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THE PROPOSED WASTE ISOLATION PILOT PROJECT (WIPP) AND IMPACTS IN THE STATE OF NEW MEXICO: A SOCIO-ECONOMIC ANALYSIS

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April 1981

New Mexico Energy Research and Development Program

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Final Report

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PART I

INTRODUCTION AND OVERVIEW

I. INTRODUCTION AND OVERVIEW OF THE STUDY

A. Introduction.

This document is a final report for research conducted with an award from the New Mexico Energy and Minerals Department* concerning the socio-economic impacts in the State of New Mexico that might attend the construction and operation of the proposed Waste Isolation Pilot Plant (WIPP), a Federal nuclear waste repository. The proposed site for the WIPP, known as the Los Medanos site, is in Southeastern New Mexico's Eddy County, some 25 miles east of Carlsbad, New Mexico and some 40 miles from Hobbs, New Mexico, in adjacent Lea County. While there has been some uncertainty as to the ultimate purpose and structure of the WIPP, the purpose as set out in the U.S. Department of Energy's environmental impact statements** is for storage of TRU waste from the U.S. defense program and the construction of a research and development area for experiments concerning the isolation of all types of nuclear waste in salt. The interested reader is referred to the relevant U.S. Department of Energy documents [April, 1979, and October, 1980] for a technical description of the proposed WIPP.

B. Purpose of the Study.

At the outset, it is important that the reader of this report fully appreciate exactly what this study is intended to accomplish and, equally important, what it is not intended to accomplish. The intended purpose of the

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**U.S. Department of Energy, [April, 1979 and October, 1980].

study is to identify, measure (when possible) and assess the range of potential socio-economic impacts in the State that may be attributable to the WIPP. Every effort has been made by the authors to approach this task in an objective manner; of course, the reader will judge the authors' ultimate success, or lack thereof, in this regard. In efforts to provide an objective analysis of the WIPP, however, particular attention was required in providing a comprehensive review of potential impacts. This means that however unlikely an impact might seem, the authors have purposely avoided pre-judging the potential magnitude of the impact and have applied their best efforts to measure it.

On the other hand, this study is not intended to provide a definitive calculation regarding the net balance of WIPP-related benefits and costs. The ultimate weighing of beneficial and adverse effects associated with the WIPP will be made by citizens in New Mexico and their representatives in state government and to accomplish this they will require information and judgment. Information from this study as well as others, such as the study of health and safety issues conducted by the State's Environmental Improvement Division, are important inputs to this decision making process. Given, as will be vividly demonstrated in this study, that a large part of the potential beneficial/adverse effects from the WIPP are subject to considerable uncertainty, the final weighing of these effects must involve a subjective process in which judgment and values play a predominant role. Clearly, this process lies in the purview of those who have the responsibility and accountability for decisions affecting the public interest.

However, these considerations do not relieve the authors of a responsibility for demonstrating, in whatever way possible, the conclusions suggested by their work, as such conclusions are relevant as inputs to the decision process described above. At State expense the authors have been deeply immersed in specialized studies and analyses concerning potential socio-economic impacts from the WIPP, and a corresponding obligation exists to make available to the State the implications of this investment in learning as they may be useful for deliberations concerning the WIPP. It is in this context, and for these purposes, that the conclusions and recommendations offered in this report are given. As implied in the above, every effort is made in this work to provide both comprehensive and objective analyses of the potential impacts in New Mexico that might be associated with the location of the WIPP in the southeastern part of the State.

To help ensure objectivity, two advisory boards were formed at the outset of the project for the purpose of providing periodic reviews of research efforts. The first of these is a Technical Advisory Board, consisting of several of the nation's better known professional economists with expertise regarding impact analyses of the type studied here (see Table I.1). Members of the Technical Advisory Board have offered constructive criticism concerning technical and methodological aspects of the study as well as concerning the scope of research efforts. The second board, the Public Advisory Board (Table I.2), consists of a group of businessmen, local and State planners, and others who share various interests regarding the WIPP. This Public Advisory Board provided the UNM research team with a mechanism by which diverse points of view could be offered concerning the appropriate scope of the socio-economic analyses and the objectivity of methods and approaches used in measuring and analyzing impacts. The authors of this report are deeply indebted to members of these advisory boards for their efforts and cooperation.

TABLE I.1

TECHNICAL ADVISORY BOARD

For the WIPP Socio-Economic Study

NAME	UNIVERSITY
Professor James Quirk	California Institute of Technology
Professor Ralph d'Arge	University of Wyoming
Professor William Schulze	University of Wyoming
Dr. Thomas Crocker	University of Wyoming
Dr. Allen V. Kneese	Resources for the Future, Inc.

TABLE I.2

PUBLIC ADVISORY BOARD

FOR THE WIPP SOCIO-ECONOMIC STUDY*

John Dendahl	-Eberline Instrument Corporation Santa Fe, New Mexico
Ivan Hall	-Urban and Regional Planning Southeastern New Mexico Economic Development District - Roswell, NM
Don Hancock	-Southwest Research Information Center Albuquerque, New Mexico
Emily Miller	-Energy and Minerals Development Santa Fe, New Mexico
Jack Mobley	-Environmental Evaluation Group Santa Fe, New Mexico
Charles Turpen	-Energy and Minerals Department Santa Fe, New Mexico
Lee B. Zink	-Institute for Applied Research Services University of New Mexico Albuquerque, New Mexico

*Mr. John Gervers, formerly with the Governor's Task Force on the WIPP, served on the Public Advisory Board until July, 1980.

It must be made clear, however, that board members neither necessarily concur with nor endorse the conclusions of this study. Responsibility for the results reported here remains with the authors.

C. Relationship Between this Study and the DOE's FEIS.

The DOE has prepared draft and environmental impact statements concerning the WIPP [DOE, April 1979 and October 1980]. Included in these DOE-sponsored studies are analyses of socio-economic impacts, and this fact raises the obvious question as to the rationale for still another study of WIPP-related socio-economic impacts.

There are two major differences between the socio-economic analyses given in this study and those in the DOE reports. The first difference concerns the scope of analyses. The socio-economic analyses in the DOE reports* reflect competent, coherent analyses of local (Eddy and Lea Counties) impacts attributable to the WIPP, and they are comprehensive in terms of criteria generally considered appropriate for environmenal impact statements. In contrast with the DOE studies, however, mandates for this study require the consideration of State-wide impacts which include, in addition to socio-economic impacts in Eddy and Lea Counties, income-expenditure effects at the State level and potential benefits and costs attributable to the following: the transport of wastes to the WIPP site; foregone economic development options in the State that may result from the WIPP (as well as any expanded options that may result); jurisdictional issues; and the general implications for the State of any change in the "risk environment" associated with the

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*U.S. Department of Energy [April, 1979, and October, 1980].

transport and storage of nuclear wastes within the State. By the same token, the DOE studies consider a number of topics, such as siting and engineering issues, which are outside the terms of reference of this study. Thus, the intended scope of analyses in the two studies differs markedly.

Secondly, there is some difference in the methodologies used for analyzing "local" impacts in this study and the DOE report. Generally, impact estimates from the DOE reports are used here for analyses of local impacts except in those instances wherein alternative assumptions and/or methodologies were considered to provide more robust impact estimates. In these cases, both the DOE estimates and those derived in this study are reported, to give ranges of estimates for socio-economic impacts. As an example, population/employment estimates in the DOE report are generated from input-output analyses, and those analyses include the implicit assumptions that the capital and labor use remain in constant proportions as levels of economic activity change and that labor force participation rates (number of workers per family) also remain constant. Particularly during the five-year construction phase, one might expect that temporary increases in the demand for locally-produced goods and services might be met by the more intensive use of existing machinery, equipment and buildings, and hence there would not be a constant ratio of capital use to labor use.* Further, it would seem reasonable to assume that sharp increases in job availabilities in the local community would, for many families, result in an increase in the number of individuals who are labor force participants.

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*As an example, in response to temporarily increased demand for restaurant services, restaurant owners hire more cooks and waitresses, extend operating hours, etc., rather than build <u>new</u> restaurants.

To continue this illustration, the use of increasing labor force participation rates, for the WIPP's construction phase in this study, results in lower estimates for the number of in-migrating workers than would result from the DOE's input-output approaches, all else equal. One cannot judge the "rightness" or "wrongness" of either approach to estimating local population impacts -- the two estimates are simply based on different views of the type of responses by the local population to changes in labor market conditions. The two sets of estimates may be viewed as providing a range of impacts within which actual impacts may in fact lie.

Thus, there is little duplication of efforts in the two studies; differing impact estimates in the two studies reflect efforts to enrich one's appreciation for the potential range in socio-economic impacts which may attend the proposed WIPP, and each study addresses a number of issues outside the scope of the other study.

D. Plan of the Study.

A major problem encountered in efforts to provide a comprehensive socio-economic analysis of a project like the WIPP arises from the fact that many potential effects from the WIPP are not amenable to quantitative analysis. Some likely effects, such as those concerning employment and income, can be estimated quantitatively, albeit only approximately. Other effects, however, such as risk associated with possible accidents at the WIPP site or with the transport of nuclear waste to the site, as well as many other socio-economic issues, are such that meaningful quantitative estimates for expected benefits or costs cannot be derived. For a comprehensive analysis of the WIPP, these latter considerations must be included, notwithstanding the fact that they cannot be quantified. Therefore, in what follows we define as "impacts" those WIPP-related effects -- benefits and costs -- for which quantitative measures can be developed; WIPP-related impacts are discussed in Part II of this report. We define "issues" to be those WIPP-related effects, relevant for the State's consideration of the implications of having the WIPP located in southeastern New Mexico, which can only be described in qualitative terms; quantitative measures for these effects cannot be derived in any defensible manner. Nonetheless, the issues are important and are discussed in Part III of this report.

The plan of this study is as follows. In the remaining sections of this chapter, an overview of the study's conclusions and recommendations is given. Chapters II, III and IV are intended to provide the reader with a general overview of the research results from this work which underlie these conclusions and recommendations. Chapter II sets the stage for the study with a description and evaluation of the study's basic methodological approaches. Chapter III develops the rationale underlying estimates for State and local impacts which are unrelated to issues concerning risk. In Chapter IV, management problems and issues related to risk are reviewed. Chapter IV concludes the overview section (Part I) of this study.

Part II of this study discusses in detail the derivation of estimates for WIPP-related impacts (quantifiable effects). Employment, income and other impacts at the local (Eddy-Lea Counties) levels are discussed in Chapter V; these discussions are extended to the State level in Chapter VI. Benefits and costs relevant for the mangement of risk are described in Chapter VII.

Our detailed discussions of socio-economic issues which are relevant for an assessment of the WIPP (Part III) begin in Chapter VIII where the subjective dimensions of risk associated with the WIPP are considered. Other issues related to risk are taken up in Chapter IX where we consider the potential for problems at the WIPP site, the transport of waste through the State, jurisdictional issues and the issue of liability. The study concludes with a discussion of remaining socio-economic issues in Chapter X.

E. Conclusions and Recommendations: An Overview.

Conclusions and recommendations derived in this study regarding potential WIPP-related socio-economic impacts in the State are stated in this section. The reader is referred to Chapters II through IV for a review of research results which support these conclusions and recommendations.

E.1. Conclusions Concerning Impacts in the Eddy-Lea County Area.

(i) Annual personal income in the two-county area will, on the average, be increased by $23 million to $28 million during the WIPP's seven-year construction phase and by $21 to $23 million during the WIPP's 23-year operations phase.

(ii) Annual increases in employment in the two-county area will be on the order of 700 to 1,000 jobs during the WIPP's construction phase -- 2,100 to 3,000 jobs per year during the third and fourth, "peak" construction years. During the 23-year operations phase the annual increase in job opportunities attributable (directly or indirectly) to the WIPP will be on the order of 954 to 1,081 jobs. Over the 30-year life of WIPP activity, some 29,278 to 34,149 man-years of employment will be created in the two-county area.

(iii) Severe housing shortages can be expected in Loving and, to a lesser extent, in Carlsbad; housing facilities should be adequate in Hobbs and other areas in Eddy and Lea Counties. These conclusions are based on the FEIS site access design which calls for a southward extension of the U.S. highway 62-180 to the WIPP site. Should for any reason this extension not be built, the increase in travel time required for commuting from the WIPP site to Hobbs could result in more aggrevated housing conditions in the Carlsbad and Loving areas.

(iv) Anticipated increases in revenues to municipal and school district units in the two-county area should be adequate to cover increases in expenditures; over the WIPP's thirty-year life, budgetary surpluses of \$4 - \$6 million and \$2 - \$6 million could accrue to municipalities of Carlsbad and Hobbs, respectively, with small surpluses accruing to the respective school districts and to the municipality of Loving.

(v) However, revenues to county governments in Eddy and Lea Counties are likely to fall short of increased expenditures required as a consequence of the WIPP. These deficits are likely to be small, however, ranging from \$0.6 to \$1.3 million in Eddy County and \$0.3 to \$0.6 million in Lea County over the 30-year life.

(vi) Financial institutions in the two-county area should have sufficient capacity to facilitate WIPP-related expansions in economic activity. The current high interest rates may impose serious restrictions on such expansions, however. In terms of <u>assumed</u> expansions in baseline housing construction and the construction of mobile home facilities which underlie our housing scenarios (see conclusion iii above), continuing high interest rates could result in more severe shortages in housing facilities than those suggested in conclusion (iii).

(vii) While the WIPP will deepen the two-county area's economic base, few if any diversification effects on the economy can be expected.

(viii) The decommissioning (closing) of the WIPP, after 30 years, will involve short-term, but relatively insubstantial, distortions in the local economy; the expectation of relatively slight effects follows from the small percentage of total employment in the two-county area which is represented by WIPP-related employment during the operations phase — less than 3%.

(ix) While unable to derive defensible dollar estimates, we have identified several likely sources for WIPP-related costs that may be imposed on low-income individuals, as well as on local and State organizations, in the two county area. Among the more important of these sources are:

- increased strains on already over-taxed health facilities, particularly those which serve low-income families;
- increased crime rates which may imply the need for budget increases for local law enforcement agencies, particularly at county levels;
- local inflation, which may impose severe burdens on fixed and low-income families as well as on budgets for local and State agencies which provide welfare and social services to the area's low-income families.

The reader is referred to Recommendation 1 below for proposed actions for dealing with these potential WIPP-related impacts.

(x) Related to the conclusion described above, experience with energy-related construction activities in other New Mexico (and Wyoming) counties suggests that higher <u>unemployment</u> levels may accompany increases in total employment levels during the WIPP's construction phase. Higher unemployment levels result from increased labor force participation rates for local families and, more importantly, from in-migrating families seeking jobs without finding them immediately. Larger pools of unemployed workers can result in severe strains being placed on local facilities for social services.

(xi) We find no conclusive evidence that would suggest that the WIPP will result in adverse effects on property values (at the site or along transport routes), on Carlsbad's appeal as a retirement community, or on tourism (particularly at Carlsbad Caverns).

E.2. <u>Conclusions Concerning State-Wide Monetary Impacts</u>.

(xii) Annual additions to personal income in the State to individuals outside of the two-county area could average between very slight amounts (the FEIS estimate) and \$5 - \$6 million over the WIPP's 30-year life.

(xiii) Annual additions to State taxes attributable to the WIPP will be on the order of \$0.9 million during the construction phase and \$0.7 million during the 23-year operations phase. (See, however, the summary conclusion in section E.4.)

(xiv) Based on the best available reserve estimates for potash and oil/natural gas resources, the exploitation of which may be foreclosed by the WIPP, \$119 million in wage incomes and \$46 million in State tax collections could be lost to the State as a result of foreclosing these future options for resource extraction; since, in the absence of the WIPP, these extractive activities would not be likely to be initiated for some 20-plus years, the discounted value of these losses (using a 6 7/8% discount rate) is \$30 million (foregone wage incomes) and \$24 million (foregone tax revenues for the State).

E.3. Conclusions Concerning Risk and Risk Management.

(xv) A number of different expenditures are required for emergency preparedness and highway upgrading if prevailing criteria for health/safety considerations are to be satisfied during the period of transport of nuclear wastes through the State. These costs represent safety-related expenditures which may be viewed as an integral part of the WIPP project *per se*, in which case the issue as to who pays these costs is an important matter. The "who pays" question is considered below in section F (see, also, section E.4 below). The costs at issue here (over 30 years) are the following:

- emergency preparedness training for approximately 4,000 firemen and law enforcement officers at a cost of \$16 million;
- monitoring equipment for emergency vehicles, \$200,000;

- .equipment and training at hospitals, $900,000;
- .planning and administrative costs, $2.5 million;
- .costs for upgrading deficient sections of US highways 40, 25, 60, 285, 62 and 34, $57.2 million.

(xvi) In terms of waste transportation, accident probabilities are somewhat higher for road transport than for rail transport; however, the chance of a severe accident (in terms of such things as crush force and fire duration) is much more likely with rail transport than with road transport (see Recommendations for the implications of this important trade-off).

(xvii) The use of special trains for waste transport to the WIPP has been rejected by the DOE, seemingly on the basis that the additional costs associated with the use of special trains is not justified by the associated small reduction in accident probabilities. Given the potential for severe accidents in rail transport, this decision should be reviewed, particularly with reference to shipments of high level wastes.

(xviii) It is highly desirable that among those individuals first at the scene of any accident involving nuclear waste, someone have the training and authority to evaluate the need for and, if necessary, to order evacuations. The State's Radiation Protection Bureau (RPB) has responsibilities for responding to minor radiological accidents, and the Joint Nuclear Accident Coordinating Center (at Kirtland Air Base) is equipped to assist the RPB in the case of large-scale radiological emergencies; the authority to order evacuation, however, rests with the State's Office of Civil Emergency Preparedness. This diffusion of responsibilities raises serious questions as to the immediacy with which protective measures — particularly evacuation decisions — can be initiated in the event of an accident in nuclear waste transport, particularly in the more remote areas of the State.

(xix) Related to the above, the liability for costs incurred for any evacuation is unclear; this is particularly relevant for "preventive" evacuations — evacuations which, after the incident, might be found to have been unnecessary. If individuals with authority to order evacuations do not have clear instructions regarding liability issues, an undesirably conservative approach to the ordering of evacuations could result.

(xx) Minor accidents in the transport and storage of nuclear wastes undoubtedly will occur in New Mexico. However, the chance of a severe accident, involving radiologically-caused injuries or loss of life, is very small. In terms of this latter conclusion, two corollary considerations are relevant. First, to say that the chance, or probability, of a severe accident is small, for example, once in many thousand years, does not permit us to say with certainty that such an accident (or more than one such accident) will not occur during the WIPP's lifetime. Small accident probability measures mean just that: the chance, or probability, of a severe accident is very small. The issue to be stressed here is that small accident probabilities should not result in complacency in terms of vigorous efforts to maintain highest possible standards for safety procedures and emergency preparedness. Secondly, but clearly related to the above, the Federal government's decision to proceed with the WIPP implies the judgment that WIPP-related risks to public health and safety are in some sense "acceptable", within the context of best available designs and policies to protect the public. It would appear that both the Federal and State governments are willing to go to considerable lengths to ensure that a project of this nature is indeed safe, and that therefore they would give safety considerations a heavy weight in making benefit-cost calculations for expenditures associated with the WIPP. Policy options should then be considered within the safety-over-cost context.

(xxi) As noted above, there remains considerable ambiguity as to the assignment of liability for costs associated with an accident in waste transport; it is conceivable that the State could find itself in the position of "insurer of last resort." Abstracting from loss of life considerations, the potential magnitude of accident-related costs in extreme but very unlikely accidents could be very large: a (necessarily) very approximate estimate for clean-up costs involved for an accident where relatively modest amounts of short-lived materials are released in an area like Albuquerque could be on the order of \$5 - \$10 million. For accidents involving larger releases — again, however improbable these accidents — the consequences could involve land denial and clean-up costs on the order of \$50 - \$150 million in smaller urban areas like Roswell and Carlsbad, and \$100 - \$300 million in areas like Albuquerque. All of this points to the critical importance of early resolution of liability issues and, particularly, the State's liability position in the event of an accident.

(xxii) There exists, and probably will continue to exist, strong fear and anxiety (technically, "phobic" reactions) concerning the WIPP on the part of many individuals. Such reactions relate to the subjective dimensions of risk associated with the WIPP. There are a number of reasons why such fear and anxiety is unlikely to dissipate, particularly in the short run. Among these reasons are the following.

- the existing WIPP risk assessments are based largely on "fault tree" analyses, in which the analyst must consider all possible human and system design sources for system failures. It is argued that an analyst cannot possibly imagine <u>all</u> possible sources (particularly those related to human error) for failures and examples are cited to support this position (e.g., the Brown's Ferry incident and the DC-10 accident in Chicago.) Given the lack of alternatives to the fault tree method for assessing WIPP-related risks, the potential source for continued controversy is then obvious.

- there is evidence that suggests that, when faced with events characterized by very large costs and very small probabilities, individuals tend to <u>ignore</u> the probability and simply focus on the outcome (the costs). This phenomena may explain, to some extent, continuing anxiety about the WIPP in the face of very low probabilities reported for severe, WIPP-related accidents.
- there is also evidence that suggests that societal values may be disproportionately averse to "catastrophic" risk, i.e., individuals may be more averse to one accident per year involving (e.g.) 100 fatalities than 100 small accidents per year, each involving one fatality.
- there remains uncertainty about the long-term institutional and physical environment of the WIPP, and hence concerns about possible risks to future generations cannot be allayed definitively.

These observations suggest that little can be done to alleviate sources for many individuals' fear and anxiety concerning the WIPP.

(xxiii) The kinds of potential costs related to risk are, first and most obvious, possible injury or loss of life and, second, costs associated with risk bearing <u>per se</u>. Unfortunately, the current state of the arts for measuring such costs is relatively undeveloped, and defensible measures for such costs are not obtainable at this point in time.

E.4. A Summary Conclusion.

The conclusions described in the preceeding sections provide the reader with an overview of results from the many different lines of inquiry investigated in this study. In this section an effort is made to bring together the many specific conclusions developed in this work with the aim of focusing on the following question: on the whole, what is the relationship between WIPP-related beneficial and adverse effects in the State of New Mexico?

In responding to this question, we begin with the particularly troublesome issue of risk. The conclusions described in section E.3 above, together with the discussion of chapter VIII, should at a minimum convince the reader that there simply is no objective way for dealing with this inherently subjective issue. There appears to be good reason for accepting the scientific community's conclusions that there is only very small -- minute -- chance of a severe accident occurring over the WIPP's lifetime. These estimates of "chance" can be assailed on a number of grounds and continued controversy can be expected as regards the possibility of severe accidents as well as the possible magnitude of effects should an accident occur. In the end, it is true that, however improbable, a severe accident could occur. Even though such an accident would be much less serious than a severe nuclear reactor accident, the simple chance of a mishap is a source for lingering fear and anxiety. Obviously, the authors of this study cannot resolve this issue, nor can they offer even bounded measures for potential risk-related costs. If this study is to offer a contribution in these regards, its contribution must be limited to simply laying out for the reader the objective and subjective dimensions of the risk issue for his/her use in forming a best judgment as to the nature of WIPP-related risk. Implications and ranges for costs that could be associated with severe, WIPP-related accidents, should they ever occur, therefore, are given above in conclusion (xxi). Subjective issues are given in conclusions (xxii) and (xxiii).

Looking now to quantifiable benefits and costs, WIPP-related increases in personal income (benefits) in the State may range from $634 million to $892 million over the WIPP's 30-year life.* Costs associated with increased municipal and county services, taxes and incomes foregone by the foreclosure of development options for potash and hydrocarbon reserves, emergency preparedness and highway upgrading may be on the order of $282 million. Personal income increases then exceed the level of identifiable costs. But obviously other costs exist: potential accident and clean-up costs, and the cost of risk bearing *per se*. For the reasons above, the comparison of personal income increases with identifiable costs cannot be interpreted as an indication that benefits to the State exceed costs for the State. However, there is another reason that this conclusion does not necessarily hold. It is the fact that, on the whole, recipients of WIPP-related benefits are different groups of people from those who may bear a good part of WIPP-related costs. The bulk

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*Discounted values leave unaffected the comparisons of interest in this section; see Chapter III below.

of personal income increases will accrue to residents of the Eddy-Lea Counties area. Setting aside costs for municipal/county services and for foreclosed options for potash and hydrocarbon reserves,* costs for emergency preparedness programs and highway upgrading (some $76.8 million) would, all else equal, be borne by <u>all</u> citizens in the State via higher taxes.**

A viable mechanism for dealing with this equity issue simply is not available to the State, in which case a comparison of benefits (accruing to one group of people) with costs (accruing State-wide) becomes a difficult issue. While benefit-cost comparisons may be conducted under a number of different criteria, in this work we adopt the "Pareto" criterion for efficiency which requires that, for an efficient project, some members of society are made better off by the project while no other members are made worse off.

Within the context of the criterion given above, and abstracting, as we must, from loss-of-life considerations, the following conclusion is suggested as a response to the summary question posed above concerning the <u>net</u> beneficial effects of the WIPP in the State of New Mexico:

> <u>Apart from risk considerations, WIPP-related benefits to the State are unequivocally greater than WIPP-related costs, only under circumstances in which costs associated with emergency preparedness and highway upgrading (some $76.8 million), plus costs associated with any accident, are not borne by the general citizenry of the State.</u>

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*Costs for increased local services will be largely covered by increases in local tax revenues (see conclusions iv and v); for purposes of this discussion, foreclosure costs, or "opportunity costs", may not be relevant given questions related to underlying employment assumptions discussed below in Chapter II.

**Or, alternatively, reduced levels of State services. The WIPP-related increases in State taxes over 30 years are only on the order of some $7 million to $9 million (at a 6 7/8% discount rate).

E.5. Recommendations.

The following recommendations are derived from the conclusions given above as well as from other parts of this study.

1. It is recommended that the State look to means by which Federal funds can be made available for the following three categories of costs (see section F below for a discussion of "compensation"):

   (a) expenditures required for emergency preparedness and highway upgrading;

   (b) expenditures which may be required to mitigate various types of local impacts in Eddy and Lea Counties; particularly important here are potential impacts from local inflation, impacts from increased crime rates and impacts on health facilities (especially those available for low income families).

   (c) any and all expenditures related to the State's liability for WIPP-related accidents, including liability for costs associated with evacuations.

2. It is recommended that the State request clarification by the DOE as to Federal plans for decommissioning of the WIPP after 30 years, and post-decommissioning practices for monitoring the WIPP site. Arrangements should then be made for Federal compensation for any adverse impacts that may attend decommissioning.

3. It is recommended that the State endorse the recommendations of the California Resources Agency that type B and high-level shipping containers be tested more completely — with tests carried to failure stresses when possible.

4. Training is recommended for some 4,000 firemen and law enforcement officers concerning responses to radiological emergencies; attitudinal issues should be stressed in two-week sessions which are repeated, at a minimum, at three-year intervals.
5. It is recommended that the State emergency response plans give particular attention to lines of authority and responsibilities for local officials which may be required in instances wherein delay is involved in officials from the State's RPB or JNACC reaching the scene of an accident; further, authority for emergency response, training, evacuation decisions and, perhaps, post-accident clean-up should be centralized in a single State department.
6. It is recommended that the State insist on the federal government's provision of escort vehicles for (at a minimum) those shipments involving high level wastes.
7. It is recommended that the State consider augmented placard rules which result in visible exterior labeling of each WIPP shipment.
8. It is recommended that the State request that the Federal government review its rejection of the use of special trains.
9. It is recommended that the State insist on routing of waste shipments so that rail shipments are confined to those entering the State from the east or west; i.e., that rail shipments entering the State from the north, which must pass through major metropolitan areas, be prohibited.
10. Based on population-at-risk criteria, as well as considerations related to accident rates, the following road routing schemes are recommended as optimal from the State's point of view:

North-South

a) I-25 south to U.S. 84, south to I-40, east to U.S. 54 (at Santa Rosa), southwest to U.S. 285,

b) I-25 south to U.S. 285; south on U.S. 285 to Carlsbad,

c) east on I-40 to State highway 6, east on State highway 6 to I-25;

(c.1.) south on I-25 to U.S. 60, east on U.S. 60 to U.S. 285 and south on U.S. 285 to Carlsbad.

(c.2.) south on I-25 to U.S. 82, east on U.S. 82 to U.S. 285, south on U.S. 285 to Carlsbad.

F. The Compensation Issue.

A recurring issue in the bulk of results from this study -- see, particularly, the summary conclusion in section E.3 and Recommendation 1 in section E.4 -- involves the question as to who pays for such things as the State's programs for risk management, highway upgrading, costs associated with any accident that might occur and costs associated with a few somewhat unusual types of local impacts (see Recommendation 1). In this regard, it is argued in this work that benefits from the military use of nuclear-related materials accrue to the public-at-large in the United States and as a result of this benefit-generating activity, the need for the deposit of nuclear wastes arises. Associated with the disposal of such wastes as proposed by the WIPP project is the range of costs identified above which are a step removed from the WIPP site *per se*. However, these costs must be viewed as inextricable parts of a Federal project which satisfies existing requirements for safety, impact minimization and the equitable treatment of liability issues. Thus, the case for compensation (the Federal government compensates the State for these costs) is based primarily on the principle of equity or "fairness", that the beneficiaries (the public-at-large) should share equally in bearing all related costs, notwithstanding the indirectness of any such costs.

In this study we demonstrate the consistency of the compensation argument with generally accepted ethical systems as well as with some common practices observed in the interface between state governments and the private sector and between the Federal government and state governments. While counterarguments exist (and are reviewed in the study), the authors find the case for compensation to be particularly appealing given, first, the relative weights of the pro and con arguments considered and, secondly, the argument that such costs are an integral part of a "safe" WIPP project.

II. SOCIO-ECONOMIC IMPACTS FROM THE WIPP: SETTING THE STAGE

The purpose of this chapter is to provide the reader with a frame of reference which is relevant for the study results which are summarized in the following two chapters. Common to all benefit-cost analyses are a number of basic premises and methodological approaches which the reader must appreciate if study results are to be interpreted in a meaningful way. Peculiarities associated with the WIPP project introduce still other problems of an interpretative nature. In what follows a few of the more basic issues relevant for this study of the WIPP are discussed, and an effort is made to relate these caveats to results given in the concluding sections of the study.

A. The Structure and Relevance of a Benefit-Cost Study.

The essential rationale for this Federal pilot plant (the WIPP) is the nation's need to develop safe, reliable means for the permanent disposal of nuclear wastes generated in defense activities, commercial power plants and other activities. Thus, from the standpoint of evaluating socio-economic impacts, the outlay of federal funds for the construction and operation of the WIPP logically would be justified by the national benefits from such a facility in terms of this mode for disposing of nuclear wastes. This is to say that primary benefits and costs associated with the WIPP are national rather than regional or local in scope. Nevertheless, secondary flows of benefits and costs will result from the WIPP and, in many instances, such flows may be concentrated in specific regions in the United States. Indeed, the potential for such flows being concentrated in the State of New Mexico is the basis for concern on the part of policy makers and the general public in New Mexico and thus is the raison d'être for this study.

It is useful at the outset to place the regional and national dimensions of WIPP-related socio-economic impacts in perspective. In this regard we inquire as to the relationship between WIPP-related benefits and costs that accrue to New Mexicans and those that accrue outside of the State. In terms of its basic structure and methodology, this study may be termed a "regional benefit-cost study," the region being New Mexico, but much more is involved here than the simple computation of benefits and costs from the WIPP which might occur within the State. Of particular importance in a study of this type are, first, as noted above, the relationships between New Mexico-specific benefits and costs and those which obtain in other States and in the nation as a whole, and, second, the criteria used for identifying WIPP-related effects which are justifiably included in the study.

These issues are best treated by beginning with an examination of WIPP-related benefits and costs as they would be viewed on a national level. Benefit-cost studies are routinely prepared by agencies of the U.S. government in support of projects which are to be considered by the President and/or Congress.* Common to all of these studies is an accounting for project-related benefits and costs on a geographical basis; while the taxonomy of economic accounts used in such analyses may vary from agency to agency, one will always encounter, in one form or another, a "national account" and a series of "regional accounts". In what follows we consider the types of effects which are generally included as benefits or costs in national and regional accounts and we examine the implicit criteria used for differentiating between regional and national effects.

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*As examples, see Water Resources Council (1973) and U.S. Forest Service (1979).

Elements in a Benefit-Cost Study. Standards for the preparation of benefit-cost studies have received considerable attention over the last two decades.* At the forefront of efforts to establish principles and standards for project evaluation have been those by the Water Resources Council (WRC) and its forerunners;** current WRC guidelines may be used as representative of those used by the OMB and other government agencies. From these guidelines,*** broad categories of objectives for public investment projects may be derived. These objectives, which are as follows, are served in whole or in part by every public expenditure program:

a. National economic development

b. Regional economic development

c. Quality of the total environment

d. Well-being of the people of the United States

By using these four objectives as reference points, procedures have been developed to define those kinds of project impacts which promote them (benefits) and those kinds of impacts which detract from them (costs).

From the above, it is obvious that virtually any identifiable project effect on mankind and his environment is appropriately included in benefit-cost analyses, at least in principle. Indeed, analysts are mandated to use

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*See, e.g., Burness, et.al. (1980).

**See Ibid., for an overview of the development of principles and standards for project evaluation involving water reclamation.

***See Water Resources Council (1973).

imagination in their search for elements to be included in such studies. For example, "...planning studies should explicitly recognize the limitations of present methods (for measuring project effects) and explore innovative approaches to the identification and measurement of the social well-being effects".* Further, a comprehensive analysis of project effects should include analysis of both quantifiable <u>and</u> nonquantifiable effects; e.g., "...beneficial or adverse effects of the proposed plan...(when nonquantifiable) ...will be displayed when appropriate".**

<u>National and Regional Benefits</u>. Criteria for assigning benefits and costs to national or regional accounts are essentially two-fold. First, project effects which unambiguously can be defined as occurring in populations in well-defined regions may be assigned to the relevant regional accounts. Secondly, it is recognized that many times it will be difficult, if not impossible, to specifically identify beneficiaries of project benefits, or those who will bear project costs. Examples of these types of benefits include recreation-related benefits that may attend the establishment of a national forest and improved air quality that may result from increased environmental standards; cost examples include higher downstream silt loads that result from the construction of a dam. In such cases, benefits and costs are commonly assigned to the national account.

<u>An Implied Benefit-Cost Structure for the WIPP Project</u>. Based on the above discussions, we can now posit a logical structure for an aggregative benefit-cost (B/C) study of the WIPP which would be useful for an assessment

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*Water Resources Council (1973, p. 82).

**<u>Ibid</u>., p. 8.

of the project at the Presidential or Congressional level. First of all, we would expect to see regional accounts for each state affected by the WIPP, including the State of New Mexico. We wish to emphasize that these accounts are constructed to facilitate measurement of flows of benefits and costs, and therefore they are not financial accounts. In particular, inclusion of specified cost items in the State-Level account should not be taken to mean that the State should pay those costs. The question of cost-sharing is a separate issue which is considered later. Using the account for New Mexico as an example, the regional account would have the following form.

REGIONAL ACCOUNT:
State of New Mexico

A. Benefits:

- direct and indirect employment (wages)
- other income effects
- state/local tax revenues
- positive effects from emergency preparedness expenditures
- effects on land values
- positive tourism effects
- diversity effects

B. Costs:

- increases state/local expenditures to mitigate expansion effects.
- socio-cultural effects
- costs for highway upgrading, and other safety-related costs
- emergency preparedness programs
- accident-related damages -- site and transport
- other risk costs (social well-being)
- effects on land values
- adverse tourism effects
- opportunity costs
- environmental effects

Regional effects would then be aggregated across all regions (States) in the development of the national account; the national account would have the following general form.

NATIONAL ACCOUNT

A. Benefits:

- sum of regional benefits
- benefits to nuclear power sector, military and non-military
- benefits related to national security; effects on nuclear proliferation, etc.
- impacts on balance of payments items such as oil imports
- avoidance of (possibly) higher costs associated with the next-best location (other than New Mexico) for a WIPP

B. Costs:

- sum of regional costs
- WIPP construction-operation costs
- other national costs

Net benefits, or benefit-cost ratios, based on this national account would normally serve as the basis for project assessment at the national level.

Implications of B/C Accounting for this Study. Procedures used in this socio-economic study of the WIPP are consistent with established criteria for preparing benefit-costs analyses. Therefore results from the study may be viewed as a comprehensive accounting for Statewide benefits and costs that are appropriate for the regional account that in turn would be included in national accounts used for assessing the overall socio-economic feasibility of the WIPP. Of course, no effort is made in this study to account for benefits and costs which may accrue to other States nor those of a national character. Given that the WIPP's proposed location is in New Mexico, the regional account for New Mexico probably would dominate other regional accounts: nevertheless, benefit-cost measures developed (or displayed) here are but one of potentially many regional accounts.

The relevance of the output from this study -- essentially a regional accounting of relevant benefits and costs -- for decision making at the national level is evident from the discussions above. At issue here is another question: What is the relevance of this study for decision-makers and residents in the State of New Mexico?

A response to this question involves an issue of primary importance to virtually all federal projects which involve geographically dispersed benefits and costs, viz., the issue of equity.* This is to say that while a project may be "efficient" from a national standpoint, in the sense that aggregated benefits equal or exceed aggregated costs, the project may involve serious questions related to equity if project beneficiaries and those who bear the bulk of project costs are distinctly different groups -- different in terms of geography, income, ethnic class, etc. In such cases, one faces the problem of making "interpersonal comparisons" of effects: how does one compare one person's gain of one dollar with another person's loss of eighty cents? The equity issue must be addressed in order to answer the question: does the fact that beneficiaries gain more than cost-bearers lose -- the project is "efficient" -- imply that the project results in a net societal gain?

At the risk of oversimplifying a topic which has been the subject of considerable debate,** resolution of the equity issue may essentially be seen

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*See, e.g., (Dasgupta, pp. 61 - 69).

**See, e.g., Dasgupta (1978, particularly, Chapter 2).

as a process of negotiation between gainers and losers. At a conceptual level, the common criterion for a project to be judged "feasible" on a benefit-cost basis is that the project results in a "Pareto Improvement",* which is to say that it is conceptually possible for gainers to compensate losers and still realize a net gain. Rules for implementing such compensation notions, however, are obscure at best, involving, among other things, relative bargaining power of participants and intergenerational issues.**

Apart from assisting in evaluation of the equity issue, the report also addresses concerns of State planners by identifying areas in which State actions may be required as a consequence of the WIPP. Examples are found in the areas of emergency preparedness and highway upgrading; in these and other cases, the report discusses the options in some detail.

The potential relevance of this study for New Mexicans is then clear from these discussions. In addition to the straightforward contributions of the study in terms of a comprehensive assessment of benefits and costs that obtain in New Mexico as a result of the WIPP, which is of direct importance to New Mexicans and, however indirectly, to any national assessment of the WIPP, the study also provides a basis for identifying costs borne by this specific region which _may_ (and we emphasize "may") be the counterpart to benefits generated primarily in other regions. Information as to the source and potential magnitude of such costs may then provide useful inputs to the process of negotiation between New Mexico and other regions, as represented by the Federal government, as to the resolution of _equity_ considerations (if they are shown to exist) relevant for a nationally efficient project.

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*_Ibid_.

**See Dasgupta (1978) and Schulze (1979).

B. The Substance of Benefits and Costs.

Discussion in section A relates to how benefits and costs associated with a particular project might, in theory, be assessed. A number of problems arise, however, in efforts to derive defensible estimates for these benefits and costs.

One of these problems which is of particular importance in this study concerns the overstatement of benefit measures that results from the (usually unavoidable) use of employment-related income as a basis for project benefits. Following conventional procedures of benefit-cost analysis, we have estimated the employment which would be generated directly and indirectly by the WIPP, and the income associated with that employment has been counted as a benefit. However, this procedure carries with it the implicit assumption that incremental employment ultimately means jobs for people who otherwise would have been unemployed. This may occur via direct hiring of the unemployed or, more likely, via a chain of creation of vacancies leading to a job which ultimately is filled by an out-of-work person: person A leaves his or her job to work in the WIPP area, person B leaves a job to take A's job, person C leaves a job to take B's job, etc., until an opening is filled by an unemployed person. This "positive employment effect" may well occur for most of the direct and indirect WIPP jobs, but it may not occur for all of them. Movement of workers to the WIPP area may result in some other jobs (down the chain somewhere) being left unfilled.

It is hard to estimate to which extent this may occur. Given that our economy has lived with considerable unemployment, on the average, over the past decade, it is likely that there will be significant unemployment when the WIPP is built. Therefore, it is probable that most of the employment creation will be positive in net terms -- total jobs will increase as a result of the WIPP. However, we must acknowledge the reverse possibility -- that to some extent the WIPP may simply draw workers away from other jobs (after all replacements have been accounted for). Therefore, one must recognize that computations of WIPP-related benefits reported in this study constitute an upper bound for such "benefits".

Still a further problem with benefit-cost measures given in this report arises from the uncertainty concerning the timing and scheduling of WIPP construction which existed during the period in which this study was prepared.* Indeed, considerable uncertainty existed as to whether or not the WIPP would in fact be located in New Mexico prior to the recent, January 23, 1981, announcement of DOE approval of the WIPP.** As a result of these uncertainties, "impacts" analyzed in this work are based on 1979-1980 conditions in the Eddy - Lea counties area and in the State, and such conditions were assumed to remain unchanged over the WIPP's 30-year life (other than baseline population changes). Such a procedure is subject to criticism on a number of grounds for a project with a known starting date. With an uncertain starting date however, this procedure was made palatable by the expectation that the study would require updating at that unknown, future date at which time WIPP construction might be initiated; the expectation of required future updating is reflected by the study's emphasis on methodologies to be used for such future work.***

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* See DOE, DEIS, pp. 6-12 to 6-14 and 2-19, and DOE, FEIS, pp. 6-17 to 6-19 and 9-5.

** See Albuquerque Journal, January, 1981.

*** See Resource Economics Program, University of New Mexico (companion report, 1981).

The most dramatic implication for results given in this study of the recent disclosure that WIPP construction may be initiated in the near future concerns our estimates for impacts in the Eddy-Lea county area. For reasons given above, the potential overlapping of WIPP construction activities with the construction of other projects, particularly, the Brantley Dam, was ignored. Construction of the Brantley Dam, however, is to begin in late 1981.* This seven-year, $172 million project will employ directly some 600 workers during peak construction years. Obviously, project overlapping is now a real possibility, if not a certainty, and associated impacts on housing, medical services, congestion, etc. are not considered in this report.** Thus, the reader is advised to view impact estimates for Eddy and Lea counties as lower bounds for such impacts.

C. Benefits vs. Costs: The Equity Problem.

Basic to the use of benefit-cost studies for the purpose of assessing the potential feasibility of a project is the assumption that dollar measures for benefits and costs are comparable and the differences between benefit measures and cost measures are, in some sense, indicative of net social gains or losses. In section A, it was pointed out that this assumption may be very

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*Telephone communication with Mr. Alan Solbert, Water and Power Resources Service, Amarillo Office, November 10, 1980; also, see Albuquerque Journal November 9, 1981, p. 1, Section E.

**Also excluded here are considerations related to "leveling", i.e., impacts associated with cessation of WIPP construction at various levels of completion. This exclusion resulted from uncertainties as to the outcome of State-Federal negotiations that were taking place in late 1980 and early 1981.

strong when used to derive net national benefits in cases where beneficiaries of project benefits are differentiated from those who bear project costs. In such cases, a comparison of benefits and costs may not be meaningful inasmuch as net benefits do not indicate net gains to an individual or group of individuals; positive net benefits simply indicate that gainers gain more than losers lose. The equity questions involved here are obvious.

It must be recognized that the equity issue is not a problem that is limited to the assessment of national projects -- indeed, there are few public or private actions that result in conditions such that <u>every</u> affected individual receives a net benefit. In the case of the WIPP, it is shown here that the bulk of project benefits (in terms of increased incomes, etc.) are realized in the Eddy-Lea county area; a substantial part of project costs -- particularly those associated with congestion, socio-cultural effects and local infrastructure -- are also concentrated in that area. While increased incomes, State taxes, etc., which will result from the WIPP do accrue to New Mexicans outside of the two-county area, it is shown in this study that a large proportion of project costs -- particularly those associated with risk and risk management -- may well be imposed on the citizenry at large in New Mexico.

The point here is that in evaluating results from this study related to State-wide net benefits from the WIPP, one must bear in mind that aggregative, State-wide measures may obscure the distribution of WIPP-related benefits and WIPP- related costs among individual groups and communities in New Mexico.

D. Present vs. Future Values.

In any study involving a flow of revenues (benefits) and/or costs over time, one is faced with the problem of comparing measures (for example) for the first year of the project with those for (say) the tenth or twentieth year.

From the standpoint of an individual, or a private company, it is obvious that a dollar today has a different value than a dollar to be received only after 10 or 20 years. Obviously, a dollar received today and put to work earning interest would be worth much more than a dollar received after 10 or 20 years.

The common method for making commensurate values received at different points in time is called "discounting", or the "present value" method. To find the present value of, say \$100.00 which will be received 10 years from now, one divides \$100.00 by $(1 + r)^{10}$, where r is the interest rate, or the discount rate. The present value of \$100 received at the end of year 10, with a discount rate of 10%, would be $\$100 \div (1.1)^{10}$, or \$38.55. If one were to put \$38.55 in the bank for 10 years, with interest compounded at 10%, one would have \$100.00 at the end of the 10th year. Thus, \$38.55 is the present value -- the equivalent value "today" -- of \$100.00 to be received after 10 years.

The present value method is typically used to value the flow of benefits and costs associated with public projects. Two major problems arise with such practices for projects like the WIPP. The first problem relates to the choice of an appropriate discount rate -- the higher the discount rate the less weight is given to future benefits and/or costs. There is considerable controversy as to just what such a rate should be for public projects -- some would argue for a zero discount rate, others for something akin to the average market rate of interest. Thus, there is no objective choice for a discount rate. This being the case, results from this study are given for <u>three</u> alternative choices for discount rates: zero, 6 7/8% (the 1979 rate used by the U.S. Water Resources Council) and 10%. Since there exists no objective way to choose one of these rates over the other, this choice must be left to the individual reader.*

The second problem concerns the ethics of discounting when multiple generations may be affected by a project. This point is particularly relevant when risk is involved. Suppose that one calculated the probability of health/safety risks from the WIPP that would be imposed on some future generation and, by whatever method, determined a measure for the resulting "damage". Suppose, strictly as an example, that this damage was \$50 million. At issue then is the appropriateness of discounting this \$50 million in the benefit-cost study. At 10% and assuming the damage occurred after, say, 200 years, the present value of the damage would be but \$0.26. The ethical dimensions of "valuing" \$50 million in health damages to individuals in the year 2189 at 26¢ are then obvious. For these and other reasons, future costs associated with potential health effects are <u>not</u> included in this study.**

E. <u>Summary</u>.

An objective, comprehensive analysis of the socio-economic impacts which are associated with the construction and operation of the proposed WIPP in New Mexico must suffer from deficiencies in available data as well as in best available methodologies for impact assessments. It is well that the reader bear these limitations in mind. Lack of data (and certainty) at the outset

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*These discount rates are "real," in the sense that they do not allow for the effects of inflation. A ten percent real discount rate could correspond to a market rate of twenty percent or more at current rates of inflation.

**The primary other reason for not valuing health effects is the lack of an acceptable methodological basis for determining and valuing loss-of-life effects as well as for quantifying "perceived risk" (see Chapter VIII).

of this study regarding the socio-economic conditions in Eddy and Lea counties which would exist when (and if) the WIPP would be constructed have had the effect of limiting the usefulness of local impact assessments given here; this is primarily due to the overlapping of construction activities for WIPP and the Brantley Dam. Methodological limitations leave unanswered questions concerning the distribution of project benefits and costs among individuals and communities within the State, between the State and the nation and between the present and future generations. Methodological limitations result in our inability to measure, in any defensible manner, potential costs associated with risks to the public health and safety. In evaluating study results presented in the following two chapters, the reader is unavoidably left with the task of placing study results in the context of these caveats.

III. WIPP-RELATED IMPACTS AND ISSUES AT THE STATE AND LOCAL LEVELS

A. State and Local Impacts.

Benefits which may accrue to New Mexico as a result of the WIPP are measured in this study in terms of increases in personal income. Estimated ranges for WIPP-related increases in personal income are given for the Eddy-Lea county area and for the rest of the State in Part A of Table III.1. Since increases in personal income accrue over a thirty-year period, the appropriate sum of this income flow depends upon one's choice of a discount rate (see section D of Chapter II); these sums for discount rates of 0%, 6 7/8% and 10% are given in Table III.1. The range of benefits with r = 6 7/8% is \$290 - \$367 million, and that range reflects differences in the assumptions used here and in the DOE's FEIS. As argued above, the WIPP-related increases in personal income would be likely to fall somewhere between these two bounds.

The reader may inquire about other important kinds of benefits to the State which may flow from the WIPP, particularly State and local tax collections. Inasmuch as personal income measures reflect gross income earned by individuals and businesses in the State, tax collections are included in the personal income measure. If one wishes to separate out estimates for State tax collections, or other items, appropriate factors can be applied to the personal income measures for this purpose. For example, assuming 2.5% average rate for State income taxes, the present value of increases in State income taxes (with r = 6 7/8%) would range between \$7.25 and \$9.18 million. The point is that the addition of tax receipts to personal income measures would involve a double counting of tax receipts. From this observation follows a weakness of the personal income measure as a surrogate for benefits

TABLE III.1

QUANTIFIABLE BENEFITS AND COSTS

ATTRIBUTABLE TO THE WIPP: SUMMARY

A. PRESENT VALUE OF BENEFITS:

ITEM	r = 0%	r = 6 7/8%	r = 10%
	(millions of 1979 dollars)		
Personal Income:1/			
Eddy & Lea Counties	$ 738	$ 300	$ 229
(from FEIS)	(634)	(290)	(215)
Rest of State2/	154	67	50
(from FEIS)	(0)	(0)	(0)
TOTAL	$ 892	$ 367	$ 279
	$(634)	$(290)	$(265)

B. PRESENT VALUE OF COSTS:

ITEM	r = 0%	r = 6 7/8%	r = 10%
	(millions of 1979 dollars)		
CLASS 1 COSTS:			
Costs to Municipal and County Governments3/	$ 42.8	$ 18.1	$ 16.4
CLASS 2 COSTS:			
Opportunity Costs:			
Income Foregone4/	119.0	30.0	18.0
Taxes Foregone4/	43.0	16.0	12.0
Emergency Preparedness:5/			
Planning/Administration	2.5	.91	.63
Monitoring Equipment (firetrucks)	.2	.09	.07
Hospital Equipment/Training	.9	.3	.2
Other Training	16.0	5.81	4.0
Highway Upgrading	57.2	38.4	32.0
TOTAL, CLASS 2 COSTS	$238.8	$ 91.5	$ 66.9
TOTAL CLASS 1 AND CLASS 2 COSTS	$281.6	$109.6	$ 83.3

1/Tables V.6 and VI.1

2/Table VI.1

3/Table V.46, "high"cost estimates.

4/Table VI.4 and VI.7

5/ Chapter VII, pp. 7.61 and 7.67.

to the State, viz., contributions to such things as social security and Federal income taxes are included in this measure.

Underlying the benefit measures given in Table III.1 are new employment opportunities, the bulk of which would occur in Eddy and Lea counties. Referring to Table III.2, during the WIPP's peak construction year, between 2,128 and 2,989 new jobs may be available in this area (at a maximum, see Part B of Chapter II) as a result of the WIPP; during the 23-year operations phase, some 954 to 1,081 new jobs may be expected to result from the WIPP. Over the project's 30-year life, the WIPP will contribute between 29,000 and 34,000 man-years of employment to the two-county area's economy.

The potential exists for a number of other WIPP-related benefits which are not included here owing primarily to deficiencies in information and/or methods for measurement. Examples include the following: i) Federal payments in lieu of taxes may result from the WIPP, ii) the WIPP may result in diversification effects in the Eddy-Lea county economy, iii) expenditures for highway upgrading (discussed below) can result in net gains in employment and income if, in fact, such expenditures are made and if compensation is made by the Federal government (this issue is addressed in Chapter I), and iv) the WIPP broadens New Mexico's involvement in the various links of the nuclear fuel cycle, and potential then exists for an enhancement of New Mexico's attractiveness for related industries.*

Estimated costs to New Mexico which are attributable to the WIPP are best viewed as falling into three classes, two of which are given in Table III.1; these are costs associated with local impacts in Eddy and Lea

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*An assessment of the relative advantages and disadvantages of such developments is well beyond the intended scope of this study.

TABLE III.2

WIPP-RELATED EMPLOYMENT EFFECTS

IN EDDY AND LEA COUNTIES

YEAR	EMPLOYMENT EFFECTS IN EDDY AND LEA COUNTIES: HIGH ESTIMATE, THIS STUDY	FEIS ESTIMATE
1980	146	152
1981	755	717
1982	2,531	2,137
1983	2,989	2,128
1984	835	686
1985	753	615
1986	1,277	901
1987 - 2010	1,081	954
Total man-years, 1980-2010	34,149	29,278

SOURCE: Tables V.3 and V.4

counties (Class 1) and costs which are state-wide in nature (Class 2). A third class of costs relates to accidents and is discussed in Chapter IV. The first class of costs includes those costs related to the provision of government services (including education) which are, in a general sense, associated with tax receipts included in our benefit measures; as such they are logically deducted from benefits. Class 1 costs are shown to lie between $16.4 million and $42.8 million (Table III.1), depending on the discount rate used.

With local taxes subsumed in the personal income (benefit) measures, this method of presenting local costs does not allow one to evaulate the potential impact of the WIPP on the financial structures of local governments. Data relevant for this issue are given in Table III.3. As may be seen from these data, the present value (over 30 years) of net revenue (tax revenue less required expenditures) is positive — revenues exceed costs — for all municipal governments and school districts. For county governments in Eddy and Lea counties, however, estimated costs <u>exceed</u> estimated revenues — net revenue is negative.*

An annual breakdown of county revenues and expenditures is given in Table III.4. High and low estimates (reflecting different estimates for the numbers of in-migrants and their location) developed in this work, as well as estimates developed in the FEIS, suggest that, in terms of WIPP-related effects, county expenditures may exceed revenues during the entire 30-year project life. Two observations are relevant, however. First relative to total annual county expenditures (e.g., $4.8 million during 1978-79 in Eddy

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* FEIS, p. H-71.

TABLE III.3

IMPACTS OF THE WIPP ON NET REVENUES

TO LOCAL GOVERNMENT UNITS

GOVERNMENT UNIT	PRESENT VALUE OF NET REVENUES (Tax receipts less expenditures) ATTRIBUTABLE TO THE WIPP: r = 0% HIGH	r = 0% LOW	r = 6 7/8% HIGH	r = 6 7/8% LOW	r = 10% HIGH	r = 10% LOW
Carlsbad	$ 5.8	$4.1	$ 2.4	$1.5	$ 2.1	$1.3
Carlsbad School District	.4	.3	.2	.1	.2	.1
Loving	.3	.1	.1	.03	.1	.03
Loving School District	.2	.04	.1	.02	.1	.01
Hobbs	6.2	2.3	2.5	.9	2.3	.8
Hobbs School District	.2	.1	.1	.03	.07	.02
Eddy County	-1.3	-.6	-.7	-.2	-.6	-.2
Lea County	-.6	-.3	-.3	-.1	-.2	-.1

SOURCE: Discounted values given in Tables V.34, V.36, V.38, V.40, V.42 - V.45.

TABLE III.4

COMPARISON OF WIPP-RELATED COUNTY REVENUES
AND EXPENDITURES BY YEAR

COUNTY/YEAR	WIPP-RELATED REVENUES High[1/]	Low[1/]	FEIS[2/]	WIPP-RELATED EXPENDITURES High[1/]	Low[1/]	FEIS[2/]
	(thousands of 1979 dollars)			(thousands of 1979 dollars)		
Eddy County:						
1980	$ 6.4	$ 4.8	$ 20.0	$ 9.2	$ 6.9	$ 31.0
1981	41.8	24.8	74.0	59.6	35.3	108.0
1982	187.0	82.0	129.0	326.8	117.1	177.0
1983	247.3	90.9	113.0	680.3	130.0	139.0
1984	47.2	26.3	64.0	67.6	37.9	72.0
1985	39.7	23.5	51.0	56.9	33.6	66.0
1986	83.3	41.6	59.0	119.5	57.2	80.0
1987-Thereafter	64.5	51.6	64.0	90.9	70.5	84.0
Lea County:						
1980	$ 3.8	$ 1.9	$ 7.0	$ 5.7	$ 2.8	$ 12.0
1981	24.8	9.8	27.0	37.6	17.6	41.0
1982	112.8	32.6	47.0	171.3	49.4	68.0
1983	147.5	36.2	41.0	223.4	54.9	54.0
1984	28.2	10.5	23.0	42.8	15.9	28.0
1985	20.2	9.3	19.0	29.5	30.0	25.0
1986	49.8	15.9	21.0	75.7	24.2	30.0
1987-Thereafter	38.3	19.5	23.0	57.7	29.6	32.0

1/Tables V.38 and V.42

2/FEIS, Tables M-12 and M-16

County*), the estimated deficit is small; for example, the estimated operations-phase deficit for Eddy County ($20,000 to $25,000) is less than 1% of 1978-79 expenditures. Second, county revenue and expenditure estimates are based on per capita (or per household) measures for 1978-79 which are applied to estimates for WIPP-related in-migrating population. Thus, in looking to WIPP-related <u>changes</u> in county revenues, revenues from oil and gas -- which accounted for 24% of Eddy County revenues in 1978-79 -- are excluded from this study and the FEIS (Table III.5) inasmuch as they do not vary with population <u>per se</u>; revenues from interest on investment and payments in lieu of taxes (25% of county revenues) are <u>not</u> assumed to increase with in-migrants in this study, in contrast with FEIS estimates (Table III.5). Thus, the county deficits shown here and in the FEIS must be viewed with some askance inasmuch as small changes in revenues could eliminate the deficit and, more importantly, 1979 per capita levels of county expenditures may not in fact be maintained in the face of any budget shortages, particularly during the WIPP construction phase. Nevertheless, the potential for county deficits, however small, should be noted and county planning may wish to give particular attention to means for handling such deficits if they in fact occur.

