
CHEMICAL FEARS: THE SOCIAL EFFECTS OF THE CHEMICAL STOCKPILE DISPOSAL PROGRAM

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Abstract. Analysis of the socioeconomic effects of the Chemical Stockpile Disposal Program (CSDP) departed from the concentrated analysis of traditional types of socioeconomic impacts associated with large-scale construction projects. Such impacts were documented, but due to the nature of the program never emerged as significant concerns. The work forces to construct and operate the facilities are small in comparison to available workers, adequate infrastructure exists to support any in-migration, and the sites are on government installations and can be located to avoid visual, cultural, and noise impacts.

Despite the apparent benign nature of the program with regard to direct environmental effects, massive public controversy developed in communities near some of the storage sites. At issue was the safety of incinerators that would be burning some of the most toxic substances ever to be produced, or alternatively of transporting agents to other sites for disposal. Issues arose over the possibility of accidents and the routine release of uncombusted agents into the air. These issues lead to a somewhat unique analysis of socioeconomic impacts.

This assessment has led to several important conclusions about the analysis of socioeconomic impacts associated with projects involving hazardous material with a potential for accidental releases of materials with human health consequences. First, the projection of impacts in a variety of categories cannot be done given current knowledge and models. These include the increase in incidence of mental health impairments from exposure to a hazardous activity, the effects of increased risk on local economic structures including property values and industrial growth, or the impact of an accident on demographic change or the local economy to cite a few. There is a distinct need to initiate further research that would lead to models to forecast such effects. Such work, in addition to the obvious applied value, could also help improve the theoretical understanding of human systems and human/environmental relationships.

Second, achieving a set of validated models to forecast such impacts is not going to be an easy undertaking. In the course of reviewing the literature relevant to this effort, it has become obvious that two significant factors limit that development. One is that the theoretical and methodological framing of the problem may dramatically influence the outcome of the research. Another is that the number of known variables (not to mention the unknown ones) that may affect the outcome of a process is so large that isolating cause and effect sequences may be impossible. Both problems confound the possibility of achieving validated models.

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DEFINING RELEVANT IMPACTS: A DEPARTURE FROM TRADITIONAL SOCIOECONOMIC ANALYSIS

Although every impact assessment has certain unique features, the analysis of the socioeconomic impacts of the Chemical Stockpile Disposal Program (CSDP) represents a significant departure from the analyses found in other impact statements. The departure was due in part to the nature of the proposed action: chemical agents are among the most toxic substances known to exist. It was also shaped by the concerns of local citizens. The issues raised by the public were somewhat different than those addressed in previous National Environmental Policy Act (NEPA) documents. For example, the concern over the ramifications of an accidental release of chemical agent extended far beyond health effects into the social consequences on the community. Likewise, concern over the release of emissions from the incineration process extended into the effects on the mental health and well-being of residents in the vicinity of the plant. This paper describes the approach used to assess such impacts, including the definition of impact categories, uses analogy as a means of identifying impact levels, and describes what are potentially significant effects of the program on socioeconomic resources.

Setting the Agenda

The socioeconomic assessment of most, if not all large-scale projects and programs typically focus on construction and operations impacts. The critical variables in the analysis often are:

- The size of the project work force in relation to the existing work force,
- The demand for new community infrastructure induced by in-migration,
- Traffic and noise associated with the project, and
- Loss of aesthetic and cultural resources due to construction activities.

Analysis of the socioeconomic effects of the CSDP departed from the concentrated analysis of traditional types of socioeconomic impacts associated with large-scale construction projects. Such impacts were documented, but due to the nature of the program never were identified as significant concerns. First, the work forces to construct and operate the facilities are small in comparison with available workers, adequate infrastructure exists to support any in-migration, and the sites are on government installations and can be located to avoid visual, cultural, and noise impacts.

Despite the apparent benign nature of the program with regard to direct environmental effects, massive public controversy has developed in communities near some of the

storage sites. At issue are the safety of incinerators that would be burning some of the most toxic substances ever to be produced and the safety of transporting agents to other sites for disposal. Issues arose over the possibility of accidents and the routine release of uncombusted agents into the air. These issues led to a somewhat unique analysis of socioeconomic impacts.

