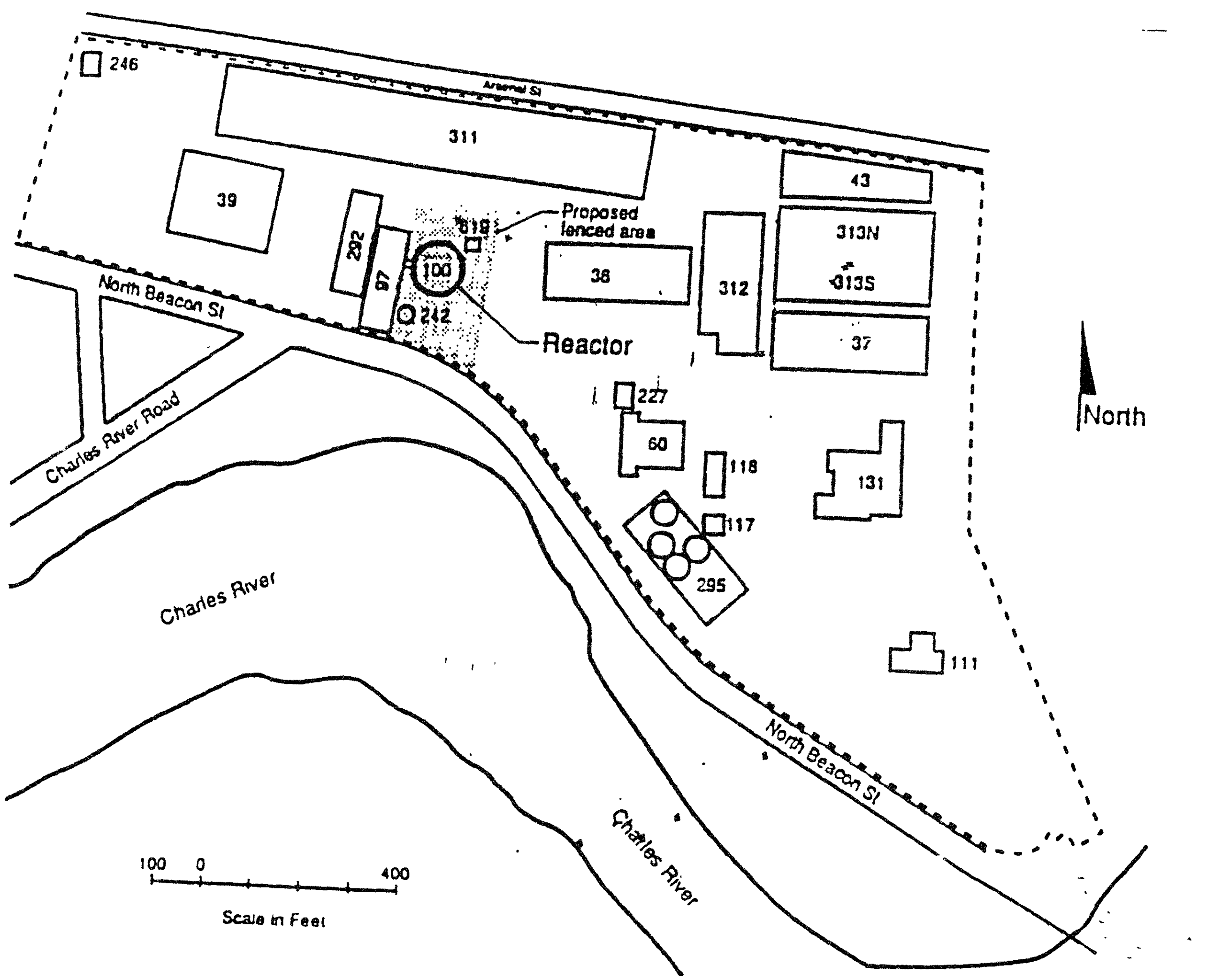
---

[77]Decommissioning Plan for AMTL Research Reactor, p. 1-19 - 1-23.

4.2.3 History of AMTL's Facilities Nuclear Activities

Radiological contamination was identified in seven buildings: 39, 43, 97, 292, 311, 312, and 313. Additionally, Building 37 was found to contain elevated radon levels near some openings in the floor. Figure 4.2 depicts the location of these buildings within the AMTL installation.

Figure 4.2



AMTL began development of artillery projectiles containing depleted uranium (DU) in the 1950s. DU was melted and machined on the first and second floors of Building 39 until approximately 1960 when the operation was transferred to buildings that have since been sold. In 1963, these operations transferred back to the present facility, Building 39, where they have remained until recently. The melting and forging operations transferred to Building 43 and the machining operations transferred to Building 312. Building 43 also contained an incinerator used to burn DU chips and flakes.

After the DU stock was machined it was sometimes electroplated in the plating shop in Building 312. Pieces of DU material were then taken to Buildings 39, 97, 292, and 313, where various experiments or tests were conducted. Generally, these tests did not result in the spread of significant amounts of radioactive contamination. Melting and machining operations caused most of the radiological contamination at AMTL.

A wet chemistry analytical laboratory, located on the fifth floor of Building 39, did extraction of uranium-containing solutions. The wastewater from the reactor went to a sump and three tanks in Building 97. This facility also contained a Kaman neutron generator and radioactive sources used to calibrate radiation detectors.[78]

---

[78]Facility Decommissioning Plan, p. 2-7 - 2-8.

4.3 Characterization of Contaminants

4.3.1 Chemical Contaminants

4.3.1.1 Soils[79]

A soil sampling program was conducted to identify and delineate potential soil contamination throughout the site. A facility-wide grid system was used to carry out sampling of the soil on 300 foot centers to collect data throughout the AMTL property. Additional borings were installed in areas where contamination had been identified in previous studies or near locations where hazardous or radioactive contaminants may have been stored or used. A continuous split spoon sampling technique advanced sixty-two soil borings from ground surface to the water table. 30 additional surface soil samples were collected using stainless steel bowls and scoops. A total of approximately 180 samples was submitted for laboratory analysis for the following parameters: volatiles; semivolatiles; cyanide; metals; and pesticides/PCBs. The sampling results were compared to the background samples.[80]

Samples collected from beneath three buildings (43, 311, and 312) showed elevated concentrations of carcinogenic semivolatile organic compounds. Contaminant levels were generally the highest at ground surface. Soil samples collected from borings completed in the grassy area between North Beacon Street and the Charles River showed elevated concentrations of polynuclear aromatic hydrocarbons (PAHs). The highest level of PAHs was detected next to Building 39 and in the parking lot of

---

[79]Summarized from Remedial Investigation Report, AMTL, pp. 4-9 - 4-22.

[80]Background samples do not have to be off-site, but merely located away from and/or upslope or upgradient of site operations. Additionally, background samples do not need to be pristine, just outside of site influence.

between Buildings 37 and 131. Samples showed metal concentrations, above the Massachusetts Contingency Plan (MCP) soil standards, immediately outside Buildings 39, 43, 311, and 313. The metal concentrations detected was primarily beryllium. Noncarcinogenic pesticides were detected in the surface soil samples collected in the grassy areas within the southeast and central portions of the site and along the southeastern fence line. The contractor removed approximately 177 tons of soil contaminated with Number 6 fuel oil on the north side of Building 227.

4.3.1.2 Groundwater[81]

Characterization of the groundwater was conducted upgradient of and beneath the site. A total of thirty-one groundwater monitoring wells was installed to collect data. The groundwater samples were submitted to a laboratory for analyses of volatiles, semivolatiles, metals, cyanide, and pesticides/PCB's. Analytical results were compared to proposed MCP groundwater standards and federal and Massachusetts groundwater standards. To learn if the on-site concentrations were significantly above background, the analytical results from the site were compared to upgradient results obtained from sampling of wells across Arsenal Street from AMTL and similarly on the northern part of the site.

All upgradient wells showed detectable quantities of chlorinated solvents. Chlorinated solvents identified in background wells included tetrachloroethylene, trichloroethylene (TCE), and 1,1,1-trichloroethane (TCA). In twelve on-site monitoring wells, TCE and TCA

---

[81]Ibid, pp. 4-22 - 4-36.

concentrations were detected that exceeded regulatory standards. Groundwater, collected from a well in the central part of the site, showed high concentrations of 1,3-dimethylbenzene and xylene. Results from additional groundwater monitoring and soil boring work completed in the area around this well, found that the contamination plume has not migrated beyond the immediate area. The RI did recommend that this well should be used as a groundwater recovery well to extract contaminated groundwater.

The groundwater near the site is not used as a water source and will not be one in the future. Watertown is a Massachusetts Water Resources Authority (MWRA) member community and as such obtains its water supply from the MWRA reservoir system. The remedial investigation did however recommend action be taken to mitigate potential impacts on the Charles River quality due to the contaminated groundwater. The feasibility study, currently being reviewed by regulatory agencies, will decide the type of groundwater remediation technology used for remediation.