As was the case with benefits, there are a number of potential costs of a Class 1 nature which could not be quantified and included in the estimates given in Table III.1. Such costs include, first, WIPP-related expenditures by the State which could be required for such things as highway maintenance and higher levels of community services (including welfare payments and unemployment benefits). Second, there are costs associated with potential

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* FEIS [October, 1980, p. H-71].

TABLE III.5

COUNTY REVENUES AND COSTS INCLUDED IN

FINANCIAL ANALYSES FOR EDDY COUNTY

SOURCE OF REVENUE:	REVENUE/COST COMPONENT AS PER CENT OF TOTAL (1979)1/	INCLUDED IN: THIS STUDY	FEIS2/
TAXES:			
Property	17%	YES	YES
Oil and Gas	24	NO	NO
Lodgers	*	YES	YES
Special	1	YES	YES
CHARGES AND MISCELLANEOUS:			
Licenses, permits and fees	1%	YES	YES
Charges for Services	*	YES	YES
Fines and forfeits	*	YES	YES
Interest on Investments	7	NO	YES
Payments in lieu of taxes	18	NO	YES
Miscellaneous	4	YES	YES
INTERGOVERNMENTAL TRANSFERS:			
STATE:			
Gasoline Tax	11%	YES	YES
Cigarette Tax		YES	YES
Motor Vehicle Tax		YES	YES
Fire-district Allotments		YES	YES
Miscellaneous		YES	YES
FEDERAL:			
Revenue Sharing	14%	YES	YES
Taylor Grazing Act	1	NO	YES
Miscellaneous	*	YES	YES
COUNTY EXPENDITURES:3/			
Total, Personal Services	40%	YES	YES
Total, Operating Expense	48%	YES	YES
Total, Capital Outlay	12%	NO	4/

*Less than 1%

1/ FEIS, Tables H-30 and H-31

2/ FEIS, Table 1-19

3/ Applies to General Government, Public Safety, Public Works, Health and Welfare and Recreation/Culture.

4/ Non-recurring items excluded, FEIS, p. L-62.

congestion, including such things as higher crime rates and dislocations attributable to housing shortages and more crowded medical facilities. Finally, there are potential increases in costs for all government units that would attend "local" inflationary pressures. Local inflation -- price increases at rates higher than national and regional averages -- is a phenomenon that has occurred in conjunction with several construction projects in the Rocky Mountain region; lack of data make efforts to estimate local inflationary impacts an impossible task, however. It should be noted that the possibility of local inflation resulting from the WIPP was identified as a major problem area by respondents in Adcock's socio-cultural survey in the two-county area (Adcock, November, 1980, pp. 20-21).

Before moving to Class 2 costs, study results concerning other local impacts warrant mention. Analyses of housing markets suggest that housing markets may well be very tight, particularly during the peak construction years. However, the potential exists for the development of mobil home facilities and for commuting workers which could mitigate housing shortages. It must be noted that this conclusion depends upon an important assumption which, as discussed in Chapter II.B, is now very questionable, viz., that WIPP construction does not coincide with other major construction projects in the area. Should the WIPP project begin immediately, this assumption would be invalidated, given current plans for initiating construction on the Brantley Dam in late 1981.* This seven-year, $172 million project would employ some 600 direct workers during peak construction years which, if overlapped with the WIPP, could give rise to severe housing problems in the two-county area

*Telephone communication with Mr. Alan Solbert, Water and Power Resources Service, Amarillo Office, November 10, 1980; also, see Albuquerque Journal November 9, 1980, p. 1, Section E.

as well as exacerbating potential socio-institutional and cultural impacts discussed below.

Other potential Class 1-related impacts considered here are those associated with financial institutions and those associated with diversification in the local economies. Financial institutions in the two-county area were found to have sufficient capacity -- current high interest rates aside -- to provide financial services for WIPP-related growth. While the WIPP facility itself broadens, or diversifies, the two-county economy, there are no compelling reasons for anticipating forward or backward "linkages" that would have the effect of attracting new industries to the area, thereby further adding to economic diversification in the area. The potential for local distortions, and decreasing diversification, that may attend the decommissioning of the WIPP at the end of thirty years was considered. Given the small amount of employment involved -- relative to total employment -- such distortions may be expected to be manageable.

Attention is now turned to the second class of WIPP-related costs given in Table III.1, referred to as Class 2 costs. The distinguishing features of Class 2 costs are that, first, many of these costs are several steps removed from the two-county area and the WIPP site _per se_ -- they are State-wide in nature and, second, considerable controversy may exist as to who bears such costs -- the State or the Federal government. Class 2 costs include three major components which are discussed in turn.

The first component of Class 2 costs is referred to as "opportunity costs" which consist of income and taxes* from sources which may be

*Primarily, severance and related taxes which are not necessarily included in personal income measures.

eliminated — foreclosed — as a result of the WIPP. The major source for these opportunity costs are hydrocarbon and potash resources underlying the WIPP site. For reasons that will be apparent later in these discussions, "high" estimates for these costs are given in Table III.1, which range from $30 million to $162 million depending on one's choice of a discount rate. Foregone grazing opportunities would also constitute an opportunity cost; these values are negligible, however, given low grazing densities in this area.

Two other potential sources for opportunity costs were considered in this study, viz., potential adverse effects on Carlsbad's growing attractiveness as a center for retirees and potential adverse effects on tourism. In terms of retirees, some concern over the WIPP on the part of retirees in the area was identified in Adcock's socio-cultural survey — such concern was primarily focused on potential cost-of-living impacts (Adcock, November, 1980, pp. 20-21 and 22-23). Informal discussions with senior citizens groups conducted as a part of this study, as well as results from the above-cited survey by Adcock, suggest that it is improbable that existing retirees in the area would leave as a result of the WIPP or that new retirees would necessarily choose not to locate in Carlsbad. Data required for any conclusive assessment of this issue simply are not available, in which case this potential source for opportunity costs must remain an open issue.

The potential for tourist-related opportunity costs -- or, for that matter, positive tourist benefits -- which might be associated with the WIPP must also remain as speculative at this point. With data from other regions, efforts were made in this study to correlate recreation visitor days and proximity to nuclear facilities, particularly those facilities at which accidents or mishaps have occurred. Hard data were not available.

Officials in Alabama report no adverse effects on tourism as a result of the Brown's Ferry incident in the mid-70's; indeed, officials report that recreation activities have flourished. Other than temporary cancellation of hotel reservations immediately following the Three Mile Island incident, conclusive data do not exist that would suggest further adverse tourism effects in Pennsylvania associated with nuclear facilities. As in the case with retiree effects, tourism-related opportunity costs must remain an open issue.

The second component of Class 2 costs is related to emergency preparedness. It is the State and not the Federal government which has primary responsibility for implementing emergency procedures. Responsibility for responding to radiological emergencies in the State lies with the Radiation Protection Bureau (RPB) in the Environmental Improvement Division. The RPB prepares emergency response plans for the State and has capabilities for responding to minor radiological accidents. For large-scale radiological emergencies, the RPB would request the assistance of the Joint Nuclear Accident Coordinating Center (JNACC) located at Kirtland Air Base;* JNACC has the equipment and trained personnel required for dealing with large-scale accidents. However, the RPB is not charged with the responsibility for providing emergency response training for radiological emergencies to such local-level units as police and Sheriff's departments, ambulance-rescue squads, firemen, nurses, physicians and hospital administrators -- and those units are likely to be the first involved in an accident. Further, the RPB does not have the authority to order evacuations; such authority lies with the State's Office of Civil Emergency Preparedness (OCEP). Thus, at the

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*RPB, August 28, 1980, p. 2.

risk of over-simplification, a response to an accident involving a transporter of nuclear waste would involve the notification of the RPB which would, in turn, determine the need for requesting JNACC assistance; acting on its own or in conjunction with the RPB, the OCEP would determine the need for ordering evacuation.

Laying aside ongoing discussions concerning the desirability of consolidating all aspects of a total response capability in the State,* arguments concerning the need for monitoring equipment and trained personnel at the local level may be regarded as compelling, particularly in light of the need for immediate responses and decisions as to accident severity and implications for possible evacuation and the treatment of injuries. Thus, emergency preparedness costs for such things as training and equipment at local levels -- involving $4.9 million to $19.6 million over 30 years -- are included here as a Class 2 cost.

The third and final component of Class 2 costs included in this study is those outlays required for highway upgrading. The issue of road vs. rail transport of nuclear wastes is considered in some detail in this report (Chapters VIII and IX), from which two conclusions are suggested. First, while train transport has lower accident probabilities than truck transport, the probability of a severe accident, involving a fire with a duration of two hours or more, is much higher with train transport. Based on population-at-risk and other criteria, the State may be well advised to oppose the transport of waste by rail via routes which pass through major population areas. If this policy were adopted, existing route configurations

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*See, e.g., Samuelson and Rivera (1980).

would allow road-rail combinations for shipments entering the State from the west and northwest, but shipments entering the State from the north would be limited to road transport. Second, 17 alternative routes for road transport were evaluated with the aim of minimizing accident probabilities and population at risk (see Table III.6). Two northern routes (routes 1 and 2), two northwestern routes (routes 9 and 13) and three routes for shipments entering from the east* are identified as warranting particular consideration as being preferable from the State's point of view.

The northern and northwestern routes may be described briefly in the following terms:

Route #	Highway Numbers	Cities and Towns
1	I-25	Raton to Las Vegas
	US84 & I-40	Las Vegas to Santa Rosa
	US54	Santa Rosa to Vaughn
	US285	Vaughn, Roswell, Artesia, Carlsbad
2	I-25 US285	Raton, Las Vegas, Glorieta, Clines Corners, Vaughn, Roswell, Artesia, Carlsbad
9	I-40	Gallup to NM 6 turn-off
	NM 6	I-40 to Los Lunas
	I-25	Los Lunas to Bernardo
	US60	Bernardo to Vaughn
	US285	Vaughn, Roswell, Artesia, Carlsbad
13	I-40	Gallup to NM 6 turn-off
	NM 6	I-40 to Los Lunas
	I-25	Los Lunas to Las Cruces
	US82	Las Cruces, Alamogordo, Artesia
	US285	Artesia to Carlsbad

*Given the short in-State distance involved for eastern routes, out-of-state considerations would most likely dominate route selection decisions for shipments entering New Mexico from the east. Thus, all three eastern routes are included.

Table III.6. POPULATION AT RISK ALONG THE ALTERNATIVE HIGHWAY ROUTES*

ROUTE NUMBER	POPULATION, 1977
1	61,000
2	59,000
3	178,000
4	183,000
5	306,000
6	162,000
7	165,000
8	170,000
9	73,000
10	173,000
11	76,000
12	97,000
13	81,000
14	201,000
15	33,000
16	62,000
17	20,000

*Approximations based on 1977 population estimates for incorporated areas multiplied by the fraction of the area within one mile of the route.

Appealing to the notion that, at a minimum, the State would require that routes used by transporters of nuclear waste meet "adequate" safety standards (as contrasted with the "deficient" safety classification for some portions of New Mexico highways), the costs for upgrading "deficient" segments of these routes to meet "adequate" standards are estimated at $57.2 million (for $r = 0\%$) and are included as a component of Class 2 costs. Total Class 2 costs are shown to lie between $66.9 million and $238.8 million, depending on one's choice of a discount rate.

B. State and Local Issues Related to the WIPP.

In the preceding section concern was focused primarily on socio-economic impacts related to the WIPP which are in some sense amenable to measurement in terms of dollars and cents; some non-quantifiable considerations were unavoidably intermixed in those discussions given their relevance for the topic in hand. There are, however, a number of other potential impacts of a socio-economic nature which are clearly relevant for assessing the impacts of the WIPP which must be considered, notwithstanding the fact that they are not measurable in terms of incomes and expenditures. In many cases, the relative magnitudes of potential impacts associated with the issues to be discussed in this section will depend on choices of policy actions related to the questions raised by these issues. Thus, the non-quantifiable issues of concern here -- as well as those discussed in section B -- may be every bit as important as the measurable benefits and costs, described in Table III.1.

The first of these issues concerns the potential for socio-cultural distortions in the Eddy-Lea county area which could arise from the WIPP construction. In a relatively small community in which rapid but temporary population growth occurs, the results of such things as crowded facilities (public and private), tight housing markets, crowded schools, etc., may be manifested in increased crime rates and heightened social tensions as reflected by increased alcoholism, divorce rates, etc. When the social and cultural values of in-migrating families are markedly different from those held by the existing residents of a community, the potential for social conflicts will exist. Such has been the experience in a number of small communities in the Rocky Mountain region during periods of energy-related developments. At one level, it seems reasonable to expect that such distortions associated with the WIPP would be minimal, primarily due to the fact that in-migrants will constitute a relatively small part of the two-county population. Two caveats to this conclusion are relevant, however. First, the numbers of new in-migrants (and, therefore, the potential for socio-cultural problems) could increase markedly should the WIPP construction overlap with other, major construction projects in the area (such as the Brantley Dam). Second, the smaller communities in the two-county area could be exposed to disproportionately large influxes of population, with the attendant potential for social tensions and problems. In this latter regard, Loving, a village with a large proportion of Hispanic families, is relatively close to the WIPP site and could bear a disproportionate amount of the social costs associated with in-migration of WIPP workers.

These considerations relate to a second issue of potential concern in the two-county area, viz., the jurisdictional issue. To the extent that housing requirements for in-migrating families that locate in the Loving area are satisfied by temporary facilities -- mobile home parks, etc. -- property values and other sources for local taxes may not provide revenues to the county commensurate with expenditure levels required to maintain standards for public health and safety in the Loving area. The bulk of taxes from sales and service taxes from new, Loving-area residents can be expected to accrue to Carlsbad. Jurisdiction for public safety would lie with the county, which, as shown above in section A, may lack funds to meet increased needs for services. Thus, the most affected community -- the village of Loving -- may be subjected to major impacts without corresponding increases in tax revenues, nor perhaps, required increases in county services. The same sort of issue is relevant for Carlsbad which must provide for high school students in the Loving area. We can do little more in this study than identify the potential for jurisdictional issues of this sort; the need for collaboration of state, county and municipal levels on solutions to such problems is obvious.

A third issue examined in this work concerns the potential effect of the WIPP site and/or WIPP transport on property values. The possibility exists that increased risk of accidents along transport routes, as well as at the WIPP site, could affect the value of property in close proximity to the WIPP facility and/or designated transport routes. In terms of property along transport routes, no evidence could be found that would suggest such effects in other focal points of transport of nuclear wastes (Morris, Illinois and Barnswell, South Carolina); we must note, however, that owners of property along such routes, and the general public as well, seem to be unaware of the designated routes and the volume (and nature) of wastes shipped thereon. Further, there is no evidence that proximity to a nuclear-related facility will directly affect property values, all else equal. All else is <u>not</u> equal in the area around the Rocky Flats facility in Colorado. There, property value effects can be identified. Curiously enough, such effects are not directly related to proximity to Rocky Flats <u>per se</u>; rather, they appear to be the result of a HUD requirement that, within a ten-mile radius of the Rocky Flats facility, sellers advise potential buyers of property of "varying levels of plutonium concentrations in soils" (that are, however, below EPA maximum acceptable levels). Given the relative isolation of the WIPP site, as well as the fact that it is surrounded by a buffer area of Federal and state property, site-related effects on property values must be regarded as unlikely to occur. Related opportunity costs to the state remain relevant, however, as outlined in section B. For property along transport routes, no persuasive reason exists for expecting adverse effects on values, so long as an accident does not occur (see Chapter IX). Should an accident result in the contamination of an area, potential property value effects could result notwithstanding clean-up efforts.

A fourth issue identified in this work must be mentioned. In Chapter II of this work we have identified a distributional issue between the state and the Federal government, _viz._, potential costs associated with the WIPP may be centered in New Mexico whereas associated benefits accrue, in the main, to other areas in the U.S. One may argue that benefits and costs are unevenly distributed. One must recognize that the same sort of distributional effects exist _within_ the State of New Mexico. This is to say that the bulk of WIPP-related benefits — income and employment — as well as Class 1 costs, accrue in the Eddy-Lea county area. Some Class 1 costs, most of Class 2 costs and a large part of the imponderable Class 3, risk-related, costs are borne by New Mexicans that reside outside of the two-county area. While WIPP-related incomes (benefits) outside the two county area may well obtain — from zero dollars (FEIS estimate) to some $30 million/year (our upper bound estimate) — the relative distribution of benefits and costs within the state would hardly be uniform. This issue is particularly important for some of the conclusions that result from this study, and it is expanded below in Chapter IV.

A final issue, about which little can be said in a definitive manner, concerns the termination of WIPP operation. Direct economic effects of the closed operation were considered above. A number of questions of potential socio-economic importance remain, however, and little is said regarding these questions in the FEIS. These questions include the following. Is, in fact, nuclear waste stored at the WIPP site to be retrieved at the end of the WIPP's 30-year life? If such retrieval is to take place, what is the nature of planned decontamination actions for this storage area? If retrieval is not to take place, what is the nature of plans for monitoring stored wastes and security; for what period of time will monitoring/security practices continue? Obviously, responses to these questions are required if one is to do other than speculate about socio-economic impacts in the post-operations phase of the WIPP.

IV. RISK AND THE WIPP: MANAGEMENT PROBLEMS AND ISSUES

A. Risk Management.

Risk management is perceived increasingly as an integral part of decision-making for high technology activities which have come to dominate our industrial sectors. In response to the need for better guidelines in this area, a considerable literature has grown up, much of it devoted to comparisons of levels of risk to life and limb in different fields and to weighing risks against various scales of benefits (Okrent, 1975).

In spite of the growing scope and sophistication of risk analysis, however, much of it remains inapplicable to the WIPP. The WIPP is a special case in a number of respects. First, risk -- or perceptions of it -- have been the dominant issues in public debate over the project; if risk could be reduced to zero, and perceived that way, public concern over the project would very likely vanish. In contrast, while risk may be a part of other modern technological activities, it rarely is such a dominant part. Second, many of the benefits associated with the WIPP are national in scope, while its riskiness affects only certain locales. Third, these benefits are inherently difficult, if not impossible, to quantify: how do we value the worth of national defense to the average citizen? Hence a weighing of risk against benefits cannot be contemplated. Fourth, the level of risk associated with the WIPP is difficult if not impossible to quantify. There is considerable uncertainty about the likelihood of accidents occurring, and there is even greater uncertainty about their consequences. And finally, some of the potential risk associated with the WIPP may impinge on very distant generations. This last problem also characterized the disposal of some toxic chemicals, but it doesn't apply to the typical industrial production technology, whose operating lifetime is expected to be 20 or 30 years at most.

It is worth saying at the outset of this discussion, as we have elsewhere in this document, that careful efforts have been made to measure the potential riskiness of the WIPP, and that these studies thus far indicate that the hazard to life and limb is low relative to that associated with many other modern technological activities. Given the newness of nuclear technology, however, there is not sufficient experience to permit us to fully validate these studies. The uncertainties weigh larger in some people's minds than the fact that available risk estimates are rather low.

In these circumstances, prudence appears warranted, and indeed safety considerations have figured prominently in the design of the WIPP and related activities. In more general terms the Federal government has promulgated a series of regulations designed to minimize the risk entailed in the management of nuclear wastes, and it also has made substantial expenditures for improving shipping container design with the aim of minimizing the possibility of accidental radiation exposure. These are appropriate measures which enhance the safety of the WIPP. Nevertheless, the state of New Mexico has a right and a responsibility to review the planning for the WIPP in order to determine whether there are additional and reasonable measures which would further improve the safety of the project. In dealing with unfamiliar hazards, obviously independent reviews can be more helpful than in cases of well-known hazards.

While the state cannot develop on it own a comprehensive risk management program for the WIPP, there are a number of ways it can influence the safety aspects of the project, both acting under its own jurisdiction and urging the Federal government to act in other areas. In the context of the WIPP, risk management means:

- Minimizing the chances that an accidental radiation release will occur;
- Minimizing the consequences of such an accidental release should it occur;
- Developing procedures and capabilities in response to a WIPP-related accident;
- Clarifying liability assignments and ensuring that indemnification is available in the event of an accident.

Clearly, in order to develop a risk management program a prior determination needs to be made regarding the types of risk -- the nature of accidental events which could occur, however unlikely they may be. Also, although probability estimates are difficult to make with precision in this field (see Chapter VIII), it is useful to compare the probabilities of different kinds of events as a guide to planning appropriate measures.

The DOE's studies on the WIPP provide information along these lines, and Chapters VII and IX of this report present additional investigations of the nature of WIPP-related risks. Some of the conclusions of those chapters are as follows:

- The risk of an accident involving nuclear wastes is greatest in the transportation phase;
- The chances of a significant release of radioactivity are extremely small, but such an event could occur;
- The consequences of a very severe accident would be much less than the consequences of a nuclear reactor accident, but in an extreme case a few fatalities would be imaginable, along with damages in the tens or hundreds of million dollars if the accident ocurred in a New Mexico urban area;

- Truck accidents occur relatively more frequently than train accidents do, but the latter can be more severe;
- There are a number of measures which the state can implement to reduce the potential likelihood and consequences of a radiological transportation accident, and to improve its emergency response capability; these are listed in chapter I above and are discussed more fully in Chapter VII below.

B. The Subjective Dimensions of Risk.

As noted in section A above, the available risk estimates suggest that the chance of a severe accident over the WIPP's thirty-year life is very small. Notwithstanding such small chances for severe accidents, considerable controversy, reflecting to some extent strong fear and anxiety on the part of some individuals, continues to be associated with this project.

As a part of this study (Chapter VIII), an effort is made to assist the reader in sorting out the various issues relevant for assessing WIPP-related risk. Judgments are required in this area, inasmuch as a definitive answer as to the WIPP's risks to public health and safety simply does not exist.

The subjective nature of WIPP-related risk is shown to result from a number of characteristics of this type of risk, two of the more important of which are the following. First of all, the common method for developing scientific risk estimates for technological systems such as the WIPP is the use of fault trees. A fault tree is essentially a schematic characterization of a series of interrelated events which may jointly result in the failure of a system. Probabilities are assigned to each of the events on the basis of engineering information, and then those probabilities are combined so as to assess the probability, or chance that a particular type of system failure might occur.

A basis for controversy then arises because this approach may be viewed as subjective for at least two reasons; 1) individual event probabilities often are assigned on a judgmental basis, not according to historical frequencies, and 2) the analyst must attempt to set out all possible types of failure (failure modes) in the fault tree, and whether or not the set of elements is complete depends upon the judgment of the analyst. The basis for controversy is then apparent, as exemplified by the following statements:

> "...it is very rare that actual system failures are found to be due to hardware failures (i.e., the failure modes that are usually considered in fault tree analysis). The cause of failure usually turns out to be one that...the analyst would have a very hard time imagining — like a specific design error or human error" (Apostolakis, 1978, p. 313). "In fault tree analysis, the analyst essentially is required to imagine that which never has been experienced before" (Zeckhauser, 1975, p. 445).

Further, we must note that the controversy surrounding risk estimates based on fault tree analyses is not based simply on methodological, or theoretical, differences of opinion among researchers. Arguments by critics of fault tree analyses are supported by real world experiences in which design error or unanticipated human error have resulted in potentially dangerous mishaps at nuclear facilities. A well known example of the latter type of error is the Brown's Ferry incident. Also, in terms of design errors, a malfunction of the Three Mile Island type was evaluated (in terms of the chance of it happening) beforehand and assigned an occurrence probability of 100 million to 1; the fault tree study used a Westinghouse design, however, while the actual Three Mile Island reactor was of a different design (constructed by Babcock and Wilcox; see Epps, 1979, p. 45). Postmortem NRC calculations showed that the odds for the Three Mile Island malfunction in a real Babcock and Wilcox reactor were very much higher than the original 100 million to 1 (Epps, 1978, p. 45).

From the above discussions, the reader can readily appreciate the nature of ongoing controversies concerning risks associated with nuclear power in general, and the WIPP more specifically. Given that one cannot engage in repeated experiments for full-scale nuclear-related systems, and that our experience is limited with many of these systems, fault tree types of analyses are the only viable methods for assessing the chance of system failures -- accidents. While researchers apply these analyses carefully, the experimental and hypothetical uncertainties described above do in fact exist and one can clearly point to incidents that have occurred that were not considered in ex ante risk analyses. Since an alternative to fault tree analyses for risk assessment is not immediately apparent, there are, and will likely continue to be, sharp differences in opinion regarding the reliability of risk assessments for WIPP-related accidents and the nature of resulting damages.

A second source for controversy concerning risk estimates for WIPP-related accidents relates to problems in interpreting, in any meaningful way, received risk estimates; this is particularly true for the non-technical layman. While a statement like "one in a hundred" may be meaningful to an individual, it may be most difficult to appreciate chance statements like "one in a million", "one in 100 million", etc., not to mention the virtual impossibility of differentiating, in any meaningful way, between $4(10^{-5})$ and, e.g., $2(10^{-7})$. At some point, very low probability risks become blurred in perception and the only interpretation then is "virtually impossible" or "a credible probability measure cannot be developed." In the words of Fairley (1975), "there is some minimum value below which a small estimate of a probability of a real world event is not credible."

Indeed Kahneman and Tversky (1979) present evidence which suggests that when individuals are faced with low probability, high consequence alternatives they tend to <u>ignore</u> the probabilities and make decisions solely on the basis of consequences. This tendency may become even more profound when individuals are made aware of the mechanisms by which consequences occur. The same point has been made by Starr, Rudman, and Whipple (1976, p. 632): "accident probabilities are usually not given significant weight in an individual perception...the size of the potential accident is given more weight than the probability...This is probably representative of societal values to a great degree, and activities capable of producing catastrophic accidents therefore must meet more stringent societal standards than higher-frequency individual risks." To the extent that individuals, faced with events characterized by very low probabilities but highly dangerous consequences, ignore probabilities and simply focus on consequences (as suggested by the works cited above), the reader can immediately appreciate the potential for "phobic thinking" and continuing controversy.

Two additional observations are relevant for an understanding of the subjective dimensions of risk. First, the nature of risk-related damages remains obscure at this point in time. While loss of life is a potential damage which is immediately obvious, some would argue that damages result from risk bearing *per se*. An extension of the argument for risk bearing as a damage is the notion that risk, or damages, *as perceived* by the public is the measure of damages relevant for public assessments of projects like the WIPP. The "perceived risk" argument is weakened, however, if it can be demonstrated that perceived risk is, in some sense, only transitory. It can be argued that considerable apprehension was associated with the introduction of many now-common technologies (e.g., the automobile, electricity, etc.); greater understanding of a familiarity with the technology results in the gradual elimination of this apprehension. Indeed, studies of perceived risk provide results that are somewhat supportive of this argument. For example, perceived risk measures for certain technololies are suggested to be influenced by the number of times that articles about the technology have appeared in newspapers.* Further, it is suggested** that, once exposed to a technology, there is a tendency for individuals to deny the presence of risk. This latter point suggests that, prior to the introduction of a technology, perceived risk would likely be much higher than after its introduction. In any case, the potential damages associated with WIPP-related perceived risk and risk-bearing is not well-defined at present.

The second observation of interest here concerns the problem of valuing damages associated with a WIPP-related accident, particularly, damages related to loss of life. The method which has historically been used for valuing loss of life is based on the earnings lost by an individual suffering premature death. This approach reflects the notion that the most important effect on society of the death of one or more of its members is the loss in social production -- as measured by an individual's wages and income --

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*Slovic, et al. (1979).

**Ibid.

which would otherwise be produced by the decedent. Mishan (1971b) has shown that this and related approaches violate principles commonly held by society. Thus, the income-loss measure is unsatisfactory as a measure for risk damages inasmuch as "...it has no regard for the feelings of potential decedents. It restricts itself to the interests only of the surviving members of society ex post" (Mishan, 1971, p. 690). Further, when present value earnings measures (see Chapter II.D) are used, life-values for nonearners would be essentially zero; life-values for grandmothers would be zero because they have no earnings, and they would be essentially zero for infants given the 20-odd year period before earnings begin. Nor, as argued by Mishan, would insurance premiums provide consistent approximations for loss of life values inasmuch as insurance policies provide only for compensation to others and, as such, could not serve as an index for the value that an individual would set on his own life (Mishan, 1971, p. 691).

A number of efforts have been made to develop alternative measures for loss of life damages that might, in some probabilistic sense, be associated with projects like the WIPP (Chapter VIII). At this point in time, however, there are no generally accepted methods which have been developed. Therefore in this study we do not attempt a monetary valuation of potential health damages from accidents, but rather we attempt to focus on the kinds of policy decisions which can be made in the absence of such valuations.

C. Risk and the Compensation Issue.

A recurring issue in this study involves the question as to who pays for the state's programs for risk management, as well as for evacuation costs and any costs associated with an accident. In closing this chapter, we wish to formally address this issue.

The central issue here is the following. Benefits from the military use of nuclear-related materials accrue to the public-at-large in the U.S., clearly, this proposition is unequivocal. As a result of this "benefit" generating activity, the need for disposed of nuclear wastes arises. Associated with the disposal of such wastes, a range of costs are implied which are a step removed for the waste isolation site *per se*. Who is to bear these costs?

Obviously, there is no completely objective way to respond to this question. One may argue that, on its face, the fair solution is for beneficiaries to share all costs, but "fair" is at least partly a subjective matter. However, this matter is of considerable importance to the State of New Mexico for reasons alluded to above, and ultimately, the Federal government must consider this issue.* Therefore, we wish to consider three arguments which are relevant for the "beneficiaries share cost" proposition which then implies the government's compensation of risk-related costs. These three arguments concern ethical systems, precedents in the private sector of the economy, and precedents in the public sector, and they are developed below. Following these arguments, the case against compensation is considered. This section concludes with a discussion of possible mechanisms which might be used for implementing the compensation principle should it be adopted.

In terms of the question posed above concerning "who pays the bill," one case for compensation is essentially little more than the moral argument

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*An interesting overview of issues relevant for the Federal government's consideration of the compensation problem is given in a 1978 draft report prepared by Roland J. Cole, *et al*., at the Human Affairs Research Center of the Battelle Memorial Instutute. We acknowledge an intellectual debt to the authors of this draft report, but honor their request that quotes not be drawn from this draft document.

that beneficiaries must pay benefit-related costs. When the compensation issue is considered within the context of ethical systems, compensation is seen to be consistent with the principles basic to the Judeo-Christian ethical systems reflected in aphorisms like the Golden Rule ("do unto others what you would have them do unto you").* This ethical system underlies the "Pareto criterion" of economics, viz., that an action can be judged as involving, unequivocally, beneficial effects only when some individuals are made better off and no one is made worse off. Based on this ethical system, the case for compensation would seem to be made prima facie.

One also may look to precedents for compensation in the private sector. There are a number of examples in which the operations of a privately-owned business gives rise to effects which are off-site, or external, to the business per se. In such cases, the state will generally employ one or both of two measures, taxation and regulation, which have the effect of requiring that beneficiaries of the firm's production activities bear the related external costs. A few examples may serve to establish this point.

In terms of the use of regulations, the classic example involves state and Federal environmental standards imposed on private business. Typically, the external effect is the firm's emission of air pollutants. By imposing standards — regulations — the firm's operating costs are often increased by the necessity to use pollution abatement equipment. Such higher costs are then generally passed on to the consumer of the firm's production via higher prices. Obviously, the end result is that beneficiaries — users — of the firm's services bear the costs for external (safety-related, in this case) effects of the benefit-generating activity.

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*Schulze (1979, p. 13).

In terms of taxes, a tax of relevance for these discussions is the severance tax. Historically, a large number of states, realizing that economic activity was depleting their natural resource base, imposed severance taxes on resource extraction, the argument being that levying such taxes would enable the states to keep their resource base intact in one form or another. More recently, however, it has been acknowledged that these taxes perform another function as well, in that they provide a revenue base with which states can, at least in part, begin to deal with the external problems of environmental degradation associated with resource-related activities. Obvious examples are environmental disruptions due to strip mining of coal and the presence of uranium tailings. As in the case of regulations, such taxes are generally passed on to consumers, the end result being that beneficiaries pay the bulk of external costs.

The third and final argument concerning the question "who pays the bill" relates to precedents in the public sector which support the "beneficiaries pay costs" principle. In cases where the government's use of Federal lands results in adverse effects to communities in close proximity to a Federal reservation, payments in lieu of taxes are commonly paid by the government. A recent example of the application of this principle in the public sector occurred in Nevada. Increased accident rates along highways used by commuters from the Nevada nuclear test site and Las Vegas resulted in Federal legislation which provided funds for upgrading these highways (the cost sharing arrangement involved a 90% federal contribution and a 10% state contribution).* Here again, beneficiaries of the activity -- the public-at large -- paid the bulk of associated external costs.

Thus, the case for compensation rests primarily with the principle of equity or fairness which appears to have been embodied in Federal standards. We have demonstrated the consistency of this principle with generally accepted ethical systems as well as with some common practices observed in the interface between state governments. We must acknowledge, however, the existence of alternative arguments that raise questions as to the appropriateness of compensation in the case of the WIPP project.

A counterargument to compensation on ethical grounds if found in the "Utilitarian", or Benthamite, system of ethics as expressed in the works of Jeremy Bentham (1789), John Mill (1863) and others.** The essence of the Utilitarian system is the oft-quoted criterion, the greatest good for the greatest number. Thus, if an action results in gains in satisfaction, or utility, across society which exceed losses in satisfaction across society, the action is "right". This principle effectively underlies the standard application of benefit-cost analyses in which total benefits, to whomsoever they may accrue, are simply compared with total costs, to whomsoever they may accrue. Two common problems or criticisms are often associated with the use of this ethical system for social decision making. The first is the issue of equity which was discussed earlier. The second is"... the obvious difficulty in making the requisite calculations necessary for moral choices...(namely) measuring (gains and losses) in utility (or satisfaction)"***

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*Public Law 87-701 (September 1962). Also see House Miscellaneous Reports on Public Bills IV. House Reports 1793-1967, 87th Congress - 2nd Session, Report 1871 Authorizing Appropriations of the AEC, pp. 11 and 12.

**Schulze (1979, p. 8).

***Ibid., p. 8.

These problems notwithstanding, we must recognize that, in spite of our society's general adherence to the Judeo-Christian ethic, the bulk of public decisions more closely reflect the Utilitarian system of ethics.*

A second counterargument must be mentioned; the argument that New Mexico receives a disproportionate share of national military-related benefits. Particularly in the case of military wastes, it can be argued that, relative to the rest of the nation, disproportionate benefits from the process by which military wastes are generated accrue to the State of New Mexico. Related to this process is mining of uranium which generates income and, particularly, severance taxes, as well as Federally-funded research and development concerning military uses of nuclear materials (Los Alamos Scientific Laboratory, Sandia National Laboratories, White Sands testing facilities, etc.). The force of this particular counter-argument is weakened however, by a number of considerations. First of all, if one is to argue this case, one must consider the range of external costs associated with these benefits -- one must establish that net benefits are involved. Probably this could be done, but it would not be an easy task. Growing concern exists in terms of potential costs associated with the disposition of uranium tailings and related groundwater contamination. Secondly, facilities such as the White Sands area are not costless -- denial of access to public lands is a legitimate cost which must be considered. Thus, the case

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*This decision criterion reflects the "potential Pareto improvement" concept mentioned above, under which feasibility tests simply require the demonstration that gainers could compensate losers, without the requirement that such compensation actually takes place. We also acknowledge here the conceptual problems that are associated with actual compensation (see, e.g., Baumol and Oates, 1975) whereby "victims" are induced to incur damages to some degree. Given the lump sum nature of the compensation at issue here, the relevance of these problems to the case at hand is peripheral.

for net benefits accruing to New Mexico from other military, nuclear waste-generating activities cannot be made on *prima facie* grounds; as suggested above, difficult empirical questions concerning external costs must be answered before such net benefits can be claimed.

Finally, we note that existing Federal regulations encompass both cases in which compensation for the effects of public projects is required, and cases in which it is prohibited. The majority of cases fall in between (Cole *et al.*, 1978) -- in which compensation is a viable but not a mandatory policy instrument -- and in those cases the particular circumstances have a strong bearing on whether compensation is appropriate.

Although these paragraphs do not constitute a comprehensive review of arguments for or against compensation, perhaps the statements presented here will serve to provide the reader with a broader perspective on the major issues which are relevant to this controversy. In terms of specific conclusions, we wish to step beyond the objective descriptions of relevant pros and cons concerning the compensation issue and suggest that we find the case for compensation to be particularly compelling for those costs related to emergency preparedness, highway upgrading,* and local impact costs described above. This finding is based primarily on the argument that such costs are an integral part of the WIPP project *per se*. If the WIPP project is defined in such a manner that maximum efforts are made to insure the health and safety of U.S. citizens, it would be necessary to include as

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*Thus, opportunity costs are left as an open issue. Few Federal properties throughout the country, benefits from which accrue to the public-at-large, including citizens in New Mexico, do not involve some form of opportunities foreclosed in the project's region. Examples include Forest Service developments and water reclamation projects.

project costs those outlays required to meet a reasonable version of the "safety over costs" criterion discussed above. In other words, these costs are appropriately considered part of the project if it is designed to standards such that a severe accident cannot occur.

Should compensation in fact be made, a remaining issue concerns the method by which compensation is made. In terms of costs for emergency preparedness and highway upgrading, the bulk of these expenditures are required prior to the initiation phase of the WIPP project. It seems logical to expect that such funds would be made available to the state in a lump sum form, analogous to up-front outlays for the construction of the WIPP, i.e., the bulk of compensation for these purposes would be treated as a capital expenditure. Of course, some operating-type expenditures are required through time for maintaining training programs and special equipment, as are described in Chapter VII. Obvious financial mechanisms for such compensation include the use of general tax revenues and/or charges to the users of the facility.*

Questions as to compensation mechanisms for costs that would arise in the case of an accident are discussed at length in Chapter IX of this report. The essence of these discussions, relevant for the topic at hand, is as follows. There is some ambiguity involving nuclear wastes, particularly in the case of military wastes; under present statutes and contractual arrangements, it appears not to be applicable. The position of the State in terms of indemnification also is obscure at present. Thus, a first critical step in speaking to compensation mechansims relevant for accident costs is

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*See Cole, et al., (1978). Since the primary "user" is the Federal government, "user charges" take the form of an accounting mechanism whereby waste disposal costs are "charged" to defense budgets.

clarification of the extent that Price-Anderson provisions apply to nuclear waste shipments and storage.

If Price-Anderson provisions can be made to apply to the WIPP via arrangements with DOE, the WIPP would be indemnified for any liability in excess of $560 million, roughly 20% of which would be underwritten by private insurers and the balance by the Federal government. However, this limit may be somewhat academic inasmuch as damages below $560 million may not be fully covered. Also, the state should note the potential inequities of these provisions in the event -- however improbable -- of a very severe accident when damages to property and/or health exceeds $560 million (see Chapter IX for a discussion of this issue).

If Price-Anderson provisions cannot be made to extend to the WIPP, the State may have little recourse other than the options adopted in several other states, viz., implementing statutes requiring insurance by private carriers of waste within the state. In such case, maximum insurance levels offered by private insurers are likely to be relatively low. Given the magnitude of possible damages -- again, low probabilities of such damages notwithstanding -- the State may feel compelled to play the role of insurer of last resort, particularly with respect to clean-up costs. The compensation arguments given above are clearly relevant for such costs and the central question becomes that of identifying the source for these funds that would be available in the event that they would be required.

Some options for clarifying this liability/compensation issue may be identified -- and we emphasize here the need for such clarification prior to the operation of the WIPP. First, an agreement could be made with the Federal government for immediate compensation, up to agreed upon limits, in the event of a serious accident; obviously, this would be an alternative akin to current Price-Anderson arrangements but possibly could apply to amounts lower than $560 million. Second, the State could develop a contingency fund based on either direct, periodic grants by the Federal government, or *via* a tax on wastes shipped to the WIPP, or *via* general taxation of the citizens of New Mexico.

In closing we note that the taxing of wastes has appeal in that it takes the form of an "acceptance tax" and, in the likely event that a serious accident does not occur, the resulting fund may serve as a source of revenue to provide funds which might be required for such things as post-operations monitoring and security, compensation for opportunity costs and/or property value effects in the State, and for other purposes. The disadvantages of this tax scheme include the potential for insufficient funds in the case (however remote) of an early accident and the State's potential liability for damages in excess of agreed State-Federal limits as a result of the State's concurrence with the contingency fund arrangements (see Chapter IX, Section D.1).

PART II

ANALYSIS OF WIPP-RELATED IMPACTS

V. WIPP-RELATED IMPACTS IN EDDY AND LEA COUNTIES

A. Overview

Attention in this chapter is focused on the range of socio-institutional and economic impacts in Eddy and Lea counties which may arise from the construction and operation of the proposed WIPP.

The impacts of concern here are primarily determined by the new jobs--direct and indirect--which result from WIPP activity and any increases in population associated with new jobs. Therefore, analyses begin in section B with estimates for the number of new jobs which will likely result from the WIPP (the "demand" for labor). In section C inquiry is made as to the source of workers which will fill these new jobs (the "supply" of labor). Of concern in section C are analyses of the potential for local residents to fill new jobs and the potential magnitude for the flow of in-migrating non-local workers (and their families) to the two-county area.

The results of analyses in section B and C are estimates for WIPP-related changes in employment and income, as well as scenarios for population changes in the towns of Carlsbad, Hobbs and Loving, and in other parts of Eddy and Lea counties. The stage is then set for analyses of some implications of these changes. In particular, impacts on housing markets are considered in section D. Impacts on municipal and county services are discussed in section E. Potential impacts on financial institutions and on the structure of the two-county area's economy are considered in section F and G, respectively.

B. WIPP-Related Job Opportunities

Estimates for annual WIPP expenditures for the seven-year construction/ design phase and the operation phase (1987 and thereafter) are given in Table V.1. Estimates for employment at the WIPP site -- referred to as "direct" employment -- are given in Table V.2; direct employment estimates are taken from the FEIS [p. 9-47].

Given that the jobs described in Table V.2 are filled, the general increase in spending and overall economic activity can be expected to give rise to a "multiplier" effect -- or indirect economic effect. This is to say that as the level of economic activity in the two-county area increases -- as a result of WIPP expenditures on goods and services produced in the area, as well as expenditures by those holding the new jobs -- the local economy (the butcher, the baker, the restauranteur, etc.) responds by expanding operations in an effort to meet the increased demands for goods and services. The nature of changes in local economic activity is a subject for some debate, particularly in terms of "appropriate" methods for measuring such responses. In this study, estimates for indirect jobs, created as a result of the WIPP during the construction phase are based on historical observations of direct-indirect employment relationships in New Mexico counties which have experienced past changes in the level of economic activity on the order of that expected as a result of the WIPP.* For the operations phase, input-output coeffecients from the FEIS are used for estimates of indirect jobs that result from the WIPP. Estimation techniques are detailed

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*The statistical technique used here in deriving these estimates is described in (Resource Economics Program, University of New Mexico, 1981, Working Paper A).

TABLE V.1

ANNUAL WIPP EXPENDITURES BY YEARS AND ACTIVITY*
($000)

Year	Above Ground Contstruction	Below Ground Contstruction	Management and Design	General Above Ground Operation	Security and Remote Handling	Below Ground Operation	Total
1980	$ 178.7	$ 6,395.1	$ 607.8				$ 7,181.6
1981	20,190.4	16,475.4	4,173.6				40,839.4
1982	56,751.4	36,093.2	10,027.5				102,373.1
1983	53,133.2	12,570.9	17,460.1				83,144.2
1984	8,685.1	954.4	12,341.4				21,980.9
1985	--------	--------	15,018.3**				15,018.3
1986	--------	--------	20,970.2**				20,970.2
(Total)	(133,418.8)	(72,489.0)	(80,518.9)				(291,506.0)
1987 & thereafter				$13,644.0	$2,345.0	$7,461.0	$ 23,450.0

*Source: Data provided in letter to R. G. Cummings from D. T. Scheuler, DOE, Albuquerque Operations Office, dated May 8, 1980; while explicit data are not given in the FEIS, data in Table 9-29 suggest that expenditures somewhat different from these given in this Table were used in the FEIS.

**Transition to operation activity.

TABLE V.2

DIRECT WIPP EMPLOYMENT
BY YEARS

Year	Above Ground Construction	Below Ground Construction	Management and Design	Total
A. Construction Phase				
1980	4	56	5	65
1981	68	162	52	282
1982	415	355	152	922
1983	551	119	281	951
1984	79	9	208	296
1985	---	---	269	269
1986	---	---	417	417

B. Operations Phase	General Operation	Security And Remote Control	Underground	Total
	256	44	140	440

Source: FEIS, Table 9-29, p. 9-47.

in a companion report to this study;* resulting employment estimates are given in Table V.3.

As shown in Table V.3, WIPP-related jobs in the first construction year--direct and indirect--number some 146. During peak construction years, years 3 and 4, these employment changes amount to some 2,531 and 2,989 jobs, respectively. During the operations phase, year 8 and continuing for 23 years, total annual employment consists of 440 jobs at the WIPP facility and 641 indirect jobs.

Employment estimates in Table V.3 are compared with those from the FEIS in Table V.4. Total WIPP-related employment changes in Table V.3 are higher than those in the FEIS (Table V.4); e.g; 2,989 jobs in 1983 are estimated here compared with 2,128 estimated in the FEIS. The primary reason that estimates given here are higher is that FEIS estimates are based on the assumption that changes in WIPP-related economic activity lead to proportional (relative to the pre-WIPP economic structure) changes in employees, buildings, equipment, etc. In this study, the corresponding assumption is that short-term adjustments are non-proportional and are met by augmenting employment in order to use existing facilities more intensively. For example, new restaurants are not built to meet increased demands during the construction phase; rather, existing restaurants hire more employees and, perhaps, extend operating hours. The FEIS employment estimates and those developed in this study may be viewed as providing a <u>range</u> for employment effects which may result from the WIPP.

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*See(Resource Economics Program, University of New Mexico, 1981, Working Paper A.)

TABLE V.3

ESTIMATES FOR DIRECT AND INDIRECT EMPLOYMENT ATTRIBUTABLE TO THE WIPP

YEAR	DIRECT EMPLOYMENT[1/]	CHANGE IN DIRECT EMPLOYMENT	INDIRECT EMPLOYMENT[2/]	CHANGE IN INDIRECT EMPLOYMENT	TOTAL WIPP-RELATED EMPLOYMENT	CHANGE IN TOTAL EMPLOYMENT
1980	65	65	81	81	146	146
1981	282	217	473	392	755	609
1982	922	640	1,609	1,336	2,531	1,776
1983	951	29	2,038	429	2,989	458
1984	296	-655	539	-1,499	835	-2,154
1985	269	-27	484	-55	753	-82
1986	417	148	860	376	1,277	524
1987 - Operations Phase	440	23	641	-219	1,081	-196

[1/] Table V.2

[2/] Calculated with the equation (See Appendix A): Change In Indirect Employment = 1.037 (change in underground construction jobs) + 2.542 (change in all other WIPP employment). For the operations phase, implied multipliers (FEIS, Tables L-1 and L-2) for general operations, security/remote control and underground (Table V.2) are 1.488, 1.565 and 1.364, respectively.

TABLE V.4

WIPP-RELATED EMPLOYMENT IN EDDY AND LEA COUNTIES
ESTIMATED IN THE FEIS

YEAR	DIRECT	INDIRECT*	TOTAL
1980	62	91	152
1981	282	435	717
1982	922	1215	2137
1983	951	1176	2128
1984	296	390	686
1985	269	346	615
1986	417	484	901
1987 - thereafter	440	514	954

*Includes government jobs

Source: FEIS, Table L-13.

In concluding this section it is desirable to convert the employment estimates given in Table V.3 to associated estimates for increases in personal income (net of transfer payments; see FEIS, Section L). Estimates for net personal income per employee are given in Table V.5. Multiplying personal income per employee times total WIPP-related employment (Table V.3) yields estimates for total WIPP-related changes in personal income in the two-county area, as given in Table V.6. Also given in Table V.6 for purpose of comparison are personal income estimates from the FEIS. These latter estimates are lower for at least two reasons. First the lower FEIS estimates for personal income reflect the correspondingly lower employment estimates used in the FEIS. Second, the application of average per-worker net income figures to total employment data implies that the ultimate impact on personal income in the two-county area is the same for jobs held by commuters as for jobs held by residents in the area. As is discussed below, however, as much as 8,641 man-years of work (Scenario II, Table V.9) may be filled by non-local workers over the 7-year construction period, of which 15% (1,296 man-years) may be provided by those who commute to the Eddy-Lea county area. While, as a percent of total man-years of work--direct and indirect--associated with the WIPP construction phase, the share to cummuters is small (12.7%), the potential for bias exists if they are ignored in the analysis. Thus, analyses in this study will use the range of estimates for personal income which is provided by the analyses of this report and the analyses reported in the FEIS. This range is given in Table V.6.

TABLE V.5

FEIS ESTIMATES FOR WIPP-RELATED CHANGES
IN PERSONAL INCOME PER UNIT OF EMPLOYMENT

PERSONAL INCOME FROM THE WIPP
(Per WIPP-Related Employee Given in Parentheses):

YEAR	DIRECT SALARY/WAGES	INDIRECT SALARY/WAGES	INTEREST, DIVIDENDS, RENT	PUBLIC SECTOR	NET TRANSFER	NET PERSONAL INCOME
			(Millions of 1979 Dollars)			
1980	2.2 (.0355)	1.0 (.011)	.5 (.0033)	.1 (.0007)	(.2) (.0013)	3.6 (.0237)
1981	9.3 (.033)	4.9 (.0113)	2.1 (.0029)	.6 (.0008)	(.9) (.0013)	16.0 (.0223)
1982	28.1 (.0305)	13.7 (.0113)	6.1 (.0029)	1.8 (.0008)	(2.6) (.0012)	47.1 (.0220)
1983	27.8 (.0292)	13.0 (.0111)	6.0 (.0028)	1.8 (.0008)	(2.6) (.0012)	46.0 (.0216)
1984	8.4 (.0284)	4.2 (.0108)	1.9 (.0028)	.6 (.0009)	(.8) (.0012)	14.3 (.0208)
1985	7.3 (.0271)	3.7 (.0107)	1.6 (.0026)	.5 (.0008)	(.3) (.0005)	12.7 (.0207)
1986	10.1 (.0242)	5.2 (.0107)	2.2 (.0024)	.7 (.0008)	(.5) (.0006)	17.8 (.0198)
1987 - thereafter	11.9 (.0270)	5.5 (.0107)	2.5 (.0026)	.8 (.0008)	----- -----	20.7 (.0217)

Source: FEIS, Table L-17, L-11 and L-12. Income per employee for columns 4 - 7 are based on total WIPP-related employment in Table V.3.

TABLE V.6

ESTIMATES FOR WIPP-RELATED CHANGES IN PERSONAL INCOME

YEAR	BASED ON THIS STUDY'S EMPLOYMENT ESTIMATES*	FROM THE FEIS**
	(Millions of 1979 Dollars)	
1980	$ 3.46	$ 3.60
1981	16.84	16.00
1982	55.68	47.10
1983	64.56	46.00
1984	17.37	14.30
1985	15.59	12.70
1986	25.28	17.80
Annually during Operations Phase	23.46	20.70

*Source: Total employment, Table V.3, multiplied times net personal income per employee, column 7 of Table V.6.

**Source: FEIS, Table L-17

C. Labor Supply and Population Changes

Analyses in section B have been built around the increased demand for new employees associated with the WIPP project. The next logical step in these analyses involves an inquiry as to who fills these WIPP-related jobs and the implications for the Eddy-Lea county area of alternative responses to this inquiry. The new jobs created, directly or indirectly, as a result of the WIPP will be filled from three sources: local residents, individuals that re-locate in the two-county area (in-migrants) and individuals living outside the two-county area that commute to the area on a daily or weekly basis. Each of these sources for employees are considered in sub-section C.1; implications for population changes are discussed in sub-section C.2. Other demographic considerations are taken up in sub-section C.3.

C.1. Labor Supply. Our analysis of labor supplies begins with a consideration of the potential employment of individuals that now reside in Eddy and Lea counties and those who would reside in the area in the absence of the WIPP. This "without WIPP" population is referred to as the "Baseline Population." Estimates for baseline population are given in column 2 of V.7. Two alternative scenarios are used concerning the percentage of the baseline population that participates in the labor force (i.e., the percent that is willing and able to work)--this percentage is referred to as the "labor force participation rate", which is currently 46.14% in the Eddy-Lea county area. Under Scenario I (column 3 of Table V.7), it is assumed that the baseline population's response to increased WIPP-related job opportunities is manifested by an increased participation rate -- i.e., more housewives, children, etc., enter the labor market. This assumption reflects the results of analyses conducted in this research concerning the

TABLE V.7

BASELINE POPULATION AND TWO SCENARIOS

FOR THE BASELINE LABOR FORCE

IN EDDY AND LEA COUNTIES

YEAR	POPULATION[1/]	BASELINE LABOR FORCE: SCENARIO I[2/]	SCENARIO II[3/]
1980	108,000	50,828	49,831
1981	110,200	51,863	50,846
1982	112,800	53,087	52,046
1983	114,500	53,887	52,830
1984	116,700	54,922	53,845
1985	119,000	56,005	54,907
1986	121,600	57,228	56,106
1987	124,100	57,260	57,260

[1/] Source: FEIS, Table L-14, p. L-49

[2/] Current participation rate (.4614) increased by 2% to .4706, applied to baseline population.

[3/] Current participation rate (.4614) applied to baseline population.

historical behavior of labor force participation rates in other New Mexico counties during periods of increased construction activity.* There seems to be little question but that participation rates have increased during sharp upturns in the level of economic activity in these counties; existing data do not allow for prior estimates for such increases, however. Thus, in an effort to capture this potentially important response to WIPP-created conditions, the labor force participation rate for the baseline population is arbitrarily assumed to increase by 2% -- from .4614 to .4706 -- during the WIPP's construction phase. The pre-WIPP rate of .4614 is assumed to obtain during the more stable operation phase of the WIPP.

Scenario II estimates for the baseline labor force, column 4 of Table V.7, are based on the assumption that the labor force participation rate is unaffected by the WIPP -- it remains at .4614.

Underlying the estimates for baseline population is some level of employment that is unrelated to the WIPP. Given a current unemployment rate in the two-county area of some 4%, it is assumed here that 96% of the scenario II labor force would fill jobs associated with baseline increases in the level of economic activity. During the WIPP construction phase, however, the baseline unemployment rate is assumed to fall to 3.5%. This means that, all else equal (with no change in participation rate), 0.5% of the scenario II labor force is assumed to be available for WIPP-related jobs as shown in column 3 of Table V.8. If, as is posited in scenario I, there is an increase in the participation rate, potential employment from the baseline population consists of 0.5% of the scenario II labor force plus 96.5% (maintaining a 3.5% unemployment

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* Counties included in these analyses are: San Juan, McKinley, Valencia, Eddy and Lea; see Resource Economics Program, University of New Mexico (1981).

TABLE V.8

POTENTIAL WIPP-RELATED EMPLOYMENT FROM THE BASELINE POPULATION:

SCENARIOS I AND II

	BASELINE LABOR FORCE AVAILABLE FOR WIPP-RELATED JOBS[1/]		WIPP-RELATED JOBS WHICH COULD BE FILLED BY BASELINE POPULATION		
YEAR	SCENARIO I	SCENARIO II	DIRECT[2/]	INDIRECT[3/]	TOTAL
1980	1,211	249	26	41	67
1981	1,235	254	121	237	358
1982	1,265	260	407	808	1,215
1983	1,284	264	442	1,023	1,465
1984	1,308	269	144	271	415
1985	1,335	275	132	243	378
1986	1,364	281	209	432	641
1987	286[4/]	286[4/]	221	322	543

[1/] 96% of the Scenario II labor force (Table V.7) is assumed to hold jobs unrelated to the WIPP. Baseline labor force available for WIPP-related jobs is then .5% of the Scenario II labor force under Scenario II conditions (column 3) and, for Scenario I: .5% of Scenario II labor force plus 96.5% of the difference between the Scenario I and Scenario II labor force given in Table V.7.

[2/] 46.1% of above-ground construction jobs (Table V.2), 39.4% of below-ground construction jobs and 50.2% of management/design jobs (see FEIS, pp. L-41 through L-43).

[3/] 50.2% of indirect jobs (Table V.2).

[4/] 0.5% of the 1987 baseline labor force in Table V.7.

rate) of the increased labor force. Thus, referring to column 2 of Table V.8, the number of baseline residents available for WIPP-related jobs in 1983 under scenario I is: (i) 0.5% of 52,830 (96% of this labor force holds jobs unrelated to the WIPP), or 264; plus (ii) 96.5% of the increased labor force (53,887 - 52,830 = 1,057), or 1,020 for a total of 1,284. As the operations phase begins (1987), labor market conditions are assumed to stabilize at pre-WIPP levels; i.e., the participation rate returns to .4614. For scenarios I and II, however, the unemployment rate of 3.5% is assumed to continue.

It is important that one appreciate the implications of these two scenarios concerning the two-county labor force. If the local labor market is responsive to changes in labor market conditions, and of course if skills of new labor force participants will in some sense match those required for direct and/or indirect WIPP-related jobs, the local labor force may absorb the bulk of WIPP-related jobs in all but peak construction years and during the operations phase; this is essentially the case represented by scenario I. Obviously, impacts associated with in-migrating workers would be minimal under these conditions. Of course, the less responsive is the local labor force, and/or the greater the divergence between skills demanded in new direct and indirect jobs and those of the local labor force, the greater is the number of jobs which will be filled by non-local workers and the greater is the potential for socio-economic impacts. An unresponsive (or unskilled) local labor force is implied by scenario II.