Cognizable Impacts Under NEPA

Under NEPA, an EIS must consider secondary impacts from direct alteration of the environment. This would include psychological impacts as well as all other health impacts directly linked with the proposed action. The U.S. Supreme Court has ruled that psychological effects associated with the perceived risk of an accident should not be considered impacts because risk is not a tangible part of the environment (*PANE vs. USNRC*, 1982). In this ruling, the court felt that the causal string of events between risk and mental health was too weak and remote to warrant consideration. The opinion would suggest, however, that the psychological impacts from exposure due to chronic or acute releases of hazardous materials would be cognizable under NEPA. Although research has challenged the scientific accuracy of the ruling that risk is irrelevant to analyzing mental health impacts of hazardous accidents (Sorensen et al., 1987; Hartsough and Savitsky, 1984), the analysis followed the Court's guidelines. In keeping with the letter of the ruling, the CSDP analysis was designed only to deal with impacts of the chronic release of materials into the environment and the tangible hazard of exposure under accident conditions.

Bounding the Analysis

The definition of impacts to be included in the analysis was derived in three ways. First, public concerns expressed at scoping meetings were examined to determine which impact categories were of concern to the public. Second, previous NEPA documents concerning hazardous materials such as nuclear waste were examined. Third, the social science literature concerning the public impacts of hazardous technologies and materials was examined (Sorensen et al., 1987; Lebovits et al., 1986).

Based on those activities the following impact categories were identified for further analysis:

- quality of life
- historic resources
- archaeological resources
- population
- land use
- economic development

- emergency planning
- noise
- transportation
- economic change.

Quality of life can be broadly defined as the aggregate effect of all impacts on individuals, families, communities, and other social groupings and on the way in which those groups function. As defined herein, the quality of life subsumes what others label as the psychological, psychosocial, well-being, distributional, or satisfactoral impacts. In order to structure this analysis, quality of life was divided into three categories:

- Mental health and well-being encompasses changes in the mental states of individuals, including their attitudes, perceptions, and beliefs as well as the associated psychological and physiological consequences of those changes.
- Social structure encompasses changes in the social organization of families and groups, their collective postures over the impacts, and how impacts affect the cohesion and viability of the group.
- Community well-being encompasses changes in community structure that relate to non-economic factors, such as desirability, social cohesion, livability, attractiveness, and sense of place.

The historical and archaeological environments are defined as sites of cultural importance and significance. Importance or significance is determined by a number of factors including the uniqueness, rarity, age, scholarly value, and public interest of the site. Some sites may attract visitors or users. Sites may also be given formal recognition of their value by being placed on the National Register of Historic Preservation or by being designated a historic site or monument.

The category of emergency planning includes the development of contingency plans and activities to support planning and plan implementation. Under Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA Title III), communities are required to develop emergency plans for hazardous material accidents if a facility in the community stores or uses certain quantities of listed chemicals. There is little federal fiscal support for communities to implement this requirement. Therefore, the addition of a hazardous technology is likely to require community expenditures on enhanced emergency planning. The level of emergency planning and response impacts is determined by the level of emergency planning and response requirements that cannot be met with existing civilian and facility resources and hence would require the use of additional state and local resources. Emergency response includes participating in emergency and security

activities such as exercises, maintaining plans and equipment, training, and responding to a spill or accident.

The siting of a new industrial facility will have several direct and secondary impacts on the local economy. These types of impacts are understood, and a variety of models exist for predicting these impacts. Other economic impacts are more unique to the program. These concerned a drop in property values, a decline in industrial attractiveness, economic decline, and the effects of an accident on the local economy. While the decline in property values, industrial attractiveness, and local economy are temporary, lasting for the duration of the program, or until the stockpile is destroyed, the social impacts of an accident are of unknown duration.

PROBLEMS IN MEASURING IMPACTS

Projected impacts are estimates of the behavior of certain phenomena or variables over time. The projection can be based on qualitative or quantitative assumptions and understandings of the relationships between the phenomena and the factors that shape, drive, or influence their value. The precision of the estimate will ultimately vary with the robustness of the forecasting technique and the quality of the data used. For example, projections of increased noise from trains carrying munitions can be made in a relatively precise manner. Projections of out-migration from the area specifically induced by the operations of the chemical agent incinerators cannot be made on a quantitative basis.

The problems in estimating impacts from a future alteration of the environment are similar to those in any prediction — unless a validated model and the data needed to use the model exist, the limits of prediction are quickly encountered. This is well illustrated by the issues in predicting quality of life impacts. Variation among the different dimensions of quality of life, represented by objective and subjective measures, might be found from place to place in the various sites and along the various off-site transportation routes that make up the affected environment. The variations may be fairly small for certain items and large for others.

For example, based on results from studies of mental health on state-wide or national bases, great variations in mental health conditions for people living in impact zones would not be expected. However, variations could be expected in family cohesion (e.g., divorce, or family violence rates) or in the perceived desirability of a place based on aesthetics or other valued features. No attempt was made to quantify these measures for two reasons. First, it is difficult to measure quality of life in precise ways. Second, even if a baseline were established, there is no way of predicting how the baseline would change due to implementation of the various alternatives, except in a general and qualitative fashion.