4.3.1.3 Surface Water and Sediments[82]

To learn the impact of surface runoff from the AMTL installation on the Charles River, surface water and sediment samples was collected at locations upstream and downstream of the storm sewer outfalls at AMTL. Surface water and sediment samples were collected from a total of five locations upstream of the site's storm sewer river outfalls. Sediments were collected from fourteen downstream locations. Of these downstream sediment collection locations, nine were also sampled for surface water. Samples were analyzed for the same parameters as

---

[82]Ibid, pp. 4-37 - 4-39.

for groundwater analysis. Also, samples were analyzed for total organic carbon. The chemical data from downstream samples for surface water were compared to available EPA and Commonwealth of Massachusetts criteria for protection of aquatic life or human use of the river. The sediment data were compared to the available Draft National Sediment Criteria.

Ten metals and one organic compound were detected in the surface water samples collected from the five upstream sampling locations. Fifteen semivolatile organic compounds and nineteen metals were detected in sediments collected from the same five locations. Petroleum products contain many semivolatiles detected in the upstream sediments. This fact, combined with observation of evidence that long-term depositing of dark-colored organics (possibly heavy oil) suggests that the area immediately upstream of the AMTL site has been influenced by the practices of an adjacent yacht club.

Eight metals were detected in downstream surface water samples that exceeded upstream concentrations. Of these, only chromium was detected in downstream locations without also being detected in the upstream locations. Not detected in upstream locations, but detected downstream, were four organic compounds: toluene, ethylbenzene, xylene, and TCE. The RI suspected the first three compounds were associated with the fuel-related activities of the yacht club.

19 metals, 20 semivolatile compounds, and cyanide were detected in downstream sediment samples. Fourteen of these exceeded the upstream concentrations. Samples collected downstream detected silver, anthracene, naphthalene, dibenzofuran, dibenzo(a,h)anthracene, indeno(1,2,3-

c,d)pyrene, and cyanide. Upstream samples did not detect these same contaminants.

The RI concluded that river contamination does exist, both upstream and downstream of AMTL. Further the report said that most of the surface water contamination is located downstream of AMTL's influence. Much of the sediment contamination is upstream of AMTL outfalls.

4.3.1.4 Storm Sewers[83]

Flow monitoring and sampling of storm sewer runoff during a rain event was used to investigate the storm sewers. Also, an internal TV inspection investigated the integrity of the lines and possibility of groundwater infiltration. Background sampling points were used to find out the flow and contaminants contributed from off-site.

Since the storm sewers contained little or no sediment, only liquid samples were obtained. The results from analyzing these samples showed the site contributed small amounts of some metals and pesticides to storm sewer runoff. Copper and zinc were the only two metals that exceeded twice the maximum background values. Both metals also exceeded the typical urban runoff range. Pesticides confirmed to exceed twice the background concentrations included alpha-, beta-, and delta-BHC; chlordane; DDE; and methoxychol. The TV inspection revealed no evidence of groundwater infiltration, past or present, in any of the segments investigated.

---

[83]Ibid, pp. 4-39 - 4-47.

4.3.2 Radiological Contaminants

4.3.2.1 Soils[84]

The major source of potential radiological contamination of soil stems from AMTL's use of depleted uranium (DU) in the development of artillery projectiles. The methodology for sampling was previously discussed in an earlier section of this chapter. Laboratory analysis of samples included the following radiological parameters: gross alpha and beta; and uranium isotopes U-234, U-235, and U-238. The RI reported analytical results that showed the total uranium activity in all soil samples was below the federally mandated maximum allowable for DU, thirty-five picocuries per gram for soil. Therefore, there is no apparent soil contamination caused by uranium from AMTL's operations.

4.3.2.2 Groundwater[85]

Laboratory analysis of groundwater samples collected also measured radiological parameters including gross alpha, beta, and gamma activity and uranium isotopes U-234, U-235, and U-238. The analytical results from the groundwater samples collected revealed that the federal maximum contamination level (MCL) of 15 picocuries per liter (pCi/L)for alpha activity was not exceeded in any of the site wells. Analysis of beta activity in groundwater collected from the on-site wells revealed that the concentration that would result in a dose of 4 millirems per year for the most limiting beta emitter was not exceeded. The total uranium concentrations were below the federal MCL of 10 pCi/L for all on-site wells.

---

[84] Ibid, pp. 4-12 - 4-22.

[85] Ibid, pp. 4-22 - 4-36.

4.3.2.3 Sewers[86]

The sampling program of the sewers detected no radiological contamination.

4.3.2.4 Buildings[87]

Isotopic analyses performed at the AMTL site produced no evidence that any radioisotope other than uranium was a source of the building surface contamination. Background readings were taken at several off-site locations. Most of the indoor readings were taken in brick buildings with concrete floors since this is the predominant construction used at AMTL.

Two buildings(Buildings 43 and 312) were found to have extensive contamination. Beta-gamma activities on the floors, walls, and rafters for both buildings significantly exceeded the established limits. Several coats of paint on the walls of these buildings compounded the difficulty of the characterization effort and it could not be learned whether underlying coats were contaminated until remediation began. Also, lower portions of the painted brick walls did not appear to be contaminated; however, elevated radiological activity levels from existing equipment precluded a complete assessment of contamination on the walls.

Seven buildings (37, 39, 97, 241, 292, 311, and 313) were classified as having suspected contamination. Elevated levels of beta-gamma activity were detected only in specific rooms and areas of these buildings, as compared to Buildings 43 and 312 which was contaminated throughout.

---

[86]Ibid, p. ES-16.

[87]Summarized from Facility Decommissioning Plan, pp. 2-8 - 2-36.

4.4 Treatment Technologies

This section discusses in general the methodology employed to remediate the low-level radioactive wastes. A detailed discussion of the actual remediation technology to be used for remediation on the site cannot be presented since the feasibility study is still under review by appropriate agencies. Upon completion of this review, a record of decision will be prepared with December 1994 as the target date for its completion.

AMTL has used the radioactive material depleted uranium (DU) in testing and development activities since the 1940s. The remediation effort required for the areas where DU was used at AMTL consists of decommissioning actions. Through decommissioning, AMTL will cease its use of radioactive DU and clean those areas where DU was used. Also, as part of its decommissioning actions, AMTL must terminate all of its U.S. Nuclear Regulatory Commission (NRC) licenses which regulate the use of radioactive materials within facilities. Termination of all licenses must be completed by September 1995 due to the Base Closure and Realignment Act requiring closure of the AMTL installation.[88]

4.4.1 Research Reactor[89]

The reactor facility was decommissioned by decontamination. The Army decided total dismantlement as the preferred methodology. The methodology called for continuous dismantlement as necessary to decontaminate through physically removing contaminated materials. This would allow for total decommissioning and the eventual

---

[88] Facility Decommissioning Plan, pp. ES-1 - ES-2.

[89] Decommissioning Plan for AMTL Research Reactor, pp. 1-23 - 1-29.

release of the facility for unrestricted by the private sector. The first step was removal of the reactor building's internal components. Due to the high radiation fields associated with the annulus materials and core support structure, the contractor used remote cutting and handling equipment during the removal operation to reduce worker radiation exposure. Irradiated and unirradiated fuel elements containing nuclear material were removed under contract with National Lead Company and returned to the U.S. Atomic Energy Commission. The beryllium oxide reflector elements, shim-safety rods, armatures and stainless-steel pieces from the guide tubes were disposed of as high-activity radioactive waste. The contractor transported these wastes to a site in Bornwell, SC that owns the license for accepting these types of radioactive materials. However, the cost of disposal at this site is extremely high, $300 per cubic foot. The fission chambers containing U-235 were transported to another reactor facility. Ionization chambers were disposed of as low-level radioactive waste at Bornwell, SC. The radioactive sources used for calibration and checked of survey meters were transferred to the Army Radiation and Occupational Safety Branch, Army Material Command.

Water from the primary and secondary coolant systems, secondary coolant pumps, main reactor pool, and fuel storage tank was drained and disposed of. Water was monitored for radioactivity and discharged. If below regulatory standards, the water was discharged into the sanitary sewer or it was diluted to achieve acceptable release criteria before discharging.

4.4.2 Buildings[90]

Contamination in AMTL facilities is not easily removable. Most of it is fixed to surfaces and must be aggressively removed. Progressively more aggressive removal techniques were used in a sequence that included vacuuming; damp wiping; scrubbing with soap, water, or solvents; wire brushing; chiseling off the first one-eighth to one-quarter inch of surface; sand blasting; and CO_2 blasting.

The contractor attempted to remediate the walls first by washing with detergent and water and wiped with absorbent rags. If, necessary, the wall was scraped or wire brushed. As a final resort, chemical paint removers were applied. Waste that contained paint debris or sludge was segregated and marked and transported as "Paint-Containing Waste." Due to the possibility that paint may mask underlying contamination, the top layer of paint was removed by mechanical or nonhazardous chemical removal methods in approximately 10% of the bottom three feet of the wall. The underlying surface was then surveyed. If any uncovered area was found to exceed the surface contamination limits then all the paint was removed from that three-foot section and additional tests conducted on the next three-foot section. The contractor repeated this process until no areas were found to exceed the action limits.

Concrete floors were surveyed and if found to exceed established limits were cut into sections. The sections were then chipped down approximately three to four inches. These sections were then resurveyed and, if necessary, additional chipping action was conducted until surveys met

[90]Facility Decommissioning Plan, pp. 2-28 - 2-56.

the appropriate standards. This method was used to curtail the high price of disposing of the low-level radioactive waste. The disposal facility licensed to accept mixed waste is Envirocare, Inc. in Clive, Utah. Cost of disposal is $70 per cubic foot. While considerably less expensive than the disposal facility required for the reactor waste, both chipping and CO^2 blasting are used to reduce the volume of waste requiring disposal.

