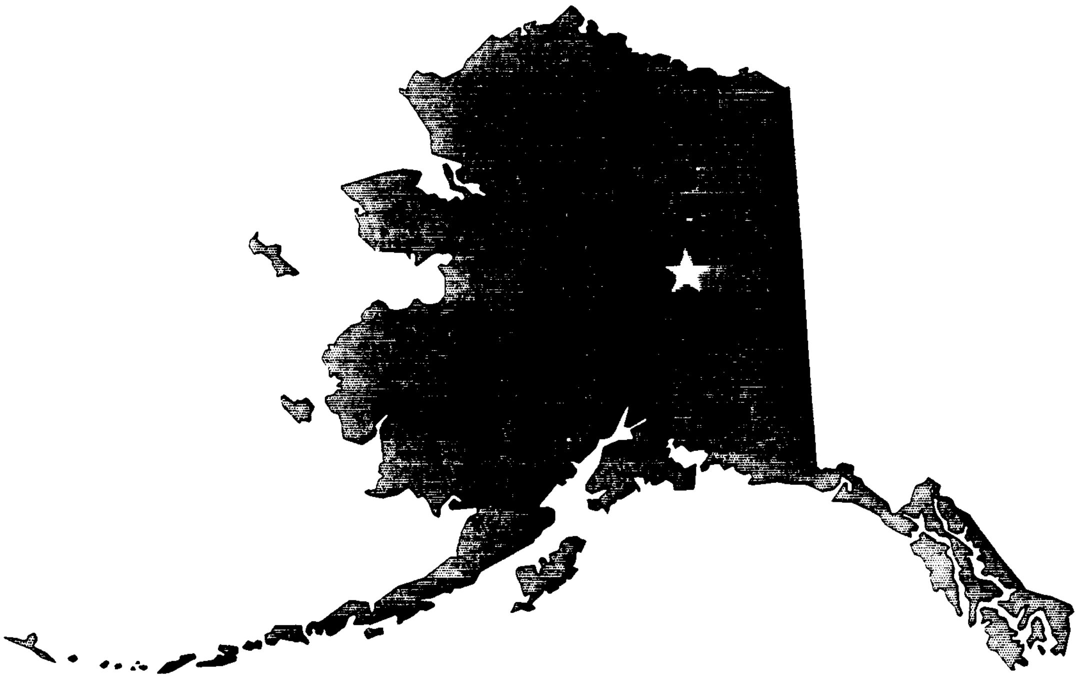
OFR 12-89

TECHNICAL APPENDICES

THE POTENTIAL SUPPLY OF MINERALS
from
THE WHITE MOUNTAINS NATIONAL RECREATION AREA
and
THE STEESE NATIONAL CONSERVATION AREA
in
ALASKA



BUREAU OF MINES

U.S. DEPARTMENT OF THE INTERIOR

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APPENDIX A -- POTENTIAL MINERAL SUPPLY ANALYSIS METHODOLOGY

The development of the potential supply analytic system has advanced to the point that quantitative estimates of economically recoverable resources can be made as the final step of the traditional regional mineral resource assessment process. In 1983, the BOM and the ADGGS jointly developed a methodology to quantitatively assess the potential for undiscovered yet economically recoverable minerals within a designated geographic area. This methodology was first applied in the assessment of the undiscovered mineral potential of the Kantishna Hills, Alaska (White et al., 1987). At that time the assessment procedure combined a series of technical judgements regarding the major geologic, engineering and economic factors that influenced the occurrence and exploitation of mineral resources in the Kantishna Hills area. Since then the methodology has been further developed and enhanced, particularly with respect to the engineering and economic analysis components. The resulting Potential Supply Analysis System (PSAS) was recently used to evaluate the economic potential of selected types of undiscovered precious-metal deposits in the Tonopah quadrangle of Nevada (Gunther, et al., 1988) and, with some enhancements, has been used to estimate the economic value of the undiscovered mineral potential of the WMNRA/SNCA study area.

The PSAS has been designed to address five basic questions about the mineral potential of an area:

1) What alternative states of geologic nature are possible in the area of interest (e.g. How many and what types of undiscovered deposits could be present and what might be their grade, tonnage and depth attributes?)?;

2) Given uncertainty regarding the true state of geologic nature, what quantities of economically recoverable minerals could be contained in the region's mineral endowment?;

3) How many and what types of mining and milling operations might occur under alternative economic and policy conditions?;

4) How would alternative levels of mining activity affect selected local economies of the region?; and

5) What is the expected economic value of the mining activity which might occur in the area?

The PSAS draws on much of the available mineral-related data for the region being evaluated. In so doing, it synthesizes the assorted technical data and information from maps and studies which, by themselves, tell only part of the story, and are often difficult for the non-scientist to interpret. The major results of a potential supply analysis include probabilistic estimates of the quantities and values of commodities which might be produced from the undiscovered deposits in an area, assuming that they will be discovered. The application of the analytical components of the PSAS to the WMNRA/SNCA study area is discussed below.

Overview

An overview of the PSAS is presented in Figure A-1. The conceptual framework of the System is multidisciplinary and consists of four major components: 1) a geologic analysis component which identifies the significant deposit types, or mineral terranes, present in an area of interest and produces probabilistic estimates of their associated mineral resource characteristics; 2) an engineering analysis component which yields the appropriate mine/mill methods, associated mineral recovery

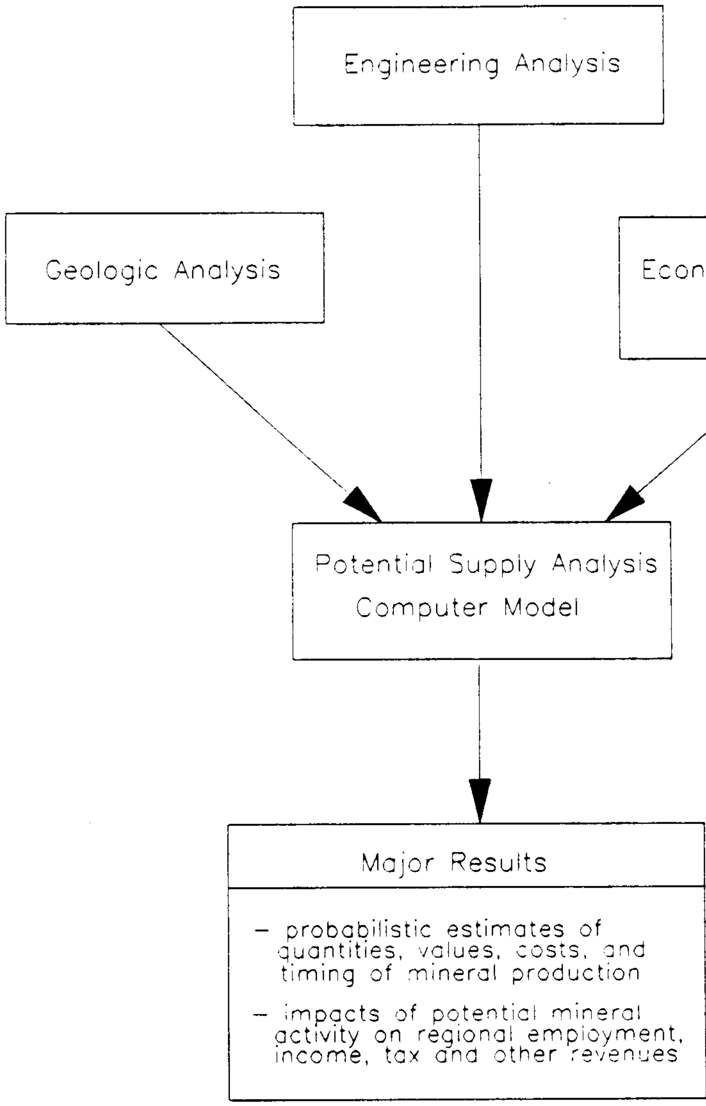


Figure A-1. The Potential Supply Analysis System factors, and development and production cost estimates; 3) a set of economic and policy analysis assumptions and alternative metal price scenarios which describe the business and economic environments within which future mineral-related activities are assumed to occur; and 4) a Potential Supply Analysis Computer Model which integrates the products of the first three analytical components to statistically estimate the quantities and values of the undiscovered but potentially recoverable mineral resources which may exist within an area. The model expresses the uncertainty associated with the geologic and economic results in the form of probability distributions.

Geologic Analysis Component. The geologic analysis component of the WMNRA/SNCA assessment is depicted in figure A-2. The primary objectives of the geologic analysis were to identify those lands within the study area which are geologically favorable for specific types of undiscovered mineral deposits and to provide probabilistic estimates of their associated mineral resource characteristics. The results of USGS field work in the WMNRA, BOM field work on the placer potential in both the WMNRA and the SNCA, and field work done by the ADGGS in the Lime Peak-Mt. Prindle areas which overlap the boundary between the WMNRA and the SNCA[1] provided important contributions to this analysis.

Based on their review and interpretation of compiled data, geologists identified eight major types of mineral deposits which could be present in the remaining endowment[2] of the study area: alkalic-associated gold

[1]For additional information see Administrative Report on the Mineral Resource Assessment for Part of the WMNRA Alaska, USGS, 1987 and Mineral Assessment of the Lime Peak-Mt. Prindle Area, Alaska, State of Alaska, Department of Natural Resources, Division of Geological and Geophysical Surveys, Volume I, September, 1987.

[2]Endowment is defined as the sum of the physical quantities of each mineral contained in undiscovered deposits of specified types subject to limits on grade, tonnage, and depth.

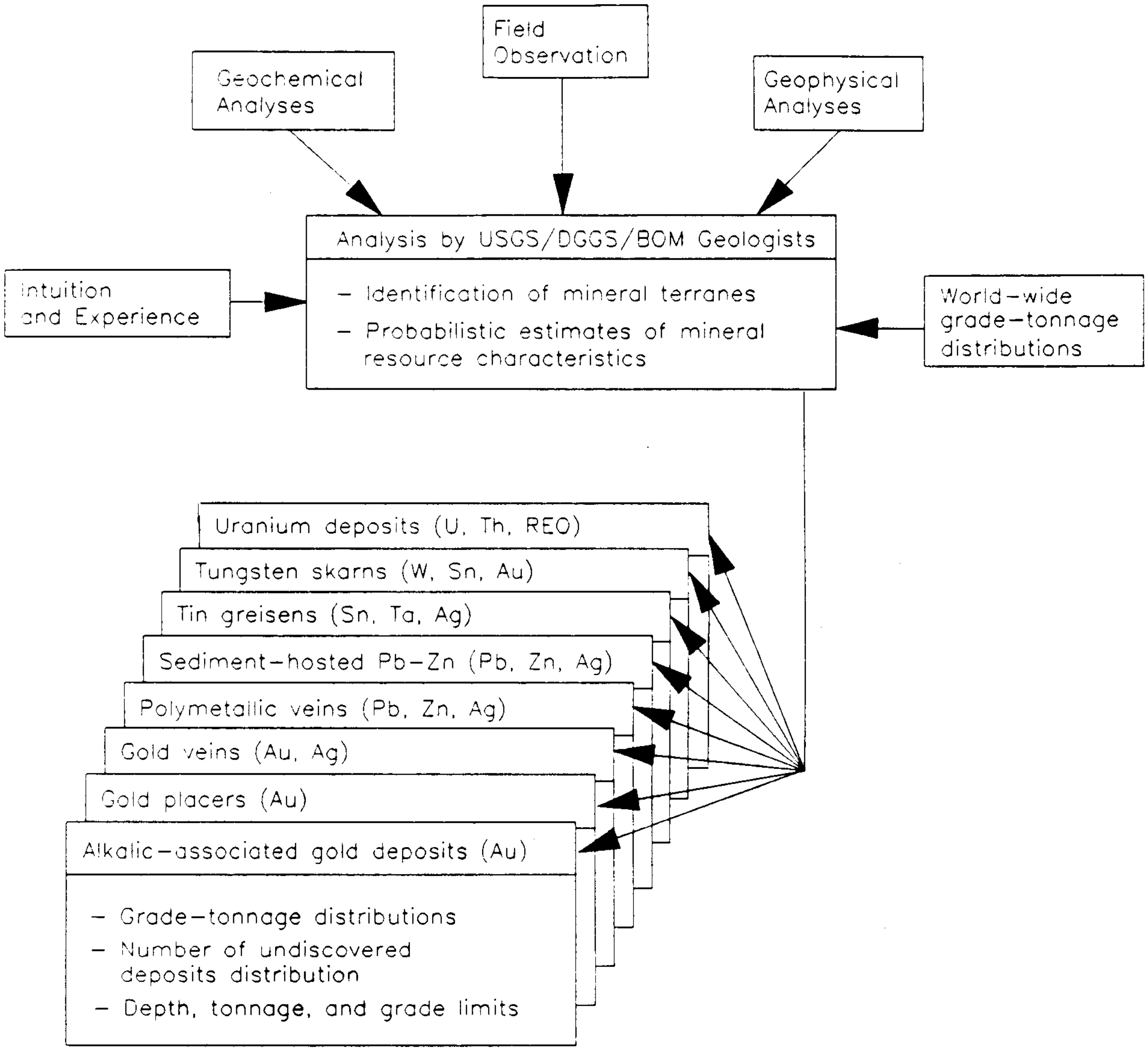


Figure A-2. The Geologic Analysis Component of the WMNRA/SNCA Potential Supply Analysis deposits, gold placers, gold veins, polymetallic veins, sediment-hosted lead-zinc deposits, tin greisens, tungsten skarns and uranium deposits. These types of deposits typically contain varying amounts of gold (Au), lead (Pb), rare earth oxides (REO), silver (Ag), tantalum (Ta), thorium (Th), tin (Sn), tungsten (W), uranium (U_3O_8) and zinc (Zn). Assessment teams[3] developed probabilistic estimates of the resource characteristics associated with each of the eight deposit types by selecting or statistically estimating an appropriate grade-tonnage deposit model, by assessing the number of undiscovered deposits that could exist in the area, and by establishing maximum depth, tonnage and grade limits. These data were used to probabilistically estimate the mineral endowment of the study area and provided the basic geologic inputs to the Potential Supply Analysis System. Appendix B contains the quantitative mineral resource characteristics assessed during this phase of the study.

Engineering Analysis. The engineering analysis component of the PSAS is depicted in figure A-3. The primary objectives of the engineering analysis were to identify specific mine-mill configurations which would be appropriate to the development and recovery of metals from each of the prospective deposit types; specify the conditions under which each of the configurations would be utilized; establish the metal recoveries that could be achieved; and provide estimates of associated development, production, transportation, infrastructure and post-mill processing costs appropriate to a central Alaska setting. The analysis was based on

[3]Geologic assessment teams included R.B. McCammon, T.D. Light and C.D. Rinehart of the USGS; G. Pessel, L. Burns, and T. Smith of the Alaska Division of Geological and Geophysical Surveys and R. Newberry of the U. of Ak.; and S. Fechner and M. Balin of the U. S. Bureau of Mines.

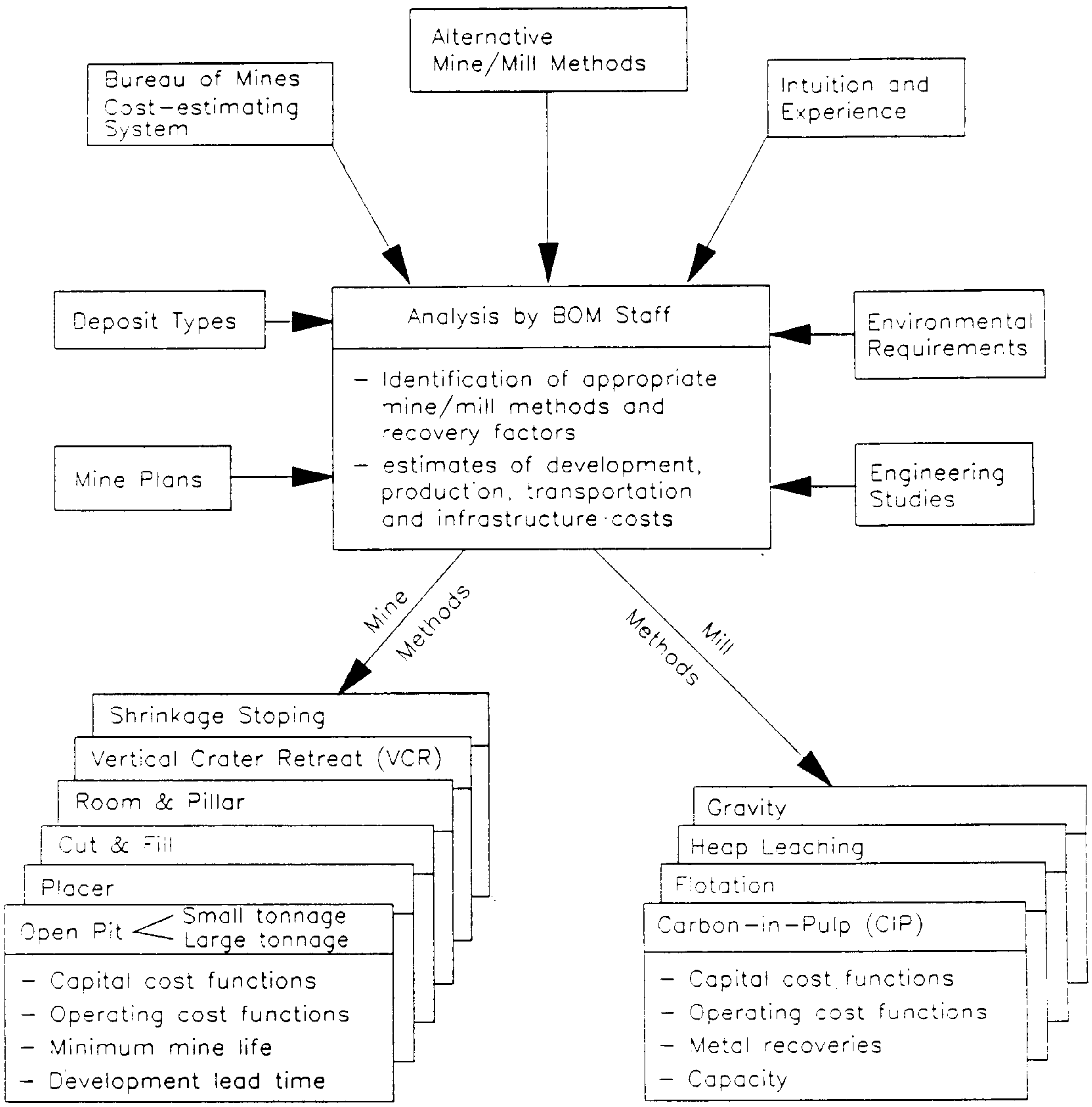


Figure A-3. The Engineering Analysis Component of the WMNRA/SNCA Potential Supply Analysis information concerning the eight prospective types of deposits which were identified during the geologic analysis, and engineering and cost data for alternative mining and milling methods that might be appropriate to the development and production of these types of deposits in Alaska.

Based on their review and evaluation of the geologic characteristics of the assessed deposit types and the compiled engineering data, BOM staff[4] selected seven mining methods and four general milling (beneficiation) methods that could be used to develop deposits of the type predicted to exist in the study area. The seven mine methods included small tonnage open-pit, large tonnage open-pit, room-and-pillar, cut-and-fill, shrinkage stoping, vertical crater retreat (VCR), and placer; the four general mill (beneficiation) methods were carbon-in-pulp (CIP) processing, flotation, heap leaching, and gravity. Individual mill models were constructed based on one or more of these techniques.

Table A-1 shows the specific mine-mill configurations assigned to each deposit type. Operating and capital cost functions were developed for each mine and mill method using the BOM Cost Estimating System, or CES (Bureau of Mines, 1987). Three infrastructure cost models were also developed to enable the major additional infrastructure costs which would be associated with various types and sizes of mining operations in central Alaska to be taken into account. The resultant sets of cost functions provided the means for estimating development, production and infrastructure costs which reflect the tonnage, grade and depth characteristics of the deposits which could exist in the WMNRA/SNCA study area. Appendix C provides a detailed description of the cost models which were developed during this phase of the study.

[4]The engineering analysis was performed by B. Gosling, T. Camm, N. Wetzel and S. Stebbins of the Western Field Operations Center.

Table A-1. Deposit Types and Associated Mine and Mill Methods

Deposit type	Recovered commodities	Mine methods	Mill methods
Alkalic-associated gold	Au	Open-pit VCR	Heap leaching CIP processing
Gold placer	Au	Placer	Placer
Gold vein	Au, Ag	Open-pit Cut-and-fill VCR	Heap leaching CIP processing
Polymetallic vein	Pb, Zn, Ag	Open-pit Cut-and-fill	Polymetallic flotation
Sediment-hosted Pb-Zn	Pb, Zn, Ag	Open-pit Room-and-pillar	Pb-Zn flotation
Tin greisen	Sn, Ta, Ag	Open-pit Cut-and-fill VCR	Sn flotation/ gravity
Tungsten skarn	W, Au	Open-pit Shrinkage stope VCR	W flotation W gravity
Uranium	U, REO	Open-pit VCR	REO flotation

Economic Analysis Assumptions and Mineral Price Scenarios. The third set of inputs to the Potential Supply Analysis System consisted of a set of economic analysis assumptions and two metal price scenarios. Table A-2 lists the economic and policy assumptions used for the analysis. Any of the assumptions can be changed in order to test the sensitivity of the assessment results to different metal prices, for example, or to changes in the assumed cost structure. An important assumption in the present analysis is that all deposits in the mineral endowment are discovered. In reality, some of the undiscovered deposits remaining in the endowment may not be discovered for many years into the future and some perhaps never. The results of the potential supply analysis, therefore, reflect the maximum mineral production that would be expected to occur from the study area, given what the geologists presently know about the geology of the area and given the particular development cost and metal price assumptions utilized.

Two price scenarios (table A-3) were employed to show the influence that an increase in contained metal prices could have on the potential supply of minerals from yet-to-be discovered deposits in the study area. The current metal price scenario was based on 1987 average annual market prices for the nine metals which could be produced from the specific types of deposits predicted to exist within the study area. The high price scenario consisted of prices equal to two times the 1987 average annual market price for each metal. Prices for most of the metals included in the analysis have been this high, or higher, during the past ten years.

The Potential Supply Analysis Computer Model. The results of the geologic and engineering analyses, the economic and policy analysis assumptions,

Table A-2. Economic and Policy Analysis Assumptions

Exploration, Development and Production Assumptions:

-- All deposits are known to exist in year 1

-- Regional exploration costs = $0.0

-- Operating unit consists of a mine and a mill plus infrastructure

-- Lead-time to production is 2-6 years

-- Capital costs expensed equally over their respective mine, mill, or infrastructure construction period

-- Deposits are fully produced at a constant rate over the life of the mine

-- Constant costs and prices

-- Required rate of return = 15%

Development Decision Criteria: Net Present Value of deposit > 0.0

Activity Area Boundaries:

-- As designated in BLM Resource Management Plans for the White Mountains National Recreation Area and the Steese National Conservation Area

Mineral Price Scenarios:

-- 1987 average annual metal market prices will prevail

-- Prices equal to two times the 1987 average annual metal market prices will prevail

Environmental Requirements:

-- Mine/mill technologies conform to current environmental laws and regulations

-- Any site specific environmental requirements can be complied with at no significant additional cost

Table A-3. Metal Price Scenarios

Commodity	Current Price Scenario (1987 Average Annual Prices)	High Price Scenario (Two times 1987 Prices)
Gold ($/oz)	$444.00	$888.00
Lead ($/lb)	0.36	0.72
REO ($/lb)	1.00	2.00
Silver ($/oz)	7.20	14.40
Tantalum ($/lb)	22.00	44.00
Tin ($/lb)	4.18	8.36
Tungsten ($/lb)	2.87	5.74
Uranium ($/lb)	16.55	33.10
Zinc ($/lb)	0.42	0.84

and the price scenarios outlined above provide the basic inputs to the Potential Supply Analysis Computer Model (PSACM). The model incorporates a statistical procedure, called a Monte Carlo simulation, which combines the geologic, engineering, and economic factors to produce probabilistic estimates of the potentially recoverable resources in the WMNRA/SNCA study area.

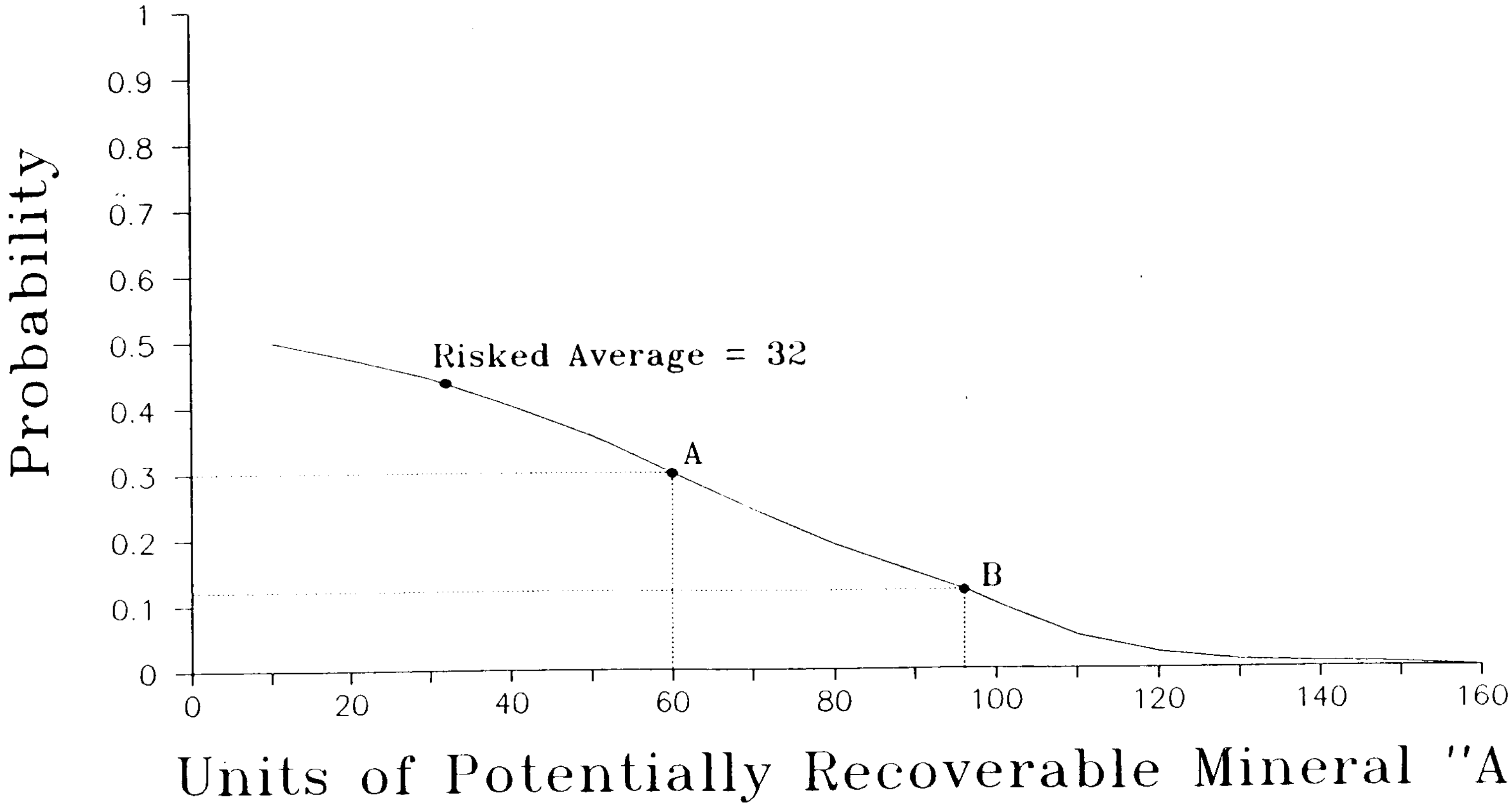
In overview, the PSACM first simulates one possible state of geologic nature by establishing a number of undiscovered deposits and their associated tonnage, grade and depth attributes. This is done by sampling from the mineral resource probability distributions for each of the eight deposit types. The resulting grade and tonnage assignments for each of the undiscovered deposits in the simulated state of nature are used to compute associated amounts of ore and contained metals (e.g. the mineral endowment). The attributes of each undiscovered deposit are then evaluated from an engineering and economic perspective to determine whether they could support profitable development and production, assuming that the deposit was discovered. A mine life is calculated based on the deposit size, and the net present value of an appropriately-sized mining operation is determined. The mine-mill configuration is based on the simulated deposit's depth, size and minerology. For those deposits at depths where either a surface or an underground operation would be technically feasible, the lower cost mining method is applied. The quantities of recoverable metals are a function of the beneficiation method. If the computed net present value is greater than or equal to zero at an assumed 15% discount rate, the deposit is considered to be potentially economic. This evaluation process continues until the economic feasibility of each undiscovered deposit has been evaluated.

This process of simulating and evaluating a possible geologic state of nature is called a 'pass' and is repeated many times. The results of each pass are saved, aggregated, and used to build probability distributions which describe the potential quantities and economic value of metals which might be produced from the study area as well as the various types of mining activity which might occur. Additional information concerning the structure and execution of the PSACM is provided in Appendix D.

Presentation of Results

The probabilistic results of the potential supply analysis are presented both in tables and graphically. In some cases, when shown graphically the exceedance chance is plotted against the range of potentially recoverable metal quantities or values. When shown tabularly, the exceedance chance is generally presented at the 95th, 50th and 5th fractile values. The exceedance chance is the chance that the quantity or value of a particular metal produced will be equal to or greater than the amount shown. This concept is illustrated in figure A-4. In this hypothetical example, the graph presented is a fully risked probability curve. That is, it reflects the possibility that there might not be any undiscovered deposits in the area which contain metal A, as well as the possibility that some or all of the undiscovered deposits which do contain metal A might not be economic to produce, assuming that they were discovered. As is shown, these probability curves are typically highly skewed toward the low probability, high resource values. This indicates that while no or only small quantities of a particular metal are likely to be economically recoverable from an area, there usually does remain some chance for relatively large quantities of the metal to exist and be

Figure A-4. An Example of a Risked Probability Curve



produced. The chance for production will increase as the market price for the contained metal increases.

Although the probability curve format is not easy to comprehend, it is essential for portraying the uncertainties and risks inherent in a potential supply analysis. In figure A-4, the exceedance chance is presented on the vertical axis and ranges from 0.0, or no chance, to 1.0, or 100 percent chance. The quantity of metal A produced is presented on the horizontal axis and ranges from a minimum of 10 units to a maximum of 160 units. (Ten units or fewer are considered here to be insignificant values and are treated as zero.) The curve represents the set of possible production quantities, ordered from smallest to largest and shows the uncertainty in the range of quantities of metal A which might be produced, given what the geologists know about the geology of the assessed area and given an assumed cost and price structure.

In this example, there is only a 0.5 chance that the area contains producible amounts of metal A. In other words, if there were 100 geologically favorable areas like the one represented in this example, only 50 (50 percent) would have producible quantities of metal A in the range from 10 to 160 units, and if all 100 areas were fully explored, the average amount of metal A produced would be 32 units. This is the arithmetic mean of the 50 zeros and the 50 values from the 10 to 160 unit range.

To interpret a particular point on the curve, such as point A, the exceedance chance is read from the vertical axis and the associated minimum quantity produced is read from the horizontal axis. Thus, point A on the curve indicates that there is a 0.30 chance (30 percent chance) of the area containing more than 60 producible units of metal A. Similarly, point B on the curve indicates that there is a 0.12 chance (12 percent chance) of the area containing more than 96 producible units of metal A.

Because of statistical considerations, aggregation of the results for several deposit types into a composite potential supply appraisal is not intuitive. For instance, and as the tabular results will confirm, averages may be added, but this is not true for estimates at the 95th, the 5th and other fractile levels. Summation of several probability curves is possible, but only by the use of appropriate statistical methods. The potential supply estimates presented later in this report will refer either to the individual deposit types assessed and the specific metals which they can contain, or to those lands which are open or closed to mineral access within the WMNRA/SNCA study area, or to the study area as a whole. In the latter two cases, the associated aggregate or composite results were developed as part of the Monte Carlo process described above.

APPENDIX B -- MINERAL RESOURCE CHARACTERISTICS OF THE MAJOR TYPES OF UNDISCOVERED DEPOSITS IN THE WMNRA/SNCA STUDY AREA

A quantitative mineral assessment was performed in order to provide the geologic data required as input to the potential supply analysis of the White Mountains National Recreation Area (WMNRA) and the Steese National Conservation Area (SNCA). The appraisal efforts were focused on those parts of the WMNRA and the SNCA which are currently classified as primitive or semi-primitive and are, therefore, largely unavailable for mineral exploration and development. The area studied was approximately 1.24 million acres and included all of the WMNRA and the western part of the North SNCA (fig. B-1).

Probabilistic estimates of the mineral resource characteristics associated with the significant mineral terranes in the WMNRA/SNCA study area were provided by geologists from the U.S. Geological Survey (USGS), and from the Bureau of Mines (BOM) and the Alaska Division of Geological and Geophysical Surveys (ADGGS). The estimates were based on the results of on-the-ground field programs performed for the study and previosly, and which included detailed geologic mapping, geochemical and geophysical studies, and examinations of known mineral occurrences. The resource characteristics are statistically combined with appropriate mine, mill and infrastructure cost models to quantitatively estimate the potential supply of minerals from the assessed mineral terranes under various economic conditions.