One of the major problems confounding this analysis is the lack of historical data on the action. Chemical weapons have never before been disposed of on the proposed scale of operations and close to human population centers. The only current operating disposal facility at TEAD South (CAMDS) is a pilot disposal plant which has neither the scale nor proximity to an urban area to provide information regarding the level of social impacts. The facility is only a fraction of the scale of the proposed incineration plants. More importantly, it is located in the sparsely populated Rush Valley in Tooele County, Utah. Disposal activities at the Rocky Mountain Arsenal in Denver occurred prior to NEPA.

Given the lack of historic experiences and absence of validated models on which to base the assessment, the assessment examined what could be learned by comparing the program to analogous actions. The exposure of the public to hazardous technology is not without precedent. The nuclear power and chemical industries expose the public to the threat of chronic exposure and accidental releases of materials. Public reactions are similar to those observed for some members of the public in scoping for the CSDP: "don't do it here." The approach developed to assess impacts relies heavily on the use of data, knowledge, and theory derived from the study of analogous events. This somewhat limits the ability to make precise forecasts, but does allow reasonable estimates of the direction and range of impacts.

The analysis of the socioeconomic impacts was done using a generic analysis to be consistent with the programmatic approach. It draws on the existing body of knowledge on the impacts of large-scale disasters on individuals, families, and communities. It is general in that all the variables that would affect the level and type of impact and prescribe how those factors would change among different accident scenarios cannot be specified and measured. The uncertainties associated with the specification of accident scenarios and the range of possible scenarios is sufficiently great that analyses of different scenarios becomes meaningless. For example, an alternative may have twenty different accidents with varying release characteristics and potential downwind hazards. The area affected is a function of the agent type and quantity, wind direction, wind speed, and atmospheric stability over the course of the release and dispersion. Literally hundreds of different accident scenarios could be developed by varying these factors. As a result, the analysis looked at the general impacts of the largest credible accident where credible was defined as an accident with a probability of 10^{-8} or greater.

IMPACTS BY ANALOGY: THE CASE OF MENTAL HEALTH IMPACTS

This section reviews the procedure developed to estimate impacts by analogy and to illustrate the application of that

procedure in the area of mental health effects. In order to use this approach as a means of identifying and measuring impacts, it was first necessary to establish a theoretical perspective from which to accept or reject whether the causes of the impacts from analogous events could frame the impacts from the CSDP. Next the results of empirical research conducted on the analogous events were reviewed. Third, a framework was developed to translate those results into projections of impacts for the CSDP. At times the framework was highly explicit as in the example presented. At other times the framework was more vague, reflecting the lack of analogies on which to base the analysis.

The framework here is largely derived from a model of stress. The basic structure of the model is that a stressful event occurs and, as mediated by social processes, results in physical and psychological health effects. The next subsection lays out the model in more detail. This is followed by two subsections that examine stress effects from low-level stressors, such as exposure to chronic threats, and from acute stressors, such as major accidents. These subsections review studies of stress effects and studies that identify vulnerable subgroups of the population. The final subsection draws conclusions, based on the use of analogy, about the types and magnitude of mental health impacts from the disposal program.

Theoretical Perspectives

A Definition of Stress. The process by which the CSDP is expected to cause negative mental health effects is based on the assumption that exposure to the threat of a hazardous waste incinerator or experiencing a disaster is similar in nature to going through a stressful life event (Logue et al., 1981). The model of life events and mental health is composed of a three-stage process. First, a person is exposed to an initial stressor event. The nature and magnitude of this event and the way in which it is perceived as harmful are important determinants of impact (Lazarus, 1966). The second stage involves exposure to a series of events that may mediate response to the stressors; such events in some cases can help reduce stress or, conversely in others, raise somatic stress levels (Perry and Lindell, 1978; Perry, 1983). Finally, the increased stress levels may result in both physical and mental impairments. Such impairments are diverse in type and severity (Baum et al., 1980). One major problem in predicting mental health effects is a weak knowledge of the social and environmental determinants of perceived stress levels and the causal mechanisms by which stress results in debilitating illness (Sorensen et al., 1983; Perry, 1983).

Baum et al. (1980) define stress as a complex set of emotional, mental, behavioral, and biological responses to the threat of being harmed or losing something dear. Some phenomenon or event must, however, produce that threat.