4.4.3 Concerns

4.4.3.1 Cleanliness

Throughout the ongoing decontamination of radioactive wastes and the planning for remediation of hazardous waste, the Army and the Corps have kept the public knowledgeable of cleanup efforts. U.S. Army Corps of Engineers considered Watertown's Arsenal Reuse Plan in its remediation plans for the site. The reuse plan includes a mix of residential, commercial, and light-industry uses. An issue that has surfaced centers on how thoroughly the Army should cleanup AMTL. Some members of the Arsenal Reuse Committee argue that basing the remediation on a reuse plan may limit future options. They say that the plan is hypothetical. A developer could come in and have a totally different idea for usage of the land that may be precluded due to the cleanup effort level. Others argue that the cost of the cleanup should not be important. This group wants 100% or pristine conditions to exist once the site is transferred to the town. Chuck Paone, the Arsenal Base Transition Coordinator, responded by saying "From the Army's standpoint it is important. We don't manufacture money. The community wants mixed-used. The money is not unlimited."[91] His point is the town, through intensive

[91]"Cost Muddies Arsenal Clean-up Picture", Watertown Press, March 24, 1994, p. 1.

analysis and study, determined the site will be used for various purposes. The Corps based its decisions on the desires of the municipality. USACE prepared plans and was appropriated a certain amount of funds to accomplish the plans. Congressionally appropriated funding is a lengthy process as discussed earlier. Therefore, money is only available to carry out the remediation plan as designed. Changing the scope now would require additional funds that would delay remediation efforts and closure of AMTL that cannot be delayed.

4.4.3.2 Superfund NPL Status

The EPA placed AMTL on the Superfund's NPL on May 31, 1994. This action gives EPA oversight ability over remediation technology to be used. WESTON has prepared a feasibility (FS) study for the remediation of hazardous waste on the AMTL site. This study is now being reviewed by appropriate agencies, one of which is the EPA. Based on its findings, WESTON's RI report recommends no remediation is required for the Charles River, storm sewers or sanitary sewers. Site soils require remediation of contamination primarily due to petroleum products. Also, the RI recommended action be taken to mitigate potential impacts on the Charles River quality due to contaminated groundwater. Actual remediation efforts and utilized technologies will be elaborated on in the pending FS report. A Record of Decision is scheduled to be published in December 1994. The EPA, U.S. Representative Joseph Kennedy, and the public are concerned about the Charles River quality. The impact of being listed on the NPL is not yet known. USACE is concerned that the EPA, upon review of the FS, will want some type of remediation for the Charles River where none was recommended before in the RI. This might require changes to the FS, which in turn would delay the ROD and the commencement of cleanup action.

4.4.3.3 Cost Risk

As previously stated, the cleanup of the AMTL site is complex in nature due to the existence of mixed-wastes. Compounding this problem is the difficulty in identifying the contaminants and the extent of contamination. USACE, based on this analysis opted for a contract on a reimbursable basis. Morrison Knudson, the contractor, agreed to use its best efforts in pursuing performance within a negotiated cost estimate. They also agreed to notify NED, USACE when expenditure rates reached a specified percentage of the estimate. MK would provide a revised estimate for cost-to-completion if the funds required to complete the job exceeded the estimate. MK's commitment extends to the performance of work specified in the contract.

MK is not obligated to continue performance beyond to the negotiated cost estimate unless USACE modifies the contract to increase the estimate. If USACE opts not to modify the estimate, MK only choice is to stop work because there is no basis for its being paid for additional effort. USACE has, to date, approved all modifications to the original estimate. The modifications now make the contract worth $23.7 million. Throughout this project, USACE had to be very involved in the accounting process in order to ensure the contract did not exceed the $50 million Pre-Placed Remedial Action Contract (PPRAC) ceiling. To attenuate this risk, USACE sent personnel to the Omaha District office to receive training in cost type contracts. Omaha, since it has been involved with these types of contracts for a reasonably long period of time, has more experience and expertise in this field than most of the Corps' other districts. Also, it carefully oversees construction efforts to ensure that MK does not attempt unnecessarily spend up to the limit of the agreed-to cost estimate. With cost type contracts, the contractor may have an incentive to spend up to the cost estimate, thereby, requiring modification to the estimate in order to continue work and increase its profits.

4.4.4 Alternative Treatment Methods

Two alternatives were considered and rejected because they would not achieve the Army's objective of unrestricted use upon turnover to the private sector. These two options were safe storage and entombment. In either case, the radiological wastes would remain on the site.

Partial dismantlement was strongly considered. This methodology entailed the removal of those interior and exterior contaminated components. The remainder of the facility would be left intact for possible reuse. As with the preferred method, this alternative would achieve total decontamination of the facility.

Total dismantlement was chosen over partial primarily for two reasons. First, the building site could be returned to its original condition for unrestricted use. Second, and most important, total dismantlement would provide, with maximum certainty, the removal of all radioactive contamination. The Omaha District, U.S. Corps of Engineers estimated the cost of partial dismantlement to be only $1 million dollars less inexpensive than total dismantlement. This did not make the partial option sufficiently more advantageous to justify a possibility of contamination remaining on the site.

4.5 Contractor Selection Procedure[92]

Contracts titled, Preplaced Remedial Action Contracts (PPRAC), are available for full-scaled remediation actions. These contracts are neither site nor project specific. The U.S. Corps of Engineers, Missouri River Division, Omaha District developed PPRAC to resolve time critical environmental problems of federal agencies. USACE has used PPRACs since 1989 to carry out a wide range of source control, groundwater remedies, removal actions, incineration, and low-level radioactive waste cleanup. Omaha District advertises, negotiates and awards the PPRAC. Thirty firms responded to Omaha's advertisement. A selection source board convenes and evaluates the firms' responses. Selection criteria includes expertise, experience in remediation work, staff qualifications, and a firm's financial stability. Detailed selection criteria cannot be divulged since Omaha District owns proprietary rights to the acquisition plan for PPRACs. The acquisition plan specifies the selection criteria USACE uses and the weight it attaches to each criteria. A few of the firms awarded PPRACs include Morrison Knudson, IT, WESTON, and OHM Remediation Services. Each contract has the flexibility to accept fixed-price or cost reimbursable indefinite orders. The period of performance is one year with four one-year options. No annual award ceiling exists other than the total $50 million contract limit. The approximate time required to award a site-specific delivery order ranges from 75 to 90 days. At the conclusion of this time a 90% scope of work design is accomplished. A contractor can be on-site within forty-five days from the notice to proceed.

---

[92]Concept of PPRACs is summarized from Introduction to the Rapid/Immediate Response and Preplaced Remedial Action Programs, Omaha District, U.S. Corps of Engineers, November 1992, pp. 9 - 11.

Omaha District awarded Morrison Knudson the contract to remediate the radiological wastes at AMTL. The requesting agency, AMTL in this case study, submitted a request for a PPRAC from the Omaha District. After reviewing the request, a determination was made as to acceptability for use at the AMTL site. Omaha accepts usage of PPRACs based on the following:

- A Congressionally mandated start date has been established where time does not allow for the normal acquisition process;
- An enforcement action has been issued for initiation of remedial action and time does not allow for the normal acquisition process;
- the project has a regulatory or judicially mandated start date;
- It is necessary to begin the remedial action immediately due to the possible detrimental effects on human health and/or the environment, if the remedial action is delayed; or
- If during the evaluation of controlling and scheduling of alternatives, it can be determined that the use of PPRACs is most effective and economical approach to the remedial action.

Omaha approved the use of PPRAC at the AMTL site because the criteria of an enforcement action issued for initiation of remedial action were met. Namely, the Base Realignment and Closure Act requires AMTL to be closed by September 1995. Also, the design for remediation of low-level radioactive wastes was a lengthy process. Omaha felt that awarding a contract to accomplish the remediation efforts through the normal acquisition process would further delay actions. MK received the notice to proceed in April 1992 and was on site by July 1992. Omaha District transferred the responsibility for contracting, engineering, and construction management to New England Division, USACE simultaneously to the awarding of the contract to MK.

4.6 Current Project Status

The Base Realignment and Closure Act approved closure for 81 DoD installations including the AMTL site. September 1995 is the closure date for AMTL. As the licensee, the AMTL Commander is responsible for the total decommissioning project and has authority in all associated matters, including safety. NRC is the federal regulatory agency for the decommissioning of the research reactor and support facilities that used radioactive material. New England Division (NED), USACE is the overall project construction manager, not at risk. Also, it is the contracting agency for the project. Morrison Knudson (MK) is the general contractor for the decontamination and decommissioning of the reactor and facilities. The contract is on a reimbursable basis, i.e., cost plus firm fixed fee (6%).

Presently the project is 90% complete and on schedule. MK has completed remediation work by decontamination and dismantled the entire research reactor. Of the nine buildings, the contractor has finished decontaminating seven and is currently completing remediation efforts on the two (Buildings 43 and 312) found to have extensive contamination.