Data simply do not exist that would allow for an assessment of skills held by individuals who are not now in the labor force in Eddy and Lea counties. Such assessments could be very useful in terms of efforts to match jobs with available baseline workers, including income effects that may attend job switching from lower paying to higher paying jobs. In the absence of such analyses, however, it seems reasonable to expect that skills of the local labor force would be relatively more applicable to secondary types of jobs than to jobs at the WIPP site.* In this regard, the following FEIS assumptions concerning the proportion of various jobs held by local workers would seem palatable (see FEIS, pp. L-41 through L-43):

Job Type	% Held by Local Workers
A. Construction Phase:	
Above-ground construction	46.1%
Below-ground construction	39.4
Management/Design	50.2
B. Operations Phase:	
All Jobs	50.2%

In the absence of better data, the FEIS proportions given above are applied to the WIPP-related jobs given in Tables V.2 and V.3 to the end of estimating the number of jobs which could be filled by local workers; these estimates are reported in columns 4-6 of Table V.8.

The difference between the number of WIPP-related jobs available and those which can be filled by local workers represents jobs to be filled by non-local workers; to this number must be added those jobs which <u>could</u> be filled by local workers but insufficient local workers exist. Those data--estimates for the number of jobs to be filled by non-local workers--are given in Table V.9. Comparable estimates from the FEIS are given in column 5 of Table V.9.

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*This follows from the expectation that baseline workers with mining and construction skills will already be employed.

Jobs to be filled by non-local workers identified in Table V.9 are assumed to be filled by workers from outside of the two-county area. These non-local workers will either relocate in the Eddy-Lea county area or will simply commute to the area on a weekly or monthly basis. Data from the Construction Workers Profile suggest that as many as 25% of non-local construction workers may commute to areas with ongoing construction projects.* This figure may be somewhat high; the FEIS generally assumes 13-15% of above and below ground workers as being in the commuting, non-local category (FEIS, Table L-1). In terms of the percent of total (direct and indirect) WIPP-related workers that commutes to the area during the WIPP construction period, the FEIS uses an estimate of roughly 9%**; since non-locals constitute more than half of the FEIS labor supply***, commuters then constitute something more than 18% of FEIS non-local workers. Since we wish to use FEIS estimates as a basis for estimating lower bounds for WIPP-related impacts, a lower rate for commuters (which will then imply more in-migrading families) will be used in this study; therefore, a 15% rate for commuters is used here. The resulting estimates for jobs to be filled by non-local workers who are likely to relocate in the Eddy-Lea county area are given in Table V.10.

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*75.4% of workers are married; 33.3% of married workers are reported as being without families present, Old West Regional Commission, [1975, pp. 21 and 22].

**FEIS, Table L-2; commuters associated with above-ground construction range from 7.5% to 9% between 1980 and 1986; the range for below-ground construction is 10% to 10.6%.

***53.9% for above-ground construction, 60.6% for below-ground construction and 49.8% for non-construction workers (FEIS, p. L-41).

TABLE V.9

WIPP-RELATED JOBS TO BE FILLED BY NON-LOCAL WORKERS

YEAR	WIPP-RELATED JOBS FILLED BY NON-LOCALS DUE TO SKILLS CONSIDERATIONS[1]	TOTAL WIPP-RELATED JOBS FILLED BY NON-LOCAL WORKERS: SCENARIO I[2]	SCENARIO II[3]	FEIS[4]
1980	79	79	79	80
1981	397	397	501	430
1982	1,316	1,316	2,271	1,458
1983	1,524	1,705	2,725	1,693
1984	420	420	566	536
1985	375	375	478	466
1986	636	636	996	654
1987 - thereafter	538	795	795	332

1/ Total WIPP-related Employment (Table V.3) less column 6 of Table V.8.

2/ From Table V.8, column 6 less column 2 (if positive) plus column 1 of this table.

3/ From Table V.8, column 6 less column 3 (if positive) plus column 1 of this table.

4/ Approximation using a 52% ratio -- a weighted average for 1981 -- to total WIPP-related jobs (see Table V.4 above and pp. L-40 to L-42 in the FEIS).

TABLE V.10

NON-LOCAL WORKERS THAT WILL RESIDE

IN THE TWO-COUNTY AREA

YEAR	NUMBER OF NON-LOCAL WORKERS THAT WILL RESIDE IN EDDY-LEA COUNTIES: SENARIO I	SCENARIO II
1980	67	67
1981	337	426
1982	1,119	1,930
1983	1,449	2,316
1984	357	481
1985	319	406
1986	541	847
1987 - thereafter	676	676

Source: 85% of non-local workers given in Table V.9

C.2. Population Effects. Estimates for in-migrating, resident workers, given in Table V.10, may be used as a basis for estimating family units, population and number of school-aged children in the following manner. First, the Construction Workers Profile (CWP) [1975] provides estimates for the number of workers per family which may be applied to our estimates for in-migrating WIPP construction workers (1.31) and indirect workers (1.35, see footnote 2 in Table V. 11). Estimates for the number of non-local workers that fill direct and indirect jobs are given in columns 2 - 5 in Table V.11. Dividing direct non-local workers by 1.31 and indirect non-local workers by 1.35 yields estimates for the number of family units associated with the in-migrating labor force (columns 6 and 7 in Table V.11)

The average family size for construction workers is estimated at 2.28 in the CWP*; this factor will be used for direct WIPP jobs during the construction phase. For indirect workers and all workers during the operations phase, one can do little better than use regional estimates for average family size for non-local workers. Here, average family size for western households of 2.72** is used for non-local, indirect workers. Average family size measures are multiplied by direct and indirect non-local family units (Table V.11) to derive the population estimates given in Table V.12.

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*See FEIS, p. L-42.

**U. S. Department of Commerce [1979, Table 59, p. 45].

TABLE V.11

CALCULATION OF WORKERS PER FAMILY AND FAMILY UNITS FOR RESIDENT IN-MIGRANTS

YEAR	DIRECT JOBS HELD BY NON-LOCAL WORKERS[1/]		INDIRECT JOBS HELD BY NON-LOCAL WORKERS[1/]		NUMBER OF IN-MIGRATING FAMILY UNITS[2/] (direct workers/household are in parentheses)	
	SCENARIO I	SCENARIO II	SCENARIO I	SCENARIO II	SCENARIO I	SCENARIO II
1980	39	39	40	40	59 (30)	59 (30)
1981	161	200	236	301	298 (123)	376 (153)
1982	515	863	801	1,408	986 (393)	1,702 (659)
1983	567	1,138	891	1,834	1,093 (433)	2,227 (869)
1984	152	204	268	362	315 (116)	424 (156)
1985	134	171	241	307	281 (102)	358 (131)
1986	208	326	428	670	476 (159)	745 (249)
1987	324	471	324	471	596 (247)	596 (360)

[1/] Tables V.2 and V.8: deficit local workers for jobs which could be held by locals (Table V.8) are allocated to non-locals in the same proportion as direct and indirect jobs to total WIPP-related jobs.

[2/] From the CWP (p. 43), in the "direct workers" category (in-migrants) 12% have 2 workers/family, 9.3% have 3 workers/family. For newcomers filling indirect jobs, 25% have 2 workers/family, 4.9% have 3 workers/family. This implies 1.31 workers/family for direct workers and 1.35 workers/family for indirect workers. Thus, columns 6 and 7 are calculated by dividing the number of direct and indirect by 1.31 and 1.35, respectively, and summing the two.

TABLE V.12

ESTIMATED POPULATION CHANGES ATTRIBUTABLE TO THE WIPP

YEAR	POPULATION IN TWO-COUNTY AREA -- IN ADDITION TO BASELINE POPULATION -- ATTRIBUTABLE TO THE WIPP		
	SCENARIO I[1]	SCENARIO II[1]	FEIS[2]
1980	147	147	135
1981	756	955	610
1982	2,509	4,339	1,910
1983	2,782	5,675	2,240
1984	806	1,085	1,050
1985	719	916	660
1986	1,225	1,917	890
1987 - thereafter	1,512	1,463	980

[1] Direct and indirect households (columns 6 and 7 in Table V.11) are multiplied by average household size of 2.28 and 2.72, respectively.

[2] FEIS, Tables L-14, M-1 and M-2.

C.3. Geographic Dispersion of Population. In terms of estimating impacts that may attend population changes on the order of magnitudes suggested by data in Table V.12, it is important to have some notion as to the geographic dispersion of these populations. Two location scenarios were developed as a part of this research. The method used for developing these location scenarios was as follows. First, based on the current availability of housing units in Hobbs, Carlsbad, Loving and the remainder of Eddy and Lea counties, estimated population was dispersed in these localities in proportion to existing local capacities to house new family units. Second, these initial estimates were reviewed with planning officials in the above named localities and revisions were made. The result was the following alternative location scenarios.

PERCENT OF IN-MIGRATING POPULATION LOCATED IN:

SCENARIO:	CARLSBAD	LOVING	REMAINDER OF EDDY COUNTY	HOBBS	REMAINDER OF LEA COUNTY
A	65%	10%	5%	15%	5%
B	52%	3%	5%	35%	5%
(FEIS-A)	(84%)	(4.5%)	(6%)	(0)	(5.5%)
(FEIS-B)	(54%)	(0)	(4%)	(36%)	(6%)

Also given above are location scenarios used in the FEIS. The only major differences in scenarios used are, first, higher estimates for in-migration to Carlsbad in the FEIS Scenario A and lower estimates for in-migration to Loving in both of the FEIS location scenarios.

It must be noted that these population distributions (and, therefore, resulting impacts), as well as those used in the FEIS, are based on a particularly critical assumption, viz., that the new southward extension of U. S. Highway 62-180 to the WIPP site is constructed as proposed in the FEIS (p. 8.39). If this extension should not be built as a part of the WIPP project, almost 40 additional miles would be required for any commuting to Hobbs by WIPP workers. Resulting congestion effects in Carlsbad and Loving could then result in impacts that would be much more severe than those estimated here and in the FEIS. The construction of this highway extension can play an important role in terms of dispersing WIPP-related population impacts throughout the two-county area.

Location scenarios described above are applied to data given in Tables V.11 and V.12 to the end of deriving estimates for changes in population, family units and school-aged children (.85 school children per family unit) by locality. These data are given in Tables V.13 - V.16. Scenario I-A refers to the scenario I assumption as to the local labor force (Table V.8) and location scenario A; II-B refers to scenario II concerning the local labor force and location scenario B, etc.

Population effects, by location, as given in Tables V.13 - V.16 can be compared with those used in the FEIS by reference to Table V.17. Comparing, for example, scenario I-A (Table V.13) with the FEIS scenario 1 (Table V.17), population increases in Carlsbad during the peak construction years 1982 and 1983 are 1,631 and 1,808, respectively, as estimated here compared with 1,630 and 1,880, respectively, in the FEIS.*

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*Population for Eddy county in Table V.17 includes Carlsbad, in contrast with "remainder of Eddy County" used in Tables V.13 - V.16.

TABLE V.13

WIPP-INDUCED DEMOGRAPHIC CHANGES BY AREA IN EDDY AND LEA COUNTIES: SCENARIO I-A[1/]

YEAR	CARLSBAD POPULATION[2/]	CARLSBAD FAMILY UNITS[3/]	CARLSBAD SCHOOL AGED CHILDREN[4/]	LOVING POPULATION[2/]	LOVING FAMILY UNITS[3/]	LOVING SCHOOL AGED CHILDREN[4/]	REMAINDER OF EDDY COUNTY POPULATION[2/]	REMAINDER OF EDDY COUNTY FAMILY UNITS[3/]	REMAINDER OF EDDY COUNTY SCHOOL AGED CHILDREN[4/]
1980	96	38	33	15	6	5	7	3	3
1981	491	194	165	76	30	25	38	15	13
1982	1,631	641	545	251	99	84	125	49	42
1983	1,808	710	604	278	109	93	139	55	46
1984	524	205	174	81	32	27	40	16	13
1985	407	183	155	72	28	24	36	14	12
1986	796	309	263	123	48	40	61	24	20
1987 - thereafter	983	387	329	151	60	51	76	30	25

YEAR	HOBBS POPULATION[2/]	HOBBS FAMILY UNITS[3/]	HOBBS SCHOOL AGED CHILDREN[4/]	REMAINDER OF LEA COUNTY POPULATION[2/]	REMAINDER OF LEA COUNTY FAMILY UNITS[3/]	REMAINDER OF LEA COUNTY SCHOOL AGED CHILDREN[4/]
1980	22	9	8	7	3	3
1981	113	45	38	38	15	13
1982	376	148	126	125	49	42
1983	417	164	139	139	55	46
1984	121	47	40	40	16	13
1985	108	42	36	36	14	12
1986	184	71	61	61	24	20
1987 - thereafter	227	89	76	76	30	25

[1/] Scenario I-A uses scenario I assumptions concerning labor force participation rates and the following scenario for the dispersion of in-migrants:

Carlsbad	65%	Hobbs	15%
Loving	10%	Remainder of Lea County	5%
Remainder of Eddy County	5%		

[2/] Percentages in footnote 1 applied to scenario I population changes given in Table V.12.

[3/] Percentages in footnote 1 applied to scenario I family unit changes given in Table V.11

[4/] Assumes .85 school-aged children per family unit.

TABLE V.14

WIPP-INDUCED DEMOGRAPHIC CHANGES BY AREA IN EDDY AND LEA COUNTIES

SCENARIOS I-B [1/]

WIPP RELATED CHANGES IN:

	Carlsbad			Loving			Remainder of Eddy County			Hobbs			Remainder of Lea County		
Year	Population [2/]	Family Units [3/]	School Aged Children [4/]	Population [2/]	Family Units [3/]	School Aged Children [4/]	Population [2/]	Family Units [3/]	School Aged Children [4/]	Population [2/]	Family Units [3/]	School Aged Children [4/]	Population [2/]	Family Units [3/]	School Aged Children [4/]
1980	76	31	26	4	2	2	7	3	3	51	21	18	7	3	3
1981	393	155	132	23	9	8	38	15	13	265	104	88	38	15	13
1982	1305	513	436	75	30	26	125	49	42	878	345	293	125	49	42
1983	1447	568	483	83	33	28	139	55	46	974	383	326	139	55	46
1984	419	164	139	24	9	8	40	16	13	282	110	94	40	16	13
1985	374	146	124	22	8	7	36	14	12	252	76	65	36	14	12
1986	637	248	211	37	14	12	61	24	20	429	167	142	61	24	20
1987 - Thereafter	786	310	264	45	18	15	76	30	25	529	209	178	76	30	25

[1/] Scenario I-B uses Scenario I assumptions concerning labor force participation rate and Scenario B dispersion of in-migrants.

[2/] Percentages in Footnote 1 applied to Scenario 1 population changes given in Table V.12 and rounded to the nearest unit.

[3/] Percentages in Footnote 1 applied to Scenario 1 family units changes given in Table V.11 and rounded to the nearest unit.

[4/] Assume .85 school aged children per family unit rounded to the nearest unit.

TABLE V.15

WIPP-INDUCED DEMOGRAPHIC CHANGES BY AREA IN EDDY AND LEA COUNTIES

SCENARIOS II-A 1/

WIPP RELATED CHANGES IN:

	Carlsbad			Loving			Remainder of Eddy County			Hobbs			Remainder of Lea County		
Year	Population 2/	Family Units 3/	School Aged Children 4/	Population 2/	Family Units 3/	School Aged Children 4/	Population 2/	Family Units 3/	School Aged Children 4/	Population 2/	Family Units 3/	School Aged Children 4/	Population 2/	Family Units 3/	School Aged Children 4/
1980	96	38	33	15	6	5	7	3	3	22	9	8	7	3	3
1981	621	246	209	96	38	32	48	19	16	143	57	48	48	19	16
1982	2820	1106	940	434	170	145	217	85	72	651	255	217	217	85	72
1983	3689	1448	1230	568	223	191	284	111	95	851	334	287	284	111	95
1984	705	276	234	109	42	36	54	21	18	163	64	54	54	64	54
1985	594	233	198	92	36	30	46	18	15	137	54	46	46	18	15
1986	1247	484	412	192	75	33	96	37	32	287	112	56	96	37	32
1987 - Thereafter	951	387	330	146	60	51	73	30	25	219	89	76	73	30	25

1/ Scenario II-A uses Scenario II assumption concerning labor force participation rates and Scenario concerning the dispersion of in-migrants.

2/ Percentages of Scenario A applied to Scenario II population changes given in Table V.12 rounded to the nearest unit.

3/ Percentages in Scenario A applied to Scenario II family units changes given in Table V.11 rounded to the nearest unit.

4/ Assume .85 school aged children per family unit.

TABLE V.16

WIPP-INDUCED DEMOGRAPHIC CHANGES BY AREA IN EDDY AND LEA COUNTIES

SCENARIOS II-B[1/]

WIPP RELATED CHANGES IN:

	Carlsbad			Loving			Remainder of Eddy County			Hobbs			Remainder of Lea County		
Year	Population[2/]	Family Units[3/]	School Aged Children[4/]	Population[2/]	Family Units[3/]	School Aged Children[4/]	Population[2/]	Family Units[3/]	School Aged Children[4/]	Population[2/]	Family Units[3/]	School Aged Children[4/]	Population[2/]	Family Units[3/]	School Aged Children[4/]
1980	76	31	26	4	2	2	7	3	3	51	21	18	7	3	3
1981	497	196	166	27	11	10	48	19	16	334	131	112	48	19	16
1982	2256	885	752	130	14	12	217	85	72	1519	596	506	217	85	72
1983	2951	1158	984	170	67	57	284	111	95	1986	779	663	284	111	95
1984	564	220	187	33	13	11	54	21	18	380	148	128	54	21	18
1985	374	186	158	22	11	9	46	18	15	252	125	107	46	18	15
1986	997	248	210	57	22	19	96	37	32	671	261	222	96	37	32
1987 - Thereafter	760	310	263	44	18	15	73	30	25	512	209	177	73	30	25

[1/] Scenario II-B uses Scenario II assumptions concerning labor force participation rates and Scenario B concerning the dispersion of in-migrants.

[2/] Percentages of Scenario B applied to population Scenario II changes given in Table V.12 rounded to the nearest unit.

[3/] Percentages in Scenario B applied to Scenario II Family Units changes given in Table V.11 rounded to the nearest unit.

[4/] Assure .85 school aged children per family unit rounded to the nearest unit.

TABLE V.17

ESTIMATED POPULATION EFFECTS OF THE WIPP FROM THE FEIS

POPULATION INCREASES DUE TO WIPP:*

YEAR	EDDY COUNTY 1	EDDY COUNTY 2	CARLSBAD 1	CARLSBAD 2	LOVING 1	LOVING 2	LEA COUNTY 1	LEA COUNTY 2	HOBBS 1	HOBBS 2	TOTAL
1980	125	70	100	60	10	--	10	50	--	40	135
1981	580	350	510	330	30	--	30	250	--	220	610
1982	1,830	1,110	1,630	1,030	90	--	80	800	--	690	1,910
1983	2,120	1,300	1,880	570	100	--	120	940	--	800	2,240
1984	980	610	870	360	40	--	70	440	--	380	1,050
1985	630	380	560	480	30	--	30	280	--	240	660
1986	850	520	760	530	40	--	40	370	--	320	890
1987 - thereafter	940	570	830	530	50	--	40	440	--	350	980

*Tables L-14, M-1 and M-2 in FEIS; totals for Eddy and Lea Counties for scenarios 1 and 2 are not the same, in some cases, apparently due to rounding errors.

TABLE V.18

POPULATION CHARACTERISTICS IN THE STATE,
EDDY COUNTY AND LEA COUNTY, 1970

	EDDY COUNTY	LEA COUNTY	STATE OF NEW MEXICO
Age Distribution:			
Under 18	37.8%	40.0%	40.0%
18 - 44	31.5	35.8	35.5
45 - 64	21.8	19.7	17.5
65 and over	8.9	5.4	6.9
Racial Distribution:			
White	97.1%	93.7%	90.1%
Negro	2.2	5.3	1.9
Indian	0.2	0.4	7.2
Other	0.5	0.7	0.8
Percent of Population Spanish Surname or Spanish Language:	30.5%	12.5%	40.1%
(Carlsbad)	(41.6%)		
(Hobbs)		(11.3%)	

Source: Bureau of Business and Economic Research [1979 - 80, pp. 101, 103, 106 and 107].

C.4. Other Population Characteristics. In concluding this section, two additional points are raised which are relevant for later discussions concerning population impacts in the two-county area. The first relates to the characteristics of the in-migrating population estimated above. Population characteristics in Eddy and Lea counties in 1970 are given in Table V.18. Age distribution of the population in Lea County is shown to be very similiar to that for the State; the higher percentage of the population 65 and over in Eddy county undoubtedly reflects the area's development as a center for retirees. In Eddy and Lea counties, white population accounts for a higher proportion of the total population than in the State of New Mexico. Of the white population, there are relatively fewer individuals with spanish surname or language in Eddy and, particularly Lea counties than in the State. In Carlsbad, however, Spanish surname/language population as a percent of total population is roughly the same as in the State.

More relevant for the impacts of interest in later sections, however, are data given in Table V.19. In Eddy County, 12.6% of the Spanish surnamed/language civilian labor force was unemployed in 1976, compared with the County's general unemployment rate of 6.7% — 36% of those unemployed in the county were with Spanish surname or language. In Lea County, the Spanish surname/language population were unemployed in rough proportion to population. According to the 1970 census, the labor force participation rate for Spanish surnamed population was lower than that for the rest of the population — 24.7% compared with 52.3%. Thus, the Spanish surname/language population constitutes (i) a good part of the unemployed available for WIPP-related jobs and (ii) a logical source for increased local workers that result from scenario I's higher labor force participation rate. Thus, in relative terms, the potential exists for the Spanish surname/language

TABLE V.19

LABOR FORCE DATA FOR EDDY COUNTY,
LEA COUNTY AND THE STATE, 1976

AREA	PER CENT OF CIVILIAN LABOR FORCE THAT IS EMPLOYED: TOTAL, ALL WORKERS	SPANISH SURNAMED	SPANISH SURNAMED EMPLOYED AS A PER CENT OF TOTAL EMPLOYMENT
State	90.8%	88.4%	26%
Eddy County	93.3	87.4	17.9
Lea County	96.0	90.9	7.2

AREA	PER CENT OF CIVILIAN LABOR FORCE THAT IS UNEMPLOYED: TOTAL, ALL INDIVIDUALS	SPANISH SURNAMED	SPANISH SURNAMED UNEMPLOYED AS A PER CENT OF TOTAL UNEMPLOYED
State	9.2%	11.6%	33.9%
Eddy County	6.7	12.6	36.5
Lea County	4.3	9.1	17.0

Source: Bureau of Business and Economic Research (1979-80, pp. 38-39).

population to reap relatively large employment benefits from WIPP-related job opportunities, provided, of course, that their skills are commensurate with those required for direct or indirect employment opportunities.

A number of changes in population characteristics in the two county area have undoubtedly occurred since 1970; one must await 1980 census data for updating the characteristics of the baseline population. In terms of the in-migrating population, it is impossible to do little more than speculate as to the characteristics of this group of people at this point in time. Such estimates would require numerous data that are not now available, including the following: racial - ethnic composition of construction workers in New Mexico and, most likely, western Texas; contractual arrangements for WIPP construction (location of the contracting firm, covenants concerning the hiring/training of New Mexico workers, etc.); and job market conditons in the Southwest at the time that WIPP construction is initiated.

The second point which deserves mention here concerns unemployment in the two county area during the WIPP construction phase. Recall that in estimating the baseline labor force that was available for direct and indirect WIPP-related jobs (Table V.8), a 3.5% unemployment rate was assumed. This 3.5% may be viewed as akin to "structural" unemployment, reflecting, however crudely, an assumed persistent mismatch between skills demanded and supplied in the local labor market. In many cases, however, local workers "available" for WIPP-related jobs will exceed jobs which can be filled by local workers (compare columns 2 and 3 with column 6 in Table V.8); thus, *ex post* unemployment in the baseline labor force will exceed 3.5%.

Unemployment and unemployment rates for the baseline labor force which are consistent with employment estimates developed above in Tables V.7

through V.9 are given in Table V.20. Referring to Table V.20, baseline unemployment remains at the 3.5% level except in the first year of construction under scenario II (the labor force participation remains at pre-WIPP levels). For scenario I, however, ex post unemployment rates are close to or above 5% in five of the seven years of WIPP construction activity as local households provide addditional job-seekers, part of which are unable to find employment.

There is a second potential source for unemployment, however. Implicit to the employment and population estimates for non-local, in-migrating workers given above is the assumption that all in-migrating families are employed. Note, from Tables V.9 - V.17, that when job availability falls in the fifth and sixth years of construction, it is implicitly assumed that the then unemployed in-migrants leave the two county area and then return in years seven and eight when the demand for workers increases. It is, of course, highly unlikely that in-migrating families would be so highly mobile and, therefore, higher unemployment rates would likely obtain during the lull in job availabilities that occurs in the fifth and sixth years of the project. While no basis exists for estimating just how unemployment might be affected by these considerations, the potential for such effects should be recognized by local planners.

Still another potential source for increases in unemployed persons in the two county area is the in-migration of families in search of WIPP-related jobs who do not immediately find work. It is certainly plausible to expect that job seekers from outside the two county area, aware of the WIPP construction activity in the Carlsbad area, may migrate to the area with hopes of finding work. Given the likely lag between the time of their arrival in the area and their placement in jobs -- if indeed such placement takes place -- unemployment levels would increase, all else equal.

TABLE V.20

IMPLIED UNEMPLOYMENT IN BASELINE POPULATION: 1980 -1987

YEAR	IMPLIED UNEMPLOYMENT IN BASELINE POPULATION:[1/]		IMPLIED UNEMPLOYMENT RATE:[2/]	
	SCENARIO I	SCENARIO II	SCENARIO I	SCENARIO II
1980	2,923	1,926	5.75%	3.87%
1981	2,692	1,780	5.19	3.50
1982	1,908	1,822	3.59	3.50
1983	1,886	1,849	3.50	3.50
1984	2,815	1,885	5.13	3.50
1985	2,917	1,922	5.21	3.50
1986	2,726	1,964	4.76	3.50
1987	2,004	2,004	3.50	3.50

[1/] 3.5% of scenario I and II baseline labor force (Table V.7) plus difference (if positive) between "Baseline population" available for WIPP jobs (columns 2 and 3 of Table V.8) and jobs available for baseline population (column 6 of Table V.8).

[2/] Column 1 or 2 divided by labor force (Table V.7).

Unemployment effects from unemployed local workers/and or unemployed in-migrants are suggested from data given in Table V.21. McKinley, San Juan and Valencia counties experienced sharp increases in construction activity during the 1970-78 period; during the five year period 1974 - 1978, total employment increased by 50%, 61% and 52%, respectively. Despite this relatively rapid growth in employment, however, unemployment rates remained relatively high during this period and, in fact, unemployment rates rose during some periods of rising total employment (e.g., 1974-1976 in McKinley county, 1974-1975 in San Juan and Valencia counties).

Data are not available which would allow for the determination of the composition (local and non-local) of the unemployed in these counties. Therefore, one is unable to develop meaningful projections for these sources of unemployment which may well attend rising employment levels as a result of the WIPP. Hopefully, however, these discussions may serve to alert local planners to the potential for rising unemployment rates attending rising employment rates during the WIPP's construction phase. This potential will be considered in a necessarily crude manner in analyses of population impacts given below.

TABLE V.21

EMPLOYMENT LEVELS AND UNEMPLOYMENT RATES IN McKINLEY, SAN JUAN AND VALENCIA COUNTIES: 1970 - 1978

County/Item	1970	1971	1972	1973	Year 1974	1975	1976	1977	1978
McKinley:									
Employment (000)	11.4	11.6	11.8	12.5	12.9	13.8	15.4	17.4	19.1
Unemployment Rate	8.5%	9.7%	7.9%	7.7%	7.2%	7.4%	7.6%	7.0%	5.9%
Unemployment (000)	1.05	1.01	1.02	1.04	1.00	1.09	1.27	1.30	1.19
San Juan:									
Employment (000)	14.8	15.9	17.2	18.6	19.9	21.7	23.2	29.0	32.6
Unemployment Rate	11.7%	11.0%	11.0%	10.7%	10.7%	12.2%	10.3%	7.4%	6.4%
Unemployment (000)	1.97	1.72	2.12	2.22	2.37	3.01	2.65	2.33	2.23
Valencia:									
Employment (000)	12.8	13.0	12.6	14.6	14.0	15.4	16.4	19.2	21.3
Unemployment Rate	6.8%	7.8%	7.4%	8.0%	8.8%	9.6%	8.8%	7.4%	5.7%
Unemployment (000)	.87	1.01	1.01	1.74	1.36	1.64	1.62	1.53	1.29

Source: Employment Security Commission of New Mexico Employment Service Division Table A - Civilian Labor Force, Employment, Unemployment Rate, 1970 - 1978

D. Impacts on Housing Markets

Given the estimates for WIPP-induced in-migration of families (family units, Tables V.13 - V.16) to the two county area described above, an immediate concern relates to the capacity of the region to absorb these increases in population. One aspect of the region's "absorptive capacity" is the availability of housing to serve the needs of the in-migrating families.

Estimates for housing demands by in-migrating families in Carlsbad, Loving, the remainder of Eddy County, Hobbs and the remainder of Lea County are given for each participation rate-location scenario in Tables V.22 - V.26. Total housing units given in these tables are based on estimates for family units. The breakdown of required housing units by type of housing is based on the average pattern of housing used by construction workers as reported in the CWP (1975) (also, see Adcock [Oct., 1980, p. 3 - 28]). This breakdown of housing units demanded by in-migrating families must be viewed as simply suggestive housing patterns; average housing-use patterns reported in the CWP reflect the availability of the different housing types in particular areas in Wyoming and Colorado and may be quite different from conditions that exist in Eddy and Lea Counties.

Of course, the magnitude and implications of WIPP-related housing demand will depend upon such things as the responsiveness of the local labor force and, therefore the extent of in-migration (our scenarios I and II) and location patterns (our scenarios A and B). The relevance of these considerations in terms of potential impacts are seen by comparing, e.g., for Carlsbad (Table V.22), the low housing scenario* (scenario I-B) with the high population

*Scenario I-B assumes a 2% increase in the baseline labor force participation rate and relatively small percentages for in-migrants locating in Carlsbad.

Table V.22

WIPP-RELATED INCREASES IN HOUSING DEMAND:
CARLSBAD

Scenario/ Housing Type	1980	1981	1982	1983	1984	1985	1986	1987 - thereafter
				YEAR				
Scenario I-A:								
Total	38	194	641	710	205	183	309	387
Permanent Single Family	12.5	64.0	211.5	234.3	67.7	60.4	102.0	127.7
Permanent Multifamily	4.2	21.3	70.5	78.1	22.6	20.1	34.0	42.6
Mobile Homes And Others	21.3	108.6	359.0	397.6	114.8	102.5	173.0	216.7
Scenario I-B:								
Total	31	155	513	568	164	146	248	310
Permanent Single Family	10.3	51.2	169.3	187.4	54.1	48.2	81.8	102.3
Permanent Multifamily	3.4	17.1	56.4	52.5	18.0	16.1	27.3	34.1
Mobile Homes And Others	17.4	86.8	287.3	318.1	91.8	81.8	130.9	173.6
Scenario II-A:								
Total	38	246	1,106	1,448	276	233	484	387
Permanent Single Family	12.5	81.2	365.0	477.8	91.1	76.9	159.7	127.7
Permanent Multifamily	4.2	27.1	121.7	159.3	30.4	25.6	53.2	42.6
Mobile Homes And Others	21.3	137.8	614.4	810.9	154.6	130.5	271.0	216.7
Scenario II-B:								
Total	31	196	885	1.158	220	186	248	310
Permanent Single Family	10.3	64.7	212.1	382.1	77.6	61.4	81.8	102.3
Permanent Multifamily	3.4	21.6	97.4	127.4	24.2	20.5	27.3	34.1
Mobile Homes And Others	17.4	109.8	495.6	684.5	123.2	104.2	138.9	173.6
FEIS:								
Scenario I	40	210	660	740	325	205	280	310

Source: Tables V.13-V.16; total housing demand allocated to housing types by: 33% Permanent Single Family; 11% Permanent Multifamily; and 56% Mobil Home and Others -- see FEIS [Table 9-35, p. 9-67].

TABLE V.23

WIPP-RELATED INCREASES IN HOUSING DEMAND:
LOVING

Scenario/ Housing Type	1980	1981	1982	1983	1984	1985	1986	1987 - thereafter
Scenario I-A:								
Total	6	30	66	109	32	28	48	60
Permanent Single Family	2	9.9	32.7	36.0	10.6	9.2	15.8	19.8
Permanent Multifamily	.7	3.3	10.9	12.0	3.5	3.1	5.3	6.6
Mobile Homes And Others	3.4	16.8	55.4	61	17.9	15.7	26.9	36.6
Scenario I-B:								
Total	2	9	30	33	9	8	14	18
Permanent Single Family	.7	3.0	9.9	10.9	3.0	2.6	4.6	5.9
Permanent Multifamily	.2	1.0	3.3	3.6	1.0	.9	1.5	2.0
Mobile Homes And Others	1.1	5.0	16.8	18.5	5.0	4.5	7.8	36.6
Scenario II-A:								
Total	6	38	110	223	42	36	75	60
Permanent Single Family	2	12.5	36.3	73.6	13.9	11.9	24.8	19.8
Permanent Multifamily	.7	3.6	12.1	24.5	4.1	4.0	8.3	6.6
Mobile Homes And Others	3.4	21.3	61.6	124.9	23.5	20.2	42.0	36.6
Scenario II-B:								
Total	2	11	14	67	13	11	22	18
Permanent Single Family	.7	3.6	4.6	22.1	4.3	3.6	7.3	5.9
Permanent Multifamily	.2	1.2	1.5	7.4	1.4	1.2	2.4	2.0
Mobile Homes And Others	1.1	6.2	7.8	37.5	7.3	6.2	12.3	10.1
FEIS:								
Scenario 1	3	12	38	41	16	11	16	17

Source: Tables V.13-16; total housing demand allocated to housing types by: 33% Permanent Single Family; 11% Permanent Multifamily; and 56% Mobil Home and Others -- FEIS [Table 9-37, p. 9-70].

TABLE V.24

WIPP-RELATED INCREASES IN HOUSING DEMAND
HOBBS

Scenario/ Housing Type	YEAR 1980	1981	1982	1983	1984	1985	1986	1987 - thereafter
Scenario I-A:								
Total	9	45	148	164	47	42	71	89
Permanent Single Family	3.0	14.9	48.8	54.1	15.5	13.9	23.4	29.4
Permanent Multifamily	1.0	5.0	16.3	18.0	5.2	4.6	7.8	9.8
Mobile Homes And Others	5.0	25.2	82.9	91.8	26.3	23.5	39.8	49.8
Scenario I-B:								
Total	2.1	104	345	383	110	76	167	209
Permanent Single Family	6.9	34.3	113.9	126.4	36.3	25.1	55.1	69.0
Permanent Multifamily	2.3	11.4	38.0	42.1	12.1	8.4	18.4	23.0
Mobile Homes And Others	11.8	58.2	193.2	214.5	61.6	93.5	93.5	117.0
Scenario II-A:								
Total	9	57	255	334	64	54	112	89
Permanent Single Family	3.0	18.8	84.2	110.2	21.1	17.8	37.0	29.4
Permanent Multifamily	1.0	6.3	28.1	36.7	7.0	5.9	12.3	9.8
Mobile Homes And Others	5.0	31.9	142.3	187.0	35.8	30.2	62.7	49.8
Scenario II-B								
Total	21	131	596	779	148	125	261	209
Permanent Single Family	6.9	43.2	196.7	257.1	48.9	41.3	86.3	69.0
Permanent Multifamily	2.3	14.41	65.6	85.7	16.3	13.8	28.7	23.0
Mobile Homes And Others	11.8	73.4	333.8	436.2	82.9	70.0	146.2	117.0
FEIS:								
Scenario 2	20	90	280	320	145	90	120	130

Source: Tables V.13 - V.16; total housing demand allocated to housing types by: 33% Permanent Single Family; 11% Permanent Multifamily; and 56% Mobil Home and Others -- FEIS [Table 9-39, p. 9-72].

TABLE V.25

WIPP-RELATED INCREASES IN HOUSING DEMAND:
REMAINDER OF EDDY COUNTY

Scenario/ Housing Type	YEAR 1980	1981	1982	1983	1984	1985	1986	1987 - thereafter
Scenario I-A:								
Total	3	15	49	55	16	14	24	30
Permanent Single Family	1.0	5.0	16.2	18.2	5.3	4.6	7.9	9.9
Permanent Multifamily	.3	1.7	5.4	6.1	1.8	1.5	2.6	3.3
Mobile Homes And Others	1.7	1.0	27.4	30.8	9.0	7.8	7.9	11.8
Scenario I-B:								
Total	3	15	49	55	16	14	24	30
Permanent Single Family	1.0	5.0	16.2	18.2	5.3	4.6	7.9	9.9
Permanent Multifamily	.3	1.7	5.4	6.1	1.8	1.5	2.6	3.3
Mobile Homes And Others	1.7	1.0	27.4	30.8	9.0	7.8	7.9	16.8
Scenario II-A:								
Total	3	19	85	111	64	18	37	30
Permanent Single Family	1.0	6.3	28.1	36.6	21.1	5.9	12.2	9.9
Permanent Multifamily	.3	2.1	9.4	12.2	7.0	2.0	4.1	3.3
Mobile Homes And Others	1.7	10.6	47.6	62.2	35.8	10.1	20.7	16.8
Scenario II-B:								
Total	3	19	85	111	64	18	37	30
Permanent Single Family	1.0	6.3	28.1	36.6	21.1	5.9	12.2	9.9
Permanent Multifamily	.3	2.1	9.4	12.2	7.0	2.0	4.1	3.3
Mobile Homes And Others	1.7	10.6	47.6	62.2	35.8	10.1	20.7	16.8

Source: Tables V.13 - V.16; total housing demand allocated to housing types by: 33% Permanent Single Family; 11% Permanent Multifamily; and 56% Mobil Home and Others.

TABLE V.26

WIPP-RELATED INCREASES IN HOUSING DEMAND:
REMAINDER OF LEA COUNTY

Scenario/ Housing Type	1980	1981	1982	1983	1984	1985	1986	1987 - thereafter
				YEAR				
Scenario I-A:								
Total	3	15	49	55	16	14	24	30
Permanent Single Family	1.0	5.0	16.2	18.2	5.3	4.6	7.9	9.9
Permanent Multifamily	.3	1.7	5.4	6.1	1.8	1.5	2.6	3.3
Mobile Homes And Others	1.7	1.0	27.4	30.8	9.0	7.8	7.9	11.8
Scenario I-B:								
Total	3	15	49	55	16	14	24	30
Permanent Single Family	1.0	5.0	16.2	18.2	5.3	4.6	7.9	9.9
Permanent Multifamily	.3	1.7	5.4	6.1	1.8	1.5	2.6	3.3
Mobile Homes And Others	1.7	1.0	27.4	30.8	9.0	7.8	7.9	16.8
Scenario II-A:								
Total	3	19	85	111	64	18	37	30
Permanent Single Family	1.0	6.3	28.1	36.6	21.1	5.9	12.2	9.9
Permanent Multifamily	.3	2.1	9.4	12.2	7.0	2.0	4.1	3.3
Mobile Homes And Others	1.7	10.6	47.6	62.2	35.8	10.1	20.7	16.8
Scenario II-B:								
Total	3	19	85	111	64	18	37	30
Permanent Single Family	1.0	6.3	28.1	36.6	21.1	5.9	12.2	9.9
Permanent Multifamily	.3	2.1	9.4	12.2	7.0	2.0	4.1	3.3
Mobile Homes And Others	1.7	10.6	47.6	62.2	35.8	10.1	20.7	16.8

Source: Tables V.13 - V.16; total housing demand allocated to housing types by: 33% Permanent Single Family; 11% Permanent Multifamily; and 56% Mobil Home and Others .

scenario* (scenario II-A). For these two scenarios, in-migrant demands for housing in Carlsbad ranges from 568 to 1,448 units in the peak construction year (1983). This wide range for the potential impact on local housing markets as a result of the WIPP is a striking example of the problems facing local planners as a result of uncertainty as discussed above in Chapter II.

Estimates for the availability of housing units to satisfy the demands described above -- the supply of housing -- are also subject to considerable uncertainty. Preliminary data from the 1980 census (Table V.27) suggest relatively high vacancy rates in Carlsbad (6.7%), Hobbs (10.3%) and the Loving area (15.7%). For a number of reasons, local officials reject these estimates as being much too high. A casual survey of housing units listed for sale or rent in Carlsbad and Hobbs (Sunday, January 27, 1980) resulted in data (Table V.28) which would tend to support the argument that the census estimates for vacancies are somewhat high. Further, the FEIS describes vacancy rates of but 1% in Carlsbad in 1979 and approximately 2% in Hobbs (end of 1978, FEIS, pp. H-35 and H-37); FEIS estimates for unoccupied housing units in Carlsbad, Hobbs, Loving are given in Table V.29.

Other than for the low housing demand scenarios, there would seem to be little question but that shortages in permanent single and/or multifamily housing units will occur in the two county area, particularly during the first four years of the WIPP's construction phase. There are a number of ways by which housing demands may be accomodated, however. The City of Carlsbad has annexed some 8,544 acres of land over recent years and, while zoning of

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*Scenario II-A assumes no change in the baseline labor force participation rate and relatively large percentages for in-migrants locations in Carlsbad.

TABLE V.27

PRELIMINARY POPULATION AND HOUSING

1980 CENSUS FOR LEA AND EDDY COUNTY AREA[1/]

	EDDY COUNTY	CARLSBAD DIVISION	CARLSBAD	LOVING DIVISION	LOVING	LEA COUNTY	HOBBS
HOUSING UNITS	17,889	11,681	9,744	652	449	19,941	12,279
VACANT UNITS	1,524	874	645	102	62	2,023	1,156
VACANCY RATE	8.7%	7.6%	6.7%	15.7%	13.9%	10.7%	10.3%
POPULATION	45,797	30,077	24,813	1,940	134	49,978	29,636
POPULATION/ RESIDENCE	2.83	2.8	2.73	3.55	3.5	2.95	2.91

[1/] Housing Units and Population are probably underestimated and Vacancy Rate is over estimated. Final results are not expected until January 1, 1981.

SOURCE: Coral Robarts, New Mexico State Planning Office.

TABLE V.28

RENTAL AVAILABILITY AS OF JANUARY 27, 1980

IN CARLSBAD AND HOBBS

	HOBBS	CARLSBAD
Apartments Furnished	6+ [1]	7
Apartments Unfurnished	8+	6+
Mobil Homes	9	2
Mobil Home Sites	7+	10+
Homes Furnished	7	0
Homes Unfurnished	14	4
Rooms	2	0
Homes for Sale	25	50

[1] An advertisement for an apartment in a complex and a mobile home site in a trailer park can represent more than one vacancy.

SOURCE: Daily News, Hobbs, New Mexico, Sunday, January 27, 1980.
Current Argus, Carlsbad, New Mexico, Sunday, January 27, 1980.
Multiple Listing, Real Estate Bureau

TABLE V.29

UNOCCUPIED HOUSING UNITS IN CARLSBAD, HOBBS AND LOVING: 1978

	UNOCCUPIED UNITS IN 1978 (1979 FOR LOVING):		
TYPE OF HOUSING:	CARLSBAD	LOVING	HOBBS
All Units	153	21	226
Single Family Units	122	21	174
Multifamily Units	17	--	26
Mobile Homes	14	--	28

Source: FEIS [1980, pp. H-36 to H-38].

this area remains an open issue, such land may be available for the development of facilities for recreation vehicles and mobile homes.* There are now some 100 camping sites with utility hook-ups near Carlsbad and an additional 150 sites within ten miles from Carlsbad. Further, discussions with businessmen in Carlsbad suggest that 300 mobile home spaces could be added to the 510 spaces that now exist with less than a one year lead time. Of course, such expansion will be influenced by considerations other than simply short-term demands; particularly relevant at this point in time are prevailing interest rates.

Further, temporary housing is available in the area's motels. Carlsbad has some 20 motels with 1100 rooms** with relatively high vacancy rates during weekdays in the non-summer months. Hobbs has 11 motels, with 482 rooms with vacancy rates that are generally higher than those in Carlsbad. Such temporary housing units are, therefore, a potential source for housing which may then serve to ease tight housing market conditions during the WIPP's construction phase.

The essential elements of discussions given above concerning housing demand and supply are summarized in Table V.30, for Carlsbad, Hobbs, and Loving; comparable data for the remainders of Eddy and Lea counties are not available. Referring to Table V.30, the demand for housing in Carlsbad during the peak construction year (1983) may range from 568 to 1,448 housing units, depending on location patterns of in-migrants and, perhaps more importantly, the extent by which local households join the labor force. Depend-

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*See FEIS [1980, p. H-35].

**FEIS [1980, p. H-36]. 19 motels in the Carlsbad area were surveyed as a part of this research. These motels had 970 rooms -- 120 of which had kitchenettes -- and 1,600 beds.

TABLE V.30

SUMMARY OF POTENTIAL HOUSING CONDITIONS IN PEAK CONSTRUCTION YEAR IN CARLSBAD, HOBBS AND LOVING

COMMUNITY	HOUSING UNITS IN PEAK YEAR	POTENTIAL SUPPLY OF HOUSING UNITS: TOTAL SUPPLY OF HOUSING UNITS	EXISTING UNOCCUPIED HOUSING UNITS	50% OF MOTEL CAPACITY	ADDITIONAL MOBILE HOME SITES
Carlsbad	568 - 1,448[1/]	1,003 - 1,724	153 - 874[4/]	505	300
Hobbs	164 - 779[2/]	467 - 1,397	226 - 1,156[4/]	241	?
Loving	33 - 223[3/]	21 - 102	21 - 102[4/]	--	?

1/ Table V.22; Scenarios I - B and II - A for 1983.

2/ Table V.24; Scenarios I - A and II - B for 1983.

3/ Table V.23; Scenarios I - B and II - A for 1983.

4/ FEIS [Table H-16 to H-18, pp. H-36 to H-38] and census estimates given in Table V.27.

ing on the estimate used for current unoccupied housing -- the FEIS estimate of 153 units or the census estimate of 874 units -- the supply of housing units which may be available to satisfy these demands is between 1,003 and 1,724 units, when 50% of Carlsbad's motel room capacity and 300 new mobile home sites are included. Under worst conditions -- high demand and low supply -- serious shortages in housing units would exist in Carlsbad during peak construction years.* While a rationale for choosing any point in these ranges for housing demand and supply does not exist, the community would seem to have the potential capacity for absorbing above-baseline increases in the demand for housing units on the order of some 1,000 units. Thus, while Carlsbad may experience tight housing markets (particularly for permanent single and multifamily units) during the WIPP's peak construction years, best available data suggest that the in-migrating population would most likely find housing facilities of one kind or another except under the most pessimistic assumptions concerning responses of the local labor force.

The potential for housing shortages in Loving are much greater than in Carlsbad, as one might expect. Discussions with local officials in Loving suggest that this community has the prerequisites for responding to in-migrant demands for such things as mobile home sites (i.e., land and utilities for hook-ups). No basis exists, however, for estimating the possible extent of such developments. From data given in Table V.30,

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*The authors are not concerned with the maintenance of "normal" vacancy rates of 3% during the construction period as in the FEIS [1980, p. H-35 section 3.3.2.1] inasmuch as norm conditions would not be expected during the short-lived disequilibrium period of WIPP construction; i.e., "normal" rates are not anticipated during abnormal surges in economic activity.

however, extensive development of mobile home sites would not be required for Loving to absorb the range of in-migrants estimated in this study.

Of the three communities, the potential for severe housing shortages would seem to be the least in Hobbs. Housing shortages in Hobbs would seem likely only with high demand--low supply conditions.

In summary, tight, but manageable housing market conditions can be expected in Carlsbad and Hobbs with low impact scenarios; under higher impact scenarios, severe housing shortages could obtain, particularly in Carlsbad. Severe housing shortages can be expected in Loving under all impact scenarios. There are at least two implications of relevance for planners that can be drawn from these analyses of potential housing conditions in the two-county area. First, the potential for sharply inflated rental and housing costs, which can be expected to reinforce all other local inflationary pressures, must be recognized and resulting implications for impacts on low income families must be anticipated. Secondly, severe housing shortages may well impede the flow of in-migrating workers required for the WIPP project to proceed as scheduled. To the extent that this occurs, the construction period may be extended beyond the planned seven years, thereby prolonging the period in which WIPP-related local impacts must be managed by local planners.

E. Municipal and County Services

In looking to potential impacts on municipal and county ("local") services which may attend WIPP-related increases in population, two issues must be addressed at the outset. The first issue concerns the types of local expenditures which would most likely be effected by these population increases during the construction and operations phases. Per capita expenditures for fiscal years 1976-78 are given in Table V.31 for Carlsbad, Hobbs and Loving. While outlays for capital (a stock) are not strictly comparable with those for operating expenditures (a flow), these data serve to indicate relative expenditures in these two classes of municipal costs.

Capital expenditures involve outlays for equipment and facilities that are generally long-lived. Water/sewage facilities, school buildings, streets/-roads, etc. are usually constructed with initial excess capacity which will serve to accommodate future (relative to the time of construction) demands on such facilities from population growth anticipated over several decades. By their very nature, capital facilities are not items that are altered in any substantive way in response to short-term changes in conditions, such as those associated with swells in population during the 2 - 3 year peak construction period for the WIPP.

Based on the above, analyses in this section abstract from considerations related to capital expenditures by municipal and county governments. Major implications of this abstraction are as follows.

(i) While interviews with local officials suggest (with exceptions noted below) that structures for municipal infrastructure are adequate for any in-migration that may attend the WIPP (see, also [FEIS, p. L-57], should WIPP construction coincide with other construction projects (e.g., the Brantley Dam

TABLE V.31

PER CAPITA CAPITAL OUTLAY AND OPERATING EXPENDITURES BY CATEGORY IN CARLSBAD, HOBBS AND LOVING - FISCAL YEARS 1975-78

	Carlsbad			Hobbs			Loving		
Per Capita Capital Outlay	1975-76	1976-77	1977-78	1975-76	1976-77	1977-78	1975-76	1976-77	1977-78
General Government	$ 4.76	$ 1.93	$20.09	$1.43	$ 4.13	$ 1.94	$11.68	$ 2.76	$ 3.06
Police	1.26	0	1.53	.39	4.06	2.19	0	0	6.02
Fire	.54	.41	1.27	.03	3.17	.99	4.48	7.41	6.66
Parks & Recreation	4.58	4.41	6.70	2.56	1.01	3.27	0	0	0
Water, Sewer, Sanitation	12.16	9.39	8.96	3.81	3.04	4.95	4.28	2.75	2.66
Streets & Roads	15.16	12.22	59.39	.66	3.73	1.22	0	0	0
Utilities	0	0	0	0	0	0	0	0	0
Library	.05	.04	0	.06	0	.05	0	0	0
Airport	.07	0	0	.80	0	0	0	0	0
Subtotal	$38.50	$28.40	$97.94	$9.74	$19.14	$14.61	$20.44	$12.92	$18.40
Per Capita Operating Expenditures									
General Government	$ 5.79	$ 6.58	$ 8.08	$ 8.94	$ 8.79	$10.21	$ 6.67	$ 7.49	$10.77
Police	2.39	2.80	2.93	3.93	3.40	5.65	1.75	1.67	2.70
Fire	1.52	1.82	1.98	1.49	1.63	1.99	3.25	2.80	2.95
Parks & Recreation	5.65	5.93	6.26	2.90	3.11	3.94	.74	.72	1.57
Water, Sewer, Sanitation	9.69	12.13	11.93	7.41	8.03	27.44	14.55	13.96	20.97
Streets & Roads	5.40	5.34	7.17	8.54	5.78	10.09	.71	.54	.53
Library	.48	.48	.90	.81	.80	.98	0	0	0
Airport	.96	.96	1.04	1.07	.24	.23	0	0	0
Subtotal	$31.88	$36.04	$ 40.29	$35.09	$31.78	$60.59	$27.67	$27.18	$39.49
Total	$70.46	$64.44	$138.23	$44.83	$50.92	$75.14	$48.11	$40.10	$57.89

Source: 1975-1976, 1976-1977, 1977-1978 Municipal Budgets for Carlsbad, Hobbs and Loving.

discussed earlier), strains on existing facilities would be exacerbated and substantial capital expenditures may be unavoidable.*

(ii) Related to the above, should any sorts of major capital outlays be associated with the WIPP, local communities could encounter severe "front end"** problems that could be particularly severe given the relatively brief construction period for the WIPP. The potential for such conditions cannot be evaluated at this point in time, but must await firm information as to the precise timing of WIPP and other construction projects in the two county area.

Should front-end types of problems be anticipated in the two-county area, potential sources for relief exist in several state and federal programs exemplified in Table V.32. "Potential" is stressed here inasmuch as these programs are not specifically structured to deal with anticipatory impacts, and some legislative changes might be required if they are to apply to WIPP-related impacts. For example, it is not clear that the WIPP would be considered as an "energy or mineral development" activity, thereby qualifying (partially) impacted communities for relief under the Community Assistance Program (Table V.32); similarly, the Energy Impact Assistance Program applies to areas "impacted by increased coal or uranium production" (Table V.32),

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*A thorny problem would arise in this case, however, in terms of any effort to attribute some part of these costs to the WIPP project per se. One could not logically attribute such costs solely to the WIPP nor to the Branson Dam project; the incidence of costs result from the coincidence of the projects. One would then be forced to develop a logical basis for allocating these costs to the two projects.

**The "front end" problem describes financing problems faced by communities when there is a lag between the time at which impacts occur and the time at which property values -- which affect bounding capacity -- are increased.

TABLE V.32

DESCRIPTION OF THREE MAJOR FINANCIAL ASSISTANCE PROGRAMS FOR IMPACTED COMMUNITIES

A.	Program:	New Mexico Public School Outlay Council Emergency Fund*
	Source of Funding:	The New Mexico State Legislature appropriates funds each year under the Capital Outlay Act.
	Energy or Mineral Criteria:	None
	Financial Criteria:	School district is bonded to 75% of capacity and a mill levy has been imposed, but the district can't afford necessary construction or remodeling.
	Infrastructure Criteria:	District can show a need for more classrooms. Classrooms or buildings have been cited by the fire marshall or have structural defects.
	Available Aid:	The Public School Outlay Council can award all or part of the funds needed for building, remodeling or renovating existing structures or may provide portable classrooms.

*Information is from telephone conservations with Ernest Vigil of the Public School Outlay Council, Santa Fe, New Mexico on October 15 and November 4, 1980.

Table V.32, Continued

B. Program:	Community Assistance Program*
Source of Funding:	New Mexico State Severance Tax Bond Fund
Energy or Mineral Criteria:	Area must be impacted by energy or mineral development. Generally, to be considered impacted a city must be within 60 miles of the energy or mineral development and the industry must either have a minimum employment of 300 and experienced a 5% increase for the next three years or have a minimum sales value of $10,000,000.00.**
Financial Criteria:	The community must impose the maximum gross receipts tax and must utilize available general obligation and revenue bonding capabilities.
Infrastructure Criteria:	Communities demonstrate that due to the increase of population related to energy or mineral development they are required to increase the services they provide such as, water, sewer, roads, etc., and the communities are not capable of financing the required improvements.
Available Aid:	The Community Assistance Program provides grant funds for eligible facilities to political subdivisions based on health and safety, needs of eligible political subdivisions, and utilization of local or other sources of funds to finance the needed facilities.

*Information from telephone conversations with Don Gonzales. Program Manager of the Community Assistance Program, on October 14 and November 4, 1980.

**Don Gonzales feels that the WIPP will not qualify as an energy or mineral development and an amendment to the Community Assistance Act would be necessary before it could apply to the WIPP.

Table V.32, Continued

C. Program:	Energy Impact Assistance Program*
Source of Funding:	Title VI, Section 601, of the Power Plant and Industrial Fuel Use Act of 1978, "Assistance to areas impacted by increased coal or uranium production."
Energy or Mineral Criteria:	Employment in coal or uranium mining must have increased 8% in the last year and be expected to increase 24% over the next three years.**
Financial Criteria:	The Department of Energy looks at total revenues, total expenditures, and bonding capacity.
Infrastructure:	The DOE must put together a comprehensive plan of development in the impacted area, including available facilities and expected changes in the population profile to determine increases in demand for public facilities and services.
Available Aid:	The Program cannot pay for any structure but can buy land and provide water and sewer lines to it.**

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*Information is from a telephone conversation with Jerry O'Shea of the State Planning Division, Department of Finance and Administration on October 24, 1980.

**There are presently five versions of a bill before the U.S. Senate and House of Representatives to amend Title VI of the Power Plant and Industrial Fuel Use Act of 1978. A similar bill was defeated in Congress last year. Senate Bill 1699 calls for amending the definition of 'Major energy development' to include "...any federally funded energy project (including uranium processing and nuclear spent fuel storage and waste facilities)." The bill also broadens the type of aid available to impacted areas. (S.1699, 96th Congress, 1st Session) and its' applicability to the WIPP project is questionable. All of this is to suggest that earlier efforts to define arrangements required to provide relief to WIPP-impacted local communities -- should the need for relief be demonstrated -- is highly desirable from the State's standpoint.

The second issue which warrants mention here concerns capital expenditures, WIPP-related population estimates and jurisdictional questions. Under the high impact scenario II-A given above in Table V.15, WIPP-related population increases during the peak construction year (1983) are 3,689, 568 and 851 for Carlsbad, Loving and Hobbs, respectively. These changes translate into 11.7%, 33.4% and 2.4% percentage changes* in the three (respective) communities. Arguments given above for abstracting from capital expenditure considerations in Carlsbad and Hobbs may be regarded as tenable in light of these short-term impacts. On its face, such abstractions for Loving -- facing a potential population increase of 33.4% -- may then seem highly questionable.**

As is discussed above in the housing section, vacancies in permanent housing facilities in Loving would accommodate but a fraction of this high estimate of 568 people (223 family units); nor, given the short, peak construction period, would one expect to see such facilities built. Acceptance of the population scenario would necessarily require the expectation that temporary, mobile home facilities would be developed in the Loving area, wherein demands on municipal infrastructure would be minimal. Given Loving's

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*Based on baseline population estimates for 1983 given in [FEIS, p. L-49].