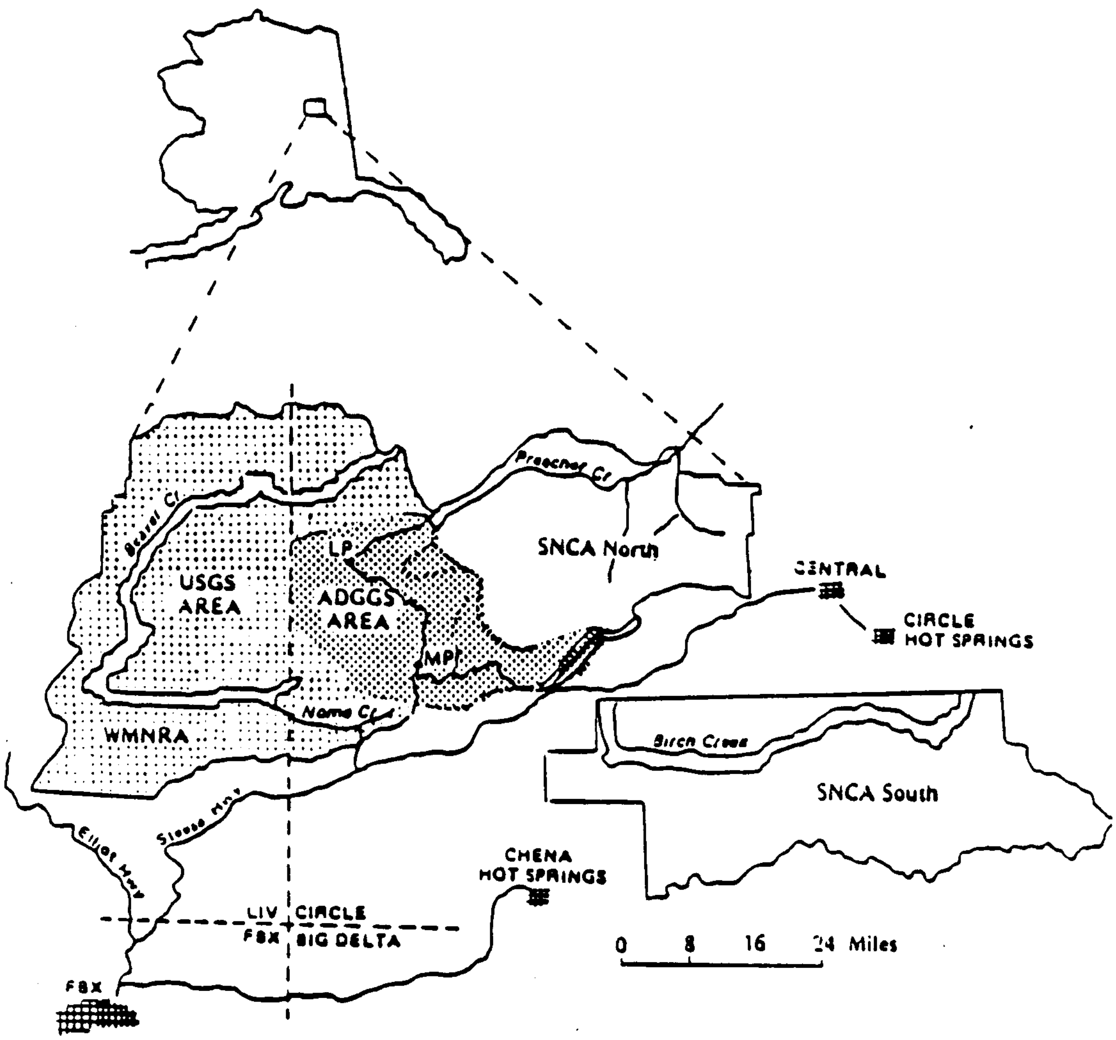


Figure B-1. Location of appraisal areas in west-central Circle Quadrangle (ADGGS) amd east-central Livengood Quadrangle (USGS). Area of study includes the White Mountains National Recreation Area (WMNRA) and the western part of the Steese National Conservation Area (SNCA-North).
Source: Smith, T.E. et al., 1987.

USGS Mineral Resource Assessment for Part of the White Mountains National Recreation Area

The USGS assessed the mineral potential for approximately three-fourths or about 860 sq mi of the WMNRA (fig. B-1). The study area included all of the WMNRA that lies within the Livengood Quadrangle, and the northern- and southernmost parts of the WMNRA which are located in the Circle Quadrangle. The assessment of the remaining one-fourth of the WMNRA was carried out by the ADGGS. The BOM assessed the potential for gold placer deposits throughout the study area.

The assessment methodology used by the USGS is described by Drew and others (1986). Based on the results of an accelerated program of field mapping, geochemical and geophysical surveying, and mineral resource investigations[1] conducted during 1986 and 1987, the following seven major types of deposits were predicted to exist in the USGS study area (fig. B-2):

(1) tin greisens (TRACT I),

(2) uranium/thorium rare-earth element deposits (TRACT II),

(3) tungsten skarn deposits (TRACT III),

(4) polymetallic vein deposits (TRACTS VA and VB),

(5) lode gold deposits (TRACT VI),

(6) placer gold deposits (TRACT VII), and

(7) sedimentary exhalative zinc-lead deposits (TRACT VIII).

The resource characteristics which USGS geologists expect to be associated

[1] see Administrative Report on the Mineral Resource Assessment for Part of the White Mountains National Recreation Area Alaska. U.S. Geological Survey. 1987, 130 pp.

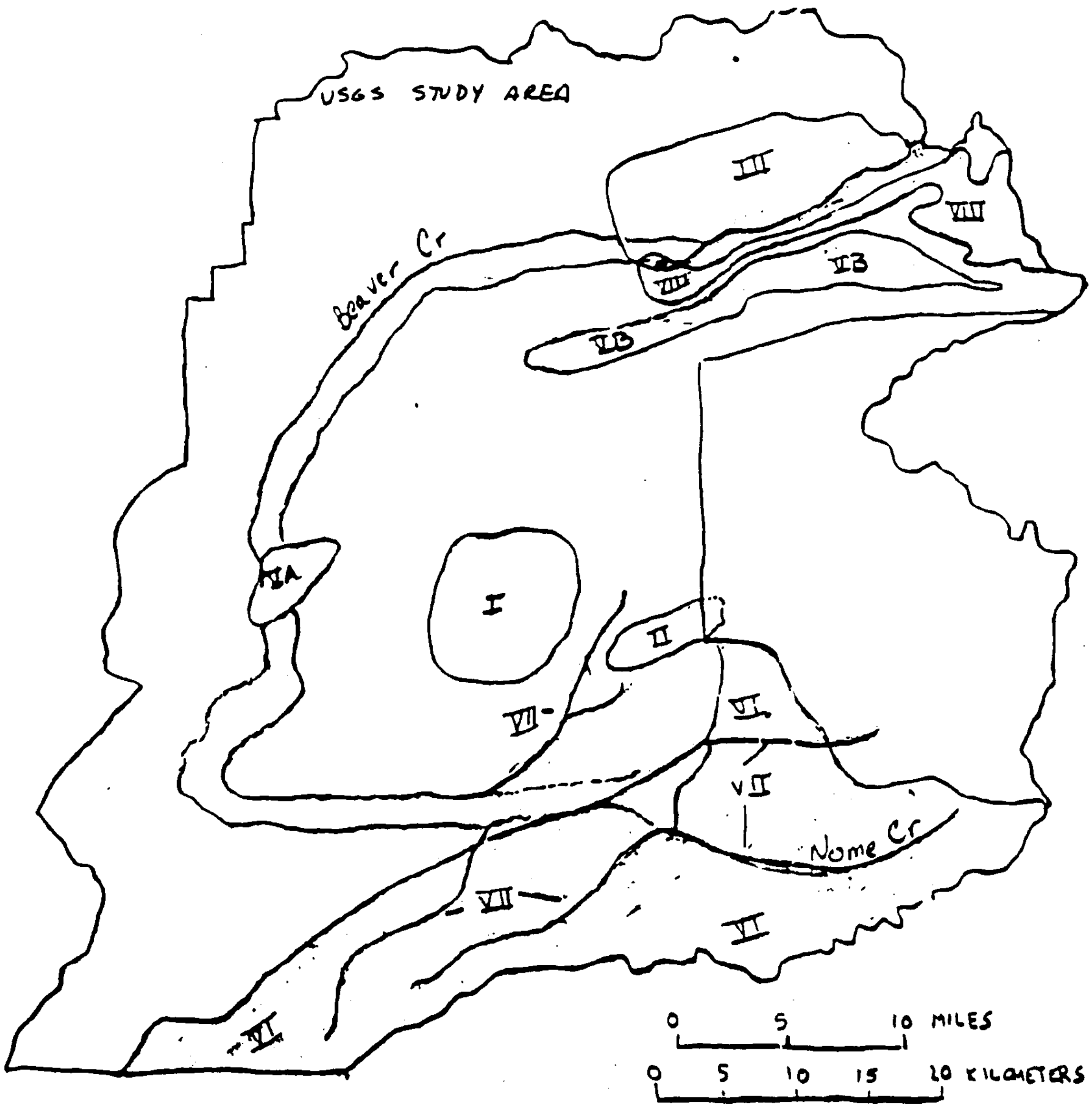


Figure B–2. Map Showing Location of Mineral Terranes in the WMNRA Assessed by the US Geological Survey with each of these deposit types are presented in Tables B-1a through B-1g. Each table specifies the location of the favorable area, the deposit probabilities, and the deposit size, depth, and grade characteristics for one of the deposit types. For most of the deposit types the probability that one or more undiscovered deposits exist is small due primarily to the overall lack of evidence of mineralization in the exposed rocks and the degree of weathering that has occurred. Estimates of the existence and of the number of undiscovered deposits might be different if more were known about the subsurface. The deposit characteristics appropriate to each deposit type were determined using the concept of geologic deposit models.[2] Most of the deposit models are based on similar models found in U.S. Geological Survey Bulletin 1693 (Cox and Singer, 1986).

The estimates shown in Tables B-1 were used to probabilistically estimate both the physical quantities of in-place mineral resources (e.g. the mineral endowment) and the physical quantities of economically recoverable resources (e.g. the potential mineral supply) contained in the associated mineral terranes.

[2] A geologic deposit model is defined as the set of attributes common to a particular class of mineral deposit.

Table B-1a. Tin Greisen Resource Characteristics - USGS

I. Favorable Area

TRACT I - Cache Mountain pluton

II. Deposit Probabilities

Probability at least one undiscovered deposit exists: .10

	Given existence of undiscovered deposits, probability that the number equals or exceeds the given number		
	.9	.5	.1
Number of undiscovered deposits	1	1	1

III. Deposit Characteristics

A. Deposit Size

Unit of measure: metric tons
Deposit size distribution form: Lognormal*
Distribution average: 13.08896
Standard deviation: 1.653285
Maximum tonnage: 7.7 million tons

B. Deposit Depth

Unit of measure: meters
Deposit depth distribution form: Uniform
Maximum depth: 1000 meters

C. Contained Metals

Tin (Sn):
Probability Sn is present: 1.0
Unit of measure: pct
Grade distribution form: Lognormal
Distribution average: -6.2146
Standard deviation: 0.77949
Correlation with size: -0.17137
Maximum grade: .6 pct

* When distributions are of the form "Lognormal," parameters given are for the normal distribution derived from the original data. Parameters for the original distribution (average, mode, median, standard deviation, etc.) may be derived using appropriate formula.

Table B-1b. Thorium/Rare Earth Oxide Resource Characteristics - USGS

I. Favorable Area

TRACT II - Roy Creek syenite

II. Deposit Probabilities

Probability at least one undiscovered deposit exists: 0.10

	Given existence of undiscovered deposits, probability that the number equals or exceeds the given number		
	.9	.5	.1
Number of undiscovered deposits	1	1	1

III. Deposit Characteristics

A. Deposit Size

Unit of measure: metric tons
Deposit size distribution form: Lognormal
Distribution average: 15.54893
Standard deviation: 1.297286
Maximum tonnage: 44.3 million tons

B. Deposit Depth

Unit of measure: meters
Deposit depth distribution form: Uniform
Maximum depth: 1000 meters

C. Contained Metals

Thorium (ThO_2):
Probability ThO_2 is present: 1.0
Unit of measure: pct
Grade distribution form: Lognormal
Distribution average: -5.52146
Standard deviation: 1.215203
Correlation with size: -0.35472
Maximum grade: 4.0 pct

Rare Earth Oxides (REO):
Probability REOs are present: 1.0
Unit of measure: pct
Grade distribution form: Lognormal
Distribution average: -5.29831
Standard deviation: 0.821028
Correlation with size: -0.49514
Maximum grade: 2.0 pct

Table B-1c. Tungsten Skarn Resource Characteristics - USGS

I. Favorable Area

TRACT III - Area surrounding Victoria Mountain pluton

II. Deposit Probabilities

Probability at least one undiscovered deposit exists: 0.05

	Given existence of undiscovered deposits, probability that the number equals or exceeds the given number		
	.9	.5	.1
Number of undiscovered deposits	1	1	1

III. Deposit Characteristics

A. Deposit Size

Unit of measure: metric tons
Deposit size distribution form: Lognormal
Distribution average: 13.73104
Standard deviation: 1.834717
Maximum tonnage: 57 million tons

B. Deposit Depth

Unit of measure: meters
Deposit depth distribution form: Uniform
Maximum depth: 1000 meters

C. Contained Metals

Tungsten (WO_3):

Probability WO_3 is present: 1.0
Unit of measure: pct
Grade distribution form: Lognormal
Distribution average: -5.11599
Standard deviation: 0.628682
Correlation with size: -0.00684
Maximum grade: 1.7 pct

Table B-1d. Polymetallic Vein Resource Characteristics - USGS

I. Favorable Areas

TRACT VA - Delineated area in west-central part of WMNRA
TRACT VB - Delineated area in north-eastern part of WMNRA

II. Deposit Probabilities

Probability at least one undiscovered deposit exists: 0.50

	Given existence of undiscovered deposits, probability that the number equals or exceeds the given number		
	.9	.5	.1
Number of undiscovered deposits	1	1	2

III. Deposit Characteristics

A. Deposit Size
- Unit of measure: metric tons
- Deposit size distribution form: Lognormal
- Distribution average: 9.064869
- Standard deviation: 1.589224
- Maximum tonnage: 2.46 million tons

B. Deposit Depth
- Unit of measure: meters
- Deposit depth distribution form: Uniform
- Maximum depth: 1000 meters

C. Contained Metals
- Lead (Pb):
  - Probability Pb is present: 1.0
  - Unit of measure: pct
  - Grade distribution form: Lognormal
  - Distribution average: -2.56394
  - Standard deviation: 1.333506
  - Correlation with size: -0.31540
  - Maximum grade: 72.0 pct
- Zinc (Zn):
  - Probability Zn is present: 0.8
  - Unit of measure: pct
  - Grade distribution form: Lognormal
  - Distribution average: -4.26869
  - Standard deviation: 0.958364
  - Correlation with size: 0.456194
  - Maximum grade: 8.9 pct
- Silver (Ag):
  - Probability Ag is present: 0.99
  - Unit of measure: g/mt
  - Grade distribution form: Lognormal
  - Distribution average: -6.32800
  - Standard deviation: 1.195239
  - Correlation with size: -0.34015
  - Maximum grade: 25,500 g/mt

Table B-1e. Lode Gold Resource Characteristics - USGS

I. Favorable Area

TRACT VI - Delineated area in southcentral and southeastern part of WMNRA

II. Deposit Probabilities

Probability at least one undiscovered deposit exists: 0.10

	Given existence of undiscovered deposits, probability that the number equals or exceeds the given number		
	.9	.5	.1
Number of undiscovered deposits	1	1	2

III. Deposit Characteristics

A. Deposit Size

Unit of measure: metric tons
Deposit size distribution form: Lognormal
Distribution average: 9.798127
Standard deviation: 2.892991
Maximum tonnage: 1.68 million tons

B. Deposit Depth

Unit of measure: meters
Deposit depth distribution form: Uniform
Maximum depth: 1000 meters

C. Contained Metals

Gold (Au):

Probability Au is present: 1.0
Unit of measure: g/mt
Grade distribution form: Lognormal
Distribution average: -11.0429
Standard deviation: 0.820331
Correlation with size: -0.54417
Maximum grade: 150 g/mt

Table B-1f. Placer Gold Resource Characteristics - USGS

I. Favorable Area

TRACT VII - Delineated river drainages in southern part of WMNRA

II. Deposit Probabilities

Probability at least one undiscovered deposit exists: 0.50

	Given existence of undiscovered deposits, probability that the number equals or exceeds the given number		
	.9	.5	.1
Number of undiscovered deposits	1	2	3

III. Deposit Characteristics

A. Deposit Size

Unit of measure: metric tons
Deposit size distribution form: Lognormal
Distribution average: 10.95080
Standard deviation: 1.589224
Maximum tonnage: 1.8 million tons

B. Deposit Depth

Not assessed

C. Contained Metals

Gold (Au):

Probability Au is present: 1.0
Unit of measure: g/mt
Grade distribution form: Lognormal
Distribution average: -13.8800
Standard deviation: 1.627333
Correlation with size: -0.62442
Maximum grade: 16 g/mt

Table B-1g. Sedimentary Exhalative Resource Characteristics - USGS

I. Favorable Area

TRACT VIII - Delineated area in northeasternmost part of WMNRA

II. Deposit Probabilities

Probability at least one undiscovered deposit exists: 0.10

	Given existence of undiscovered deposits, probability that the number equals or exceeds the given number		
	.9	.5	.1
Number of undiscovered deposits	1	1	1

III. Deposit Characteristics

A. Deposit Size
- Unit of measure: metric tons
- Deposit size distribution form: Lognormal
- Distribution average: 16.67771
- Standard deviation: 1.376849
- Maximum tonnage: 270 million tons

B. Deposit Depth
- Unit of measure: meters
- Deposit depth distribution form: Uniform
- Maximum depth: 1000 meters

C. Contained Metals
- Lead (Pb):
  - Probability Pb is present: 1.0
  - Unit of measure: pct
  - Grade distribution form: Lognormal
  - Distribution average: -3.47215
  - Standard deviation: 0.576819
  - Correlation with size: 0.192253
  - Maximum grade: 11.3 pct
- Zinc (Zn):
  - Probability Zn is present: 1.0
  - Unit of measure: pct
  - Grade distribution form: Lognormal
  - Distribution average: -2.81341
  - Standard deviation: 0.545646
  - Correlation with size: 0.053664
  - Maximum grade: 19.0 pct
- Silver (Ag):
  - Probability Ag is present: .86
  - Unit of measure: g/mt
  - Grade distribution form: Lognormal
  - Distribution average: -9.88368
  - Standard deviation: 0.639801
  - Correlation with size: 0.082500
  - Maximum grade: 240 g/mt

ADGGS/BOM Mineral Resource Assessment for Part of the White Mountains National Recreation Area and Part of the Steese National Conservation Area

The ADGGS assessed the mineral potential of approximately 550 sq mi in the west-central Circle Quadrangle (fig. B-1). The study area is referred to as the Lime Peak-Mt. Prindle area and included the approximately one-fourth of the WMNRA not included in the USGS assessment as well as a small portion of the western North SNCA. The area was previously known to contain tin, uranium, tungsten and gold occurrences. The BOM assessed the placer gold potential of numerous river drainages in the WMNRA and in a part of the North SNCA. The results of both assessments are reported jointly because the same assessment methodology was used by both agencies.

The assessment methodology used by the ADGGS and the BOM is described by White and others (1987) and Burns and others (1987). Based on the results of field mapping, geochemical and geophysical surveying, and mineral resource investigations[3] the following six major types of deposits were predicted to exist in the ADGGS study area (fig. B-3):

(1) tin greisens (TRACTS IA, IB, IC, ID and IE),

(2) tungsten-tin skarn deposits (TRACT II),

(3) tungsten-gold skarn deposits (TRACT III),

(4) uranium rare-earth element deposits (TRACTS IVA and IVB),

(5) stratabound gold deposits (TRACT V), and

(6) alkalic gold deposits (TRACTS VIA, VIB and VIC).

[3]Smith, et al. Mineral Assessment of the Lime Peak-Mt. Prindle Area, Alaska. Sept. 1987.

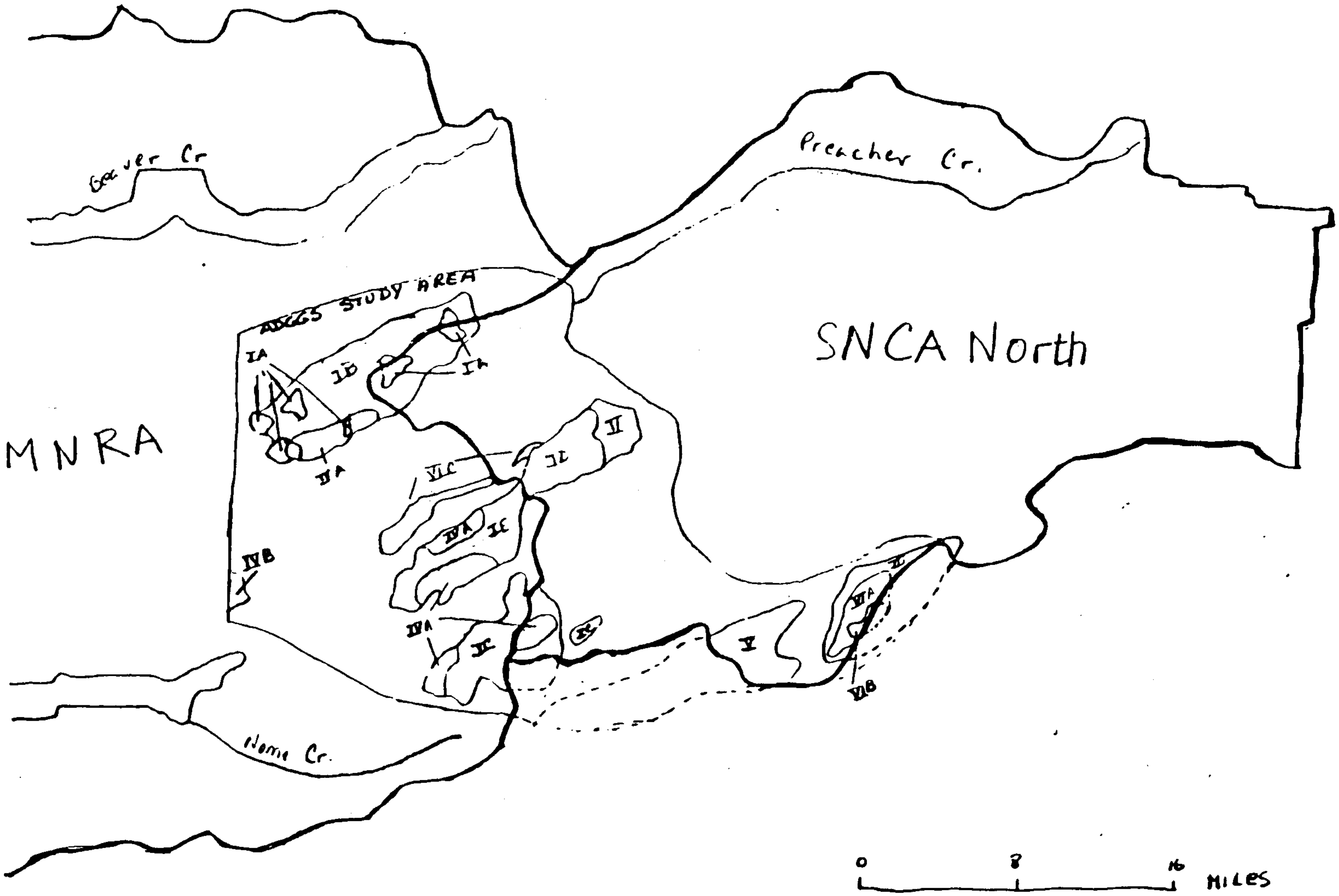


Figure B–3. Map Showing Location of Mineral Terranes in the WMNRA and the SNCA Assessed by the Alaska Division of Geological and Geopysical Surveys

The resource characteristics which are expected to be associated with each of these deposit types are presented in Tables B-2a through B-2f. Each table includes the location of the favorable area, the prospect and deposit probabilities, and the deposit size, depth, and grade characteristics for one of the deposit types. Probabilistic estimates were made by comparing various attributes of the observed geology, geochemistry, and mineralization with similar, well-studied mining districts worldwide. For many of the deposit types the probability that one or more undiscovered deposits exist is relatively large. This is because the favorable areas are geologically similar to other areas known to contain deposits and because of the existence of many prospects with high mineral values. The deposit characteristics appropriate to each deposit type were determined using the concept of a geologic deposit model.

The BOM assessed the placer gold potential of the WMNRA and of the western part of the North SNCA (fig. B-4). The area is known to contain at least one active bench placer mine. Based on the analysis of a large number of stream sediment samples the study area was considered favorable for the occurrence of two types of undiscovered gold placer deposits: (1) bench placers and (2) alluvial placers. The resource characteristics which are expected to be associated with each of these types of placer deposits are presented in Table B-3.

The information shown in Tables B-2 and Table B-3 was used to probabilistically estimate both the quantities of in-place resources (e.g. the mineral endowment) and the quantities of the recoverable resources (e.g. the potential mineral supply) contained in the associated mineral terranes.

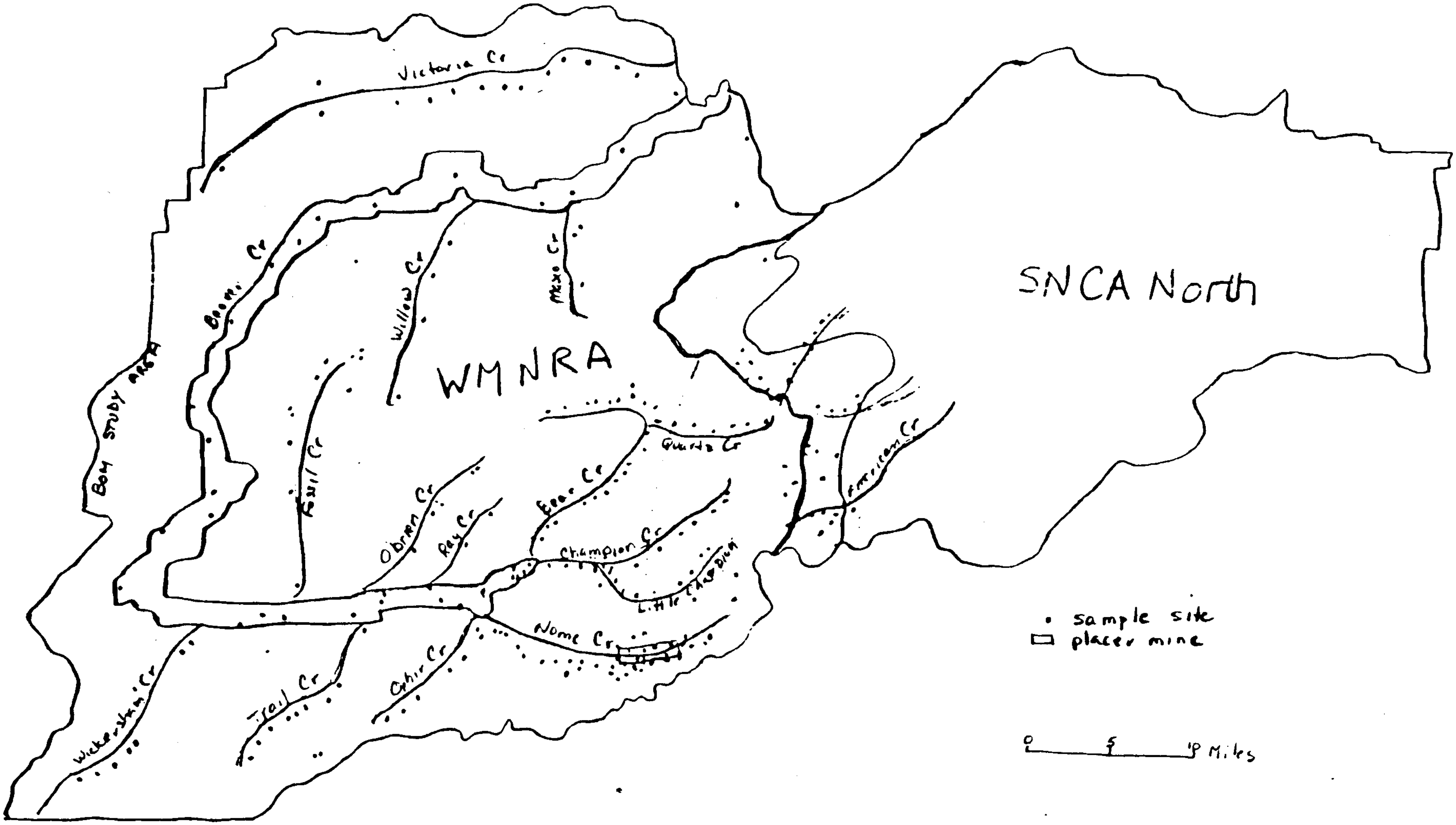


Figure B-4. Map Showing Location of Sites Sampled for Gold Placer Potential by the Bureau of Mines

Table B-2a. Tin Greisen Resource Characteristics - ADGGS

I. Favorable Areas

TRACT IA -Lime Peak pluton I (57% in WMNRA; 43% in SNCA):
Probability delineated area is favorable for tin greisens: 1.0

Given the area is favorable, probability that the number of prospects equals or exceeds the given number

	1.0	.95	.75	.5	.25	.05	.01	.0
Number of prospects	2	3	5	6	7	8	9	10

TRACT IB - Lime Peak pluton II (62% in WMNRA; 38% SNCA):
Probability delineated area is favorable for tin greisens: .75

Given the area is favorable, probability that the number of prospects equals or exceeds the given number

	1.0	.95	.75	.5	.25	.05	.01	.0
Number of prospects	1	1	2	2	3	3	4	5

TRACT IC - Mount Prindle pluton (50% in WMNRA; 34% in SNCA):
Probability delineated area is favorable for tin greisens: .6

Given area is favorable, probability that the number of prospects equals or exceeds the given number

	1.0	.95	.75	.5	.25	.05	.01	.0
Number of prospects	1	1	2	2	3	3	4	5

TRACT ID - NE part of the Quartz Cr pluton (2% in WMNRA; 98% in SNCA):
Probability delineated area is favorable for tin greisens: .4

Given area is favorable, probability that the number of prospects equals or exceeds the given number

	1.0	.95	.75	.5	.25	.05	.01	.0
Number of prospects	1	1	1	1	1	1	2	2

Table B-2a. (continued)

TRACT IE - SW part of the Quartz Cr pluton (99% in WMNRA; 1% in SNCA):
Probability delineated area is favorable for tin greisens: .1

	Given area is favorable, probability that the number of prospects equals or exceeds the given number							
	1.0	.95	.75	.5	.25	.05	.01	.0
Number of prospects	1	1	2	2	2	3	3	4

II. Deposit Probability

Probability a prospect is a deposit (e.g. is at least 400,000 short tons with an average tin grade of at least .13 percent): .375

III. Deposit Characteristics

A. Deposit Size:
Unit of measure: millions of short tons
Deposit size distribution:

	probability that the deposit size equals or exceeds the given value							
	1.0	.95	.75	.50	.25	.05	.01	.0
Deposit size	.4	.6	2.0	7.2	20.0	90.0	105.0	110.0

B. Deposit Depth:
Deposit depth distribution form: Uniform
Range of values: 60 - 600 meters (Quartz Creek and Mt. Prindle)
60 - 300 meters (Lime Peak)

C. Contained Metals: Tin (Sn), Tantalum (Ta), Silver (Ag), Tungsten (WO_3)

Probability Sn is present: 1.00
Probability Ta is present: .10
Probability Ag is present: .66
Probability WO_3 is present: .10

	probability that the average contained metal grade equals or exceeds the given number								Unit of measure
	1.0	.95	.75	.50	.25	.05	.01	.0	
Sn grade	.13	.16	.21	.28	.37	.50	.55	.60	pct
Ta grade	.0005	.0007	.002	.005	.01	.03	.04	.05	pct
Ag grade	.024	.03	.06	.15	.33	.54	.58	.60	tr oz/st
WO_3 grade	.10	.12	.17	.20	.30	.43	.48	.50	pct

Table B-2b. Tungsten-Tin Skarn Characteristics - ADGGS

I. Favorable Area

TRACT II - Quartz Creek pluton - Northeast end (100% in SNCA):
Probability delineated area is favorable for tungsten-tin skarns: 0.5

	Given the area is favorable, probability that the number of prospects equals or exceeds the given number							
	1.0	.95	.75	.5	.25	.05	.01	.0
Number of prospects	4	4	5	6	7	8	9	10

II. Deposit Probability

Probability a prospect is a deposit (e.g. is at least 6,300 short tons with an average tungsten grade of at least .15 percent): .06

III. Deposit Characteristics

A. Deposit Size:
Unit of measure: millions of short tons
Deposit size distribution:

	probability that the deposit size equals or exceeds the given value							
	1.0	.95	.75	.50	.25	.05	.01	.0
Deposit size	.0063	.021	.28	1.1	5.0	42.0	80.0	90.0

B. Deposit Depth:
Deposit depth distribution form: Uniform
Range of values: 30 - 600 meters

C. Contained Metals: Tungsten (WO_3), Tin (Sn)
Probability WO_3 is present: 1.00
Probability Sn is present: .90

	probability that the average contained metal grade equals or exceeds the given number								Unit of measure
	1.0	.95	.75	.50	.25	.05	.01	.0	
WO_3 grade	.15	.20	.25	.33	.42	.55	.58	.60	pct
Sn grade	.08	.12	.27	.40	.50	.65	.72	.75	pct

Table B-2c. Tungsten-Gold Skarn Characteristics - ADGGS

I. Favorable Area

TRACT III - Pinnell Trail area (74% in SNCA):
Probability delineated area is favorable for tungsten-gold skarns: 1.0

	Given the area is favorable, probability that the number of prospects equals or exceeds the given number							
	1.0	.95	.75	.5	.25	.05	.01	.0
Number of prospects	5	6	7	10	12	20	22	25

II. Deposit Probability

Probability a prospect is a deposit (e.g. is at least 6,300 short tons with an average tungsten grade of at least .15 percent): .5

III. Deposit Characteristics

A. Deposit Size:
Unit of measure: millions of short tons
Deposit size distribution:

	probability that the deposit size equals or exceeds the given value							
	1.0	.95	.75	.50	.25	.05	.01	.0
Deposit size	.0063	.021	.25	.60	1.0	2.0	4.5	5.0

B. Deposit Depth:
Deposit depth distribution form: Uniform
Range of values: 0 - 300 meters

C. Contained Metals: Tungsten (WO_3), Gold (Au)
Probability WO_3 is present: 1.00
Probability Au is present: .50

	probability that the average contained metal grade equals or exceeds the given number								Unit of measure
	1.0	.95	.75	.50	.25	.05	.01	.0	
WO_3 grade	.15	.28	.46	.62	1.0	1.35	2.0	2.3	pct
Au grade	.003	.005	.008	.01	.015	.03	.04	1.0	tr oz/st

Table B-2d. Uranium Resource Characteristics - ADGGS

I. Favorable Areas

TRACT IVA - Lime Peak - Mt. Prindle area (86% in WMNRA; 14% in SNCA):
Probability delineated area is favorable for Uranium-Rare earths: 0.1

Given the area is favorable, probability that the number of prospects equals or exceeds the given number

	1.0	.95	.75	.5	.25	.05	.01	.0
Number of prospects	1	1	1	1	1	1	1	2

TRACT IVB - Syenite near western boundary of North Steese (10% in WMNRA):
Probability delineated area is favorable for Uranium-Rare earths: 1.0

Given the area is favorable, probability that the number of prospects equals or exceeds the given number

	1.0	.95	.75	.5	.25	.05	.01	.0
Number of prospects	1	1	1	1	2	2	2	3

II. Deposit Probability

Probability a prospect is a deposit (e.g. is at least 10,000 short tons with an average uranium grade of at least .02 percent): 1.0

III. Deposit Characteristics

A. Deposit Size:
Unit of measure: millions of short tons
Deposit size distribution:

probability that the deposit size equals or exceeds the given value

	1.0	.95	.75	.50	.25	.05	.01	.0
Deposit size	.01	.08	.30	1.0	3.0	5.0	15.0	30.0

Table B-2d. (continued)

B. Deposit Depth:
Deposit depth distribution form: Uniform
Range of values: 0 - 600 meters

C. Contained Metals: Uranium (U_3O_8), Rare Earth Oxides (REO)
Probability U_3O_8 is present: 1.0
Probability REO is present: 1.0

	probability that the average contained metal grade equals or exceeds the given number								Unit of measure
	1.0	.95	.75	.50	.25	.05	.01	.0	
U_3O_8 grade	.02	.035	.08	.13	.18	.35	.64	.71	pct
REO grade	.006	.03	.10	.30	.70	1.1	1.5	1.8	pct

Table B-2e. Stratabound Gold Resource Characteristics - ADGGS

I. Favorable Area

TRACT V - Hope Creek area (37% in SNCA):
Probability delineated area is favorable for stratabound gold: 1.0

Given the area is favorable, probability that the number of prospects equals or exceeds the given number