USACE prepared an independent government estimate for this project and valued the cost for the reactor portion to be $6 million and the facilities to be $10 million. Currently, modifications to the original contract number 36. The final cost to decontaminate and dismantle the reactor was $12.8 million. To date, costs for the decontamination of the nine buildings are at $23.7 million. These cost overruns are due primarily to additional work required; therefore, an increase in the number of modifications. MK was reimbursed for its costs but there was no corresponding increase in fee or profit since the additional work was within the original scope of work.

As previously stated, the quantity of contaminants was only estimated. Total characterization to learn the extent of contamination in Buildings 43 and 312 could not be accomplished until equipment was removed first. Elevated radiological activity from this equipment precluded a complete assessment of the contamination on the walls. Walls within the facilities often had three and four layers of paint on them. The contractor was only able to determine the extent of contamination after removing the top layer from the bottom three feet of the wall. The underlying surface is then surveyed. Also, leading to additional modifications was the increase in scope of work for the remediation work for concrete floors. In several instances, the contractor decontaminated the concrete floor of three buildings and radiation surveys showed activity within the regulatory guidelines. To MK and USACE's knowledge these buildings always had concrete flooring and neither agency suspected contamination of the underlying soil. The NRC requested borings through the concrete to find out whether any radiological activity was present underneath to ensure 100% cleanup was accomplished. Results from the borings detected activity that caused the contractor to remove the concrete flooring to remediate the soil underneath. Thus, MK incurred additional work since this was within the original scope of work. USACE reimbursed MK for its costs but the contractor's profit margin decreased since fee was based on the estimated not actual cost.

4.7 Risks from Contractor's Point of View[93]

The risks associated with a cost type contract for a contractor are two fold. The first is financial and the second is health and safety of his employees.

4.7.1 Financial Risk

USACE uses cost type contracts for projects in which a clear delineated and defined scope of work cannot developed. Contractors winning these type of contracts find it hard to lose money, but in most cases the profit margin is minimal. Contractors who respond to advertisements for these type contracts, base their estimates on the site's history, knowledge of contaminates used, and disposal locations. Responsible parties provide this information and in many instances the information is incomplete. The fee or profit margin associated with cost type contracts is based on the negotiated cost estimate. Incomplete data results in low estimates which lowers the fee.

Adding to the financial risk is the complexity of the site. An example illustrating this is the presence of mixed wastes within a few of the AMTL buildings. The scope of work required the contractor to dispose of these mixed wastes. The negotiated cost estimate, to process the mixed waste to neutralize and transport it to an off-site facility, was $350,000. The actual cost was $900,000. Thus, the contractor's profit margin was greatly diminished due to the additional work required since the fee was based on the estimated not the actual cost.

---

[93]Summarized from interview with Mark Helstrom, Project Manager, Morrison Knudson, Army Material Technology Laboratory, June 29, 1994.

Financial risk is attenuated through data collection and negotiation. Obtaining complete data is paramount for the contractor to submit a "good" cost estimate. Fees are based on estimated costs. Secondly, negotiations are important to ensure the contractor's cost estimate is close to the agreed to actual estimate. This will better position the contractor to obtain and realize the expected profit margin.

4.7.2 Health and Safety Risk

Health and safety risks to a contractor's employees are often encountered due to unknowns, quality of personnel, and the required safety equipment. In each case, these risks may cause the contractor's profits to decrease. Two types of unknowns were encountered during the remediation of the low-level radioactive waste. The first was in the form of ordnance found in the underlying soil of the buildings. The second was discovering pipelines that were not in any of the plans for the facilities. In both cases, safety of employees was a factor. The ordnance had to be disposed of safely without injury to personnel. This required training costs which were not foreseen in the original estimate. Radioactive material was discovered in the unknown pipelines which resulted in additional work which in turn reduced the profit margin. Generally unknown site conditions are covered by a separate contract clause which allows profits on additional costs. However, AMTL's scope of work included remediation of any contaminants found anywhere inside the buildings even though their locations may not be depicted in the plans. Thus, MK was obligated to cleanup these pipelines and dispose of ordnance discovered inside the buildings. The contractor was reimbursed for his costs but the fee did not increase since there was not a change to the original scope of work.

Throughout the duration of the project, there were occasions that required workers to wear protective equipment. The productivity while wearing such apparel is decreased by 40%, and the probability of injury increases two fold due to the restricted vision. Thus, the contractor is required to take out expensive workmen's compensation insurance in order to minimize his liability exposure. Productivity decreases resulting in more manhours to accomplish the work, thus, higher labor costs.

Although the labor force is adequate, quality labor, in terms of trained personnel, is not adequate. Without trained personnel, with experience in this type work, the chance of injury increases. Therefore, the best method to attenuate these risks is through a quality training program. This requires not only the mandatory OSHA training for any project, but also site specific training.

4.8 Recommended Contracting Method[94]

4.8.1 Organization

4.8.1.1 Project Drivers

Time Constraints - Time is of an essence in preparing a base for closure especially if hazardous and radiological wastes are present. The Base Realignment and Closure Act approved the closure of AMTL in December 1988. September 1995 is the scheduled closure date. Before the transfer of AMTL to the town of Watertown, MA, remediation and decommissioning of the research reactor and support facilities must be completed. Additionally, remediation of chemical contamination of soils and groundwater is

[94]Adopted from Christopher Gordon's Compatibility of Construction Contracting Methods with Project and Owners. Thesis submitted to the Department of Civil and Environmental Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts, September 1991.

required. Remediation of radiological contaminants is almost complete. MK has decontaminated and dismantled the reactor. However, decontamination of the support facilities is scheduled for completion July 1994. One year remains to accomplish remediation of hazardous waste which is not much time! A possible impact on cleaning up AMTL is potential EPA involvement because of the site's inclusion on the NPL. The EPA now has oversight powers for the cleanup and technology to be used. The FS review process may lead to changes in the amount of remediation required and technology employed. In turn, an approved ROD may be delayed which will require additional time for remediation efforts.

Flexibility Needs - The size and complexity of this project favors flexibility during the construction phase. Changes and increases in scope of work due to differing site conditions are distinct possibilities. As of July 6, 1994, thirty-six modifications to the original contract have been made. Uncertainties associated with remediation of radiological contaminants required these modifications. Stone & Webster, the A/E firm that prepared the design, was unable to fully determine the extent of contaminants as described in a previous section.

Pre-construction Service Needs - USACE requires pre-construction services in remediating the AMTL site. Although the Corps has an abundance of in-house expertise in the remediation of hazardous waste sites, the AMTL site presented an additional challenge. Not only did the site contain chemical contamination, but radiological contaminants as well. Only one experienced chemist was located throughout the Corps' districts and divisions to provide assistance in the pre-construction phase. Additionally, a nuclear reactor had to be decommissioned.

This is not typical of the work USACE is normally involved in.

Design Process Interaction - Interaction in the design process is a key requirement. Remediation of hazardous waste sites is a new and evolving arena. USACE wants interaction to monitor methods and technologies that will be used. Design interaction is even more paramount when the site also has radiological contaminants present. A new set of federal and state regulatory agencies come into play. With these new players, come additional and new regulatory guidelines. USACE must be aware of all requirements and possible technologies that may be used to ensure public safety.

Financial Constraints - This factor is not applicable for USACE. A contract cannot be awarded unless the project is approved. Once approved, Congress appropriates funds in sufficient amounts to cover the cost of the project.

Conclusion - There are six organizations from which to choose, based on either a fixed price or reimbursable type contract, as applicable: General contractor, Construction manager, Design-Build team, Multiple prime contractors, Turnkey team, and Build-Operate-Transfer team. Based on the above evaluation of the five project drivers, the controlling factors are:

- Need for fastrack schedule
- Need for flexibility during construction
- Need for pre-construction services
- Need for design interaction
- No requirement for outside financing

The analysis of project drivers found the most appropriate organizations for the AMTL project are (a) a general contractor on a reimbursable basis (which is the organization used on AMTL); (b) a construction manager; or (c) a design-build team on a reimbursable basis.

4.8.1.2 Owner Drivers

Construction Sophistication - The U.S. Corps of Engineers employs very knowledgeable individuals with broad backgrounds. This organization has been involved in construction and its administration for a long period. However, environmental remediation is a new and evolving field. USACE is just beginning to gain expertise and experience within this field. Radiological decontamination is an additional challenge since this is not typical of Corps projects. Also, not all districts and divisions within USACE have as good a familiarity with cost type contracts as the Omaha and Kansas City Districts. Until recently the Corps has minimized the employment of cost type contracts. Therefore, the experience and expertise are limited in these types of contracts.

Current Capabilities - As stated previously, USACE has a sophisticated construction organization. It is gaining experience and knowledge in the remediation of hazardous waste sites. Expertise is limited in the decontamination and decommissioning of nuclear facilities. Additionally, the Corps as with the entire military force is experiencing a reduction in staff. However, the amount of work to be accomplished remains the same, USACE just has fewer personnel to do it.

Risk Aversion - USACE is risk averse. For any project it considers undertaking, the Corps wants to know the cost up front. This is the reason the vast majority of their projects are lump-sum. They answer to the public since they are a government agency. Financial constraints are a factor. Therefore, USACE wants to implement cost controls. Contractors are knowledgeable of the fact that sites must be cleaned up and funding is available for remediation. The Corps wants to avert as much risk as possible, and eliminate the contractor's temptation to carry out more costly techniques than are required. To accomplish this, USACE monitors contractor's cost and interacts with various agencies skilled in remediation work during the design phase.