Stressors or stress events cover a broad range of incidents that may elevate stress levels. Such stressors occur constantly, yet do not always cause stress-related impairments to mental health. One view of stress phenomena differentiates between acute and chronic stressors. Acute stressors are short-lived phenomena usually producing a sudden elevation of stress that endures for the length of time the stressor is present. Chronic stressors either are constantly present or repeat themselves for a long time. In a similar fashion, Lazarus and Cohen (1977) identify cataclysmic and background stressors. The former are defined as strong, sudden, unique, and rare events or groups of events. The latter are defined as ordinary, persistent, or repetitive events.

Frederick (1980) investigated in more depth the characteristics of cataclysmic stressors that may affect stress levels. He classified stressors by whether they are natural or man-made, are preventable or non-preventable, have short or long recovery periods, have been prepared for or not, have resulted in widespread evacuation and displacement or not, and have resulted in recoverable or irrevocable damage. Preliminary hypotheses suggest that events with the latter value of each dichotomy are more stressful. As yet, a precise empirical model of how such factors determine stress levels or stress-induced debilitating effects is not available, partly because there is no grounded body of field and experimental research on risk- and disaster-induced stress. This lack of understanding is also attributable to the factors that mediate stress.

Mediators of Stress. A variety of factors related to the individual, the social setting, and the situational context of the threat will mediate stress or heighten it. Individual factors that seem to play major roles in shaping stress response include previous susceptibility to stress (Selye, 1956) or psychological instability (Perry, 1983), coping ability (Sorensen et al., 1983), coping resources (Lazarus, 1966), coping skills (Perry, 1983), perceptions of the hazard and risk (Slovic et al., 1979; Sorensen et al., 1983), individual grief reactions (Perry, 1983), perceptions of control (Seligman, 1975), and concern with other issues and problems (Sorensen et al., 1983).

Factors related to social setting that influence stress include social support networks (Bolin, 1982; Drabek and Key, 1984; Perry, 1983), community and group ties (Sorensen et al., 1983; Perry and Greene, 1982), and crisis intervention (Hartsough, 1982; Tierney and Blaisden, 1979). Situational factors that play a role include experience with witnessing death (Perry, 1983), experience with evacuation (Frederick, 1980), media influence and coverage (Sorensen et al., 1983), and post-disaster relief (Bolin, 1982).

Stress problems may be exacerbated when people feel helpless to deal with a stressor. According to learned-help-

lessness theory, this occurs when one is exposed to an uncontrollable event and believes that nothing can be done to change the outcome of the event (Seligman, 1975; Murphy, 1985). The consequences of helplessness include reduction in mental abilities, negative emotional states, maladaptive behavior, and depression (Baum et al., 1980). Thus when a stressor and a feeling of helplessness are both present, the potential for negative mental health consequences are increased.

Stress Effects. Distinctions are usually drawn between psychological reactions to stress and physiological responses (Baum et al., 1983). Furthermore, it is often desirable to distinguish between direct effects, which are immediate responses to the stressor, and second-order effects, which are longer term manifestations of stress impacts.

Direct psychological responses are numerous. First reactions often involve a feeling of shock or increased anxiety. Some stress victims may develop apathy and depressive mental states. Others may become irritable and resentful. Often, a feeling of being trapped or of helplessness will accompany the stress.

Direct physiological responses are often associated with increased levels of adrenaline and other catecholamines that increase heart rate and blood pressure and accelerate respiration, perspiration, and other physiological functions. Stress can also cause a numbing reaction in which people experience a stunned or dazed feeling and are unable to respond in a normal fashion. Physical symptoms of these responses include muscular tension, memory lapse, headache, insomnia, tiredness, sweating, dizziness, and general weakness. These are typically referred to as somatic stress effects because of a lack of a specific etiology of their manifestation.

Second order impacts are divided into coping reactions and behavioral and physical manifestations of stress or etiological effects. Coping is usually defined as behavior employed to reduce or eliminate the danger posed by the stressor. Coping may involve conscious and purposeful actions to remove the stressor, to get away from it, or to eliminate the stressor's effects. It also may include actions that are not directed toward the stressor, such as drinking or drug use, or other detrimental effects sometimes called the "costs of coping" (Cohen et al., 1986). In addition, coping may be solely cognitive; that is, people make mental adaptations, frequently referred to as defense mechanisms, to deal with the stressor. Social support structures such as kinship and friendship ties play an extremely important role in the coping process and may be one of the major ways in which stress is mediated.