	1.0	.95	.75	.5	.25	.05	.01	.0
Number of prospects	1	1	1	1	1	1	2	3

II. Deposit Probability

Probability a prospect is a deposit (e.g. is at least 4,000 short tons with an average gold grade of at least .005 tr oz/st): 1.0

III. Deposit Characteristics

A. Deposit Size:
Unit of measure: millions of short tons
Deposit size distribution:

probability that the deposit size equals or exceeds the given value

	1.0	.95	.75	.50	.25	.05	.01	.0
Deposit size	.004	.07	.30	.94	4.0	25.0	150.0	160.0

B. Deposit Depth:
Deposit depth distribution form: Uniform
Range of values: 60 - 300 meters

C. Contained Metals: Gold (Au), Silver (Ag)
Probability Au is present: 1.0
Probability Ag is present: 1.0

probability that the average contained metal grade equals or exceeds the given number

	1.0	.95	.75	.50	.25	.05	.01	.0	Unit of measure
Au grade	.005	.01	.12	.30	.50	.80	1.0	1.2	tr oz/st
Ag grade	.005	.008	.02	.05	.088	.50	1.6	1.8	tr oz/st

Table B-2f. Alkalic Gold Resource Characteristics - ADGGS

I. Favorable Areas

TRACT VIA - Table Mountain I (99% in SNCA):
Probability delineated area is favorable for alkalic gold: .40

Given the area is favorable, probability that the number of prospects equals or exceeds the given number

	1.0	.95	.75	.5	.25	.05	.01	.0
Number of prospects	1	1	2	2	2	2	3	3

TRACT VIB - Table Mountain II (80% in SNCA):
Probability delineated area is favorable for alkalic gold: 1.0

Given the area is favorable, probability that the number of prospects equals or exceeds the given number

	1.0	.95	.75	.5	.25	.05	.01	.0
Number of prospects	1	1	1	2	2	2	2	2

TRACT VIC - Quartz Creek area (90% in WMNRA; 10% in SNCA):
Probability delineated area is favorable for alkalic gold: .20

Given the area is favorable, probability that the number of prospects equals or exceeds the given number

	1.0	.95	.75	.5	.25	.05	.01	.0
Number of prospects	1	1	1	1	1	1	1	1

II. Deposit Probabilities

Probability a Table Mtn prospect is a deposit (e.g. is at least 100,000 short tons with an average gold grade of at least .006 tr oz/st): 0.68

Probability a Quartz Cr prospect is a deposit (e.g. is at least 100,000 short tons with an average gold grade of at least .006 tr oz/st): 0.56

Table B-2f. (Continued)

III. Deposit Characteristics

A. Deposit Size:
Unit of measure: millions of short tons
Deposit size distribution:

	probability that the deposit size equals or exceeds the given value							
	1.0	.95	.75	.50	.25	.05	.01	.0
Deposit size	.1	1.0	4.0	10.0	20.0	30.0	60.0	100.0

B. Deposit Depth:
Deposit depth distribution form: Uniform
Range of values: 0 - 300 meters

C. Contained Metals: Gold (Au)
Probability Au is present: 1.0

	probability that the average contained metal grade equals or exceeds the given number								Unit of measure
	1.0	.95	.75	.50	.25	.05	.01	.0	
Au grade	.006	.007	.015	.03	.08	.15	.20	.25	tr oz/st

Table B-3. Placer Gold Resource Characteristics - BOM

I. Favorable Areas

A. Bench placers (95% in WMNRA; 5% in SNCA):
Probability river drainages are favorable for undiscovered bench placer gold deposits: 1.0

	Given the area is favorable, probability that the number of prospects equals or exceeds the given number							
	1.0	.95	.75	.5	.25	.05	.01	.0
Number of prospects	20	23	27	30	35	40	43	50

B. Bench placers - known deposit on Beaver Creek (100% in WMNRA):
Probability Beaver Cr is favorable for placer gold: 1.0

	Given the area is favorable, probability that the number of prospects equals or exceeds the given number							
	1.0	.95	.75	.5	.25	.05	.01	.0
Number of deposits	1	1	1	1	1	1	1	1

C. Stream gravels (73% in WMNRA; 27% in SNCA):
Probability drainages are favorable for placer gold: 1.0

	Given the area is favorable, probability that the number of prospects equals or exceeds the given number							
	1.0	.95	.75	.5	.25	.05	.01	.0
Number of prospects	1	2	4	6	7	8	13	15

II. Deposit Probabilities

Probability a bench prospect is a deposit (e.g. is at least 50,000 yds^3 with an average gold grade of at least .0007 oz/yd^3): .05 (Probability is 1.0 for known Beaver Cr deposit)

Probability a stream gravel prospect is a deposit (e.g. is at least 15,000 yds^3 with an average gold grade of at least .001 oz/yd^3): 1.0

Table B-3. (Continued)

IIIa. Deposit Characteristics - Bench Placers

A. Deposit Size:
Unit of measure: millions of yds^3
Deposit size distribution:

	probability that the deposit size equals or exceeds the given value							
	1.0	.95	.75	.50	.25	.05	.01	.0
Deposit size	.050	.10	.40	.50	.60	.80	.90	1.00

B. Contained Metals: Gold (Au)
Probability Au is present: 1.0

	probability that the average contained metal grade equals or exceeds the given number								Unit of measure
	1.0	.95	.75	.50	.25	.05	.01	.0	
Au grade	.0007	.002	.004	.0095	.015	.02	.03	.044	oz/yd^3

IIIb. Deposit Characteristics - Stream Gravels

A. Deposit Size:
Unit of measure: millions yds^3
Deposit size distribution:

	probability that the deposit size equals or exceeds the given value							
	1.0	.95	.75	.50	.25	.05	.01	.0
Deposit size	.015	.020	1.0	3.0	6.0	8.0	12.0	17.0

B. Contained Metals: Gold (Au)
Probability Au is present: 1.0

	probability that the average contained metal grade equals or exceeds the given number								Unit of measure
	1.0	.95	.75	.50	.25	.05	.01	.0	
Au grade	.001	.0015	.0019	.0026	.004	.009	.035	.045	oz/yd^3

APPENDIX C. — ENGINEERING COST ANALYSIS FOR THE WMNRA/SNCA STUDY AREA

Staff in the BOM's Branch of Engineering and Economic Analysis in Spokane, Washington[1] developed seven mine models and nine mill (beneficiation) models for estimating the costs associated with exploiting the eight types of deposits predicted to exist in the WMNRA/SNCA study area (table C-1). Three infrastructure cost models were also developed to allow the major additional infrastructure costs associated with various types and sizes of mining operations in central Alaska to be taken into account.

Placer mine and mill models were constructed using the "Cost Estimating Handbook for Small Placer Mines" (Stebbins, 1987). Cost models for the other mine and mill methods and the infrastructure requirements were constructed using actual cost data augmented by the BOM's Cost Estimating System, or CES (Bureau of Mines, 1987). All costs were converted to January 1987 dollars and adjusted to reflect the increased expense of development and operation in central Alaska. Placer capital costs were escalated by a factor of 2.3 and placer labor costs were adjusted by a factor of 1.412 (Bottge, 1986); non-placer labor costs were escalated by a factor of 1.75 and all other non-placer costs were increased by a factor of 1.5, with the exception of fuel and lubricant costs which were considered comparable to those in the lower 48 states. To estimate the full cost of mining activity associated with a particular deposit, the appropriate mine, mill and infrastructure models were

[1]The engineering analysis team consisted of Burton Gosling, Thomas Camm, Nicholas Wetzel and Scott Stebbins.

Table C-1. Deposit Types and Associated Mine and Mill Methods

Deposit Type	Mining Options	Milling Options
Polymetallic Vein	Cut and Fill VCR > 2000 mt/d	Polymetallic Flotation
Skarn	Open-Pit Shrinkage Stoping VCR > 2000 mt/d	W Flotation or Gravity
Sediment-hosted Exhalative	Open-Pit Room and Pillar	Pb-Zn Flotation
Alkalic Associated Gold	Open-Pit VCR	Heap Leaching or CIP
Tin Greisen	Open-Pit Cut and Fill VCR > 2000 mt/d	Sn Flotation/ Gravity
Placer Gold	Placer	Placer
Rare Earths	Open-Pit VCR > 2000 mt/d	REO Flotation
Vein Gold	Open-Pit Cut and Fill VCR > 2000 mt/d	Heap Leaching or CIP

VCR = Vertical Crater Retreat

combined.

Mine Cost Models

Cost models were developed for seven mining methods: (1) small tonnage open-pit, (2) large tonnage open-pit, (3) room and pillar, (4) cut and fill, (5) shrinkage stoping, (6) vertical crater retreat (VCR), and (7) placer. In order to develop the cost models, simplifying assumptions were made about orebody geometries. Except for polymetallic vein, tin greisen, vein gold and gold placer deposits, the orebody was assumed to be a horizontal, circular-shaped disk having a vertical thickness equal to half the circular radius in plan view. For vein gold deposits, tin greisen deposits and polymetallic vein deposits, a single, vertically-oriented, tabular-shaped vein having a length:width:depth ratio of 20:1:100 was assumed; and for placer deposits, a pay zone having an average width of 100 ft and a thickness of 10 ft was assumed.

For each mine model, representative daily tonnages, based on expected resource ranges for each deposit type and an annual operating rate of 350 days (100 days in the case of placers), were used to generate mine costs for eight cost categories: labor, equipment, steel, lumber, fuel, chemicals, industrial materials, and construction materials. Cost models were developed by fitting each category of costs into general equations of the form $Y=AX^B$, where X = tonnage, A and B are constants estimated through a geometric regression analysis, and Y = cost. Depth factors were subsequently incorporated into the models as appropriate, yielding a set of operating and capital cost equations for each of the six mine models as a function of resource tonnage, T, or daily capacity, X, and deposit depth, d.

During each year of production it is assumed that additional capital expenditures will be incurred equal to six percent of the original capital investment for surface mines, and five percent of the original capital investment for underground mines.

Finally, ore recovery is assumed to be 100 percent for all underground mine methods.

Open-Pit Mine Models.

In order to make volumetric calculations and derive a stripping-ratio equation to include depth as a variable in the open-pit cost model, the following assumptions were made: (1) ore and waste have the same specific gravity, (2) the pit slope is equal to 35 degrees, (3) the pit wall intersects the orebody at its vertical midpoint and then steepens to 60 degrees, and (4) the upper surface of the disk-shaped orebody is parallel to the ground surface, which is flat. From the generalized orebody shape and these assumptions, a relationship was derived for determining the stripping ratio as a function of deposit ore tonnage and depth of burial.

$$SR = \frac{5.9631}{T} (D_B + 0.5943T^{1/3})^3 - 1.0381$$

where: SR = stripping ratio

D_B = depth to top of orebody in meters

T = total metric tons of ore in deposit

Due to the geometry of the model, this equation was found to be valid for stripping ratios (waste:ore) greater than 0.2:1. In effect, lesser values can only exist if the orebody protrudes above the surface. Based on the model geometry, an ore recovery of 93.12 pct was calculated.

The estimated tonnage of ore mined per day, X, including waste, is a function of the orebody size and was calculated by applying Taylor's Rule.

Taylor's Rule:

$$L \text{ (mine life yrs)} = 0.2(FT)^{1/4}$$

where: T = total tonnage of ore in deposit

F = open-pit ore recovery factor = 0.9312

and, assuming 350 operating days per year:

$$X = \text{metric tons/day (ore)} = \frac{FT}{L(350)}$$

Substituting for L and F:

$$X = \frac{(.9312T)^{3/4}}{70}$$

Since the mining method for a small open-pit mine differs from that for a large mine, two open-pit cost models were developed, a small tonnage model and a large tonnage model. Given the assumption that there is no substantial cost differential between mining ore and mining waste, the cost models were developed based on total tonnage of ore and waste mined daily irrespective of the proportion of ore and waste mined. The tonnage rates selected for baseline costing of the small tonnage model ranged from 1,000 to 10,000 mt/d ore and waste, and ranged from 10,000 to 100,000 mt/d ore and waste for the large tonnage model. Revised CES formulas were used to derive the operating and capital costs for various mine capacities in these ranges. These values were then used to develop equations applicable to small tonnage operations and equations applicable to large tonnage operations through geometric regression. The resultant cost models (tables C-2a and C-2b) can be used to estimate mining costs on a per ton of ore and waste mined basis.

With the determination of the stripping ratio and given the tons of ore and waste mined per day, the total capital cost and the operating cost per ton of ore can be estimated by combining the cost equations in table C-2a or C-2b with the following general cost formulas:

Mine operating cost per metric ton of ore = $(SR+1)(Y_o)$

Mine capital cost = Y_c

Starting with these general equations and substituting the derived values of Y shown in table C-2a, for example, then substituting for X and inserting the stripping ratio equation where appropriate yields the operating and capital costs for a small tonnage open-pit mine.

Room and Pillar Mine Model.

The room-and pillar mine model assumes the use of jumbo drills for production and drift development, and rock bolts for wall support. Front-end loaders, trucks, and scoop trams are used to move ore to the ore storage pocket.

To develop the model, daily tonnages of 900, 9,000, and 27,000 mt/d of ore were used. It was assumed that an additional 0.8 pct of material would be removed as waste (7, 72, 216 mt/d waste, respectively). These daily capacities correspond to ore reserves of 2.5 million, 55 million, and 236 million mt. The estimated costs of each mine capacity were based

Table C-2a. Small Tonnage Open-Pit Mine Cost Model
(1,000-10,000 mt/d ore and waste)

Cost Component	Capital Cost, $ Equation	Operating Cost, $/mt Equation
Labor	$122599.0(X)^{0.5145}$	$88.8300(X)^{-0.3361}$
Equipment	$290421.0(X)^{0.4449}$	$9.6400(X)^{-0.1399}$
Steel	$4526.0(X)^{0.5054}$	$12.9400(X)^{-0.4797}$
Fuel	$9134.0(X)^{0.5737}$	$28.7900(X)^{-0.4245}$
Chemical	$15139.0(X)^{0.5055}$	$46.1600(X)^{-0.4930}$
Industrial Materials	$247.0(X)^{0.6031}$	$4.0425(X)^{-0.3947}$
Construction Materials	$172290.0(X)^{0.3290}$	NA

X = Total metric tons of ore and waste mined daily
NA = Not applicable

Table C-2b. Large Tonnage Open-Pit Mine Cost Model
(10,000-100,000 mt/d ore and waste)

Cost Component	Capital Cost, $ Equation	Operating Cost, $/mt Equation
Labor	$69568.00(X)^{0.5263}$	$99.5200(X)^{-0.4045}$
Equipment	$102019.00(X)^{0.5526}$	$2.2660(X)^{-0.00122}$
Steel	$25.38(X)^{0.9764}$	$0.1064(X)^{-0.04153}$
Fuel	$2105.00(X)^{0.6094}$	$6.2960(X)^{-0.4065}$
Chemical	$230.00(X)^{0.8906}$	$0.5581(X)^{-0.0931}$
Industrial Materials	$208.00(X)^{0.6219}$	$3.4710(X)^{-0.3782}$
Construction Materials	$56797.00(X)^{0.4505}$	NA

X = Total metric tons of ore and waste mined daily
NA = Not applicable

on actual labor, supply, and equipment costs for individual unit processes and adjusted to reflect the higher costs typical of an Alaskan operation. These values were used to develop a set of operating and capital cost equations for mines with adit entry (table C-3a) through geometric regression. For mines with shaft entry, a depth variable was incorporated in the cost curves. The adjusted cost equations are shown in table C-3b and assume the use of one production shaft, plus the installation of one combination ventilation shaft/escapeway,. The depth variable, d, is the depth of the shaft in meters. The cost models are considered valid for deposit sizes, T, ranging from 53,000 to 160,000,000 mt, with corresponding daily capacities, X, of 50 to 20,000 mt/d.

Given a known ore reserve tonnage, the capacity of a mine can be determined using Taylor's Rule. Ore recovery is assumed to be 100 pct. Once the daily ore tonnage is calculated, the appropriate cost model can be used to estimate the various operating and capital cost components. The total operating cost in dollars per mt/d of ore and the total capital cost in dollars are calculated by summing up the associated cost components.

Cut and Fill Mine Model.

This mine model is based on cut and fill stoping with hydraulic backfill. Jackleg drills and stopers are used for production, and small jumbos for drift development. Slushers move the ore from the stope to the ore chutes, LHDs move the ore from the chutes to the ore storage pockets.

To develop the model, daily tonnages of 400, 1,320, and 4,000 mt/d of ore were used. It was assumed that an additional amount of material (4, 26, and 38 mt/d respectively) would be removed as waste. These

Table C-3a. Room and Pillar With Adit Entry Cost Model

Cost Component	Capital Cost, $ Equation	Operating Cost, $/mt Equation
Labor	$11958.0(T)^{0.3544}$	$146.849(T)^{-0.1618}$
Equipment	$31067.7(T)^{0.3990}$	$3.836(T)^{-0.0880}$
Steel	$7474.0(T)^{0.3205}$	$4.955(T)^{-0.0745}$
Lumber	$27.6(T)^{0.4080}$	$0.014(T)^{-0.0681}$
Fuel	$843.3(T)^{0.3217}$	$1.897(T)^{-0.0936}$
Industrial Materials	$10746.0(T)^{0.3250}$	$9.814(T)^{-0.0743}$
Construction Materials	$2256.4(T)^{0.4001}$	$0.065(T)^{-0.0733}$

T = Total resource in metric tons

Table C-3b. Room and Pillar With Shaft Entry Cost Model

Cost Component	Capital Cost, $ Equation	Operating Cost, $/mt Equation
Labor	$11958.0(T)^{0.3544} + 4693(d)$	$146.849(T)^{-0.1618} + 1.78$
Equipment	$31067.7(T)^{0.3990} + 9{,}000{,}000 + 2100(d)$	$3.836(T)^{-0.0880} + 0.001(d)$
Steel	$7474.0(T)^{0.3205} + 478(d)$	$4.955(T)^{-0.0745}$
Lumber	$27.6(T)^{0.4080} + 13(d)$	$0.014(T)^{-0.0681}$
Fuel	$843.3(T)^{0.3217} + 226(d)$	$1.897(T)^{-0.0936} + .0003(d)$
Industrial Materials	$10746.0(T)^{0.3250} + 436(d)$	$9.814(T)^{-0.0743}$
Construction Materials	$2256.4(T)^{0.4001} + 424(d)$	$0.065(T)^{-0.0733} + 0.27$

T = Total resource in metric tons
d = depth of shaft in meters

daily capacities correspond to ore reserves of 1 million, 5 million, and 19 million mt. The estimated costs of each mine capacity were based on actual labor, supply, and equipment costs for individual unit processes and adjusted to reflect the higher costs typical of an Alaskan operation. These values were used to develop a set of operating and capital cost equations for mines with adit entry (table C-4a) through geometric regression. For mines with shaft entry, a depth variable was incorporated in the cost curves. The adjusted cost equations are shown in table C-4b and assume the use of one production shaft, plus the installation of one combination ventilation shaft/escapeway. The cost models are considered valid for deposit sizes ranging from 53,000 to 62,000,000 mt, with corresponding daily capacities, X, of 50 to 10,000 mt/d.

Given a known ore reserve tonnage, the capacity and mine life of a cut and fill mine were determined using Taylor's Rule. Ore recovery of 100 pct is assumed. The operating and capital cost components were estimated using the appropriate cost model. Operating cost is in dollars per mt/d, capital cost is in total dollars, and d is the depth of the shaft in meters.

Shrinkage Stoping Mine Model.

The shrinkage stoping mine model assumes a vertical orebody. Jackleg and stoper drills are used for production and drift development, and rock bolts are used for wall support. LHDs are used to move the ore to the ore storage pocket.

To develop the model, daily tonnages of 200, 1,000, and 3,000 mt/d were used. These daily capacities correspond to ore reserves of 337,400, 2,884,900, and 12,482,200 mt. The estimated costs of each mine capacity

Table C-4a. Cut and Fill With Adit Entry Cost Model

Cost Component	Capital Cost, $ Equation	Operating Cost, \$/mt Equation
Labor	$2839.6(T)^{0.5033}$	$2249.8(T)^{-0.2365}$
Equipment	$92873.0(T)^{0.3589}$	$381.0(T)^{-0.3653}$
Steel	$50.4(T)^{0.5362}$	$1083.8(T)^{-0.4049}$
Lumber	$26.6(T)^{0.4533}$	$3.27(T)^{-0.0417}$
Fuel	$7.2(T)^{0.4909}$	$56.2(T)^{-0.3279}$
Industrial Materials	$127.4(T)^{0.5311}$	$6.79(T)^{-0.0939}$
Construction Materials	$2709.8(T)^{0.4726}$	$23.9(T)^{-0.1295}$

T = Total resource in metric tons

Table C-4b. Cut and Fill With Shaft Entry Cost Model

Cost Component	Capital Cost, $ Equation	Operating Cost, \$/mt Equation
Labor	$2839.6(T)^{0.5033} + 4693(d)$	$2249.80(T)^{-0.2365} + 1.78$
Equipment	$92873.0(T)^{0.3589} + 9{,}000{,}000 + 2100(d)$	$381.00(T)^{-0.3653} + 0.001(d)$
Steel	$50.4(T)^{0.5362} + 478(d)$	$1083.80(T)^{-0.4049}$
Lumber	$26.6(T)^{0.4533} + 13(d)$	$3.27(T)^{-0.0417}$
Fuel	$7.2(T)^{0.4909} + 226(d)$	$56.20(T)^{-0.3279} + .0003(d)$
Industrial Materials	$127.4(T)^{0.5311} + 436(d)$	$6.79(T)^{-0.0939}$
Construction Materials	$2709.8(T)^{0.4726} + 424(d)$	$23.90(T)^{-0.1295} + 0.27$

T = Total resource in metric tons
d = depth of shaft in meters

were based on actual labor, supply, and equipment costs for individual unit processes and adjusted to reflect the higher costs typical of an Alaskan operation. These values were used to develop a set of operating and capital cost equations for a mine with adit entry (table C-5a) through geometric regression. For mines with shaft entry, a depth variable was incorporated into the equations. Based on using one production shaft, plus the installation of one combination ventiliation shaft/escapeway, the adjusted cost equations are shown in table C-5b. These cost models are considered valid for daily capacities, X, ranging from 50 to 20,000 mt/d.

Given a known ore reserve tonnage, the capacity and mine life of a shrinkage stope mine were determined using Taylor's Rule. Ore recovery is assumed to be 100 pct. The operating and capital cost components were estimated using the appropriate cost model. The operating cost components are in dollars per mt/d ore and the capital cost components are in total dollars.

Vertical Crater Retreat (VCR) Mine Model.

The VCR model also assumes a vertical orebody. Down-the-hole and jumbo drills were used for production and drift development, and rock bolts were used for wall support. Front-end loaders, trucks, and scoop trams were used to move the ore to the ore storage pocket.

To derive the cost equations, daily tonnages of 650, 1,300, and 2,600 mt/d were used. These daily capacities correspond to ore reserves of 1,624,000, 4,093,000, and 10,314,000 mt of ore. The estimated capital and operating costs for these mine capacities were based on actual labor, supply, and equipment costs for individual unit processes and adjusted to reflect the higher costs typical of an Alaskan operation. These values

Table C-5a. Shrinkage Stope With Adit Entry Cost Model

Cost Component	Capital Cost, $ Equation	Operating Cost, $/mt Equation
Labor	$8762.90(T)^{0.4286}$	$801.400(T)^{-0.2654}$
Equipment	$22142.50(T)^{0.4114}$	$15.850(T)^{-0.1954}$
Steel	$192.70(T)^{0.4737}$	$11.660(T)^{-0.1508}$
Lumber	$17.20(T)^{0.6042}$	$9.481(T)^{-0.1978}$
Fuel	$38.09(T)^{0.3844}$	$12.740(T)^{-0.2076}$
Industrial Materials	$678.80(T)^{0.4319}$	$22.030(T)^{-0.1136}$
Construction Materials	$6530.60(T)^{0.4123}$	$55.240(T)^{-0.2107}$

T = Total resource in metric tons

Table C-5b. Shrinkage Stope With Shaft Entry Cost Model

Cost Component	Capital Cost, $ Equation	Operating Cost, $/mt Equation
Labor	$8762.90(T)^{0.4286} + 4693(d)$	$801.400(T)^{-0.2654} + 1.78$
Equipment	$22142.50(T)^{0.4114} + 9{,}000{,}000 + 2100(d)$	$15.850(T)^{-0.1954} + 0.001(d)$
Steel	$192.70(T)^{0.4737} + 478(d)$	$11.660(T)^{-0.1508}$
Lumber	$17.20(T)^{0.6042} + 13(d)$	$9.481(T)^{-0.1978}$
Fuel	$38.09(T)^{0.3844} + 226(d)$	$12.740(T)^{-0.2076} + .0003(d)$
Industrial Materials	$678.80(T)^{0.4319} + 436(d)$	$22.030(T)^{-0.1136}$
Construction Materials	$6530.60(T)^{0.4123} + 424(d)$	$55.240(T)^{-0.2107} + 0.27$

T = Total resource in metric tons
d = depth of shaft in meters

were then used to develop a set of operating and capital cost equations for mines with adit entry (table C-6a) through geometric regression. For mines with shaft entry, a depth variable was incorporated into the cost model. Cost equations based on using one production shaft plus the installation of one combination ventilation shaft/escapeway are shown in table C-6b. These models are considered valid for daily capacities, X, ranging from 500 to 20,000 mt/d.

Given a known ore reserve tonnage, the mine life and capacity were determined using Taylor's Rule. Ore recovery is assumed to be 100 pct. The operating and capital costs were estimated using the appropriate cost model.

Placer Mine Model.

The placer model is based on using dozers to move pay gravel to the plant and overburden to the spoil pile.

In order to make volumetric calculations and derive a stripping-ratio equation to include depth of overburden as a variable in the cost models, a generalized deposit shape having a constant average width of 100 ft and a constant pay zone thickness of 10 ft was assumed. From this generalized deposit shape a relationship was derived for stripping ratio (S) as a function of deposit size and depth of overburden.

$$S = \frac{Tov}{Tpg} = \frac{(5.67d + 0.03d^2)(L)}{Tpg} = \frac{(5.67d + 0.03d^2)}{56.7}$$

where: Tov = mt of overburden

Tpg = mt of pay gravel

d = depth of overburden

Table C-6a. Vertical Crater Retreat With Adit Entry Cost Model

Cost Component	Capital Cost, $ Equation	Operating Cost, $/mt Equation
Labor	$3613.100(T)^{0.4892}$	$398.500(T)^{-0.2270}$
Equipment	$5346.500(T)^{0.5081}$	$7.891(T)^{-0.1546}$
Steel	$41.360(T)^{0.5546}$	$0.942(T)^{-0.0054}$
Lumber	$1.465(T)^{0.6791}$	$0.210(T)^{+0.0208}$
Fuel	$4.696(T)^{0.5261}$	$8.340(T)^{-0.1817}$
Industrial Materials	$100.700(T)^{0.5520}$	$5.366(T)^{-0.0314}$
Construction Materials	$3845.100(T)^{0.4502}$	$14.190(T)^{-0.1328}$

T = Total resource in metric tons

Table C-6b. Vertical Crater Retreat With Shaft Entry Cost Model

Cost Component	Capital Cost, $ Equation	Operating Cost, $/mt Equation
Labor	$3613.100(T)^{0.4892} + 4693(d)$	$398.500(T)^{-0.2270} + 1.78$
Equipment	$5346.500(T)^{0.5081} + 9{,}000{,}000 + 2100(d)$	$7.891(T)^{-0.1546} + 0.001(d)$
Steel	$41.360(T)^{0.5546} + 478(d)$	$0.942(T)^{-0.0054}$
Lumber	$1.465(T)^{0.6791} + 13(d)$	$0.210(T)^{+0.0208}$
Fuel	$4.696(T)^{0.5261} + 226(d)$	$8.340(T)^{-0.1817} + .0003(d)$
Industrial Materials	$100.700(T)^{0.5520} + 436(d)$	$5.366(T)^{-0.0314}$
Construction Materials	$3845.100(T)^{0.4502} + 424(d)$	$14.190(T)^{-0.1328} + 0.27$

T = Total resource in metric tons
d = depth of shaft in meters

L = length of deposit in ft = Tpg/56.7

The estimated loose cubic yards of gravel mined per hour (LCY/h), X, is a function of placer size and was calculated by applying the following formula:

$$X = \text{LCY/h gravel} = 0.1814(\text{Tpg})^{0.4429}$$

Placer mines are assumed to operate 12 h/d, 100 d/yr, plus a two week start-up period for overburden removal and site preparation. Using a factor of 1.342 to convert from LCY to mt, the mine life is calculated as follows:

$$L = (\text{mine life yrs}) = \frac{\text{Tpg}^{0.5571}}{(12)(100)(X)(1.342)} = \frac{\text{Tpg}^{0.5571}}{292.13}$$

The tonnage rates selected for baseline costing were 27,000, 134,000, 805,000, 2,684,000, and 13,420,000 mt. Using the above formulas, these tonnages correspond to plant capacities of 20, 25, 75, 150, and 250 LCY/hr and mine lives of from 1 season to 32 yrs. The estimated costs of each mine capacity were based on actual labor, supply and equipment costs for the various unit processes and adjusted to reflect the higher costs of an Alaskan operation. These values were used to develop a set of capital and operating cost equations through geometric regression. The resultant cost model, shown in table C-7a, can be used to estimate placer mining costs on a per ton of gravel mined basis.

Given a placer deposit of known tonnage, the daily capacity and mine life were determined by using the above formulas. The mining cost model

Table C-7a. Placer Mine Cost Model
(50 pct pay gravel)

Cost Component	Capital Cost, $ Equation	Operating Cost, $/mt Equation
Labor	$299.600(T)^{0.3413}$	$277.700(T)^{-0.4173}$
Equipment	$11871.200(T)^{0.2729}$	$5.449(T)^{-0.2105}$
Steel	$0.300(T)^{0.5281}$	NA
Fuel	$2.718(T)^{0.5276}$	$9.631(T)^{-0.2405}$
Construction Materials	$6.308(T)^{0.4192}$	NA

T = Total resource in metric tons
NA = Not applicable

Table C-7b. Placer Mine Cost Model with Stripping Ratio

Cost Component	Capital Cost, $ Equation	Operating Cost, $/mt Equation
Labor	$300.800(T)^{0.3413}(S)^{0.2432}$	$273.000(T)^{-0.2270}(S)^{0.0856}$
Equipment	$11693.100(T)^{0.2729}(S)^{0.7076}$	$5.269(T)^{-0.2105}(S)^{0.4739}$
Steel	$0.302(T)^{0.5281}(S)^{0.2670}$	NA
Fuel	$2.734(T)^{0.5276}(S)^{0.2670}$	$9.323(T)^{-0.2405}(S)^{0.4565}$
Construction Materials	$6.308(T)^{0.4193}$	NA

T = Total resource in metric tons
S = Stripping ratio
NA = Not applicable

shown in table C-7a was used to estimate the total capital costs and the operating cost per ton of gravel. These equations assume that 50 pct of the rock moved is non-paying overburden. For circumstances in which a higher stripping ratio is expected, a depth factor must be applied. The appropriate equations adjusted for stripping ratio are shown in table C-7b. These models are considered valid for daily capacities ranging from 100 to 10,000 mt/d.

Mill Cost Models

The procedure for developing mill cost models appropriate for each of the ore deposit types was similar to that for mining. In general, models were developed using four milling techniques: (1) carbon-in-pulp (CIP) gold leaching, (2) heap leaching, (3) gravity, and (4) flotation. Individual mill models for each deposit type used one or more of these techniques.

The choice of mill method(s) was based on the ore type or contained metal grade(s) of the paricular deposit type. Daily tonnage ranges were based on the range for the corresponding mining method. Table C-1 identifies the mill model(s) applied to each deposit type. Cost equations were developed for six capital and operating cost components: labor, equipment, steel, fuel, industrial materials, and construction materials; and were used to estimate the capital and operating costs at various mill feed rates, X.

During each year of production it is assumed that additional capital expenditures will be incurred equal to three percent of the original capital investment for the mill to replace wornout and obsolescent equipment.

Carbon-in-Pulp (CIP) Gold Leaching Mill.

The final product of this milling method is dore' bullion. The mill configuration includes:

(1) a crushing plant which prepares mine-run ore for the mill,

(2) a grinding circuit which reduces ore to 80 percent passing 200 mesh,

(3) a carbon-in-pulp gold recovery curcuit, and

(4) a tailings disposal system.

The equations developed estimate costs for CIP processing of ores containing approximately 0.09 to 0.7 tr oz gold/ton (3 to 24 g gold/mt) and minor amounts of silver. Included in the costs are the successive unit processes of thickening of the slurry of ground ore; cyanide agitation leaching; wood-chip and trash screening; adsorption of precious metals by activated coconut carbon; countercurrent carbon transfer; screening for separation of charcoal from pulp; hot caustic cyanide stripping of carbon; carbon acid washing and regeneration by heating and quenching; electrowinning on steel wool cathodes; carbon column scavenger recovery from bleed streams and tailing return water used in the process; and bullion refining and casting, including slag processing. Cyanide is not regenerated from the barren solution in the process.

It is assumed that the mill would operate 24 hours/day, 365 days/year. It is also assumed that this method would recover 90 pct of the gold in the mill feed and 61 pct of the silver.

The independent variable in the capital and operating cost equations is capacity in metric tons of mine-run ore per day. To make the transition from a given resource tonnage to metric tons per day, Taylor's Rule was used.

$$L \text{ (mill life yrs)} = 0.2(T)^{1/4}$$

where: T = total tonnage of ore in deposit

and then:

$$X = mt/d = \frac{T}{L(365)} = \frac{T}{.2(T)^{1/4}(350)} = \frac{T^{3/4}}{70} * \frac{350}{365}$$

Once the daily capacity, X, of the mill was determined, the cost model shown in table C-8 was used to estimated the mill's capital and operating costs. The equations shown are considered valid for mill feed rates ranging from 50 to 20,000 mt/d.

Heap Leaching.

This mill model was designed to treat ores containing less that 0.09 tr oz of gold per st. The mill is assumed to include:

(1) a crushing plant which prepares mine-run ore for leaching,

(2) leach pads with four layers of lining to prevent leakage and insulate the permafrost below the pads,

(3) a solution distribution and collection system,

(4) a counter-current decantation gold recovery system, and

(5) a discharge water treatment system.

For this mill model, it is assumed that run-of-mine ore is leached in a heap leaching plant or facility with a barren cyanide solution that

Table C-8. Carbon-in-Pulp Gold Leach Mill Cost Model

Cost Component	Capital Cost, $ Equation	Operating Cost, $/mt Equation
Labor	$98593.10(X)^{0.674}$	$664.349(T)^{-0.565}$
Equipment	$118274.38(X)^{0.661}$	$6.004(X)^{-0.146}$
Steel	$34895.44(X)^{0.599}$	$0.818(X)^{-0.028}$
Fuel	$1.29(X)^{1.408}$	$6.860(X)^{-0.520}$
Industrial Materials	$0.58(X)^{1.417}$	$41.895(X)^{-0.412}$
Construction Materials	$47882.63(X)^{0.652}$	$0.141(X)^{-0.002}$

X = Mill feed rate, metric tons per day

slowly percolates through the heaps to dissolve the gold values to produce a pregnant solution. The pregnant solution is then pumped through columns containing activated charcoal where the gold is adsorbed on carbon particles. Loaded carbon is stripped in a stripping column to recover the precious metal with a hot caustic cyanide solution. The high-grade strip solution then reports to electrowinning cells where the gold is recovered on steel wool cathodes, which are then smelted to recover dore' bullion. The dore' bullion is the final product and is shipped to a refinery.