Restrictions on Methods/Other External Factors - The same concepts addressed in the discussion of Baird & McGuire site apply here. On a different note, with the decentralization of the Corps, the opportunity for work for small businesses and disadvantaged contractors is greater.

Conclusion - Analysis of the project drivers indicated that three types of organizations would be appropriate for the AMTL project: (a) General contractor on a reimbursable basis (the type used for AMTL); (b) Construction manager; and (c) Design-build team. Upon assessment of the owner drivers, two of these three types of organizations were eliminated. Construction manager is the first to be eliminated. The Corps already serves as the construction manager for its projects. Contracting with another entity for the same type work only adds unnecessary costs and does not serve the public's best interest. The second organization to be eliminated as not appropriate for AMTL is general contractor. As stated previously, USACE is experiencing a cut in personnel. Using a general contractor requires an increased amount of involvement by Corps personnel. Therefore, a design-build team is the recommended organization for the AMTL project.

4.8.1.3 Market Drivers

Availability of Contractors - There are several contractors experienced in the environmental field. This is evidenced by 30 firms responding to Omaha District's advertisement for a preplaced remediation action contract.

Current State of the Market - The public and private sector face the problem of remediating hazardous waste sites. The number of sites requiring remediation increases each year. As an example, six New England DoD facilities were added to the Superfund National Priorities List on May 31, 1994. The future is bright for work in the environmental remediation field.

Packaging Size of Project - AMTL is divided into two cleanup phases. The first, and currently ongoing, is the decontamination and decommissioning of a research reactor and its support buildings. The second phase is the remediation of hazardous waste, chemical contaminants, found in the soil and groundwater. Morrison Knudson has the contract for the decommissioning and decontamination phase. A feasibility study is being reviewed currently and a record of decision is due out in December 1994. Once the ROD is published, another contractor may potentially be awarded the contract for the hazardous waste remediation phase. Or MK could possibly be awarded a contract under its PPRAC, if the PPRAC limit has not been exceeded. As of July 1994, USACE did not know who it would contract with nor what contracting arrangement it would use for the chemical wastes contract. Since cleanup operations are complex, dividing the project into two phases and contracting with two different firms for each phase can cause additional complications. For example, what happens if the second contractor detects levels of radiation inadvertently missed by the first contractor? Who is responsible for remediation of these contaminants? The second contractor may not possess the capability since his work only involves chemical remediation. Differing site conditions will exist and cost will increase. Therefore, the recommendation is to contract with one firm for the total remediation effort required on the site.

4.8.2 Contract Type

Remediation of hazardous and radiological wastes invariably leads to uncertainties. These uncertainties include characterizing the subsurface media, nature and extent of subsurface contaminants, extent of radioactive contaminants on building surfaces, and etc. For these reasons, cost type contracts are more appropriate than firm-fixed price contracts for these type projects.

The main advantage of a firm-fixed price contract is that costs are known before beginning work. However, in the environmental remediation field, this advantage has not been realized. Contracts are either modified extensively due to unforeseen conditions and the difficult nature of the work; or the contractor's price includes large contingencies for uncertainties. This can be seen in the case study presented previously on the Baird & McGuire site. The contract type was a firm-fixed with the price set at $57.8 million. The contract has been extensively modified (21 times) so that the price is now $76 million. This translates into 30% cost overrun with two more years remaining before project completion. This is not in the best interest of the public. Taxpayers fund cleanup activities of federal remediation projects. Government agencies have a responsibility to the public to wisely spend their money. Increases to the original contract price can indicate a waste of money and or financial irresponsibility on the part of the government.

Cost-plus contracts have several advantages. The most important ones are (a) it allows fastracking; (b) preconstruction advice can be obtained from the contractor; (c) teamwork approach replaces the typical adversarial relationship; (d) changes to scope of work can be quickly and efficiently handled; and (e) if managed properly by a sophisticated owner, such as the Corps, total final costs may be reduced by elimination of contingencies, claims, and the bidding process. Cost type contracts are negotiated which results in a better estimation of the total costs involved. Bidding often results in obtaining a price that is below actual costs in order to win the contract. Thus, contractors attempt to make their profit by requests for modifications to the original contract which increases the price of the contract.

There are disadvantages associated with use of cost type contracts. Not knowing the total cost before the start of construction is the most obvious disadvantage. Also, close monitoring is required to prevent contractor overcharges, on-time schedule performance, and uncompetitive purchases of materials and supplies. Competition on contracts may be reduced by the elimination of lump-sum bidding. Also, greater emphasis is placed on the owner's sophistication. The Corps can mitigate these disadvantages by strict contract site monitoring and cost accounting procedures. Additionally, personnel involved in this must be adequately trained. USACE is a sophisticated organization, but, depending on the district, their personnel may require training in cost type contracts.

4.8.3 Award Method

Design-build team organizations require the owner to be entirely dependent on that team for the success of the project. The owner of a remediation project is concerned about the effective and timely cleanup of the site. Therefore, an appropriate award method should be based on the team's merit and time required to accomplish the remediation. Multiple parameter is the recommended award methodology. The parameters should include the team's qualifications, time, and cost. USACE should place emphasis on time and the team's capability since it is paramount that the design-build team be competent, experienced and possess the expertise required for environmental remediation projects. Time required to remediate a project is a critical element in cleanup projects. Society is demanding that the Federal government accomplish cleanup operations on its hazardous waste sites more quickly than in the past. Thus, USACE should consider a firm's construction schedule or work plan to select the team that best remediates a site in the least amount of time.

In reviewing a team's qualifications, USACE should consider the following attributes: (i) experience on projects with similar costs, complexities, and types of contaminants; (ii) success rate on similar projects in terms of on-time completion and within the allocated budget; (iii) firm's management plan relating to construction, quality control, and quality assurance; (iv) degree to which sub-contracting is required to accomplish similar projects; (v) company's staff qualifications pertaining number of engineers and architects, type of engineers, and number of years of employment; and (vi) team's safety plan for its employees and safety record.

This will ensure the successful, efficient, and timely execution of a project. Cost is a consideration since USACE is a public entity and answers to the taxpayers. However it should not have precedence over the other two parameters in the selection of a contractor.

4.9 Recommendation For AMTL Site Contract Structure

Based on the above analysis and assessment, a design-build team is the recommended contract organization. This fosters a partnering approach to the project. The adversarial relationship often encountered in the general contractor organization will be tremendously reduced. The design-build team is part of the design process and changes in scope of work are easier and more efficiently handled. Also, the owner must be very involved and well versed in the cost accountability process. The contact should remain as reimbursable, cost plus firm fixed fee. As stated before, the complexity and uncertainty, with regards to unanticipated conditions and the extent of contaminants on hazardous waste sites, warrant cost reimbursable type contracts. Contractors must prepare bids, consultants must estimate costs, and owners must evaluate alternatives. This is difficult to do when the extent or type of contaminants are not fully known as in the case of the AMTL site. Using this approach attenuates the risk of the contractor. The burden of risk is placed on the government who is a more appropriate party. The contractor will be reimbursed for incurred cost associated with work accomplished. Additionally, the contractor will receive a profit in the form of a fixed fee. Multiple parameter award method is recommended with time, quality, and cost being the parameters.

Also, recommended is that the total remediation effort required for the site be given to a single entity or firm. As seen in this case study, USACE is dividing cleanup efforts into two phases, low-level radioactive wastes and chemical wastes. USACE can possibly contract with two different contractors to accomplish these two phases. This will further delay the time it takes to cleanup the site due to the lengthy acquisition process. USACE attempted to expedite cleanup by using a Preplaced Remediation Action Contract (PPRAC). Even though PPRAC was used because of the AMTL September 1995 closure date, it took more than three years to characterize the contaminants and prepare a 90% complete scope of work design. It took another three months for the contractor to get established on site. On the other hand, USACE may award the contract to remediate the chemical wastes to Morrison Knudson. It may do so using PPRAC or another type of contract, such as fixed price. As of July 1994, USACE has not decided on who to award the chemical waste contract to or what contracting arrangement will be used. Once the Record of Decision is finalized and a treatment method is selected, these questions will be answered. If USACE awards the chemical waste remediation contract to MK, it must be careful in how it goes about the awarding. Should MK learn that they may be awarded the contract, they may increase the estimated costs whereas without prior knowledge their estimate would be lower in order to be competitive. Also, USACE must not give the appearance it is favoring MK over other contractors. To do so, would invite claims of favoritism by other firms and future legal problems which will delay the cleanup.

By employing the total site remediation approach, cleanup would be expedited. There are a sufficient number of firms available that possess capabilities to perform a wide range of services for total site remediation. This is evidenced USACE awarding PPRACs to a number of firms that responded to its advertisement. A total of thirty firms responded to USACE's PPRAC advertisement. Some of the companies awarded PPRACs include WESTON, IT Corporation, OHM and MK. Each has demonstrated its capabilities, experience, and expertise to do all remediation activity necessary for an entire site. These environmental remediation firms' capabilities include source control work, groundwater remedies, removal actions, incineration, and low-level radioactive waste cleanup. Having demonstrated their abilities to do total remediation, the cleanup time can be expedited by using one of these firms for the entire site cleanup. USACE would only have to go through the contractor selection process once instead of three times as it did for the Baird & McGuire project or potentially twice for the AMTL site. The design-build team would take the project from conception to cleanup. The team would conduct and prepare all the site inspections, investigations, studies, and approved remediation work. This would expedite the whole process. Also, the EPA and USACE would only be dealing with and holding one entity responsible for all facets of the project. Status of reports and cleanup efforts could easily be tracked.