**Alternatively, one might simply reject the location scenario for Loving wherein this many in-migrants are involved. For the first year of operations, population increases are 2.8%, .1% and 7.9% for Carlsbad, Hobbs and Loving, respectively, under the high scenario II-A.

proximity to Carlsbad (some 12 miles), one might well expect Loving's increased population to place direct and indirect pressures (however small in relative terms) on municipal infrastructure in Carlsbad. An example of such direct effects is Loving's current use of Carlsbad high schools. Thus, population scenarios and negligible municipal expenditures for capital items may be rationalized on these grounds.*

Of course, the above implies the potential for jurisdictional conflicts which we can only identify here, viz., that while Loving must deal with any congestion and/or socio-cultural problems (see footnote) associated with the in-migrating population, the bulk of taxes and other revenues that attend local expenditures would tend to accrue to Carlsbad.

Turning attention now to estimated impacts on municipal/county revenues and operating expenditures, a qualitative description of the types of changes in municipal activities is given in the FEIS [section 9.4], e.g., during the peak construction period years, Carlsbad may require 5 - 10 new teachers, 2 additional firemen, 3 additional policemen and an additional physician. In developing the quantitative measures for impacts of interest here, we have little recourse to using per capita measures for municipal expenditures and revenues. One must recognize the source for potential upward biases in these measures: per capita measures for municipal expenditures ignore possible economics of scale and the potential for substituting congestion (or, deteriorated services) for expenditures.

Estimates for WIPP-related impacts on municipal and county revenues and operating costs are given in Tables V.33 - V.42 for Carlsbad, Loving, Eddy

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*The potential for socio-cultural problems in Loving is not so easily rationalized, however. See discussions below in Chapter IX.

TABLE V.33

OPERATIONAL EXPENDITURES FOR CARLSBAD

SCENARIO II-A (High)

YEAR	TOTAL	GENERAL GOVERNMENT	PUBLIC SAFETY	PUBLIC WORKS	RECREATION AND CULTURE	HEALTH AND WELFARE
			(thousands of 1979 dollars)			
1980	$ 19.1	$ 2.5	$ 4.6	$ 9.7	$ 2.2	$ .1
1981	123.3	16.2	29.7	62.8	13.9	.7
1982	588.4	73.5	133.3	285.2	63.2	3.2
1983	732.5	96.2	176.6	373.0	82.6	4.1
1984	140.0	18.4	33.7	71.3	15.8	.8
1985	118.0	15.5	28.4	60.1	13.3	.7
1986	247.6	32.5	59.7	126.1	27.9	1.4
1987-Thereafter	188.9	24.8	45.5	96.2	21.3	1.1

SCENARIO I-B (Low)

YEAR	TOTAL	GENERAL GOVERNMENT	PUBLIC SAFETY	PUBLIC WORKS	RECREATION AND CULTURE	HEALTH AND WELFARE
1980	$ 15.3	$ 2.0	$ 3.6	$ 7.9	$ 1.7	$ .1
1981	77.9	10.2	18.8	39.7	8.8	.4
1982	259.2	34.0	62.5	132.0	29.2	1.5
1983	287.3	37.7	69.3	146.3	32.4	1.6
1984	83.3	10.9	20.1	42.4	9.4	.5
1985	74.3	9.8	17.9	37.8	8.4	.4
1986	126.5	16.6	30.5	64.4	14.3	.7
1987-Thereafter	156.1	20.5	37.6	79.5	17.6	.9

SOURCE: Per capita expenditures were computed from Expenditure Table H-25 (p. H-64, FEIS) (excluding capital costs). Then 1979 population estimates in MI (p. M-1, FEIS) were applied resulting in per capita estimates for operations expenditures. These 1979 per capita figures were applied to High and Low scenarios, Tables V-14 - 17 (this report) resulting in operation expenditure estimates related to WIPP.

TABLE V.34

CARLSBAD MUNICIPAL REVENUES AND EXPENDITURES
FROM WIPP-RELATED INCREASES IN POPULATION

YEAR	REVENUES: SCENARIO II-A (High)	REVENUES: SCENARIO I-B (Low)	EXPENDITURES: SCENARIO II-A (High)	EXPENDITURES: SCENARIO I-B (Low)
	(thousands of 1979 dollars)		(thousands of 1979 dollars)	
1980	$ 36.6	$ 28.9	$ 19.1	$ 15.3
1981	236.8	149.3	123.3	77.9
1982	1,074.9	495.6	588.4	259.2
1983	1,406.1	540.5	732.5	237.3
1984	268.7	159.1	140.0	83.3
1985	226.4	142.0	118.0	74.3
1986	475.2	241.9	247.6	126.5
1987-thereafter	362.8	298.5	188.9	156.1

SOURCE: Expenditures were taken from Table V.33 (this report). Revenues were estimated from Table H-24 (H-63, FEIS) excluding interest on investments, sale of bonds, and a fixed value of 40,000 for the high scenario and 0 for the low scenario for Lodgers Tax. 1979 population figures were applied [Table M-1 (M-1, FEIS)] resulting in a per capita revenue. Population increases estimated in Tables 14 - 17 (this report) were then applied and then revenues related to WIPP population were estimated. Property tax revenues were estimated based on existing housing stock [Table H-16, (p. H-36 FEIS) resulting in a per house tax; then family units (housing) estimates from Tables 14 - 17 (this report) were applied resulting in an estimate of property tax revenues for related increase in WIPP housing units.

TABLE V. 35

OPERATIONAL EXPENDITURES FOR LOVING

SCENARIO II-A (High)

YEAR	TOTAL	GENERAL GOVERNMENT	PUBLIC SAFETY	PUBLIC WORKS	RECREATION AND CULTURE	HEALTH AND WELFARE
		(thousands of 1979 dollars)				
1980	$ 1.7	$ .3	$ .5	$ .8	$ 1/	$ 1/
1981	10.8	2.0	2.9	5.4	.3	.2
1982	48.8	9.0	13.2	24.3	1.2	1.1
1983	63.9	11.8	17.3	31.8	1.6	1.4
1984	12.3	2.3	3.3	6.1	.3	.3
1985	9.9	1.9	2.3	5.2	.3	.2
1986	21.7	4.0	5.8	10.8	.6	.5
1987-Thereafter	16.4	3.0	4.4	8.2	.4	.4
SCENARIO I-B						
1980	$ .5	$ .1	$ .1	$ .2	$ 1/	$ 1/
1981	2.7	.5	.7	1.3	.1	.1
1982	8.5	1.6	2.3	4.7	.2	.2
1983	9.3	1.7	2.5	4.7	.2	.2
1984	2.7	.5	.7	1.3	.1	.1
1985	2.6	.5	.7	1.2	.1	.1
1986	4.2	.8	1.1	2.1	.1	.1
1987-Thereafter	5.0	.9	1.4	2.5	.1	.1

1/ Less than $50.

SOURCE: Per capita expenditures were computed from Expenditure Table H-28 (p. H-64, FEIS) (excluding capital costs). Then 1979 population estimates in MI (p. M-1, FEIS) were applied resulting in per capita estimates for operations expenditures. These 1979 per capita figures were applied to High and Low scenarios, Tables V-14 - 17 (this report) resulting in operation expenditure estimates related to WIPP.

TABLE V.36

LOVING MUNICIPAL REVENUE AND EXPENDITURES
FROM WIPP-RELATED INCREASES IN POPULATION

YEAR	REVENUES: SCENARIO II-A (High)	REVENUES: SCENARIO I-B (Low)	EXPENDITURES: SCENARIO II-A (High)	EXPENDITURES: SCENARIO I-B (Low)
	(thousands of 1979 dollars)		(thousands of 1979 dollars)	
1980	$ 2.7	$ .7	$ 1.7	$ .5
1981	17.5	4.2	10.8	2.7
1982	79.2	13.7	8.8	8.5
1983	103.0	15.1	63.9	9.3
1984	19.9	4.4	12.3	2.7
1985	16.8	4.0	9.9	2.6
1986	35.0	6.7	21.7	4.2
1987-thereafter	26.6	8.2	16.4	55.0

SOURCE: Expenditures were taken from Table V.35 (this report). Revenues were estimated from Table H-28 (p. H-68, FEIS) excluding interest on investments, sale of bonds, and a fixed value of 40,000 for the high scenario and 0 for the low scenario for Logers Tax. 1979 population figures were applied [Table M-1 (M-1, FEIS)] resulting in a per capita revenue. Population increases estimated in Tables 14 - 17 (this report) were then applied and then revenues related to WIPP population were estimated. Property tax revenues were estimated based on existing housing stock [Table H-18 (p. H-38, FEIS)] resulting in a per house tax; then family units (housing) estimates from Tables 14 - 17 (this report) were applied resulting in an estimate of property tax revenues for related increase in WIPP housing units.

TABLE V. 37

OPERATIONAL EXPENDITURES FOR EDDY COUNTY

SCENARIO II-A (High)

YEAR	TOTAL	GENERAL GOVERNMENT	PUBLIC SAFETY	PUBLIC WORKS	RECREATION AND CULTURE	HEALTH AND WELFARE
			(thousands of 1979 dollars)			
1980	$ 9.2	$ 3.0	$ 1.6	$ 3.6	$ .9	$ .1
1981	59.6	19.7	10.2	23.3	5.5	.9
1982	326.8	88.0	45.4	104.1	24.6	3.8
1983	680.3	116.9	60.3	138.3	32.9	5.1
1984	67.6	22.4	11.5	26.4	6.3	1.0
1985	56.9	18.8	9.7	22.3	5.3	1.8
1986	119.5	39.5	20.4	46.8	11.1	1.7
1987-Thereafter	90.9	30.1	15.5	35.6	8.4	1.3

SCENARIO I-B

YEAR	TOTAL	GENERAL GOVERNMENT	PUBLIC SAFETY	PUBLIC WORKS	RECREATION AND CULTURE	HEALTH AND WELFARE
1980	$ 6.9	$ 2.2	$ 1.2	$ 2.7	$ .6	$ .2
1981	35.3	11.7	6.0	13.8	3.3	.5
1983	117.1	38.7	20.0	45.8	10.9	1.7
1983	130.0	43.0	22.2	50.8	12.1	1.9
1984	37.9	12.4	6.4	14.7	3.9	.5
1985	33.6	11.1	5.7	13.2	3.1	.5
1986	57.2	18.9	9.8	22.4	5.3	.8
1987-Thereafter	70.5	23.4	12.0	27.6	6.5	1.0

SOURCE: Per capita expenditures were computed from Expenditure Table H-31 p. H-71, FEIS) (excluding capital costs). Then 1979 population estimates in MI (p. M-1, FEIS) were applied resulting in per capita estimates for operations expenditures. These 1979 per capita figures were applied to High and Low scenarios, Tables V-14 - 17 (this report) resulting in operation expenditure estimates related to WIPP.

TABLE V.38

EDDY COUNTY REVENUES AND EXPENDITURES

FROM WIPP-RELATED INCREASES IN POPULATION

YEAR	REVENUES: SCENARIO II-A (High)	REVENUES: SCENARIO I-B (Low)	EXPENDITURES: SCENARIO II-A (High)	EXPENDITURES: SCENARIO I-B (Low)
	(Thousands of 1979 Dollars)		(Thousands of 1979 Dollars)	
1980	S 6.4	$ 4.8	$ 9.2	$ 6.9
1981	41.8	24.8	59.6	35.3
1982	187.0	82.0	326.8	117.1
1983	247.3	90.9	680.3	130.0
1984	47.2	26.3	67.6	37.9
1985	39.7	23.5	56.9	33.6
1986	83.3	41.6	119.5	57.2
1987-thereafter	64.5	51.6	90.9	70.5

SOURCE: Expenditures were taken from Table V.37 (this report). Revenues were estimated from Table H-30 (H-70, FEIS) excluding interest on investments, sale of bonds, and a fixed value of 40,000 for the high scenario and 0 for the low scenario for Logers Tax. 1979 population figures were applied [Table M-1 (M-1, FEIS)] resulting in a per capita revenue. Population increases estimated in Tables 14 - 17 (this report) were then applied and then revenues related to WIPP population were estimated. Property tax revenues were estimated based on existing housing stock with "Selected characteristics of Urban and Rural Housing - New Mexico Counties 1970", New Mexico Statistical Abstract 1979-1980, p. 52-53.

TABLE V. 39

OPERATIONAL EXPENDITURES FOR HOBBS:

SCENARIO II-B (High)

YEAR	TOTAL	GENERAL GOVERNMENT	PUBLIC SAFETY	PUBLIC WORKS	RECREATION AND CULTURE	HEALTH AND WELFARE
			(thousands of 1979 dollars)			
1980	$ 10.7	$ 2.1	$ 3.2	$ 3.6	$ .8	$ 1.0
1981	84.5	14.4	22.0	24.8	5.6	7.0
1982	319.2	61.9	94.6	108.4	24.2	30.1
1983	415.1	81.0	123.6	139.1	31.7	39.7
1984	75.4	15.5	23.7	26.6	6.1	7.5
1985	52.6	10.3	15.7	17.6	4.0	5.0
1986	140.2	27.4	41.8	47.8	10.7	13.3
1987-Thereafter	107.0	20.9	31.9	35.9	8.2	10.1

SCENARIO I-A (Low)

YEAR	TOTAL	GENERAL GOVERNMENT	PUBLIC SAFETY	PUBLIC WORKS	RECREATION AND CULTURE	HEALTH AND WELFARE
1980	$ 4.5	$ .9	$ 1.4	$ 1.5	$ .3	$ .4
1981	23.5	4.6	7.0	7.9	1.8	2.2
1982	78.5	15.3	23.4	26.3	6.0	7.5
1983	87.2	17.0	26.0	29.2	6.7	8.3
1984	22.3	4.9	7.5	8.5	.6	.8
1985	20.3	4.4	6.7	7.7	.7	.8
1986	38.3	7.5	11.4	12.9	2.9	3.6
1987-Thereafter	47.7	9.6	14.1	15.9	3.6	4.5

SOURCE: Per capita expenditures were computed from Expenditure Table H-27 (p. H-67, FEIS) (excluding capital costs). Then 1979 population estimates in MI (p. M-1, FEIS) were applied resulting in per capita estimates for operations expenditures. These 1979 per capita figures were applied to High and Low scenarios, Tables V-14 - 17 (this report) resulting in operation expenditure estimates related to WIPP.

TABLE V.40

HOBBS MUNICIPAL REVENUES AND EXPENDITURES
FROM WIPP-RELATED INCREASES IN POPULATION

YEAR	REVENUES: SCENARIO II-B (High)	REVENUES: SCENARIO I-A (Low)	EXPENDITURES: SCENARIO II-B (High)	EXPENDITURES: SCENARIO I-A (Low)
	(thousands of 1979 dollars)		(thousands of 1979 dollars)	
1980	$ 29.0	$ 12.5	$ 10.7	$ 4.5
1981	189.5	64.1	84.5	23.5
1982	861.7	213.3	319.2	78.5
1983	1,126.6	236.6	415.1	87.2
1984	215.5	68.6	75.4	22.3
1985	143.9	61.2	52.6	20.3
1986	380.5	104.3	146.2	38.3
1987-thereafter	284.5	128.8	107.0	47.7

SOURCE: Expenditures were taken from Table V.37 (this report). Revenues were estimated from Table H-24 (H-63, FEIS) excluding interest on investments, sale of bonds, and a fixed value of 40,000 for the high scenario and 0 for the low scenario for Lodgers Tax. 1979 population figures were applied [Table M-1 (M-1, FEIS)] resulting in a per capita revenue. Population increases estimated in Tables 14 - 17 (this report) were then applied and then revenues related to WIPP population were estimated. Property tax revenues were estimated based on existing housing stock [Table H-17 (p. H-37, FEIS)] resulting in a per house tax; then family units (housing) estimates from Tables 14 - 17 (this report) were applied resulting in an estimate of property tax revenues for related increase in WIPP housing units.

TABLE V.41

OPERATIONAL EXPENDITURES FOR LEA COUNTY

SCENARIO II-A (High)

YEAR	TOTAL	GENERAL GOVERNMENT	PUBLIC SAFETY	PUBLIC WORKS	RECREATION AND CULTURE	HEALTH AND WELFARE
			(thousands of 1979 dollars)			
1980	$ 5.7	$ 1.6	$ 1.1	$ 2.5	$ .5	$ 1/
1981	37.6	10.8	6.9	16.8	3.0	.1
1982	171.3	49.3	31.5	76.3	13.7	.5
1983	223.4	64.4	41.2	99.8	18.0	.7
1984	42.8	12.3	7.9	19.1	3.4	.1
1985	29.5	8.5	5.4	13.1	2.4	.1
1986	75.7	21.8	13.9	33.7	6.1	.2
1987-Thereafter	57.7	16.6	10.6	25.7	4.6	.2

SCENARIO I-A (Low)

YEAR	TOTAL	GENERAL GOVERNMENT	PUBLIC SAFETY	PUBLIC WORKS	RECREATION AND CULTURE	HEALTH AND WELFARE
1980	$ 2.8	$ .8	$ .5	$ 1.3	$ .2	$ 1/
1981	17.6	4.3	2.7	6.6	1.2	1/
1982	49.4	14.2	9.1	22.0	4.0	.1
1983	54.9	15.8	10.1	24.4	4.4	.2
1984	15.9	4.6	2.9	7.1	1.3	1/
1985	30.0	4.1	2.6	6.3	1.1	1/
1986	24.2	7.0	4.4	10.8	1.9	.1
1987-Thereafter	29.6	8.5	5.4	13.2	2.4	.1

1/ Less than $50.

SOURCE: Per capita expenditures were computed from Expenditure Table H-33 (p. H-73, FEIS) (excluding capital costs). Then 1979 population estimates in MI (p. M-1, FEIS) were applied resulting in per capita estimates for operations expenditures. These 1979 per capita figures were applied to High and Low scenarios, Tables V-14 - 17 (this report) resulting in operation expenditure estimates related to WIPP.

TABLE V.42

LEA COUNTY REVENUE AND EXPENDITURES
FROM WIPP-RELATED INCREASES IN POPULATION

	REVENUES:		EXPENDITURES:	
YEAR	SCENARIO II-B (High)	SCENARIO I-A (Low)	SCENARIO II-B (High)	SCENARIO I-A (Low)
	(thousands of 1979 dollars)			
1980	$ 3.8	$ 1.9	$ 5.7	$ 2.8
1981	24.8	9.8	37.6	17.6
1982	112.8	32.6	171.3	49.4
1983	147.5	36.2	223.4	54.9
1984	28.2	10.5	42.8	15.9
1985	20.2	9.3	29.5	30.0
1986	49.8	15.9	75.7	24.2
1987-thereafter	38.3	19.5	57.7	29.6

SOURCE: Expenditures were taken from Table V.41 (this report). Revenues were estimated from Table H-31 (H-72, FEIS) excluding interest on investments, sale of bonds, and a fixed value of 40,000 for the high scenario and 0 for the low scenario for Lodgers Tax. 1979 population figures were applied [Table M-1 (M-1, FEIS)] resulting in a per capita revenue. Population increases estimated in Tables 14 - 17 (this report) were then applied and then revenues related to WIPP population were estimated. Property tax revenues were estimated based on existing housing stock with "Selected characteristics of Urban and Rural Housing - New Mexico Counties 1970", New Mexico Statistical Abstract 1979-1980, p. 52-53.

County, Hobbs and Lea County for high and low scenarios relevant for each unit. Referring, for example, to the "high" scenario for Carlsbad (scenario II-A), operating expenditures during the peak years 1982 and 1983 are $588,400 and $732,500, respectively, compared with corresponding revenues of $1.1 million and $1.4 million. During the operations phase, revenues and expenditures are $362,800 and $188,900, respectively. For all municipal units, WIPP-related increases in revenues exceed estimated increases in operating costs by a considerable margin. This result should be expected inasmuch as total expenditures (including debt retirement and capital costs) do not rise proportionally to population-related revenues.

Estimates for increases in revenues and operating costs for the Carlsbad, Hobbs and Loving school districts are given in Tables V.43 - V.45. Estimated revenue increases are sufficient to cover estimated cost increases in all districts; again, capital costs are excluded.

To facilitate later analyses, present value calculations are made for net revenues -- revenues less costs -- for these local government units and are given in Table V.46; present values are calculated with discount rates of zero, 6 7/8% and 10%.

As seen from data in Table V.46, the present value (over 30 years) of net revenue (tax revenue less required expenditures) is positive -- revenues exceed costs -- for all municipal and school district units. For county governments in Eddy and Lea counties, however, estimated costs exceed estimated revenues -- net revenue is negative.*

*FEIS, p. H-71.

TABLE V.43

CARLSBAD SCHOOL DISTRICT EXPENDITURES AND REVENUES

FOR OPERATIONS RELATED TO INCREASES IN WIPP POPULATION
(thousands of 1979 dollars)
HIGH SCENARIO II - A

	EXPENDITURES		REVENUES	
YEAR	SCENARIO II-A	FEIS	SCENARIO II-A	FEIS
1980	$ 49.3	$143	$ 50.6	$145
1981	312.2	491	320.2	504
1982	1,404.4	814	1,440.1	848
1983	1,837.6	650	1,884.4	699
1984	349.6	345	358.5	381
1985	295.8	317	303.3	335
1986	615.5	382	631.2	398
1987-Thereafter	493.0	402	505.6	422

LOW SCENARIO I-B

	EXPENDITURES	REVENUES
1980	38.8	39.8
1981	197.2	202.2
1982	651.4	668.0
1983	721.6	740.0
1984	207.7	212.9
1985	285.3	190.0
1986	315.2	323.2
1987-Thereafter	394.4	404.4

SOURCE: Per student operational expenditures from the "New Mexico Public School Finance: Statistics 1978-1979", (p. 94-97) were applied to the number of school aged children estimates in Tables 14 - 17 (this report) resulting in estimates for operational expenditures required by increases in WIPP population. Revenues were estimated using the FEIS School District Revenues Table H-34, excluding the Debt Service Fund and building funds, and applied to the school aged childrenestimates in Tables 14 - 17 this report. Although children in Loving attend High School in Carlsbad no adjustment was made.

TABLE V.44

HOBBS SCHOOL DISTRICT EXPENDITURES AND REVENUES
FOR OPERATIONS RELATED TO INCREASES IN WIPP POPULATION
(thousands of 1979 dollars)

HIGH SCENARIO II - B

	EXPENDITURES		REVENUES	
YEAR	SCENARIO II-B	FEIS	SCENARIO II-B	FEIS
1980	$ 25.6	$ 48	$ 26.2	$ 49
1981	159.2	172	163.0	176
1982	719.0	288	736.2	287
1983	942.1	231	964.7	242
1984	181.9	124	186.2	131
1985	152.0	112	155.7	117
1986	315.5	136	323.0	140
1987-Thereafter	251.5	142	257.5	147

LOW SCENARIO I - A

	EXPENDITURES	REVENUES
1980	$ 11.4	$ 11.6
1981	54.0	55.3
1982	179.0	183.3
1983	197.5	202.2
1984	56.8	58.2
1985	51.2	52.4
1986	86.7	88.6
1987-Thereafter	108.0	110.6

SOURCE: Per student operational expenditures from the "New Mexico Public School Finance: Statistics 1978-1979", (p. 94-97) were applied to the number of school aged children estimates in Tables 14 - 17 (this report) resulting in estimates for operational expenditures required by increases in WIPP population. Revenues were estimated using the FEIS School District Revenues Table H-34, excluding the Debt Service Fund and building funds, and applied to the school aged children estimates in Tables 14 - 17 of this report.

TABLE V.45

LOVING SCHOOL DISTRICT EXPENDITURES AND REVENUES
FOR OPERATIONS RELATED TO INCREASES IN WIPP POPULATION
(thousands of 1979 dollars)

HIGH SCENARIO II - A

YEAR	EXPENDITURES SCENARIO II-A	EXPENDITURES FEIS	REVENUES SCENARIO II-A	REVENUES FEIS
1980	$ 8.0	$ 5	$ 8.5	$ 4
1981	51.1	24	54.1	21
1982	231.4	39	245.1	34
1983	304.8	34	322.8	30
1984	57.5	18	60.8	15
1985	47.9	16	50.7	13
1986	52.7	21	55.8	17
1987-Thereafter	81.4	27	86.2	21

LOW SCENARIO I - B

	EXPENDITURES	REVENUES
1980	$ 3.2	$ 3.4
1981	12.8	13.5
1982	41.6	43.9
1983	44.9	47.3
1984	12.8	13.5
1985	11.2	11.8
1986	19.2	20.3
1987-Thereafter	23.9	25.4

SOURCE: Per student operational expenditures from the "New Mexico Public School Finance: Statistics 1978-1979", (p. 94-97) were applied to the number of school aged children estimates in Tables 14 - 17 (this report) resulting in estimates for operational expenditures required by increases in WIPP population. Revenues were estimated using the FEIS School District Revenues Table H-34, excluding the Debt Service Fund and building funds, and applied to the school aged children estimates in Tables 14 - 17 of this report.

TABLE V.46

PRESENT VALUE OF NET, WIPP-RELATED REVENUES FOR LOCAL GOVERNMENT UNITS

GOVERNMENT UNIT	PRESENT VALUE OF NET REVENUES (Tax receipts less expenditures) ATTRIBUTABLE TO THE WIPP: [Millions of 1979 Dollars] r = 0% HIGH	r = 0% LOW	r = 6 7/8% HIGH	r = 6 7/8% LOW	r = 10% HIGH	r = 10% LOW
Carlsbad	$ 5.8	$4.1	$ 2.4	$1.5	$ 2.1	$1.3
Carlsbad School District	.4	.3	.2	.1	.2	.1
Loving	.3	.1	.1	.03	.1	.03
Loving School District	.2	.04	.1	.02	.1	.01
Hobbs	6.2	2.3	2.5	.9	2.3	.8
Hobbs School District	.2	.1	.1	.03	.07	.02
Eddy County	-1.3	-.6	-.7	-.2	-.6	-.2
Lea County	-.6	-.3	-.3	-.1	-.2	-.1

SOURCE: Discounted values given in Tables V.34, V.36, V.38, V.40, V.42 - V.45.

An annual breakdown of estimated county revenues and expenditures is given in Tables V.38 and V.42. High and low estimates (reflecting different estimates for in-migrants and their location) developed in this work, as well as estimates developed in the FEIS, suggest that, in terms of WIPP-related effects, county expenditures exceed revenues during the entire 30-year project life. Two observations are relevant, however. First, relative to total annual county expenditures (e.g., $4.1 million during 1978-79 in Eddy County *), the estimated deficit is small; for example, the estimated operations-phase deficit for Eddy County ($20,000 to $25,000) is less than 1% of 1978-79 expenditures. Second, county revenue and expenditure estimates are based on per capita (or per household) measures for 1978-79 which are applied to estimates for WIPP-related in-migrating population. Thus, county revenues from oil and gas -- which accounted for 24% of Eddy County revenues in 1978-79 -- are excluded in this study and the FEIS (Table III.5) inasmuch as such revenues are <u>not</u> related to population; similarly, revenues from interest on investment and payments in lieu of taxes (25% of county revenues) are not assumed to increase with in-migrants in this study, in contrast with FEIS estimates. Thus, the county deficits shown here in the FEIS must be viewed with some askance inasmuch as small changes in revenues could eliminate the deficit and, more importantly, 1979 per capita levels of expenditures may not in fact be maintained, particularly during the construction phase. Nevertheless, the potential for county deficits, however small, should be noted and county planning may wish to give particular attention to means for handling such deficits if they in fact occur.

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*FEIS [October, 1980, p. H-71].

These discussions of municipal effects are closed with the following observations which are informational in character. The New Mexico Highway Department has estimated traffic flow on major streets, roads and highways* and peak hour loads for Carlsbad. The peak hour capacity of streets, roads and highways as estimated in the DEIS are from 30% to 500% greater than 1976 peak loads. These data imply that congestion is unlikely to occur during the construction or operation phase due to WIPP engendered commuting and other automobile trips. Highway congestion is unlikely particularly if WIPP contractors utilize the bus park-and-ride transportation system which has been proposed. In cases where WIPP-related automobile trips do cause additional congestion, travel times are unlikely to be increased by a significant amount because of the few critical intersections in Carlsbad and Hobbs and the relatively short average trip lengths.

There are a number of recreational facilities in Hobbs and Lea county; the following facilities are in service in Hobbs and Lea county:

28 tennis courts
2 golf course
4 swimming pools
2 bowling alleys (36 lanes)
9 city parks
1 dirt auto race track
16.5 acres of public picnic facilities

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*See Traffic Flow Maps of Urban Areas, New Mexico Highway Department; also, Carlsbad Traffic Study, New Mexico HIghway Department.

The following recreational facilities are in place in Carlsbad and Eddy county:

12 tennis courts

2 golf courses

6 swimming pools

1 bowling alley (24 lanes)

20 municipal parks including Lake Carlsbad and Presidents Park

1 municipal museum

1 dirt auto race track

1 roller rink

These facilities can be expected to be adequate for baseline population and WIPP engendered growth until the mid 1990s; Carlsbad is considering the construction of one or two additional swimming pools to accommodate baseline population growth.

F. Financial Institutions

The primary role of financial institutions is one of an intermediary between savers and borrowers. Savers, both individuals and businesses, utilize demand deposits (checking accounts), time deposits (savings accounts) and certificates of deposit as financial investments in order to carry out their short term (to smooth inflows and outflows of income and expenditures) and long term (savings and investing) financial objectives. Financial institutions utilize these funds, after meeting the required reserve requirements established by state and federal regulations, to make loans to borrowers in the local economy and to purchase government and private securities on national markets. Financial institutions fall into three major classes -- commercial banks which specialize in commercial loans made to businessmen, savings and loan institutions which specialize in mortgage loans, and other institutions such as credit unions, mortgage and finance companies and a wide variety of other entities which perform specialized functions.

There are two inquiries which should be made concerning these institutions and the potential effects of the WIPP: (1) What institutions exist at present and (2) do these institutions have the capacity to provide the additional services which may be required as a result of the WIPP? The first question can be dealt with in a straightforward manner. The number of institutions as of 1978 are given below:

	Carlsbad*	Hobbs
Commercial Banks (State & National)	3 (5)[1]	3 (12)
Savings & Loans (State & Federal)	1 (0)	1 (1)
Credit Unions	1 (0)	0 (0)

[1]Number in parenthesis are the total number of branches.

*Loving has one of Carlsbad's branch banks.

In terms of the second question, three considerations are relevant: attitudes of the financial community and general economic conditions; present loan capacities of financial institutions; and, WIPP-related impacts on capacities of financial institutions. Discussions with members of the financial community in the two county area suggest the existence of financial institutions committed to promoting stable growth in the area. The collapse of housing markets in the late 1960s, as a result of depressed economic conditions in the potash industry, has given rise to understandable conservatism in terms of speculative housing, but few problems are anticipated with regards to the availability of financing for homes and businesses at levels consitent with baseline growth in population and WIPP-related population in the operations phase, all else equal.

In terms of general economic conditions, current, high interest rates and expectations for further increases in interest rates pose obvious problems. One can only speculate as to the possible character of unemployment and interest rates at whatever future date WIPP construction might be initiated. If current conditions were to obtain, tight money conditions could well lead to severe problems in housing construction, discussed above, financing for new business, discussed below in section G, as well as local/county government efforts to acquire funds required for meeting needs of an expanded economy.

Loan capacities of the two county area's financial institutions are, in large part, determined by the volumn of monies held as deposits in commercial banks and savings/loan institutions. An indication, however crude, of relative loan capacities in given by the ratio of loans to total deposits. These data are given for financial institutions in Carlsbad and Hobbs in

Table V.47 ; also included in Table V.47 are comparative data for Farmington and Grants. For the five-year period 1974-1978, loans as a percent of deposits were about the same in Farmington, Grants and Hobbs -- averaging between 53% and 58%. The corresponding average for Carlsbad was considerably higher, however, averaging about 88%. The higher ratios for Carlsbad over this 5-year period and for Farmington during 1977 and 1978 is explained in part by the high loan rate, relative to deposits, during these periods, reflecting the resurgence of oil/gas development activities in Carlsbad and coal developments in the Farmington area. During the 1974-78 period, loans increased by 288% in Carlsbad compared to a 258% increase in deposits; in Farmington, loans increased by 320% compared with a 215% increase in total deposits (Table V.47).

Of course, not only would the WIPP project given rise to increased demands for loans and other services from financial institutions, but loan capacities would be increased as a result of larger deposits from increases in income -- wage and non-wage -- in the area. Based on an average for four growth counties in the State,* deposits in financial institutions are some $7,000.00 per employed person. Using this datum as a rough measure, increased deposits in local financial institutions could average some $9.3 million per year during the construction phase and some $7.6 million during the operations phase.

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*Eddy, Lea, San Juan and McKinley counties.

TABLE V.47

LOANS, DEMAND DEPOSITS, SAVINGS DEPOSITS IN BANKS AND SAVINGS AND LOANS, 1970-1978

YEAR	LOANS	DEMAND DEPOSITS	TIME AND SAVINGS DEPOSITS	TOTAL DEPOSITS*	LOANS ÷ TOTAL DEPOSITS
		(millions of 1979 dollars)			
		FARMINGTON			
1970	170.2	109.9	125.4	653.3	.26
1971	353.7	147.2	171.5	823.5	.43
1972	376.2	146.8	196.5	971.5	.39
1973	471.5	213.1	232.8	1095.5	.43
1974	594.7	273.9	288.1	1276.6	.47
1975	841.4	393.0	635.2	1621.0	.52
1976	1103.9	417.4	774.1	1953.3	.57
1977	1506.5	571.4	910.2	2439.5	.62
1978	1903.2	716.1	1223.6	2750.4	.69
		GRANTS			
1970	36.4	27.2	31.8	75.0	.48
1971	46.9	29.7	35.7	81.1	.58
1972	51.5	32.8	42.6	92.2	.57
1973	61.6	40.9	52.8	116.9	.53
1974	88.8	42.4	64.8	144.4	.62
1975	130.4	73.5	85.2	212.9	.61
1976	170.9	105.2	112.3	374.6	.46
1977	221.0	155.2	152.3	374.6	.59
1978	286.9	179.6	203.0	475.5	.60

*Total Deposits Consist of:

1) Total Deposits in State Banks
2) Total Deposits in National Banks
3) Total Savings in S & L Associations: Regular Savings Accounts; Savings Certificates; Income Retirement Accounts
4) Shares and Deposits in Credit Unions

TABLE V.47 Continued

LOANS, DEMAND DEPOSITS, SAVINGS DEPOSITS IN BANKS AND SAVINGS AND LOANS, 1970-1978

YEAR	LOANS	DEMAND DEPOSITS	TIME AND SAVINGS DEPOSITS	TOTAL DEPOSITS*	LOAN ÷ TOTAL DEPOSITS
		(millions of 1979 dollars)			
		CARLSBAD			
1970	167.3	85.2	154.4	204.7	.81
1971	198.7	91.3	292.5	241.1	.83
1972	247.1	117.3	236.4	302.2	.82
1973	298.4	131.4	286.9	362.7	.82
1974	385.2	161.0	365.8	457.7	.84
1975	496.5	197.7	480.8	581.0	.86
1976	646.8	237.1	614.5	780.0	.83
1977	899.0	293.9	681.9	980.2	.92
1978	1110.8	303.7	933.7	1182.9	.94
		HOBBS			
1970	261.8	121.9	208.5	728.9	.36
1971	314.0	132.8	255.9	824.9	.38
1972	417.2	166.3	308.3	1003.5	.42
1973	531.5	214.0	396.0	1206.5	.44
1974	670.5	275.9	487.8	1397.5	.48
1975	830.4	331.3	599.0	1630.6	.51.
1976	987.4	347.4	759.1	1970.9	.50.
1977	1353.4	490.7	985.8	2446.8	.55
1978	1796.0	546.5	1158.3	2964.5	.61

Source: "Annual Report of The Department of Banking", 1970 - 1978.

*Total Deposits is the sum of Demand Deposits, Time and Savings Deposits, Deposits of U.S. Government, Deposits of States & Political Subdivisions, Deposits of Commercial Banks, Certified and Officers checks.

The observations noted above ignore potential effects on the two-county areas' financial environment from external sources and, for completeness, examples of such external sources are mentioned here. First, it should be noted several local banks are owned by large holding companies and, as such, have degrees of flexibility beyond those implied by local bank assets. On the other hand, the fact that local banks are interconnected with regional and/or national financial institutions implies that local investors must essentially compete for funds in regional/national markets; i.e., the "leakage" of loanable funds to non-local institutions is a plausible occurrence.

Thus, with obvious cavaets related to the external considerations noted above, as well as general economic conditions at the time that WIPP construction is initiated, the WIPP may have positive effects on loan capacities of local financial institutions, providing (based on average 1978 loan-deposit ratios for Eddy and Lea Counties, .70) more than $6.5 million per year in loanable funds during the construction phase* and $5.3 million during the operations phase.

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*Of course, amounts in excess of expected long-term deposits would be available only for short-term loans.

G. Diversification

The importance of diversification in a local economy is essentially two-fold. First, a more diversified economy is one in which economic activity is taking place in more industries and sectors. This means that occupational choice and the location and number of establishments in which to find employment is greater for the local labor force. Over time increased diversification involves upgrading in the training and experience of the labor force which, in turn, enhances the pool of labor available to prospective businessmen and corporations.

Secondly, diversification reduces risk. Economic and financial risk is measured by the variability in employment, profits and other measures of economic activity. A local economy which is specialized in one industry or one firm is vulnerable because a change in market conditions, a technological change, a decision to relocate, or the exhaustion of a natural resource may be devastating to the community's economy. The ghost towns of the western U.S. and New England mill towns remain as stark reminders of the costs of specialization. In financial theory it is easily proven that a diversified portfolio of assets is inherently less risky than one which is concentrated in only a few investments. The analogous situation in a regional economy is that diversification in terms of the number of different industries and individual enterprises reduces risk of the business cycle or other economic and social changes creating major impacts.

Of concern in this section is the question: to what extent might the WIPP project affect the character of economic diversification in the two county economy? Obviously, the WIPP is, *per se*, a new "industry" in the two county area and, as such, broadens the area's economic base. On its face, then, the WIPP project makes the local economy more diversified.

There is a flip-side to this issue, however. The designed operations life for the WIPP facility is 23 years [FEIS, p. 1-5]. Therefore, the source for employment and other economic effects that contribute to the expansion of the two county area's economic base will disappear in 23 years. Dislocations will undoubtedly attend the closing of the WIPP - - total annual WIPP-related employment during this 23 year period is 1,081 jobs and personal income generated each year is some \$20 - \$25 million dollars (1979 dollars). Costs associated with these dislocations are difficult to define and measure, however, and would be quite small in terms of present value measures. Relevant costs would be those related to immobile factors of production that would become unused or underutilized upon the closing of the WIPP. Since total WIPP-related employment would account for only about 3.5% of current employment levels in the two county area, and will undoubtedly account for a smaller percentage of total employment after 30 years (a 7-year construction period plus 23 years operation), the source for any substantial costs are almost impossible to conceive. By "substantial" reference is made to the following exaggerated example of costs. If half of the total WIPP-related job holders, (540) were to remain totally unemployed for eight years following the WIPP's closing, and assuming, however arbitrarily, a \$6,000 annual opportunity cost for each unemployed person, the present value of these costs (with a 10% discount factor) would only amount to some \$800,000. Therefore, costs associated with the WIPP's closing mentioned here is a factor deserving consideration once the WIPP's operations begin; no effect is made to quantify such costs in this study, however.

Looking beyond the WIPP itself as a source for diversification in the two county economy, one may inquire as to the existance of forward or backward "linkages" associated with the WIPP which might give rise to diversification effects. "Forward linkages" would refer to users of the WIPP's output which might locate in close proximity to the WIPP; "backward linkages" would refer to firms that sell goods and services to the WIPP which might locate near the WIPP site. There is no evidence that would suggest the existence of backward or forward linkages during the WIPP's construction phase. This is not to say that trade activities will not expand in the area during the construction phase; indeed, estimates given above for indirect employment are based on such expansions. Given the short period of time involved in the WIPP construction period--relative to time required for depreciating capital goods--it seems plausible to expect that a large part of the expansion in economic activity during the construction phase would take the form of more intensive use of labor, in which case one would not anticipate a substantial increase in the number of operating businesses during this phase. In any case, construction-related expansion can be expected to have a "deepening" effect in the two county area's economic sectors rather than a "broadening"--diversifying--effect.

In terms of the WIPP's operations phase the WIPP will contribute to an expansion in the level of economic activity in the two county area as has been demonstrated above. However, there is little reason to expect that WIPP-induced economic activity would reflect diversification in the area's economic base. In terms of forward linkages, the WIPP's "output"--the storage of nuclear waste--is not a product whose use would attract new firms to the area. In terms of backward linkages, the WIPP's major "inputs" are nuclear wastes and scientific expertise. The "producers" of nuclear wastes--primarily, the military--would not be attracted to the area for obvious reasons. The scientific expertise "input" will be provided, primarily, by direct WIPP employment (already included in impact measures) and, possibly back-up research activities at the Sandia Laboratories. Implication of these latter expenditures are discussed in the following chapter concerning WIPP-related impacts on the State.

Of course, the WIPP facility will undoubtedly require a wider range of materials and supplies during the operations phase. If the WIPP is operated by the federal government, federal procurement procedures will dictate how such materials and supplies are to be acquired in the local economy. If the WIPP is operated under contract with the DOE by a private organization (which is currently thought to be the case), a larger proportion of the local purchases of materials and supplies is likely. Reflecting this latter case, the FEIS provides estimates for WIPP-induced indirect employment by economic sector during an average year during the operations phase as shown in Table V.48. When compared with estimated 1987 baseline employment in each economic sector, these data can be used as a rough measure for the <u>relative</u> impact of WIPP purchases on each economic sector.* As demonstrated by data in Table V.48, the <u>relative</u> impact of WIPP purchases on activity levels in each economic sector is likely to be small--the largest impact is a 2.6% increase in sales in the finance-insurance-real estate sector.**

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* Employment is used here as a surrogate for sales. The percent increase given in column 4 of Table V.48 <u>overestimates</u> the potential impact of direct WIPP purchases inasmuch as indirect employment (column 3) reflects the effects of increased purchases by the baseline population and in-migrating population.

** Again the upward bias of these relative impact measures noted in the previous footnote should be observed.

TABLE V.48

RELATIVE IMPACTS OF THE WIPP ON TOTAL EMPLOYMENT
BY SECTORS DURING THE OPERATIONS PHASE

ECONOMIC SECTOR	EMPLOYMENT[1/]	WIPP-INDUCED INDIRECT JOBS IN AN AVERAGE YEAR OF OF THE CONSTRUCTION PHASE[2/]	PERCENT INCREASE FROM WIPP-INDUCED EMPLOYMENT
Agriculture	2,747	2	0.1%
Mining	14,286	3	-----[3/]
Manufacturing	2,747	14	0.5
Construction	3,297	13	0.4
Transportation, Communication and Utilities	4,945	53	1.1
Trade	13,187	192	1.5
Finance, Insurance and Real Estate	2,198	58	2.6
Services	7,143	121	1.7
Government	6,593	58	0.9

1/ Assuming a 1987 population of 124,100 in Eddy and Lea counties [FEIS, p. L-49], a .4612 labor force participation rate and 4% unemployed, baseline (without WIPP) employment would be 54,946. Allocation to economic sectors is based on the 1979 allocation given in Adcock [Oct., 1980, p. 2 - 26].

2/ Adcock [Oct., 1980, p. 3 - 26]; rounded to nearest whole number.

3/ Less than 0.1%.

Based on the considerations given above, the authors of this study find no basis for attributing additional benefits (or costs) to the WIPP project from diversification impacts. This conclusion is subject to a potentially important caveat, however. Due to the nature of available data, analyses of potential diversification effects are necessarily conducted at a relatively aggregated level -- the county or two-county area level. The range of services available in each of the communities of interest here -- Carlsbad, Hobbs and Loving -- will obviously be very different; a survey of such services available in each of these communities is given in Tables V.49, V.50, and V.51. Thus, while analyses of economic activity in the two-county area may fail to support hypotheses as to diversification effects attributable to the WIPP, diversification effects may well obtain in small, sub-areas such as Loving. Referring to Table V.51 , few services are available in Loving, an observation that is not surprising given the range of services available in nearby Carlsbad (Table V.49). Should appreciable increases in Loving's population result from the WIPP, incentives may well exist for the establishment of small service firms in that community, thereby diversifying Loving's economy. However, even if one were to construct a scenario for such diversification in Loving, the issue of defining relevant "benefits" would be extremely complex inasmuch as the diversification of Loving's economy would most likely reflect a "deepening" loss in the Carlsbad economy; i.e., at issue here would be an inter-area transfer in economic activity wherein the net gain would likely be viewed as zero.

TABLE V.49

PRIVATE SERVICES IN CARLSBAD, NEW MEXICO

Service	No. of Services
Financial, Insurance, Legal and Business Assistance	
Banks	3
Branches	2
Savings & Loans Associations	4
Financing Co.	7
Investment securities	1
Insurance Co.	~ 60
Accountants	9
Tax Return Preparation	4
Lawyers	29
Title Companies	5
Real Estate - Sales & Services	
Agencies - residential	20
Agencies - business & industrial (included in the above)	4
Appraisers (6 inc. in resid. agencies)	7
Apartments - furnished	7
Apartments - unfurnished (4 inc. in the above) (Info. from CC lists 11 total)	7
Mobile home parks	16
Mobile home dealers	5
Homes for elderly	2
Medical Services, Pharmaceuticals and Other Health Goods	
Physicians & surgeons	27
Chiropractors	4
Podiatrists	2
Dentists	12
Pharmacies	14
Hospital	1
Medical administrative service	1
Medical equipment & supplies	1
Optical goods-services (opticians)	4
Optometrists	4
Hearing aid goods & services	1
Nursing-home service	1
Nursing homes (homes for elderly)	2
Medical laboratories	3

Service	No. of Services
Services - General	
Transportation	
Airport	1
Bus depot	1
Public	1
Auto service stations	~55
Auto body repairing	8
Hair	
Barber shops	11
Beauty salons	24
Cleaners	4
Mobile home reapiring & services	1
Social services	8
Laundries - drop off (5 inc. one branch)	4
Laundries - self service	6
Butane gas supplies	2
Moving & storage	6
Self-storage	1
Social service organizations	8
Travel agencies	8
Telephone answering service	1
TV & radio repair service	9
Preschools	5
Religion	
Churches	~55
Parochial schools	2
Church organizations	3
Food & Beverages	
Grocery stores (super markets)	16
Convenience stores	9
Bakers - retail	1
Bakers - wholesale	1
Suppliers - food products	1
- dairy, wholesale	1
Restaurants (~ 20 fast food)	55
Liquor establishments	
cocktail lounges	9
retail	11

Carlsbad, New Mexico

TABLE V.49 (Continued)

Service	No. of Services
Contractors	
Concrete	7
Building	33
Electric	6
General	24
Heating	13
Paving	2
Remodeling	7
Roofing	12
Architects	3
Hardware & Building Supplies	
Brick & concrete blocks	1
Lumber	4
Concrete	1
Used building materials	1
Roof truss co.	1
Gravel	1
Hardware-retail	9
Cabinet makers	3
Cabinets	2
Glass plate	4
Retail - General	
Auto dealers - new	18
Auto dealers - used	15
Mobile home equipment	2
Sporting goods	10
Retail - Apparell, Housewares, Gifts & Jewelers	
Department stores	8
Apparell	
Children	1
Ladies	9
Men's	1
Shoes	4
Uniform sales	1
Uniform supply	1
Furniture dealers - new	12
Furniture dealers - used	8
Gift shops	16
Jewelers	13
Variety stores	2
TV & radio dealers	12
Stereo equipment	8

Service	No. of Services
Recreation	
Bowling lanes	1
Clubs/organizations	6
Parks	2
Parks - amusement	1
Campgrounds	4
Skating rink	1
Library	1
Physical fitness centers	2
Theaters - movie	2
Theaters - community theater	1

TABLE V.50

PRIVATE SERVICES IN HOBBS, NEW MEXICO

Service	No. of Services
Financial, Insurance, Legal and Business Assistance	
Banks	2
Savings and Loans	3
Financing Co.	6
Investment Co.	1
Insurance Co.	26
Accountants	5
Tax Return Preparations	3
Lawyers	18
Title Companies	2
Real Estate - Sales and Service	
Agencies	9
Apartments	11
Mobile home parks	8
Mobile home dealers	7
Homes for elderly	2
Medical Services, Pharmaceuticals and Other Health Goods	
Physicians and surgeons	21
Chiropractors	3
Dentists	8
Pharmacies	10
Hospital	1
Medical Clinic	1
Mental health clinic	1
Opticians	3
Hearing aid center	1
Nursing home	1
Religion	
Churches	46
Parochial Schools	2

Service	No. of Services
Services - General	
Hair	
Barber shops	12
Beauty salons	26
Cleaners	7
Laundries	
Drop-off	2
Self-service	2
Auto service stations	44
Butane gas suppliers	2
Moving & storage	4
Travel agencies	2
Social service agency	1
Telephone answering service	3
TV & radio service	6
Food and Beverages	
Grocery stores	14
Convenience stores	17
Restaurants (~ 14 fast food)	48
Bakers	7
Suppliers	
Dairies	5
Liquor establishments	
Cocktail lounges	15
Retail stores	9
Night clubs	2
Contractors	
Building	17
Concrete	5
Electric	15
General	19*
Plumbing	12
Roofing	4
Architects	3
Carpenters	1

*Three electric contractors included in General

TABLE V.50 (Continued)

Service	No. of Services
Retail - Apparell, Housewares, Gifts & Jewelers	
Department Stores	8
Apparell	
Children & Infants	3
Ladies	13
Men's	4
Shoes	7
Uniform supply & work clothes	2
Furniture dealers - new	12
Furniture dealers - used	1
Gift shops	10
Jewelers	8
TV & radio dealers	7
Variety Stores	2
Stereo equipment	3
Recreation	
Bowling lanes	2
Clubs/organizations	4
Race track (auto)	1
Amusement park	1
Skating rink	1
Campgrounds	1
Theaters	4
Physical fitness centers	2
Libraries	1
Retail - General	
Auto dealers - new	5
Auto dealers - used	14
Sporting goods	6
Hardware & Building Supplies	
Brick & concrete blocks	2
Builders hardware	5
Cabinet makers	5
Lumber	5
Glass plate	4
Concrete - ready mix	2

TABLE V.51

PRIVATE SERVICES IN LOVING, NEW MEXICO

Financial, Insurance, Legal and Business Assistance

Commerce Bank and Trust
Loving Loan Co.

Religion

Loving Baptist Church
Our Lady of Grace Church

Services - General

Automobile Service:
- Loving Truck Stop Service Station

Commercial Establishments (other than food or drink)
- Loving Beauty Bar
- Loving Hardware & Lumber Co.
- Ideal Painting and Sandblasting
- Mikes Welding Service
- Pecos Valley Cotton Oil Inc.

Food and Beverages

Food-Grocery Stores
- Burkham & Sons Groc.
- Burkham & Sons No. 3 Groc.

Food-Suppliers
- Carlsbad Growers Co-Op
- Harroun Farms

Food-Service
- W T 3 Truck Stop
- Loving Mealsite Nutritional Program

Liquor Establishments
- Chris's Palace Bar
- Roadrunner Liquors

Mining

Craft Fertilizer & Chemical Co.
Duval Corporation Mining
Mississippi Potash Inc.

Source: Carlsbad, Hobbs and Loving Telephone Book.

VI. STATE-WIDE IMPACTS FROM THE WIPP

A. Overview.

In this chapter attention is focused on some of the potential direct, monetary impacts in the State of New Mexico which may result from the WIPP. Excluded in these discussions are other state-wide impacts related to risk management, emergency preparedness, accidents in the transport of nuclear wastes, accidents at the WIPP site, and property values; these topics are considered in later chapters.

Three major types of state-wide impacts are considered here. In section B, potential WIPP-related impacts on incomes in areas of the State outside of the Eddy-Lea county area are discussed. In section C attention is focused on foregone incomes and employment in the State -- "opportunity costs" -- which may attend the WIPP project. Potential WIPP-related impacts on State revenues and expenditures are considered in section D.

B. WIPP-Related Impacts on Incomes Outside of the Eddy-Lea County Area.

WIPP-related impacts on incomes (and, therefore, employment) outside of the two county area -- but in the State -- are suggested to be minimal in the FEIS:

> "The indirect impacts that will be felt throughout the State in terms of new jobs and additional income... should not be substantially greater than those reported for the two county area." [FEIS, p. 9.52]

The rationale given in the FEIS for this conclusion is that the linkage between these two counties and other areas of the State are weak; Eddy county is more closely linked with El Paso, Texas and Lea county with Dallas, Texas [FEIS, p. 9.52].

The FEIS does not report estimates for just what "substantially greater" might mean in terms of WIPP-related State-wide incomes outside of the two county area for good reason: current input-output and/or inter-county trade flow studies for the State do not exist. This lack of data notwithstanding, it would be desirable to develop some approximation for these State-wide incomes even if, as must be the case here, such approximations represent an upper bound for these measures of interest.

To the end of developing an approximation for WIPP-related incomes in the State outside of the two county area, the following data are brought together in an effort to characterize, however imperfectly, the disposition of personal income. For each dollar of personal income received in the two county area, the following is assumed.

(i) \$0.49 is spent on local goods and services [FEIS, Table L-1, column sum for row 54];

(ii) \$0.174 is spent on the purchase of goods and services from out-of-state sources -- i.e., out-of state imports [BBER, 1965, Table A, household expenditures on imports (row 50, column 43) divided by gross household income (sum of row 43)];

(iii) \$0.0452 is saved [U.S. Department of Commerce, 1979, Table 732, personal savings divided by personal income];

(iv) \$0.103 is paid for federal taxes [BBER, 1965, Table A];

(v) \$0.0265 is paid for State taxes [New Mexico Taxation and and Revenue Department].

(vi) the residual, \$0.1613, is spent for goods and services provided by New Mexico firms outside of the two county area.

The assumptions described above provide an estimate for first round effects on gross sales in the State from WIPP-related personal income generated in the two county area, viz., 16.13% is spend for New Mexico goods and services produced outside of the area. The impact of such expenditures on household incomes in the State is estimated at 1.29.* Thus, each dollar of WIPP-related personal income in the two-county area is assumed to result in $.2081 ($.1613 times 1.29) in State-wide income outside of the two county area.

Resulting estimates for State-wide increases in income attributable to the WIPP are given in Table VI.1. During the peak construction years of 1982 and 1983, personal income in the State outside of the two county area may increase by some $12 million; in the operations phase, annual increases in personal income in the State may average some $23.5 million in the two county area and some $5 million in other parts of the State.

It must be re-emphasized that the State-wide income estimates for the non-two county area must be regarded as an upper bound for such measures for a number of reasons, most important among which is the likely under-estimate for out-of-state purchases implicit to these measures. The logical lower bound for such estimates is that suggested in the FEIS, viz., a negligible impact of the WIPP on State incomes outside of the two-county area.

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*The household income multiplier implied by column 54, row 54 of the FEIS I-O model (FEIS, p. L-17) -- household income per dollar spent by households -- is used here.

TABLE VI.1

UPPER BOUND ESTIMATES FOR WIPP-RELATED INCREASES IN STATE-WIDE INCOME OUTSIDE OF EDDY AND LEA COUNTIES AND TOTALS

YEAR	WIPP-RELATED INCREASES IN PERSONAL INCOME: IN EDDY AND LEA COUNTIES[1/]	EXCLUDING EDDY AND LEA COUNTIES	TOTAL FOR STATE
	(million's of 1979 dollars)		
1980	$ 3.46	$ 0.72	$ 4.18
1981	16.84	3.50	20.34
1982	55.68	11.59	67.27
1983	64.56	13.43	77.99
1984	17.37	3.61	20.98
1985	15.59	3.24	18.83
1986	25.28	5.26	30.54
1987 - Thereafter	23.46	4.88	28.34

[1/] Table V.6

Source: 20.81% of personal income given in Table V.6.

C. Present vs. Future Values.

Concern in this section is with the potential foreclosure of other development options in the State as a result of the WIPP and the potential detrimental effects of the WIPP on established sectors of the State's economy all of which are referred to as "opportunity costs". First in this section, the opportunity costs which are amenable to estimates in sums of dollar losses to the State are described; these include the options of minerals and energy development and agricultural use (grazing) which may be foregone as a result of the WIPP. The discussion is then devoted to investigating qualitative issues related to possible detrimental repercussions in the markets for local dairies, tourist attractions and recreation areas, and retirement housing and services in Carlsbad as a result of the WIPP. A final issue which is to be considered is the opportunity cost in terms of developing a "wild" area and the resultant losses in terms of what has been described as "option value" and/or "existence value."

C.1. Measurable Opportunity Costs. In what follows, opportunity costs are described for potash, hydrocarbons and ranching.

C.1.a. Potash. The WIPP site is located in the United States' most extensive potash mining district, and there are two types of potash deposits which have been identified at the site. The majority of minable potash in the site is langbeinite, while sylvite is found in lesser quantities.

In the United States, potash is used almost exclusively for agricultural fertilizers; it is not reclaimed or recycled, and there are no substitutes for potash in agriculture. Some 90% of agricultural consumption is muriate (potassium chloride) made from sylvite. Sylvite is found extensively in New Mexico, Utah and Michigan, and vast deposits exist in the Canadian potash fields. Another 5% of consumption is langbeinite, a potassium and magnesium sulfate. Langbeinite is used mainly for crops such as citrus and tobacco which are sensitive to chlorine (i.e., those which are sensitive to muriates) and, in a much smaller market, for soils deficient in magnesium used for grazing purposes however, industry experts expect that as soil minerals become more and more depleted, this market for langbeinite will grow over time. Though some langbeinite exists in Eastern Europe and very small quantities are produced in West Germany, the langbeinite deposits in the Carlsbad district represent essentially the only major deposit in the free world. Currently, langbeinite is being produced in the Carlsbad region by two mining companies.