It is assumed that the mill will operate 24 hours/day, 180 days/year to avoid freeze-up of the operation during winter months. It is also assumed that the heaps are drained prior to shut-down at the end of the operating season. This mill method is expected to recover 70 pct of the gold in the mill feed and 45 pct of the silver.

Table C-9 presents the operating and cost equations developed for this mill method. The independent variable in these equations is capacity in metric tons of mine-run-ore per day which was calculated using the formulas derived above. The model is considered valid for mill feed rates ranging from 50 and 1,000 mt/d.

Tungsten Oxide Gravity Mill Model.

The derived costs pertain to the production of tungsten concentrates from ore containing approximately 1.5 pct WO_3. The mill configuration is assumed to include:

(1) a two-stage crushing plant to prepare mine-run-ore for grinding,

(2) a duplex mineral jig to recover a high grade sand and hutch concertrate prior to grinding,

(3) a rod mill grinding plant to prepare crushed ore for tabling,

Table C-9. Heap Leach Mill Cost Model

Cost Component	Capital Cost, $ Equation	Operating Cost, $/mt Equation
Labor	$7391.22(X)^{0.861}$	$117.525(X)^{-0.386}$
Equipment	$2959.31(X)^{0.894}$	$9.818(T)^{-0.292}$
Steel	$826.43(X)^{0.854}$	$0.030(X)^{-0.307}$
Fuel	$43.40(X)^{0.935}$	$5.560(X)^{-0.429}$
Industrial Materials	$17.21(X)^{0.954}$	$30.759(X)^{-0.405}$
Construction Materials	$1218.99(X)^{0.983}$	$0.398(X)^{-0.088}$

X = Mill feed rate, metric tons per day

(4) a tabling circuit handling four size fractions - coarse, medium, fine, and slimes,

(5) a sulfide float cell to remove sulfides from the tungsten concentrate prior to thickening and drying,

(6) a fresh water reservoir, and

(7) a tailings disposal system.

Included in the costs are the successive unit processes of crushing, sizing, jigging, rod mill grinding, spiral classification, table concentration, thickening, and drying. Final tungsten concentrates assay at 60 pct WO_3 with an 86 pct circuit recovery.

The mill is assumed to operate 24 hours/day, 365 days/year. The crushing plant operates 16 hours/day, 365 days/year. All power is generated on site using diesel generators.

Table C-10 presents the capital and operating cost equations developed for this mill. Capital costs are estimated in total dollar amount, and operating costs in dollars per metric ton of mill feed. The model is considered valid for feed rates from 50 to 500 mt/d.

Rare Earth Oxide Flotation Mill Model.

This mill model is designed to produce rare earth oxide concentrates from ore containing approximately 5.0 pct rare earth minerals. The mill configuration is assumed to include:

(1) a crushing plant to prepare mine-run ore for mill feed,

(2) a mill where crushed ore is ground, concentrated by flotation, dewatered and dried,

(3) a storage building where the concentrate is bagged and stockpiled for shipment,

Table C-10. Tungsten Oxide Gravity Mill Cost Model

Cost Component	Capital Cost, $ Equation	Operating Cost, $/mt Equation
Labor	$97481.0(X)^{0.5437}$	$178.290(X)^{-0.3835}$
Equipment	$103998.0(X)^{0.5086}$	$34.000(X)^{-0.4079}$
Steel	$29548.0(X)^{0.5151}$	$2.116(X)^{-0.1099}$
Fuel	$7153.0(X)^{0.55}$	$1.166(X)^{-0.3966}$
Industrial Materials	$1436.0(X)^{0.6777}$	$.340(X)^{-0.0}$
Construction Materials	$20165.0(X)^{0.5741}$	NA

X = Mill feed rate in metric tons per day
NA = Not applicable

(4) a fresh water reservoir, and

(5) a tailings disposal system.

Initially, mine-run ore is crushed to minus 10 cm in a jaw crusher, then fed to a vibrating screen and cone crusher in closed circuit to produce a minus 16 mm product. The crushed ore is conveyed to a surge bin for subsequent feed to the mill.

At the mill, crushed ore is fed to a ball mill in closed circuit with a cyclone. The ball mill grinds the ore to 90 pct passing 325 mesh and 100 pct passing 150 mesh. Ground ore passes to conditioning tanks, where reagents and steam are added in four separate stages. The conditioned feed is then passed through rougher, cleaner, and scavenger flotation cells. Flotation cells use a fatty acid collector at a temperature of about 95 degrees C, and are maintained at a pH of between 8 and 9 with soda ash.

After flotation, rare earth oxide concentrates pass to a thickener, then to drum filters. Concentrates are further dried in rotary drums using heat from the power generation plant. The dried concentrate, which contains 60 pct REO and represents approximately 70 pct recovery, is conveyed to storage bins in a separate concentrate storage building. In the storage building, the concentrate is bagged and stockpiled for shipment.

If uranium minerals are present in the ore, then a nitric acid leach circuit may be added to recover them from the tails of the flotation mill. These tails pass to a series of spirals used to concentrate any uranium minerals that might be present. This concentrate flows to a leach plant where uranium and thoriom are leached using nitric acid, then separated in a solvent extraction circuit. Uranium minerals are then precipitated and dried to produce a final concentrate. It is estimated that approximately 75 pct of the uranium minerals are recovered from an ore that contains approximately 0.1 pct uranium minerals.

Either mill is assumed to operate 24 hours/day, 365 days/year. The crusher plant operates 16 hr/day, 365 days/yr. Make-up water is supplied from a reservoir designed to provide fresh water year round. An estimated 65 pct of mill water is recycled from the thickener, filter, and tailings pond.

Due to the unusual problems of mining and milling in extreme climates and at remote locations several special features were incorporated in the model: (1) all power is generated onsite using diesel generators; (2) the mill and concentrate storage buildings are constructed in modular form at the point of purchase, then transported to the site; (3) covered storage is provided for approximately 90 days of concentrate production in case shipping is interrupted by severe weather; (4) a fresh water reservior supplies water even under freeze conditions; and (5) the tailings facility is designed to contain the entire volume of mill waste produced over the life of the operation in order to eliminate the winter freeze-up potential of open air spigots which are typically used to build up tailings dams.

The operating and capital cost equations developed for this mill model without and with a uranium recovery circuit are shown in tables C-11a and C-11b. They are valid for mill feed rates ranging from 50 to 20,000 mt/d. Capital costs are estimated in total dollars and operating costs in dollars per mt mill feed.

Polymetallic Sulfide Flotation Mill Model.

This mill model was designed to treat ores containing combinations of

Table C-11a. Rare Earth Oxide Flotation Mill Cost Model

Cost Component	Capital Cost, $ Equation	Operating Cost, $/mt Equation
Labor	$6921.0(X)^{0.972}$	$1705.12(X)^{-0.715}$
Equipment	$16858.0(X)^{0.804}$	$48.04(X)^{-0.362}$
Steel	$6165.0(X)^{0.756}$	$1.74(X)^{-0.228}$
Fuel	$360.0(X)^{1.045}$	$3.93(X)^{-0.369}$
Industrial Materials	$198.0(X)^{0.961}$	$3.99(X)^{-0.0}$
Construction Materials	$2692.0(X)^{0.867}$	NA

X = Mill feed rate in metric tons per day
NA = Not applicable

Table C-11b. Rare Earth Oxide Flotation Mill Cost Model with Uranium Recovery Circuit

Cost Component	Capital Cost, $ Equation	Operating Cost, $/mt Equation
Labor	$9341.0(X)^{0.948}$	$1617.07(X)^{-0.655}$
Equipment	$35665.0(X)^{0.751}$	$39.43(X)^{-0.304}$
Steel	$6175.0(X)^{0.755}$	$1.75(X)^{-0.229}$
Fuel	$360.0(X)^{1.045}$	$27.32(X)^{-0.433}$
Industrial Materials	$197.0(X)^{0.961}$	$8.70(X)^{-0.040}$
Construction Materials	$7364.0(X)^{0.815}$	NA

X = Mill feed rate in metric tons per day
NA = Not applicable

copper, lead, and zinc, along with minor amounts of gold and silver. The mill configuration is assumed to include:

(1) a crushing plant which prepares mine-run ore for feed to the mill,

(2) a mill where crushed ore is ground, concentrated by flotation, then dewatered to produce copper, lead, and zinc concentrates,

(3) a fresh water reservoir, and

(4) a tailings disposal system.

Initially, mine-run ore is crushed and sized in a series of crushers and vibrating screens to approximately minus 5/8 inch. Crushed ore is ground in a series of rod mills and passed through a bank of cyclones for size separation. Cyclone oversize is reground using ball mills then pumped back to the cyclones until a minus 200 mesh flotation feed is obtained. Cyclone undersize is mixed with cyanide to depress zinc minerals, then passed to a series of rougher cells where the lead-copper minerals are floated. Copper is then separated from lead in another bank of cells where reagents are added to depress the lead.

All three concentrates are upgraded by additional flotation in sets of rougher and cleaner cells. Middlings from rougher cells and tails from cleaner cells are recirculated to improve recovery. All concentrates are thickened and dried prior to stockpiling for shipment. This mill method is assumed to recover 88 pct of the lead, 85 pct of the zinc, 85 pct of the copper, 78 pct of the gold and 73 pct of the silver in the mill feed.

The mill is assumed to operate 24 hours/day, 365 days/year. Operating cost estimates are based upon anticipated labor, equipment, and supply needs for various mill feed rates. Operating and capital cost equations are presented in table C-12 and are considered valid for operating rates between 50 and 10,000 mt/d. Capital costs are reported in total dollar

Table C-12. Polymetallic Sulfide Flotation Mill Cost Model

Cost Component	Capital Cost, $ Equation	Operating Cost, $/mt Equation
Labor	$26657.81(X)^{0.813}$	$342.407(X)^{-0.583}$
Equipment	$36921.25(X)^{0.725}$	$41.140(X)^{-0.330}$
Steel	$6853.19(X)^{0.826}$	$0.049(X)^{-0.082}$
Fuel	$1811.91(X)^{0.840}$	$2.381(X)^{-0.272}$
Industrial Materials	$971.83(X)^{0.735}$	$0.971(X)^{-0.0}$
Construction Materials	$5425.68(X)^{0.834}$	NA

X = Mill feed rate in metric tons per day
NA = Not applicable

amount; operating costs are reported in dollars per mt mill feed.

Lead-zinc Flotation Mill Model.

This mill model is designed to produce separate lead and zinc concentrates from ore containing between 4.0 and 9.0 pct lead and from 6.0 to 12.0 pct zinc. Main ore constituents are assumed to be galena and sphalerite. Mill configuration is assumed to include:

(1) a crushing plant which prepares mine-run ore for feed to the mill,

(2) a mill where crushed ore is ground, concentrated by flotation, and dewatered to produce lead and zinc concentrates,

(3) a fresh water reservoir, and

(4) a tailings disposal system.

Initially, mine-run ore is crushed and sized in a series of crushers and vibrating screens to approximately minus 5/8 inch. Crushed ore is then ground in rod mills and passed through a bank of cyclones. Cyclone oversize is ground in ball mills then pumped back to the cyclones until a minus 200 mesh flotation feed is obtained. Cyclone undersize is mixed with cyanide to depress zinc minerals, then passed to lead rougher flotation cells where lead minerals are floated. Lead rougher concentrates pass to a bank of cleaner cells where lead minerals are further concentrated. Tails from the cleaner cells and middlings from the rougher cells are re-circulated through the lead flotation circuit. From the cleaner cells, lead concentrates are thickened and dried prior to stockpiling for shipment.

Zinc rich tails from the lead rougher cells flow to a zinc flotation circuit. Zinc minerals are reactivated with copper sulfate then passed to a series of zinc rougher cells where the zinc is floated. Rougher concentrates flow to cleaner cells where zinc minerals are further concentrated. Tails from the cleaner cells and middlings from the rougher cells are re-circulated through the zinc flotation circuit. Tails from the zinc rougher cells flow to the tailings pond. Zinc concentrates are thickened and dried prior to stockpiling.

The mill is assumed to operate 24 hours/day, 365 days/year and to produce a 75 pct lead concentrate and a 60 pct zinc concentrate. The crushing plant is assumed to operate at the same schedule, but is equipped with higher capacity machinery to handle fluctuations in mine production. Approximately 95 pct of the lead, 83.5 pct of the zinc, and 95 pct of the silver present in the initial feed are recovered.

The cost equations presented in table C-13 were used to estimate capital and operating costs at various mill feed rates. They are considered valid for feed rates ranging from 50 to 20,000 mt/d.

Tungsten Oxide Flotation Mill.

This mill is designed to produce tungsten concentrates from ore containing approximately 0.5 pct WO_3. Mill configuration is assumed to include:

(1) a three-stage crushing plant to prepare mill-run ore for grinding,

(2) a two-stage grinding plant where crushed ore is ground by both rod and ball mills,

(3) a flotation plant with dewatering and drying,

(4) a fresh water reservoir, and

(5) a tailings disposal system.

Initially, mine-run ore is crushed and sized in a series of crushers and vibrating screens to approximately minus 3/4 inch. Crushed ore is

Table C-13. Lead-Zinc Flotation Mill Cost Model

Cost Component	Capital Cost, $ Equation	Operating Cost, $/mt Equation
Labor	$23404.0(X)^{0.817}$	$456.963(X)^{-0.609}$
Equipment	$33672.0(X)^{0.716}$	$37.284(X)^{-0.332}$
Steel	$6099.0(X)^{0.830}$	$0.051(X)^{-0.084}$
Fuel	$3057.0(X)^{0.845}$	$2.280(X)^{-0.297}$
Industrial Materials	$874.0(X)^{0.727}$	$0.891(X)^{-0.0}$
Construction Materials	$4801.0(X)^{0.839}$	NA

X = Mill feed rate in metric tons per day
NA = Not applicable

then ground in a series of ball rod mills and passed through a bank of cyclones for size separation. Optimum grind for flotation feed is 65 to 100 mesh.

Ground ore is conditioned in three stages prior to being fed to the flotation cells. The conditioned pulp is then concentrated in sets of rougher and cleaner flotation cells. The concentrate is thickened and dried prior to shipment. The dried concentrates are assumed to contain 15 pct WO_3 with a circuit recovery of 88 pct.

The mill is assumed to operate 24 hours/day, 365 days/year. The crushing plant is assumed to operate 16 hours/day, 365 days/year. Make-up water for the mill is supplied from a reservior designed to provide fresh water year round. All power is generated on site using diesel generators.

Table C-14 presents the capital and operating cost equations developed for this mill. They are considered valid for mill feed rates ranging from 500 to 5,000 mt/d.

Tin Greisen Flotation/Gravity Mill Model.

This mill is designed to produce three products: a low-grade tin flotation product, a high-grade tin product, and a sulfide flotation product. Mill feed grade was assumed to be 1.25 pct Sn with recoverable silver and tantalum potentially present. The general milling scheme includes:

(1) a three-stage crushing plant,

(2) a single-stage primary grinding circuit,

(3) bulk sulfide float followed by regrind and cleaner flotation to develop tin/tantalum/silver concentrate,

(4) tabling of bulk sulfide float tails to recover high-grade tin

Table C-14. Tungsten Oxide Flotation Mill Cost Model

Cost Component	Capital Cost, $ Equation	Operating Cost, $/mt Equation
Labor	$29103.0(X)^{0.7745}$	$635.340(X)^{-0.5552}$
Equipment	$52338.0(X)^{0.659}$	$7.546(X)^{-0.2065}$
Steel	$15443.0(X)^{0.659}$	$2.143(X)^{-0.1391}$
Fuel	$1681.0(X)^{0.819}$	$0.759(X)^{-0.3591}$
Industrial Materials	$148.0(X)^{1.072}$	$6.460(X)^{-0.0}$
Construction Materials	$4427.0(X)^{0.852}$	NA

X = Mill feed rate in metric tons per day
NA = Not applicable

concentrate,

(5) tin flotation of all fines to recover low-grade float tin product,

(6) a fresh water reservoir, and

(7) tailings disposal and water recycling facilities.

Mill-run ore is crushed and sized in a series of crushers and vibrating screens to minus 3/8 inch. The crushed ore is then ground in one or more ball mills, in parallel, to minus 100 mesh for preparation of bulk sulfide float feed.

The ground ore is conditioned by adding the required reagents and then sent to the bulk flotation cell bank. Tails from this flotation unit are directed to the gravity section of the plant where the tin mineral cassiterite is recovered through tabling. The bulk sulfide concentrates are reground to allow reduction of concentrate gangue content through a second flotation stage in cleaner cells.

The table concentrates are reground and sent to a small flotation bank to remove residual sulfides and are then sent to the dewatering section to be filtered and dried. Table tails and fines scalped from the table feed report to the tin flotation section where a low-grade product is recovered in two stages. Total tin recovery is approximately 65 pct.

Table C-15 presents the capital and operating cost equations developed for this mill. They are considered valid for feed rates ranging from 50 to 20,000 mt/d.

Placer Mill Model.

In this model front-end loaders feed a sluice for primary treatment and sluice concentrates are tabled for final cleanup. Two settling ponds are required.

Table C-15. Tin Greisen Mill Cost Model

Cost Component	Capital Cost, $ Equation	Operating Cost, $/mt Equation
Labor	$75621.0(X)^{0.71777}$	$84.540(X)^{-0.3667}$
Equipment	$61423.0(X)^{0.6986}$	$49.710(X)^{-0.35051}$
Steel	$17491.0(X)^{0.7458}$	$0.975(X)^{-0.0}$
Fuel	$5166.0(X)^{0.7454}$	$7.229(X)^{-0.41283}$
Industrial Materials	$3213.0(X)^{0.6151}$	$4.242(X)^{-0.09827}$
Construction Materials	$90076.0(X)^{0.4984}$	NA

X = Mill feed rate in metric tons per day
NA = Not applicable

As for the placer mine model, the tonnage rates used for baseline costing were 27,000, 134,000, 805,000, 2,684,000, and 13,420,000 mt, which correspond to plant capacities of 20, 25, 75, 150, and 250 LCY/h. The estimated costs of each mill capacity were based on actual labor, supply and equipment costs for the various unit processes and adjusted to reflect the higher costs of an Alaskan operation. These values were used to develop a set of capital and operating cost equations through geometric regression. The resultant cost model, shown in table C-8a, can be used to estimate placer milling costs on a per ton of gravel mined basis.

Given a placer deposit of known tonnage, the daily capacity is determined and the milling cost model shown in table C-16 is used to estimate the total capitals and the operating cost per mt of gravel. The cost model is considered valid for mill feed rates ranging from 500 to 20,000 mt/d.

Infrastructure Requirements

Due to the remote location of potential mining and milling sites in central Alaska, infrastructure costs are expected to be significantly higher than those normally incurred in similar types of mining operations in the lower 48 states. In general, the magnitude of these costs will be a function of the type and size of the mining operation, and will include the construction and maintenance of access roads, camp facilities, and on-site power generation facilities.

In order to explicitly take account of these additional costs, three infrastructure cost models were developed: (1) one for surface mines; (2)

Table C-16. Placer Mill Cost Model

Cost Component	Capital Cost, $ Equation	Operating Cost, $/mt Equation
Labor	$2745.900(T)^{0.2578}$	$30.457(T)^{-0.2400}$
Equipment	$11861.000(T)^{0.2220}$	$1.633(T)^{-0.0938}$
Steel	$7.727(T)^{0.2207}$	NA
Fuel	$147.200(T)^{0.2804}$	$1.186(T)^{-0.1059}$
Construction Materials	$1476.300(T)^{0.2460}$	$0.184(T)^{-0.1909}$

T = Total resource in metric tons
NA = Not applicable

one for low tonnage underground mines, such as a cut-and-fill mine; and (3) one for high tonnage underground mines, such as a room-and-pillar mine. To develop each model, various daily tonnages and mine methods were used to derive the associated infrastructure costs. Regional cost factors were used to escalate these costs to reflect the increased expense of infrastructure development in Alaska. Operating and capital cost equations were then developed for each infrastructure model through the use of geometric regression.

The infrastructure cost model for surface mining operations is presented in table C-17a. The equations are considered valid for daily tonnages ranging from 1,000 to 100,000 mt/d. The infrastructure cost model for low tonnage underground mining operations is shown in table C-17b. This model is appropriate for all low tonnage mining operations, including shrinkage stoping, cut and fill, and square set mining. It is considered valid for daily tonnages ranging from 200 to 5,000 mt/d. Finally, the infrastructure cost model for high tonnage underground mining operations is shown in table C-17c. This model is appropriate for all high tonnage mining operation, including room and pillar, verical crater retreat, and block caving. It is considered valid for daily tonnages ranging from 2,000 to 50,000 mt/d.

To determine the full cost of mining activity associated with a particular deposit, the appropriate infrastructure model was combined with the applicable mine and mill models. A road toll charge of $.60/per ton of ore mined was also applied.

Table C-17a. Surface Mine Infrastructure Cost Model

Cost Component	Capital Cost, $ Equation	Operating Cost, $/mt Equation
Labor	$597164.0(X)^{0.4158}$	$126.64(X)^{-0.6333}$
Equipment	$109597.0(X)^{0.5365}$	$16.45(X)^{-0.4138}$
Steel	$57301.0(X)^{0.0462}$	$9.87(X)^{-1.0074}$
Fuel	$22814.0(X)^{0.4396}$	$15.52(X)^{-0.3360}$
Chemicals	$23094.0(X)^{0.4620}$	$9.15(X)^{-0.2611}$
Industrial Materials	$12389.0(X)^{0.4485}$	$103.90(X)^{-0.5522}$
Construction Materials	$312122.0(X)^{0.4833}$	NA

Table C-17b. Small Underground Mine Infrastructure Cost Model

Cost Component	Capital Cost, $ Equation	Operating Cost, $/mt Equation
Labor	$495283.0(X)^{0.5241}$	$150.99(X)^{-0.5753}$
Equipment	$170884.0(X)^{0.5013}$	$28.17(X)^{-0.4469}$
Steel	$72575.0(X)^{0.0153}$	NA
Fuel	$94708.0(X)^{0.2461}$	$47.71(X)^{-0.4419}$
Chemicals	$117469.0(X)^{0.2388}$	$10.58(X)^{-0.2706}$
Industrial Materials	$5247.0(X)^{0.5775}$	$79.60(X)^{-0.4227}$
Construction Materials	$285314.0(X)^{0.5742}$	NA

Table C-17c. Large Underground Mine Infrastructure Cost Model

Cost Component	Capital Cost, $ Equation	Operating Cost, $/mt Equation
Labor	$495799.0(X)^{0.4916}$	$157.51(X)^{-0.6118}$
Equipment	$166391.0(X)^{0.5050}$	$26.05(X)^{-0.4453}$
Steel	$71071.0(X)^{0.0186}$	NA
Fuel	$86637.0(X)^{0.2597}$	$45.70(X)^{-0.4357}$
Chemicals	$106549.0(X)^{0.2537}$	$10.52(X)^{-0.2698}$
Industrial Materials	$4493.0(X)^{0.5587}$	$67.94(X)^{-0.4411}$
Construction Materials	$265549.0(X)^{0.5529}$	NA

X = Metric tons of ore mined daily
NA = Not applicable

APPENDIX D. — DESCRIPTION OF THE POTENTIAL SUPPLY ANALYSIS COMPUTER MODEL

The Potential Supply Analysis Computer Model (PSACM) is coded in FORTRAN and runs on an IBM 3090 mainframe. The program simulates and evaluates the potential supply of minerals from a particular geographic region by combining specific probability estimates of geologists, mining engineers and mineral economists in a Monte Carlo Simulation. A prospective deposit is defined by random sampling from probability distributions to determine its depth, tons of ore, contained metals and their respective average grades. A state of nature (SON) is defined by the collection of deposits simulated during a single pass of the model. Monte Carlo techniques are used to generate a large number of SONS.

Each SON is evaluated to determine the portion of the mineral endowment which might be economically produced under certain cost and metal price assumptions. Mine, mill and infrastructure cost models are used to compute the costs of extracting and processing the metals contained in each simulated deposit. Annual cash flows are computed and the net present value (NPV) is determined. A deposit is assumed to be economically feasible if its NPV is greater than or equal to zero. The recoverable metal quantities and NPV for each economic deposit are accumulated and used to develop probability distributions of the quantities and values of the potentially economic resources from the area.

Input Requirements

The input data for the PSACM consists of two data files (tables D-1 and D-2). Table D-1 describes the geographic, geologic and engineering data needed for the simulation, as well as data which direct the execution of the simulation, such as control codes for the Monte Carlo simulation and economic evaluation, file names and options and report options.

The geographic data describes how the region is to be evaluated from a geographic or activity area perspective. An activity area is a geographically bounded section of the larger area. It may include portions of, or all of, one or more of the specific mineral terranes being considered in the evaluation. The activity area designation is particularly important when alternative land-use classifications are being considered. The geologic data describes the mineral terranes or deposit types which are being evaluated. Each mineral terrane to be evaluated is described by probability distributions which specify the number of potential prospects or deposits, deposit sizes, depths, and the average grades for each of the contained metals. Engineering inputs define the combinations of mine, mill and infrastructure cost models that are to be used for the economic evaluation of specific types of deposits.

The second data file (table D-2) specifies the metal prices and units information.

Table D-1. The Potential Supply Analysis Computer Model Input File.

I. Simulation Control Data

Record 1:

		Format
TITLE	title of the potential supply simulation	A80

Record 2:

ISEED	starting seed for random number generator	I10
NTERR	number of terranes (deposit types)	I4
NFRAC	number of output fractiles for resource endowment data	I4
NACT	number of activity areas	I4
NPASS	number of Monte Carlo passes	I4
IFLRSK	do full-risk reporting for economic runs 0 —> no 1 —> yes	I4
NPRINT	level of optional print 0 —> no optional print 1 —> input echo check 2 —> input echo check plus SON lists	I4
NCOMNT	number of comments	I4
IECON	0 —> endowment simulation only 1 —> simulate economics	I4
DISFAC	discounting factor for calculating NPV	F5.3

(Table D-1. cont.)

		Format
Record 3:		
PRICEFL	title of price file	A20
ISONFILE	SON file option	I1
	0 --> do not create nor use a SON file	
	1 --> create a SON file	
	2 --> read a specified SON file	
SONFILE	SON file name	A20
IECONFIL	ECON file option	I1
	0 --> do not create an ECON file	
	1 --> create an ECON file	
ECONFILE	ECON file name	A20
IIOFILE	IO file option	I1
	0 --> do not create an IO file	
	1 --> create an IO file	
IOFILE	IO file name	A20
Record 4:		
FA(11)	up to 11 output probability fractiles	11F7.4

II. Activity Area Data

Record 1 to 1+NACT:		
ACTNAM	name of activity area	A20
REGINC	include in regional summary	A3
	Y,YES,N,NO	
ASONINC	include in state-of-nature file	A3
	Y,YES,N,NO	
Records 1+NACT+1 TO 1+NACT+1+NCOMNT:		
COMMENT	comment to be printed	A80

(Table D-1. cont.)

III. Mineral Terrane Data (repeated NTERR times)		
Terrane record 0:		
	dummy comment record for input only	
Terrane record 1:		
TERR	terrane name	A20
DTYPE	deposit type	A20
NCOMMODS	number of commodities potentially present	I4
NMODS	number of inf/mine/mill model combinations (may be 0 for an endowment run)	F4
TSONINC	include terrane in results Y,YES,N,NO	A3
Terrane record 2:		
ACTPROB	given that a deposit exists, probability that a deposit within this terrane will be within each activity area	15F6.3
Terrane record 3:		
AFCTR	number of factors which determine regional favorability (up to 5)	I2
RFCTR	factor values	5F6.3
Terrane record 4:		
PRSPRO	probability that a prospect is a deposit	F6.3
DEPPRO	probability of undiscovered deposits	F6.3
PROS	number of prospects distribution	8F8.1

(Table D-1. cont.)

<u>Terrane record 5 (all values specified in millions of tons)</u>:		
TONMIN	minimum tonnage (for non-cd distributions)	F10.3
TONMAX	maximum tonnage (for non-cd distributions)	F10.3
TONTYPE	type of distribution for tonnage	A10
CD	—> conditional probability (fractiles)	
NORMAL	—> normal (mean, std. dev.)	
LOGNORMAL	—> lognormal	
LOGNORMCOR	—> lognormal correlated to another distribution (mean, std. dev., rho)	
UNIFORM	—> uniform (min, max)	
UNKNOWN	—> simulation stops	
CDTON	conditional deposit tonnage distribution (or parameters)	8F11.1
<u>Terrane record 6</u>:		
DPTHMIN	minimum depth	F10.3
DPTHMAX	maximum depth	F10.3
DPTHTYPE	type of distribution for depth	A10
CDDPTH	conditional deposit depth distribution	8F11.1
<u>Terrane record 7 through 7+NMODS</u>:		
INFMOD	infrastructure model subroutine name	A6
MINMOD	mine model subroutine name	A6
MILMOD	mill model subroutine name	A6
PSTMOD	post mill model	A6

(Table D-1. cont.)

<u>Terrane records 7+NMODS through 7+NMODS+NCOMMODS</u>:

CSYMB	commodity symbol	A2
PSIND	type of commodity	A2
	P1 --> primary commodity	
	P --> primary commodity	
	S --> secondary commodity	
OCCPROB	commodity occurrence probability	F8.5
GRDMIN	minimum grade (for non-cd distributions)	F10.6
GRADMAX	maximum grade (for non-cd distributions)	F10.6
GRDTYPE	type of distribution for grade	A10
AVGGRD	average grade distribution	
	(fractiles or parameters)	8F10.6

Table D-2. Commodity Price File Description.

VARIABLE NAME	DESCRIPTION	TYPE & FORMAT
1. CNAME	Commodity name	Alphanumeric (Line 1, A20)
2. CSYM	Commodity symbol	Alphanumeric (Line 1, A2)
3. GFCTR	Grade conversion	Real (Line 1, F4.0)
4. PRICE	Commodity unit price	Real (Line 1, F10.3)
5. KOUNITS	Output units label indicator	Integer (Line 1, I2)
KOUNITS = 01	a. 10E3 tons	
KOUNITS = 02	b. 10E3 oz	
KOUNITS = 03	c. tons	
6. CFCTR	Output conversion factor	Real (Line 1, F9.6)
7. OUTPRICE	Output price label e.g.($0.19/lb), ($12.10/oz)	Alphanumeric (Line 1, A12)

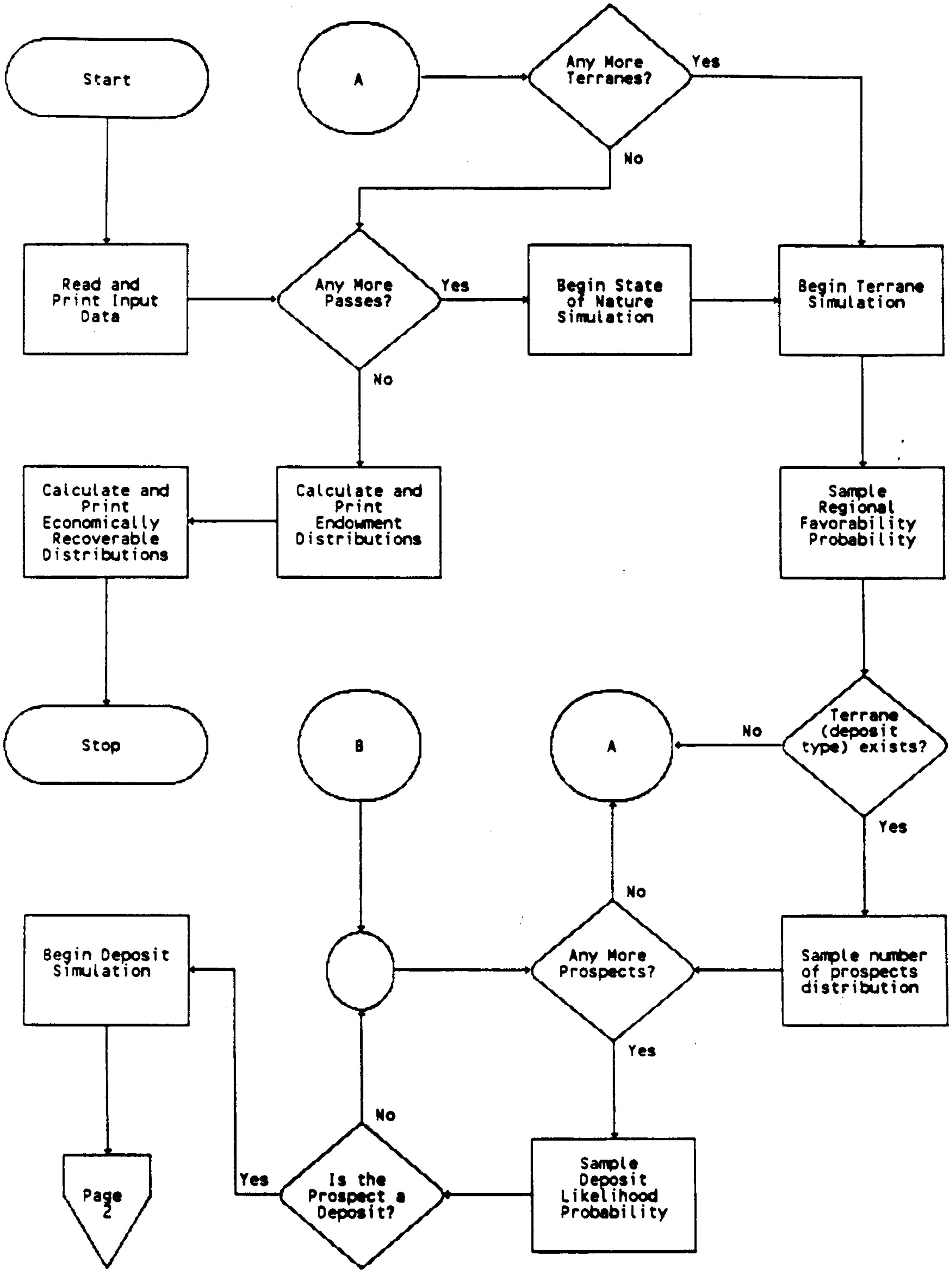
Note: Items 1 through 7 are repeated once for each potentially recoverable commodity assessed.