CHAPTER 5

Conclusions/Recommendations

While the number of hazardous waste sites being remediated is increasing, the number of sites still requiring remediation is increasing on a yearly basis. The most noticeable increase in number of sites consist of Department of Defense installations which are being closed due to the down sizing of the military. The public's increased awareness of the environment and resolve to clean up the seemingly endless number of hazardous waste sites has made the issue a national priority.

The increasing backlog of hazardous waste sites can be attributed to the slow process each must undergo prior to remedial action being accomplished. Upon determination that a site contains hazardous waste, there are a series of investigations and reports that must be prepared. First, a preliminary assessment and site investigation is conducted. Then a remedial investigation (RI) report is prepared that provides the site history, identifies potential responsible parties, characterizes the contaminants and their extent, and gives recommendations for remediation. A feasibility study is prepared, using the information obtained from the RI, which considers alternative technologies for cleanup, evaluates these options, and selects one of the alternatives for use. The Record of Decision captures the final decision. This process is very time consuming.

The United States Army Corp of Engineers (USACE) adds further delays to the process through its contracting procedures. Until recently, USACE has had to contract with a different firm for each step of the process. This resulted in having to go through a lengthy award selection process for each contract.

5.1 Timeliness of the Cleanup Process

The two case studies presented in this thesis typify the time consuming cleanup process. The remediation of the Baird & McGuire site will take approximately fourteen years to remediate from the time hazardous wastes were discovered until cleanup activities are completed. The EPA in August 1982, through its contractor, Ecology Environment, Inc., scored the site on the Hazardous Ranking System. The site was proposed for inclusion on the National Priorities List (NPL) in October 1982. It currently ranks 14 out of a total of 888 current or proposed sites on the NPL. In March 1983 and July 1985, the EPA conducted immediate removal actions on the site. An RI was completed in 1986 and, during 1989, additional investigations were conducted that addressed contamination in the Cochato River environment, which abuts the site. Records of Decision were finalized between 1986 and 1990 and determined the treatment technology to be used. In 1990, Metclaf & Eddy completed the design of the remediation effort. USACE awarded the contract for the groundwater treatment plant in 1990 to Barletta Engineering which completed construction in 1992 and is currently operating the facility. The Corps awarded a soils incineration contract to OHM Remediation Services, Inc. in 1992. As of July 1994, OHM is constructing the incinerator and is scheduled to complete the incineration of all contaminated soils by 1996. The last contract to be awarded is for the dredging of river sediments. This contract was originally awarded to Site Remediations Services, Inc. in 1993. USACE is currently reviewing the contractor's bid to ensure the firm is competent and experienced since it underbid an independent government estimate by $500,000.

The lengthy process for remediation action is also evident in the Army Material Technology Laboratory (AMTL) project. The Department of the Army site has existed for over 150 years. The Secretary of Defense in December 1988, based on a recommendation made by his ad-hoc Commission on Base Realignment and Closure, approved AMTL's September 1995 closure. In 1987, USACE contracted EG&G Idaho to conduct the preliminary assessment and site investigation. WESTON, in 1990, began preparation of a RI for the AMTL site and completed it in 1993. USACE also contracted the firm to prepare a feasibility study which is now under review by appropriate agencies. Morrison Knudson was awarded the contract for the remediation of low-level radioactive wastes in 1992 and will complete the work in August 1994.

These cases attest to the slow cleanup process and USACE is adding further to the delay through its contracting procedures. It took eight years before actual remediation activity was started at the Baird & McGuire site. Assuming that the current work schedule is maintained, it will have taken fourteen years to complete the cleanup of the site. The preparation of the RI for the AMTL site took fours years and when the site is finally transferred to the town of Watertown, it will have taken eight years from conception to completion of remediation action. Also, each step of the cleanup procedure was accomplished by a separate contractor. This added to the delay in remediating the sites since USACE had to go through a lengthy award selection process for each contract.

5.2 Contracting Arrangement

USACE's contracting arrangement for remediation action, whether the Department of Defense or Superfund is funding the cleanup, also contributes to the lengthy process of remediating sites. The Corps, being risk averse and bound by regulatory requirements, prefers to use a general contractor and a fixed price contract structure. This is not the best way to attenuate the risks for the parties involved in the cleanup of hazardous sites.

5.2.1 Risks

The two cases illustrate a range of risks associated with HTRW projects. The most significant of these risks and how they were managed at each project is presented in the following sections.

5.2.1.1 Unknown Types and Quantities of Contaminants

Generally it is not possible to complete the full characterization of a site's contaminants prior to starting the remediation effort. Unknown types and quantities are often discovered during the remediation process. As a result, the amount of remediation work that must be done increases. This is a risk faced on every project and by those involved in its remediation.

USACE and the EPA ignored this risk for the Baird & McGuire project and awarded a contract for the on-site incineration of contaminated soils on a fixed price basis. This placed the burden of risk mostly on the contractor. The Government believed that they had identified the total amount of contaminants, the various types, and their location. The original scope of work called for the incineration of approximately 200,000 tons of contaminated soils. During construction of the incinerator, OHM conducted further characterization of the levels of soil contamination to determine any additional requirements for soil remediation. OHM installed nine additional monitoring wells to detect further migration of contaminants. Results obtained from soil borings and monitoring wells identified additional quantities of soil requiring remediation. Approximately, 100,000 more tons of contaminated soil required incineration. This has an immediate impact on both the owner and the contractor. The owner is faced with a cost overrun (30% as of July 1994) with two more years remaining until completion of the project and the actual incineration of soils yet to begin. The work schedule is delayed due to the additional amount of soils requiring incineration. Major contract modifications to the original contract have been necessary in order to reimburse the contractor for costs and a reasonable profit. An adversarial relationship is building between the owner and contractor due to the increased price of the contract and added delay to the work schedule.

The AMTL project, on the other hand, recognized this risk and used a cost type contract to remediate the site. This contracting arrangement better attenuates the contractor's burden of risk. Morrison Knudson, under this arrangement, negotiated a cost estimate and a profit margin with USACE. MK is reimbursed for all costs incurred while performing remediation work and is paid a fee based on the agreed-to estimated cost. As a result, both parties are experiencing a better working relationship than in the previous case. Also, the project is on schedule.

5.2.1.2 Profits

Remediation of hazardous waste sites is a business and those working in this market must make a profit to remain in this field. Contractors, competing for remediation work, must look for ways to maximize profits or even realize a profit. The risks taken to realize or maximize profits vary depending on type of contracts.

OHM decided to submit a bid for the Baird & McGuire project fully aware that the contract was fixed priced. Fixed priced contracts are competitively bid with the lowest bidder usually being awarded the contract. Thus, upon being awarded the contract, the contractor is responsible for the remediation work at the submitted bid price. OHM will bear any cost overruns due to their mismanagement or estimating errors. However, as stated earlier, generally the amount, types, and exact locations of contaminants cannot be fully defined and delineated. Uncertainties always exist. Therefore, when bidding on a fixed priced contract, the contractor will bid on the "known" quanitities and types of contaminants. OHM submitted a bid that was competitive in order to win the contract. It took a risk that there would be additional amounts of contaminants needing remediation and, thus, could realize a profit through modifications to the contract. The contract modifications would reimburse OHM for its costs and provide for a reasonable profit margin. As seen in the case study, this is exactly what OHM is doing. OHM is sacrificing quality to cut costs and requesting major modifications to the contract, thereby attempting to increase its profit margin. As a result, an adversarial working relationship is being created since USACE percieves OHM's actions only as an attempt to obtain a higher than normal profit margin for this type work. Also, the schedule is being delayed since OHM had to redo some of its work that did not meet standards because OHM had sacrificed quality.

There are other options contractors may use to minimize the risk of not making a profit when bidding on fixed price contracts. One method is to incorporate sizeable risk premiums within their bids. Another way is to submit bids with qualifications. Contractors opting for either of these two alternatives not only have to be concerned with profit, but also must risk the chance of not winning the contract. The need to be competitive often mitigates against the use of these measures.

USACE used a cost type contract for the AMTL site's remediation of low-level radioactive wastes. The Corps selected this method since a clear delineated and defined scope of work could not be developed due to the uncertainties and anticipated contract modifications. The fee or profit margin associated with cost reimbursable contracts is derived from the negotiated cost estimate. MK's profit risk, in pursuing this type of contract, centers on its dependance for complete information upon which to base its estimate. The more complete information available, the more accurate the estimate and corresponding profit margin. Incomplete data results in low estimates which lowers the fee or profit margin. During its remediation activities, MK discovered that there was a lack of information and it underestimated some of the costs associated with the required work. For example, the negotiated cost estimate to process the buildings' mixed wastes to neutralize and transport it to an off-site facility, was $350,000. The actual cost was $900,000. Thus, the contractor's profit margin was greatly diminished due to the additional work required since the fee was based on the estimated not the actual cost. Due to the additional work that was within the original scope of work, MK is attempting to complete the project as quickly as possible to minimize any more loss of profits.