The other main potash product is potassium sulfate which is also used for chlorine-sensitive crops, but which contains no mangesium, and so can be used as a fairly close substitute for langebeinite (except in instances where magnesium is required.) Outside of New Mexico, sulfates are found in the Great Salt Lake and other brine lakes in the U.S., in the extensive Canadian potash deposits, and in several Western European nations and the U.S.S.R. Therefore, in considering opportunity costs of foreclosing the WIPP site to mining development, the following factors are relevant:

- the majority of the site's potash deposits are langbeinite;
- though langbeinite represents a small portion of U.S. potash consumption, the Carlsbad District contains the only known langbeinite deposit in the free world;
- potassium sulfate, available at Carlsbad and other locations, can be substituted for langbeinite in agricultural uses, except for those few cases where magnesium is required.

Using drilled core samples from the WIPP site, two separate studies of the extent of the potash deposits there have been made, one by the U.S. Bureau of Mines and another by a consulting firm, Agricultural & Industrial Minerals, Inc. (AIM). The AIM study, the more recent of the two, derived more conservative estimates than the U.S.B.M. study, and discussions with potash industry experts in Carlsbad suggest that the AIM results are considered to be more reliable.

Therefore, the following estimations of the opportunity costs associated with foregone potash mining at the WIPP site are based on two estimates made by AIM. First, taken as an upper bound opportunity costs are derived based upon the resource estimate. The estimate of potash resources is defined to be the probable extent of ore body which could be mined without regard to economic constraints. Since, over time, better technology and/or market conditions could warrant mining which is not currently profitable, it is assumed that the identified resources could represent opportunity costs of the future. Second, the reserve estimate by AIM, defined to be that portion of the potash resource which is currently profitable to mine, is used as a lower bound on opportunity costs. Discussions with experts in Carlsbad whose mining companies currently hold leases and have operations adjacent to the WIPP have indicated that, in the absence of the WIPP, mining operations might begin in that area only after some 20 years. One company in particular has developed a patented process which allows mining of very low grade ore if a combination of langbeinite and sylvite can be mined (though one of the two must be of a relatively higher grade.) However, officials at other mining companies indicated that the low grade ore underlying the WIPP site might not be mined for at least 50 years, and therefore the opportunity cost calculations for reserves reflect this fact for their lease holdings.

Table VI.2 provides the AIM estimates of potash ore resources and reserves:

TABLE VI.2

AIM ESTIMATES FOR POTASH RESOURCES AND RESERVES AT THE WIPP SITE

	Resources (tons x 10^6)	Reserves (tons x 10^6)
All Potash	153	29.7
Muriate Product	6	1.8
Langbeinite Product	30.9	4.2

Table VI.3 presents AIM estimates of the percentage of the total regional and national muriate and langbeinite products found at the WIPP site:

TABLE VI. 3

AIM ESTIMATES FOR WIPP AFFECTED POTASH RESERVES AND RESOURCES AS A PER CENT OF REGIONAL AND NATIONAL SOURCES

	Wipp Affected Sources: % of Carlsbad District		% of U.S.	
	Reserves	Resources	Reserves	Resources
Muriate Products	3%	8.9%	2.2%	3.2%
Langbeinite Products	11%	49%	11%	49%

After discussions with industry officials, it was assumed for the reserve estimate that current langbeinite and sylvite production by the company capable of producing at WIPP in 20 years would be near current levels--about 527,000 tons of langbeinite/year and 473,000 tons of muriate per year. In 50 years, another lease containing 890,000 tons of langbeinite is assumed to be mined; these production rates are projected into the future until reserves are exhausted. In total, this represents approximately 7 years of refined langbeinite production and 4 years of muriate production from reserves.

Resources are assumed to be developed in 20 years by both companies, yielding an annual production of refined langbeinite of 1,377,000 tons and annual muriate production (by one company) of 473,000 tons. Again, these rates are projected into the future until resources are exhausted. Under these assumptions, langbeinite resources would last about 23 years, and muriate production could be undertaken for 13 years.

Based on these assumptions, Table VI.4 presents opportunity costs to the State of New Mexico, in terms of foregone income (wage payments) and foregone taxes and royalties, if the potash reserves and resources at the WIPP site are not developed. It should be remembered that withdrawal of the WIPP site would not affect the local economy at present, since the market can be met with current production; opportunity costs presented are for 20 years hence and beyond.

A final important point with respect to opportunity costs associated with potash reserves and resources is the possibility of allowing mining in Zone IV. Recommendations made for siting criteria by Sandia Laboratories researchers state that existing mining activity which is not related to

TABLE VI.4

Potash Opportunity Costs: Zones I-IV

	r = 0%	r = 6 7/8%	r = 10%
Local wages generated:[a/]			
reserves	$ 99,274,560	$ 18,946,867	$ 9,652,518
resources	$589,390,560	$ 82,976,617	$ 37,209,843
Personal income taxes paid to the state on above.[b/]			
reserves	$ 2,541,429	$ 485,040	$ 207,104
resources	$ 15,088,398	$ 2,124,201	$ 952,572
Corporate income taxes:[c/]			
reserves	$ 5,664,336	$ 1,075,681	$ 548,002
resources	$ 34,114,104	$ 4,782,851	$ 2,141,895
Other State Tax and royalty payments collected.[d/]			
reserves	$ 15,441,678	$ 2,947,094	$ 1,501,403
resources	$ 91,676,856	$ 12,906,612	$ 5,787,811

[a/] Based on AIM (1978) reserve and resource estimates; 1980 prices of $55/ton of langbeinite and $70/ton of muriate; annual langbeinite production of 1.377 million tons and muriate production of 473,000 tons, beginning in 20 years (based on predictions made by industry experts); a direct income multiplier = .27808 from the FEIS I/O tables is used. Note: this may be an upper bound, since it assumes all "new" employment, drawn either from the State pool of unemployed or from new workers entering the State, rather than intra-state movement of labor.

[b/] Using 1979 average income tax rate = 2.65%, based upon data from the N.M. Taxation and Revenue Department, personal taxes paid as a percent of gross incomes.

[c/] Using 1978-79 average corporate income tax rate = 4.744%, based upon data from N.M. Taxation and Revenue Department, corporate income taxes paid as a per cent of total gross corporate income.

[d/] Property tax = 26.793 mills (Carlsbad School District); royalty payments = 5%; resource excise tax = 1/8 of 1%; processor's tax = 1/8 of 1%; severance tax = 2.5% (taxable value is estimated as in Sections 7-26-4 NMSA 1979.)

the WIPP respository should not be allowed within two miles of the respository. The entire area of Zone IV is within that two mile limit. However, the recommendation is that "future, controlled" mining will be allowable up to one mile from the repository.* Discussions with researchers have not revealed when that future time might be, and so a statement cannot be made as to when Zone IV might be released to mining activity.

If, as researchers claim, Zone IV would be released, the AIM analysis suggests that some 69% of the potash reserves and resources would be recoverable. The potential impact of this assumption for opportunity costs to the State associated with the production of potash (commencing in 20 years) is exemplified in Table VI.5 for the wages component.

TABLE VI.5

Potash ($1980)

Potash Opportunity Costs: Zones I-III

If Zone IV is released, opportunity costs decline to: (31% left in Zones I, II, III).

	r = 0%	r = 6 7/8%	r = 10%
Local wages generated:			
reserves	$ 30,775,114	$ 5,873,529	$ 2,992,281
resources	$182,711,070	$ 25,722,751	$ 11,535,051

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*Powers, et. al.

C.1.b. Hydrocarbons. A hydrocarbon resource study was performed by the New Mexico Bureau of Mines and Mineral Resources (Foster, 1974) to determine the levels of oil, natural gas, and natural gas distillate present at a site 5 miles northeast of the current site. That resource evaluation (a measure of hydrocarbons potentially recoverable without economic constraints) is used here as the best available approximation of an upper bound on opportunity costs associated with removing the WIPP site from energy development options.* As in the potash analysis, resource estimates are again used as an approximate upper bound for opportunity costs.

A reserve estimate (delineating those resources that may be profitably mined at current market prices and production costs) was made by Keesey in 1976 (updated in 1979). Reserve estimates for natural gas and distillate, (the Keesey study found no economic crude oil deposits) are used here to provide a lower bound for opportunity costs associated with foregone hydrocarbon production.

The hydrocarbon reserve and resource estimates are presented in Table VI.6, along with estimates of their relative importance for national reserves and resources.

Following the same methodology described for estimating bounds on the opportunity cost of foregone potash development, upper and lower bounds on potential hydrocarbon development have been derived from the Keesey (1979) and Foster (1974) estimates of reserves and resources. The bounds on the present value of opportunity costs to the State of New Mexico are presented in Table VI.7 for discount rates of 0%, 6-7/8%, and 10%. Production of hydrocarbons is assumed to begin in 5 years.

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*Due to upcoming condemnation hearings, data on potential production and costs on the various leases held within the WIPP by several oil companies are not available at this time.

TABLE VI.6

ESTIMATES FOR HYDROCARBON RESERVES

AND RESOURCES AFFECTED BY THE WIPP

	Crude Oil at WIPP Site (10^6 bbl)	% of U. S.
reserves	nil	nil.
resources	37.5	.019%

	Natural Gas (10^6 mcf)	
reserves	44.622	.021%
resources	490.120	.057%

	Distillate (10^3 bbl)	
reserves	118,524	.0003%
resources	5,720	not available

TABLE VI.7

Oil, Natural Gas, and Distillate Opportunity Costs: Zones I-IV

	r = 0%	r = 6 7/8%	r = 10%
Local wages generated:[a]			
reserves	$ 20,053,407	$ 10,877,406	$ 8,087,382
resources	$ 398,079,980	$103,428,410	$ 67,442,009
Personal income taxes paid on the above:[b]			
reserves	$ 531,415	$ 288,251	$ 214,316
resources	$ 10,549,119	$ 2,740,853	$ 1,787,213
Corporate income taxes:[c]			
reserves	NA	NA	NA
resources	NA	NA	NA
Other State tax and royalty payments:[d]			
reserves	$ 21,938,107	$ 11,899,709	$ 8,847,467
resources	$ 435,493,160	$113,149,030	$ 73,780,484

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[a] Based on Keesey (1979) reserve and resource estimates; 1980 prices of \$36,33/bbl new crude oil, \$3.69/mcf natural gas, and \$29/bbl distillate (estimates by American Petroleum Institute, Statistics Div.); annual crude production of 1.875 x 10^6 barrels, annual natural gas production of 4.4622 x 10^6 mcf, and annual distillate production of 11,852 barrels/yr. (based on predictions made by, petroleum industry consultants); wage income estimated based on direct income multiplier = .1193 from the FEIS I/O tables. Note: this may be an upper bound since it assumes all "new" employment the state, rather than intra-state movement of labor.

[b] Using 1979 average income tax rate = 2.65%, based upon New Mexico Taxation and Revenue Department data, personal income taxes paid as a per cent of total gross incomes.

[c] Not available due to the unavailability of adequate cost data to estimate net revenues (taxable income).

[d] Royalty rate = 12.5%, severance ad valorem taxes based on Keesey (1979) estimations (p. 9-26-27, FEIS).

If at some time Zone IV were released for drilling (and it should be emphasized that there has been no guarantee if and when this would be possible) the Foster study indicates that some 57% of the hydrocarbon resources would become accessible for production. Reserves in the Keesey study were also estimated for Zones I, II, and III assuming that Zone IV would not be removed from drilling activities. However, though the Keesey study found that 53% of the natural gas reserves and 75% of the distillate reserves at the site are located in Zone IV, if slant drilling from outside the zone were required the drilling costs would exceed production revenues; therefore, a requirement of slant drilling into Zone IV may very well render the natural gas and distillate reserves there sub-economic. The reduced opportunity costs to New Mexico associated with foregone hydrocarbons production, assuming Zone IV is released, are exemplified in Table VI.8 for the wages component of opportunity costs.

TABLE VI.8

Oil, Natural Gas, and Distillate Opportunity Costs: Zones I-III

If Zone IV is released, opportunity costs decline to:

(reserves: 47% of natural gas, 25% of distillate left in Zones I, II, III.

resources: 43% of all left in Zones I, II, III)

	r = 0%	r = 6 7/8%	r = 10%
Local wages generated:			
reserves	$ 9,334,892	$ 5,057,924	$ 3,764,689
resources	$171,174,390	$ 94,474,215	$20,000,064

C.1.c Ranching. Though potash and hydrocarbons are the only minable natural resources that have been identified at the WIPP site, the entire area has also been leased for grazing activities. However, the grazing in the area is restricted by BLM guidelines to a density of 70-106 acres/head (i.e., on the WIPP site of 18,960 acres, the allowance is some 178-267 head total). The associated present value of the opportunity cost of foregone grazing activities is presented in Table VI.9 in terms of the net returns over 30 years from a "medium" commercial cow-calf ranch in southeastern New Mexico (as estimated by researchers at New Mexico State University).

TABLE VI.9

Opportunity Costs from Ranching

r = 0%	r = 6-7/8%	r = 10%
\$309,551	\$138,580	\$106,997

Though the values are relatively small, it has been argued that ranching activities do provide benefits other than monetary returns,* i.e., the "ranching as a way of life" position maintains that increasing restrictions on ranching operations and withdrawal of grazing lands significantly and detrimentally impact local ranchers.

However, project analysts predict that once the facility is constructed and in operation, grazing land will be reduced by only 1000 acres. After the construction period, commercial grazing may be allowed in Zones III and IV, and much of Zone II. If this is indeed the case, the impact on local ranching activities would reduce to a negligible opportunity cost.

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*John M. Fowler and James R. Gray, Market Values of Federal Grazing Permits in New Mexico, Range Improvement Task Force, Cooperative Extension Service, Las Cruces, NM, March, 1980, p. 8.

*Fowler and Gray [1980, p.8].

In summary, the quantifiable impacts on State incomes and tax revenues attending the WIPP site development are present in Tables VI.3 - VI.9. These opportunity costs associated with foregone mineral and energy production and (to a lesser extent) grazing could be reduced significantly with the release of Zone IV to mining activities and of Zones III and IV to ranching activities.

C.2. Other Considerations of an Opportunity Cost Nature. Several issues related to opportunity costs have been raised with respect to the WIPP site development. These issues deal with the possible community repercussions (in Eddy and Lea Counties) associated with perceived dangers attending a radioactive waste facility where the potential for a nuclear accident exists.

For example, one issue that has been raised suggests that local dairies and food-related processing operations would be detrimentally affected by lost sales revenues in the event of an accident and possible radioactive contamination in the area. However, discussions with officials at the State Board of Health revealed that the nearest food-processing operations to the site are several dairies which are 50 miles or further from the site--a distance which constitutes a reasonably wide margin of safety. Furthermore, looking at the Three Mile Island nuclear incident for reference, the Pennsylvania Department of Agriculture reported no evidence of a permanent decrease in the sale of agricultural commodities from farms and food processors in the vicinity of TMI.*

Another possible repercussion from either the presence of the facility or problems with its operation is the potential for lost tourism visitation

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*Mountain West Research, [1975, p. 72].

to the Carlsbad area resulting in losses in employment and revenues. Three recreational areas--Carlsbad Caverns, Guadalupe Mountains National Parks, and Living Desert State Part, draw about 1 million visitors per year to the area. Officials at the National Park Service have estimated that visitors to Carlsbad Caverns spend about \$30-\$40/day, while visitors to Guadalupe spend some \$20/day. In 1979, expenditures by visitors amounted to some \$39.7 million dollars (not counting expenditures by 66,000 visitors to the Living Desert State Park.) Furthermore, entrance fees collected and payments made to Eddy County by the Department of the Interior amount to over \$1 million annually and the payroll for the two national parks is about \$1.5 million/year.*

Clearly, there is a large potential for losses of State income and employment if an accident associated with the WIPP were to significantly impact tourist visitation to southeastern New Mexico. However, as yet there is no conclusive evidence to indicate that tourist visitation to the area would decline significantly. Discussions with officials in areas near nuclear facilities in other locations have revealed that tourism in those areas has not been significantly impacted. For example, in Alabama near the Brown's Ferry nuclear power plant, where the first nuclear incident occured in the mid-70's (the worst incident before Three Mile Island), officials report that recreational activities have flourished--so much so that a recent analysis of local recreation is being used in support of the construction of another nuclear facility in that state.** At Three Mile Island, cancellation of conventions scheduled for the period directly after the incident resulted in economic losses in Harrisburg, Pennsylvania of \$500,000-\$600,000. However, other evidence since the incident is not

*National Park Service, 1979.

**Personal communication with Mr. Gil Langley, Alabama Mountain Lakes, Association, Decatur, Alabama.

conclusive since gas shortages and a polio outbreak in the area have contributed to declines in tourist visitation to the region.

Another potential for economic loss to the Carlsbad area is the possibility of a drastic decline in the influx of retirees if the WIPP site were established and/or an incident were to occur. Carlsbad has experienced an economic boost from the increased demand for housing and services as a substantial population of retirees has located in the community; there has been some concern that the WIPP would significantly deter new residents from moving to the area. However, informal discussions with retirees in the Carlsbad area have revealed no evidence in support of this claim. The generally perceived dangers of radio-active contamination, such as fetal deformities or development of cancer over long periods of time, were not viewed as important concerns by elderly residents who moved to the area for amenities such as climate, relatively inexpensive housing, tranquility of a small community, etc. There may be indirect impacts on the retirement community if the Carlsbad area were to experience "boom" effects (increase crime, congestion, pollution, etc.) during and after construction at the WIPP site, but discussions with officials in other boom communities with large retiree segments have not revealed any significant declines in their retiree populations.

One must acknowledge the potential for impacts of an archaeological type. As described in the D.O.E.'s Draft Environmental Impact Statement (p. 9-10), 12 or more of the WIPP area's 247 archaeological sites may be disturbed or lost during the construction of the WIPP. One can do little more than report this possibility -- such effects are not amenable to measures of dollar losses.

One final issue which has been raised concerns the opportunity costs associated with placing the WIPP facility in a previously undeveloped, "wild" environment. Such damages to society have been described as a loss of "option value" (foregoing any option to visit and enjoy the undeveloped area) and for a loss in "existence value" (foregoing the option of simply having the wild environment exist, whether or not it is ever visited.) Though these opportunity costs are not easily quantified, it is possible to discuss their significance in a relative sense. First, the environment at the WIPP site does not support any endangered life forms, implying that irreversible ecological effects on local bio-systems would not be substantial. Second, the environment is not unique in the sense that the 30-acre area is a comparatively small plot in relation to the thousands of acres in Southern New Mexico exhibiting similar ecological characteristics. Therefore, though the development of wild environments may be of concern, the absence of irreversible impacts on wildlife species and the presence of numerous substitutes for this particular site do not support an argument for large opportunity costs in terms of existence value and option value lost with development.

In summary, while the several issues discussed above do represent reasonable concerns, especially if an incident at the WIPP were to occur in the future and be publicized, the scant documented evidence which is available and discussions with officials familiar with nuclear facilities in other parts of the country did not reveal any long term evidence of detrimental impacts on local economies or recreational areas. It should be acknowledged, however, that the occurrence of a major accident <u>could</u> impose significant opportunity costs on the region (e.g., a rail transport accident causing train stoppages would substantially impact the potash industry in its ability to transport ore, or any emergency evacuations of local populations would obviously entail costs); the risk associated with such an accident is dealt with in detail in Chapter VIII. But in the absence of such an event, it appears that at this time there is no conclusive evidence that any of the qualitative issues presented above entail significant opportunity costs if the WIPP site were to be established.

D. Summary: WIPP-Related Impacts on the State.

On the basis of estimates for personal income increases attributed to the WIPP (Table VI.1), state income taxes could increase by as much as $2.1 million* during the peak construction year (1983) and $ .8 million during the operation phase. As pointed out in the FEIS [p. 9-52], however, these revenues and any associated cost, would represent a negligible effect on state receipts or disbursements (total state revenues and expenditures in the 1976-77 fiscal year were $1.4 billion and $1.1 billion, respectively**). Furthermore, it should be added, such revenues would not be added to personal income estimates for deriving benefit measures inasmuch as personal income estimates <u>include</u> tax payments.

Setting aside direct state tax receipts and related expenditures, relevant measures to be considered for impacts that are relevant at the state level will include the local impacts described in Chapter V, personal income effects given in Section B of this chapter, opportunity costs given in Section C of this chapter and costs associated with risk management which are considered in the following chapter.

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*Assumes an average 2.65% rate on personal income (Table VI.1).

**Bureau of Business and Economic Research [1979-80, pp. 117 and 121].

CHAPTER VII

ISSUES IN RISK MANAGEMENT:

THE TRANSPORTATION OF NUCLEAR WASTES IN NEW MEXICO

A. General Considerations

A.1. Introduction

This chapter reviews a number of issues which arise out of the transportation of radioactive wastes to the WIPP site. Particular emphasis is placed on those areas where public policy may be able to affect public safety: mode of transportation, selection of routes, possibilities for route improvements and emergency preparedness programs. Quantitative analysis is difficult in the entire area of hazardous materials transportation (see Chapter VIII for some reasons why), but for these specific topics, a limited degree of quantification is possible and helpful, at least in terms of accident frequencies and dollar costs of various programs. Other issues, which are less susceptible to numerical analysis but are equally important, are discussed in Chapter IX.

Increasing volumes of hazardous materials of all types are shipped annually in the United States. In 1975, about 100 million hazardous packages were shipped, and about 2% of those involved radioactive materials (U. S. Nuclear Regulatory Commission, NUREG-0170). The safety record in radioactive shipments has been good thus far, but as the numbers of shipments grow, the risk of population exposure to radioactivity may increase. The purpose of this chapter is to examine the projected shipments of nuclear wastes within New Mexico, and to identify possible areas of concern and possible policy actions which may help reduce public risk from these shipments.

To keep matters in perspective, it is worth stressing that to date, radioactive materials transportation activities have a better record than transportation of other hazardous materials. Accidents for radioactive packages shipped have been proportionately lower than (less than a fourth of) those occurring in other hazardous shipments;* also, no serious radiological injuries or deaths have occurred in radioactive shipping, whereas, in 1977 alone, 750 injuries and 32 deaths occurred in the course of shipping other hazardous materials.**

Nevertheless, expressions of public concern over radioactive materials transportation continue and public agencies and researchers continue to investigate factors determining safety performance in this area. In part, this is to be expected in a relatively new, high-technology field which is acknowledged to carry with it at least some possibilities of severe accidents. Also, unlike site-specific activities, "Transportation activities expose a broad spectrum of the population to energy-related risks" (Rhoads and Johnson, 1978, p. 135). Another perspective on public concern in this area was offered by the Department of Transportation in its preamble to new regulations for the highway routing of radioactive materials: "Reasons for this interest involve qualitative differences between transportation hazards posed by radioactive materials and transportation hazards posed by other materials." *** The DOT notes that "Public concern with

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* Nuclear Regulatory Commission, NUREG-0170, p. 1-2. The "accidents" reported also include incidents of suspected contamination, many of which turned out to be groundless. Hence, the relative safety record in nuclear transportation may be even better than these figures suggest.

** Resources Agency for the State of California, 1979, p. 334.

*** Federal Register, January 31, 1980, p. 7141.

radioactive materials transportation . . . is more profound than those estimates [the NUREG-0170 risk estimates] would suggest is justified," and comments that this concern "may reflect the perceived limits of society to deal with catastrophic occurrences." *

The difference between technical risk estimates and public perceptions of risk is explored at some length in Chapter VIII of this study. Here, attention is confined to identification of areas of concern in transportation and analysis of policy alternatives for those areas. Comparisons between the nuclear industry and other industries, in terms of relative safety records, are not germane to this task and, hence, they are not developed further.**

In order to carry out the analysis of this chapter, it has been necessary to cite statistics and to display various scenarios, drawing upon prior studies. It should be stated clearly at the outset that the more severe accident scenarios are highly improbable, and the discussion herein should not be construed to imply that their probability of occurrence is anything but minuscule. Nevertheless, a recognition of what could occur, however remote the chance, is essential for the design of safety measures and preparedness programs.

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* <u>Ibid</u>.

** Such comparisons may, however, suggest the need to give close scrutiny to the conditions of transport of other dangerous substances. In a related context, O'Donnell and Mauro (1979) have found that public safety programs and regulations lead to expenditures per life saved which differ by orders of magnitude across and within industries. In general, more is spent per life saved in nuclear power design than in many other industries.

In broad terms, safety-related policies in nuclear transportation can be grouped into the following categories:

(i) policies designed to minimize public exposure to radiation in accident-free transportation;

(ii) policies designed to minimize the probability of accidents;

(iii) policies designed to minimize the consequences of accidents when they occur -- through packaging requirements, routing decisions, and accident response capabilities;

(iv) special policies for the prevention of theft and sabotage.

In this chapter, items (i) - (iii) are discussed, with emphasis on (ii) and (iii). The next section discusses the quantities and types of wastes involved, then decision areas are outlined, and analyses of transport options are developed at some length. The chapter concludes with a summary of findings.

A.2. Types and Quantities of Nuclear Wastes

A large portion of the radioactive wastes in the United States is generated by nuclear electric power plants. Other significant sources for nuclear wastes are defense activities, medical activities (involving diagnostic and therapeutic radiopharmaceuticals), radiographics for examination of the structural integrity of fabricated metal products, the geologic well-logging industry, research institutions, and other manufacturing activities (use of radioisotopes for food sterilization, density and thickness measurement, etc.).*

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*Resources Agency of the State of California, 1979 (Executive Summary, pp. 96-97.

Many different kinds of radioisotopes are included in waste shipments. For transportation planning purposes, the wastes destined for the WIPP are classified in three categories: contact-handled transuranic (CH TRU) wastes, remotely-handled transuranic (RH TRU) wastes, and high-level wastes. The distinction between the first two is one of radioactive emmissions measured at the surface of the package. If the surface dose rate is no greater than 200 millirem* per hour, a transuranic waste package may be handled directly and is classified as CH TRU; otherwise it is RH TRU. These limits refer to the wastes as shielded by the packaging, and not to the contents of the packaging (FEIS, Vol. 1, pp. 5-3, 5-4). The upper limit on RH TRU waste packages has been established by the U.S. Department of Transportation at 100 rem/hour. In general, high-level wastes refer primarily to spent fuel, but in the case of the WIPP they refer to reprocessed solidified waste. According to present plans, the WIPP will not be receiving spent-fuel shipments.

Transuranic elements are those with a lighter atomic number than uranium. The main transuranics present in radioactive waste are isotopes of neptunium, plutonium, americium, and curium. These wastes are classified as low-level, because a) their radiation, primarily α-particles, is

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*A milliren is one-thousandth of a rem. Rem is the acronym for "Roentgen equivalent man", and it is a measure designed to approximately quantify the amount of biological damage upon absorption in tissue. The rem in turn is defined on the basis of a rad ("radiation absorbed dose"), which is a pure energy absorption measure: one rad is the amount of radiation depositing 100 ergs of energy per gram of tissue. A rad of α-particles is said to have a dose equivalence of 20 rem, whereas a rad of β- or γ-particles carries only one rem of dosage. However, β-particles and γ-radiation are more penetrating and, hence, require greater shielding. A basic referecne regarding nuclear health physics is BEIR (1972). Good summaries are found in Nuclear Energy Policy Study Group, 1977, Ch. 5; DOE, Management of Generated Radioactive Wastes, 1979, Vol. 2, Appendix E; and NRC, NUREG-0170, 1977, Ch. 3.

not as penetrating as other types and hence they require less shielding, and b) there is little heat generated by their radioactive decay. Nevertheless, from a public health viewpoint, these isotopes are of particular concern because they have long half-lives and because alpha particles, if ingested, are more damaging to living tissue than beta or gamma particles (Nuclear Energy Policy Study Group, 1977, pp. 161 and 243). For example, "The Toxicity of plutonium-239 is known to be very great; that of the other actinide elements is not yet as well known . . . alpha-emitters present a cancer risk even in quantitites as small as ten-millionths of a gram if inhaled . . ." (op. cit., p. 247). Also, "very rough calculations suggest that [a body burden of] 40 nanocuries* may increase the risk of delayed fatal cancer by about 0.2 percent, though there is considerable uncertainty about the exact value" (op. cit., p. 184).

Some commentators have taken statements of the kind cited above to imply that a curie of plutonium, if distributed among thousands of persons and ingested by all, has the potential to cause many thousands of cancers. Of course, while this inference is correct in the literal sense, one curie simply could not cause these effects because, if released to the atmosphere, most of the radioactive particles would be dispersed and utlimately end up in the ground or in water. Therefore, the health effects would be orders of magnitude less than the above figures imply. As one pshychologist has pointed out, statements like the above are perhaps akin to saying that the water in

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*One nanocurie is one-billionth of a curie. A curie is a measure of the degree of radioactivity; one curie equals the disintegration of 3.7×10^{10} nuclei per second.

a swimming pool is sufficient to drown 100,000 persons.* Suffice it to say that the transuranics are highly toxic elements.**

A principal means by which these elements are contained is through design of special packaging for shipment. While packaging technology is still evolving, a good deal of engineering effort has gone into the development of packages which, even in severe accidents, are highly unlikely to release more than a tiny fraction of their contents; packaging issues are discussed further in part A.4 of this chapter. Other ways of protecting the population from exposure include selection of routes and shipping modes, and these are discussed in part B.

As of this writing, there still is considerable uncertainty regarding the quantities of wastes which would be shipped to the WIPP site. The shipments to the WIPP would gradually draw down the backlog of wastes now stored in temporary facilities at the Idaho National Engineering Laboratory (INEL) and elsewhere, and also would handle the new volumes of defense wastes generated annually in the nation. The uncertainty about shipment volumes arises from lack of knowledge concerning the existing amount of nuclear wastes in various storage sites: "The estimates of these quantitites have large uncertainties associated with them" (FEIS, p. 6-16).

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*The Media Institute (1980).

**There also is a lively debate on the transfer of radionuclides through soil and water and into the food chain (see, for example, Larsen and Oldham, 1978, and Franke, et al., 1980). Plutonium appears to be less susceptible to this type of transfer than some other transuranic isotopes such as americium. It should be noted, however, that in general the long-run effects of radioactivity in the environment are not as well understood as the effects of immediate exposure, about which there also is uncertainty.

For planning purposes, the authors of the FEIS made working assumptions which yielded rough estimates for the annual shipment volumes to the WIPP. These estimates, which are considerably lower than those used in the DEIS, are 370,000 cubic feet of contact-handled wastes and 4,200 cubic feet of remotely-handled wastes. For high-level wastes, six or more shipments will be made during the operating lifetime for the WIPP (FEIS, p. 6 - 19).

The degree of uncertainty associated with these estimates is illustrated by the statement in the FEIS (p. 6 - 17) that the range of error in the estimated volume of CH TRU waste shipments may be from +200% to -50%. The uncertainty aside, the FEIS gives the following estimates of the annual number of transuranic waste shipments to the WIPP:*

CH TRU wastes	
rail	227
road	232
RH TRU wastes	
rail	15
road	16

Knowledge as to the number of shipments is important for analyzing impacts of nuclear waste transportation accidents in the State, but equally important are measures of the radioactivity of waste shipments. Given that a large number of different radioactive isotopes would be sent to the WIPP, the amount of radioactivity in the shipments is best described by two measures: the number of curies of specific radioactivity, and the total value of the "transport index" (TI). The TI is a measure of the radiation emitted from the surface of the package and was designed to provide guidance to transport workers in the loading of radioactive packages. It is defined in DOT

*Feis, p. 6 - 19.

regulations in terms of the radiation dose rate, in millirem (mrem) per hour, at three feet from any accessible external surface of the package, rounded up to the highest tenth (NUREG-0170, p. 2-12).

Data are not readily available which translate WIPP shipments into TI values. However, curie values for annual WIPP shipments of nuclear wastes can be estimated from data given in the FEIS. These estimates are given in Table VII.1.

Table VII.1 Radioactivity in Annual WIPP Shipments, in 1000 Curies

a.	CH TRU wastes:[a]	in drums	101.0
		in boxes	9.0
		Sub-Total:	110.0
b.	RH TRU wastes:[b]		86.0
c.	High-level wastes:[c]		1,280.0
		Total, All Wastes:	1,476.00

[a] Source: FEIS, Tables 3-1, 3-2 and 6-4; assumes one cannister contains 25 ft^3 of wastes.

[b] Source: FEIS, Tables E-3 and 6-4; assumes that the high-level wastes are shipped in equal annual amounts over 20 years; actually, proportionately more would most likely be shipped in the early years.

[c] Source: FEIS, Table E-4 and U.S. Department of Energy (January, 1981, p. 25).

Data given in Table VII.1 may be placed in perspective by comparing them with estimates of total national shipments of radioactive materials in terms of their curie content. According to NUREG-0170 (p. 1-18), the curie content of all types of radioactive shipments in the U.S. in 1985 will be about 8.45 X 10^9 curies. The curie content of WIPP shipments will therefore represent an insignificant portion of that in all shipments, about 0.02%. In terms of nuclear waste shipments to waste disposal sites, however, the curie content of estimated annual WIPP shipments (Table VII.1) is several orders of magnitude larger than average annual shipments to these sites during the 1970-1976 period (see Table VII.2).

By the volume measure, the volume of waste shipments to the WIPP will be comparable to that shipped to the Barnwell, South Carolina, waste disposal facility, and larger than those for any shipments to any of the other waste disposal sites in the U.S. (Table VII.2).

Table VII.2 Comparative Volumes of Waste Shipments to Selected Waste Disposal Sites

	1000 ft^3	1000 curries
The WIPP	about 374	about 1476
Barnwell, S.C.	433*	81**
Morehead, Ky.	148*	283**
Sheffield, Ill.	145*	5**
Beatty, Nev.	42*	10**
Richland, Wash.	31*	57**
West Valley, N.Y.	92+	6++

*1976 **Annual Average, 1971-76
+1974 ++Annual Average, 1970-74

Sources: FEIS for the WIPP; Gablin and Garner, 1978, for the other sites.

Parenthetically, it may be noted that the disposal of the nation's commercial reactor wastes constitutes a very large undertaking in comparative terms. A recent inventory of radioactive wastes for the State of California (Greenberg, 1979) reveals that in 1977 that State's accumulated wastes amounted to more than 100 million curies, most of which was spent fuel in cooling basins at commercial power reactor sites.

A.3. What Could Happen? -- Possible Transportation Accidents

Developing adequate emergency preparedness for possible WIPP-related accidents requires some understanding of the consequences of these accidents. However, as discussed elsewhere in this study, it is clear that we cannot expect to have very reliable probability estimates for differing degrees of accidental exposure to radioactivity. We can say the following: a) accidents involving shipments to WIPP will occur, and they probably will occur more than once a year; b) in some accidents, there will be release of radioactive materials; and c) it is very unlikely, but possible, that large amounts of radioactivity could be released.

Obviously, there are many types of potential radiological transportation accidents. At one end of the spectrum is an event which is more properly labelled "incident" than "accident". On a number of occasions, radioactive shipments in the U.S. have been suspected to emit greater radiation than regulations permit and, accordingly, measurements were made. In some cases, excessive radiation was found and repairs to the packaging were made.* It is not likely that bystanders received significant radiation doses in these cases, although transport crew exposure may have been higher than desirable. At the opposite extreme is a hypothetical accident in which thousands of curies of radioactive materials escape. Fortunately, there have not been any transportation accidents of this kind in the nuclear era and, hence, characterizations of such accidents are somewhat speculative. The accidents to date have mostly

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*The actual number of such incidents is no doubt greater than the number recorded. The U.S. Atomic Energy Commission has stated "perhaps 1 in 10 improperly closed packages is detected and reported" (USAEC, 1972, Appendix A, p. 72).

occurred with type A packages, which are the least resistant to stress and which are used for shipments with a relatively low radioactive content (see section A.4 for a discussion of packaging).

Defining the dimensions of a potential radiological transportation accident is difficult, for it goes beyond simply postulating a particular kind of truck or train accident at a given speed. The extent of container failure, and the corresponding amount of radioactivity released, must be assumed. Also, the description must specify the degree of dispersion of the radioactivity (over how large an area with what density), and this obviously depends in part on atmospheric conditions. Other imponderables include the length of time that bystanders are exposed (say, in backed-up traffic) before it becomes known that the radioactivity has been released.

A comprehensive analysis also must take account of the fact that radioactive releases could occur even without a vehicular accident if the coolant surrounding high-level wastes were lost for a significant length of time. Lastly, there is the consideration that sabotage could occur, and the consequences therefrom have been analyzed in some detail (Sandia National Laboratories, July, 1980).

For purposes of this discussion, it fortunately is not necessary to pinpoint exact characteristics of accidents and their associated probabilities. Orders of magnitude will suffice in regard to accident consequences and, for emergency preparedness planning, probabilities are less important than a determination that a given event <u>could</u> happen. To introduce the accident-scenario literature, it is useful to summarize the apparent professional consensus in terms of broad types of events and whether they are possible (not probable), however remotely. For New Mexico the following events are listed in increasing order of probability:

i) Can a nuclear waste transportation accident give rise to a nuclear explosion? No.

ii) Can a nuclear waste transportation accident lead to radiation accident releases which threaten hundreds of fatalities? In the case of sabotage of a high-level waste shipment, yes. Otherwise, no.

iii) Apart from the possibility of sabotage, can a waste shipment accident threaten tens of fatalities? This case represents the boundary region where estimates are very uncertain. According to the FEIS for the WIPP, a severe truck or train accident could imply 3 to 5 fatalities in an urban area if the cargo were high-level waste, and no fatalities for transuranic wastes. However, these calculations are based on very low assumptions regarding the fraction of the radioactive material which is released to the air (in, say, the smoke plume from a fire). These assumed "release fractions" are 0.02%* (.0002) for CH TRU wastes and 0.1% for RH TRU and high level wastes (FEIS, pp. 6 - 32 to 6 - 34). By contrast the Final Environmental Statement for the Hanford Waste Management Operations states that for a severe truck accident involving CH TRU wastes "Experiments carried out at Hanford indicate that from 10 to 50% of the material present in combustible waste can be expected to be airborne" (ERDA, 1975, p. III. 2 - 21). For the WIPP, the FEIS says "About 25% of the CH TRU waste is assumed to be ...combustible" (p. 6 - 32), and therefore application of the 10 - 50% rates would indicate that 2.5% to 12.5% of the shipment's radioactivity could be released in a severe truck accident. This computed overall release fraction based on the two studies is 125 to 625 times that used in the FEIS.** Obviously, the hypotehtical circumstances in the two cases are different, and we do not attempt to argue that one is right and the other is wrong. It seems clear, however, that the release fraction assumption is not predictible with any precision. Therefore, to be conservative in planning for emergency preparedness, it appears wise to allow for higher release fractions to allow for the possibility that ten or more radiological fatalities could be

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*The FEIS states that the "total airborne release [is] about 0.7% of a drum's contents" from a shipment of 42 drums of CH TRU waste (p. 6 - 33).

**The discussion below also suggests that train accident release fraction could be higher than those used in the FEIS under credible circumstances.

associated with extreme accidents involving high-level wastes and that several fatalities could be associated with accidents involving shipments of transuranic wastes.*

iv) Can a waste transporation accident be severe enough to warrant the evacuation of hundred and perhaps thousands of people? Yes.

Ignoring, as we must (see Chapter VIII), considerations related to loss of life, the economic costs of a radiological accident arise mainly from two sources: the temporary denial of access to land and buildings, and the cost of decontamination. Other factors which contribute to economic costs include on-scene emergency response activities, radiological surveys and security measures. For a large urban center like New York City, studies funded by the NRC have shown that the total economic costs (excluding health effects) of a serious radiological transport accident can exceed one billion dollars (at 1979 prices).** Cost estimates can be scaled by reference to other cities' population densities and land values. For Albuquerque, total economic costs could be in the neighborhood of one hundred million dollars to three hundred million dollars, and for cities the size of Roswell, they could be in the range of fifty to one hundred million dollars.

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*For low-level shipments, the worst-case accident scenarios in the FEIS lead to whole body population doses of 62 - 190 man-rem in small urban areas and 110 - 330 man-rem in large urban areas. If we multiply these figures by 125, to allow for the higher release fractions, we arrive at doses of 6,750 to 41,250 man-rem. The accepted estimate for rate of cancer inducement from radiation exposure is about 1 cancer per 5,000 man-rem, regardless of how the exposure is distributed among the population [Nuclear Energy Policy Study Group, 1977, p. 167; and NRC, NUREG-0170, p. 3 - 14]. Therefore we would be estimating 1.5 to 8 cancers from the altered FEIS scenarios. It is stressed that these are very rough calculations; they are presented only with the aim of emphasizing the range of uncertainty associated with any hypothetical calculation of the effects of radiological transportation accidents.

**See for example, Sandia National Laboratories, Transportation of Radionuclides in Urban Environments: Draft Environmental Assessment, NUREG/-CR-0743, prepared for the U.S. Nuclear Regulatory Commission, July, 1980, pp. 55 - 64.

Costs given above are relevant for a severe accident in which 750 curies or more of long-lived radioisotopes are released to the atmosphere. Such an accident is very unlikely, but it can occur even without sabotage. For releases of this magnitude or greater, the total costs for the case of short-lived isotopes are lower by an order of magnitude.* In the next few paragraphs we survey a few of the more severe radiological accident possibilities which have been analyzed.

A review of types of conceivable accidents reveals that criticality (attaining a critical mass, thereby causing a fission reaction) could occur but under circumstances which are hardly credible. A large portion of the contents of a spent fuel shipment would have to be released from their special containers and thrown together, and then covered with an insulating material.** According to the AEC studies, it is possible to imagine a landslide or flood causing such an occurrence, but the chance of such an occurrence is infinitesimally small. In any case, because of the shielding effects of the earth or water, the consequences would not be as serious as many other kinds of accidents; for example, "In the unlikely event of accidental criticality, the critical array likely would be disassembled by pressures developed during the reaction but a nuclear explosion is impossible. The critical reaction would last only a few seconds and probably would not recur. It is estimated that from 10^{17} to 10^{18} fissions might take place, but this would not be expected to cause release of any radioactive materials from the fuel elements ... Persons within a few feet of such a critical assembly would receive a lethal

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*See for example, Sandia National Laboratories, Transportation of Radionuclides in Urban Environments: Draft Environmental Assessment, NUREG/-CR-0743, prepared for the U.S. Nuclear Regulatory Commission, July, 1980, pp. 55-64.

**<u>Ibid</u>., p. 57.

dose ... Persons beyond 100 feet would be unlikely to receive serious radiation exposures ... The consequences would be reduced because the reaction takes place in a moderator such as water which acts both as a radiation shield and an absorber of some of the gaseous fission products...." [AEC, 1972, appendix B, pp. 78-79].

The same reference describes a more plausible accident in which a rail accident causes "moderate damage" to a spent fuel cask and hence the cask's mechanical cooling system becomes inoperative. If the cask is left unattended for several hours,* "some of the fuel may reach a temperature at which the cladding will perforate .... The radioactivity released in such an accident could be as much as 5,500 curies of Kr-85, 0.1 curies if I-131, and 650 curies of gross fission products [including Cesium-137]".** The AEC study estimates the probability of such a rail accident at no more than one in one hundred million per reactor year.

A more recent study mentions credible accidents in which 9.1 million curies are released (rail) and 1.4 million curies are released (truck) from spent fuel shipments.*** Such extreme accidents are estimated to occur with annual probabilities of one in one hundred forty million and one in fifty million, respectively, and the assumed dispersion pattern is such that at most one latent cancer fatality is caused per accident (these probability calculations are based on the presumed 1980 rate of shipments). The same study finds greater threats to life in some kinds of shipments of unprocessed fuel.

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*Several rail accidents have occurred in which fires lasted more than 24 hours, and fires can prohibit access to the damaged cargo.

**AEC, 1972, pp. 85-86.

***NUREG - 0170, pp. 5-46 to 5-48.

A still more recent document, the WIPP FEIS, postulates a hypothetical rail accident involving spent fuel in which 8,240 curies are released to the air (including 440 curies of Cesium-137 and other volatile fission products). The annual frequency of this event is calculated to be 1 in 50,000. If that occurred in Albuquerque, about 100,000 people could be exposed to radiation from the airborne plume of particles, and some fatalities (possibly 10 or more) could occur.*

Clearly these probabilities are a) low, and b) variable. It also is apparent that there is considerable divergence of professional opinion regarding the health consequences of radiological accidents. Extreme accidents of this nature are very unlikely, but it is important to recognize several important caveats which are relevant for these estimates for accident probabilities. First, not all shipping containers have been tested to failure, and we do not know the effects of, say, a severe rail accident with fires lasting several hours on the fraction of radioactivity released. Second, possible human error in the construction and sealing (loading) of shipping containers has not been incorporated explicitly into the published accident analyses. A severe accident involving a vehicle carrying defective or improperly sealed waste containers is likely to be the most damaging in its consequences. According to the NRC reports on transportation-related radioactive material incidents in 1975, 8 of 19 incidents were attributable to "human error and deviations from accepted quality assurance practices" [Sandia National Laboratories, 1980, p. 75]. A recent GAO report [GAO, May, 1979] notes that "A 1976 Department of Transportation study showed that faulty

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*The number of fatalities depends on the relationship between man-rems of exposure, by organ, and mortality. This relationship still is debated; see C. E. Land (1980) for a health statistician's summary of these uncertainties.

Type A packages were associated with most of the radioactive releases in highway incidents.* Packaging problems cited were loose and defective fittings or closures, corrosion, rust, and seam failures. The GAO further notes that federal agencies do not inspect shipping packages for integrity, but rather they rely on "shipper's quality assurance records" without independent verification.

The one radiological transport accident study which does examine human error assumes "that the maximum result of a human error is the release of all contaminated coolant water in the cask" [Sandia National Laboratories, 1980, p. 77]. While it is useful to study the implications of such an incident, this procedure does not recognize the potentially more serious synergistic effect of human error worsening accident consequences, for example by raising release fractions. If a shipping container is faulty in its construction or it is improperly sealed, an accident could spill a greater proportion of its contents.

A final caveat concerning accident probability estimates relates to inherent limitations of fault tree analysis. As detailed in Chapter VIII of this report, some scientists have pointed out that use of fault trees requires imagining <u>all</u> possible occurences, even those which never have occurred before. By definition, this is virtually impossible -- to imagine all contingencies not experienced.

In conclusion, extremely serious WIPP transportation accidents are quite unlikely, but the small <u>ex ante</u> probabilities assigned to them should not be grounds for complacency and lack of preparedness. An official of the

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*The reader is reminded that WIPP shipments do not involve the use of Type A packages.

DOT's Office of Hazardous Materials has stated, with regard to radioactive shipments in general, "It is likely that someday some of these shipments will be involved in severe accidents" [D. Shapley, 1971, pp. 1318-1319]. In addition, minor WIPP-related radiological accidents are almost certain to occur in New Mexico. Consequently, the succeeding sections of this chapter discuss measures designed to minimize the potential consequences of WIPP accidents, by means such as routing shipments away from major population centers and by improving emergency preparedness.

A.4. Transportation Accidents: The Role of Packaging.

As suggested in earlier discussions in this Chapter, the consequences of an accident involving a shipment of nuclear waste will depend in large part on the characteristics of the shipping container. Packaging standards for waste shipments have received a great deal of attention in the past decade and research continues on engineering designs for containers (Allied-General Nuclear Services, 1978, p. 357). At present, the basic package distinction is between Type A containers, Type B containers (which will be used for the bulk of WIPP shipments) and special casks or cannisters for high-level wastes ("large quantity shipments"). Less stringent standards are specified for "limited quantity" shipments.

Type A containers are designed for the least toxic shipments. They are built to withstand the stress of normal (accident-free) transportation, but they are not necessarily expected to remain intact under typical accident conditions. Type B containers must pass a series of hypothetical accident test simulations without loss of physical integrity.

The NRC rules regarding quantities which may be carried in each type of continer are based on a classification of the various isotopes in terms of their degree of toxicity. There are seven "transport groups", indexed I to VII, in decreasing order of radiotoxicity. At the lowest level of toxicity, another category has been created, called "special form" material. The four transuranic radionuclides which are typical contents of nuclear waste shipments are found in group I (see NRC, NUREG-0170, pp. B-10, B-11).

The regulations for use of each of the package types specify the number of curies of material in each transport group which may be shipped in the package (Table VII.3).

Table VII.3 Quantity Limits for Shipments, According to the Transport Groups

Transport Group	Limited Quantity (Curies)	Type A Quantity (Curies)	Type B Quantity (Curies)	Large Quantity (Curies)
I	≤ .00001	≤ .001	≤ 20	> 20
II	≤ .0001	≤ .05	≤ 20	> 20
III	≤ .001	≤ 3	≤ 200	> 200
IV	≤ .001	≤ 20	≤ 200	> 200
V	≤ .001	≤ 20	≤ 5,000	> 5,000
VI	≤ .001	≤ 1,000	≤ 50,000	> 50,000
VII	≤ 25	≤ 1,000	≤ 50,000	> 50,000
Special Form	≤ .001	≤ 20	≤ 5,000	> 5,000

Source: NRC, NUREG-0170, p. 2-5.

Both Type A and Type B containers come in a variety of sizes, and they may be made available for either road or rail shipment. An exception is the high-level wastes, for which 60-100 ton rail containers are being designed and they would have to be sent by rail.

Rail shipments generally are seven times or more the volume (in cu. ft.) of road shipments, and the latter are easily scaled to highway load limits for Type A and Type B containers. A truck carrying wastes would weigh no more than 40 tons, and all State and Federal highways in New Mexico will accomodate vehicles weighing up to 86,000 pounds.

A recent California government report* is quite critical of the design limits established for both Type A and Type B packages, and it recommends that consideration be given to upgrading the standards. The main grounds for criticism are that there is little empirical verification of the assumptions about accident stresses, release fractions (of the packages' contents), and dosages absorbed by persons in the accident vicinity. The report applauds the NUREG-0170 analysis of accident possibilities, and recommends that it be extended. It also quotes NUREG-0170 to the effect that "the paucity of data on package responses to severe accidents makes it difficult to predict even the average release fraction, much less a distribution."**

A similar point was made in a recent article in Nuclear Safety: "Container failure thresholds used to determine failure probabilities are the subject of continuing investigation. Unfortunately it is impossible to pinpoint these failure thresholds, therefore when estimates are made, they are conservative in nature . . . . The determination of release fraction is another area where uncertainty exists" (Rhoads and Johnson, 1978, p. 139).

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*Resources Agency of the State of California, 1979, pp. 380-391.

**Ibid., pp. 386-87.

While it may seem obvious that stronger packaging is preferable, a safety trade-off does arise as packages are stengthened. Stronger containers are heavier, and per unit of weight they allow less storage space for the contents. This means the same volume of wastes must be transported in more shipments, which given rise to a higher probability of an accident (USAEC, 1972, p. 60). Unfortunately, this trade-off cannot be evaluated without fairly precise data on the consequences of accidents for each package type.

Apart from accident possibilities, evaluations of shipment risk must take into account radiation exposure in normal (accident-free) transportation. As indicated in the description of Type A and Type B containers, radiation is emitted from the shipments. The FEIS indicates that the total annual population exposure to motorists and population along shipping routes received from normal WIPP transportation would be about 6.73 man-rem.* Annual exposure to transport crews would be 22.22 man-rem.** The most exposed person*** "would receive 0.00015 rem annually" and a "person detained in a car for two hours while waiting for the stalled truck to move would receive an external dose of about 0.0016 rem."**** For comparison, the comparable annual individual dose from natural sources is about 0.1 rem.

These calculations do not take into account the possibility of undetected leakages, caused by errors in container sealing or defective workmanship, but nonetheless the FEIS is no doubt correct in stating that "health effects resulting from this exposure would be undetectable."*****

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*FEIS, p. 6 - 24.

**Ibid., p. 6 - 25.

***A person who watches all annual WIPP shipments from a distance of 25 feet from shipment paths; FEIS, p. 6 - 22.

****FEIS, p. 6 - 26.

*****FEIS, p. 6 - 26.

In summary, provisions for the containment of radioactive material are the subject of legitimate public concern, and public agencies are continuing work in this area. However, to keep matters in perspective, the overwhelming majority of actual radiation releases have been extremely small. The largest releases to date involved not wastes, but uranium yellowcake (NUREG-0535 and Sandia Labs TTC accident tapes). To date, there have been no serious radiological injuries from transportation of radioactive materials. The magnitude of possible severity of nuclear transport accidents is nowhere near as large as that of reactor accidents, and the average nuclear transportation accident consequences are "far less than the average consequences now being experienced for accidents in chlorine shipments."* Further, "the most severe consequences are probably no worse than for the chlorine case."**

A.5. Shipment Decisions and Agency Jurisdictions.

Given the volume and nature of wastes to be shipped to the WIPP, choices must be made as regards types of packaging, modes of shipment, and the routes to be used. Regulatory agencies have promulgated rules for routing, packaging, placarding and notification, licensing and inspection, as well as emergency preparedness programs. Other possible areas for regulation concern limits on shipment speeds (particularly for trains), requirements for escort vehicles, restrictions on the days of the week for travel, etc. Overlapping jurisdiction of these regulatory agencies, however, result in a somewhat confusing web of regulations. As examples, packaging criteria are the responsibility

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*National Academy of Sciences, 1979, p. 85.

**Ibid.

of DOE; however, DOT is drafting regulations which would affect highway routing.

Of primary interest here is the question of state vs. Federal regulatory jurisdiction. A number of individual states have promulgated regulations affecting the movement of radioactive wastes, and they typically cover the following areas: bonding and assignment of liability, provision for inspection and notification, emergency preparedness, and routing. However, in January, 1980, the DOT announced the drafting of new federal regulations for waste routing and associated driver training.* These regulations, as proposed, would establish criteria for route selection, as follows:

a) "The general rule would require [a placarded vehicle] to be operated on a route that presents a risk to the fewest persons..."

b) "State agencies could designate preferred highways...based on the policy of an overall minimization of radiological and non-radiological impacts of both normal transportation accidents." However, rule (a) could dominate rule (b) in some circumstances.

c) Subject to (a) and (b), "the motor vehicle would have to be operated on a route which minimized transit times, so as to minimize unnecessary exposure."

The importance of the "risk-to-the fewest persons" provision is illustrated by a further passage in the proposed regulations which states that the rule "would require use of an Interstate urban circumferential or bypass route to avoid cities...notwithstanding a minor transit time increase."**

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*Federal Register, January 31, 1980, pp. 7140-7153.

**One import of the proposed new DOT regulations is that states are invited to examine routing alternatives and to draw up legal routing requirements. The degree of latitude left to the states in this area still is not clear, but it appears that they have an important role to play if they wish to do so. Accordingly, one of the main emphases of this chapter (section B.2) is the route choice, and some attention also is given to the mode (road vs. rail) issue.

There is a considerable body of legal opinion that says that Federal agencies have the right to preempt state rules in the area of interstate shipment of nuclear wastes. For example, referring to Title I of the Hazardous Materials Transportation Act of 1974, a recent article in Environmental Law has affirmed that "the major purpose of section 112 is clear: It definitely preempts inconsistent state regulation of hazardous materials unless the Secretary of Transportation expressly approves such regulation" (England, 1977, p. 209). Federal authority in this area, moreover, has origins which go back much further in time than this 1974 legislation: "The source of the Federal government's regulatory power springs principally from the commerce clause of the United States Constitution...." (Trosten and Ancarrow, 1980, p. 253).

On the other hand, states and local jurisdictions have considerable authority in this area, based on "their inherent police powers to protect health and safety" (Trosten and Ancarrow, 1980, p. 252). Prevailing legal opinion holds that outright bans on the shipment of nuclear materials through a state or locality, such as those promulgated by Connecticut and New York City, are likely to be found in contravention of prior Federal authority,* but nevertheless "state routing requirements that define the practical highway alternatives available to shippers are likely to be upheld" (Trosten and Ancarrow, 1980, p. 290). More generally, nuclear materials transportation activities "remain subject to the ordinary regulatory authority of state and local governments, so long as such regulation does not unduly impede interstate commerce" (England, 1977, p. 210). In other words, states

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*Through a technicality, the New York City ban has been allowed to stand.

may participate in the regulation of radioactive materials shipments, and are invited to do so under the latest DOT regulations,* but their rulings must be broadly consistent with Federal regulations and must not result in a significant increase in the cost of such shipments.

The exact limits of state authority in this field still are not clear, and a series of court rulings may be required before the desired clarification is achieved. As of August, 1980, twenty-six states (including New Mexico) had entered into agreements with the NRC to share regulatory responsibilities for nuclear shipments (National Conference of State Legislatures, Issue Brief: Radioactive Materials Transport, draft, August, 1980, p. 6). Nevertheless, a number of state and local rulings are of uncertain validity and have not yet been tested in court. Federal agencies generally have proven reluctant to force the jurisdictional issue except in extreme cases; rather, emphasis is given to the development of cooperative Federal-State programs.

One area in which state and local authority is unquestionably paramount is that of emergency preparedness for radiological transportation accidents. "It is certainly appropriate and within the constitutional and legislative authorities of the state governments to develop emergency response programs..." (Tucker, 1974, p. 126). Federal agencies have acknowledged this fact. In the words of the GAO, "State and local authorities are responsible for implementing emergency measures because they (1) are usually the first on the scene at a transportation accident and (2) have the authority to take required protective measures, such as evacuation" [GAO, May, 1979, pp. 25].

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*"The [proposed regulations] would recognize action by appropriate state agencies to designate non-Interstate public roads as preferred highways, and to remove the preferred status of an Interstate highway if an equivalent route is provided" (Federal Register, January 31, 1980, p. 7149).

The same point was made by the Federal Preparedness Agency (FPA; it now is part of the Federal Emergency Management Agency, or FEMA):

> "...it is recognized that, under our constitutional form of government, those emergencies, unless they occur in Federally-controlled areas or involve Federally-owned material or equipment, are in first instance a matter of concern to State and local authority" [General Services Administration and Federal Preparedness Agency, April, 1977].

But the same document notes that

> "The Federal government will provide assistance upon request... during a peacetime nuclear emergency."

In fact, the Federal government's role in this area is extensive. It performs three functions: issuing guidelines for state and local agencies to use in their own drafting of emergency response plans; maintaining a capability to respond to incidents involving weapons and other Federally-controlled nuclear materials; and being prepared to assist states as called upon in radiological emergencies. For New Mexico, these Federal capabilities are especially relevant.