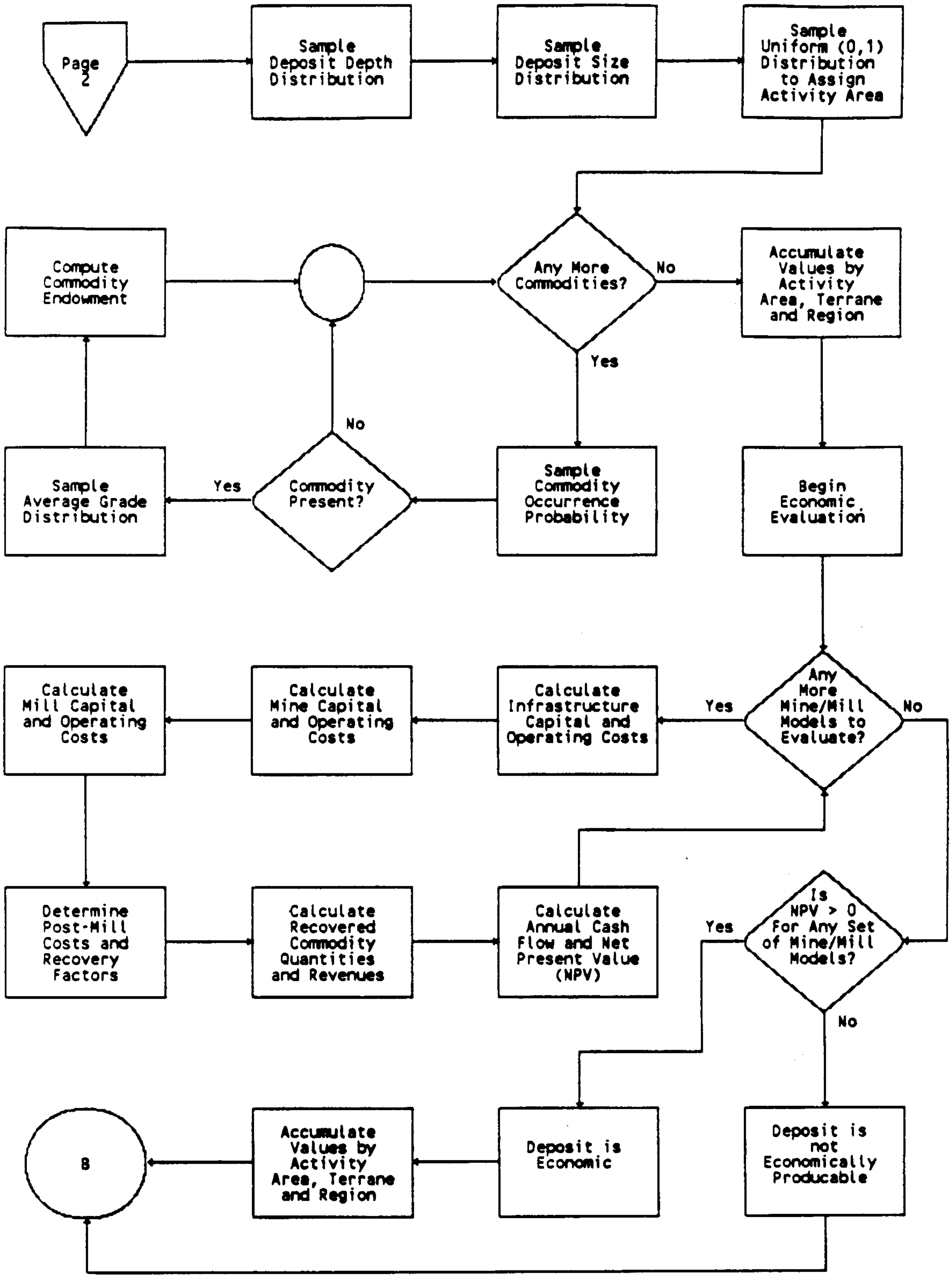
Model Description

Each repetition or "pass" of the model simulates one possible state of nature. Information about the geologic endowment and economically recoverable resources is saved for each SON and each deposit and used to develop output distributions by terrane and by activity area. Figure D-1 provides a flow chart of the computer program. In general, the program performs the following steps during each pass to generate and evaluate a feasible state of nature:

1. Sample against the regional favorability probability to simulate if a particular terrane is favorable for the formation of deposits in this state of nature.
2. If the terrane is favorable, sample from the number of prospects distribution to determine the number of prospects to be tested.
3. For each prospect, sample against the deposit likelihood probability to determine if the prospect meets the threshold size, depth and grade criteria to be considered a deposit.
4. If the prospect is a deposit, sample from the deposit size distribution to determine the tonnage of ore present.
5. Sample from the deposit depth distribution.
6. Determine which activity area contains the deposit by sampling from a uniform (0,1) distribution.

Figure D-1. Potential Supply Analysis Computer Program





Page 2
Sample Deposit Depth Distribution
Sample Deposit Size Distribution
Sample Uniform (0,1) Distribution to Assign Activity Area
Compute Commodity Endowment
Any More Commodities?
No
Accumulate Values by Activity Area, Terrane and Region
Yes
No
Sample Average Grade Distribution
Yes
Commodity Present?
Sample Commodity Occurrence Probability
Begin Economic Evaluation
Calculate Mill Capital and Operating Costs
Calculate Mine Capital and Operating Costs
Calculate Infrastructure Capital and Operating Costs
Yes
Any More Mine/Mill Models to Evaluate?
No
Determine Post-Mill Costs and Recovery Factors
Calculate Recovered Commodity Quantities and Revenues
Calculate Annual Cash Flow and Net Present Value (NPV)
Yes
Is NPV > 0 For Any Set of Mine/Mill Models?
No
B
Accumulate Values by Activity Area, Terrane and Region
Deposit is Economic
Deposit is not Economically Producable

7. Sample against each primary and secondary commodity occurrence probability to determine which commodities are present in the deposit.
8. Sample the average grade distribution for each commodity present.
9. Compute the endowment of each commodity as ore tonnage times average grade.
10. For each mine/mill/infrastructure combination possibility, calculate the net present value (NPV) of the deposit as shown in steps 11 through 15. Select the mining and milling methods which result in the largest NPV. If the NPV is greater than zero, it is assumed that the deposit is an economically viable operation.
11. Calculate the capital and operating costs for infrastructure, mining and milling.
12. For each metal present, compute the recovered metal as quantity times average grade times mine recovery factor times mill recovery factor times postmill recovery factor. Calculate the revenue as total recovered metal times price times the postmill paid-for proportion.
13. Compute the transportation, treatment and reinvestment costs.
14. Compute annual cash flow for the development and production years.

15. Use the discounting factor to calculate the NPV of the cash flow. (steps 3 through 15 are repeated for each prospect)

16. Accumulate totals across all economic deposits (steps 1 through 16 are repeated for each deposit type).

17. Accumulate totals across all deposit types.

18. Calculate summary statistics and print results.

EXAMPLE ECONOMIC ANALYSIS OF A HYPOTHETICAL TIN GREISEN DEPOSIT

In order to illustrate the evaluation procedures used to determine if a deposit would be potentially economic (steps 10 through 15 above, a hypothetical tin greisen deposit is examined below. Calculations are performed to determine if the deposit is potentially economic to develop and produce. The procedure is based upon cash flow analysis and includes a determination of the least-cost mining method. Amounts of each metal recovered and associated market values are also determined.

The physical characteristics of the example deposit are as follows:

ore body size:	85,000,000 metric tons,
depth of burial of ore body:	120 meters,
average tin grade:	0.4 pct, and
average silver grade:	0.3 troy ounces per short ton.

These values are within the parameters specified for potential deposits of this type in the Lime Peak area.

The economic evaluation of the deposit consists of four steps:

Step 1. Calculate mine life and daily operating rate,

Step 2. Compute capital and operating costs for infrastructure, the mine and the mill,

Step 3. Determine postmill recoveries, treatment and transportation costs, and revenues to the mine/mill owner/operator, and

Step 4. Calculate annual cash flows and the net present value (NPV).

These steps are performed for each feasible mining method. The least-cost mining method is the one which yields the greatest NPV. For tin greisen deposits in the study area, there are three possible mining methods: open pit (surface), cut and fill (underground), or vertical crater retreat (underground). The appropriate underground mining method is determined by the size of the deposit. If the rate of production is less than 2,000 metric tons per day, cut and fill is used. Otherwise, vertical crater retreat is the selected underground mining method. Thus, for a specific tin greisen deposit, two sets of calculations are made: one for open pit operations and one for the appropriate underground mining method.

Step 1: Calculate Mine Life and Daily Operating Rate

The mine life is calculated using Taylor's rule:

$$L = 0.2 * (FT)^{0.25}$$

where T is the ore body size in metric tons and F is the mine recovery factor.

For this study, mine recovery is assumed to be 100 pct for underground mines and 93.12 pct for open pit mines. Thus, the mine life for the hypothetical deposit is 18 years if it is developed as an open pit mine and 19 years if it is developed as an underground mine.

Metric tons of ore mined per day is calculated as

$$TPD = (FT)^{0.75}/70.$$

This equals 12,646 metric tons per day for the example deposit and since it exceeds the 2,000 TPD cut-off value for use of the cut-and-fill method, vertical crater retreat is the appropriate underground mining method for this deposit. The metric tons of ore mined per day for open-pit operations is 11,988. In open pit mining, the total tons mined per day is the number of tons of ore mined per day times one plus the stripping ratio. Assuming an ore body geometry of a lozenge with fixed proportions,

$$SR = (5.9361/T)\ (D+0.5943T^{1/3})^{3}-1.0381$$

where SR is the stripping ratio,

T is the ore body size in metric tons, and

D is the depth to the top of the deposit in meters.

Thus for the example deposit, the stripping ratio is 1.851 and the total tons of ore and waste mined per day is 46,168.

Step 2: Calculate Capital and Operating Costs

Using the equations from Appendix C, the costs are as follows:

	Open Pit	Underground
Infrastructure Capital	$150,333,870	$157,451,523
Infrastructure Opcosts	$25,607,538	$18,136,720
Mine Capital	$71,381,382	$113,781,073
Mine Opcosts	$64,648,579	$65,284,807
Mill Capital	$138,987,579	$144,290,761
Mill Opcosts	$31,208,134	$32,477,700

The operating costs are calculated on an annual basis by multiplying the operating cost per ton by the total number of tons mined annually.

Step 3: Calculate Revenues, Postmill Recoveries, and Postmill Cost

	Open Pit	Underground
Tons of ore mined annually, mt	4,195,816	4,426,100
Tin		
grade	0.004	0.004
recovered from mine, mt	16,783.26	17,704.40
mill recovery factor	0.75	0.75
recovered from mill, mt	12,587.45	13,278.30
Transportation charges $/mt	$218.00	$218.00
transportation charges	$2,744,064	$2,894,669

postmill recovery factor	0.98	0.98
available to market, mt	12,335.70	13,012.73
price, $/lb	$8.36	8.36
price, $/mt	$18,425.44	$18,425.44
annual value on market	$227,290,70	$239,765,350
paid for rate	0.95	0.95
revenues to mine operator	$215,926,165	$227,777,082
Silver		
grade	0.0000102857	0.0000102857
recovered from mine, mt	43.15690	45.52554
mill recovery factor	0.70	0.70
recovered from mill, mt	30.20983	31.86788
postmill recovery factor	0.98	0.98
available to market, mt	29.60564	31.23052
price, $/troy ounce	$14.40	$14.40
price, $/mt	$462,840.00	$462,840.00
annual value on market	$13,702,672	$14,454,733
paid for rate	0.70	0.70
revenues to mine operator	$9,591,871	$10,118,313

Tons of ore mined annually is calculated as tons of ore mined per day times 350 days of operation per year. Treatment charges are assessed for some commodities in the study area and are calculated in the same fashion as transportation charges.

Step 4: Calculate Annual Cash Flow and Net Present Value

The model assumes that a three year period is necessary prior to any mine, mill or infrastructure development in order to do exploration, perform feasibility studies and complete the permitting process. This lag period may be different for other deposit types.

For an open pit operation, development of the mine, the mill and infrastructure is assumed to take two years. Thus half of the total capital costs are spent in each of the two development years.

For an underground operation, development of the mine is assumed to take three years; mill and infrastructure development is assumed to take two years. One third of the mine capital costs are therefore spent in the first year of development. In the second and third years of development, one third of the mine capital costs and one half of the mill and infrastructure capital costs are spent.

For the example deposit, the cash flow for the years prior to production is as follows:

Year	Open Pit	Underground
1	0	0
2	0	0
3	0	0
4	-180,351,424	-37,927,024
5	-180,351,424	-188,798,166
6	production begins	-188,798,166

Once production begins, annual cash flow is computed from the following components:

	Open Pit	Underground
Tin revenues	$215,926,165	$227,777,082
Silver revenues	9,591,871	$10,118,313
Transportation costs	-$2,744,064	-$2,894,669
Road toll charges	-$2,517,490	-$2,655,660
($0.60/ton of ore mined annually)		
Opcosts		
Infrastructure	-$25,607,538	-$18,136,720
Mine	-$64,648,579	-$65,284,807
Mill	-$31,208,134	-$32,477,700
Reinvestment as a percentage of original capital costs		
3 pct inf.	-$4,510,016	-$4,723,546
5 pct mine	-$3,569,069	NA
6 pct mine	NA	-$6,826,864
3 pct mill	-$4,169,627	-$4,328,723
Total Annual Cash Flow	$86,543,519	$100,566,706

The open pit operation has a producing life of 18 years. Thus the open pit operation has a cash flow of $86,543,519 for years 6 through 23. The underground operation has a producing life of 19 years. Thus years 7 through 25 have a cash flow of $100,566,706.

Net present value is calculated from the cash flows using a discounting factor of 15 pct. This rate includes both expected inflation and a rate of return on investment for the mine/mill owner/operator. This discounting factor can be changed in the potential supply analysis computer program.

Net present value is the sum over all years of the cash flow times a discounting multiplier. The discounting multiplier is calculated as

DM = 1/(1+DF)**(YR)

where DM is the discounting multiplier,

DF is the discounting factor as a decimal value,

YR is the year.

Using this method, the net present value of the open pit operation equals $88,032,390 and the net present value of the underground operation equals $95,026,778. Therefore, for this deposit the least cost method of development is by underground mining.

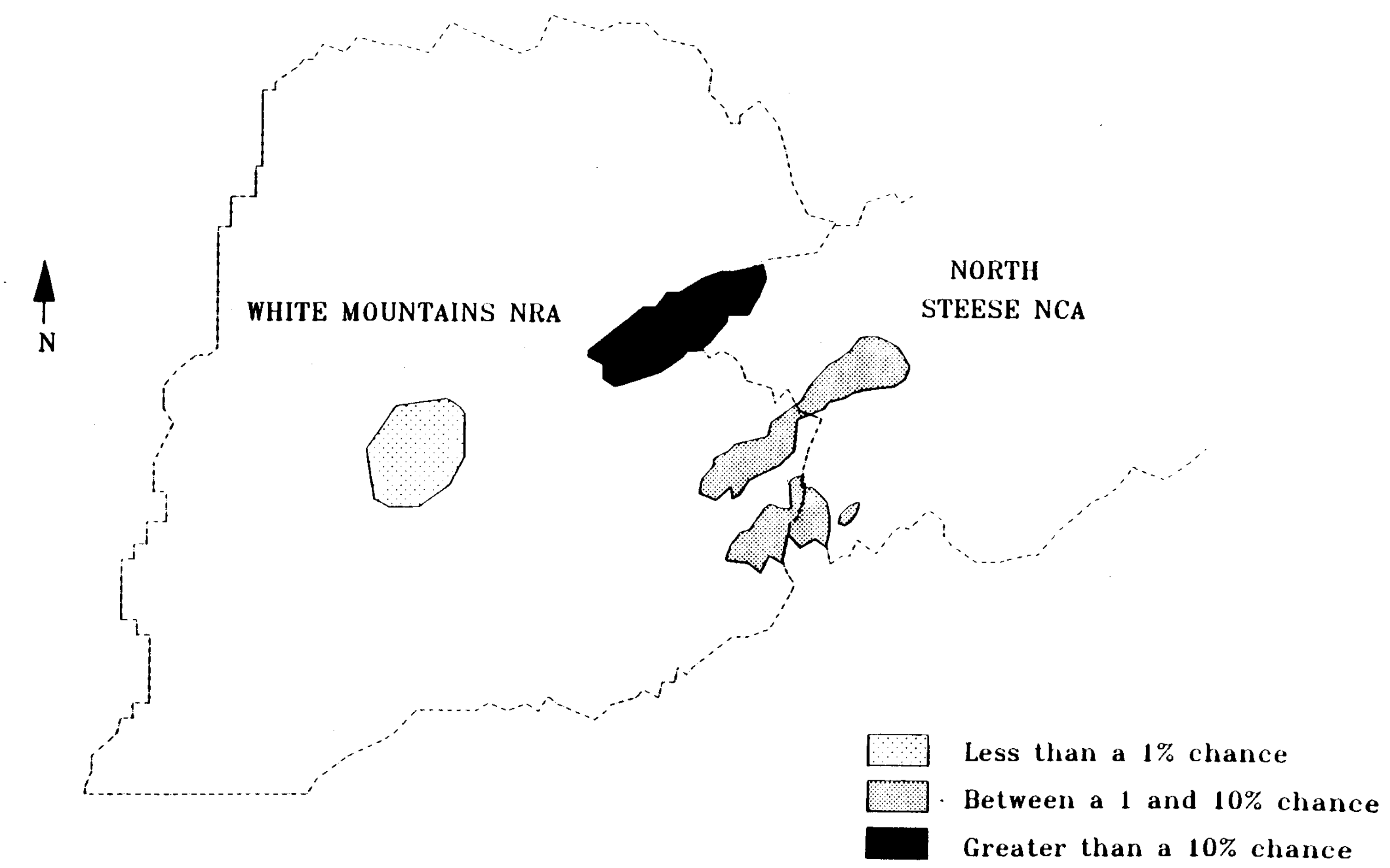
APPENDIX E-- CHARACTERISTICS OF POTENTIALLY ECONOMIC DEPOSITS IN THE WMNRA/SNCA STUDY AREA

Additional information regarding the mineral supply potential of the assessed deposit types in the WMNRA/SNCA study area is presented in this Appendix. The information compiled for each deposit type includes a map which shows the location of those area(s) identified as geologically favorable for the specific type of deposit and indicates their relative likelihood of containing potentially economic resources; summary statistics which describe the size and contained metal attributes of potentially economic deposits of that type at current contained metal prices; summary statistics which describe the size and contained metal attributes of potentially economic deposits at two-times-current metal prices; and the types, average life and net present value (NPV) of the associated mining and milling operations.

Potentially Economic Tin Greisen Deposits

Figure E-1 shows those tracts of land in the study area which have been identified as geologically favorable for the occurrence of tin greisen deposits. Specifically, the permissive areas are in the vicinity of Cache Mountain, Lime Peak, Quartz Creek and Mt. Prindle. Deposits of this type typically contain various amounts of tin, tantalum, tungsten and silver. Tin, tantalum and tungsten are designated critical and strategic minerals.

Figure E-1. Likelihood of Economic Tin Greisen Deposits in the Study Area at Two Times Current Prices



The results of the potential supply analysis indicate that the undiscovered tin greisen deposits which may exist within the identified favorable areas are not expected to contain economically recoverable resources at current mineral prices (table E-1).

At two-times-current contained metal prices the results of the potential supply analysis indicate that there is about a 20 percent chance that some of the undiscovered tin greisen deposits which might exist within the study area could contain economically recoverable metals (table E-1). Economic deposits are most likely to exist in the vicinity of Lime Peak (15 percent chance) and least likely to exist in the vicinity of Cache Mountain (fig. E-1). Given that they do exist, at the 90 percent confidence level, economic deposits are estimated to range from approximately 26 million to 99 million tons of ore in size, with an average size of 66 million tons of ore, and contain from 110 thousand to 350 thousand tons of recoverable tin, with an average of 229 thousand tons, and from 480 thousand to 25 million recoverable ounces of silver, with an average of 6.8 million ounces. There is also a very small chance that recoverble quantities of tantalum could be present. Tungsten is typically not recovered from this type of deposit. Given that deposit development does occur, at two times current contained metal prices, on average, the market value of production is estimated to be approximately $139.7 million.

At this price level the total number of potentially economic tin greisen deposits is estimated to range from one to three, given that such deposits do exist. The mining and milling methods used in the development of deposits of this type typically consist of either an open-pit, VCR or cut-and-fill mine, depending on the size and depth of the deposit, in

Table E-1. Characteristics of Potentially Economic Tin Greisen Deposits

Economic Deposit Attributes	Average	Fractiles 95%	50%	5%
A. At Current Prices (Sn-$4.18/lb, Ta-$22.00/lb, Ag-$6.20/oz):				
Likelihood of at least one economic deposit: 0.0				
B. At Two Times Current Prices (Sn-$8.36/lb; Ta-$44.00/lb; Ag-$14.40/oz):				
Likelihood of at least one economic deposit: 0.2				
Likelihood of economic activity in Lime Peak area: 0.15				
Quartz Cr area: 0.03				
Mt. Prindle area: 0.02				
Cache Mtn area: 0.0				
Economic Deposit Size (10^6 st)	66.6	26.0	70.0	99.0
Recoverable Sn (10^3 st)	229.1	110.0	240.0	350.0
Recoverable Ag (10^3 oz)	6789.2	480.0	3200.0	25000.0
Recoverable Ta (10^3 st)	.4	0.0	0.0	2.4
Conditional no. of economic deposits: 1 to 3				
Mining methods: Open-pit, Cut-and-fill or VCR				
Milling methods: Sn flotation or gravity with a silver recovery circuit				
Mine life: 12 to 20 years				
Net present value of deposit ($\$10^6$)	111.3	8.9	100.0	270.0

combination with either a tin gravity or flotation mill plus a silver recovery circuit, depending on the grades of the contained metals. The mine life is estimated range from 12 to 20 years, with an average of 17 years. The net present value, or economic value, of a prospective mining operation is estimated to range from $8.9 million to $270 million, at the 90 percent confidence level, with an average value of $111.3 million.

Potentially Economic Alkalic-associated Gold Deposits

Figure E-2 shows those tracts of land in the study area which have been identified as favorable for the occurrence of alkalic-associated gold deposits. The areas are in the vicinity of Quartz Creek and Table Mountain. Deposits of this type contain various amounts of gold and are bulk mineable.

The results of the potential supply analysis at current gold prices indicate that there is only a 4 percent chance that some of the alkalic-associated gold deposits which might exist in the study area could contain economically recoverable gold (table E-2). Given that such deposits do exist, they are more likely to be present in the vicinity of Table Mountain than in the vicinity of Quartz Creek. At the 90 percent confidence level, economic deposits are estimated to range in size from 12 million to 60 million tons of ore, with an average size of 29 million tons, and contain from 2.5 million to 9.8 million ounces of recoverable gold, with an average of 4.8 million ounces. Given that deposit development does occur, there is a 95 percent chance that the value of the gold produced could exceed $1.1 billion at gold prices of $444.00/oz.

Figure E-2. Likelihood of Economic Alkalic-associated Gold Deposits in the Study Area at Two Times Current Prices

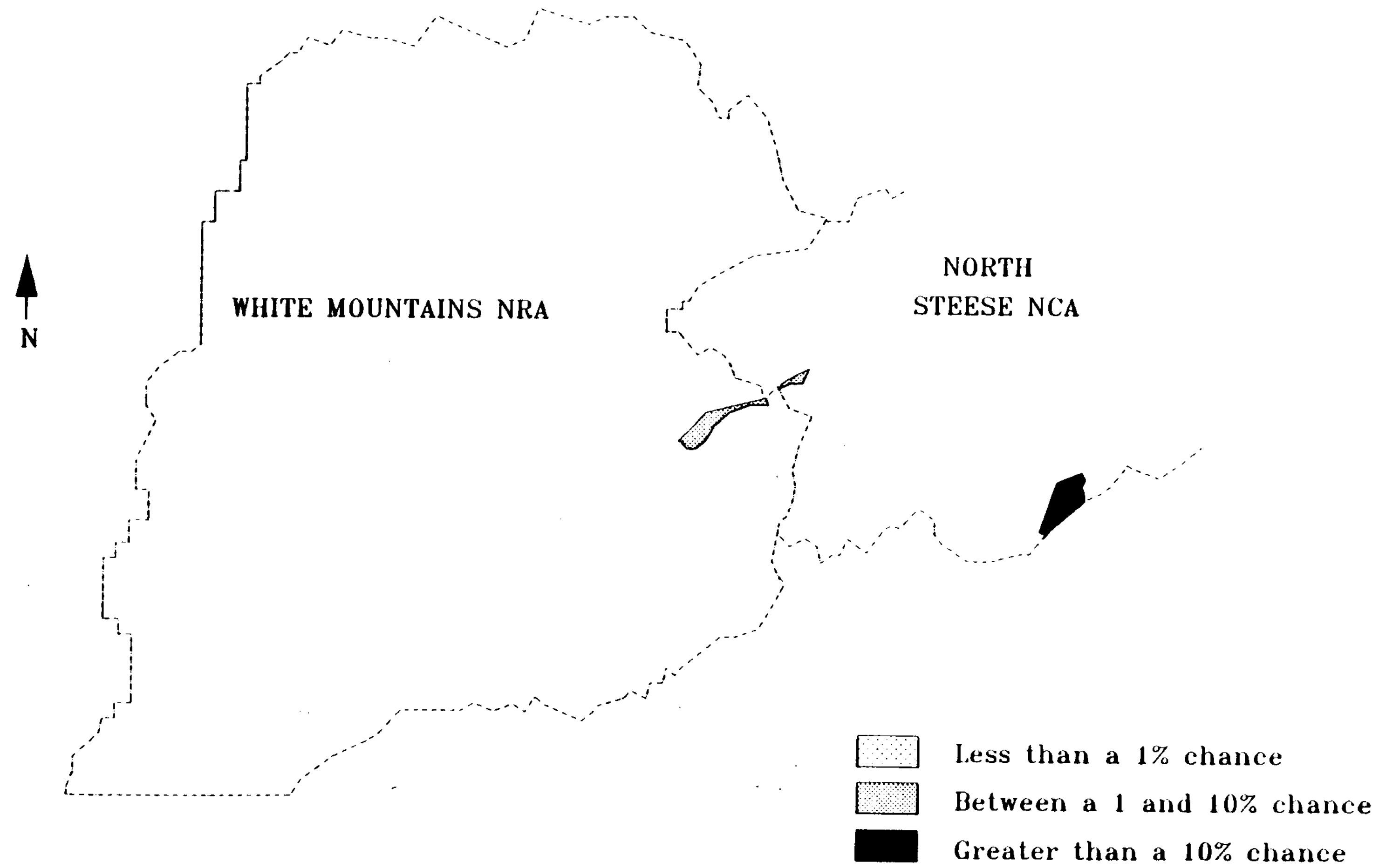


Table E-2. Characteristics of Potentially Economic Alkalic-associated Gold Deposits

Economic Deposit Attributes	Average	Fractiles 95%	50%	5%
A. At Current Prices (Au-$444.00/oz):				
Likelihood of at least one economic deposit: 0.04				
Likelihood of economic activity in Quartz Cr area: 0.005				
Table Mtn area: 0.035				
Economic Deposit Size (10^6 st)	29.1	12.0	25.0	60.0
Recoverable Au (10^3 oz)	4794.4	2500.0	4200.0	9800.0
Conditional no. of economic deposits: 1				
Mining methods: Open-pit or VCR				
Milling methods: Heap leaching or CIP leaching				
Mine life: 10 to 19 years				
Net present value of deposit ($\$10^6$)	73.9	220.0	330.0	670.0
B. At Two Times Current Prices (Au-$888.00/oz):				
Likelihood of at least one economic deposit: 0.22				
Likelihood of economic activity in Quartz Cr area: 0.02				
Table Mtn area: 0.20				
Economic Deposit Size (10^6 st)	18.7	3.8	17.0	46.0
Recoverable Au (10^3 oz)	2231.6	600.0	1900.0	4900.0
Conditional no. of economic deposits: 1 to 3				
Mining methods: Open-pit or VCR				
Milling methods: Heap leaching or CIP leaching				
Mine life: 7 to 19 years				
Net present value of deposit ($\$10^6$)	134.3	3.2	84.0	440.0

At this price level only one potentially economic alkalic-associated gold deposit is estimated to exist, given that such deposits do exist. The mining and milling methods used in the development of this type of deposit typically consist of either an open-pit or VCR mine, depending on the size and depth of the deposit, in combination with either heap or CIP leaching, depending on the grade of the gold. The mine life is estimated to range from 10 to 19 years, with an average mine life of 14 years. At current gold prices, the net present value of a prospective mining operation is estimated to range from $220 million to $670 million, at the 90 percent confidence level, with an average value of $73.9 million.

At two times current gold prices the results of the potential supply analysis indicate that there is a significantly higher likelihood (a 22 percent chance) that some of the alkalic-associated gold deposits which might exist in the study area could contain economically recoverable metals (table E-2). Again, given that such deposits do exist, they are far more likely to be present in the vicinity of Table Mountain than in the vicinity of Quartz Creek (fig. E-2). Since some of the smaller deposits become economic to produce at this higher gold price, at the 90 percent confidence level, economic deposits are now estimated to range in size from 3.8 million to 46 million tons of ore, with an average size of 18.7 million tons, and contain from 600 thousand to 4.9 million ounces of recoverable gold, with an average of 2.2 million ounces. Should deposit development occur, there is a 95 percent chance that, at twice current gold prices, or $888.00/oz, the value of the gold produced could exceed $532 million

At this price level the total number of potentially economic alkalic-associated gold deposits is estimated to range from one to three. The mining and milling methods expected to be used are the same as above, however, because smaller deposits become economic to produce, the mine life is now estimated to range from 7 to 19 years, with an average mine life of 12 years. At two times current gold prices, the net present value of a prospective mining operation is estimated to range from $3.2 million to $440 million, at the 90 percent confidence level, with an average value of $134.3 million.

Potentially Economic Sediment-hosted Lead-Zinc Deposits

Figure E-3 shows the tract of land in the study area which has been identified as geologically favorable for the occurrence of sediment-hosted lead-zinc deposits. Specifically, the permissive area is located in the northeasternmost part of the WMNRA. Deposits of this type typically contain various amounts of lead, zinc and silver. Lead and zinc are classified as critical and strategic minerals.

The results of the potential supply analysis indicate that the undiscovered lead-zinc deposits which might exist within the identified favorable area are not expected to contain economically recoverable resources at current metal prices (table E-3).

At two times the current contained metal prices the results of the potential supply analysis indicate that there is about a 7 percent chance that at least one of the undiscovered lead-zinc deposits which might exist could contain economically recoverable metals (fig. E-3,table E-3). At

Figure E-3. Likelihood of Economic Sediment-hosted Pb-Zn Deposits in the Study Area at Two Times Current Prices

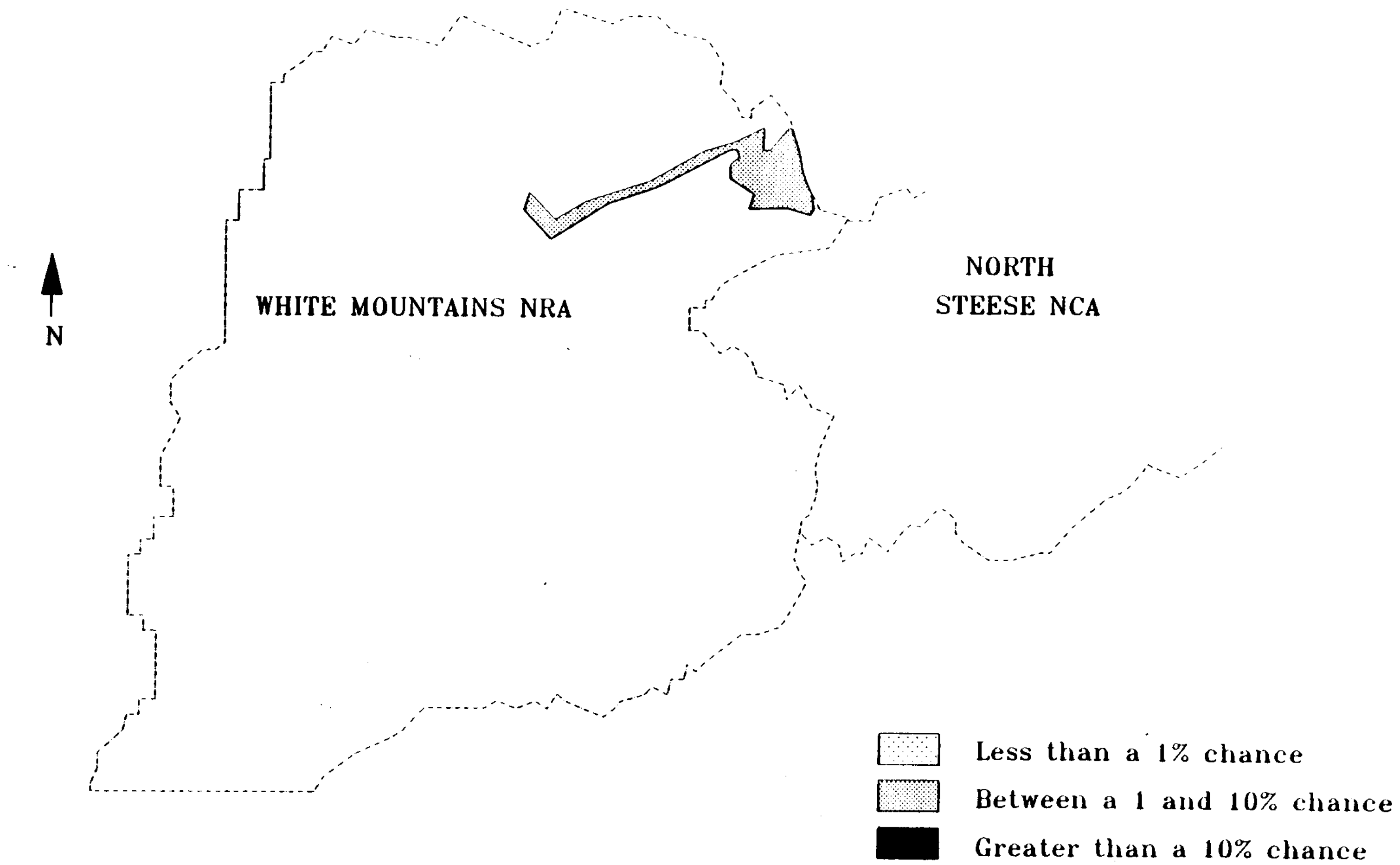


Table E-3. Characteristics of Potentially Economic Sediment-hosted Lead-Zinc Deposits

Economic Deposit Attributes	Average	Fractiles 95%	50%	5%
A. At Current Prices (Pb-$0.36/lb, Zn-$0.42/lb, Ag-$6.20/oz):				
Likelihood of at least one economic deposit: 0.0				
B. At Two Times Current Prices (Pb-$0.72/lb, Zn-$0.84/lb, Ag-$14.40/oz):				
Likelihood of at least one economic deposit: 0.074				
Economic Deposit Size (10^6 st)	48.8	6.2	27.0	180.0
Recoverable Pb (10^3 st)	2148.9	140.0	950.0	8400.0
Recoverable Zn (10^3 st)	2705.5	340.0	1600.0	8900.0
Recoverable Ag (10^6 oz)	86.9	3.9	46.0	290.0
Conditional no. of economic deposits: 1				
Mining methods: Open-pit or Room-and-pillar				
Milling methods: Pb-Zn flotation with a silver recovery circuit				
Mine life: 8 to 35 years				
Net present value of deposit ($\$10^6$)	359.35	13.0	190.0	1400.0

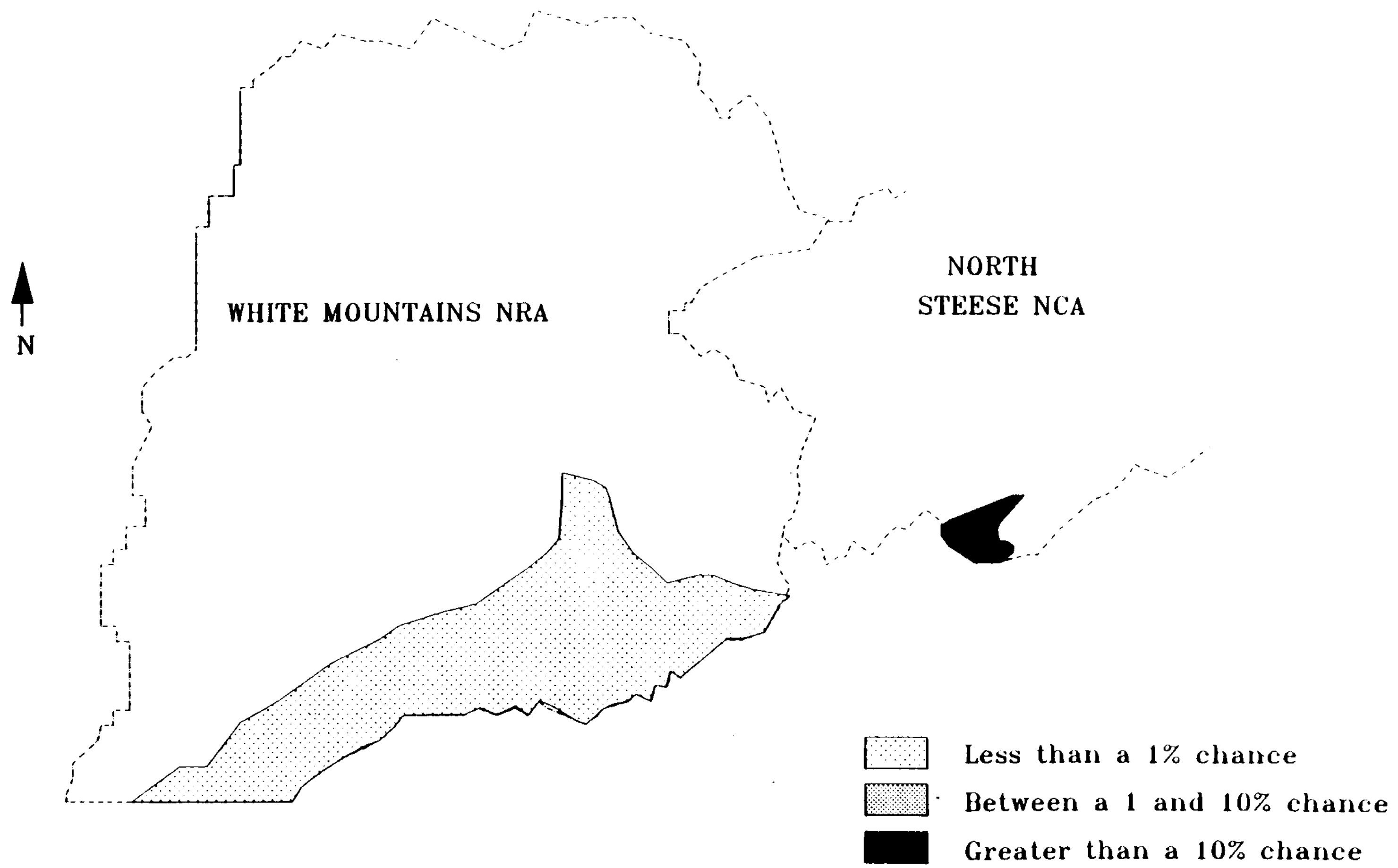
the 90 percent confidence level, economic deposits of this type are estimated to range from 6.2 million to 180 million tons of ore in size, with an average size of 48.8 million tons of ore, and contain from 140 thousand to 8.4 million tons of recoverable tons of lead, with an average of 2.1 million tons, from 340 thousand to 8.9 million tons of recoverable zinc, with an average of 2.7 million tons, and from 3.9 million to 290 million ounces of recoverable silver, with an average of 87 million ounces. Given that deposit development does occur, on average, the value of production is estimated to be approximately $8.9 billion.