5.2.1.3 Liability

Another risk associated with remediation of hazardous waste sites is liability for third party injuries resulting from the accidental release or creation of harmful contaminants during remediation work. USACE and the EPA recognized this risk in the Baird & McGuire project. They required OHM to purchase pollution liability insurance. This type of insurance is not presently readily available. If available, pollution liability insurance is extremely expensive as illustrated by the case study. The insurance for this project cost $690,000 which is approximately 1% of the total costs. To minimize this the financial burden, USACE reimbursed OHM for the purchase expense of the insurance and the EPA indemnified OHM for amounts that exceeded the insurance coverage.

This risk was also recognized in the AMTL project. However, the measure to attenuate this risk was different from that taken in the other case study. MK defrayed the cost of purchasing pollution liability insurance by being self-insured. This method creates a high risk for MK to bear. Should an accidental release or creation of contamination while doing remediation work occur, MK would have to have to pay expensive settlements to third parties from its profits. Therefore, they must rely on their remediation competency, safety training, and site specific training they provide their on-site personnel with to avoid occurances of accidental contamination releases.

5.3 Total Environmental Restoration Contract

With increasing public concern for the environment, the Federal government desires to move hazardous waste sites rapidly from a study phase or site assessment to actual cleanup. USACE plays a major role in the Federal government's remediation and restoration programs for thousands of sites. USACE is committed to developing improved and more efficient contracting mechanisms that will be more responsive, effective, and timely for Hazardous, Toxic, and Radioactive Waste (HTRW) work.

USACE has developed an innovative contracting methodolgy that accomplishes this objective. The methodology is called Total Environmental Restoration Contract (TERC). By definition, a TERC is a remediation, not a design, contract. As a cradle-to-grave contracting mechanism, TERC is intended to complete actual remediation, starting at any stage of the investigation or remediation process. A TERC can be used to remediate any HTRW activity. This includes sites associated with Superfund, Base Realignment and Closure (BRAC), formerly used defense sites (FUDS), Army Installation Restoration Program (IRP), and in support of other federal agencies.

TERC uses delivery orders for the performance of work under a basic indefinite-quantity contract. Each TERC will have a performance period of four years with two additional three-year options for a possible total of ten years. A guaranteed minimum amount of $300,000 will be obligated in a TERC for its base period and at the time of exercising each contract option period. The maximum contract amount specified in a TERC is $260 million.[95]

---

[95]TERC Delivery Order (Planning, Issuance, and Administration) Seminar, U.S. Army Corps of Engineers, New

The intention of using TERCs is not to replace existing contracting tools, and not all projects are appropriate for the use of a TERC. Use of TERCs is limited. Projects having any of the following characteristics are selected for TERC:[96]

- Comprising two or more sites
- Conditions indicate a high probability that interim remediation of point sources of contamination will be required
- Pre-remediation and remediation work requires significant interface and coordination
- Close coordination of remediation effort must be maintained between sites
- Funding is phased by site (operable unit)
- Contractor accountability/liability is critical
- Management of more than one contractor on an installation presents unacceptable administration problems
- Existing on-site conditions indicate a need for the contractor to respond quickly to situations without interference from another contractor working in close proximity to the site

Initially, TERCs will be administered only by seven USACE design districts and the New England Division. Each is designated as a TERC design district/division. The following is a list of the TERC design district/division and Figure 5.1 depicts their boundaries:[97]

- Omaha District/Kansas City District
- Baltimore District

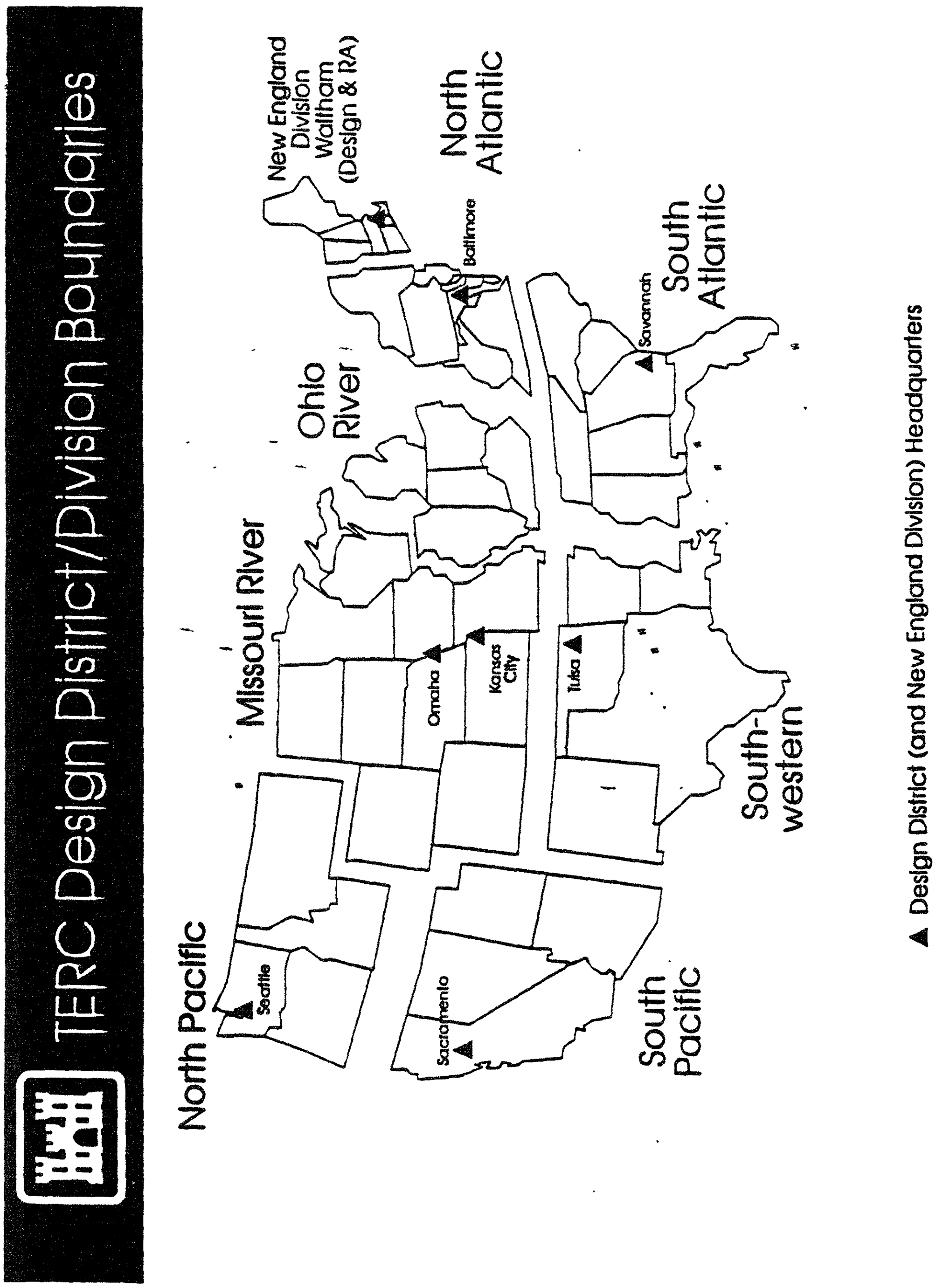
England Division, March 1994, p. 7.

[96]Ibid, p. 109.

[97]Ibid, p. 110-111.

- Savannah District
- Tulsa District
- Sacremento District
- Seattle District
- New England District

Figure 5.1



5.4 Recommended Contracting Arrangement for Federal Remediation Projects

Through the evaluation and analysis of the two case studies, a recommended contracting strategy for federal remediation projects is proposed. A Design-Build team is the recommended contract organization structure. This facilitates an improved working relationship, more efficient handling of changes, and the involvement of each party in the design phase. For the contract portion, a combination of fixed price and cost reimbursable should be used. Full control of the design and construction of remediation facilities should reside with the Design-Build team. Given this control, the contractor is the most appropriate entity to bear the risk involved in the construction of these facilities; and a fixed price contract should be awarded. The Design-Build team has no control over the amount nor type of contaminants to be remediated. Therefore, the owner (USACE) is the party that should bear the cost of this risk. A cost plus fixed fee contract is recommended for the portion of the project involving the amount and type of contaminants to be remediated. By using this contracting method, the risks associated with remediation of hazardous sites are better attenuated for all parties involved. However, through negotiations, what constitutes construction of remediation facilities and remediation of contaminants must be clearly delineated and defined to avert future claims and adversarial relationship development.

Multiple parameter award methodology is recommended with the parameters being cost, time, and qualifications of the firm. The emphasis should be placed on qualifications and time rather than on cost. By so doing, the government can assure itself of obtaining the best firm that can accomplish the work quickly and within a reasonable cost. Lastly, after evaluating both projects, total site remediation by one contractor is recommended. There are a sufficient number of firms that possess the capabilities and qualifications to do total site remediation. This is evidenced by thirty companies responding to USACE's advertisement of PPRACs which require the capability to do total site cleanup. Further confirming this is the Baird & McGuire case study. The groundwater treatment contract was awarded to Barletta Engineering. OHM won the contract for soils incineration. OHM also demonstrated that it possesses the expertise, experience, and capability to do groundwater treatment and incineration as evidenced by USACE awarding them a PPRAC contract. Therefore, it would have only made sense to award one contract for both jobs which would only require going through one award selection process rather than two lengthy processes as happened.