In New Mexico, responsibility for radiological emergency response for minor emergencies was assigned by the Governor in 1974 to the Environmental Improvement Division (EID). This responsibility is discharged by the EID's Radiation Protection Bureau (RPB) and its activation does not depend on the Governor issuing a declaration of emergency. The Radiation Protection Bureau has developed an emergency response plan for minor radiological accidents, but it does not cover "large-scale radiological emergencies [which] should be reported immediately to JNACC" [Radiation Protection Bureau, August 28, 1980, p. 2]. JNACC is the acronym for the Joint Nuclear Accident Coordinating Center which is operated by the U.S. Department of Energy at Kirtland Air Base. Its jurisdiction covers several western states, and it is prepared to send trained personnel to the site of a nuclear weapons accident or other large-scale nuclear emergency.

The Radiation Protection Bureau is not authorized to conduct training courses for emergency response personnel. It distributes literature from the DOE on emergency handling of radiation accident cases to police and sheriff's departments, ambulance-rescue squads, firemen, and nurses, physicians, and hospital administrators. However, training for radiation accidents is the responsibility of each of these other groups.*

Another contingency for which the Radiation Protection Bureau is not responsible is evacuation. Authority for evacuation decisions was assigned by legislation to the State's office of Civil Emergency Preparedness and to local emergency preparedness officials. A precautionary evacuation is not as unlikely as some of the more severe hypothetical accidents discussed above. Many of the accident scenarios developed in the FEIS and the Sandia Laboratories' studies postulate population radiation doses of hundreds or thousands of man-rems, even if they occurred in a small urban area about the size of Carlsbad or Roswell. For comparison, the U.S. Environmental Protection Agency has issued the following guidelines for evacuation during response to an emergency:

- If the projected exposure dose to the population is
  whole body, 5 Rems or more
  thyroid, 5 to 25 rems
  then "conduct mandatory evacuation of populations in the predetermined area."
- If the projected exposure dose to the population is
  whole body, 1 to 5 rems
  thyroid, 5 to 25 rems

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*In the case of training for firemen and ambulance personnel, responsibility for training resides, to some extent, with the State's Corporation Commission.

then "consider evacuation, particularly for children and pregnant women."

(Source: U.S.G.A.O., March 30, 1979, Appendix I, pp. 38.)

Clearly an evacuation decision has to be based on expert determination of radiation releases and possible population exposure, and such a determination could not be made by the local emergency preparedness officials charged with the evacuation decision. Again, rapid and effective communication is the key. Given the difficulties of making immediate evacuation decisions in the confusion of an accident, twelve states have adopted rules requiring advance notification to local jurisdiction of especially hazardous shipments, and Arkansas and New York require escort vehicles to accompany the more hazardous shipments [National Conference of State Legislatures, Issue Brief: Radioactive Material Transport, draft, August 1, 1980 pp. 5].

The New Mexico emergency response planning is discussed more extensively below; here we simply note that there is some fragmentation of jurisdiction in this area, and that this may not be desirable given the importance of rapid coordination for adequate emergency response.

B. State Options for Managing Transportation Risk.

The foregoing discussion has indicated that the State of New Mexico has an important role to play regarding the transportation of nuclear materials through the State and that WIPP-related accidents are almost certain to occur. Furthermore, it is likely that there will be radiation releases in a few of these accidents, but it is extremely unlikely that the releases would constitute a health hazard. Hence emergency preparedness planning in this field involves preparing for relatively minor events and also for more serious events which are possible, however unlikely. The potential seriousness of any given accident can be affected by a number of state policy decisions which are considered in this section.

B.1. The Road vs. Rail Choice

Radioactive materials are transported by road, rail, air, and by barge. For the WIPP shipments, only the road and rail choices are relevant. FEIS suggests that 58% (by volume) of the wastes will be shipped by rail and 42% by road.* However, the basis for this decision is not stated clearly; it seems to involve both financial and safety considerations.

The question of mode of transportation for radioactive materials has a long and litigious history. Of the four different domestic modes of shipment described above, most of the contention has focused on the railroads. From the shippers' viewpoint, railroads constitute the preferred mode of shipment in many instances because of economic considerations and because overall accident rates are lower than for highway transportation. Nevertheless, the railroad industry has been reluctant to ship highly radioactive cargo in the normal manner, because of risk of a very bad accident and because, even with a minor derailment involving radioactive cargo, "the affected railroad might be faced with population evacuation, total cessation of railroad operations in the area for an indefinite period, and overall disruption of the railroad's operation" (England, 1977, p. 217).

Beginning in 1962, several railroads and, from the opposing viewpoint, several shippers of radioactive materials, have contested cases before the Interstate Commerce Commission (ICC). Basically, the issues are two:

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*FEIS, p. 6-19; annual shipments include rail shipments of 293,100 f^3 and truck shipments of 210,000 f^3.

i) whether the railroads should be classified as common carriers of radioactive materials, thereby accepting the ICC schedule of tariffs for transport of these materials, and ii) whether, as the railroads urge, all highly radioactive rail shipments should go by special trains which do not include other kinds of freight and which travel at speeds no greater than 35 miles per hour.

The shippers, as well as ERDA (now DOE) and the AEC (now the NRC), have argued that special trains do not significantly reduce overall radiological risk and that their use would double shipping costs, resulting in an additional financial burden of more than $500 million per year in the 1980's (England, 1977) which would have to be borne by electricity rate payers. Regarding the cost argument, the railroads have countered that this increase in outlays would be offset by the reduced charges for spent fuel casks (which run about $3,000/day) as a result of expedited handling and shorter transit times. A subsequent study for DOE concluded that the net outcome can be highly variable, depending on the precise figures for cask use charges, cask turn-around time, average train speed, and special train surcharges, and consequently that "the cost of shipping spent fuel in special train service could range from 20% lower to 200% higher than the cost of shipping the fuel in regular train service" (Rhodes, Chais, et al., p. 5).

The NRC has noted that special trains would have the following advantages (NUREG-0170, p. 6-16):

- less damage is likely if an accident does occur, because crush forces would be less and fires would be minimal in duration (since no flammable freight is transported in the same train).
- a serious derailment would be less likely because of shorter train length.

- fewer switching mishaps would be expected because there is much less switching.
- cleanup operations in a major derailment might be easier if the accident involved a special train.
- the actual transit time of the spent fuel cask is likely to be quite a bit less than it would be in regular train service.

Nevertheless, the NRC concluded that special trains are not cost-effective because their "annual additional cost is about 19 times the (expected) annual savings" (NUREG-0170, p. 6-19). These savings are computed from estimates of the probabilities of accidents of different severities in regular train service, and they include expected avoidance of health damages. It should be noted, however, that the expected accident consequences may be questionable due to the uncertainties concerning release fractions discussed above.

To quantify rail and road accident possibilities, numbers must be assigned to the probabilities of two kinds of events: i) a transportation accident occurring, and ii) significant damage occurring from the accident. Clearly it is difficult to be precise about the meaning of "significant damage," but some guidance is offered by existing definitions and practices in existing studies. In quantifying the probabilities of accidents _per se_, as well as important accident characteristics, historical frequency data are available which are reasonably reliable because they are based on a large number of occurrences. In what follows, conclusions suggested from a review of these data are described.

- First of all, truck and delivery vans, taken together, have a slightly higher accident rate (1.06×10^{-6} per vehicle-kilometer) than do trains (0.93×10^{-6} per vehicle kilometer*); on the other hand integrated container vehicles, which are "trucks with large vault-like cylinders", would be expected to have about a 50% lower accident rate (0.46×10^{-6} per vehicle-kilometer) than trains, taking into account their restrictions on speed, weekend driving, etc. (NUREG-0170, p.5-5).

- Secondly, a container travelling in a train is ten times more likely to experience an accident which is "severe, extra severe, or extreme" than is a container travelling in a truck, given reasonable assumptions about load configurations.**
- Thirdly, in the study of frequencies of accidents at different severity levels (Clarke, Foley, Hartman, Larson), the severity category is based on a three-dimensional index involving fire duration, crush force, and a measure of puncture likelihood which involves impact velocity. Analyses based on this index suggest that serious accidents occur with greater frequency on railroads, and that the severity of some rail accidents far exceeds the most severe truck accidents. Further, however, The American Association of Railroads, in testimony before Congress, has pointed out that many rail accidents

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*Train accident rates are given as railcar accidents per railcar-kilometer.

**Clarke, Foley, Hartman and Larson, 1976. Clark, et. al., caution that different load configuration assumptions could lead to different results; on the other hand, they also state that sensitivity studies indicate that their results "are not greatly influenced by reasonable variations in assumed conditions."

> involve much more severe crush forces and fire durations than those used in testing radioactive materials shipping containers. An analysis of 44 recent accidents (1976 - 78) of trains carrying hazardous materials which involved fires revealed that 32 of these fires (73%) lasted over an hour, 28% burned for more than twenty-four hours, with two of these fires lasting over eight days. Such data cause us to be very apprehensive about moving nuclear casks in regular train service when they are required to withstand fires of only 30 minutes duration. Our analyses indicate that the number of cars derailed in mainline accidents does not increase significantly at speeds greater than 35 mph. However, the average damage sustained by cars derailed at higher speeds is almost two and one-half times greater than those which occur at speeds of 35 mph.*

In light of this testimony, it must be noted that the NRC classifies any train accident with fire duration of more than two hours and impact speed of more than 15 mph as the "very most severe" (of eight degrees of severity): all radioactive contents are released to the atmosphere for type A containers and non-plutonium type B containers, and they could all be released for plutonium containers.** Also, train accidents with fire duration of more than one hour and impact speeds of more than 15 mph could fall in the total release category.***

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*William J. Harris, Vice President of the Association of American Railroads, letter to Senator Adlai Stevenson, printed in Hearings before the Subcommittee on Science, Technology, and Space, on S.535, July 18, 19, and 20, 1979, U. S. Government Printing Office, Washington, D.C. 1979, p. 64.

**NRC, NUREG-0170, pp. 5-14, 5-22, and 5-23.

***Ibid.

Representatives from the railroad industry have also questioned the realism of shipping container integrity tests in light of the nature of rail accidents. In related Congressional testimony, the Association of American Railroads made the following statements regarding container tests conducted by the Sandia Labratories: "In the locomotive-truck crash tests, the trailer was adjusted vertically so the cask would be just barely caught by the underframe of the locomotive. The railcar barrier test used an old obsolete railcar of extremely heavy design. The cask was restrained by hold-down grids and cushioned by impact lifters. And, therefore, I do not accept the fact that those alleged crush tests achieved the objective of subjecting the cask to the maximum kind of credible accidents that we have. In the one case where we did challenge them on the effects of fires of longer duration than in their specifications, when they conducted the test as we proposed the lead melted down. I point out to you that casks can be designed either with spent uranium as a radiation shield, or with lead as a radiation shield. The lead, we have already shown in a test shorter in time than the duration of fires we find in many railroad accidents, did melt down. There had been no tests of this kind, so far as I am able to ascertain, with casks that involved the spent uranium material, which is a very brittle material. And with the kind of deformation that we saw in some of the casks, there is no question that they would have fractured and left voids."*

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*William J. Harris, Vice President of the Association of American Railroads, Congressional testimony printed in <u>Hearings</u> ..., <u>op</u>. <u>cit</u>., p. 162.

From these statements and the statistical data given above, it is clear that train accidents can be very severe and that bad accidents are more likely to occur with trains than with trucks. However, an accident, regardless of level of severity, is more likely to occur in truck shipments. Clearly difficult trade-offs are involved from a public safety viewpoint.

Given the (very small) possibility that a rail accident could be extremely damaging, one possible approach to risk management would be to require that rail shipments be routed away from the larger urban areas, and, where that is not possible, trucks should be used. For example, in New Mexico rail shipments entering the State near Gallup could avoid the Albuquerque metropolitan area because the east-west trunk line passes well south of the city. In contrast, shipments entering from the north (via Raton) could not avoid Albuquerque, unless they took a much longer route via Amarillo, but that too is a fairly large urban area. Hence, it might be preferable to use trucks for those shipments which enter from the north. This is a situation in which the choice of mode (road or rail) is linked with the choice of route.

Regardless of whether such an approach is adopted, it is clear that at least some of the WIPP shipments would travel by highway, and so the next sections of this chapter address some highway routing and upgrading issues.

B.2. Highway Alternatives for WIPP Shipments in New Mexico

Routing choices for both road and rail shipments are left open in the FEIS, and, as indicated earlier, the new DOT regulations appear to leave considerable scope for state determination of routes. Route choices require consideration of such things as travel times and accident frequencies, as well as population densities along routes.*

*Accident severities are also important considerations. Unfortunately, relevant data for these considerations do not exist.

It is desirable to select a route configuration which minimizes the magnitude of the first two items; unfortunately, decisions which minimize any one of them may not minimize the other.

Each of these factors varies markedly with local conditions, and a difficulty in applying the NUREG-0170 and FEIS results is that national average data have been used in these studies for accident frequencies and accident severity levels. In New Mexico, considering all highway segments of 25 miles or longer in the Interstate and Rural Federal-Aid Primary (FAP) systems, the 1978 accident frequency per vehicle-use varied by a factor of more than twelve (excluding Albuquerque). The Interstate highways generally have the safest records in the state, but through Albuquerque their accident rate is worse than outside that city. The examples could be continued, but the point is clear; local data are required in order to make adequate judgments about safety conditions along specific routes. The point holds equally for railroads and highways, but it has more force in the case of highways because the range of possible routes is greater. The immediately following sections provide data for the State of New Mexico and review the transportation alternatives in light of them.

Another important consideration is that more than one route be available for shipments entering the state from each direction, so that a back-up route can be used in the event that weather or other contingencies make a given route impassable. The State may wish to consider designating an acceptable set of routes, and establishing appropriate enforcement provisions for their use. It also may wish to formulate a provision to give flexibility to routing policies, such as a ruling that a non-designated route for nuclear waste transport could be authorized by an appropriate state official with an appropriate degree of advance notification.

The present study considers 17 alternative highway routes to the WIPP site, entering the State at six different points. For shipments entering from the north near Raton, five different routes are considered; for shipments entering from the northwest, six routes are considered; and three different routes from the east are examined, entering the State east of Tucumcari, at Clovis, and at Hobbs (see maps).

With the assistance of the State Highway Department, the Albuquerque Police Department, and the Middle Rio Grande Council of Governments, data have been compiled on traffic volumes and numbers of accidents for all highway segments in the State for 1976-78. These numbers have been used to compute the rate of accidents per vehicle per segment, and also per vehicle-mile for each segment. Finally, they were converted to a form which describes the probability of an accident for a vehicle traveling the entire length of each route, which provides a measure for accident rates per WIPP shipment for a given route* (Table VII.4.) Estimates for population at risk along each of the 17 route alternatives are given in Table VII.6. Map 1 shows the accident rates per vehicle-mile for all FAP routes in the state, excluding cities and towns. The considerable variation is readily evident. It should be borne in mind that these are historical rates, and they do change somewhat over time, particularly as highways are upgraded. As would be expected,

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*It may be observed that the probability of an accident for someone driving the entire route may differ in reality from the sum of probabilities of accidents along every segment in the route. Perhaps it is lower, because long-distance drivers may be more alert than the typical short-distance driver who uses part of the route. And perhaps it is higher, because of the fatigue factor. In any event, a divergence of this nature should not affect the choice among routes, because it should not apply proportionately more to one route than to another.

Table VII.4. Accident Rates for Alternative Highway Routes in New Mexico a/

Route Number	Cities and Towns	Route Length b/	Accident Rate per Shipment ($\times 10^{-4}$)	Accident Rate per Vehicle-Mile ($\times 10^{-6}$)
1	I-25 at Raton, south to Las Vegas; from Las Vegas, south on U.S. 84 to I-40, east to Santa Rosa; at Santa Rosa, south on U.S. 54 to Vaughn, then south on U.S. 285 to the WIPP site.	380	3.51	0.92
2	I-25 at Raton, south to Las Vegas, then south on U.S. 84 to I-40; at I-40, west to Clines Corners, then south on U.S. 285 to the WIPP site.	421	4.92	1.17
3	I-25 at Raton, south through Albuquerque to U.S. 60 (near Bernardo, south of Belen); U.S. 60 east to U.S. 285, then south on U.S. 285 to the WIPP site.	539	5.00	0.93
4	I-25 at Raton, south through Albuquerque to U.S. 380 (south of Socorro); U.S. 380 east to Roswell, then south on U.S. 285 to the WIPP site.	525	6.39	1.22
5	I-25 at Raton, south to I-10 at Las Cruces; east on I-10 to U.S. 62 at El Paso, east on U.S. 62 to U.S. 285; north on U.S. 285 to the WIPP site.	641	4.36 c/ (5.13) c/	0.68 (0.80)
6	I-40 at Gallup, east through Albuquerque to Clines Corners; at Clines Corners, south on U.S. 285 to the WIPP site.	459	4.84	1.05
7	U.S. 666 at Shiprock, south to Gallup, then use alternative route 6.	539	6.40	1.19
8.	I-40 at Gallup, east to Albuquerque; at Albuquerque, use southern leg of alternative route 3.	500	4.90	0.98
9.	U.S. 666 at Shiprock, south to Gallup, then use alternative route 8.	587	6.46	1.10
10.	I-40 at Gallup, east to State Highway 6 (west of Albuquerque); east on State Highway 6 to I-25 at Los Lunas, south on I-25 to U.S. 60; east on U.S. 60 to U.S. 285; south on U.S. 285 to the WIPP site.	465	4.81	1.03

Table VII.4. Continued

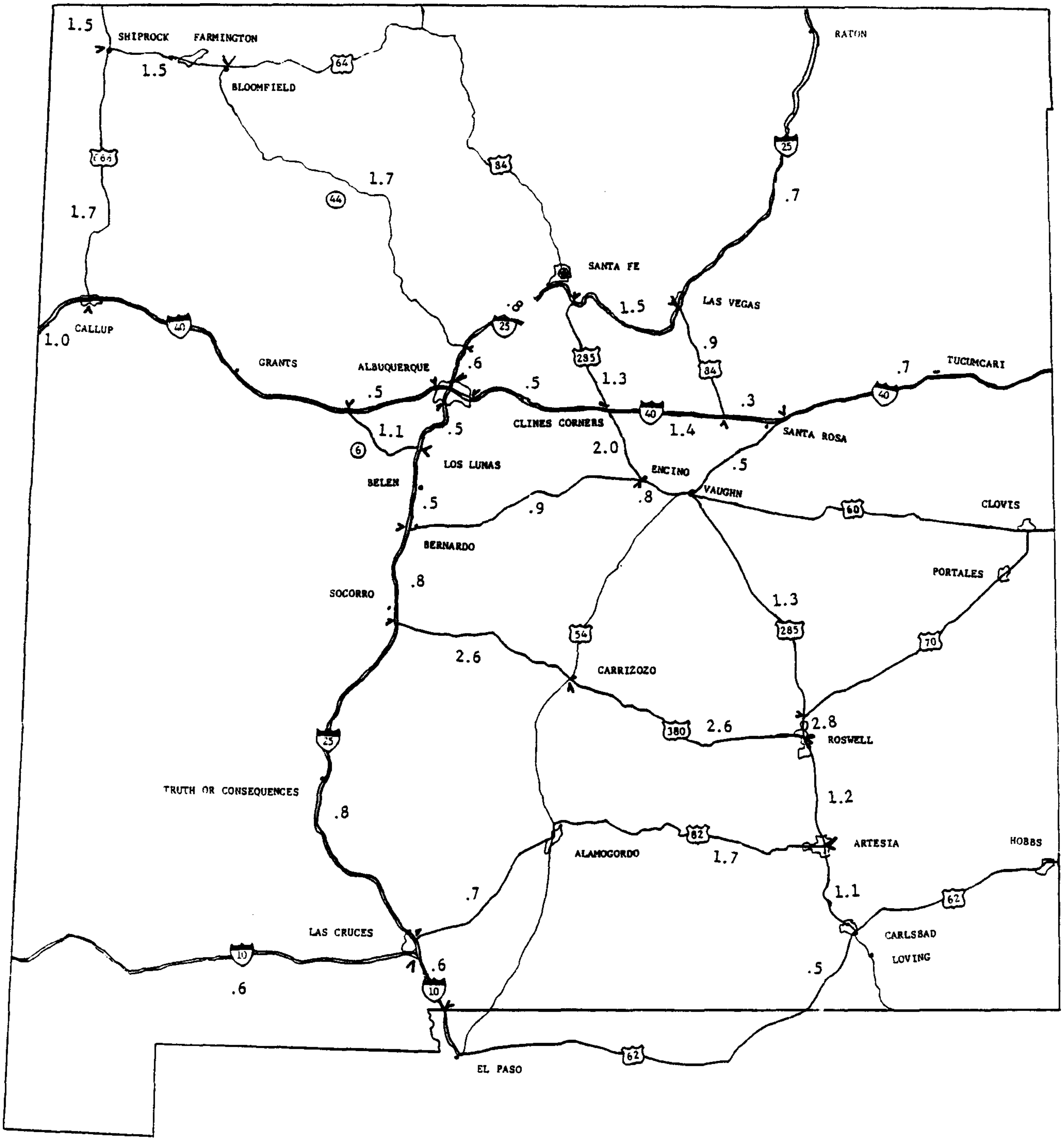
Route Number	Cities and Towns	Route Length[b/]	Accident Rate per Shipment ($x10^{-4}$)	Accident Rate per Vehicle-Mile ($x10^{-6}$)
11.	U.S. 666 at Shiprock, south to Gallup and then follow route alternative 10.	552	6.37	1.15
12.	I-40 at Gallup, east to State Highway 6, east on State Highway 6 to I-25 at Los Lunas, then southern leg of alternative route 4.	451	6.49	1.44
13.	I-40 at Gallup, east to State Highway 6, and east to Los Lunas; at Los Lunas, south on I-25 to Las Cruces, then east on U.S. 82 to Artesia; at Artesia, south on U.S. 285 to the WIPP site.	599	5.94	0.99
14.	I-40 at Gallup, east to State Highway 6, east on State Highway 6 to Los Lunas, the southern leg of alternative route 5.	588	4.27[c/] (4.94)[c/]	0.73 (0.84)
15.	I-40 east from Tucumcari to Santa Rosa, south on U.S. 54 to Vaughn, then south on U.S. 285 to the WIPP site.	301	2.81	0.93
16.	West on U.S. 60 to Clovis, then south on U.S. 70 to U.S. 285 at Roswell; south on U.S. 285 to the WIPP site.	186	2.10	1.13
17.	West on U.S. 62 through Hobbs to the WIPP site.	74	0.72	0.93

a/ Rates are compiled from 1976-78 data on traffic flows and numbers of accidents. See maps for precise delineation of routes.

b/ Route length is from State border to Carlsbad. Some additional mileage would be required in each case to get to the WIPP site.

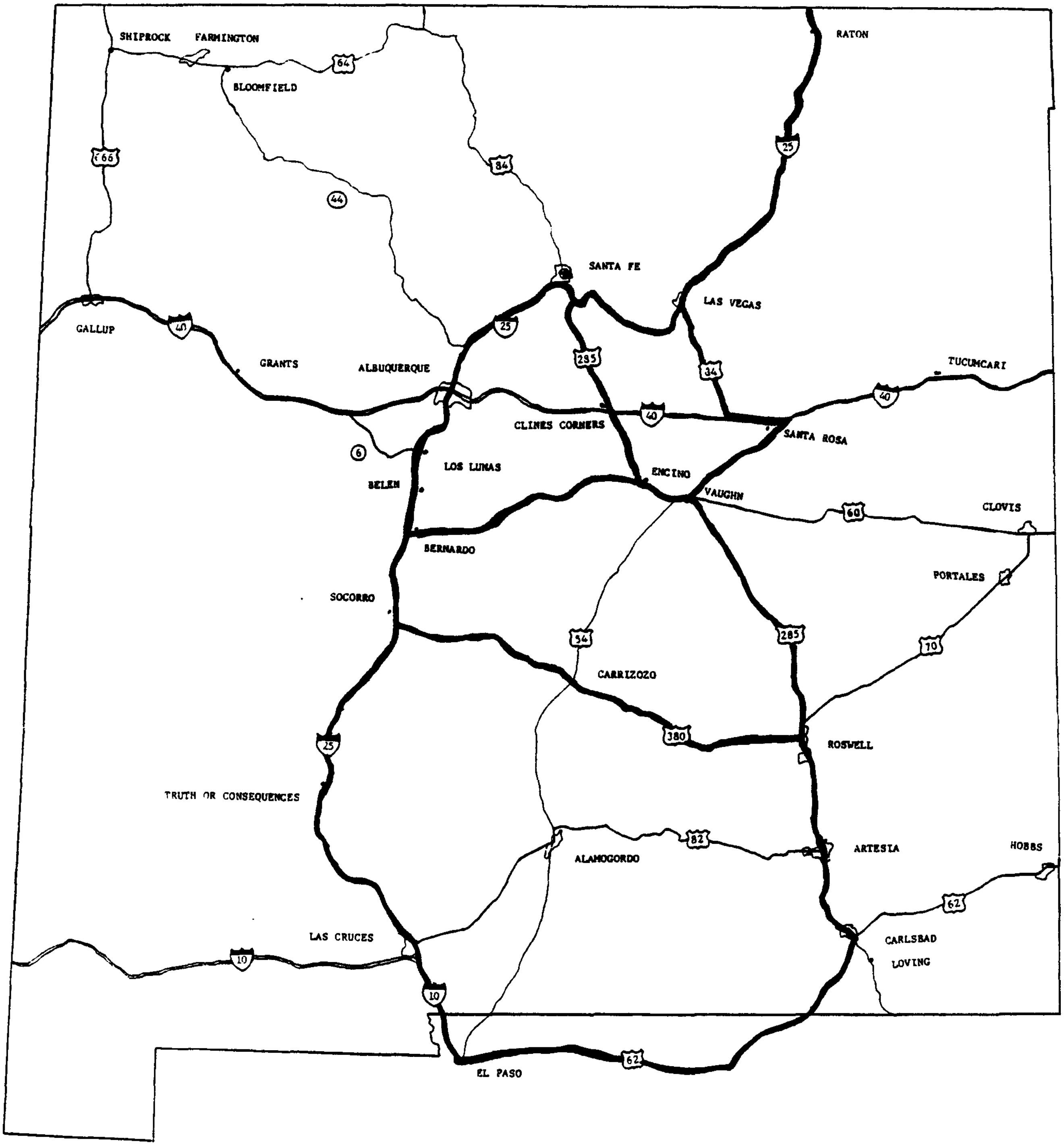
c/ For the route passing through Texas southeast of Las Cruces, the first accident rate uses an assumption of 6 x 10^{-7} as the accident frequency on the Texas portion. The second figure (in parentheses) is based on an assumed accident frequency of 1.1 x 10^{-6} for the Texas portion.

MAP 1. ACCIDENT RATES PER VEHICLE-MILE FOR SELECTED FAP SEGMENTS IN THE STATE



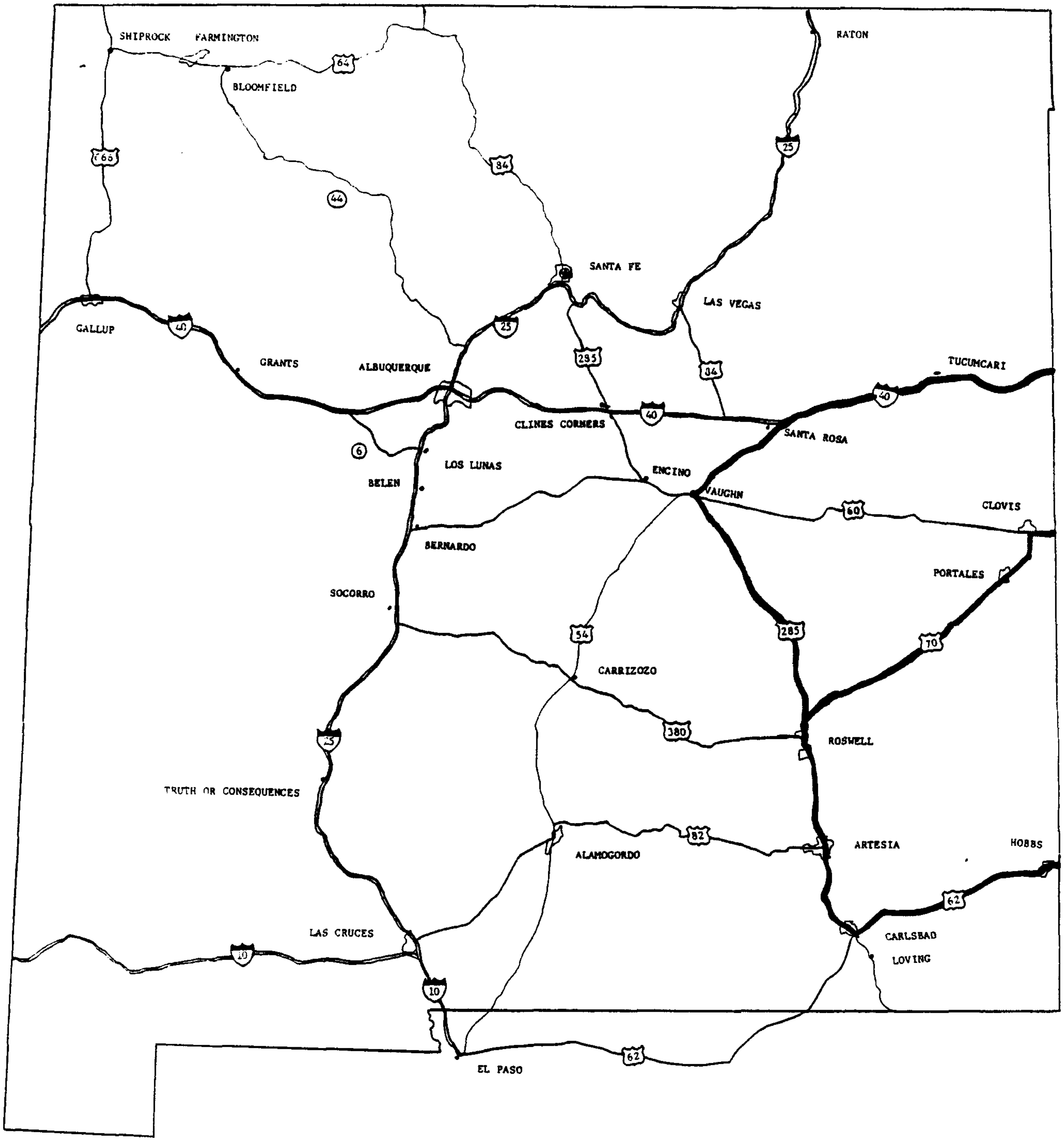
Source: See text.

MAP 2a. HIGHWAY TRANSPORTATION ROUTES TO THE WIPP SITE
(from the north)



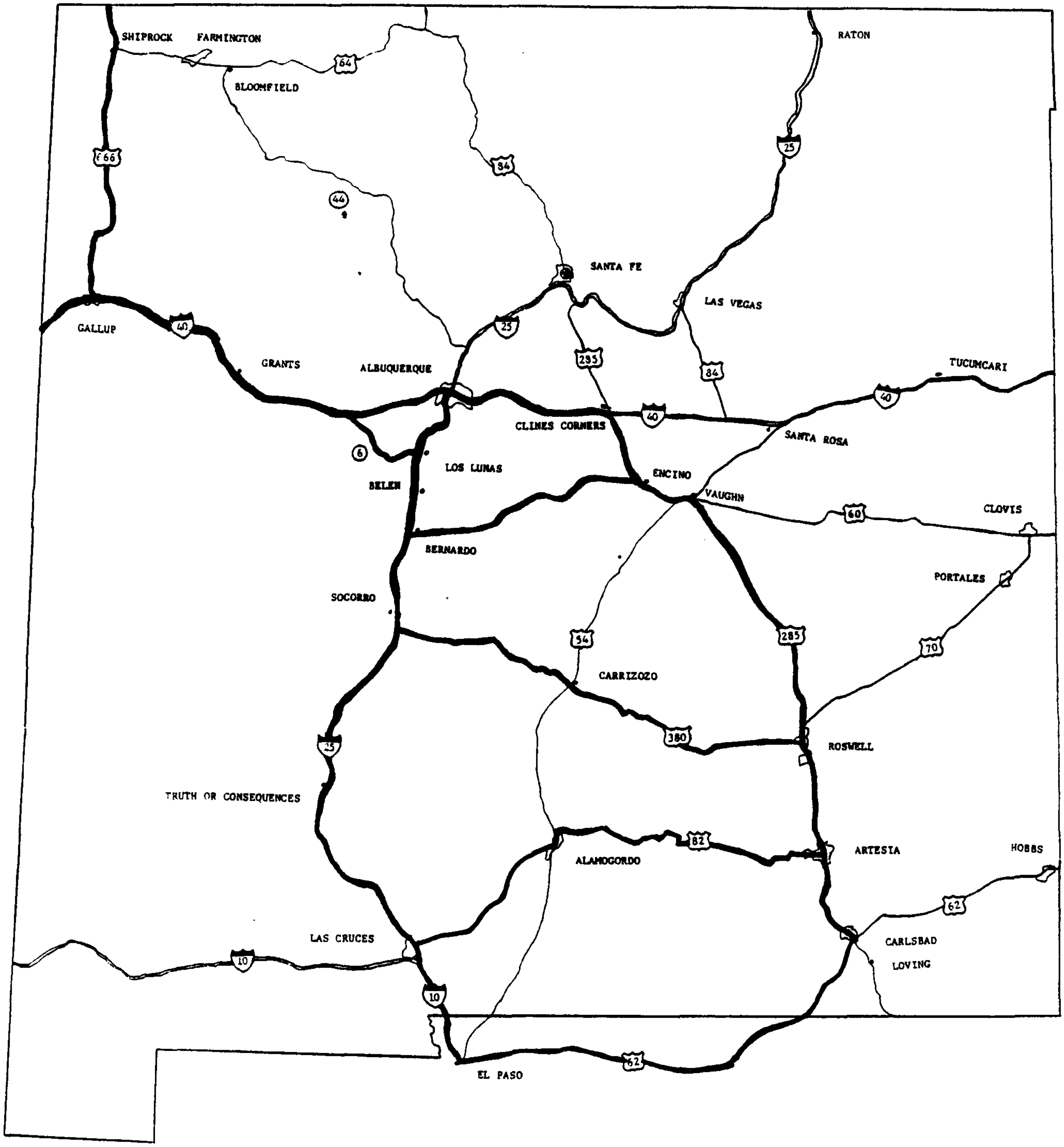
Heavy lines trace route alternatives described in Table VII.4.

MAP 2b. HIGHWAY TRANSPORTATION ROUTES TO THE WIPP SITE
(from the east)



Heavy lines trace route alternatives described in Table VII.4.

MAP 2c. HIGHWAY TRANSPORTATION ROUTES TO THE WIPP SITE
(from the west and northwest)



Heavy lines trace route alternatives described in Table VII.4.

MAP 3. SEGMENTS ALONG ROUTES DESIGNATED AS DEFICIENT IN THE 1978 RATINGS FOR HIGHWAY IMPROVEMENTS, INTERSTATE AND RURAL FEDERAL-AID PRIMARY SYSTEMS

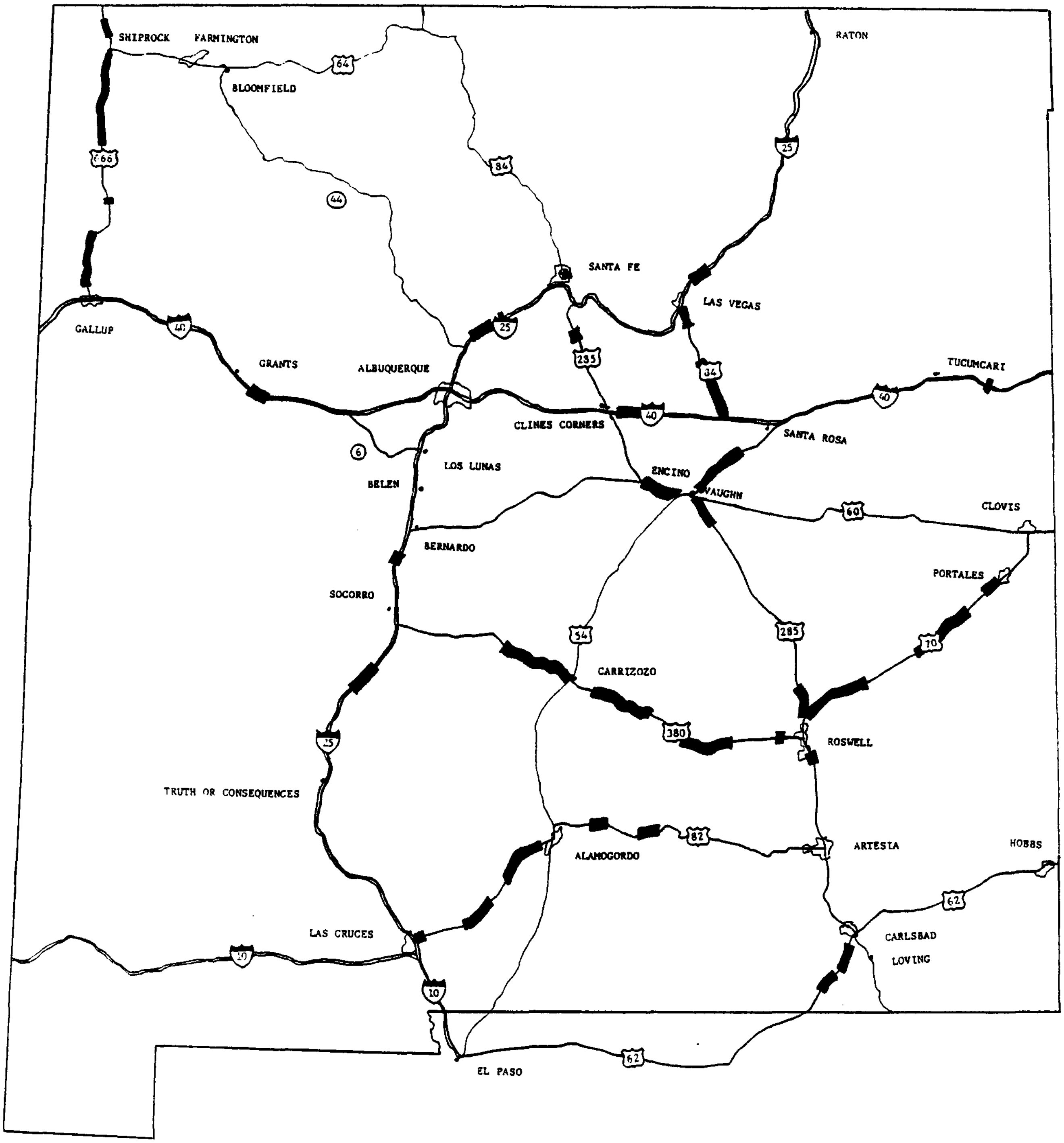


Table VII.5. Accident Rates per Vehicle-Mile in Albuquerque, on Interstate Highways

Segment	1978 Average Daily Traffic	Annual Traffic (thousands)	Distance (miles)	1979 Accidents	Annual Rate per Vehicle-Mile ($x10^{-6}$)
I-40					
Central-Coors	11,300	4,124.5	5.60	4	0.5
Coors-Rio Grande	42,100	15,366.5	1.87	48	2.4
Rio Grande-4th	56,150*	20,494.8	1.35	31	1.8
4th-I-25	71,500**	26,097.5	0.98	21	2.0
I-25-Carlisle	92,200	33,653.0	1.50	91+	1.8
Carlisle-San Mateo	96,800	35,332.0	0.55	72	3.7
San Mateo-Louisiana	85,600	31,244.0	1.10	73	2.1
Louisiana-Wyoming	67,000	24,455.0	1.13	24	0.9
Wyoming-Lomas	46,200	16,863.0	0.49	23	2.8
Lomas-Eubank	49,300	17,995.0	0.61	37	3.4
Eubank-Tramway	25,400	9,271.0	2.21	29	1.4
			17.39	443	1.5
I-25					
Rio Bravo-Gibson	30,900	11,278.5	2.60	26	0.9
Gibson-Stadium	40,700	14,855.5	0.67	8	0.8
Stadium-Lead	47,100	17,191.5	0.73	32	2.5
Lead-Grand	57,000	20,805.0	0.40		
Grand-Lomas	71,800	26,207.0	0.35	62	6.8
Lomas-I-40	82,400	30,076.0	1.07	53+	1.6
I-40-Candelaria	56,400	20,586.0	0.64	59+	4.6
Candelaria-Montgomery	41,300	15,074.5	1.44		
Montgomery-Osuna	24,400	8,906.0	2.00		
Osuna-Tramway	17,500	6,387.5	3.85		
			13.75	___	(1.9)

* Average of Rio Grande-12th (58,800) and 12th-2nd (53,450)
** Figure for 2nd-Big I
\+ Arbitrarily allocating one-fourth of the Big I accidents to this segment

Sources: Traffic volumes from the Middle Rio Grande Council of Governments; accident tabulations from the Albuquerque Police Department.

Table VII.6. POPULATION AT RISK ALONG THE ALTERNATIVE HIGHWAY ROUTES*

ROUTE NUMBER	POPULATION, 1977
1	61,000
2	59,000
3	178,000
4	183,000
5	306,000
6	162,000
7	165,000
8	170,000
9	173,000
10	73,000
11	76,000
12	97,000
13	81,000
14	201,000
15	33,000
16	62,000
17	20,000

*Approximations based on 1977 population estimates for incorporated areas multiplied by the fraction of the area within one mile of the route.

the Interstate highways are generally the safest roads in the State. Their overall accident rate of 7.6×10^{-7} per vehicle mile (excluding cities and towns) compares favorably with the national average highway accident rate of 2.5×10^{-6}. Accident rates on Interstates within the City of Albuquerque (Table VII.5.) are somewhat higher (1.5×10^{-6} to 1.9×10^{-6}) than other segments of the Interstate highways.

To compare the different routes, we refer to Tables VII.4 and VII.6. Consider the five route alternatives for WIPP shipments entering the State *via* Raton. Taking into account travel time (very approximately related to distance) and accident risk, route 1 is clearly preferred to routes 2 - 5. In terms of population at risk (Table VII.6), route 2 involves a population at risk that is 5% smaller than route 1's. Given route 2's greater length (11%) and much larger accident rate (40%), relative to route 1, it would appear that route 1 might be preferred to route 2 for WIPP transports entering the State from the north.* In terms of a back-up route, route 2 would seem to be clearly preferable to routes 3-5.

Turning to the routes entering from the northwest (Map 2.C), three basic choices are involved: (a) entering via Cortez, Colorado, and Shiprock (U.S. 666), or entering via Holbrook, Arizona, and Gallup (I-40); (b) going through Albuquerque or by-passing it by using State Highway #6 to Los Lunas; and (c) where to intersect U.S. 285 for the last, southerly leg of the journey, or whether to continue south on I-25 to El Paso before turning east. Choices (b) and (c) are interrelated.

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*Possibilities of increasing safety factors by route upgrading are discussed in the next section.

In terms of the question as to whether to enter the State via Shiprock or on I-40 west of Gallup, entry on I-40 at Gallup is preferable on the basis of accident rate and population at risk criteria. U.S. 666 from the Colorado border south to Gallup has a higher accident rate than does I-40. From the Colorado border to Shiprock, the rate is 1.5×10^{-6} accidents per vehicle-mile and from Shiprock to Gallup it is 1.7×10^{-6}. By contrast, all along I-40 from the Arizona border to Laguna Pueblo, the rate is 1.0×10^{-6} accidents per vehicle-mile. In terms of population at risk, the Shiprock entry involves higher population at risk in all comparisons of routes, _viz_., 6 _vs_. 7, 8 _vs_. 9 and 10 _vs_. 11.* Hence from a purely New Mexico viewpoint, safer entries from the northwest require entry at Gallup. The FEIS (p. 6-15) does consider these two routes as competing alternatives for wastes originating at INEL (Idaho) and Hanford, Washington.

*The higher population at risk for the Shiprock entry simply reflects the greater travel time (route length) for these routes.

The issue as to the possible Albuquerque by-pass *via* State Highway 6 for WIPP trucks entering from the Northwest is easily resolved, as we might expect. The relevant comparison in this regard is between routes 8 and 10, wherein transport vehicles entering the State at Gallup move south on I-25 to U.S. 60 and then east to U.S. 285; route 8 joins I-25 at Albuquerque, but route 10 uses the State Highway 666 by-pass in order to join I-25 at Los Lunas. Compared to route 8, route alternative 10 (which by-passes Albuquerque) has a lower accident rate per shipment (4.81 compared with 4.9, Table VII.4.) and a much lower population at risk (73,000 compared with 170,000, Table VII.6).

In terms of a "best" Gallup to Carlsbad route, we have, therefore, argued that safety considerations suggest that entry at Gallup is preferred to entry at Shiprock and that, for routes that move south on I-25, the Albuquerque by-pass is strongly preferable from the State's point of view. We are then left with the alternative routes for nuclear waste vehicles entering at Gallup given in Table VII.7.

Table VII.7.

Route Number	Five Alternative Routes, Gallup to Carlsbad	Accident Rate Per Shipment ($\times 10^{-4}$)	Route Length	Population At Risk
6	Gallup to Clines Corners, through Albuquerque, then U.S. 285 to Carlsbad.	4.84	459	162,000
10	Gallup to by-pass; I-25 to U. S. 60, east to U.S. 285.	4.81	465	73,000
12	Gallup to by-pass; I-25 to U.S. 380 then east to U.S. 285.	6.49	451	97,000

Table VII.7. Continued

Route Number	Five Alternative Routes, Gallup to Carlsbad	Accident Rate Per Shipment ($x10^{-4}$)	Route Length	Population At Risk
13	*Via* the by-pass, south on I-25 to U.S. 82 at Las Cruces then east to U.S. 285.	5.94	599	81,000
14	*Via* the by-pass, south on I-25 to I-10 at Las Cruces, continuing south through El Paso and then north on U.S. 285.	4.27-4.94	588	201,000

Source: Tables VII.4 and VII.6.

Based on these data, route 10's slightly longer route length (relative to routes 6 and 12) would seem to pale in significance when one considers its lower accident rates and, most importantly, its dramatically lower population at risk. Therefore, it is suggested here that route 10 is preferable from the State's point of view. The choice of a back-up route for trucks entering at Gallup is much more difficult. Route 13 has the lowest population at risk, but a relatively high route length and accident rate. Route 6 has the lowest accident rate and a relatively low route length, but involves the extremely high population at risk associated with passing through Albuquerque. Given these trade-offs, a recommended back-up route is not suggested here. Based strictly, and arbitrarily, on population at risk considerations, route 13 is used as a back-up route for the purpose of considering highway upgrading which is discussed in later sections.

As regards the three routes entering the State from the east (routes 15-17), the portion of these eastern routes which lies in New Mexico is very short; therefore, it seems likely that these selections will be made in light of considerations relevant for areas east of New Mexico (primarily, the state of Texas).

B.3. Route Improvement Options

For any of the feasible shipping routes, the route's safety can be improved by investments in highway upgrading. Unfortunately, there is no clear body of quantitative evidence on the degree of safety improvement which is brought about by widening roads, installing better lighting and guard rails, etc.

In the absence of good statistical estimates of changes in accident rates brought about by upgrading, the alternative is to consider engineering standards of adequacy. These standards are widely used in budgeting for highway expenditures. They refer to the condition of the road, function and surface, the sharpness of curves and dips, the width of bridges, stopping sight distances, etc. These factors have been combined by highway specialists to create an overall binary index which rates any highway segment as adequate or deficient.

The deficient index is used when any one of the following conditions are found (New Mexico Highway Department, 1978, p. 3-5):

(i) The foundation rating is zero (scale of zero to one);

(ii) The surface rating is 10 or less, on a scale of zero to 30;

(iii) The safety rating, which measures the incidence of hazardous conditions, is less than 20, on a scale of 1 to 20.

(iv) The capacity rating, in respect to traffic volume, is 10 or less on a scale of 1 to 30.

As a part of this study, safety ratings in this system were regressed against observed 1978 accident frequencies for 407 route segments in New Mexico, but there was virtually complete absence of correlation. Therefore, the alternative approach of using the deficiency index directly is adopted. The rationale for use of this index is not unreasonable: for the WIPP shipments, public policy is assumed to be directed at ensuring that deficient segments of selected routes are not used.* This is essentially the approach utilized by the State Highway Department in reporting to the Governor about needed highway improvements for the WIPP. In their study, they cited an overall average figure of $200,000 per mile to bring deficient segments up to par. This cost per mile figure and the deficiency ratings are shown in Table VII.8 for the 17 alternative routes.

An upgrading program motivated by WIPP shipments would have to consider all eligible routes, including the back-ups. Therefore, for illustration, we take the routes indicated in the text: 1, 2, 10 and 13. Also, as all routes entering the State from the east could be used, the New Mexico portion of routes 15, 16, and 17 would have to be included in the upgrading program.

For the non-overlapping portions of these routes, total expenditures on upgrading would be estimated at $57,221,000 (in 1979 dollars), on the basis of the data in 1979. This is higher than the State Highway Department's estimate of $27,540,000 (O'Cheskey, 1979) which may not have considered back-up routes.

B.4. Emergency Preparedness

Implementation of the WIPP in New Mexico will require that state and local government units be prepared to handle radiological emergencies occurring on highways and railroads. Earlier discussions concerning jurisdictional issues has established that emergency preparedness is clearly a state and local responsibility.

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*While the safety measure may not be correlated with accident rates across routes, it and related indexes may be good guides to priorities in expenditures for diminishing accident probabilities along a given route.

Table VII.8. Highway Safety Upgrading Parameters

Number	Miles Deficient[a/]	Percentage of Route Deficient	Approximate Route Upgrading Cost ($1000)
1	71.1	18.7%	14,220
2	53.4	12.7	10,680
3	67.1	12.9	13,420
4	99.2	19.6	19,840
5	27.6[b/]	4.4[b/]	5,520
6	54.8	12.3	10,960
7	128.1	24.1	25,620
8	58.1	12.0	11,620
9	131.4	23.0	26,280
10	59.2	12.7	11,840
11	132.5	24.0	26,500
12	90.7	20.1	18,140
13	80.9	13.5	16,180
14	34.1[b/]	7.5[b/]	6,820
15	33.7	11.2	6,740
16	68.5	36.8	13,700
17	0.0	0.0	0

a/ The criteria for declaring a segment deficient are explained in the text.

b/ These figures do not include the 140 miles of the route which passes through Texas.

A radiological emergency requires response by specially trained persons who will have to make on-site measurements and decisions in order to minimize the possibility of damages to public health and safety. As will be discussed, New Mexico's residents include a number of federal personnel who are trained to handle radiological accidents, owing to the presence of federal nuclear facilities in the State. Therefore, the radiological emergency response question is not a new one in the State. Nevertheless, it is important to review this topic in order to determine the adequacy of response planning and capabilities for the WIPP in particular.

B.4.1. Components of Emergency Response

Emergency response planning for transportation accidents is inherently more complex than for site-specific accidents inasmuch as responses may be required at widely dispersed locations. An adequate emergency response clearly may involve many of the usual emergency personnel, such as police, medical personnel, and fire fighters. It also involves individuals with specialized training in radiation detection and decontamination, radiological injury treatment and so forth. Above all, it requires effective communications among the different elements of the response team. This probably is the weakest link in many states' radiological emergency response capabilities.

As an example of this weakness, in March, 1977, a train carrying uranium hexafluoride and other hazardous materials derailed near Rockingham, North Carolina, and the response to that accident has become a textbook case of inadequate emergency preparedness, primarily owing to ineffective communication. According to the GAO, "at least 17 Federal, State, local and private agencies responded to the accident. However, no one assumed control until a State radiological team arrived. Even then, a lack of coordination and serious communication problems existed" (GAO, May, 1979, pp. 21). The National Transportation Safety Board (NTSB) conducted a special investigation of this accident. As matters turned out, "The primary threat at Rockingham was chemical, not radioactive. However, preoccupation with radioactivity prevented the timely response to the explosion and chemical dangers" (NTSB, September, 1979, pp. 17). The NTSB also concluded that:

> "The initial notification of emergency response agencies was time consuming and of questionable effectiveness because of the inadequacy of the Seaboard Coast Line Railroad's contingency plan."
>
> "The emergency response plans concerning radioactive hazardous materials were inadequate."
>
> "An effective hazardous materials emergency response plan must include designation of the on-scene commander, delineate the coordination of effort between all organizations, require prompt establishment of a command post, and provide guidance for communications and control of access to the accident site."
>
> "The current system of classifying hazardous materials does not provide emergency response personnel with suitable information with which to diagnose the relative dangers and formulate operational plans."

All of these points relate in one way or another to effective communications.

A discussion of response capabilities may be arranged according to the time sequence of events: planning and other preparations prior to the occurrence of accidents, capabilities for immediate response at the time of the emergency, evacuation preparedness, and post-accident operations (decontamination and other clean-up). These topics are taken up in order in the succeeding sections.

B.4.2. Emergency Response Plans

Not all states have emergency response plans for radiological transportation accidents, but many states are in the process of developing them. New Mexico has a Radiological Emergency Response Plan which was most recently updated in August, 1980, but in the absence of a firm timetable for the WIPP (prior, of course, to the DOE's January 23, 1981 covenant), there has been no attempt to augment the State's emergency preparedness for the WIPP.

The New Mexico plan contains the following elements:

Listing of 24-hour emergency telephone numbers at the EID's Radiation Protection Bureau, at JNACC, and at the State Police Headquarters.

Advice to shippers of their responsibility to minimize accident possibilities and provision to them of a pamphlet of radiological accident response.

Provision to local officials and emergency personnel of DOE pamphlets on accident response procedures.

Establishment of an EID radiation response team with monitoring equipment in the team's homes as well as in offices.

Drafting of sample public information releases for various radiological contingencies.

Thus far, no provisions are made for testing the plan or for the training of local officials and emergency personnel other than those in the response team. No mention is made of procedures for designation of an on-scene commander, although it may be inferred that the response team captain would play that role. Also, no provisions are made for coordination with local emergency preparedness officials who would bear responsibility for possible evacuation decisions. Primary reliance is placed on getting a response team, either EID or JNACC, to the accident scene and then following the team's field leadership. The two agencies (EID and JNACC) have an agreement to notify each other in the event of an accident. Aircraft and helicopters are available for transporting the team to the accident site, but these arrangements are not mentioned in the plan. To date, this mode of operation has worked well for the few minor radiological accidents which have occurred in New Mexico.

Federal and regional guidelines* for state response plans emphasize the need for training and exercises (i.e., run-throughs of simulated emergencies). For example, in its Standards for Local Civil Preparedness, the Department of Defense states:

> "Enough police personnel (should) have been trained as radiological monitors to assure that the police force can conduct its own monitoring in the case of nuclear attack or a peacetime radiological incident ....the number of monitors should be sufficient to assure that one trained man is available for each two police vehicles. The minimum training required is completion of Part I of the standard Radiological Monitoring Course."

> "Enough firefighters (should) have been trained as radiological monitors, from each company or equivalent unit, to assure one man on duty at all times, in case of nuclear attack or peacetime radiological incident."

(These passages are from Defense Civil Preparedness Agency, U.S. Department of Defense, Standards for Local Civil Preparedness, Washington, D. C., December, 1972, pp. 17-18.)

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*See, for example: Regional Training Committee, Region VIII, and the Western Interstate Nuclear Board, Guide and Example Plan for Development of State Emergency Response Plans and Systems for Transportation-Related Radiation Incidents, April, 1975.

In New Mexico as in other states, hospital certification requirements include radiological treatment capabilities, but emergency response officials question the ability of many hospitals to handle cases involving radiation contamination. Similarly, the training of firemen and policemen in New Mexico falls far short of the above cited Federal guidelines. The Albuquerque Fire Marshall's Office has urged development of radiological courses for firemen.

Fire departments and police departments are the only local units which are generally trained to respond to emergencies. Fire-fighters often are called upon to respond to floods and other disasters even though a fire may not be involved. At present, there is no doubt that fire-fighters in New Mexico are inadequately trained to handle radiological emergencies. The Albuquerque Fire Department (Lujan and Martinez, 1979) and the State Fire Marshall's Office (Garcia and Baca, 1979) have raised this issue, and the former even discusses the possibility that firemen may refuse to respond to a fire call if radiation contamination is suspected, owing to their lack of training for such contingencies.

In situations where a JNACC or Radiation Protection Bureau team can arrive at the accident scene immediately, their expert personnel can measure the radiation releases, if any, and direct the emergency operations. However, it is not difficult to imagine circumstances in which weather conditions and slow notification prevent these teams from arriving within a short time. In those circumstances, local fire and police personnel, who almost invariably are the first responsible officials to arrive on the scene, would have to make a number of important decisions. One decision they might have to make would be evacuation in the event that a possibly-radioactive smoke plume was moving toward a populated area. According to existing state regulations, such a decision lies within the jurisdiction of the State Office of Civil

Emergency Preparedness, which has representatives at the county level. These local officials have not been drilled regarding appropriate actions for radiological transportation accidents and they have not been briefed on coordination with officials of JNACC or the Radiation Protection Bureau. Monitoring equipment, which would assist in the determination of the extent of a radiation release, is not presently available to local civil emergency preparedness officials, police or firemen.

In South Carolina, State Highway Patrol Officers are given training on a semi-annual basis for handling accidents involving nuclear materials, and in California there also are radiological emergency training programs for the Highway Patrol; firemen and State Police receive such training in Arizona. In Colorado, emergency alert exercises are conducted periodically for the state's one nuclear power facility (State of Colorado, 1979, annex O). In Washington State, Gordon Goff of the State's Department of Emergency Services has stated that the level of emergency preparedness in county and local governments ranges "from very good to very bad;" this statement may be taken as indicating the need for better training programs there.