At twice current contained metal prices the maximum number of potentially economic lead-zinc deposits is estimated to be one, given that such deposits do exist. The mining and milling methods used in the development of deposits of this type typically consist of either an open-pit or room-and-pillar mine, depending on the size and depth of the deposit, in combination with a Pb-Zn flotation mill which may include a silver recovery circuit depending upon the silver grade. The mine life is estimated range from 8 to 25 years, with an average of 15 years. The net present value, or economic value, of a prospective mining operation is estimated to range from $13 million to $1.4 billion, at the 90 percent confidence level, with an average value of $359 million.

Potentially Economic Vein Gold Deposits

Figure E-4 shows those tracts of land in the study area which have been identified as geologically favorable for the occurrence of vein gold deposits. Specifically, the largest permissive area extends across the

Figure E-4. Likelihood of Economic Vein Gold Deposits in the Study Area at Two Times Current Prices



southern part of the WMNRA, with a smaller area located in the vicinity of Hope Creek in southwestern part of the North SNCA. Deposits of this type typically contain various amounts of gold and silver.

The results of the potential supply analysis at the assumed current gold and silver prices indicate that there is only about an 8 percent chance that at least one vein gold deposit could exist in the study area which contains economically recoverable metals (table E-4). Given that such deposits do exist, it is estimated that they are more likely to exist in the vicinity of Hope Creek than in the WMNRA (fig. E-4). At the 90 percent confidence level, economic deposits in the Hope Creek area are estimated to range in size from 1.2 million tons to 130 million tons of ore, with an average size of 27 million tons, and contain from 870 thousand to 52 million ounces of recoverable gold, with an average of 11.2 million ounces and from 22 thousand to 12 million ounces of recoverable silver, with an average of 2.3 million ounces. Given that deposit development does occur at current gold and silver prices, the value of production is estimated, on average, to be approximately $5 billion.

At current prices the maximum number of potentially economic vein gold deposits is estimated to be two, given that such deposits do exist. The mining and milling methods used in the development of this type of deposit typically consist of either an open-pit or cut-and-fill mine, depending on the size and depth of the deposit, in combination with either heap or CIP leaching, depending on the grade of the gold. The mine life is estimated to range from 6 to 22 years, with an average of 12 years. At current gold and silver prices, the net present value of a prospective mining operation is estimated to range from $7.7 million to $2.5 billion, at the 90 percent confidence level, with an average value of $538 million.

Table E-4. Characteristics of Potentially Economic Vein Gold Deposits

Economic Deposit Attributes	Average	Fractiles 95%	50%	5%
A. At Current Prices (Au-$444.00/oz, Ag-$6.20/oz):				
Likelihood of at least one economic deposit: 0.076				
Likelihood of economic activity in south WMNRA: 0.002				
Hope Cr area: 0.074				
Economic Deposit Size-Hope Cr (10^6 st)	27.0	1.2	14.0	130.0
Recoverable Au (10^6 oz)	11.2	0.9	4.9	52.0
Recoverable Ag (10^6 oz)	2.4	0.0	0.3	12.0
Conditional no. of economic deposits: 1 to 2				
Mining methods: Open-pit or Cut-and-fill				
Milling methods: Heap leaching or CIP leaching				
Mine life: 6 to 22 years				
Net present value of deposit ($\$10^6$)	538.2	7.7	220.0	2500.0
B. At Two Times Current Prices (Au-$888.00/oz, Ag-$14.40/oz):				
Likelihood of at least one economic deposit: 0.15				
Likelihood of economic activity in south WMNRA: 0.008				
Hope Cr area: 0.142				
Economic Deposit Size-Hope Cr (10^6 st)	16.4	0.3	3.6	100.0
Recoverable Au (10^3 oz)	6268.5	230.0	1500.0	30000.0
Recoverable Ag (10^3 oz)	1457.2	5.4	140.0	5800.0
Conditional no. of economic deposits: 1 to 2				
Mining methods: Open-pit or Cut-and-fill				
Milling methods: Heap leaching or CIP leaching				
Mine life: 4 to 22 years				
Net present value of deposit ($\$10^6$)	736.8	4.3	160.0	3200.0

At two times current gold and silver prices the results of the potential supply analysis indicate that there is about a 15 percent chance that some of the gold vein deposits which might exist in the study area could contain economically recoverable metals (table E-4). Again, given that such deposits do exist, they are far more likely to be present in the vicinity of Hope Creek than in the WMNRA (fig. E-4). At the 90 percent confidence level, because smaller deposits become economic to produce at higher prices, the economic deposit size ranges from .3 million to 100 million tons of ore, with an average size of 16.4 million tons, and contains from 230 thousand to 30 million ounces of recoverable gold, with an average of 6.3 million ounces, and from 5.4 thousand to 5.8 million ounces of recoverable silver, with an average of 1.5 million ounces. Should deposit development occur, there is a 95 percent chance that the value of the gold produced would exceed $204.2 million at twice current gold prices, or $888.00/oz, and a 95 percent chance that the value of the silver produced would exceed $.32 million at twice current silver prices, or $14.40/oz.

At two times current prices the maximum number of potentially economic vein gold deposits is estimated to be two, given that such deposits do exist. The mining and milling methods used to produce these deposits are the same as above, however, because smaller deposits become economic to produce, the mine life is now estimated to range from 4 to 22 years, with an average of 10 years. At this price level, the net present value, or economic value, of a prospective mining operation is estimated to range from $4.3 million to $3.2 billion, at the 90 percent confidence level, with an average value of $737 million.

Potentially Economic Tungsten Skarn Deposits

Figure E-5 shows those tracts of land in the study area which have been identified as geologically favorable for the occurrence of tungsten skarn deposits. Specifically, the permissive areas are in the northeastern corner of the WMNRA, in the vicinity of the upper Quartz Creek and in the vicinity of Table Mountain. Deposits of this type typically contain various amounts of tungsten, tin and gold. Tungsten is classified as a critical and strategic mineral.

The results of the potential supply analysis indicate that the undiscovered tungsten skarn deposits which may exist within the identified favorable areas are not expected to contain economically recoverable resources at current contained metal prices (table E-5).

Even at two-times-current tungsten prices the results of the potential supply analysis indicate that there is only about a 3 percent chance that some of the undiscovered tungsten skarn deposits which might exist within the study area could contain economically recoverable metals (table E-5). Economic deposits are most likely to exist in the vicinity of Table Mountain (fig. E-5). At the 90 percent confidence level, potentially economic deposits in this area are estimated to range from .4 million to 4.2 million tons of ore in size, with an average size of 1.8 million tons of ore, and contain from 1.6 thousand to 70 thousand tons of recoverable tungsten, with an average of 28 thousand tons and from 0 to 950 thousand ounces of recoverable gold, with an average of 174.2 thousand ounces. Although this deposit may contain quantities of tin, it is not assumed to be recovered. Given that development occurs, there is a 50 percent chance

Figure E-5. Likelihood of Economic Tungsten Skarn Deposits in the Study Area at Two Times Current Prices

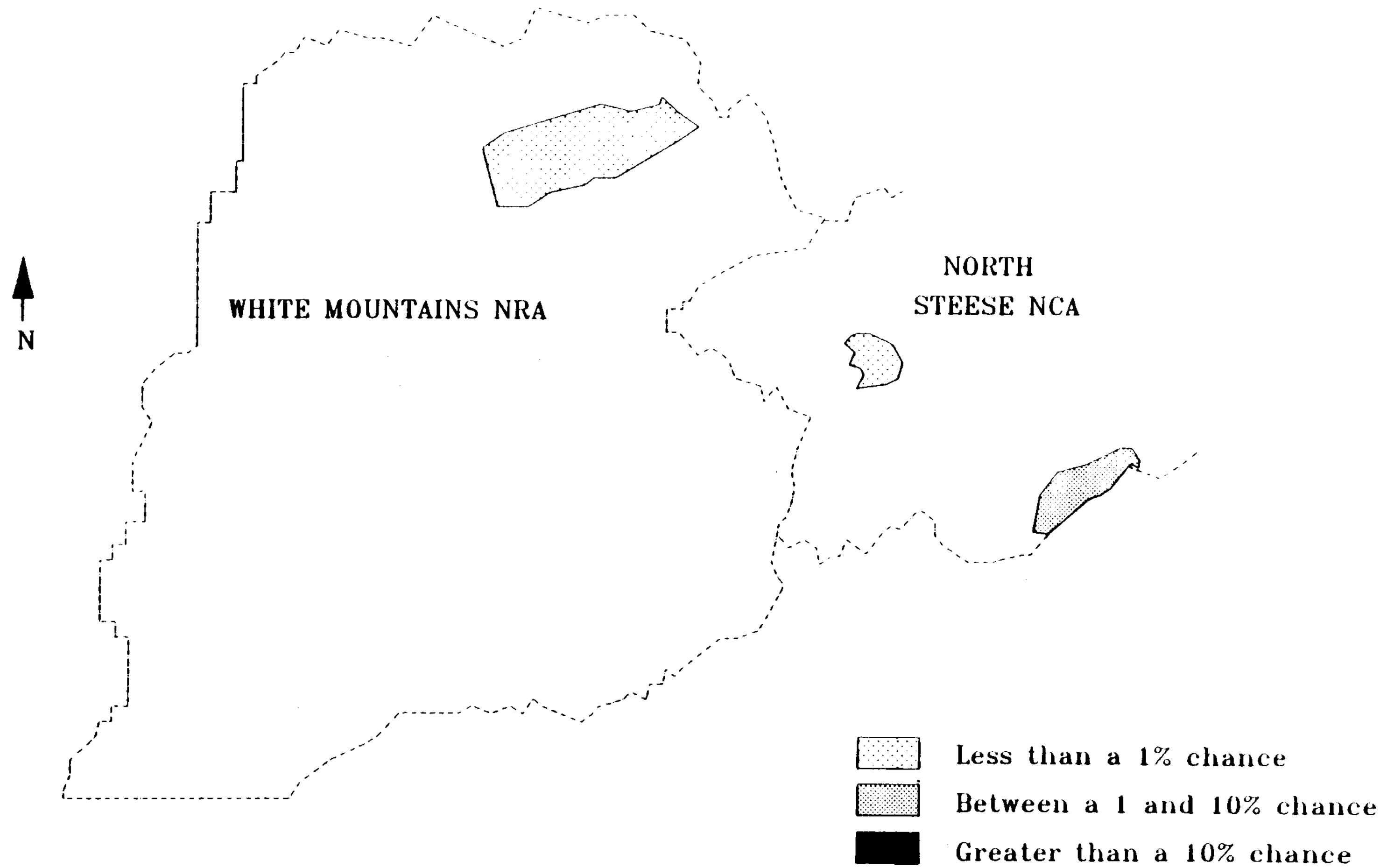


Table E-5. Characteristics of Potentially Economic Tungsten Skarn Deposits

Economic Deposit Attributes	Average	Fractiles 95%	50%	5%
A. At Current Prices (W-\$2.87/lb, Au-\$444.00/oz):				
Likelihood of at least one economic deposit: 0.0				
B. At Two Times Current Prices (W-\$5.74/lb, Au-\$888.00/oz):				
Likelihood of at least one economic deposit: 0.029				
Likelihood of economic activity in the WMNRA: 0.001				
Quartz Cr area: 0.0				
Table Mtn area: 0.028				
Economic Deposit Size-Tbl Mtn (10^6 st)	1.8	0.4	1.6	4.2
Recoverable W (10^3 st)	28.0	1.6	19.0	70.0
Recoverable Au (10^3 oz)	174.2	0.0	26.0	950.0
Conditional no. of economic deposits: 1				
Mining methods: Open-pit, VCR or Shrinkage stope				
Milling methods: W flotation/gravity				
Mine life: 4 to 11 years				
Net present value of deposit (\$$10^6$)	28.9	0.2	9.6	160.0

that a deposit will yield at least $218 million dollars in tungsten values and a 50 percent chance that it will yield at least $23.1 million in gold values.

At this price level the maximum number of potentially economic tungsten skarn deposits is estimated to be one, given that such deposits do exist. The mining and milling methods used in the development of deposits of this type typically consist of either an open-pit, VCR or shrinkage stope mine, depending on the size and depth of the deposit, in combination with either a tungsten gravity or flotation mill depending on the grade of the tungsten. The mine life is estimated to range from 4 to 11 years, with an average of 7 years. The net present value, or economic value, of a prospective mining operation is estimated to range from $.2 million to $160 million, at the 90 percent confidence level, with an average value of $28.9 million.

Potentially Economic Polymetallic Vein Deposits

Figure E-6 shows those lands within the study area which are considered geologically favorable for the occurrence of polymetallic vein deposits. Deposits of this type typically contain various amounts of lead, zinc and silver. Lead and zinc are classified as critical and strategic minerals.

The results of the potential supply analysis indicate that the undiscovered polymetallic vein deposits which might exist within the identified favorable areas are not expected to contain economically recoverable resources at the assumed current contained metal prices (table E-6.

Figure E-6. Likelihood of Economic Polymetallic Vein Deposits in the Study Area at Two Times Current Prices

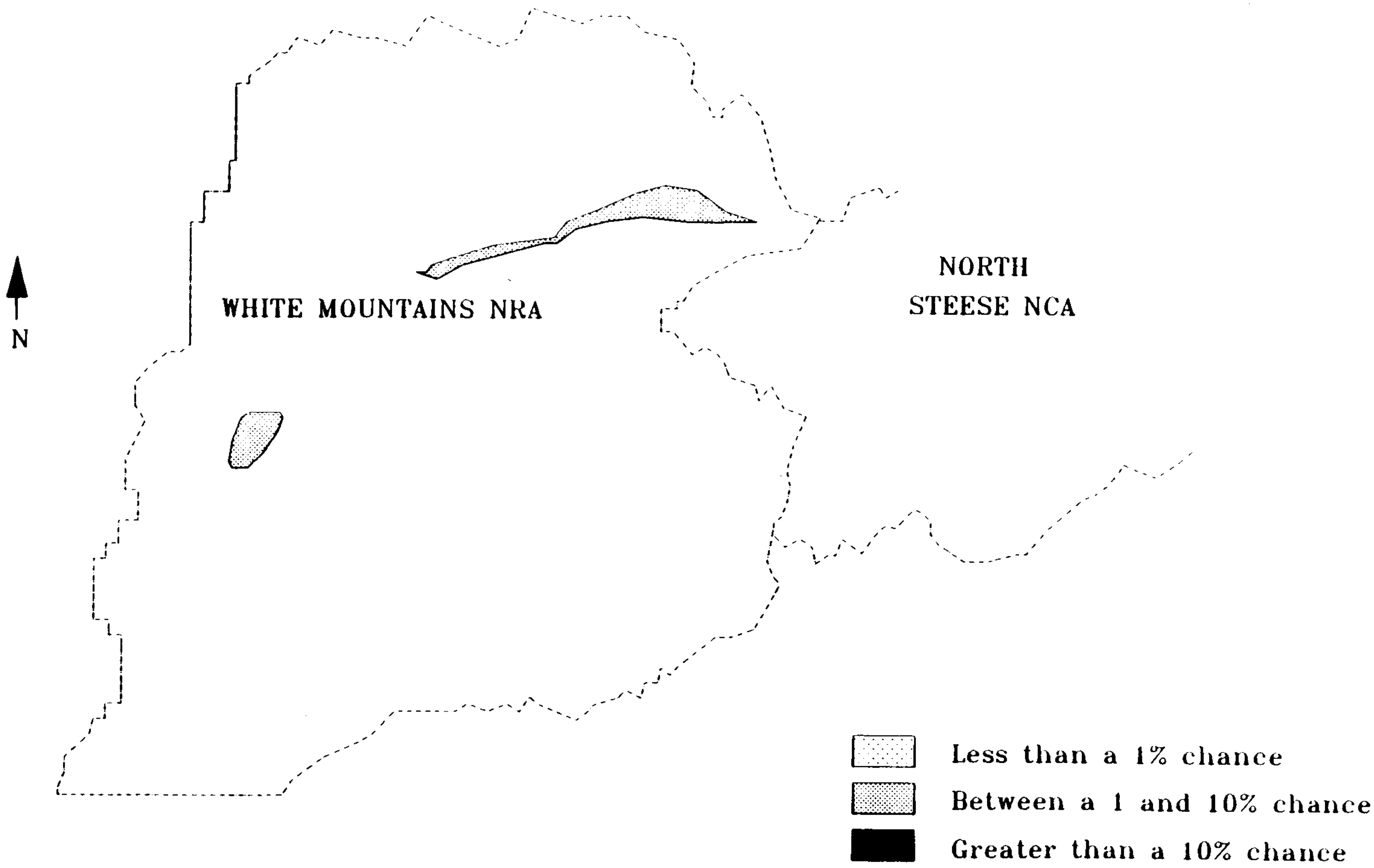


Table E-6. Characteristics of Potentially Economic Polymetallic Vein Deposits

Economic Deposit Attributes	Average	Fractiles 95%	50%	5%
A. At Current Prices (Pb-\$0.36/lb, Zn-\$0.42/lb, Ag-\$6.20/oz):				
Likelihood of at least one economic deposit: 0.0				
B. At Two Times Current Prices (Pb-\$0.72/lb; Zn-\$0.84/lb; Ag-\$14.40/oz):				
Likelihood of at least one economic deposit in the WMNRA: 0.024				
Economic Deposit Size (10^3 st)	90.0	9.0	40.0	440.0
Recoverable Pb (10^3 st)	5.7	0.1	1.6	26.0
Recoverable Zn (10^3 st)	1.1	0.0	0.4	4.4
Recoverable Ag (10^6 oz)	8.2	2.9	6.4	20.0
Conditional no. of economic deposits: 1				
Mining methods: Open-pit or Cut-and-fill				
Milling methods: Polymetallic flotation				
Mine life: 2 to 5 years				
Net present value of deposit (\$$10^6$)	13.2	0.8	8.0	52.0

At two times the current contained metal prices the results of the potential supply analysis indicate that there is still only about a 2 percent chance that at least one of the undiscovered polymetallic vein deposits which might exist could contain economically recoverable metals (fig. E-6, table E-6). At the 90 percent confidence level, economic deposits of this type are estimated to range from 9 thousand to 440 thousand tons of ore in size, with an average size of 90 thousand tons of ore, and contain from .14 thousand to 26 thousand tons of recoverable lead, with an average of 5.7 thousand tons, from .01 thousand to 4.4 thousand tons of recoverable zinc, with an average of 1.1 thousand tons, and from 2.9 million to 20 million ounces of recoverable silver, with an average of 8.2 million ounces. Given that deposit development does occur, on average, the value of production is estimated to be approximately $128.3 million.

At this higher price level the maximum number of potentially economic polymtallic vein deposits is estimated to be one, given that such deposits do exist. The mining and milling methods used in the development of deposits of this type typically consist of either an open-pit or cut-and-fill mine, depending on the size and depth of the deposit, in combination with a polymetallic flotation mill. The mine life is estimated range from 2 to 5 years, with an average of 3 years. The net present value, or economic value, of such a propospective mining operation is estimated to range from $.8 million to $52 million, at the 90 percent confidence level, with an average value of $13.2 million.

Potentially Economic Uranium Deposits

Figure E-7 shows those tracts of land in the study area which have been identified as geologically favorable for the occurrence of uranium deposits. Specificially, the permissive areas are located in the general vicinity of Lime Peak, Quartz Creek and Mt. Prindle, and in the vicinity of the Roy Creek syenite. Deposits of this type typically contain various amounts of uranium, thorium, and rare earth oxides (REO). Rare earth oxides are currently under consideration for addition to the list of critical and strategic minerals.

The results of the potential supply analysis indicate that the undiscovered uranium deposits which may exist in the identified favorable areas are not expected to contain economically recoverable resources at current metal prices (table E-7).

At two times the current contained metal prices the results of the potential supply analysis indicate that there is still only about a 2 percent chance that at least one of the undiscovered uranium deposits which might exist could contain economically recoverable metals (fig. E-7, table E-7). At the 90 percent confidence level, economic deposits of this type are estimated to range from .8 million to 13 million tons of ore in size, with an average size of 4.5 million tons of ore, and contain from 3.1 thousand to 25 thousand tons of recoverable U_3O_8, with an average of 10.2 thousand tons, and from .8 thousand to 57 thousand tons of recoverable REO, with an average of 17.3 thousand tons. Thorium is assumed not to be recovered. Given that deposit development does occur, on average, the value of production is estimated to be approximately $744.4 million.

Figure E-7. Likelihood of Economic Uranium Deposits in the Study Area at Two Times Current Prices

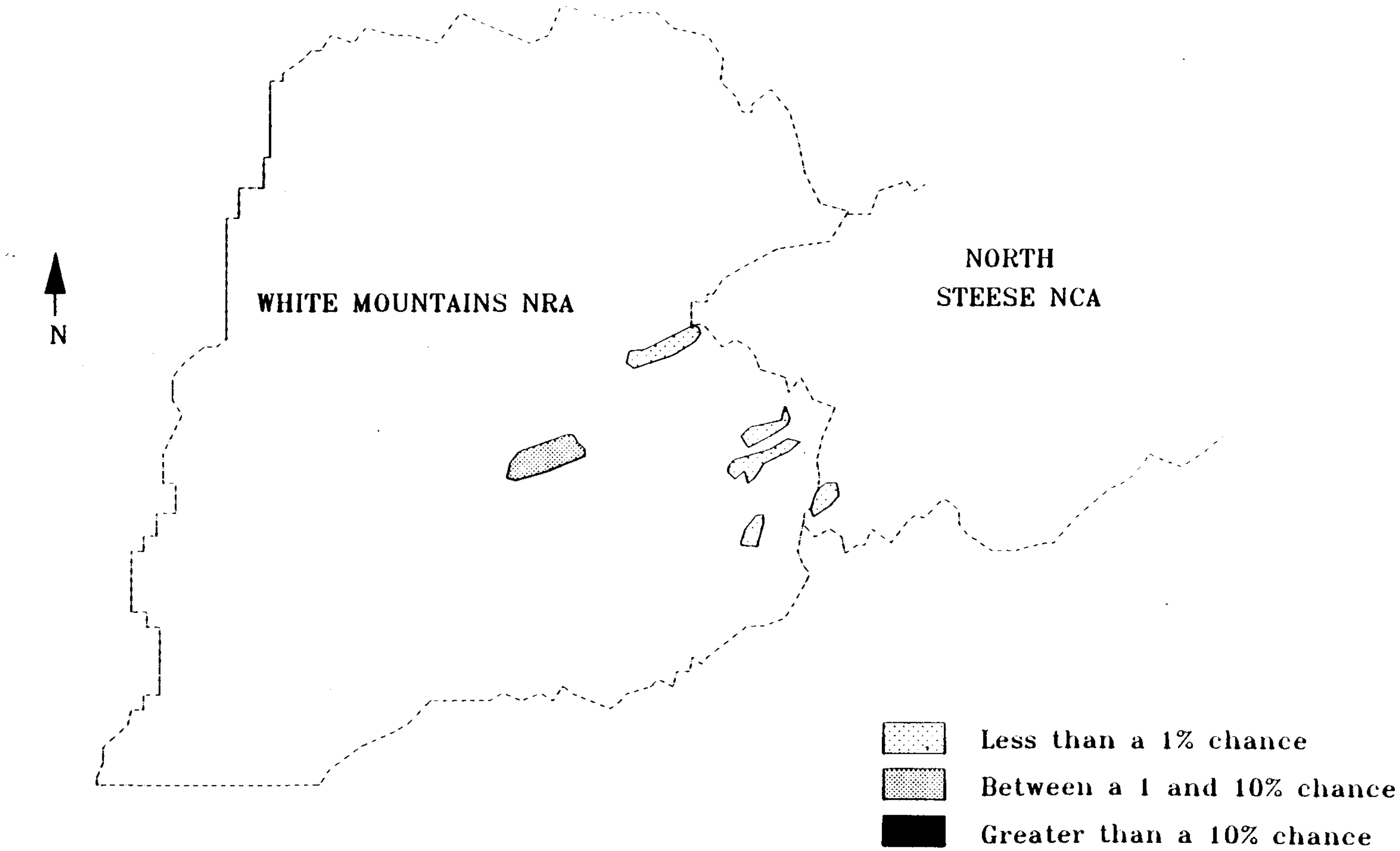


Table E-7. Characteristics of Potentially Economic Uranium Deposits

Economic Deposit Attributes	Average	Fractiles 95%	50%	5%
A. At Current Prices (U_3O_8-\$16.55/lb, REO-\$1.00/lb):				
Likelihood of at least one economic deposit: 0.0				
B. At Two Times Current Prices (U_3O_8-\$33.10/lb, REO-\$2.00/lb):				
Likelihood of at least one economic deposit in the WMNRA: 0.025				
Likelihood of economic activity in L Pk/Qtz Cr/Mt Prin area: 0.011				
vicinity of Roy Cr syenite: 0.015				
Economic Deposit Size (10^6 st)	4.5	0.8	3.2	13.0
Recoverable U_3O_8 (10^3 st)	10.2	3.1	7.5	25.0
Recoverable REO (10^3 st)	17.3	0.8	8.7	57.0
Conditional no. of economic deposits: 1				
Mining methods: Open-pit or VCR				
Milling methods: REO flotation with a uranium recovery circuit				
Mine life: 5 to 14 years				
Net present value of deposit (\$$10^6$)	59.7	2.7	30.0	220.0

At this higher price level the maximum number of potentially economic deposits is estimated to be one, given that such deposits do exist. The mining and milling methods used in the development of deposits of this type typically consist of either an open-pit or VCR mine, depending on the size and depth of the deposit, in combination with an REO flotation mill which may include a uranium recovery circuit depending upon the uranium grade. The mine life is estimated to range from 5 to 14 years, with an average of 9 years. The net present value of a prospective mining operation is estimated to range from $2.7 million to $220 million, at the 90 percent confidence level, with an average value of $59.7 million.

Potentially Economic Placer Gold Deposits

Placer gold potential is widely distributed in streambeds throughout the study area. In general, two types of placer deposits are predicted to exist within the study area, bench placer deposits and stream gravel deposits. Bench placer deposits are known to exist in the Beaver Creek and Nome Creek areas.

The results of the potential supply analysis indicate that there is a 60 percent chance that undiscovered placer deposits could contain economically recoverable gold at the assumed the current price of $444/oz, given that such deposits do exist (table E-8). At the 90 percent confidence level, economic placer deposits are estimated to contain from 1.1 thousand to 152.5 thousand ounces of recoverable gold. Given that such deposits exist in the study area, from one to 5 are expected to be economic. The average mine life of a prospective placer operation is

Table E-8. Characteristics of Potentially Economic Gold Placer Deposits

Economic Deposit Attributes	Average	Fractiles 95%	50%	5%
A. At Current Prices (Au-$444.00/oz):				
Likelihood of at least one economic deposit: 0.58				
Economic Deposit Size (10^6 st)	2.0	0.01	0.75	10.2
Recoverable Au (10^3 oz)	29.8	1.10	9.30	152.5
Conditional no. of economic deposits: 1 to 5				
Mining methods: Placer				
Milling methods: Placer				
Average mine life: 8 years				
Net present value of deposit ($\$10^6$)	1.9	0.03	0.47	9.8
B. At Two Times Current Prices (Au-$888.00/oz):				
Likelihood of at least one economic deposit: 0.94				
Economic Deposit Size (10^6 st)	2.6	0.02	0.82	10.9
Recoverable Au (10^3 oz)	18.5	0.40	7.00	72.1
Conditional no. of economic deposits: 1 to 9				
Mining methods: Placer				
Milling methods: Placer				
Average mine life: 10 years				
Net present value of deposit ($\$10^6$)	2.4	0.07	1.10	11.4

estimated to be 8 years. The total net present value of a placer mine at this price level is estimated to range from $30 thousand to $9.8 million, at the 90 percent confidence level, with an average value of $1.9 million.

At two-times-current gold prices the results of the potential supply analysis indicate that there is about a 94 percent chance that undiscovered placer gold deposits exist which would be economic to produce if they were discovered (table E-8). At the 90 percent confidence level, economic deposits are estimated contain from .4 thousand ounces to 72.1 thousand ounces of recoverable gold. The number of economic deposits, given that such deposits do exist, is estimated to range from one to nine. The placer mine life is estimated to average 10 years. The total net present value, of a prospective placer mine at this price level is estimated to range from $70 thousand to $11.4 million, at the 90 percent confidence level, with an average value of $2.4 million.

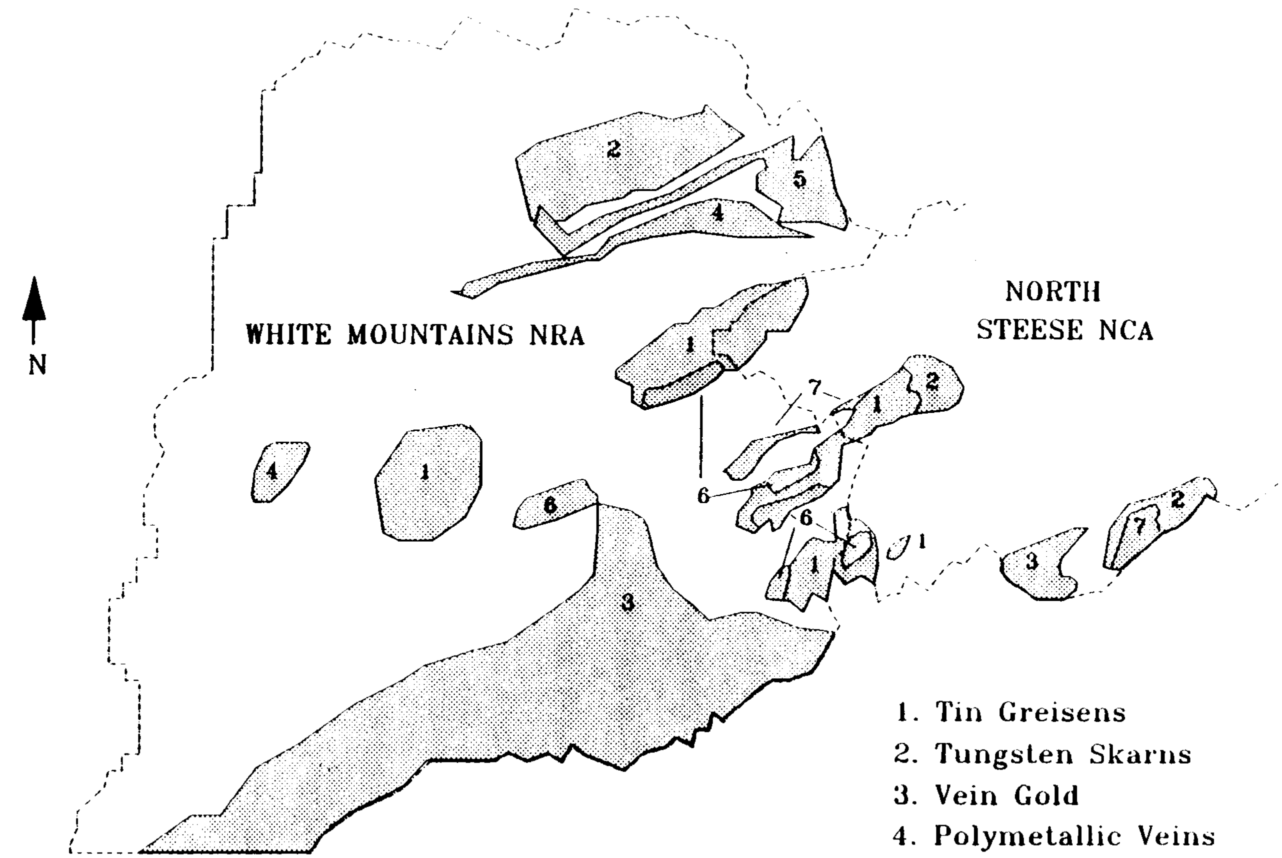
APPENDIX F. DETAILED RESULTS OF THE ANALYSIS OF ELEVEN PROSPECTIVE ACTIVITY AREAS WITHIN THE WMNRA/SNCA STUDY ARE

This appendix provides more detailed results of the potential supply analysis of eleven activity areas (referred to here as blocks) within the White Mountains National Recreation Area (WMNRA) and the Steese National Conservation Area (SNCA) study area. The quantities and values of undiscovered economically recoverable minerals which could be contained wihtin each of the delineated areas were estimated. These estimates are measures of the mineral and economic consequences of closing each block to mineral entry. The terranes, identified by the U.S. Geological Survey, the Alaska Division of Geological and Geophysical Surveys and the U.S. Bureau of Mines are shown in Figures F-1 and F-2, and the eleven blocks, defined by the BLM, are shown in Figure F-3. The eleven blocks and the deposit types and metals they may contain are listed in Table F-1. Detailed discussions of the area and its geology, the methodology used for this study and the results of other analyses are provided in the main body of the paper, in other appendices or in the references provided.