Behavioral and physical manifestations of stress can be thought of as longer term reactions to the first-order symptoms. These manifestations are often caused by

chronic experiences with stress or from repeated episodes of acute stress. The most severe problems are probably produced by repeated catecholamine releases. Such releases exert an influence on various bodily functions, which in turn can lead to cardiovascular problems or coronary heart disease. Other physical problems such as hypertension, arthritis, ulcers, and arteriosclerosis have also been associated with stress. In addition, coping responses may also produce negative consequences, such as increased drinking and alcoholism and drug use. These manifestations can lead to interpersonal difficulties, causing the loss of friends, divorce, and job-related problems. Furthermore, longer term psychological manifestations of stress may occur. These manifestations are often not diagnosable as stress impacts, nor are they debilitating. Such problems may include general irritability, antisocial behavior, feelings of worthlessness, impatience, harshness, decreases in analytical abilities, and general contrariness. Such problems, when severe, can lead to clinically diagnosable mental illness.

Results From Studies of Analogous Situations on Exposure to Low Level Threats

The research base on the mental health effects of low level threats includes studies on the Three Mile Island Accident and subsequent controlled releases of radioactive substances into the environment and exposure to hazardous waste and toxic materials. These studies provide a better notion of the impacts of threats that can be characterized as low risks.

Stress Effects. Strong empirical evidence is provided by Baum, Gatchel, and Schaeffer (1983) in a study of the stress effects of the accident at the Three Mile Island (TMI) Nuclear Power Plant in 1979. A sample population at TMI (seventeen months after the accident) were compared with those (1) at a site with an operating nuclear power plant, (2) at a site with a coal-fired power plant, and (3) at a site without any power plants. Backgrounds and demographic characteristics of each group were comparable. The results indicated that the TMI population exhibited more stress symptoms than the other populations. No significant difference was found between the population exposed to risk from another nuclear power plant and the other two groups. While this does not mean that the threat in the no-accident site plays no role in determining stress, it suggests that the threat does not elevate stress above normal levels unless some anomalous release has occurred, even though their release poses no serious health threat.

Another study by Baum investigated stress associated with the venting of radioactive gases from the damaged reactor at TMI (Baum et al., 1982). The results of this study suggested that the accident at TMI has led to elevated chronic stress among the population around TMI. The

venting of radioactive materials led to elevated acute stress before the release. The venting and post-venting measurements revealed a lowering of the anticipatory stress. In all cases, stress levels were subclinical, that is, at levels that do not require medical treatment or psychological intervention.

Dew, Bromet, and Schulberg (1987) conducted a comparative study of the stress effects of two types of stressors—the TMI accident and unemployment. They found that levels of subclinical stress symptoms were elevated to a similar degree for each stressor and remained elevated for 2 to 3.5 years.

Using different methods and measures, several recent studies have shown that toxic exposure systematically leads to elevated levels of distress, both specific and global, among individuals (Lebovits et al., 1986). This general finding holds up for a variety of situations, including acute releases of chemicals (Markowitz and Gutterman, 1986), contaminated water supplies (Gibbs, 1986), low-level releases of radiation (Davidson et al. 1986), and the presence of a hazardous waste site (Bachrach and Zatura, 1986; Levine and Stone, 1986).

These studies also found that lack of information and conflicting information exacerbated adverse psychological reactions (Lebovits et al., 1986). Feelings of helplessness, powerlessness, and lack of control also result from heightened distress (Lebovits et al., 1986). The chief implication of this set of studies is that if people believe that they are being exposed to chronic or acute releases of toxic materials, they have a potential to develop elevated distress and its various symptoms. This effect is greatest when people do not believe they are receiving accurate information about the problem and feel helpless about gaining some control over the situation.

Vulnerable Subgroups. Some evidence exists that children, depending on their age, will be either more or less vulnerable to the threat of chemical agent exposure. One study suggests that young children (<11 years) may not perceive risks from such activities (Walesa, 1977), while adolescents may feel powerlessness and resignation toward the activity (Schwebel and Schwebel, 1981). One implication of this finding is that adolescents may be more aware of an external stressor and thus more vulnerable to experiencing stress. This also implies that young children may be less aware of external stressors such as a hazardous facility and less likely to experience stress. Family studies, however, show that stress in children can occur due to factors internal to the family and other social networks such as schools. Thus, a child who has parents who are stressed by the external threat may reflect that internal stress without being aware of the specific cause. Likewise, if the issue disrupts school activities, then stress may also be experienced.

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Results From Studies of Analogous Situations on Exposure to High Level Threats

The effects of stress from experiencing a disaster are a subject of intense debate (Perry, 1983; Quarantelli, 1979; Sorensen et al., 1983; Hartsough, 1982). All agree that stress levels are elevated during a disaster, but not on whether those effects are adverse and long lasting. Some argue that stress results in social bonding and rather short-lived psychological bonding. The differences, however, may come about because of differences in theoretical approaches, methodologies, and the specific disasters investigated (Perry, 1983).