There are 250 fire departments with about 6,000 firemen in New Mexico, and there are 381 state and many municipal and county police officers. Not all of these individuals would require radiological emergency training, for many of them work in counties where there would not be any radioactive shipments.* A very crude cost estimate for the requisite training is used here based on the admittedly arbitrary assumption that 4,000 persons would be trained initially and that training on an equal scale would be repeated at least every third year to keep up with personnel rotation and turnover, to

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*Ron Mascarenas of the New Mexico State Police estimates that a minimum of 250 state police officers would have to be trained annually.

provide refresher courses, and to conduct emergency exercises. If all costs per trainee, including materials, time off with pay, etc., were $500 (per session), then the initial outlay for training would be on the order of $2,000,000 and the total discounted costs (at 6 7/8%) over thirty years, with retrains every third year, would be $5.87 million.*

If two units of radiation monitoring equipment were installed in each of one hundred firehouses, the approximate cost (1980 dollars) would be about $100,000. This expenditure probably would have to be repeated in about 15 years, to replace the equipment. The present value of these costs, at 6 7/8%, would be $92,000.**

Similar calculations may be made for hospitals in the state, as follows:

a) training costs, 1000 staff members at $100 each, repeated every three years; present value of costs is $293,000.***

b) radiological equipment, $50,000 replaced in fifteen years; present value of costs is $45,950.****

All of these figures are, of course, rough and approximate, but may be useful in suggesting an order of magnitude for the financial implications of better emergency planning.

Still another cost consideration which warrents attention here are costs associated with evacuations. Liability issues related to public costs that arise from evacuations should be laid out in detail to avoid confusion as to individual liability; this is particularly important for local officials who may be required to make judgments as to the need for evacuations in instances where trained experts are delayed in reaching accident scenes. Limitation on

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*Assuming that the initial training session begins in the sixth year of the construction period.

**Assumes initial purchase in year 6 with replacement in year 21.

***Initial training in year 6.

****Initial purchases in year 6 with replacement in year 21.

state tort liabilities are established by state law, and civil suits against individuals for evacuation-related damages would require a demonstration of negligence; clarifications of liability questions may be most useful in any case, however, in protecting individuals from the potential necessity for being involved in expensive litigations.

Finally, given New Mexico's geographical extent and the large number of local officials who could become involved in accident responses, there would appear to be a strong case for development of regional or county radiological emergency plans for those areas with potential nuclear waste transportation routes. The Standards for Local Civil Preparedness document cited above discusses the substance of such plans, even for areas with less than 5,000 population. Such plans could specify training requirements and procedures for occasional testing of the plans.

In summary, New Mexico's emergency preparedness is somewhat informal and relies strongly on the capabilities of trained accident response teams, both Federal and state. These teams are certainly capable and, in this respect, New Mexico's emergency preparedness capabilities probably compares favorably with that of other states. However, other emergency response personnel may have to be called upon, and provisions for coordination with them are sketchy and training programs are non-existent. In Appendix VII-A the status of emergency facilities throughout the state is summarized.

To provide very approximate ideas regarding the cost of improved emergency planning in other states, Tables VII.9 and VII.10 show compilations of historical nuclear emergency preparedness costs for states and localities which have developed plans. There is considerable variation by locale, and these costs refer to preparedness for contingencies at power plant sites, but still their magnitude should give some guidance for likely outlays in preparedness planning for the WIPP. Based on these data, we can infer initial

TABLE VII.9. SUMMARY OF HISTORICAL STATE EMERGENCY PREPAREDNESS COSTS FOR NUCLEAR POWER FACILITIES (in 1978 dollars; per power plant site)

State	Initial Planning Costs*	Identifiable Recurring Costs**
Alabama[1]	17,776	16,749
Arkansas[2]	240,127	96,430
California[3]	104,354	59,445
Colorado[4]	99,697	20,333
Connecticut[5]	23,696	32,361
Delaware[6]	40,250	31,625
Florida[7]	56,700	
Illinois[8]	107,910	13,526
New Jersey[9]	103,375	26,371
New York[10]	56,236	98,959
Oregon[11]	54,794	96,020
Tennessee[12]	45,000	300
Washington[13]	39,458	10,432
Wisconsin[14]	15,796	
Total	1,005,199	502,551
Average	89,600	80,374

* Initial planning costs are composed of initial planning costs and initial equipment costs.

** Identifiable recurring costs come from the summation of update planning costs, exercise costs, initial and update training costs, and update resources costs.

Source: Table VII-A.2.

Footnotes for Table VII.9

1/ Alabama has NRC concurrence. In 1983, there is an anticipated increase in annual cost based on State assistance for a county plan in support of a new site.

2/ Arkansas has NRC concurrence.

3/ California has NRC concurrence. For the emergency preparedness plan, secretarial support costs are included in the initial and update costs. Travel cost was implied as being low and, therefore, not stated. Initial training costs are comprised of 4 persons at $4,000 per person for courses, and $2,000 for on the job training.

4/ The State of Colorado presently is applying for NRC concurrence. Radiological health training is not included in the initial training cost outlay.

5/ Connecticut has NRC concurrence. Plan update costs are not cited. Special resources were not purchased.

6/ Delaware has NRC concurrence. The nuclear power site actually is located in New Jersey. Training has been provided by the NRC. It is noted that two stabilized Assay Monitors, priced at $3,300 each, were provided by the utility for the State's use.

7/ Florida has NRC concurrence. Total initial cost for the plan is exclusive of travel, secretarial support and printing. Due to these omissions it may be viewed as low. For our purposes the resources update expenditure on the jelly analyzer is treated as a fixed cost and, therefore, added to initial cost. In doing this, the distinction between fixed charges and recurring charges is maintained. The Mobile Emergency Radiological Laboratory was purchased by the utilities.

8/ As reflected in projected future outlays, Illinois has proposed to update its plan to achieve NRC concurrence. Three new sites will be added. Once the planned update is completed, a lower level maintainence cost is anticipated for the preparedness plan.

9/ New Jersey has NRC concurrence. Resources dedicated to Civil Defense and Disaster Control were partially funded by the utility.

10/ New York has NRC concurrence. The update cost for New York is noted as being low because an account of agencies other than the Dept. of Health was not done. Since transportation and assistance provided by the nuclear facility staff are not included in the exercise cost estimate, it also is viewed as low.

Footnotes, continued:

11/ At this time, Oregon does not have NRC concurrence. The 1975 and 1977 total exercise costs are not attributable solely to Oregon State. All costs are accounted for to provide a complete picture of the dollar amounts that went into the exercise programs. The $27,950 subtotal amount for the 1975 exercise, gives an indication of Oregon's share of the costs.

12/ Tennessee does not have NRC concurrence. The emergency preparedness plan was developed over a ten year period requiring a one-year effort by two persons. Only one site has been included into the plan; however, work to include the second site has been completed.

13/ Washington has NRC concurrence. The state has contributed substantial funding to two local plans. One site, the Trojan nuclear facility, is located in Columbia County, Oregon but close in proximity to Cowlitz County, Washington. Given the assumption that the state continues the same general level of involvement in local emergency radiation plans, its future outlays should continually increase as sites are added along with new nuclear power plants on existing sites.

14/ Wisconsin does not have NRC concurrence. Some emergency preparedness activities have occurred even though cost estimates are not given. Transportation plus two persons for one day per exercise are noted. In terms of training, radiological emergency preparedness sessions have been held for fire, police and other local officials.

TABLE VII.10

SUMMARY OF LOCAL GOVERNMENT EMERGENCY PREPAREDNESS COSTS FOR NUCLEAR POWER FACILITIES, ONE-STATE PLANNING

(in 1978 dollars)

County	State	Initial Planning Costs*	Identifiable Recurring Costs **
Morgan Lawrence Limestone	Alabama	455,046	7,606
Humboldt	California	37,791	75,243
Sacramento	California	10,289	8,338
San Diego	California	41,176	38,122
Tri-Town	Connecticut	71,288	10,000
Citrus Levy	Florida	9,345	8,060
St. Lucie	Florida	3,750	3,750
Dade	Florida	5,154	
Oswego	New York	487	15,450
Westchester Rockland Putnam	New York	50,324	21,234
Total		674,650	187,803
Average		137,804	32,953

* Initial planning costs are composed of initial planning costs and initial resources costs.

** Identifiable recurring costs come from the summation of update planning costs, exercise costs, initial and training costs, and update resources costs.

Source: Table VII-A.2.

state and local planning costs at roughly $225,000, and identifiable recurring costs (for plan revision, training new personnel, and emergency exercises) at some $100,000 per year. The present value of these costs (at 6 7/8%) is $910,000.*

B.4.3 Other Preventive Measures

The routing decisions and preparedness programs discussed above basically constitute preventive measures which should help reduce the probabilities and/or consequences of waste transport accidents. Three other preventive measures which have been discussed in other states are escort vehicles, placarding, and timing restrictions on shipments.

Escort vehicles are used in nuclear weapons transport and in other fields in order to reduce accident probabilities and to provide for quicker response in the event of an accident. (To most people, probably the most familiar example occurs in the case of moving houses via public highways). The disadvantage of escort vehicles is their cost and the fact that they expose still another person (the driver) to accident possibilities.

Whether the advantages of escort vehicles outweigh the drawbacks depends on the nature of the shipment, i.e., the possible consequences of an accident if it does occur. A systematic study does not appear to exist for the question of escort vehicles for radioactive waste transport, but nevertheless judgment has been exercised and some regulations have been issued. The State of Arkansas and New York City require escorts on the more hazardous shipments, and Connecticut has passed legislation authorizing the state's executive branch to require escorts if deemed appropriate.

The NRC has established new regulations which require escorts to accompany spent-fuel shipments as they pass through or near large urban areas. The larger trucking firms will provide the escort service on request.

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*Initial costs in year 6, with recurring costs, beginning in year 7 and continuing through year 30.

At present, New Mexico's regulations do not refer to the escort issue, and it does not appear to have been discussed in the drafting of the recent regulations regarding the highway transport of nuclear waste. The question may not be pertinent for New Mexico in the case of the WIPP, because present plans call for the few WIPP shipments of high-level waste to go by rail (FEIS, p. 6-19). However, the State's officials may wish to consider the escort option in the event that some of these shipments are carried by trucks, and also for spent-fuel shipments crossing the state to other locations.

Placarding refers to posting the radiation hazard logo on the outside of vehicles carrying radioactive materials. It assists accident-response crews in identifying immediately the nature of the cargo. The U.S. Department of Transportation has issued a complex set of rules regarding placarding, and their net effect is that less than ten percent of the WIPP shipments would be so labeled. While it clearly is important to placard the more hazardous shipments, the state may wish to consider complementary regulations to placard all WIPP shipments. Regulators may wish to avoid inducing fear and hesitation on the part of emergency rescue personnel, but this possible drawback of placarding has to be weighed against the potential radiological injuries which could be caused by lack of awareness of a shipment's contents.

Timing restrictions are limitations on the movement of radioactive cargo on nights or weekends or during severe storms. Given the distances which would be travelled, the night-time restrictions probably would be impracticable for WIPP shipments, but the weekend limits may be worth considering. In a related matter, given the tendency of trucks to travel above posted speed limits, state authorities may wish to consider establishing severe penalties for exceeding 55 mph while conveying radioactive cargo. Timing and speed restrictions have been implemented in other states (National Conference of State Legislatures, Issue Brief: Radioactive Materials Transport, draft, August, 1980).

C. Potential Accident Costs to the State: The "What-If" Costs

The foregoing discussions have dealt with several aspects of risks in the transportation of nuclear wastes. It appears that they may not be greater than those associated with some other hazardous activities, or possibly not even as great. It also appears that proper advance planning can help reduce those risks. Still, just how great the risks are is to some degree a matter of conjecture, and it certainly is possible (however improbable) that a severe radiological accident could occur in New Mexico.

For state planning purposes, it is appropriate that some investigation be made of the implications and costs of a severe accident. An inquiry of this kind cannot yield very precise numbers, but it need only suggest orders of magnitude.

The logical starting point should be a description of alternative accident scenarios, but there is little documentation to go by in this area and that which is available is very hypothetical in character. The 1980 NRC/Sandia Laboratories study NUREG/CR-0743 provides some categories of cost estimates and a few scenarios, and scenarios also are given in NUREG-0170, the WIPP FEIS, and the aforementioned EIS for the Hanford waste facility. The assumptions in those studies vary, and, as noted previously, the key area of uncertainty concerns the proportion of radioactive materials released from the shipping containers (the "release fraction"). The two NUREG references and the WIPP FEIS postulate extremely small release fractions -- well under

1% -- even in severe accidents. On the other hand, the Hanford study uses release fractions up to 50% (for low-level wastes) and the Congressional testimony of the Association of American Railroads (cited above) suggests accident conditions under which release fractions could well be much higher than 1%.

The structure of the population-dose calculation models is such that calculated doses increase linearly with increases in release fractions. Therefore, it is tempting to derive a "credible upper bound" case by multiplying the accident effects by some number which reflects a higher release fraction, but there are at least three important objections to that procedure. First, we would be leaving the realm of the very highly improbable for another realm even less probable, and the question arises as to the boundary for "credible" accidents. Second, other parameters besides the release fraction influence the consequences of an accident -- parameters such as wind speed at the scene of the accident, population density within a mile of the accident, and so forth. In the hypothetical situations, these parameters also are highly uncertain. Third, the consequences of potential accidents also depend on the policy framework within which waste shipments are made: are trains carrying high-level wastes to be permitted to pass through the Albuquerque area? Are they to be permitted to travel faster than 35 mph in any part of the state?

Fortunately, the very detailed studies carried out by the staff at Sandia Laboratories make it possible to derive some accident cost bounds without the need to be very specific about scenarios. Before referring to this work, however, it is important to discuss a more general aspect of a potential accident: the social and political reaction. If there were a nuclear waste transportation accident in New Mexico that involved a few fatalities, temporary denial of access to contaminated land, and other deleterious consequences, it would appear very likely -- from the vantage point of the present -- that the public reaction against the program of shipments to the WIPP would be quite strong. There are several indirect precedents for this kind of statement related to the closing of other nuclear waste storage sites. The sites in Maxey Flats, Kentucky, Sheffield, Illinois, and West Valley, New York, were closed because of leakage of radioactive materials, although no public health hazard was found (National Conference of State Legislatures, Issue Brief: Low-Level Waste Management, draft, August, 1980; and Kentucky Legislative Research Commission Staff, 1979). In each case, state officials were instrumental in bringing about the closing. In a related incident, the storage site at Beatty, Nevada, was closed temporarily because of the transportation of contaminated tools through residential areas near the site. With these experiences as background, it is not amiss to suggest that a serious WIPP transportation accident, especially if it involves radiation-caused fatalities, could lead to a markedly adverse public reaction to the project and could jeopardize its continued functioning.

Turning to the dollar costs, NUREG/CR-0743 (1980) defines the main categories of accident costs, apart from health effects, as denial of land use, decontamination, security and monitoring measures, and immediate emergency response costs. (In keeping with the overall procedure of this study, we do not attempt to assign a monetary valuation to health effects). Denial of land use and decontamination costs would account for the bulk of the costs.

Decontamination efforts are guided by the EPA's recommendation that radioactivity in the soil and structures be reduced to a level of 0.2 millicuries per square meter (USEPA, September, 1977). In very extreme accidents involving the release of long-lived materials, there would be permanent denial of the land to human occupation or use. In these cases, clean-up is not a consideration. For accidents involving releases of short-lived materials, total clean-up costs could reach the order of $50 million for a very large urban area even if only 10 curies were released. For Albuquerque, the corresponding figure would be $5 - $10 million. These figures are taken from and inferred from NUREG/CR-0743, but they must be regarded as very approximate. For example, clean-up costs in the case of short-lived radionuclides depends on whether a decision is taken to "evacuate and wait for radioactive decay" rather than to decontaminate. Correspondingly, there is a trade-off between decontamination costs and costs arising from denial of use. Owing in part to this potential trade-off, it is unclear how rapidly clean-up costs rise as the amount of released material increased beyond 10 curies.

Because the denial of land use is such a dominant economic factor, total accident costs are capable of exceeding one billion dollars in a very large urban area like New York City, even with radioactivity releases of less than 1000 curies. In fact, total costs do not tend to increase with higher releases, simply because the maximum damage, in terms of rendering land and buildings useless for a considerable period of time, would have been incurred at lesser levels of radioactivity.

Factors for scaling these costs for other urban densities are given in NUREG/CR-0743. They imply, as noted earlier in this chapter, that total costs could reach the order of $100 to $300 million for a high-level waste accident in Albuquerque and about $50 to $150 million for cities like Roswell and Carlsbad.

D. Summary of Risk-Related Questions for the State and Recommended Policies

It is evident from the foregoing that if the WIPP is built in New Mexico, a number of decisions will have to be made at the state and local level. The WIPP shipments would not be as hazardous as is sometimes feared, and it is unlikely that WIPP transportation accidents will result in radiological health damages. Nevertheless, a severe accident could occur, and proper planning can help minimize the consequences of any such accident. On the basis of the cited opinions and evidence drawn together in this chapter, the following policy conclusions may be inferred.

D.1 Recommended highway routing. On the basis of public safety considerations, WIPP shipments entering from the north should use route 1 and, as a backup, route 2 (Tabel VII.4.) Similarly, shipments entering from the west and northwest should avoid US 666 and should follow route 6 or, as a back-up, route 10.

D.2. Road and rail choices. While it appears that the state may not have any direct jurisdiction over the choice of transport mode, public safety would be improved by a regulation banning train shipments from major metropolitan areas (Albuquerque). This would have the side effect of confining to highways those shipments entering from the north or northeast.

D.3. Special trains. In view of the potential for very severe derailments at high speeds, trains carrying high-level wastes to the WIPP should be special trains.

D.4. Placarding. The State may wish to consider augmented placard rules which result in visible exterior labelling of every WIPP shipment.

D.5. Escort vehicles. If any high-level wastes are carried by truck, it is desirable that they be escorted.

D.6. Packaging. The state may wish to endorse the recommendation of the California Resources Agency that Type B and high-level shipping containers be tested more completely, to failure if possible.

D.7. Training of police and firemen. A minimum of 1000 firemen and 500 police and sheriff's officers should receive intensive training in responses to radiological emergencies. This training probably would require at least two weeks per session, and it must address attitudinal issues. The training should be repeated at least every three years, and possibly more often, to keep up with personnel rotation and turnover, and to provide refresher courses.

D.8. Monitoring equipment. Fire trucks and/or police and sheriff's vehicles should be equipped with radiation monitoring equipment.

D.9. Medical facilities. Once routes have been selected, the State may wish to consult with hospital administrators in relevant counties regarding the possible needs for additional training and/or equipment.

D.10. Emergency response plans. Comprehensive response plans should be developed for WIPP-related contingencies, at both state and local levels. Such plans should stress the required decisions in the event that officials from Santa Fe or JNACC are not immediately at the accident scene, and provision should be made for training and emergency exercises.

D.11. Jurisdiction. Authority over emergency response, training, evacuation decisions, and post-accident clean-up should be centralized in one state agency.

APPENDIX VII-A

EMERGENCY RESPONSE PERSONNEL AND FACILITIES IN NEW MEXICO

The distribution of local emergency capabilities in New Mexico is shown in Table VII-A.1. All but four of the thirty-two counties in New Mexico have airports with adequate emergency capabilities. Twenty-three State Police District Headquarters are located in twenty-two counties. There are thirty-nine short-term hospitals within twenty-five counties. All thirty-nine of these hospitals have an X-ray service. Based on the information provided by the Mexican Hospital Association and telephone conversations with several hospital directors, diagnostic radioisotope services are available in only fourteen counties.

Upon close inspection of Table VII-A.1 one discovers definite limitations on emergency capabilities within some counties. Short term hospitals* are non-existent in Catron, Guadalupe, Harding, Hidalgo, Mora, Sandoval and Torrance. Among these counties, Catron, Harding, Mora and Torrance have poor airport facilities in addition to no State Police Headquarters. (A runway lacking lights is the criterion for classifying an airport as poor.) While Hidalgo County has a lighted runway, it is without a State Police Headquarters. About seventy miles of Interstate Forty (I-40) traverse Guadalupe County and directly pass through the populated city of Santa Rosa. Yet, the area is without a State Police command center and a hospital. Other counties lacking the former facilities are Catron, Harding, Mora and Sandoval. Actually, Sandoval County lacks all three of the aforementioned emergency capabilities. Even though this county borders on Bernalillo and San Juan counties and possibly could,

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*Short-term hospitals have acute-care facilities but may not have convalescent facilities.

through institutional arrangements, receive emergency support from the respective governments, the distances between the major municipalities are great.

As mentioned, in those counties where a short-term hospital is located, each hospital has an X-ray service but not every one has a diagnostic radioisotope facility. The counties without radioisotope facilities are DeBaca, Grant, Luna, Quay, Roosevelt, San Miguel, Sierra, Socorro, Taos, Union and Valencia. And recall from the above that seven counties do not have a short-term hospital within their geographic boundaries. In terms of trained local radiological personnel, these latter counties and those without radioisotope facilities can be said to have inadequate radiological medical emergency capabilities.

Table VII-A.2 provides information as to emergency preparedness programs in other states in the U. S. These data may be useful for later comparisons with proposed programs in New Mexico.

TABLE VII - A.1

County/City	Airport: Lighted Runway	Runway Lighted On Request	Lighted Runway With Beacon	Mechanic Available	Gasoline Available	Jet Fuel	Hangar Storage	Telephone	FAA Radio Communications	Unicom (with frequency)	No Emergency Facilities	State Police Headquarters	Hospitals: Civilian	Federal (Military)*	Federal (Indian)	Beds
Bernalillo																2109
Albuquerque			X X X	X X X	X X X	x	X X X	X X X	x	X X X		X	8	1/1	1	
Catron																0
Reserve											X					
Glenwood								X								
Chaves																208
Roswell			X	X	X	X	X	X	X	X		X	3			
Colfax																82
Raton	x		x		X X			X X		X X		X	1			
Angel Fire										X						
Springer			X									X	1			
Curry																136
Clovis			X	X	X		X	X		X		X	1			
Cannon AFB														1/		
DeBaca																25
Fort Summer			X		X		X	X		X			1			
Dona Ana																160
Las Cruces			X	X	X	X	X	X		X		X	1			
Hatch											X					

*Active/VA

County/City	Airport: Lighted Runway	Runway Lighted On Request	Lighted Runway With Beacon	Mechanic Available	Gasoline Available	Jet Fuel	Hangar Storage	Telephone	FAA Radio Communications	Unicom (with frequency)	No Emergency Facilities	State Police Headquarters	Hospitals: Civilian	Federal (Military)*	Federal (Indian)	Beds
Eddy																168
Carlsbad			X	X	X	X	X	X	X	X		X	1			
Artesia			X	X	X	X	X			X			1			
White City								X								
Grant																65
Silver City			X	X	X		X	X		X		X	1			
Guadalupe																0
Santa Rosa			X		X		X	X				X				
Harding																0
Roy								X								
Hidalgo																0
Lordsburg			X		X	X	X	X		X						
Lea																205
Eunice								X								
Hobbs			X	X	X	X	X	X	X	X		X	1			
Jal			X					X		X			1			
Tatum	X							X								
Lovington			X		X		X	X		X						
Lincoln																38
Carrizozo			X	X	X	X		X		X						

TABLE VII - A.1

County/City	Airport: Lighted Runway	Runway Lighted On Request	Lighted Runway With Beacon	Mechanic Available	Gasoline Available	Jet Fuel	Hangar Storage	Telephone	FAA Radio Communications	Unicom (with frequency)	No Emergency Facilities	State Police Headquarters	Hospitals: Civilian	Federal (Military)*	Federal (Indian)	Beds
Ruidoso				X	X	X	X	X		X		X				
Los Alamos																84
Los Alamos			X					X		X			1			
Luna																52
Columbus																
Deming		X		X	X	X	X	X	X			X	1			
McKinley																353
Gallup			X	X	X	X		X		X		X	2		1	
Crownpoint															1	
Zuni			X		X			X							1	
Mora																0
Roy								X								
Otero																119
Alamogordo			X	X	X	X	X	X		X		X	1	1/		
Mescalero															1	
Quay																58
Tucumcari			X		X	X	X	X	X	X		X	1			
Ute Dam											X					

*Active/VA

County/City	Airport: Lighted Runway	Runway Lighted On Request	Lighted Runway With Beacon	Mechanic Available	Gasoline Available	Jet Fuel	Hangar Storage	Telephone	FAA Radio Communications	Unicom (with frequency)	No Emergency Facilities	State Police Headquarters	Hospitals: Civilian	Federal (Military)*	Federal (Indian)	Beds
Rio Arriba																80
Espanola	X			X	X			X				X	1			
El Vado St. Pk.											X					
Dulce		X								X						
Roosevelt																32
Portales	X			X	X		X	X		X			1			
Sandoval																0
San Juan																204
Aztec			X		X		X	X		X						
Farmington	X			X	X	X	X	X	X	X		X	1			
Shiprock															1	
San Miguel																51
Conchas Lake St. Pk.			X							X						
Las Vegas			X	X	X	X	X	X	X	X		X	1			
Santa Fe																271
Santa Fe			X	X	X	X	X	X	X	X		X	1		1	
Sierra																100
T or C			X	X	X			X	X				2			
Socorro																42
Magdalena								X								
Socorro			X		X			X				X	1			

TABLE VII - A.1

County/City	Airport: Lighted Runway	Runway Lighted On Request	Lighted Runway With Beacon	Mechanic Available	Gasoline Available	Jet Fuel	Hangar Storage	Telephone	FAA Radio Communications	Unicom (with frequency)	No Emergency Facilities	State Police Headquarters	Hospitals: Civilian	Federal (Military)*	Federal (Indian)	Beds
Taos																33
Taos			X	X	X	X		X		X		X	1			
Questa											X					
Torrance																0
Estancia																
Moriarty											X	X				
Mountainair											X					
Union																38
Clayton			X		X			X		X			1			
Valencia																68
Belen													1			
Grants			X		X		X	X		X		X	1			
Los Lunas	X			X	X			X		X						
Rio Aribba - San Juan																
Navajo Lake St. Pk.			X							X						
Colorado (near Carson in Rio Arriba County)																
Arboles								X								

TABLE VII - A.1

Sources: Bennett, Max, Judy Mantlo, Richard Patterson, Beverly O'Dell and Susan Rush, New Mexico Statistical Summary: Health Resources Register - 1978. The New Mexico Health Resources Registry of UNM.

New Mexico Aviation Department & N.M. Dept. of Development, New Mexico Aeronautical Chart, 1979.

The list of State Police Headquarters came from the State of New Mexico 1978 Telephone Directory. (Any additions or deletions had been checked for by telephone with the State Police Headquarters Administrative Information.)

Table VII-A.2

HISTORICAL STATE-LEVEL EMERGENCY PREPAREDNESS COSTS FOR NUCLEAR POWER FACILITIES (COSTS PER POWER PLANT SITE)

TABLE State	Radiological Emergency Preparedness Plans Initial	Radiological Emergency Preparedness Plans Update	Radiological Emergency Preparedness Activities Exercises	Radiological Emergency Preparedness Activities Training	Radiological Emergency Preparedness Activities Resources	Projected Future Outlays Amount & Purpose
Alabama[1/]	(Two sites) $ 7,770 Manpower, Dept. of Public Health 1,250 Manpower, Dept. of Civil Defense 1,750 Manpower, Dept. of Pension and Security $10,700 Manpower subtotal 250 Printing $10,950	(Three sites) $ 3,000 Manpower, Dept. of Public Health (30 workdays @ $100 per day) 2,000 Manpower, Other Agencies (20 workdays @ $100 per day) $ 5,000 Manpower subtotal 1,000 Travel $ 6,000	(Two sites) $ 6,000 Manpower of all State agencies plus transportation	(Two sites) Briefing @ exercises	(Two sites) No special dedicated resources purchased.	(Three sites) $ 6,000 Continued annual costs which includes the completion of one county plan and state support for the revision of two county plans.
Arkansas[2/]	(One site) $42,000 Manpower, Dept. of Health and other agencies	(One site) $ 1,400 Manpower	(One site) $ 4,600 Semiannual exercises	(One site) $47,500 Initial. State and local response team members. 5,000 Update	(One site) $115,000 Initial. Communications, vehicles, monitoring, dosimetry, miscellaneous $ 10,000 Update. 10% replacement excluding vehicles	(One site) $ 1,400 Continued annual costs for update of planning and review.
California[3/]	(Three sites) $11,333 Manpower, Office of Emergency Services 22,666 Manpower, supporting agencies such as Health, Military, Transportation, and Parks and Recreation $33,999 Manpower subtotal 1,233 Printing and postage $35,232	(Four sites) $ 1,500 Manpower, Office of Emergency Services plus supporting agencies	(Three sites) $13,500 For all agencies	(Three sites) 5,333 Initial, For Peacetime Radiological Instrument Training and Radiological Defense Officer courses 666 On job training $ 5,999 333 Update.	(Three sites) 1 666 Dept. of Health, response kits containing detectors, decontamination equipment,	(Four sites) 1,500 Continued annual costs for plan maintenance and the inclusion of an additional County plan.
Colorado[4/]	(One site) $40,000 Manpower, all agencies 2,500 Printing and miscellaneous $42,500	(One site) $ 2,600 Manpower, all agencies 2,500 Secretarial, printing and miscellaneous $ 5,100	(One site) $ 5,800 Total personnel costs derived from time spent on exercises.	(One site) $ 1,000 Initial, Meetings totaling 8 days, all agencies included. 1,700 Update. emergency response team and department staff training	(One site) $ 23,500 Initial. Dept. of Health; initial protective clothing, respirators, decontamination equipment. emergency generators, air samplers and communication equipment.	(One site) $ 5,100 Continued annual costs for exercise critique and plan revision.

Table VII-A.2, Continued

State	Initial	Update	Exercises	Training	Resources	Projected Future Outlays
				\$ 600 Radiological response training course \$ 3,300	\$ 1,100 Update. Instrument calibration and repair costs	
Connecticut[5/]	(Two sites) \$10,000 Manpower, all agencies		(Two sites) \$12,500 Manpower, all agencies, transportation plus per diem	(Two sites) Initial. Six months. No cost estimate is given.	No special dedicated resources purchased.	(Two sites) \$2,000 This is a rough estimate of continued annual costs. Here, future annual outlays are assumed to vary by the nature and amount of change made in the emergency preparedness plan.
Delaware[6/]	(One site) \$30,000 Manpower, all agencies		(One site) \$25,000		(One site) \$ 600 Initial. Installation for drop for National Weather Warning System from Salem Nuclear Power Station to Delaware State Police \$ 600 Two surplus vans 1,000 Associated equipment for Stabilized Assay Monitors \$ 2,200 300 Update. NAWAS operating charge	No estimate is available.
Florida[7/]	(Three sites) \$ 4,000 Manpower, Division of Disaster Preparedness 2,666 Manpower, Dept. of Health and Rehabilitative Services-Radiological Laboratory \$ 6,666		(Three sites) Each site has exercises. No cost estimates are available	(Three sites) State training is provided at all three sites. No cost estimates are available	(Three sites) \$ 23,000 Initial. Mobile Emergency Radiological Laboratory 3,333 Update. Jelly analyzer to replace sodium iodide detector for MERL. \$ 26,333	No estimate is available.

Table VII-A.2, Continued

State	Initial	Update	Exercises	Training	Resources	Projected Future Outlays
Illinois[8/]	(Three sites) $ 4,333 Manpower. Dept. of Health 2,333 Other $ 6,666		(Three sites) No estimate is available. However, exercise costs probably are low since limited to communications.	(Three sites) $10,000 In 1977, twelve Illinois State persons received training for radiation health emergencies.	$ 23,333 Initial. Mobile Laboratory	(Six sites) $4,333 Full time planner to write and update State plan. 1,833 Secretary Additional costs inclusive of travel 2,166 and printing $8,332 Total costs incurred annually for approximately the next five years.
New Jersey[9/]	(Two sites) $15,000 Manpower, all agencies		(Two sites) $ 7,500 Dept. of Environmental Protection, cost per drill inclusive of salaries and amortization of equipment. $ 5,000 State Police plus Civil Defense $12,500	(Two sites) No estimate is available.	(Two sites) $ 9,000 Dept. of Environmental Protection; Three Stabilized Assay Monitors 25,000 Civil Defense and Disaster Control; three base stations, one generator, twenty-four walkie talkies $ 34,000	(Four sites) No estimate is available.
New York[10/]	(Three sites) Manpower, Dept. of Health, $10,000 300 workdays from 1970-1971 3,500 Thirty workdays per site for specific operations $13,500 Manpower 1,500 Travel, all sites $15,000	(Three sites) $ 1,333 Manpower, Dept. of Health	(Two sites) Emergency simulation conducted in 1977 $ 1,250 Manpower, planning 3,950 Manpower, County and State participants $ 5,200 Manpower subtotal 1,250 Meal and lodging $ 6,450	(One site) 21,250 Initial. Participation costs for State and local officials that received the U. S. Public Health Service Management of Radiation Accidents course from 1958-1962. (Three sites)	(see next page)	(see next page)

Table VII-A.2, Continued

State	Initial	Update	Exercises	Training	Resources	Projected Future Outlays
				$ 616 Participation costs incurred for the 1976 radiological response course. $21,866 Update. Costs estimates are not available	(Three sites) $ 3,333 Initial. Four emergency kits with radiological survey instrumentation. $ 600 Update: Annual costs for upkeep of emergency kits.	(Three sites) $1,333 Continued annual cost for plan maintenance. (Four future sites) $3,000 Additional cost incurred per incorporation each new site into the plan.
Oregon[11/]	(One site) $25,000 Manpower, Dept. of Health	(one site) $ 7,000 Manpower, Dept. of Health	(One site) Initial. 1975, Oregon Civil Preparedness Instrumentation Program Personnel $22,400 Manpower 3,900 Travel 1,500 Per diem 250 Publications, printing and miscellaneous $27,950 Oregon State 7,000 Oregon State, Washington State and local costs. $35,000 1977. $10,000 Costs for exercise involvement for utility; Oregon State, Washington State, and Federal agencies; Columbia County, Oregon; Cowlitz County, Washington. $32,500 Cost for exercise development and conduct for Federal, State, and local agencies.	(One site) No cost estimates are available.	(One site) $ 10,000 Initial: Computer and related hardware for dose assessment $ 5,000 Equipment and pagers. $ 15,000	(One site) $7,000 Continued annual cost for all agencies (Two sites) $8,500 Estimated annual cost associated with a full-time planner plus additional transportation allowance when another nuclear power site is added to the emergency preparedness plan.

Table VII-A.2, Continued

State	Initial	Update	Exercises	Training	Resources	Projected Future Outlays
			$ 7,000 Manpower $49,500			
Tennessee[12/]	(Two sites $15,000 Manpower, Dept. of Health		(Two sites) $ 300 All State agencies	None to date	No cost estimates are available.	No cost estimates are available.
Washington[13/]	(Two sites) April, 1975-1977. Dept. of Emergency Services $ 2,438 Manpower 425 Travel 1,000 Secretarial support 500 Printing 250 Miscellaneous 200 Training & Education $ 4,813 Subtotal Dept. of Social and Health Services $ 2,450 Manpower 250 Travel 50 Telephone, printing, etc. $ 2,750 Subtotal Other State agencies $ 825 Manpower, subtotal $ 8,388 Total, State plan (One site) 1974-1977. Costs borne by the State for Cowlitz County Plan in support of the Trojan Nuclear Power Facility. $ 6,500 Manpower 3,300 Travel 3,000 Secretarial support 1,500 Printing and miscellaneous $14,300	(Two sites) $ 3,750 Dept. of Emergency Services 1,400 Radiation Control, Social and Health Services 2,250 Other State agencies 2,250 Two local plans $ 9,650	(One site) See Oregon State	None to date	No cost estimates are available.	(Two sites) $9,500 Estimated annual costs based on the State's upkeep of the State plan and local plans. (Three plans) $6,333 Estimated annual costs per plan assumed by the State.

Table VII-A.2, Continued

State	Initial	Update	Exercises	Training	Resources	Projected Future Outlays
	(One-site) April 1975-1977, Costs borne by the State for the Benton-Franklin Counties Plan in support of Washington Nuclear Power 1, 2, and 4. $ 4,225 Manpower 1,575 Travel 1,600 Secretarial support 2,600 Printing, postage, telephone, etc. $10,000 State's share of state and local plans $ 1,388 Total, State plan 14,300 Total, Cowlitz County Plan 10,000 Benton-Franklin Counties Plan $32,688 Total, State's share computed from costs-per site for State plan and State's outlays on two local plans. $10,895 State's share per plan					
Wisconsin 14/	(Three sites) $ 6,666 Manpower, all agencies		No cost estimates are given.	No costs estimates are given.	None to date	

Source: U. S. Nuclear Regulatory Commission, Beyond Defense in Depth: Cost and Funding of State and Local Government Radiological Emergency Response Plans and Preparedness in Support of Commercial Nuclear Power Stations, Prepared by: Stephen M. Solomon, NUREG 0553, pp. II-14 to 30, October 1979.

PART III

SOCIO-ECONOMIC ISSUES RELEVANT FOR ASSESSING THE WIPP

VIII. THE SUBJECTIVE DIMENSIONS OF RISK

A. Introduction.

In chapter VII reference was made to the chance of accidents in the transportation of nuclear wastes and the uncertainty which surrounds just what the chances of such accidents are, as well as the types of damages which might attend any accident. When we talk of risk, both of these considerations are relevant: What is the chance of an accident (at the site or in transport) and what are the effects -- the damages -- that might attend an accident?

It is surely obvious that risk is a fundamental issue in the State's evaluation of the WIPP. Without such risk, constructing the WIPP would be analogous to the introduction to the State's economy of any other type of enterprise, e.g., a shopping center, a factory, or whatever. But one may well ask: Just what is this risk that makes the WIPP so different from any other kind of enterprise? In this regard, one may note that, in 1978, New Mexico had 95 accidental deaths in the home and 33 work-related deaths.[*] With 1978 employment of 485,000,[**] the preceeding might be interpreted as implying the chance of an accidental death in other economic enterprises in the State to be 1 in 10,000, whereas WIPP-related accident probabilities are normally couched in terms of 1 in one million or 1 in ten million.[***] Is, then, the WIPP in fact "riskier" than any other economic enterprise in this world wherein risk is inherent to most if not all of man's activities?

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[*] Bureau of Business and Economic Research (1979-80, p. 144).

[**] Ibid, p. 36.

[***] U.S. Department of Energy (1980, pp. 6-28). Note that these are probabilities of an <u>accident</u>; number of probable deaths involved is purposely left as an open question.

The purpose of this chapter is to respond to this question which lies at the heart of the present controversy surrounding the WIPP. In doing so, however, our primary intent is to sort out the various subjective elements related to judgements as to issues relevant for this topic. "Subjective" and "judgements" are the operational words here inasmuch as "the" answer as to the WIPP's risks to public health and safety simply does not exist. As we will show, data and studies exist which may be used selectively to support either the view that the WIPP is essentially riskless or the view that it is very risky. In the end, the best that one can do is to consider the relevant issues and, subjectively, form a "best" judgement as to the nature of WIPP-related risk.

To illustrate the judgemental, subjective character of risk assessment, consider the following, polar expressions which reflect risk assessments concerning nuclear power:

(i) A 1978 study of risk in energy generation systems (including solar, wind, ocean thermal, methanol, coal, oil and nuclear) concludes that nuclear power and natural gas are associated with less risk (on the order of 100 times less risk) than all other technologies considered (Inhaber, 1978).* Inhaber suggests:

> "While a solar collector on a roof appears to be completely innocuous as it silently absorbs sunlight, there is considerable risk inherent in the industrial processes used to construct this device. Per unit of energy output, the solar collector requires a significantly larger input of construction material

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*Six components are considered for each system: material acquisition and construction, emissions caused by material production, operation and maintenance, energy back-up, energy storage and transportation.

than conventional systems. Fabricating and installing the systems also introduces risk."*

(ii) In a published letter to the Governor of Oregon in 1978, a protester poses the question: "Why do we give up our homes to be arrested, jailed, fined, etc.? Because we truly believe that the planet and the human race is in grave danger because of nuclear power plants".**

The rationale for such divergence in subjective assessments of risk is difficult to explain. Dupont suggests that the latter point of view reflects phobic (strong fear or aversion) thinking about nuclear power.

> "The cost of diminishing the hazards may make nuclear power uneconomical. But economics are not the driving power behind the nuclear power debate. The debate is hinged on fear of a particular kind. I would call it nuclear phobia, or more precisely, phobic thinking about nuclear power."***

It seems clear that, on the part of some people, there exists strong fear and/or aversion with reference to the WIPP. This observation is not particularly helpful, however, unless one can explain why such phobia exists. Appeal to "irrationality" as an explanation**** is strongly challenged, rightfully in our view. Such a challenge is exemplified by R. Kasperson's (Institute for Hazard Analysis at Clark University) position:

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*Of course one must realize that to the extent that product risk, whether in production, operation, etc., is recognized, risk costs will be included in the product price. In this case the relevant increase is cost per unit of energy output. Risk requires special attention in economic analysis only when market failure precludes its pricing.

**Slovic, et al. (1978, p. 1).

***The Media Institute (1980, p. 2).

****Ibid, p. 17.

"We think that the public perception of risk is not irrational and erratic; people tend to think of classes of risk in the same way. And people have a right to bear what kinds of risk they want whether it makes sense to scientists or not."*

The above observations attest to the extremely difficult task that lies before us, viz., that of attempting to provide an objective analysis of an issue which is inherently subjective. Consequently, our intent is not to challenge basic orders of magnitude of scientific estimates concerning the chance (probability) of a WIPP-related accident. Indeed, based on our review of the literature, we find compelling evidence suggesting that the chances of a "severe" WIPP-related risk are extremely low, as reported in chapters VII and IX. The central thrust of this chapter concerns the subjective dimensions of WIPP-related risk as they are relevant for an appreciation of the uncertainty and apprehension associated with the WIPP project. Objective (chapters VII and IX) and subjective (this chapter) dimensions of WIPP-related risk must be laid out in order to fulfill the goal of providing a comprehensive array of information concerning the socioeconomic aspects of the WIPP.

To the ends above, three risk-related topics are treated here. First, in section B attention is focused on how measures of risk (e.g., accident probabilities) are formed and the problems of interpreting such risk measures; these discussions relate to the considerations mentioned above concerning the probability of an accident and the likelihood that death or injury might attend the accident. In section C we focus on the question of the

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*Cited in Epps (1979, p. 46).

nature of damages associated with WIPP-related risk. "Damages" considered in this section go beyond potential health/safety effects that might attend an accident to include the question as to the existence of potential damages associated with increased risk (whether or not an accident in fact occurs). In section D the issue of measuring risk-related damages is addressed. While we had initially hoped to develop damage measures, discussions in section D indicate why these efforts were unsuccessful and, hopefully, provide an appreciation of the shortcomings associated with most damage measures. Concluding remarks are offered in section E.

B. The Dimensions of Public Risk.

To the layperson, risk is most often associated with probabilities, or chance, within a context analogous to the chance of rolling a given number on one throw of a die; it is obvious that the chance of rolling, say, a five is one out of six. Statements of chance -- or, if one is betting, the risk of losing -- of the form one out of 10, one out of 100, etc., are commonly used and generally are well understood. Such common perceptions of risk, however, may not extend to events of the low-probability type such as the chance of a serious WIPP-related accident for several reasons. First, these perceptions of risk, or chance, are often based on a notion of probability referred to as "relative frequency"; i.e., the probability of an event occurring is approximated by the relative frequency of its past occurrence. Thus, if an experiment were repeated many times, say 1000, and a particular outcome were observed, say, 400 times, one might be led to believe that the typical probability of observing this outcome would be 40%. However the application of this notion to high-technology contingencies is tenuous, at best (see Apostolakis, 1978, pp. 308-309 and Zeckhauser, 1975, pp. 444-445). For the bulk of events, or mishaps, that one might associate with the WIPP, such events are of a one-of-a-kind nature and repetitions, which are required if one is to calculate relative frequency of occurrences, would not only be highly unlikely but undesirable. Thus, estimates of such risk cannot be based on historical relative frequencies.

However, risk estimates for WIPP-related accidents are not based on relative frequencies, but as explained below, on "fault tree" analyses. In addition to problems inherent in fault tree analyses, there are additional problems associated with public perceptions and the interpretations of very small probability measures. These problems are central to an appreciation of the controversy which surrounds the issue of the "riskiness" of the WIPP. Therefore, each of these issues is examined in some detail. The specific analyses of WIPP-related accidents that have been conducted by the DOE or other state and federal agencies (which we have reviewed and which are discussed in other chapters) are not at issue. Our concern is with methods and the basis for controversy associated with the use of these methods.

B.1. Scientific Risk Estimates of Low-Probability Events. The common method for developing scientific risk estimates in technological systems such as the WIPP is through the use of fault trees. A fault tree is essentially a schematic characterization of a series of interrelated events which may jointly result in the failure of a system. Probabilities are assigned to each of the events on the basis of engineering information, and then those probabilities are combined so as to assess the probability, or chance, that a particular type of system failure might occur.

A basis for controversy then arises inasmuch as this approach may be viewed as subjective for at least two reasons: 1) individual event probabilities are often assigned on a judgemental basis, not according to historical frequencies, and 2) the analyst must attempt to set out all possible types of failure (failure modes) in the fault tree, and whether or not the set of elements is complete depends upon the judgement of the analyst. The basis for controversy is then apparent, as exemplified by the following:

> "...it is very rare that actual system failures are found to be due to hardware failures (i.e., the failure modes that are usually considered in fault tree analysis). The cause of failure usually turns out to one that...the analyst would have a very hard time imagining -- like a specific design error or human error." (Apostolakis, 1978, p. 313). "In fault tree analysis, the analyst essentially is required to imagine that which never has been experienced before." (Zeckhauser, 1975, p. 445).

Concern with reliance on risk assessments based on fault tree analyses is also expressed in the conclusions of a study conducted by the Massachusetts Commission on Nuclear Safety:

> "If one could identify all of the possible chains of events that could lead to a given category of release of radioactivity and could associate a probability of occurrence with each event in these many chains, one could, in principle, calculate the probability of the release in question. In practice, this cannot be done in a rigorous fashion. The probability that a piece of equipment, or an operator, will fail to perform satisfactorily can be estimated only approximately, based on a combination of actual plant experience and experience with similar

equipment (and/or men) in other situations. Far more troublesome is the fact that it will be impossible to anticipate all the possible chain of events that might lead ultimately to a release of given characteristics..."*

These two sources of potential error in fault tree risk estimation have respectively been termed "experimental uncertainty" and "hypothetical uncertainty" (Starr, Rudman, and Whipple, 1976, p. 654). Experimental uncertainty may be reduced, at a cost, through conducting more stress experiments on system components. Hypothetical uncertainty can be reduced only gradually and indirectly by increasing societal experience and familiarity with complex technological systems similar to the one being analyzed.

Skepticism concerning fault tree analyses contributed to doubts about official probabilities estimated for reactor mishaps. Thus, the Massachusetts Commission's report suggests: "Whether or not the estimates developed in WASH-1400 (Draft) are valid is a matter of serious dispute.... Many of the critics of WASH-1400 (Draft) concede that the approach is a useful one for <u>comparing</u> different designs, but believe the methodology cannot be used with confidence to estimate <u>absolute</u> values for probabilities of an accident."**

Further, the controversy surrounding risk estimates based on fault tree analyses is not based simply on methodological, or theoretical, differences of opinion among researchers. Arguments by critics of fault tree analyses are supported by real world experiences in which either design error or

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*Massachusetts Commission on Nuclear Safety (1975, pp. 52-53).

**Ibid, p. 53. WASH-1400 is a 1975 study by the NRC entitled <u>Reactor Safety Study</u>.

human error unanticipated in fault tree analyses have resulted in potentially dangerous mishaps at nuclear facilities. A well known example of the latter error is the Brown's Ferry incident. In terms of design errors, a mulfunction of the Three Mile Island type was evaluated beforehand and assigned a very small occurrence probability; the fault tree study used a Westinghouse design, however, while the actual Three Mile Island reactor was of a different design (constructed by Babcock and Wilcox; see Epps, 1979, p. 45). Consequently, a postmortem NRC calculation showed the odds (for a Three Mile Island malfunction) in a Babcock and Wilcox reactor to be a great deal larger than that for the Westinghouse design (Epps, 1979, p. 45).

Another source of uncertainty about the scientific estimates of risks associated with nuclear technologies is the presence of divergent views within the scientific community itself. The vast majority of technical studies on nuclear risks have concluded that they are extremely small in comparison with other contemporary sources of risk to life and public health, but there is scientific dissent. For example, the American Physical Society's Study Group on Light Water Reactor Safety concluded that the AEC's 1975 Reactor Safety Study (WASH-1400) had underestimated the potential fatalities from a serious reactor accident by a large margin. The number of prompt deaths were found to be underestimated by a factor of 10 to 16, the number of latent cancers by a factor of 33 to 67 and the number of genetic defects by a factor of 10 to 67.

While this kind of dissent appears to constitute a minority view to date in the scientific community, it is a view held by many. It is not surprising, therefore, that the scientists' majority opinion, holding that the risks associated with nuclear power are relatively low, is not totally accepted by the body politic in the United States. For example, in a recent study of risk as perceived by the public, laypersons ranked nuclear power first in "riskiness" among 30 different technology-activities while "experts" ranked nuclear power 20th (Slovic, et al., 1979, Table 2).

From the above discussions, one can readily appreciate the nature of ongoing controversies concerning risks associated with nuclear power in general, and the WIPP more specifically. Given that one cannot engage in repeated experiments for full-scale nuclear-related systems, and that our experience is limited with many of these systems, fault tree types of analyses are the only viable methods for assessing the chance of system failures. We can surely expect that, in conducting these analyses, researchers do as good a job as possible in terms of applying cautious, systematic scientific methods. However, these efforts notwithstanding the experimental and hypothetical uncertainties described above do in fact exist and one can clearly point to incidents that have occurred that were not considered in *ex ante* risk analyses. Since an alternative to fault tree analyses for risk assessment is not immediately apparent, there are, and will likely continue to be, sharp differences in opinion as to the reliability of risk assessments for WIPP-related accidents and the nature of resulting damages.

B.2. *Interpreting Risk Estimates*. A second source for controversy concerning risk estimates for WIPP-related accidents involves problems in interpreting received risk estimates; this is particularly true for the non-technical layman. While a statement like "one in a hundred" may be meaningful to an individual, it may be most difficult to appreciate chance statements like "one in a million", "one in 100 million", etc., not to mention the virtual impossibility of differentiating, in any meaningful way, between $4(10^{-5})$ and, e.g., $2(10^{-7})$.

At some point, very low probability risks become blurred in perception and the only interpretation then is "virtually impossible" or "a credible probability measure cannot be developed." In the words of Fairley (1975), "there is some minimum value below which a small estimate of a probability of a real world event is not credible."

Indeed, Kahneman and Tversky (1979) present evidence which suggests that when individuals are faced with low probability, high consequence alternatives they tend to ignore the probabilities and make decisions solely on the basis of the magnitude of consequences. This tendency may become even more profound when individuals are made aware of the mechanisms by which events occur. The same point has been made by Starr, Rudman, and Whipple (1976, p. 632): "accident probabilities are usually not given significant weight in an individual perception....the size of the potential accident is given more weight than the probability....This is probably representative of societal values to a great degree, and activities capable of producing catastrophic accidents therefore must meet more stringent societal standards than higher-frequency individual risks."

One implication of this line of reasoning is that existing governmental risk-evaluation practices which use expected values (damages weighted by occurrence probabilities) are of questionable value. An example relevant for the WIPP is the government-sponsored evaluation of the question of whether to use special trains (which carry a uniform cargo and move at slow speeds) for the rail shipment of spent fuel (see discussion in chapter VII). It has been concluded that the expected cost of accidents is not as great as the higher operating cost of special trains (U.S. Nuclear Regulatory Commission, 1977), but of course a single catastrophic high-speed accident in a regular train could be more costly than many years of special train service.

This point is relevant in the context of our earlier discussions concerning expressions of strong fear or apprehension vis-a-vis the WIPP. To the extent that individuals, faced with events characterized by very low probabilities but highly dangerous consequences, ignore probabilities and simply focus on consequences, the potential for phobic thinking and continual controversy is immediately apparent.

We have thus far identified two major issues which may aid in understanding the problems in assessing estimates for the risk of a serious WIPP-related accident: controversies concerning the reliability of methods used for estimating risk and problems associated with interpreting these estimates. Attention is now turned to issues related to the nature of risk-related damages associated with the WIPP.

C. Risk-Related Damages.

Obviously, the damages of primary concern in assessments of the WIPP are those associated with cancers, both latent and prompt, as well as potential genetic effects. The potential for these damages associated with the WIPP are discussed in other chapters of this report (particularly, chapters VII and IX), as well as in numerous other reports* and will not be belabored here; in this section section we consider an additional dimension of damages.

In keeping with our central thrust of this chapter concerning the subjective dimensions of WIPP-related risk, we now focus on still another type of damage which is inextricably related to subjective arguments concerning the riskiness of the WIPP and, more particularly, effects on the well-being of New Mexico's citizens. This damage, the substance (or lack thereof) of

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*See, e.g., National Academy of Sciences (1979), Logan (1978) and Department of Energy (1980).

which we wish to examine here, is attributable to risk bearing. At any moment in time a person is exposed to a given risk environment -- there are given chances of death and/or injury from automobiles, air pollution, cancers, etc.; one normally bears these risks as a matter of course. Suppose, now, that an additional risk of, e.g., loss of life, is introduced into the individual's environment. He (she) must now live with more risk. Two interrelated questions are then raised. First, is there any basis for viewing this change in risk bearing as a cost -- damage -- attributable to the source for increased risk (the WIPP, in the case at hand)? Secondly, is there any basis for identifying particular manifestations of risk bearing which assist in its evaluation and measurement?

The risk bearing argument, as it takes the form of a "perceived risk" argument developed below, may be viewed as an effort to provide a formal, systematic, scientific framework for evaluating the phobic phenomena discussed earlier. These arguments suffer definite weaknesses and limitations, which will be discussed. Nevertheless a full appreciation of risk-related issues which, however subjective, are relevant in assessing the WIPP is enhanced by some understanding of this dimension of risk-assessment for which (as we will show) there is growing interest in the scientific community.

A response to the first question raised above, which is conceptual in nature, is readily available. At a conceptual level, the construct commonly used for analyses of social welfare would impute a social cost to any environmental change involving higher levels of risk if risk bearing *per se* is shown to reduce individual utility or satisfaction. Damages from risk bearing might be most usefully viewed as arising from psychological stress which results from, e.g., fear or anxiety. Thus, however remote the possibility of loss of life from an incident, if living with this possibility increases anxiety, the basis for a legitimate social cost or damage exists.

A particularly difficult issue in this regard is distinguishing between "faulty" public perceptions of risk and legitimate societal values which might be disproportionately averse to catastrophic risk; i.e., the public may be more averse to one accident per year which causes 100 fatalities than one hundred small accidents in a year, each involving one fatality (Starr, Rudman, Whipple, 1976). There is no general agreement on the shape of the "societal preference function" with regard to safety (risk), but if there is an increasing relative aversion with respect to the magnitude of an accident, then expected-value approaches to the measurement of risk, which treat small and large accidents symmetrically, may not be consistent with societal attitudes.

A response to the second question concerning identifiable measurable manifestations of damages from risk bearing -- increased anxiety -- is not so readily available, as one would expect. The increase in anxiety associated with nuclear power in general has been recognized for some time. This perhaps obvious assertion is demonstrated in the following three statements which are interesting in terms of the differing perspectives in which such anxiety is viewed:

(i) "As I compare the issues we perceived during the infancy of nuclear energy with those that have emerged during its maturity, the public perception and acceptance of nuclear energy appears to be the question that we missed rather badly... This issue has emerged as the most critical question concerning the future of nuclear energy".*

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*Weinberg (1976, p. 19).

(ii) "Once a new element of risk is announced, it provides individuals with something to think and worry about....the amount that would be paid to avoid the anxiety associated with a risk would be very nonlinear with the probability of the risk. For smaller risks it would be proportionately greater...Because the types of risks that are being discussed in connection with radiation exposure are of the low-probability variety, we must expect the anxiety cost to be a fairly substantial proportion of the amount an individual would pay to avoid the risk."*

(iii) "There is, however, reason to believe that certain emotional responses are provoked by the advent of atomic energy also in a more direct manner and must in many instances, be considered as pathological. These responses, which seem to be due partly to the circumstances in which atomic power has been introduced and partly to its very nature, constitute perhaps the most important mental health aspect of the peaceful uses of atomic energy. These unhealthy reactions appear to stem from anxiety, and from attempts which human beings make to deal with anxiety. Thus they may be manifested in the form of irrational fears, irrational hopes, or irrational power. Among these reactions, the most frequent is undoubtedly irrational fear, and this fact is certainly of the greatest importance for any analysis in this field."**

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*Zeckhauser (1975, p. 442).

**Mental Health Aspects of the Peaceful Use of Atomic Energy, in the Media Institute (1980, p. 12).

To date, the only efforts to go beyond this general recognition of nuclear-related anxiety (of the type exemplified above) are those by Slovic, et al.* These works focus on measures for fatality risks as those risks are perceived by the public (referred to as "perceived risks"). While the relationship between measures for perceived risk and the measures for damages attributable to risk bearing (if, indeed, such a relationship exists) has not been established in any rigorous way, conceptually, at least, measures for perceived risk can be expected to reflect a dimension of risk bearing of interest here, viz., anxiety. Thus, within this context a brief review of this work is of interest for the risk bearing argument.

Three sets of findings in these perceived risk studies are of interest here in terms of providing some manifestation of anxiety as it relates to nuclear power -- nuclear waste disposal per se is not considered in these studies. The first set of results are given in Table VIII.1. These data are derived from the study by Slovic, and others,** wherein four groups of individuals were asked to rank 30 activities and technologies in terms of perceived risk. As a part of this same study, individuals were asked to rank perceived benefits to society that are associated with the 30 activities (Table VIII.1). A somewhat curious and confusing index is used. Individuals are asked to assign "10" to an unspecified "riskless" event and a "10" to its social benefits, and to then rank the 30 technologies relative

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*See, e.g., Slovic, et al. (1978) and (1979), and Fischhoff, et al. (1978).

**The results cited below are based on interviews with four groups in Eugene, Oregon: 30 college students, 40 members of the League of Women Voters, 25 business and professional members of a local "Active Club" and 15 "experts" in risk assessment; Slovic, et al. 1979.