Results of the Analysis

The results of the analyses of each of the eleven blocks are presented graphically in three parts: 1) resource endowment;

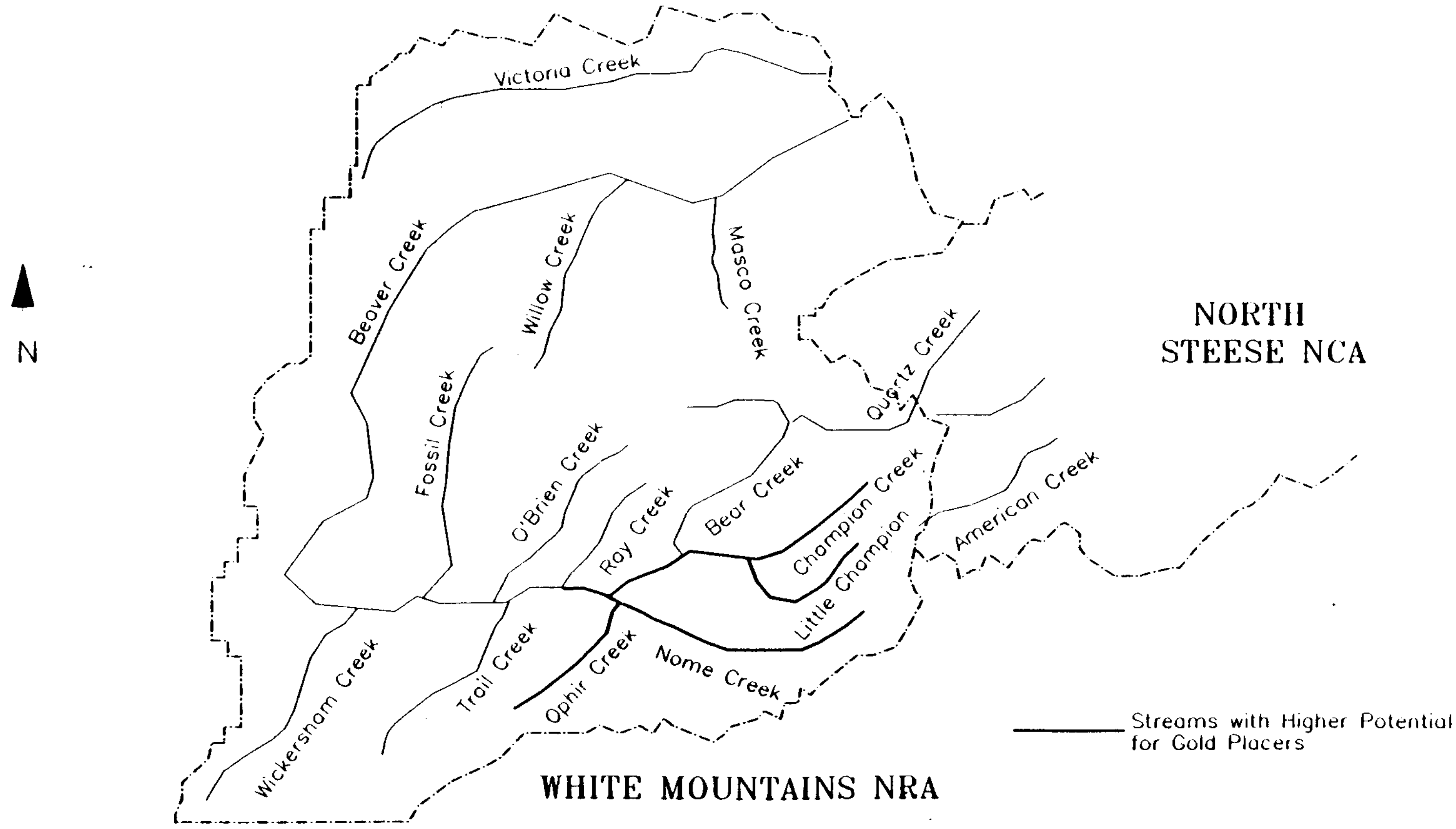
Figure F-1. Mineral Terranes Identified and Assessed in The White Mountains National Recreation Area and The Steese National Conservation Area*



1. Tin Greisens
2. Tungsten Skarns
3. Vein Gold
4. Polymetallic Veins
5. Sedimentary Exhalative Lead Zinc
6. Rare Earths
7. Alkalic Associated Gold

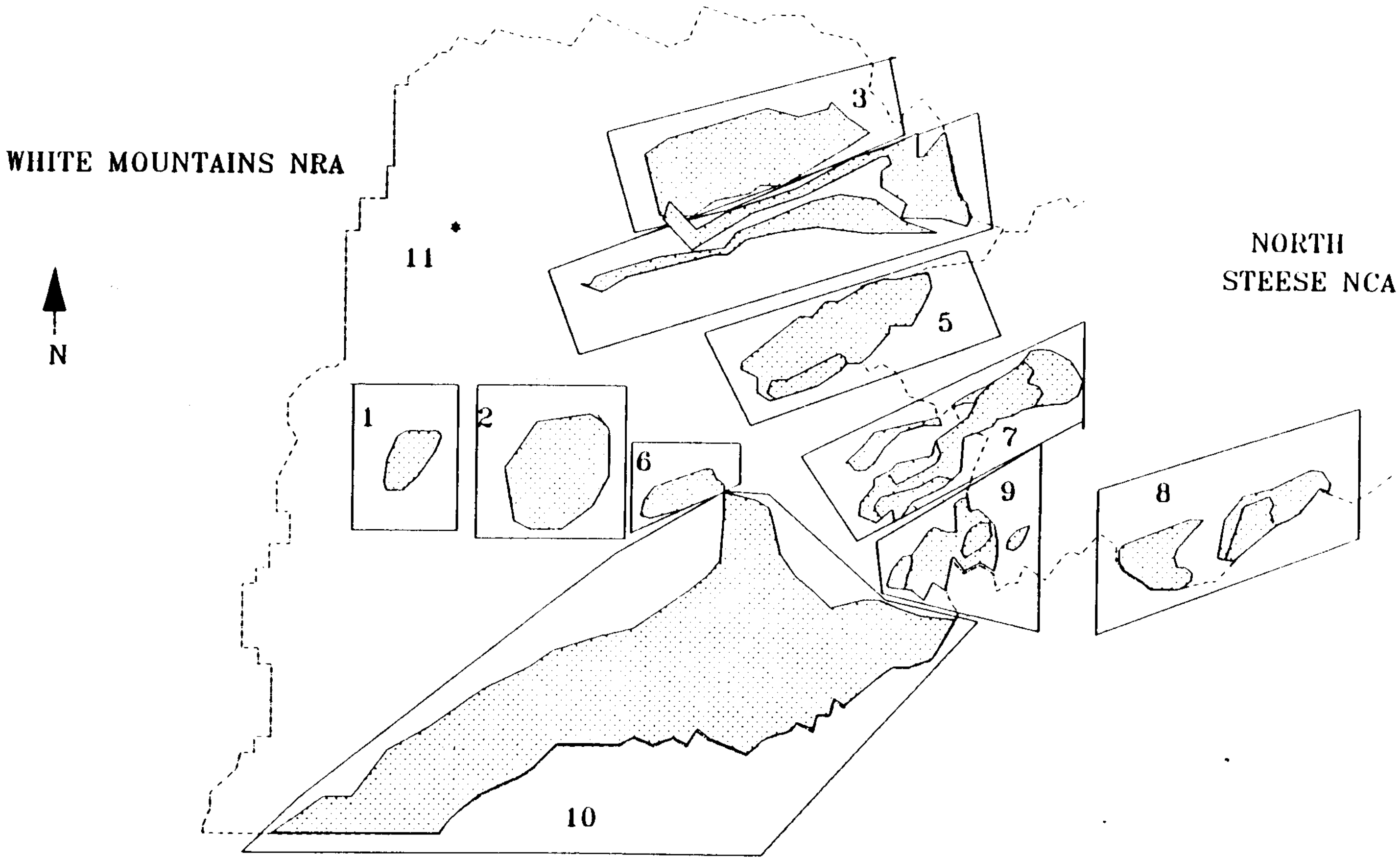
* See Figure F-2 for Gold Placer Potential Map

Figure F-2. Streams Assessed for Placer Potential in The White Mountains National Recreation Area and The Steese National Conservation Area



* Although there is placer potential throughout the study area, it is concentrated in the the southern portion of the WMNRA, in the general region of Block 10 (see Figure F-2).

Figure F-3. Blocks Identified for Individual Analysis In The White Mountains National Recreation Area and The Steese National Conservation Area



* Block 11 includes placer deposits throughout the Steese NCA and the White Mountains NRA (see Figure F-2).

Table F-1. Evaluation Blocks and Component Mineral Terranes

Block	Deposit Types	Potentially Recoverable Metals
1	Polymetallic Vein	Lead, Zinc and Silver
2	Tin Greisen	Tin
3	Tungsten Skarn	Tungsten
4	Sediment-hosted	Lead, Zinc and Silver
	Polymetallic Vein	Lead, Zinc and Silver
5	Tin Greisen	Tin, Silver and Tantalum
	Rare Earths	Uranium and Rare Earth Oxides
6	Rare Earths	Uranium and Rare Earth Oxides
7	Tin Greisen	Tin, Silver and Tantalum
	Tungsten Skarn	Tungsten and Tin
	Alkalic-associated Gold	Gold
	Rare Earths	Uranium and Rare Earth Oxides
8	Tungsten Skarn	Tungsten and Gold
	Vein Gold	Gold and Silver
	Alkalic-associated Gold	Gold
9	Tin Greisen	Tin, Silver and Tantalum
	Rare Earths	Uranium and Rare Earth Oxides
10	Vein Gold	Gold
11	Placer Gold	Gold

2) economic analysis at current prices; and 3) economic analysis of price sensitivity at up to three times current prices. Table F-2 provides definitions of the terms used. The first part, the resource endowment, shows the location of the block, the types of mineral deposits and metals that may exist in that block, and the mineral endowment characteristics of the block: the probability that deposits exist, the quantities of ore which may be contained in the block and the physical quantities of each metal which may be present in the block. The results are presented as averages and ranges to indicate the uncertainty inherent in estimates of undiscovered mineral resources.

In the second and third parts of the results, it is assumed that the blocks are available for mineral exploration and development, and that any deposits which do exist are, in fact, discovered. Thus, the results show the total quantities and values of metals that may be recovered in the absence of land-use or other restrictions. The second part, the economic analysis results at current prices, summarizes the range of mining and milling activities that might occur in the block, given the estimated costs and average annual metal prices of 1987 (Table F-3). The information presented includes the probability that economic deposits exist, the range of quantities of ore and metals which could be produced assuming economic deposits do exist, and the net present values associated with production. These values are a measure of the relative attractiveness of the block to an explorationist or mining company, as well as an indication of the value of lost

Table F-2. Terms and Definitions as used in this Appendix

Resource Endowment - the amount of mineral resources contained in undiscovered deposits in the study area.

Probability of One or More Deposits - the likelihood that at least one undiscovered deposit exists.

Probability That Deposits Exist - the likelihood that exactly 0, 1, 2, etc. undiscovered deposits exist.

Quantities

Average - the average quantity of ore or metal that is simulated, including those cases where the amount is zero.

95% - there is a 95% chance that the actual physical quantity will be this amount or more.

50% - there is a 50% chance that the actual physical quantity will be this amount or more.

5% - there is a 5% chance that the actual physical quantity will be this amount or more.

Economic Analysis: Current Prices

Economic Deposit - a mineral deposit which, if developed and produced under stated economic conditions, would have a net present value greater than zero. That is, it would yield larger discounted revenues than discounted costs (using a 15% discount rate).

Probability That Economic Deposits Exist - the likelihood that at least one undiscovered economic deposit exists.

Probability of Economic Deposits - the likelihood that exactly 0, 1, etc. economically recoverable undiscovered deposits exist.

Quantity Measures refer to the amount of metal recovered from an economic deposit. Average values are for deposits of similar type. E.g. average recoverable gold is an average for all recoverable gold deposits, not for gold and uranium deposits.

Net Present Value - discounted revenues minus discounted costs, using a 15% discount rate.

Economic Analysis: Price Sensitivity

Probability of Economic Activity - the likelihood that at least one undiscovered economic deposit exists, at prices up to three times current levels.

Values and Quantities:

Fully Risked - Average Net Present Value and Metal Production over the price range, including those cases where the amounts and quantities are zero.

Conditional - Average Net Present Value and Metal Production over the price range, for deposits of the same type that are economically recoverable.

Table F-3. Commodities and Prices Addressed in The Study

Commodity	Current Prices*	Three Times Current Prices
Tin ($/lb)	$4.18	$12.54
Gold ($/oz)	$444.00	$1332.00
Silver ($/oz)	$7.20	$21.60
Zinc ($/lb)	$0.42	$1.26
Lead ($/lb)	$0.36	$1.08
Tungsten ($/lb)	$2.87	$8.61
Rare Earth Oxides ($/lb)	$1.00	$3.00
Uranium ($/lb)	$16.55	$49.65
Tantalum ($/lb)	$22.00	$66.00

*Based on 1987 average metal prices.

metal production should the block be withdrawn from mineral activity.

The final part, the economic analysis of price sensitivity, focuses on the change in economic attractiveness of the block in response to increasing prices for the potentially recoverable metals which the block may contain. Prices up to three times the levels addressed in part two are tested, while costs of production are held constant. This sensitivity analysis allows examination of changes in the probability of economic activity, quantities recovered and the values of production as prices increase, and is an indicator of the "threshold" price, or the price levels necessary to induce economic activity.

The results are presented below for each of the eleven blocks evaluated. It should be emphasized that the results presented here reflect the current extent of knowledge of the geology of the area (as expressed by the assessments of participating geologists). Wide ranges of values in the results indicate a greater degree of uncertainty than narrow ranges, and could be reduced by additional fieldwork and/or new understanding of deposit formation processes. Economic results assume technology and environmental requirements as of January, 1988, and could be affected by new mining techniques or regulations. Sensitivity analyses for these and other issues are possible but are not addressed in this appendix.

BLOCK 1

Block 1, in the western portion of the WMNRA, includes one terrane with potential for polymetallic vein deposits which could contain varing amounts of silver, lead and zinc. There is approximately one chance in ten that the terrane actually contains any deposits, and there may be as many as two deposits in the endowment. The fully risked average quantity of metals contained in undiscovered deposits in the block ranges from zero, if no deposits exist, to 185 thousand troy ounces of silver, 90 short tons of zinc, and 330 tons of lead. There is a 5% chance the amount of silver will exceed 590 thousand troy ounces, that the quantity of zinc will exceed 140 tons, and that the amount of lead will be equal to or greater than 890 short tons.

There is less than one chance in one hundred of an economically recoverable deposit at current prices, and it is unlikely that more than one such deposit would exist. If an economic deposit does exist, it will produce (on average) about 18 million troy ounces of silver, three thousand tons of zinc, 20 thousand tons of lead, with a net present value of $8 million.[1]

The probablility of economic activity increases only slightly with increases in price, remaining less than 2% at three times current prices. The fully risked NPV averages less than $1 million, although if a deposit is found, average NPV may exceed $20 million. No more than one economic deposit is likely, and, if one is found, the range of quantities of metal that may be produced are: silver, 7 to 22 million ounces; lead, 5 to 20 thousand short tons, and; zinc, 2 to 4 thousand short tons.[2]

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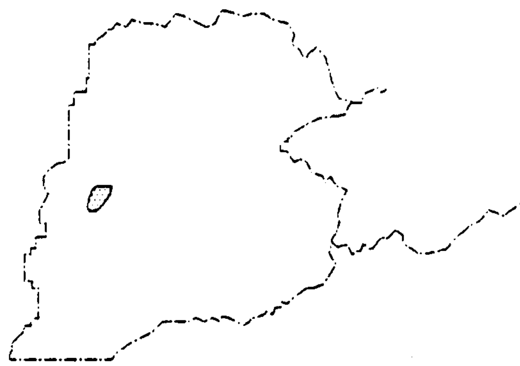
[1] In some blocks, the number of deposits or economic deposits was too few to construct reliable probability distributions. These cases are indicated by a asterisk ("*") in the following tables to distinguish them from cases in which the values or quantities simulated were zero.

[2] Note that, while the average quantities of metal produced (fully risked) increase with increases in the price index, the conditional averages tend to decrease at higher prices. Both relationships are the result of the fact that, at higher prices, smaller and/or lower grade deposits become economically recoverable. Thus, total quantities and fully risked averages increase. But the conditional averages, which show averages for a single deposit, decrease, reflecting both large, rich deposits and small, low grade deposits. (An occasional exception to this occurs when a large, low grade deposit becomes economic. See Block 5, Rare Earths, for an example.)

Block 1 Mineral Resource Endowment

General

Location



Deposit Types:

Polymetallic Vein

Contained Metals

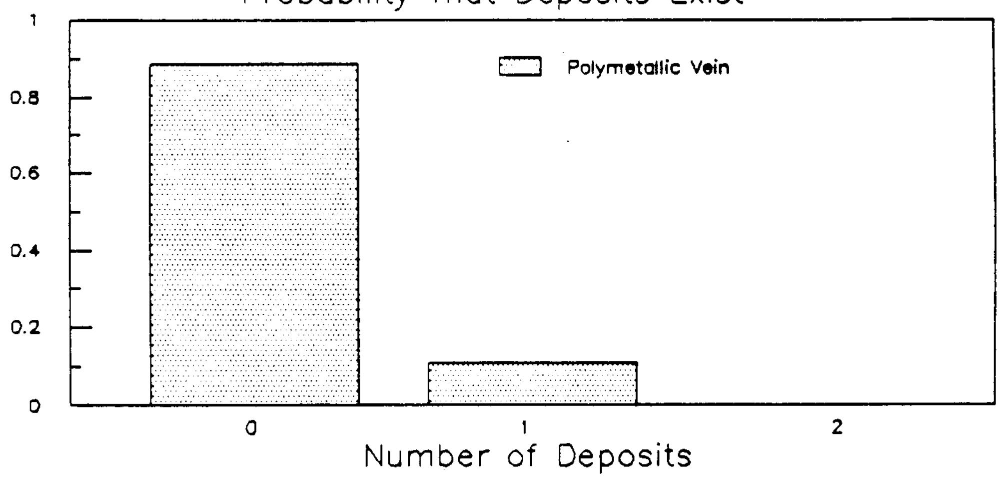
Silver

Lead

Zinc

Deposits

Probability That Deposits Exist



Probability of One or More Deposits = 0.11

Quantities

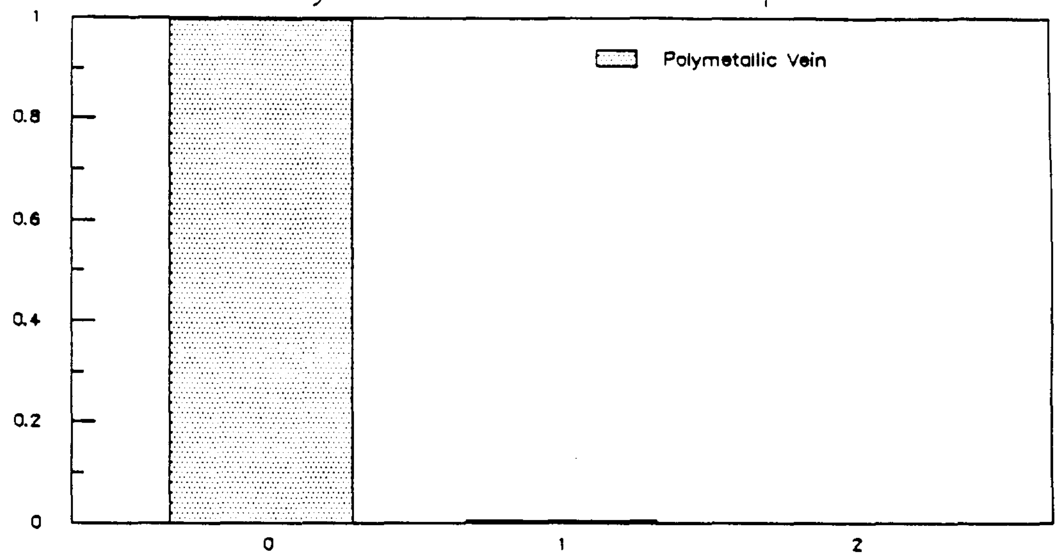
Metals Contained in Endowment (Fully Risked)

	Average	95%	50%	5%
Silver (Thousands of Troy Ounces)	185	0	0	590
Zinc (Thousands of Short Tons)	.09	0	0	.14
Lead (Thousands of Short Tons)	.33	0	0	.89

Block 1 Economic Analysis: Current Prices

Economic Deposits

Probability That Economic Deposits Exist



Probability of One or More Economic Deposits = 0.002

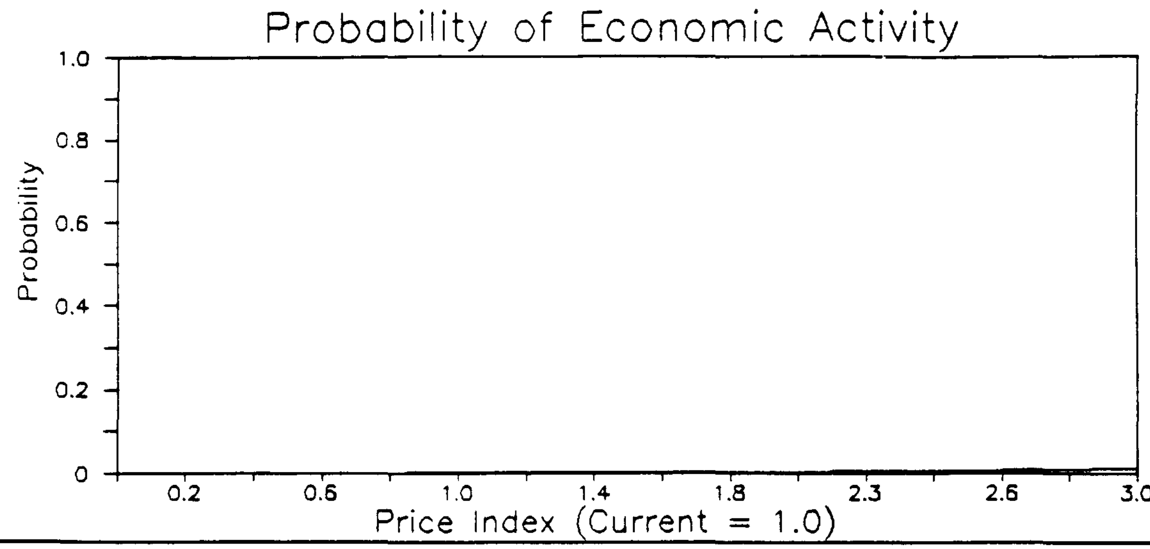
Quantities and Values

Total Recoverable Metals and NPV (Conditional)

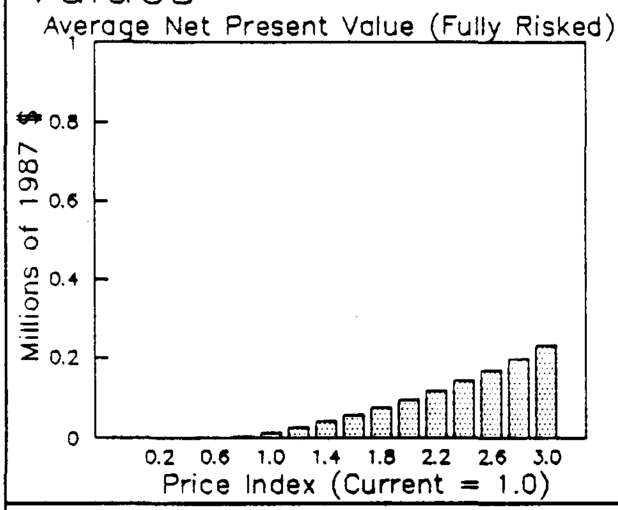
Quantities	Average	95%	50%	5%
Silver (Thousands of Troy Ounces)	17861	*	*	*
Zinc (Thousands of Short Tons)	3	*	*	*
Lead (Thousands of Short Tons)	20	*	*	*
NPV (Millions of 1987 Dollars)	8	*	*	*

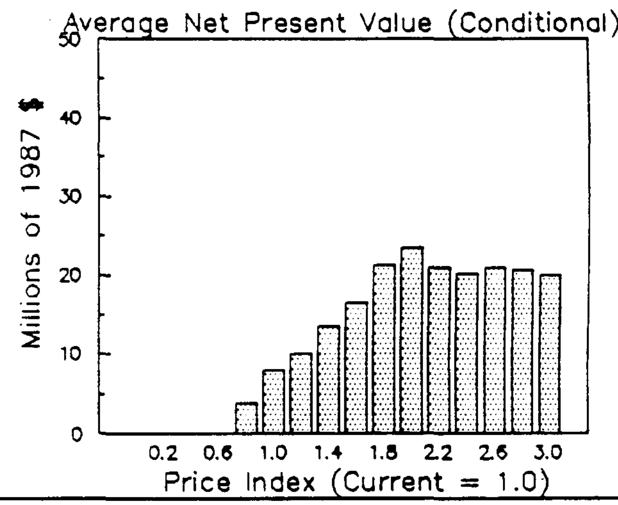
* Not Enough Observations for Meaningful Fractiles

Block 1 Economic Analysis: Price Sensitivity

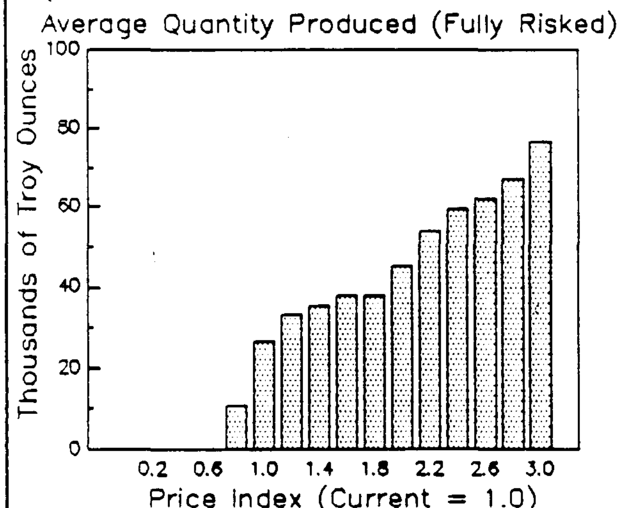


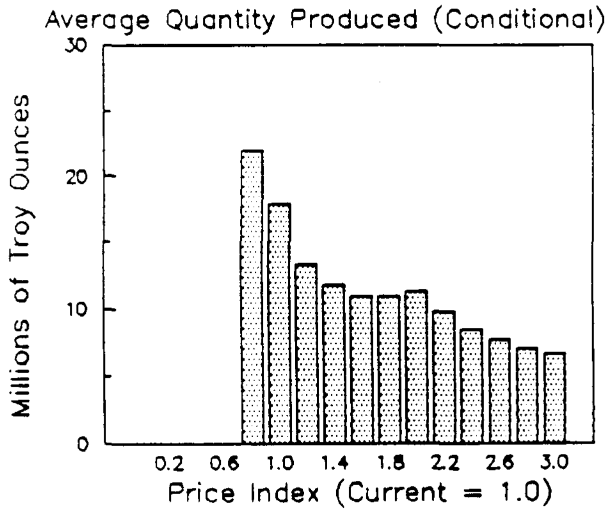
Values





Quantities: Silver

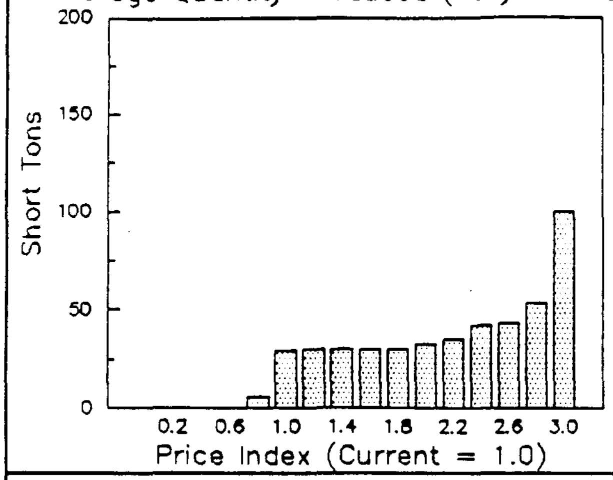




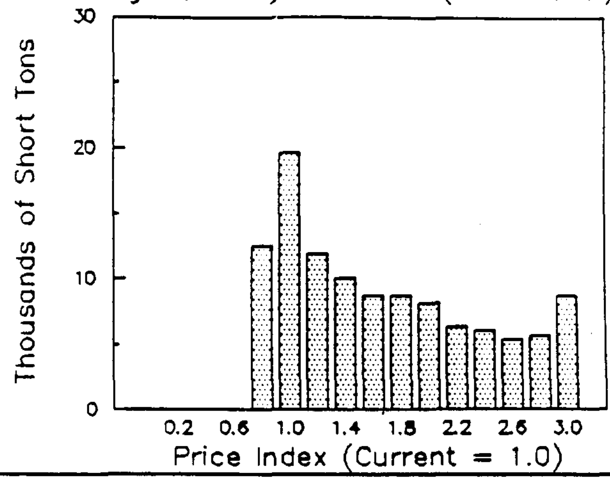
Block 1 Economic Analysis: Price Sensitivity

Quantities: Lead

Average Quantity Produced (Fully Risked)

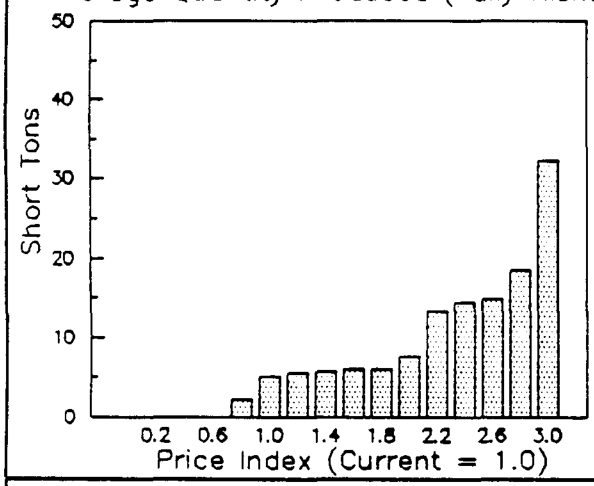


Average Quantity Produced (Conditional)

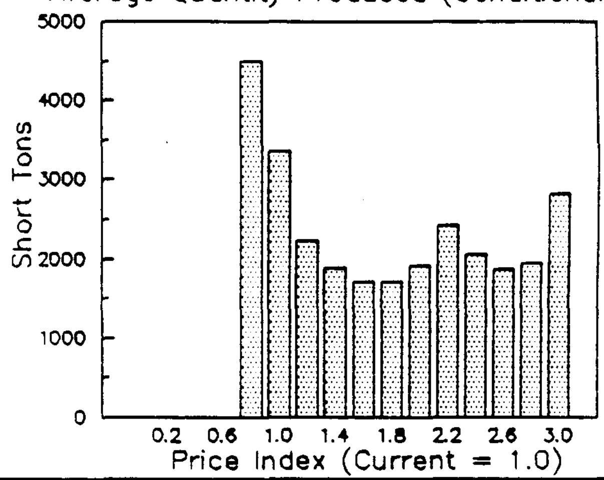


Quantities: Zinc

Average Quantity Produced (Fully Risked)



Average Quantity Produced (Conditional)



BLOCK 2

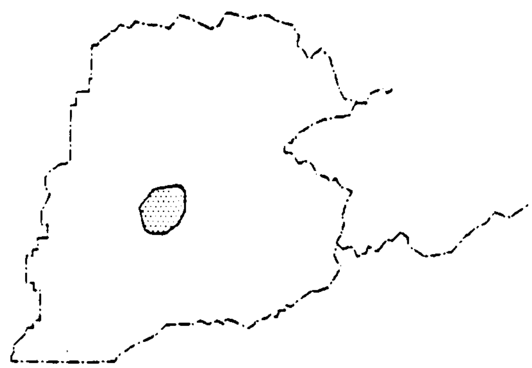
Block 2 is in the Cache Mountain area in central WMNRA. It includes one terrane which is favorable for tin greisen deposits with contained tin. There is approximately one chance in ten that a deposit exists, with an average of 400 short tons and a 5% chance of more than 960 short tons of tin.

An economic deposit is unlikely at any price level up to three times that occurring in mid-1987.

Block 2 Mineral Resource Endowment

General

Location



Deposit Types:

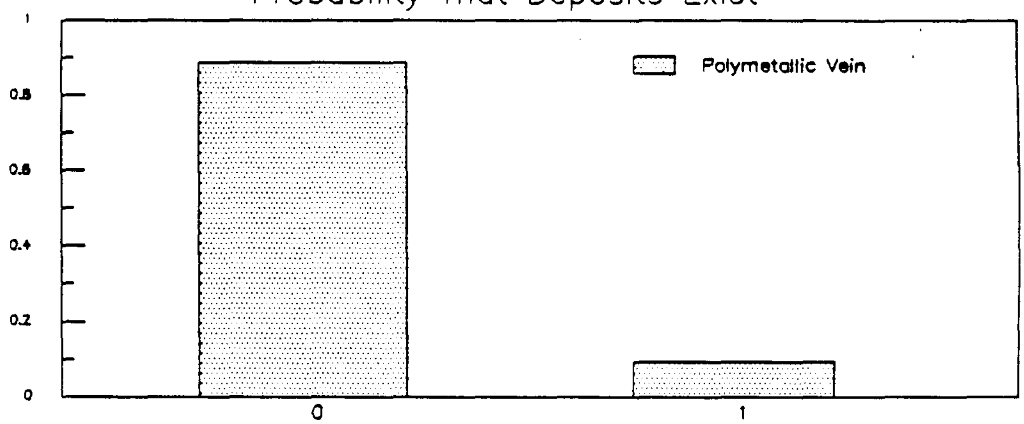
Tin Greisens

Contained Metals

Tin

Deposits

Probability That Deposits Exist



Number of Deposits

Probability of One or More Deposits = .10

Quantities

Metals Contained in Endowment (Fully Risked)

	Average	95%	50%	5%
Tin (Thousands of Short Tons)	.4	0	0	.96

Block 2 Economic Analysis: Current Prices

Economic Deposits

No Economic Deposits Simulated at Current Prices

Quantities and Values

No Economic Deposits Simulated at Current Prices

Block 2 Economic Analysis: Price Sensitivity

No Economic Deposits Simulated at Prices up to Three Times Current

Values

No Economic Deposits Simulated at Prices up to Three Times Current

Quantities:

No Economic Deposits Simulated at Prices up to Three Times Current

BLOCK 3

Block 3 is in north eastern WMNRA. It contains one terrane with the potential for tungsten skarn deposits and tungsten production. There is approximately one chance in one hundred that a deposit exists, and the block contains an average of 830 short tons of tungsten.