Stress Effects. Studies have documented numerous types of psychological effects of disaster, including acute grief, anger, anxiety, hostility, resentment, depression, and loss of ambition (Logue et al., 1981). In the immediate aftermath of disaster, researchers have documented what is commonly called the disaster syndrome (Wallace, 1956). This syndrome is described as an absence of emotion, inhibition of activity, docility, indecisiveness, lack of responsiveness, and automatic behavior (Kinston and Rosser, 1974). Some researchers conclude that the disaster syndrome is rare and when it does occur, is relatively short-lived (Quarantelli, 1979; Quarantelli and Dynes, 1977). Others suggest it is a starting point for enduring psychological problems. While this issue is likely to be further debated, a review of the evidence developed to date on negative effects provides a qualitative but not quantitative assessment of disaster-induced mental health effects.

Melick (1985) reviewed 43 empirical studies on the psychological effects of disasters and offered some generalized conclusions. First, disasters do seem to cause mental health problems in the recovery phase, which may last for several years. Not every study, however, has found long-term effects. Only a few studies have concluded that there is an increase in physical health problems associated with stress. The number of people experiencing health effects and the size of those effects appear to be related to the methods of study and measurement techniques. Clinical assessments or in-depth psychiatric interviews find much higher incidents of mental health problems than self-reports or validated mental health scales. Several studies also note that disasters have positive mental health effects that are associated with successful problem solving.

Perry (1983) discussed factors relevant to the manifestation of mental health impairment from natural disasters. He suggested (based on Barton, 1970) that duration of impact (defined by long repetitive events or steady manifestation of a condition) is a key factor in determining impacts. He also suggests that geographical extent of the disaster is the second key characteristic of the stressor event. Perry also identified disaster-specific effects, such as the extent to which friends and kin are killed or injured and the level of

personal property loss experienced, as determinants of impacts.

Vulnerable Subgroups. Several studies have focused on the mental health impacts of disasters on vulnerable subgroups of the population, including children and the elderly. Children are considered to be a particularly vulnerable subgroup of the population to disaster-induced psychological impacts (Bolin, 1985). Research has shown that following severe disasters, children exhibit separation anxieties, sleep disorders, and phobias. The persistence and duration of these effects, however, are not well known. Burke et al. (1986) found that fifth-grade girls experiencing a flood showed increased distress ten months after the event. This research also suggests that girls are more vulnerable than boys of the same age, who did not exhibit increased fear, depression, or anxiety. This is consistent with Dohrehwend's (1979) finding that somatic symptoms of stress such as nightmares or stomach aches were especially common among girls and children in the low grades following the TMI accident. Overall, there is growing evidence that disasters cause emotional problems for some children; however, ways in which to ameliorate short and long-term emotional problems in children are not well understood (Benedek, 1985).

Whether the elderly constitute a vulnerable group is still open to some debate, although growing evidence suggests that the elderly do not require special mental health considerations (Bolin, 1985). Melick and Logue (1985-86) found that elderly flood victims did not show increased levels of anxiety or depression when compared with non-victims. This contradicts earlier research that defined the elderly as a vulnerable subgroup (Friedsam, 1962).

Another vulnerable subgroup is parents, particularly females who have small children or are pregnant. Logue (1978) suggests that women under 65 with lower levels of income and education are a high-risk group. The work of Bromet, Schubert, and Dunn (1982) suggests people with mental health problems prior to a disaster are more susceptible to disaster-induced problems. Children can either create anxieties or amplify their parents' anxieties. Large families are also more vulnerable to psychological impacts than small families (Bolin, 1982).

Assessing the Impacts. Table 1 presents our best estimates of the type of impacts that would occur under various threat and disaster conditions based on the current literature. To organize this information, the hazards are divided into ones that are dreaded (e.g., nuclear power, chemical spills, plane crash, nerve gas accident) and those that are more common (floods, auto accidents, etc.). Four situations are distinguished: threat only, disaster signal, minor disaster, and catastrophic disaster. Threat only is equivalent to exposure to risk. Disaster signal is a situation in which heightened awareness is caused by a near miss or disaster elsewhere.