Also, using this approach will expedite the clean up process and simplify a complex situation. Using more than one contractor for different phases of a project complicates an already complex situation as seen in the two case studies. More than one contractor requires additional personnel for supervision and administration. In the Baird & McGuire case, coordination problems may arise between the groundwater treatment and incinerator contractor. For instance, the groundwater treatment plant may be accomplishing maintenance. Thus, the plant may not be able to accept up to 100 gpm of surface water for treatment from the incineration operations as the contract specifies. To ensure this does not occur continuous coordination and knowledge of both work schedules is required. If there was only one contractor for both of the project's operable units, closer coordination would be easier. Coordination would be between internal components of a single company rather than between two different firms. Another example of possible coordination dificulties where two different contractors are used is the AMTL site. USACE may decide to award the contract for the remediation of chemical wastes to a firm other than MK. MK would then demobilize from the project. The new firm may discover radioactive wastes during its cleanup work and not have the capability to remediate such contaminants. USACE would then have to recall MK or contract another firm with the capability to remediate the radioactive wastes. If MK were awarded both contracts, they would have the internal capability to do either type work and no additional contracting nor time delays would occur.

This recommended contracting strategy is similar in many respects to one that USACE has developed, Total Environmental Restoration Contract (TERC). The proposed contracting strategy presented in this thesis advocates the use of TERCs for all Hazardous, Toxic, Radioactive Waste (HTRW) sites as opposed to their current limited use. The USACE's criteria for selecting a project for TERC applies to all HTRW sites and the two case studies attest to this fact. Another major difference between the proposed contracting method and TERC is contract type. The method recommended in this thesis uses a fixed price contract for the portion associated with construction of remediation facilities and cost plus fixed fee for the remediation of contaminants. TERC uses strictly cost type contracts for all aspects of remediation.

5.5 Areas for Further Research

This thesis was limited to studying and analyzing the contractual structure of two hazardous waste sites and recommending an appropriate alternative contracting mechanism for each site. Based on the evaluation of both case studies, this thesis recommended an overall contracting strategy for all federal remediation projects. Suggestions for further research in federal remediation projects include:

1. Continuing the study of contractual arrangements for the AMTL site during the next phase, remediation of the chemical contaminants in the soils and groundwater. The installation is scheduled to close September 1995. A Record of Decision will be completed in December 1994. A Pre-Placed Remedial Action Contract (PPRAC) was used during the first remedial action phase.

2. Analyzing and evaluating the use of TERCs at various projects. The characteristics a project must possess for use of a TERC in the author's opinion are characteristics associated with any HTRW site. The analysis of a project using a TERC may lend insight as to the effectiveness of TERC and perhaps its increased useage.

3. Analysis of contractual strategy and associated risks of various projects strictly from a contractor's point of view.

Bibliography

Books

Porter, Michael E. *Competitive Advantage*. New York: The Free Press, 1985.

Erickson, Randall L. *Environmental Remediation Contracting*. New York: Wiley Law Publications, 1992.

Periodicals and Papers

Carpenter, Betsy. "This Land is My Land." *U.S. News & World Report*, March 14,1994, p. 65.

"Clinton Releases FY 95 Budget." *United States Corps of Engineers Update*, Vol. 18, No. 3, March 1994, p. 1.

"Cost Muddies Arsenal Clean-up Picture." *Watertown Press*, March 24, 1994.

Dodge, F. W. "Construction Forecast Predicts 9 Percent Increase in 1994." *Civil Engineering News*, December 1993, p. 1.

"Environmentalists Feel a Presidential Letdown." *Boston Globe*, April 21, 1994, p. 1.

Hawkins, Dana. "Salary Survey." *U.S. News & World Report*, November 1, 1993, p. 109.

"6 Defense Sites in N.E. Go On Superfund List." *Boston Globe*, June 1, 1994, p. 21.

Van Vooorst, Bruce. "Toxic Dumps: The Lawyers' Money Pit." *Time*, September 13, 1993, p. 64.

Wagner, Betsy. "The Greening of the Engineer." *U.S. News & World Report*, March 21, 1994, pp. 90-91.

Williams, Arthur E., Lieutenant General, Chief of Engineers. "From The Chief of Engineers." *Engineer Officer Bulletin*, January 1993, p. 1.

Williams, Arthur E., Lieutenant General, Chief of Engineers. "From The Chief of Engineers." *Engineer Officer Bulletin*, February 1994, p. 1.

Government Contracts, Publications, and Reports

Contract DACW45-92-C-0047, OHM Remediation Services, Baird & McGuire Superfund Site. Contracting Office, New England Division, U.S. Army Corps of Engineers, March 30, 1992.

Contract No. DACW45-90-D-0029, Decommissioning, Demolition and Site Restoration of AMTL Research Reactor Radiological Facilities Watertown, MA, May 14, 1992.

Defense Environmental Restoration Program, Annual Report to Congress for Fiscal Year 1992. U.S. Department of Defense, April 1993.

EG&G Idaho, Inc. *Decommissioning Plan for U.S. Army Materials Technology Laboratory Research Reactor*, October 1991.

Federal Acquisition Regulation, Chicago: Commerce Clearing House, February 1, 1992.

New England Division, Corps of Engineers. *TERC Delivery Order (Planning, Issuance, and Administration) Seminar*, March 1994.

Omaha District, U.S. Army Corps of Engineers. *Acquisition Plan, Baird & McGuire Superfund Site*, March 10, 1992.

Omaha District, U.S. Army Corps of Engineers. *Introduction to the Rapid/Immediate Response and Preplaced Remedial Action Programs*, Novenber 1992.

Omaha District, U.S. Army Corps of Engineers. *Memorandum for File, Record of Evaluation for RFP # DACW 45-90-R-0065*, March 20, 1992.

Roy F. Weston, Inc. *Facility Decommissioning Plan, Army Materials Technology Laboratory*, April 1992.

Roy F. Weston, Inc. *Phase 2, Remedial Investigation Report, Army Materials Technology Laboratory*, September 1993.

Sullivan, Gordon R., General, Army Chief of Staff. *Army Focus 93: Moving Out to the 21st Century*. September 1993, p. 39.

Source Selection Board, Omaha District, U.S. Army Corps of Engineers. *Selection Justification, On-Site Incineration, Baird & McGuire Superfund Site, RFP DACW 45-90-R-0065*, March 19, 1992.

West, Togo D. Jr., Secretary of the Army, and Sullivan, Gordon R., General, Army Chief of Staff. *A Statement on the Posture of the United States Army Fiscal Year 1995.* Presented to the Committees and Subcommittees of the United States Senate and House of Representatives, Second Session, 103d Congress, February 1994, p. 70.

United States Environmental Protection Agency. "The Baird & McGuire Site Construvtion Update." *Countdown to Cleanup*, Vol. 1, April 1992.

United States Environmental Protection Agency. "The Baird & McGuire Site Construvtion Update." *Countdown to Cleanup*, Vol. 2, Fall 1993.

United States Environmental Protection Agency. *Superfund Record of Decision: Baird & McGuire, MA*, September 1986.

Interviews

Fedele, Frank. Resident Engineer, New England Division, U.S. Army Corps of Engineers, Holbrook, Massachusetts, project update meeting, Baird & McGuire Superfund Site on April 13, 1994.

Helstrom, Mark. Project Manager, Morrison Knudson, Army Material Technology Laboratory, interview of June 29, 1994.

Henry, Fred. Contract Specialist, Contracting Division, Omaha District, U.S. Army Corps of Engineers, Omaha, Nebraska, interview of May 12, 1994.

Kam, Al. Contracting Technician, Contracting Division, Omaha District, U.S. Army Corps of Engineers, Omaha, Nebraska, interview of June 21, 1994.

Waskiewicz, Dennis. Program Manager, Army Material Technology Laboratory, New England Division, U.S. Army Corps of Engineers, Waltham, Massachusetts, interview of June 6, 1994.

Theses and MIT Course Notes

Banaji, Darius. *Contracting Methods and Management Systems of Remdial Action Contracts Within the U.S. Navy's Installation Restoration Program.* Thesis submitted to the Department of Civil and Environmental Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts, September 1993.

Camp, Dresser & McKee. *MIT Course 1.972, Environmental Restoration Engineering,* Department of Civil and Environmental Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts, Spring 1992.

Dornstauder, Alex C., Captain, USA. *Hazardous Waste Remediation and the U.S. Army Corps of Engineers: Facilitating Technological Innovation through Construction Management.* Thesis submitted to the Department of Civil and Environmental Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts, May 1991.

Gordon, Christopher M., P.E. *Compatibility of Construction Contracting Methods with Project and Owners*. Thesis submitted to the Department of Civil and Environmental Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts, September 1991.

Rossi, Michael A., Captain, USA. *The Department of Defense and the Construction Industry: Leadership Opportunities in Hazardous Waste Remediation Innovation*. Thesis submitted to the Department of Civil and Environmental Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts, January 1992.

Simoneau, Craig L., Captain, USA. *Alternative Contracting Methods in the U.S. Army Corps of Engineers.* Thesis submitted to the Department of Civil and Environmental Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts, June 1992.