TABLE VIII.1

PERCEIVED RISK AND NEED FOR RISK ADJUSTMENT

FOR 30 ACTIVITIES AND TECHNOLOGIES[a]

Activity or Technology	Perceived Benefit	Perceived Risk	Need for Risk Adjustment[b]
1. Alcoholic beverages	41	161	4.4
2. Bicycles	82	65	1.5
3. Commercial aviation	130	52	1.3
4. Contraceptives	113	50	2.0
5. Electric power	274	52	1.0
6. Fire fighting	178	92	1.1
7. Food coloring	16	31	3.0
8. Food preservatives	44	36	2.7
9. General aviation	53	114	2.1
10. Handguns	14	220	17.3
11. H. S. & college football	35	37	1.7
12. Home appliances	133	25	1.1
13. Hunting	30	82	2.5
14. Large construction	142	91	1.7
15. Motorcycles	29	176	5.3
16. Motor vehicles	187	247	6.1
17. Mountain climbing	28	68	1.0
18. Nuclear power	52	250	29.0
19. Pesticides	87	105	9.5
20. Power mowers	30	29	1.5
21. Police work	178	111	1.8
22. Prescription antibiotics	209	30	1.3
23. Railroads	185	37	1.2
24. Skiing	38	45	1.0
25. Smoking	20	189	15.2
26. Spray cans	17	73	7.8
27. Surgery	164	104	1.9
28. Swimming	68	52	1.0
29. Vaccinations	194	17	.8
30. X rays	156	45	1.7

[a]Data adapted from Fischhoff *et al.* (1978).

[b]Values of 1.0 indicate that the activity is presently at an acceptable level of risk. Values greater than 1.0 mean the activity needs to be safer by the factor indicated in the column; values less than 1.0 mean the activity could be riskier and still be acceptable to society.

Source: Slovic, *et al.*, 1978, Table 1.

to this essentially riskless event.* Thus, for example, home appliances are 2.5 times as risky as a "riskless" event, but are seen to yield social benefits that are 13.3 times those associated with the riskless event (whatever the riskless event might be). Note that nuclear power has the highest perceived risk, approached only by motor vehicles and handguns. More striking, however, are the relatively low social benefits attributed to nuclear power -- little more than those social benefits attributed to alcoholic beverages or food preservatives.

Of particular interest are the data given in Table VIII.2 which are relevant for the question: what determines perceived risk. These data indicate the correlation between perceived risk measures and the characteristics of various technologies. Thus, threats to future generations, dread, potential for catastrophe, (shown, by Slovic et al., to be associated with nuclear power) are among the major determinants of perceived risk measures.

While a number of technical problems underlie statistical methods used in the above cited study, the results may be viewed as useful in two regards. First, a method is suggested which might be used as a means for deriving subjective measures for risk bearing -- perceived risk is, all else equal, a measure of the individuals perception of risk which he(she) must bear in terms of a given technology. As such, it may be useful in efforts to derive measures for social costs. This statement presupposes that appropriate costs can be assigned to perceived risk measures. We emphasize, however, that the state-of-the-arts in studies of perceived risk is not at all well developed at this point in time -- considerable methodological research would be required before this concept could become operational.

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*It would seem then that the base "event" for each individual is different, which raises questions as to the interpretations of averages.

TABLE VIII.2

CORRELATIONS BETWEEN PERCEIVED RISK

AND RISK CHARACTERISTICS

Characteristic of Event	Correlation Between Perceived Risk and Characteristic:
Dread	.83
Future generations	.80
Global catastrophe	.78
Fatal	.74
Increasing	.73
Affects me	.70
Inequitable	.68
Not easily reduced	.63
Uncontrollable	.63
Not preventable	.51
Catastrophic	.50
Involuntary	.39
Many exposed	.25
New	.17
Immediate	.10
Unknown to exposed	-.06
Not observable	-.19
Unknown to science	-.27

Source: Slovic, *et al.*, 1979, Table 9.

One may rightfully inquire as to the relevance of risk-bearing costs -- particularly, in terms of perceived risk, if it can be demonstrated that perceived risk is, in some sense, only transitory. Considerable apprehension was associated with the introduction of many, now common, technologies (e.g., the automobile, electricity, etc.); greater understanding of and familiarity with the technology resulted in the gradual elimination of this apprehension. Indeed, the perceived risk studies cited above provide results that are somewhat supportive of this argument. First, perceived risk measures for certain technologies are suggested to be influenced by the number of times that articles about the technology have appeared in newspapers.* Secondly, it is suggested** that, once exposed to a technology, there is a tendency for individuals to "deny" the presence of risk. This latter point suggests that perceived risk measures obtained prior to the introduction of a technology would likely be much higher than those obtained after its introduction. These observations then point to the second potential use of perceived risk data: indicating areas for which the provision of public information might be productive.

Strong fear and anxiety are clearly an important consideration in an assessment of the WIPP. Some of the possible reasons for the existence of such phobia have been suggested in the above sections. Whether or not the risk-bearing argument, particularly as related to perceived risk, can be used for purposes of analyzing these issues in some formal, systematic way remains an open question, as must the question as to the relevance of perceived risk; in this latter regard, it is not clear just how one makes

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*Slovic, *et al*. (1979).

***Ibid*.

consistent the "denial" and "information" determinants of perceived risk (which may suggest that perceived risk is transitory) with the "dread", "impacts on future generations" and "potential catastrophe" determinants (which may then suggest the opposite).

D. Valuing Damages.

In this section we briefly discuss problems of assigning values to the damages discussed above, particularly in terms of loss-of-life. We have thus far focused on the subjective dimensions concerning nuclear waste disposal, and on the problems and uncertainties surrounding both risk estimates *per se* as well as the nature of damages which might be involved. One may then inquire as to the possible existence of some quantifiable measure (which would incorporate the wide range of risk measures) for the expected value of damages which might then be used for WIPP-related risk assessments and could then be included in aggregate benefit-cost measures. We begin by considering issues in the valuation of loss-of-life.

The method which has historically been used for valuing loss of life is one in which focus is centered on the earnings lost by an individual suffering premature death. This approach reflects the notion that, from a societal point of view, the importance to society of the death of one or more of its members is the loss in social production -- as measured by an individual's wages and income -- which would otherwise be produced by the decedent.

Mishan (1971b) has shown that this and related approaches violate the basic rationale for economic efficiency -- that of a Pareto improvement. An alternative criterion is that changes involve potential Pareto improvements -- net gains *could* be distributed such that at least one person is better off and no one else is made worse off. In either case, an inconsistency of the "earnings loss" measure for loss of life with the notion of Pareto improvements is that "...it has no regard for the feelings of potential decedents. It restricts itself to the interests only of the surviving members of society ex post" (Mishan, 1971, p. 690).

Further, when earnings loss measures are used for valuing loss of life, life-values for non-earners would be essentially zero, life-values for grandmothers would be zero because they have no earnings, and they would be essentially zero for infants given the 20-odd year period before earnings begin. Nor, as argued by Mishan, would insurance premiums provide consistent approximations for loss of life values inasmuch as insurance policies provide only for compensation to others and, as such, could not serve as an index for the value that an individual would set on his own life (Mishan, 1971, p. 691).

Consistency with the Pareto improvement criterion would require that, given any change in risk, the loss of a person's life be valued in terms of the minimum sum that he or she would be prepared to accept in exchange for his(her) life. Since such a measure from an individual is unobtainable for all practical purposes -- "...no sum of money is large enough to compensate a man for the loss of his life" (Mishan, 1971, p. 693) -- the alternative position suggested by Mishan involves measures for an individual's willingness to pay as it related to changes in loss of life probabilities. Thus, an individual's willingness to pay for an X% reduction in the risk of death for members of society in general from any given set of causes, when aggregated across all relevant members of society, may serve as a consistent measure of the social benefits attributable to an action which results in the X% reduction in risk. The individual's willingness to pay to avoid an

X% increase in the risk of death for society from a given set of causes is then the social cost counterpart to the above benefit measure (provided that probability changes are small).*

There have been a number of efforts to calculate the risk measure suggested by Mishan. The majority of these efforts focus on occupational risk. The argument underlying these works is that individual valuations of risk are implicit in wage differentials between jobs involving different risks. Wage-risk studies suggest that individuals require between $340 (Thaler and Rosen, 1976) to as much as $1,000 (Smith, 1974) in additional annual incomes if they are voluntarily to accept jobs which involve additional risk of death on the order of one in one thousand. Thus, a program which reduces (increases) risk to one million people by .001 would result in a benefit (cost) of between $340 million to $1 billion.

Other efforts to empirically estimate risk costs _a la_ Mishan use contingent valuation techniques. This method involves the use of questionnaires in which individuals are asked to bid on alternative risk conditions; the maximum bid is then used as a measure for the individual's willingness to pay for an improvement in risk conditions related to some specific (potential) cause of death. The contingent valuation method has been used to assess risk-costs associated with potential ozone depletion (d'Arge, _et al._, 1979) and natural hazards (particularly earthquakes; see Brookshire, _et al._, 1979).

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*Schwing (1976) offers an alternative which abstracts from dollar values for loss of life effects; the method suggested by Schwing is one wherein program benefits are measured by changes in longevity. It is unclear, however, as to what one gains in any operational sense by substituting "lives lost (or saved)" with "shorter (longer) lives".

The occupational safety measures described above have been applied to an evaluation of risk for the WIPP in a relatively recent study by Logan (1978). This study focuses on a limited number of events at the WIPP site which could result in the release of radioactive elements into the environment, _viz_., severe earthquake, volcanism, meteorite impact and surface erosion; transportation events are not considered. The essence of this valuation methodology used is as follows: (a) the occurrence probability for each event is calculated; (b) given the occurrence of an event, a "transport model" simulates the movement of radioactive materials through the environment; (c) a _linear_ transformation of doses to fatalities is then used; (d) "expected deaths", which result from (c), are then weighed by the "marginal value of safety" (MVS), where the MVS is based on Thaler-Rosen estimates for occupational safety ($260/year for a .001 change in annual risk of death is used; Logan, 1978, p. 2-2). Resulting "Base Case" estimates for total _undiscounted_ damages over one million years and damages per year are given in Table VIII.3. As that table shows, the expected value of annual damages from the four effects included in the Logan study range from $815/year to $1,260/year.

In terms of attaching values to risk-bearing types of damages discussed above, methods for deriving defensible measures for individual perceptions of increased risk loads associated with nuclear waste are, at best, speculative; the same applies to the "perceived risk" extension of these arguments. Given the infant stage of the state of the arts for risk assessments of this type, efforts to then value these effects might well be viewed as vacuous.

TABLE VIII.3

ESTIMATED LOSS-OF-LIFE DAMAGES FROM

NATURAL DISASTERS AT THE WIPP SITE

	Total Damages, Not Discounted, Over One Million Years	Damages Per Year
High Population Estimates	$1.26 billion	$1,260.00
Low Population Estimates	$825 million	$ 815.00

Source: Logan (1978), Table 8 - 4, p. 8 - 11.

E. Summary.

This chapter has identified and analyzed the subjective dimensions of risk associated with the WIPP. In view of the continual shroud of controversy that attends this project, an attempt has been made to focus attention on the various elements of this controversy and, more importantly, why it is that these issues simply defy efforts to resolve the controversy in some objective fashion. In this regard, we have shown that methods used for risk assessment are subject to considerable debate as to their reliability; given the lack of feasible, alternative methods for this task, this source of controversy will necessarily remain. Problems associated with interpreting low probabilities for events with potentially high costs have been presented. To the extent that, in evaluating this class of events, individuals simply ignore probabilities and focus on consequences, the potential source of strong fear and apprehension is immediately obvious. We have also demonstrated the uncertainties in defining possible damages involved with a project like WIPP; yet we have cited arguments which suggest that damages associated with risk bearing *per se* may be relevant. Finally, we have demonstrated that the state-of-the-arts for valuing risk-related damages is at a relatively infant stage, in which case elements of the risk question are not amenable to inclusion in aggregative benefit-cost analyses.

CHAPTER IX

SPECIFIC ISSUES RELATED TO RISK

A. Introduction

Risk is one of the main factors which distinguishes the WIPP from other kinds of industrial facilities, in terms of its socio-economic impacts on New Mexico. Some of the discussion in the preceeding chapters has indicated how pervasive the risk considerations are in the analysis of the WIPP. Risk also is present in other kinds of industrial and transportation activities, and so it is legitimate to inquire why risk considerations should be particularly important in the case of the WIPP. Why have so many reports been devoted to clarification of the risks involved in nuclear waste disposal?

One reason was suggested in the recent DOT statement which was quoted in CH. VII: handling radioactive wastes entails a potential, however small, for a very damaging incident. Few other activities have the potential for such serious accidents. The public concern, as the DOT document notes, "may reflect the perceived limits of society to deal with catastrophic occurrences"*. Another reason for the concern and for the observed amount of technical research lies in the uncertainty associated with radiation doses from nuclear wastes. There still is considerable uncertainty surrounding the estimates of probabilities of radiation exposure which could be associated with accidents, and there also is professional debate regarding the public health consequences of given levels of exposure.

Another reason for concern is the difficulty of detecting smaller levels of radiation exposure. The hazard from an exploding shipment of gasoline is obvious to everyone in the area, and those who are not immediately affected can maintain a safe distance without waiting for instructions. By contrast,

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*Federal Register, January 31, 1980, p. 7141.

a radiation leakage often goes undetected, and even if it is detected, the extent of the hazard may not be immediately obvious. People in the vicinity may not be aware that their safety requires moving quickly.

A fourth source of public concern is the long-lived nature of the risk and the possibility of health damages cumulating over time with successive -- and possibly undetected -- exposures. A related concern is the ethics of passing uncertain hazards on to future generations.

In attempting to come to grips analytically with the risk issue, some writers have emphasized that the public acceptability of risk depends in large part on the benefits perceived to be associated with it. One analyst even has attempted a quantification of the relationship: "The acceptability of risk appears to be crudely proportional to the third power of the benefits real or imagined."* Others have surveyed public opinion regarding risk related to new technologies and have concluded that "the participants in our study were not satisfied with the way that the market and other regulatory mechanisms have balanced risks and benefits."** In other words, concern over the level of safety in nuclear waste shipments and their disposal may reflect in part a lack of conviction that nuclear power brings significant benefits, vis-a-vis other energy systems.

As proposed, the WIPP is to be primarily, or entirely, a repository for defense wastes, and so the benefit evaluations regarding nuclear power should not be applicable. Nevertheless, these remarks help place in perspective the extensive literature on risks associated with nuclear waste management.

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* Starr, 1969, p. 1237.

** B. Fischhoff et al., How Safe Is Safe Enough? A Psychometric Study of Attitudes Towards Technological Risks and Benefits, Report UCLA-ENG-7717 (PB-266056), University of California, Los Angeles, NTIS, 1977, quoted in Okrent, 1979.

For the State of New Mexico, the specific issues related to risk may be summarized under the following headings:

(i) Risk management issues for the transportation of nuclear wastes: routing and placarding rules, highway upgrading investments, escort and speed limit regulations, etc.; and also public information issues.

(ii) Emergency preparedness issues for transportation: emergency preparedness planning, training of emergency response personnel, acquisition of radiation monitoring equipment, and clarification of jurisdictional responsibilities and elimination of jurisdictional ambiguities which could cause delays in emergency response.

(iii) Emergency preparedness issues for the WIPP site: drafting of an emergency preparedness plan; provision for training, equipment purchase, and emergency exercises; and education of the local population regarding emergency response.

(iv) Liability issues: clarification of liability for damages in the event of accidents of varying kinds.

In this chapter, these issues are reviewed and summarized. Particular attention is devoted to an issue not discussed in earlier chapters: the importance of public education regarding the risks associated with the WIPP. Finally, a possible side-effect of the WIPP which has not been addressed elsewhere in this report, viz., impacts on property values, is surveyed.

B. Transportation Risk and Emergency Preparedness

These issues have been discussed extensively in chapter VII and corresponding policy recommendations were made at the end of that chapter. Those recommendations were not based on the basis of comparing costs of the measures with the expected benefits (or expected avoidance of future costs), because the relevant risk probabilities simply are not known with enough precision to permit an expected-benefit calculation for preventive measures (chs. VII and VIII). They were made on the basis of criteria of reasonable public health precautions, and these were inferred from other state and Federal programs.

The discussions in Chapter VII reveal that there is significant scope for enhancing public safety via precautionary measures, although such measures are not discussed in the WIPP FEIS. A number of other states already have been active in promulgating some measures of this kind, particularly with respect to emergency preparedness and transportation routing, even though they may not have an actual or proposed waste isolation facility within their boundaries.

In relation to these topics, another issue emerges which is implicit in much of the discussion of chapters VII and VIII: the need for better public information on the risks associated with the WIPP. Better information in this context is not provided by additional fault-tree analyses which yield extremely small estimates of accident probabilities. Such estimates can in fact simply serve to widen the credibility gap between the public and the nuclear establishment. What appears to be needed is a candid discussion of what could happen in the unlikely event of a "disaster", and what prudent steps are being taken to minimize both the probabilities and consequences of such occurrences. The evidence reviewed in this report would suggest that the nuclear industry has nothing to fear from such candor; with the possible exception of the very small number of high-level waste shipments, WIPP transportation does not pose as great a hazard as certain chemical facilities.* But

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* "The probability of a chemical facility accident causing a hundred or more fatalities in a nearby population center is not insignificant" (Okrent, 1979, p. 160).

nevertheless, there is a hazard, and forthright recognition of it can assist in proper planning and also in enhancing the public's confidence in the authorities charged with managing these issues.

For the nuclear industry as a whole, the issue of public confidence has been cited as the issue most poorly anticipated and most critical for further development. "The early developers of nuclear power had three failings -- they knew too much about radioactivity, not enough about geology, and almost nothing about dealing with the public and its reactions"*. It does not follow, however, that public confidence in the decision-making-process can be restored by issuing voluminous quantities of technical materials which purport to establish the relative safety of nuclear facilities. Safety estimates which are made to appear more certain than they really are only contribute to public skepticism in the long run. Also, providing large quantities of abstruse technical information may cloud communication for another reason, and here we quote a careful study by Hébert and others (1978) on institutional and ethical issues in nuclear waste management:

> "Since 1954, more technical articles and policy statements have been written, and more rhetoric spoken, about nuclear power than most other technical-social issues of our time. Some perceive this to mean that the nuclear establishment is being candid. Others perceive this in a different way. Green (1976), for instance, believes that there has been a calculated policy on the part of the nuclear establishment since 1954 to deluge the public with a flood of highly technical information that could not possibly be understood. He feels that this has been done in order to support and perpetuate the myth that the public has to rely on the judgment of scientific and engineering experts for wisdom on what should be

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*Hammond, 1979.

done with nuclear waste. In other words, he questions whether information that can be understood by the public is being provided by the nuclear establishment"*.

Obviously this poses a dilemma for public authorities and specialists: how to provide information which is enough but not too much? It is far beyond the scope of this study to address this issue for the nuclear industry as a whole, but the research conducted for this analysis of the WIPP had led the researchers to certain viewpoints on the public information issue. First, the government-sponsored technical studies in some instances fail to consider more severe but credible accident scenarios, and for proper public information and emergency planning these need to be considered. Two examples may be cited from the discussion in ch. VII: a) the FEIS's failure to consider more severe (but plausible) train accident scenarios in which fires burn for two or even several hours; and b) the FEIS's corresponding failure to consider higher values of release fractions in constructing its range of accident consequences**.

Second, once accident-scenario analyses and other studies are completed, there is a need to summarize them in clear, non-technical terms. It is not sufficient to say only that a high-level waste shipping accident could result in a whole-body population radiation dose of 25,400 man-rem if it occurred in "a large urban area" [size unspecified], and to compare this with 50-year background doses which are much larger***. It is necessary to say also that such

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* Hébert, et al., 1978, p.9.

** FEIS, p. 6-37.

*** This point was alluded to in the radiological health review of the DEIS conducted by New Mexico's Environmental Evaluation Group: "Some of the DEIS assumptions for accidents may not be conservative. Examples [include] a fire occurring during a rail accident involving contact-handled transuranic wastes" (Neill, et al., 1979, p. 3).

an accident could result in 5-10 excess cancer fatalities, of course while adding that the likelihood of this kind of accident is very remote. It can also be pointed out that measures such as special trains would make it even more unlikely.

Such a summary of the orders of magnitude of the life risks and economic risks from waste transportation has been attempted in chapter VII. The authors of this study feel it is very imperfect and that other kinds of specialists are better placed to make such a summary. Nevertheless, we attempt it because it has not been provided in previous WIPP analyses, and because public decision-making probably is better served by orders-of-magnitude estimates of possible risk damages. The material in ch. VIII strongly indicates that the public is likely to prefer reducing the magnitude of a potential accident from 100 fatalities to 10, than reducing the probability of 100 fatalities from 10^{-6} to 10^{-5}. Yet the existing risk analyses for the WIPP tend to treat the two as conceptually equivalent.

Finally, we wish to point out that this kind of candor in simple language by no means will necessarily lead to more stringent regulation of the nuclear industry vis-a-vis other industries. _If_ it were concluded that WIPP shipping accidents threaten at most tens of fatalities, whereas, say, chlorine shipping accidents threatened hundreds of fatalities, then routing restrictions and other regulations probably would be applied more stringently against the latter.

C. Risk Management For The WIPP Site And Intergenerational Issues

Continuing with the orders-of-magnitude approach, available studies* suggest that public health risks from accidents at the WIPP site are considerably less than those associated with transportation accidents. However, given

*For example, Logan (1978) and the FEIS.

that all shipping routes converge on the Eddy-Lea County area, total transportation-related risks are greater there than in the rest of the state. For the WIPP site *per se*, the greatest uncertainties concern the very long-run hazards of the stored wastes.

Before discussing some long-run concerns, however, we note that the main hazard which the WIPP site poses for the present generation would not appear to be that associated with a possibly severe accident, but rather that associated with the cumulation of radioactive contaminants from a series of small accidental releases. This point is illustrated by the history of the Rocky Flats Plant in Colorado. Measurements suggest that plutonium concentrations in a fraction of off-site soils located downwind from the Rocky Flats Nuclear Weapons Plant are much higher than the background concentration (Johnson, 1976, p. 488). While the methods of this study have generated controversy, it seems clear that the soil concentrations of plutonium in the Rocky Flats are higher than in the background state, and that this degree of contamination clearly was not planned.

The WIPP is designed primarily for storage, but experiments with high-level wastes will take place there. Accidental releases from these experiments, and releases from accidents in the off-loading and handling process, could contribute to a build-up of radioactivity in the soils of the Los Medanos area. From a decision-making viewpoint, the implication is that it may be prudent to monitor the radioactive concentrations in soils of the area at regular intervals. Although the distance of the site from populated areas is a strong safeguard against immediate exposure of human populations, the level of soil contamination in the area could be relevant to decisions regarding eventual post-operations uses, such as grazing.

For the longer-run, the main questions are the longevity of the radioactivity underground, the possibilities of the repository being breached, and whether there are criteria for hazard acceptance when the benefits and risks are borne by different generations. Regarding longevity, "it is a fact that after about 700 years, most of the fission-product radioactivity will have decayed away"*. However, the longer-lived isotopes such as plutonium 239 will not decay to very low levels for about 500,000 years.

The likelihood of migration of radioactive materials into water tables -- in significant concentrations -- or release to the atmosphere due to geologic or human activity is very low. "However, there is no way to assure with total certainty that the geologic structure won't change and that radioactivity won't be released.... The Flowers Report (1976) perceived that the main uncertainty here was due to climatic changes and alternations in sea level rather than to changes in geologic structure.... Humans are fallible and sometimes malevolent; what is uncertain is how to include these factors when determining the probability of a waste-related accident or release.... There are enough issues involving uncertainty to have caused uncertainty itself to become an issue"**. Some writers also have pointed out that it is out of the question to attempt to forecast the nature of political institutions over periods of thousands of years, and hence institutional guarantees of the integrity of the waste repository against human intrusion have little meaning.

Given these uncertainties, it appears that some sort of risk is being transmitted to future generations by the activation of the repository, and so

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*Hébert, _et al_., 1978, p. 7.

**_Ibid_, pp. 12 - 13.

the question which arises concerns the ethics of intergenerational benefit-cost comparison. The issues in this area resemble in some respects the issues concerned with the role of distributional concerns in benefit-cost analysis, but there also are important differences. In both areas, there is no consensus on acceptable decision rules, so here we simply mention a few elements of an evolving dialogue. Recent papers by Schulze (1979) and Hébert _et al_., discuss alternative intergenerational criteria. Three of them, for example, might be*:

(i) No generation can legitimately impose "serious risks" upon future generations unless "the benefits" that the imposing generation derives clearly outweigh the costs imposed upon future generations.

(ii) No generation can legitimately place the health and safety of future generations at risk, unless such practices are necessary to preserve the health and safety of this generation.

(iii) If the present costs of some policy are minor or relatively trivial, and bearing them will avoid serious risk to the health and safety of future generations, then we ought to bear them.

While such rules may appear attractive on their face, attempting to implement them no doubt would invite endless debate over the interpretation and application of the words "serious", "trivial", and "necessary".

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*Taken from Hébert, _et_. _al_., 1978.

Schulze (1979) considers a number of extant ethical systems, including egalitarianism, elitism, utilitarianism, and Christianity, and he finds that their decision rules are different in situations where one party benefits and another suffers and the two have different income levels. Extending these prinicples to the intergenerational case introduces an additional complication: if the recent centuries' tendency toward relatively sustained economic growth continues, then we may regard future generations as likely to be better off than we are. Does this then justify imposing costs (risks) on them in order to secure present benefits, on grounds of egalitarian principles? Most individuals probably would respond negatively, or by asserting that the answer depends on the respective magnitudes of the benefits and the costs, in which case we again are left with a difficult measurement problem.

Clearly, the choices posed by new technologies are not easily illuminated by ways of thinking and ethical systems which developed in earlier eras when technological processes were at the level of sophistication of cottage industries. Evaluating a project like the WIPP goes far beyond technical calculations and raises fundamental questions about ethics and institutions.

D. Liability Issues

Apart from potential threats to health and life, operation of the WIPP incurs the risk of substantial economic damage, although that risk is extremely slight. In chapter VII, it was noted that very rough calculations indicate that a radiological transportation accident in Albuquerque could, in the extreme case, entail economic costs of $300 million, apart from health damages. This amount of money is beyond the capacity of private insurers to manage, and prevailing opinion is that for "radioactive releases at final waste repositories.... the Price-Anderson Act is not applicable...and it is questionable whether [affected] persons could sue for compensation under the Federal Tort Act".* Carriers are unlikely to hold more than $10-$15 million in insurance coverage. "Carriers can be held liable for accidents in transporting hazardous materials, but state governments must often assume responsibility for clean-up operations".** Further, "shippers and container manufacturers can be held liable if negligence is proven".***

Liability can be spread over the shipment schedules, the waste generating facility, the disposal site, or the carrier****. In the special case of wastes transported from a government-indemnified nuclear power-plant, the Price-Anderson Act would apply, but that would not be the case for the WIPP.

While the Price-Anderson Act may not be applicable to the WIPP at present, there appear to be three options open to the state: to make the Price-Anderson Act applicable via special contractual arrangements, to require sufficient insurance on the part of all participating private parties, or to "insure itself" via establishment of an appropriate contingency fund. We commence discussion of these choices with a brief description of the Price-Anderson Act and its historical origin.

D.1 The Price-Anderson Act. Commercial development of nuclear power in the U. S. stemmed from the Atomic Energy Act of 1954, which mandated AEC participation in research and development activities designed to create a viable

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*Hébert, et. al., 1978, p. 37.

**National Conference of State Legislators, 1980.

***Ibid.

****Ibid.

commercial nuclear power industry. The major effort in this direction by the AEC was the Power Reactor Demonstration Program (PRDP), under which a number of demonstration reactors of various types (light water, gas cooled, breeder) were built under joint financing by the AEC and utilities and/or reactor manufacturers.

However, hesitancy on the part of utilities and electrical supply industries to adopt the nuclear technology was in part due to the Atomic Energy Act's stipulation that nuclear technology must be regulated to protect the health and safety of the public. Their unwillingness to participate in reactor development programs stemmed largely from fears of the tremendous liabilities that might arise in the event of a major accident; neither the private insurance industry nor the Federal government was willing to underwrite such a program as to them this appeared tantamount to writing a blank check.

As a consequence the Price Anderson Act (1957) was passed. Under the provisions of the Act, suppliers were indemnified and all public liability from a nuclear accident was assigned to the electric utility owning the plant. However, in the event of a nuclear accident the utility involved was to be indemnified from any liability in excess of 560 million dollars. Roughly 165 million dollars of this is currently underwritten by private insurance companies based on the usual risk assessment practices. The remaining liability is financed by the Federal government with utility premiums based on the size and number of plants rather than on risk assessment. In the event of liability exceeding 560 million dollars, claims are to be prorated downwards in inverse proportion to total damages.*

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*Also, by industry agreement, every reactor facility in the U. S. can be assessed up to $5 million in liability coverage for an accident at any one of them, so an additional $360 million in coverage exists.

From the description above, it is unclear how the Price Anderson Act would apply in the case of waste disposal. Certainly it makes no sense to exclude this one phase of the nuclear fuel cycle from liability. The question of ownership may ultimately be of significance although potentially disturbing moral hazard questions can arise. A first step towards speaking to these questions would involve a thorough examination of the Price Anderson Act in relation to potential WIPP related damages. As, by law, the Act must be reviewed every ten years, a wealth of information exists in the form of transcripts from congressional hearings which would prove valuable in assessing potential liability scenarios for the WIPP.

In conjunction with the WIPP, legal memoranda exchanged between the State of New Mexico's Attorney General's Office and the Department of Energy have addressed the potential impact that agreements between the DOE or the NRC and federal contractors might have concerning financial redress and State of New Mexico indemnification pursuant to the Price Anderson Act for any WIPP-related accident.* A number of issues arise in this regard.

The first concerns the potential liability of the State of New Mexico in the case of a nuclear accident. At issue here is whether an individual, pursuant to a nuclear accident, might have grounds to sue the State. For example, in the case of a transportation accident, while the State can claim sovereign immunity in the cost of road design defects, it would most likely remain liable for negligence in the maintenance of highways and bridges.**

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*Statement by New Mexico Attorney General Jeff Bingaman to Subcommittee on Oversight and Investigations of U. S. House Committee on Interior and Insular Affairs, Albuquerque, New Mexico, August 10, 1979.

**Ibid.

State liability might also be established as the result of any "consultation and cooperation" agreements which might be made with the DOE.

The second issue concerns the indemnification of the State in cases where damages exceed the maximum insurance available. Specifically, the Price Anderson Act provides that financial protection established by indemnity agreements, say, for example, between the DOE and a federal contractor (in this case Westinghouse) extends to any other person who may be liable for public liability. If this were the case the State would be indemnified for any liability up to the 560 million dollar limitation and protected from any liability over and above the limitation. However, it is not clear that the State would qualify under this provision.

A related concern arises even if the State were indemnified in the manner described above. It appears, in the event of injury or damage subsequent to an illegal act of terrorism wherein material was removed from the WIPP-site or diverted from a transportation route, that the provisions of Price Anderson would not apply. In such an event the State could be liable for damages incurred.

Other issues include the possible inapplicability of Price Anderson when the only party an injured person might sue is the federal government itself, which may become even more involved in the event that WIPP is not NRC licensed. Additional problems may arise as a result of exclusion of certain legal defense waivers. These considerations are essentially legal and, while relevant, are beyond the scope of the present investigation. However, in addition to these specific problems, there are a number of generic issues attending Price Anderson which are relevant to our current considerations. We now turn to these.

As related above, the Price Anderson Act appeared as a response to the private electric utility and electrical supply industry's unwillingness to participate in reactor development programs. At that time this was the largest obstacle to the federal government's goal of a commercial nuclear power industry. Under the Act, all public liability stemming from an "extraordinary nuclear occurrence" is assigned to the utility company that owns the nuclear plant. Standard defenses, such as the statute of limitations and the lack of negligence would be waived.

A remaining concern is that in conjunction with an accident the waiver of defenses provision of the Price Anderson Act is invoked only in the event that an "extraordinary nuclear occurrence" has in fact been experienced. The NRC defines an "extraordinary nuclear occurrence" as one in which there is a specified level of off-site property damage or one which involves the death or hospitalization, within 30 days of the event, of five or more people located off-site showing clinical evidence of physical injury from exposure to the nuclear materials. Several problems arise here which are both generic and WIPP-related.

First, especially in conjunction with the WIPP, accidents could easily occur which would involve lesser damages yet still be considered substantial. Second, and more significant, physical injury from exposure may not be immediately apparent in a degree sufficient to invoke the provisions of the Act. Many cancers and cancer fatalities may not appear until many years after the incident.

The latency characteristics of radiation cancers raise a third issue; even if an "extraordinary nuclear occurrence" is declared, a large part of the damages can be expected to be related to latent cancers. The usual defense waivers extend up to three years from the date the individual could have "reasonably" known of the injury and in no event more than twenty years following the incident. One obvious problem here is in the event an effect appears more than twenty years subsequent to the incident. But a more pervasive problem is determining the cause of latent afflictions; e.g., is the cancer the result of plutonium ingested twenty years ago or thirty years of heavy cigarette smoking.

In the sections above some of the issues relating to the applicability of Price Anderson have been addressed. While no unalterable conclusions have been reached, the nature of likely problems has been briefly outlined. It is clear that DOE has contractual authority to enter into indemnification agreements with contractors concerning WIPP construction activities and that such agreements in many cases would be necessary to avail individuals the appropriate protection. Such agreements would of necessity have to be extended to cover transportation and operation aspects as well. This is evidenced by the following quote.

> "Until the present date, the Price Anderson Act, which provides insurance coverage to utilities for nuclear mishaps, has not been applied to spent fuel being shipped to and stored at other reactors. On December 29, 1978, the NRC requested public comment on the question of whether to extend indemnity protection. As of August 1, 1979, the NRC had not exercised its discretionary authority to extend indemnification. Should Price-Anderson not be extended, private insurers must be found to guarantee proper protection of the public".*

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*Evans, 1979.

D.2 Other Liability Options. If the private insurance option is followed, the state may wish to consider drafting insurance statutes for the transportation of nuclear materials. Only a few states have such statutes, including the following:*

- Georgia -- liability insurance required by the State Department of Transportation;
- Indiana -- $1 million certificate of insurance required;
- Louisiana -- liability insurance required; $300,000 public and $100,000 private liability coverage;
- Mississippi -- shippers and carriers held liable to the state for accidents;
- New York -- an insurance certificate is required to use city thruway facilities.

Given the magnitude of possible damages if one of the more unlikely accident scenarios were to occur, the state may have to be prepared to play the role of insurer of last resort, particularly with respect to clean-up costs. This then raises the question of a contingency fund and the source of its revenues: state taxes, Federal grants, or a tax on the wastes shipped for disposal. These issues are considered in Chapter IV.

D.3. Potential Effects on Property Values. Another risk-related issue associated with the transport of radioactive wastes to the WIPP storage facility is the potential for detrimental impacts on the value of properties located along transportation routes (especially, dedicated routes). However,

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*National Conference of State Legislatures, 1980.

numerous discussions with officials in the offices of State's Attorney Generals (California, Colorado, Illinois, Kentucky, Minnesota, North Carolina, Pennsylvania, South Carolina, Texas, and Wisconsin) in areas with nuclear facilities have revealed a paucity of documented damages associated with the transport of nuclear wastes. In fact, our investigation revealed only one instance, in which a Texas farmer* was actually awarded damages (in the amount of $300/acre, for a total of $105,124.00) after filing suit. The judgment was made explicitly on grounds of property damages arising from local residents' fear of the consequences of an accident involving a train which carried nuclear wastes across his property. The court's recognition of damages imposed on the individual by the potential risk of property value loss carries interesting implications for the estimation of the social costs of nuclear waste transport. However, we have been unable to find similar cases of this type, and the somewhat peculiar circumstances involved in the Texas case** make attempts to use the Texas experience as a basis for estimating property value damages speculative, at the _very_ best. We can then do no more than leave the possibility of such damages as an open issue at this point in time.

As a part of our search for property value effects along transport routes, property value effects on land in close proximity to nuclear sites were also considered. Documentation on the Maxey Flats nuclear waste

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* Texas Electric Service Company, Appellant, v. Burlyn H. Nelson et ux., Appellees, No. 17775, Court of Civil Appeals of Texas, Fort Worth.

** While the language of the court makes reference to compensation related to the plantiffs fear of a rail accident for a waste-carrying train, and the associated loss in property values, arguments and evidence submitted to the court centered on differences in _development_-related (non-agricultural) land values when such land is or is not near a railroad; see, _Ibid_.

disposal site in southeastern Kentucky* (closed in 1977) reveals that no detrimental impact on property values in the vicinity of the site occurred. A property value study conducted at the University of North Carolina (1977) found no evidence of declines in property values in the vicinity of two nuclear power plants near the recreational area of Lake Norman outside of Charlotte.** In Barnwell, South Carolina, no evidence of declines in property values has been reported in connection with the low-level radioactive waste disposal facility utilized there since 1971, though actual property value studies have not been conducted.

Two (non-waste) nuclear sites where "incidents" have actually occurred and have received extensive publicity are the nuclear power plants at Brown's Ferry, Alabama (fire at the plant in 1975) and at Three Mile Island, Pennsylvania (breakdown in safety equipment in 1978). Though no property value studies have been conducted near Brown's Ferry, discussions with local officials suggest a general public acceptance of the plant and no property differentials in the area. Two studies conducted by Pennsylvania State researchers conclude that, as yet, property values in Harrisburg (near Three Mile Island) have not been detrimentally impacted. (Data being used in a third study which is now in progress appears to support the same conclusion). However, it should be noted that long term effects of the TMI incident have yet to unfold; claims have been made by some residents of Harrisburg that they have been unable to sell their homes for more than half their worth.***

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*Kentucky Legislative Research Commission (1977).

**In fact, the study showed relative <u>increases</u> in property values in the vicinity of the plant; discussions with officials in many areas reported such increases due to land speculation in the vicinity of proposed power plant sites and increased population due to employment at the plants.

***Scott, 1980.

Two areas where detrimental property value impacts have been under litigation are (1) in the vicinity of the Sheffield, Illinois low-level nuclear waste disposal site and (2) in the vicinity of the Rocky Flats, Colorado, facility which manufacturers component parts for nuclear weapons and reprocesses obsolete nuclear weapons parts. However, the economic damages claimed in both cases seem to center around city zoning decisions with respect to the nuclear facilities.

Operators of the Sheffield disposal site, Nuclear Engineering Company, attempted to expand their facility in 1976. However, such expansion would have required that some residential land in the area be re-zoned as agricultural property. During re-zoning hearings, a State appraiser testified that one individual would suffer a $50,000 loss on 80 acres if the land were re-zoned. (Nuclear Engineering Company withdrew their expansion application in 1979). However, our discussions with the appraiser involved in these hearings suggests that the potential property value loss claimed was attributed to the re-zoning issue rather than proximity to the disposal site per se. This conclusion was supported by our discussions with former owners of a parcel of land near the site who recently sold their tract at an auction and received comparable sale prices for land close to and far from the site.

In the case of the Rocky Flats facility, low-level nuclear contamination has been detected on lands near the facility in the suburbs of Denver (i.e., higher than normal readings of plutonium, americum, and uranium have been found near the facility). Because of the possibility of contamination the City has not allowed re-zoning of some proximate lands currently zoned for agricultural uses. One firm which owns land across from Rocky Flats has sued for damages because of purchasing the property with the intent of building commercial and residential structures; that investment has not been possible due to the City's denial of re-zoning applications. The loss in property value claimed by the plaintiffs is over $2 million -- their estimation of the "true" value of the property versus its actual value which they claim is nominal due to radioactive contamination. They also claim an additional loss of $1 million in lost profits. (However, as yet there is no "proof" of contamination since there are no set standards for radioactivity in soils; only the City's denial of re-zoning can be used in making the damage claim.)

As yet, the courts have not set forth a judgment on the Rocky Flats case. However, because of the knowledge of low level radioactive discharges from the facility, HUD regulations since 1978 have required all prospective home purchases within a 10-mile radius of the facility to sign a notice which advises residents of the existence of plutonium contamination in the soil (which is acknowledged to be below the limits of EPA's radiation guidance levels). Interestingly, informal discussions with area realtors and local Chamber of Commerce officials suggest that some relative decline in property values may have occurred within the 10-mile radius. Such declines have not been formally estimated, however, and must be viewed as speculative at this point. Realtors in the area, interviewed as a part of this study, feel that any property value impacts in the Rocky Flats vicinity, are primarily attributable to the mandatory signing of the advisory notice (see Appendix) and not the existence of the facility *per se* (i.e., realtors feel the notice is discriminatory because it frightens potential homeowners into feeling they will have no recourse if actual damages were to occur).

In summary, we find little evidence that would serve as a basis to conclude that land in close proximity to a nuclear waste facility or a nuclear waste transport route would suffer detrimental impacts on property values due, either, to actual radioactive contamination or due to perceived risk associated with possible contamination, although the possibility of this occurring in the future cannot be ruled out.

APPENDIX IX-A

ROCKY FLATS ADVISORY

NOTICE AND CERTIFICATION

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
REGIONAL/AREA OFFICE
EXECUTIVE TOWER - 1405 CURTIS STREET
DENVER, COLORADO 80202

March 1, 1979

REGION VIII

IN REPLY REFER TO:

8RF-1

ROCKY FLATS ADVISORY NOTICE

This notice is to inform you of certain facts regarding the United States Department of Energy Rocky Flats Plant which is located within ten miles of your prospective residence.

You should be aware that there exist within portions of Boulder County, and Jefferson County, Colorado, varying levels of plutonium contamination of the soil. However, according to the information supplied by the Department of Energy, the soil contamination in the area in which your prospective residence is located is below the limits of the applicable radiation guidance developed by the Environmental Protection Agency (EPA). Therefore, it has been determined by the EPA that this particular area may be used without restrictions.

You should also be aware of the existence of the Colorado Radiological Emergency Response Plan for Rocky Flats developed by the Colorado Department of Military Affairs. This plan establishes certain protective actions to be taken in the event of an accidental release of radioactive materials from the Rocky Flats Plant. Your prospective residence lies within the area covered by the Radiological Emergency Response Plan. A copy of this plan may be reviewed at the State of Colorado Department of Health, 4210 East 11th Avenue, Denver, Colorado 80220, or at the office of the Rocky Flats Monitoring Committee, State Capitol Building, Room 127, 200 E. Colfax Avenue, Denver, Colorado 80203. Copies of this plan should also be available at the city and county offices, as well as the Environmental Protection Agency, 1860 Lincoln, Denver, Colorado 80203, and the Department of Housing and Urban Development.

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
REGIONAL/AREA OFFICE
EXECUTIVE TOWER - 1405 CURTIS STREET
DENVER, COLORADO 80202

REGION VIII

CERTIFICATION

IN REPLY REFER TO:
8RF-2

INSTRUCTIONS:

1. THIS CERTIFICATION MUST BE EXECUTED BY THE BUYER AND EITHER THE BROKER, REAL ESTATE AGENT, DEVELOPER OR HOME BUILDER, MORTGAGE COMPANY, BANK, OR SAVINGS AND LOAN ASSOCIATION.

2. THE CERTIFICATION MUST BE DATED BY BOTH SIGNERS ON OR BEFORE THE EXECUTION OF THE CONTRACT OF SALE.

3. THE ORIGINAL SHALL BE SUBMITTED WITH THE APPLICATION FOR MORTGAGE INSURANCE.

CERTIFICATION

I, (We), ______________________ (Name of Buyer), hereby certify that I, (We), have been furnished with, and have read, the "Rocky Flats Advisory Notice" dated March 1, 1979. This notice was furnished to me by ______________________ (Name of Party Furnishing Notice) prior to the execution of the contract of sale, for the premises located at ______________________ (Address).

Date ______________ ______________________ (Signature of Buyer)

CERTIFICATION

I,(We), ______________________ (Name of Broker, Developer, or Mortgagee), hereby certify that I, (We) have furnished ______________________ (Name of Buyer) with a copy of the "Rocky Flats Advisory Notice" dated March 1, 1979, prior to the execution of the contract of sale for the premises located at ______________________ (Address).

Date ______________ ______________________ (Signature of Party Furnishing Notice)

(This Form Should be Reproduced as Necessary)

AREA OFFICE
Denver, Colorado

X. OTHER SOCIO-ECONOMIC ISSUES

A. The problem.

Our discussions of socio-economic "issues" -- non-quantifiable "impacts" -- associated with the WIPP concludes with a brief overview of some of the distortions in social and economic institutions that may attend relatively rapid growth in communities such as those in the Eddy-Lea County areas. Considerable recent attention has been given to such effects within the context of "boomtown" developments associated, primarily, with energy-related developments in the Rocky Mountain States.* Analyses in this study are based on the tacit assumption that "boomtown" conditions -- a la the Sweetwater County, Wyoming, experience, for example** -- will not result from the construction and operation of the WIPP. This assumption is based on several considerations. First, the change in the two-county population which is attributed to the WIPP is relatively small: high estimates for population increases in Eddy and Lea counties are but 3.9% and 5% in the two peak years of WIPP construction; this compares with an almost 100% increase in population between 1970 and 1974 experienced in Sweetwater County.*** Secondly, considerable excess capacity is shown to exist in the two-county area in terms of private and municipal infrastructure (with the notable exception of Loving). Such capacity is the result, to some

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*See, as examples, Gilmore and Duff [1974], Gilmore [1976], and Ives and Eastman [1975].

**Gilmore and Duff [1974].

***Ibid., pp. 4 - 6.

extent, of the decline in population and economic activity in the 1960's due to depressed markets in the potash industry -- an important component of the two-county area's economic base. Population in Eddy and Lea counties fell by 9,664 (19%) and 3,875 (7.3%),* respectively, between 1960 and 1970. Third, but related to the above, one may expect that in-migrating population will tend to locate in areas that are compatible, in ethnic and cultural terms, and that have the most to offer in terms of private and social services and amenities. While one can certainly imagine a location pattern for in-migrating population which would result in real boomtown effects -- for example, if all in-migrants were to attempt to locate in Loving** -- such patterns were regarded as highly improbable by the research team for the reasons described above.***

B. An Overview of Boomtown Effects.

It is instructive, however, to review some of the social, cultural and economic distortions that have attended rapid growth in other communities inasmuch as some of these effects -- however diminished in magnitude -- may well occur in the two-county area as a result of the WIPP. To allow for some perspective as to the range of conditions encountered in rapid growth communities, the following describes conditions found in Sweetwater

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* Bureau of Business and Economic Research [1979-80], p. 98.

** See statement by Antonio Carrasco to the U.S. House Oversight and Investigations Committee (hearings in Albuquerque, the Honorable Harold Runnels, Chairman), no date.

*** Here again uncertainty as to future developments is relevant and potential biases exist; see discussions above in Chapter II.

County, Wyoming, during the 1970-74 period. This is the period associated with the expansion of trona mining and the construction of the Jim Bridger Power Plant (built for the Pacific Power and Light and Idaho Power Companies). Population and employment levels increased from 18,931 to 36,900 and 7,230 to 15,225, respectively (mining employment increased from 1,530 to 2,650; construction employment increased from almost zero to 4,200).[*] The quality of municipal and other local services declined markedly. In the State of Wyoming, the average doctor-population ratio is 1:1100; in Sweetwater County this ratio increased from 1:1800 in 1970 to 1:3700 in 1974.[**] Mental health clinic caseloads increased eight-fold. In 1974, there was an estimated deficit of 128 schoolrooms in the county. Capital costs for providing schoolrooms are estimated to be on the order of $5,000/child; 1970-74 increases in assessed valuation for school districts was but $2,100/child, however.[***] By 1974, the deficit in municipal facilities for homesites (water, sewage, roads, electricity, etc.) was approximately 1,397 home sites (4,599 mobile home spaces were needed). With little expansion in police facilities, crime rates increased by 60 percent between 1972 and 1973 alone.[****] More is said regarding crime below.

The statistics quoted above are only the grossest indicators of the morass of social, institutional and economic conditions that may attend the disruptions brought about by rapid, large scale economic developments in

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* Gilmore and Duff [1974], pp. 4 and 6.

** _Ibid_., p. 16.

*** _Ibid_., p. 24.

**** _Ibid_., pp. 19 and 21.

small communities. Increased rates of alcoholism, broken homes, and suicides were among the many manifestations of break-downs in social order in Sweetwater County reported in Gilmore and Duff's seminal work concerning the "anatomy" of a boomtown.

Of course, not all developments involving rapid growth result in chaotic disorder on a scale like that described above. For example, increased copper mining activity in Cuba, New Mexico, during the 1970-74 period resulted in socio-economic impacts which seem to have been beneficial to all concerned.* Although percentage increases in population and employment (156% and 73%, respectively) were not unlike those experienced in Wyoming, the scale of change in absolute terms was relatively small (over the 1970-74 period population increased from 230 to 590). More importantly, perhaps, Cuba, like the two-county area of interest here, seemed to have had substantial excess capacity in terms of municipal facilities prior to the boom (or boomlet).**

C. Specific Social and Cultural Effects.

Potential implications for Eddy and Lea counties of the general effects described above are as follows. In terms of health care, the doctor-population ratio in Eddy and Lea counties was 1:1349 and 1:1630, respectively, in 1978.*** These ratios are substantially higher than the state average (1:698) and those for the more urban counties of Bernalillo (1:387) and Santa Fe (1:434). Hospital facilities in the two-county area are viewed by local planners as

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* Ives and Eastman [1975].

** Ibid., Table 2, p. 6.

*** Bureau of Business and Economic Research [1979-80], p. 147.

being adequate at the present; however, medical facilities for low-income individuals -- e.g., the health care clinic in Loving which serves Southern Eddy County -- are seemingly under considerable pressure.* In terms of medical facilities and, particularly, the availability of doctors, there would seem to be good reason to expect that population increases during the construction phase of the WIPP may well exacerbate an existing problem in terms of health care.

Little can be said in terms of the potential for many other types of social disorders, such as increased alcoholism, broken homes, etc., which could possibly be associated with WIPP construction. A bit more can be said, however, regarding crime problems.

One of the purported undesirable social consequences of rapid growth is high crime rates. For example this is one of the characterizations made by J. S. Gilmore in his description of the hypothetical energy boomtown of "Pistol Shot, U.S.A.".** He and others utilize not only as a measure of an undesirable social environment but as an indicator of a wide spectrum of social disruption and imbalances. However, experienced researchers have found it difficult to identify the causes and predictors of crime, particularly in regional and local jurisdictions. The implication is that it is not easy to discern the level of crime which would take place in an area undergoing "normal" growth and development and much less one in which "abnormal" growth is disrupting the social structure and giving rise to higher than "normal" crime rates.

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*See statement by A. Carrasco, op. cit.

**Gilmore [1976].

The critical variables for predicting crime rates identified by researchers are factors measuring urbanization, such as total population and its density, the age distribution of the population (male teenagers and youths commit the majority of crimes), the distribution of income (unequal distribution, and greater levels of income seem to be associated with higher crime rates) and the capabilities of enforcement authorities; more efficient police and more certain and severe sentencing appears to reduce crime. However, these variables are difficult to measure and to forecast; furthermore, the WIPP project is unlikely to change these variables in great magnitude.

In addition to these reservations, the University of Wyoming study of 36 towns in Western states, including the high growth, presumably energy impacted city of Rock Springs, Wyoming, failed to associate high crime with rapid economic development.* As a part of this study,** crime data were analyzed for the simultaneous effects of population size, population growth, number of law enforcement personnel, per capita income and the percentage growth of per capita income. While the results were weak, the study did suggest a positive correlation between auto theft, large and small larceny, burglary and murder and the growth of population; population growth had no discernable effect on negligent manslaughter, rape, robbery and assault. The Wyoming study also found some correlation between higher income per capita and rates of murder and large larcenies, but per capita income was not associated with other crime categories.

In summary, some potential exists for WIPP-related increases in crime rates. The present state of the arts is not sufficiently well developed, however, to permit the development of defensible estimates for such increases.

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*Brookshire and d'Arge [1979].

**See, Resource Economics Program, University of New Mexico [1981].

Another potential cause for socio-cultural effects which warrants attention here is "local inflation" -- inflation at rates higher than "normal" inflation rates. The prime potential cause for local inflation is that in-migrant workers must be attracted to the WIPP site. Unless large pools of unemployed workers exist, wages must be higher than the prevailing ones in order to attract construction workers and miners. Two results occur. First, these workers have more income to spend and, second, in-migration increases the local population without increasing associated services and other locally supplied goods and services. Consequently, demand would exceed supply and prices would be expected to rise. Because the construction project is short-lived, establishments providing goods and services do not grow as rapidly. The resulting excess demand creates strains when supply is not responsive. The most apparent result is increased prices.

The standard measures for inflation are the Consumer Price Index and the Producers Price Index which are designed to measure changes in prices nationwide. Unfortunately, price indices for small areas are not available. A number of efforts were made in this study to develop price indices for areas in the State which have experienced periods of construction activity similar to that which would be associated with the WIPP (Farmington and Gallup); these efforts were unsuccessful, however.

While we were unable to derive defensible estimates for local inflation which might attend the WIPP, existing data (however sparse) suggest the possibility of such effects. Price data concerning two rapidly growing energy production counties and two control counties, developed at the University of Wyoming, are given in Tables X.1 and X.2. There are three comparisons of interest from these tables. First, consider the absolute differences in

TABLE X.1 COMPARISON OF RELATIVE INDICES FOR SELECTED COMMODITY PRICES IN TEST AND CONTROL COUNTIES, 1976

Description	Prices by County			
	McLean	Wheatland	Platte	Kimball
Supermarket Items	102.8	103.1	97.1	97.0
Apparel	95.9	109.6	100.5	94,0
Personal Hygiene Items	96.4	113.2	93.3	97.0
Liquor	105.6	94.6	97.9	101.9
Restaurant Meals	85.2	93.7	123.7	97.4
All Goods	96.8	105.6	101.5	96.0
New Housing Cost (sq. ft.)	113.8	91.1	94.3	100.8

Source: Socioeconomic Longitudinal Monitoring Project: Final Report, Vol. 1 Summary [Table 5-7, p. 66].

TABLE X.2 COMPARISON OF RELATIVE INDICES FOR SELECTED COMMODITY PRICES IN TEST AND CONTROL COUNTIES, 1977

Description	Prices by County			
	McLean	Wheatland	Platte	Kimball
Supermarket Items	100.7	99.5	106.2	93.6
Apparel	96.4	98.5	109.9	95.2
Personal Hygiene Items	113.1	101.8	96.4	88.7
Liquor	92.4	103.3	99.7	104.6
Restaurant Meals	86.9	96.2	118.1	98.8
All Goods	97.0	99.6	106.9	96.4
New Housing Cost (sq. ft.)	97.4	86.9	125.8	89.9

Source: Socioeconomic Longitudinal Monitoring Project: Final Report, Vol. 1 Summary [Table 5-8, p. 66].

1976 or 1977 prices in the boom counties (dominated by construction of strip mines and minemouth electrical power plants), McLean and Platte Counties, and the control counties, Wheatland and Kimball Counties. Second, consider the increase in prices in each county from 1976 (Table X.1) to 1977 (Table X.2). Finally, consider the relative change in prices from 1976 to 1977 among the four counties.

At first, it is difficult to discern any clear trends from these data. Part of this difficulty is caused by the fact that few commodities were used to compute the cost indices and that an overall price index (which would include rental and owner occupied housing) was not calculated. The data suggest that Platte County (one of the boom areas) has higher prices relative to the control counties and that from 1976 to 1977, prices in Wheatland (a control county) fell while prices remained roughly constant in Kimball County. Prices increased between 1976 to 1977 in Platte County (a high growth area) and remained roughly constant in McLean County (a control county). Unfortunately the only "conclusion" which can be drawn from these data is that the boom county of Platte displayed a higher absolute price level and a higher relative increase in prices compared to the other three counties.

In terms of the effects of interest here, the relevant issue is that if local inflation attends the construction of the WIPP, who is most likely to be adversely affected? It is unlikely that it would be in-migrating workers inasmuch as their wages must be sufficiently high to induce them to relocate to the two-county area. This implies that their wages will increase at the rate of local inflation or at a more rapid rate. Consequently, the local population would bear the inflationary impact. However, most local businessmen will be able to increase their prices and, at least, stay even with inflation; property owners would expect to see the market value of their property increase along with local inflation. As suggested above, the result is that inflation most adversely affects those who are poor and those on fixed incomes which fall in purchasing power as inflation rises.

The most conspicuous of this group are those receiving welfare and unemployment payments and those who are retired. If local inflation could be estimated, one could measure the social cost of inflation on these groups by computing the increased levels of compensation which would be necessary to maintain their standard of living. This would entail multiplying the number of families or individuals receiving fixed incomes times their income in a base year times the local rate of inflation.

Our inability to forecast local inflation notwithstanding, existing data suffice to suggest that inflationary effects may very well attend WIPP construction and the above data demonstrate that such effects may not be trivial.

D. Summary.

We have attempted here to provide an overview of some of the social and economic effects which could become real issues in Eddy and Lea Counties during the construction phase of the WIPP. While these "effects" are not amenable to realistic dollar measures at this point in time, their description serves to identify potential areas of conflicts and distortions which may face local and State planners in the future. Based on these observations, it is recommended here that the State investigate ways by which federal relief can be arranged in anticipation of costs associated with the types of impacts identified in this chapter. Thus, while such costs cannot be quantified at this point in time, it has been shown here that good reasons exist for anticipating such things as, first, stress on local health facilities, particularly those which serve low income families in the two county area; second, inflation-related costs to low income families and State/local agencies responsible for general welfare of New Mexico citizens; and third, the potential need for expanded public safety facilities. Given short lead times in terms of the recognition of the growing importance of these types of impacts, in conjunction with the lengthy prices often involved in arranging for some form of federal relief, the desirability of establishing mechanisms for such relief early-on is obvious. In arranging such mechanisms, the State may pursue any of several means for stating their case to the Federal government, two obvious examples for which include appeals to the State's congressional delegation and/or the State Planning Council for Radioactive Waste Management.

10.12

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