Table 1. Summary of Mental Health Effects

Threat Type	Threat Only	Disaster Signal	Minor Disaster	Catastrophic Disaster
Dreaded Threat				
Concerns/feelings	Some concern	High concern	Widespread and strong concern	Extreme trauma
Anxieties	May affect a few individuals	Some people will experience anxiety	Prevalent during some longer lasting emergencies	High and of lasting duration
Somatic effects/minor etiological effects	None attributable	Some people will experience symptoms	Notably higher for some	Prevalent among many individuals
Clinical impairment	None	None	Few but difficult to attribute	Some likely
Common Threat				
Concerns/feelings	No concern	Minor concern	High concern	Widespread concern; some traumatization
Anxiety	None	Only a few individuals	Prevalent during emergencies	High with some lasting effects
Somatic effects/minor etiological effects	None	Unlikely	Few	High for some individuals
Clinical impairment	None	None	None	Few but difficult to attribute

A minor disaster is one in which no loss of life occurs. Major or catastrophic disasters include the loss of life.

Under normal operating conditions, a portion of the population could believe the presence of a hazardous material is a threat to their safety. In the short run, this threat, if accompanied by a belief that one was being exposed to hazardous substances, may elevate stress, particularly in anticipation of activities or operations involving the hazardous materials. Once activities begin and as they become routine, stress is likely to be reduced. Evidence from the TMI accident research suggests that even if stress were to increase to levels found following the non-damaging accident at TMI, the effects would be sub-clinical and would not result in any adverse health effects.

In an accident with no acute health impacts, people in the adjacent area may experience elevated stress, but are not likely to experience adverse clinical effects. An accident with human exposure and fatalities has a potential for causing long-term clinical effects and adverse mental health problems. The characteristics of an accident involving hazardous materials maximize the potential for stress to occur because it meets many of the criteria that researchers suggest would maximize mental health problems. The nature of the materials involved will also influence stress levels. Greatest long-term impacts would occur from materials that are persistent in the environment (e.g., mustard agents) or are known carcinogens or mutagens. Impacts would be lower from non-persistents

with no known long-term health effects from exposure (e.g., GB).

While other factors may mediate against stress, it was concluded that many accident scenarios would lead to a strong stress response. Whether this will definitely lead to adverse mental impairment is speculative, although the probability is high that some of the victims will experience negative effects.

Defining Significant Impacts

In a process similar to that described in the previous section, impacts and their significance are estimated for each of the categories described in the opening section of this article. This final section presents the conclusions of those analyses in light of what was considered to be a significant impact.

Normal Operations Impacts. The construction of a disposal facility will produce an average of 150 new jobs per facility during the time required for construction. The construction will also likely result in increased sales in construction-related industries in the region. Additional tax revenues will be produced. The total economic impact of the creation of jobs and increased spending at any site will be minor. The direct and indirect employment associated with CSDP alone will not result in significant in-migration, and impacts to local economic infrastructures will not occur. The accumulation of impacts as-

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sociated with all projects being conducted during the same period will be examined in the site-specific NEPA documentation process.

Several categories of socioeconomic impacts from operations are common to all existing installations and are unlikely to be highly significant for any local area for any alternative, albeit the impacts may differ slightly among alternatives. Impact categories that are unlikely to be affected in a significant fashion for any of the disposal alternatives include historic and archaeological resources, quality of life, population change, and land use change. No impacts to transportation systems or to the existing noise levels will occur. Minor economic impacts will be experienced, although they will not result in negative effects.

The major impact category that will be significantly affected concerns resources to implement emergency planning. These impacts will vary by site and alternative for three reasons. First, each installation has stored a different mix of weapons and quantities that pose different threats. This changes the planning basis for an accident. Second, the total population and population distributions are different around each site. This affects the costs of providing certain emergency capabilities, such as a warning system. Third, each installation has different jurisdictions with different levels of existing capabilities. This affects the amount of resources needed to upgrade existing capabilities. These are needed regardless of the alternative selected due to the commonality of continued storage and handling accidents. Emergency planning for the transportation corridors represents an incremental expenditure.

Accident Conditions. A large accident such as an aircraft crash into the storage facility or a vehicle crash involving M55 rockets would create an accident with extremely severe socioeconomic consequences. Such accidents could result in potential fatalities out to 100 km depending on the scenario and weather conditions. The accident could involve either mustard or nerve agent, although the mustard accident would encompass a somewhat smaller area. Unless emergency preparedness was enhanced, the large accident scenarios would overwhelm current response capacities in nearby areas. It would be difficult to reduce fatalities to zero under some weather conditions, even with enhanced emergency planning.

The large accident would endanger and disrupt the lives of people in the area, creating significant negative economic impacts due to the potential contamination of residential, industrial, and commercial buildings, agricultural lands, schools, historical and archaeological sites, and other human activities in the plume exposure pathway. Any area contaminated would be lost for human use until it was determined to be safe to enter. If the contaminant were a mustard agent, which is both persistent and carcinogenic, the socioeconomic impacts would be of long duration.

The emotional and psychological consequences of such an accident would also be severe depending to a large extent on the level of fatalities, exposure, and displacement of the population. Given the moderate to high density of the population around some of the sites, some people would need to be relocated until recovery processes could ensue. The social disruption to the community would be extensive and enduring.

MITIGATION: EMERGENCY PLANNING

The FPEIS recommended enhanced emergency planning and response capabilities in the communities surrounding the disposal sites to mitigate adverse socioeconomic and health impacts. These enhancements are mitigative measures in that they can reduce the human consequences of an accidental release of agent. Army assistance with emergency planning also mitigates a socioeconomic impact in the sense that communities are required to allocate resources to develop such capabilities, if they have facilities that store chemicals such as the agents included in this program. The level of emergency planning and response impacts are determined by the extent of the new requirements that cannot be met with existing civilian and Army resources.

Finally, emergency planning and response can reduce mental health impacts in several ways. First, it provides an ongoing coping mechanism to ameliorate the stress of living with a risky activity by reinforcing the notion of being able to respond to an accident. Second, effective emergency response to an accident reduces fatalities, which are a major cause of stress following a disaster, and reinforces the notion of control over the environment. Emergency planning includes the development of contingency plans and activities to support planning and plan implementation. Emergency response also includes participating in emergency and security activities such as exercises, maintaining plans and equipment, training, and responding to a spill or accident.

State and local governments will need to prepare or amend contingency plans and to coordinate their plans with those of the Army. The preparation of plans would likely require technical assistance from the Army, as well as state and local expenditures and staff time. Prior to the beginning of operations for storage, state and local emergency personnel would need to assess the adequacy of their resources for participating in the operation and for responding to a potential emergency. They would also have to procure those resources that are necessary for ensuring public safety. Since accidents can occur in storage, emergency planning enhancements can mitigate accident impacts before operations begin as well.

The reduction in impacts can be defined in qualitative terms by comparing the potential for fatalities without

enhanced planning to the potential to reduce fatalities with sound implementation of the recommended response procedures. The results of this comparison are summarized by Rogers et al. (1989) in this volume. The reductions have been assessed for different releases under different weather conditions because the amount of reduction in fatalities will vary with the scenario. For some situations, the reductions are quite large; for others, they are more modest. Indeed, some scenarios are difficult to mitigate with emergency planning.

The impacts of an accident on emergency planning depend on the size and location of the accident and the extent to which plans and response capabilities are upgraded. Three critical situations may differentiate among impacts:

- (1) an accident that is confined on-site,
- (2) an accident that causes off-site response, and
- (3) an accident that results in fatalities.

The first situation would not generate significant off-site direct impacts, but could lead to additional investments in emergency planning. An accident that involves off-site response would likely necessitate a broad range of state and local emergency responses, including assisting in warning, conducting evacuations of the public and special facilities, maintaining road blocks, providing and maintaining evacuation shelters, procuring and distributing emergency food and water, and assisting in the reentry process.

In addition to these services, if injuries and fatalities occur, local resources will be needed to assist in transport and medical care of the injured, identify and remove bodies of the victims, assist in search and rescue, and help in the disaster recovery. The requirements of responding to an emergency will result in increased costs to all governmental entities involved. The level of these costs depends on the type of accident and the circumstances under which it occurred. These costs could strain, if not exceed, existing state and local resources, and outside assistance will be necessary.

CONCLUSIONS

This assessment has led to several important conclusions about the analysis of socioeconomic impacts associated with projects involving hazardous material with a potential for accidental releases of materials with human health consequences. First, the projection of impacts in a variety of categories cannot be done given current knowledge and models. This includes the increase in incidence of mental health impairments from exposure to a hazardous activity, the effects of increased risk on local economic structures including property values and industrial growth, or the impact of an accident on demographic change or the local

economy to cite a few. There is a distinct need to initiate further research leading to models that forecast such effects. Such work, in addition to the obvious applied value, could also help improve the theoretical understanding of human systems and human/environmental relationships.

Second, achieving a set of validated models to forecast such impacts will not be an easy undertaking. In the course of reviewing the literature relevant to this effort, it became obvious that two significant factors limit that development. One is that the theoretical and methodological framing of the problem may dramatically influence the outcome of the research. Another is that the number of known variables (not to mention the unknown ones) that may affect the outcome of a process is so large that isolating cause and effect sequences may be impossible. Both problems confound the possibility of achieving validated models.

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