An economic deposit is unlikely at current prices.

As prices increase, the probability of economic activity rises slightly, but remains less than 1%. Assuming an economic deposit is found, the average NPV may be as large as $30 million, and the amount of tungsten produced (given a deposit exists) ranges from 50 to 85 thousand short tons.

Block 3 Mineral Resource Endowment

General

Location

Deposit Types:

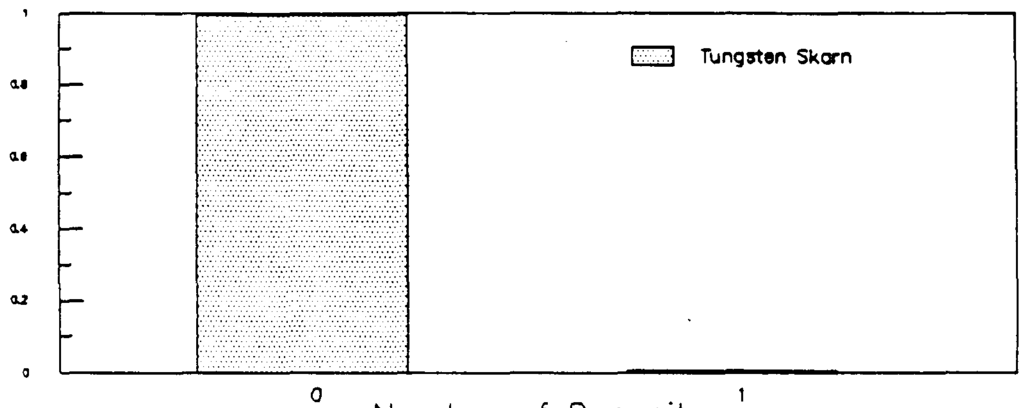
Tungsten Skarn

Contained Metals

Tungsten

Deposits

Probability That Deposits Exist



Probability of One or More Deposits = .01

Quantities

Metals Contained in Endowment (Fully Risked)

	Average	95%	50%	5%
Tungsten (Thousands of Short Tons)	.83	0	0	0

Block 3 Economic Analysis: Current Prices

Economic Deposits

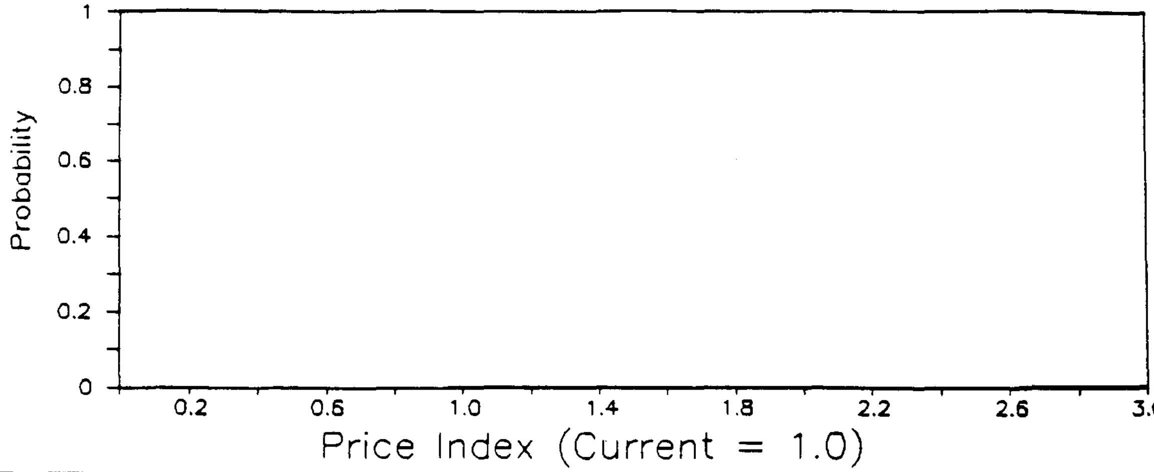
No Economic Deposits Simulated at Current Prices

Quantities and Values

No Economic Deposits Simulated at Current Prices

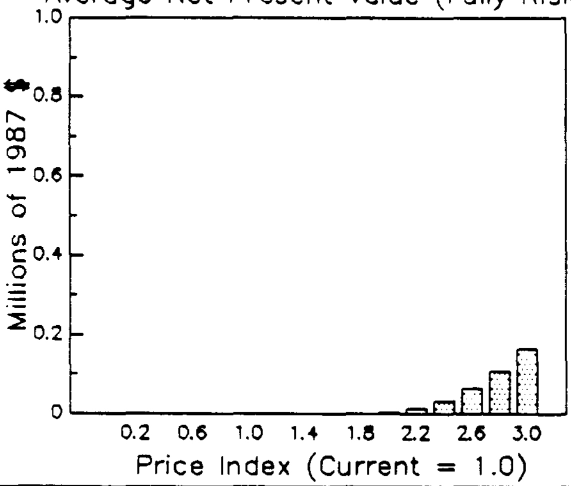
Block 3 Economic Analysis: Price Sensitivity

Probability of Economic Activity

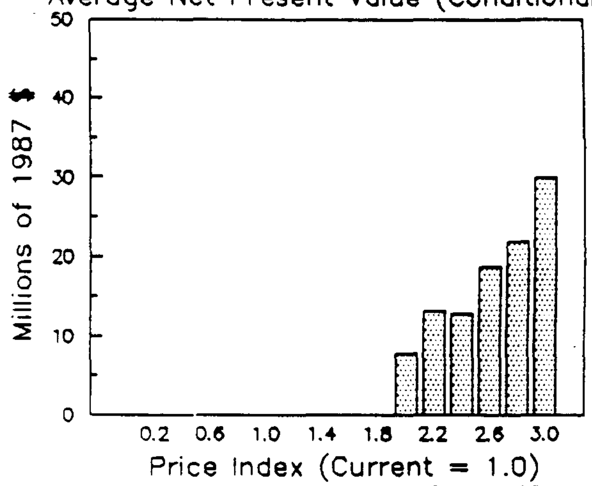


Values

Average Net Present Value (Fully Risked)

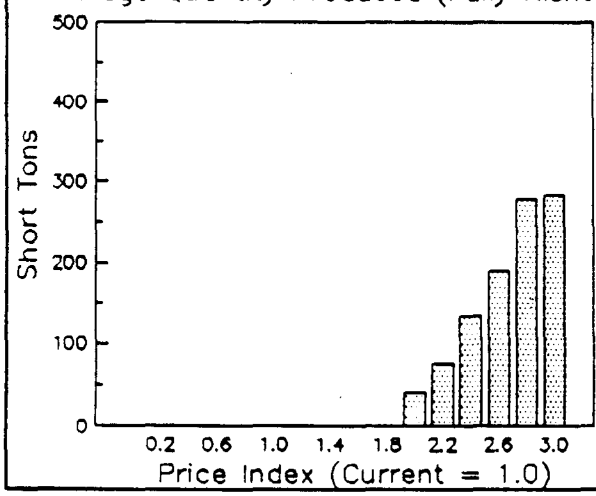


Average Net Present Value (Conditional)

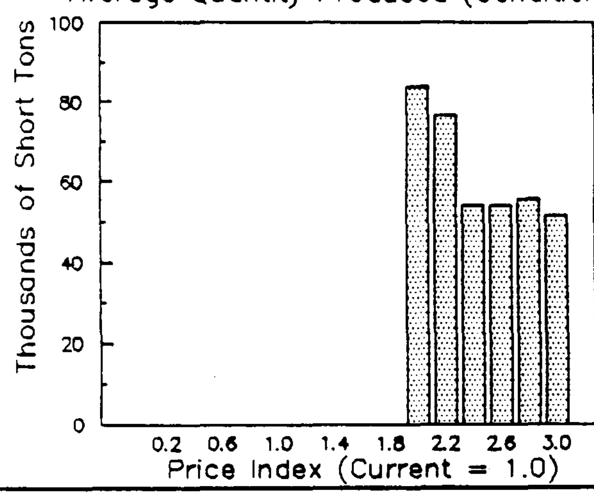


Quantities: Tungsten

Average Quantity Produced (Fully Risked)



Average Quantity Produced (Conditional)



BLOCK 4

Block 4 is in the northeastern portion of the WMNRA. It includes two terranes, one with the potential for sedimentary exhalative and the other with the potential for polymetalic vein deposits. Both types of deposits can contain varying amounts of silver, lead and zinc. There is approximately one chance in two that a deposit exists, and there may be as many as 3 deposits in the endowment. On average, the block contains 7.6 million troy ounces of silver, 260 thousand short tons of zinc, and 180 thousand tons of lead. There is a 5% chance for over 28 million ounces of silver, 1.1 million tons of zinc, and 610 thousand short tons of lead.

The chances for an economic deposit of either type at current prices are less than one in one hundred. Assuming that an economic deposit exists, it will produce (on average) almost 280 million troy ounces of silver, 2.5 million tons of zinc, 1.4 million tons of lead, and have a net present value of $66 million.

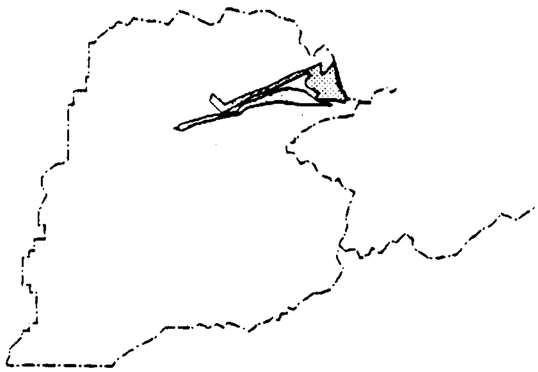
The probablility of economic activity increases steadily with increases in price, providing better than one chance in ten (14%) at three times current prices. The fully risked NPV increases to more than $60 million, and the conditional NPV to more than $450 million. Assuming that economic deposits are found, the average quantities of metal produced are: silver, from 20 to almost 300 million ounces; lead, from 1 to 1.6 million short tons, and; zinc, from 1.2 to 3.8 million short tons.

Block 4 ranks third in terms of the average net present value at current prices, and first in terms of economic significance at three times current prices. It is fifth in terms of the likelihood of economic activity at current prices and fifth at three times current prices.

Block 4 Mineral Resource Endowment

General

Location



Deposit Types:

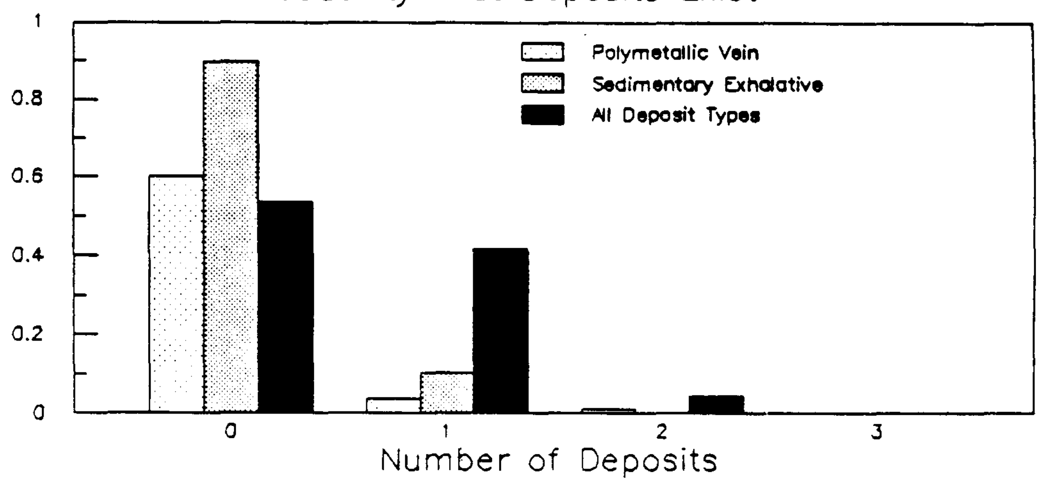
Polymetallic Vein
Sedimentary Exhalative

Contained Metals

Silver
Lead
Zinc

Deposits

Probability That Deposits Exist



Probability of One or More Deposits = .46

Quantities

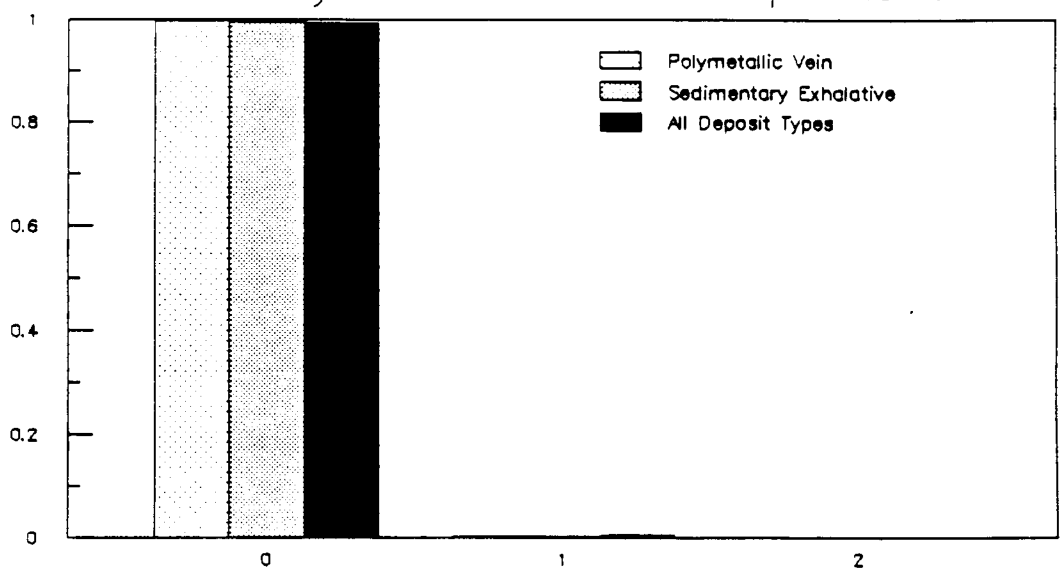
Metals Contained in Endowment (Fully Risked)

	Average	95%	50%	5%
Silver (Thousands of Troy Ounces)	7571	0	0	28000
Zinc (Thousands of Short Tons)	257	0	0	1100
Lead (Thousands of Short Tons)	180	0	0	610

Block 4 Economic Analysis: Current Prices

Economic Deposits

Probability That Economic Deposits Exist



Number of Deposits

Probability of One or More Economic Deposits = 0.005

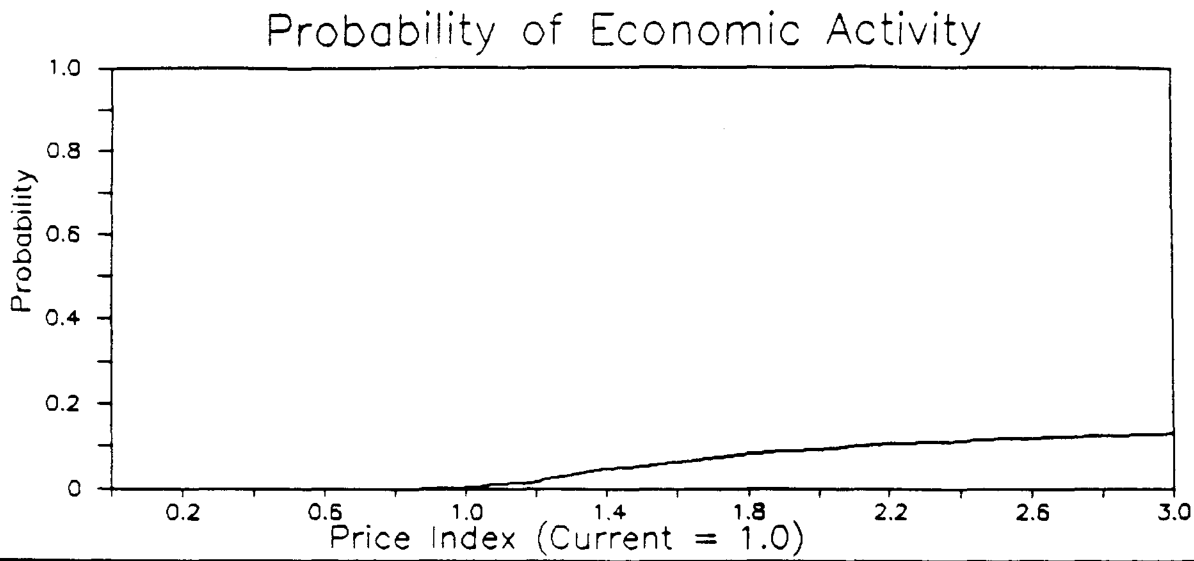
Quantities and Values

Total Recoverable Metals and NPV (Conditional)

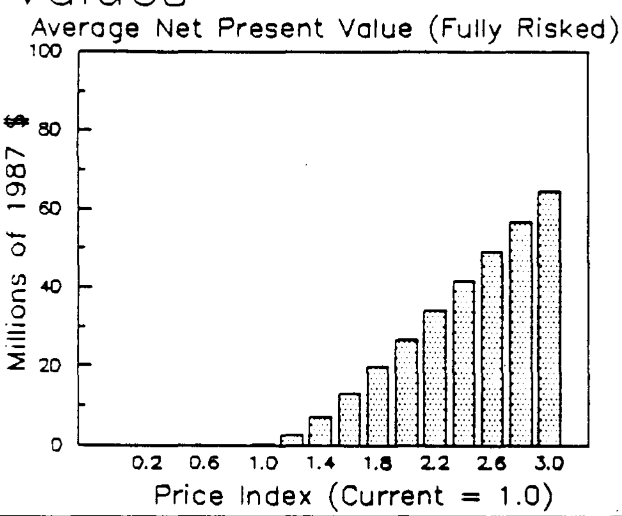
Quantities	Average	95%	50%	5%
Silver (Thousands of Troy Ounces)	286757	*	*	*
Zinc (Thousands of Short Tons)	2507	*	*	*
Lead (Thousands of Short Tons)	1423	*	*	*
NPV (Millions of 1987 Dollars)	66	*	*	*

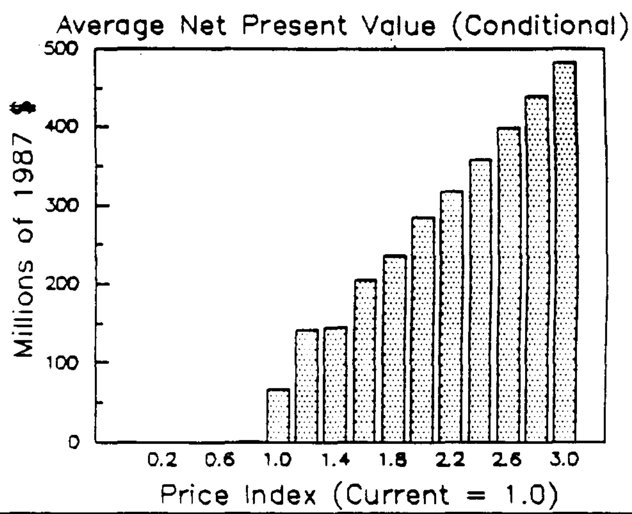
* Not Enough Observations for Meaningful Fractiles

Block 4 Economic Analysis: Price Sensitivity

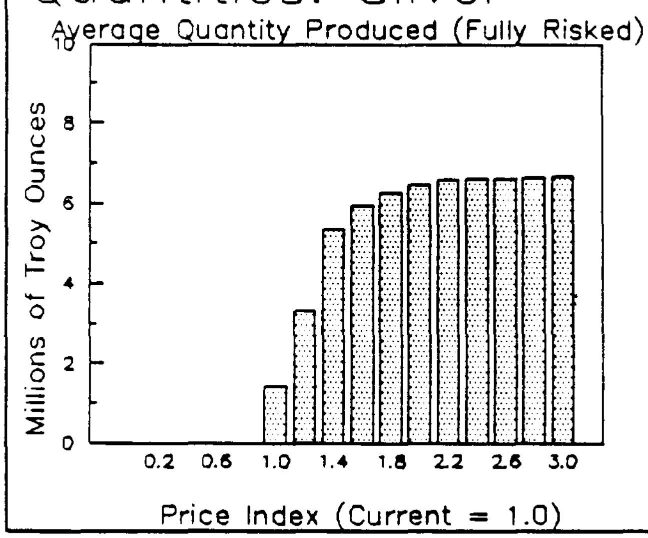


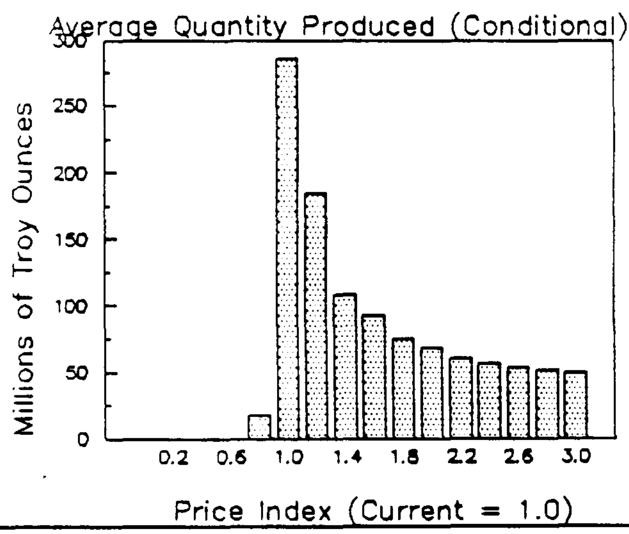
Values





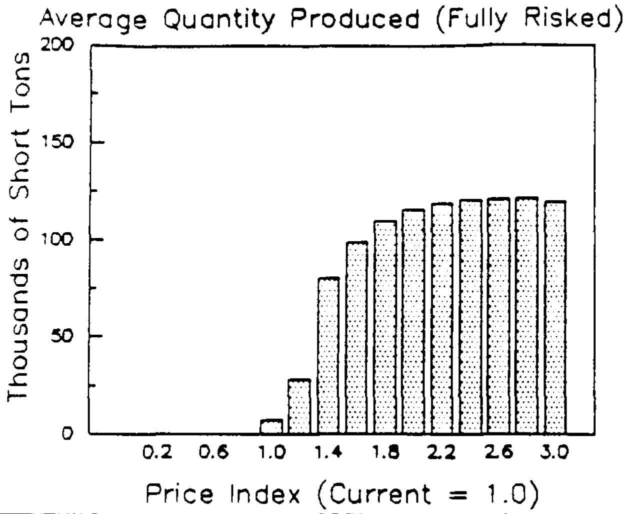
Quantities: Silver

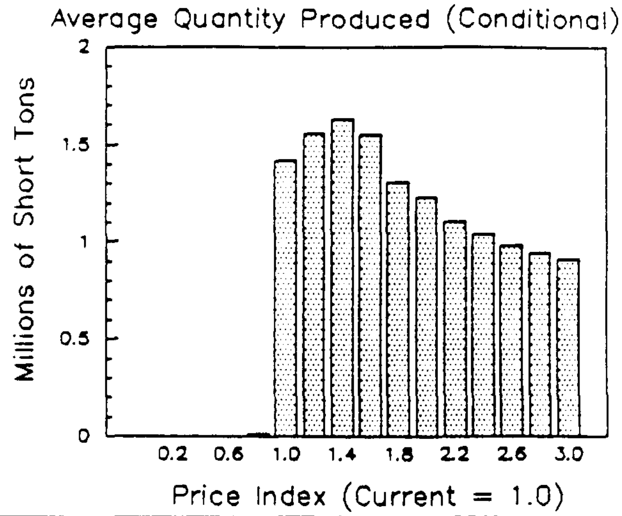




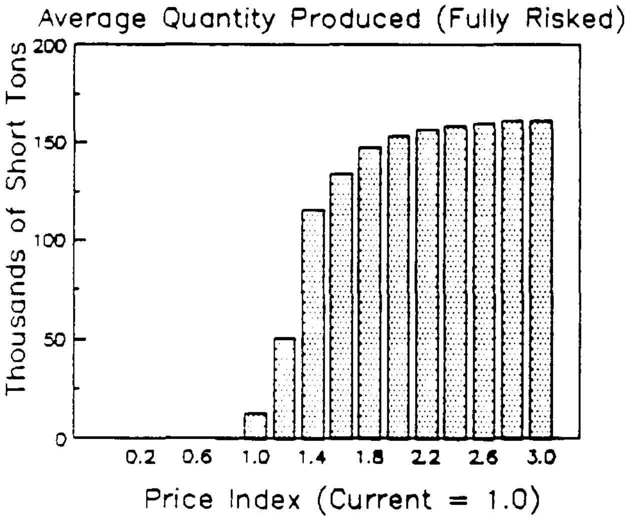
Block 4 Economic Analysis: Price Sensitivity

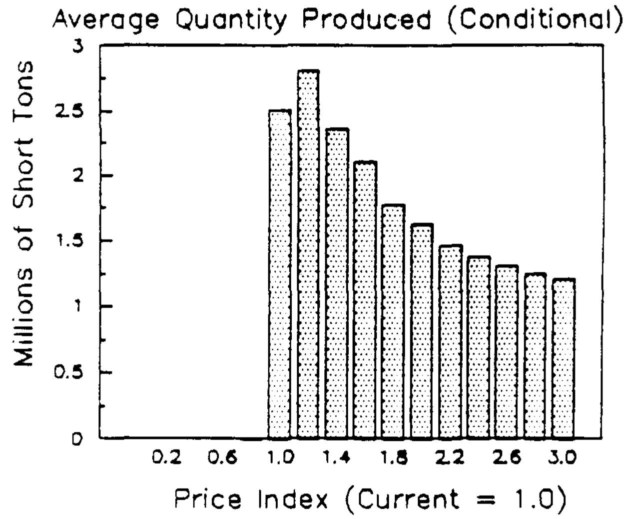
Quantities: Lead





Quantities: Zinc





BLOCK 5

Block 5 is in eastern WMNRA. It has two terranes with the potential for tin greisen and rare earth deposits. These types of deposits typically contain varying amounts of tin, silver, tantalum, tungsten, uranium and rare earths. There is a 94% chance that at least one deposit exists, with tin greisens being far more likely than the rare earth deposits. As many as eight deposits may exist, possibly one rare earth deposit and the remainder tin greisens. On average, the block contains 163 thousand short tons of tin, 500 tons of tantalum, 14 thousand tons of tungsten, 200 tons each of uranium and rare earths, and over 7.5 million troy ounces of silver.

At current prices, there is an estimated one chance in one thousand of an economically recoverable deposit. If an economic rare earth deposit does exist, it will produce (on average) 93 thousand tons of uranium, and 41 thousand tons of rare earth oxides with a NPV of $267 million. Tin greisens are unlikely to be economic at current prices.

The probablility of economic activity increases substantially with increases in price, providing almost one chance in two (42%) at three times current prices. The fully risked average NPV increases to almost $100 million, and the conditional average NPV ranges from aproximately $25 million to almost $350 million. Assuming that economic deposits are found, the approximate quantities of metal produced from both types of deposits are: tin, from 150 to over 400 thousand tons; silver, from 5 to 15 million troy ounces; tantalum, up to 9 thousand short tons; rare earths, from 17 to 40 thousand tons, and; uranium, from 40 to 140 thousand short tons.

While, at current prices, block 5 is ranked low in the likelihood of economic activity, at higher prices the block is the third most likely to experience development, and sixth in terms of conditional economic importance.

Block 5 Mineral Resource Endowment

General

Location

Deposit Types:

Tin Greisen
Rare Earths

Contained Metals

Tin	Tungsten
Silver	Uranium
Tantalum	Rare Earths

Deposits

Probability That Deposits Exist

Probability of One or More Deposits = 0.94

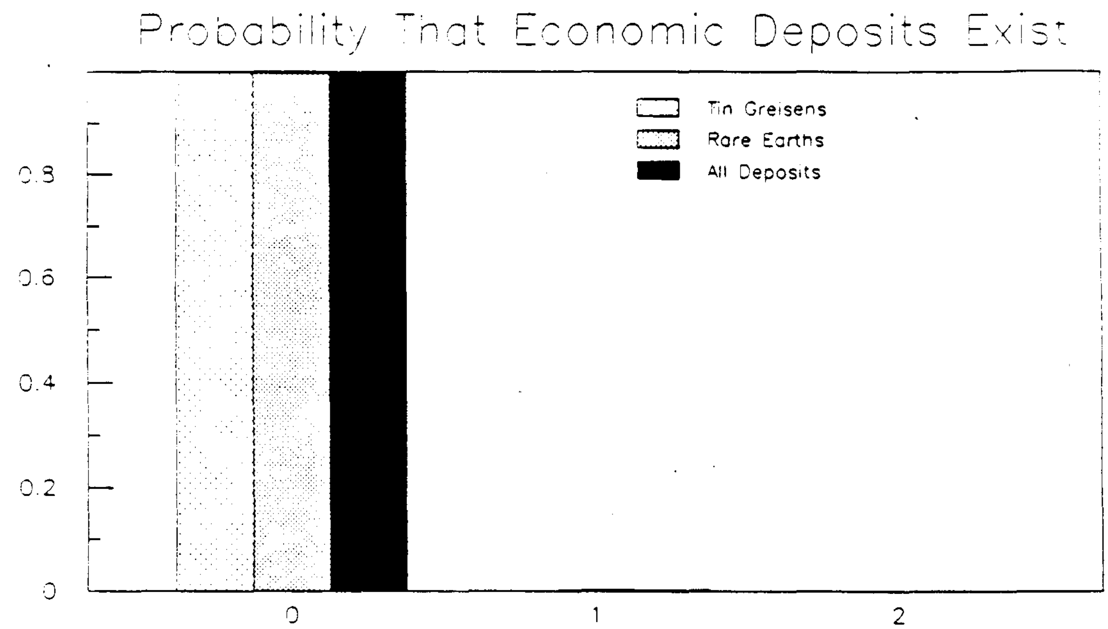
Quantities

Metals Contained in Endowment (Fully Risked)

	Average	95%	50%	5%
Tin (Thousands of Short Tons)	163	0	95	540
Silver (Thousands of Troy Ounces)	7541	0	2200	36000
Tantalum (Thousands of Short Tons)	.5	0	0	2
Tungsten (Thousands of Short Tons)	14	0	0	100
Uranium (Thousands of Short Tons)	.2	0	0	0
Rare Earths (Thousands of Short Tons)	.2	0	0	0

Block 5 Economic Analysis: Current Prices

Economic Deposits



Probability of One or More Economic Deposits = 0.001

Quantities and Values

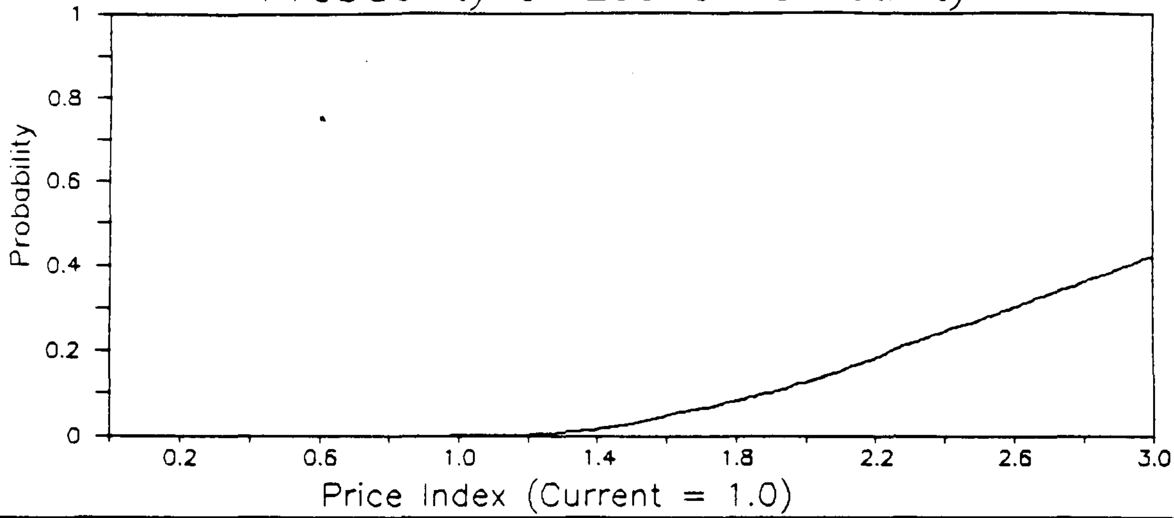
Total Recoverable Metals and NPV (Conditional)

Quantities	Average	95%	50%	5%
Tin (Thousands of Short Tons)	0	0	0	0
Silver (Thousands of Troy Ounces)	0	0	0	0
Tantalum (Thousands of Short Tons)	0	0	0	0
Tungsten (Thousands of Short Tons)	0	0	0	0
Uranium (Thousands of Short Tons)	93	*	*	*
Rare Earths (Thousands of Short Tons)	41	*	*	*
NPV (Millions of 1987 Dollars)	267	*	*	*

* Not Enough Observations for Meaningful Fractiles

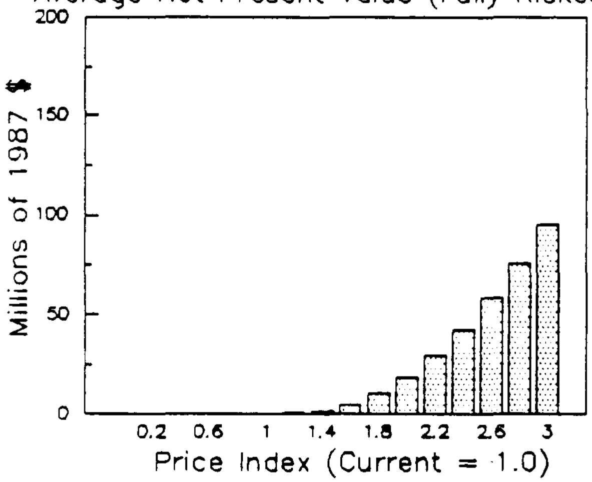
Block 5 Economic Analysis: Price Sensitivity

Probability of Economic Activity

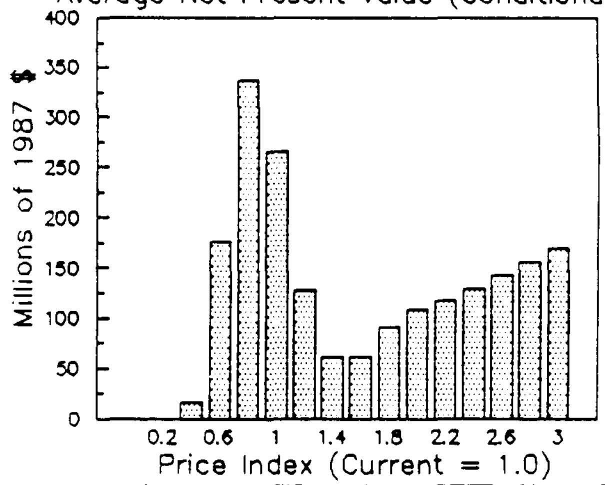


Values

Average Net Present Value (Fully Risked)

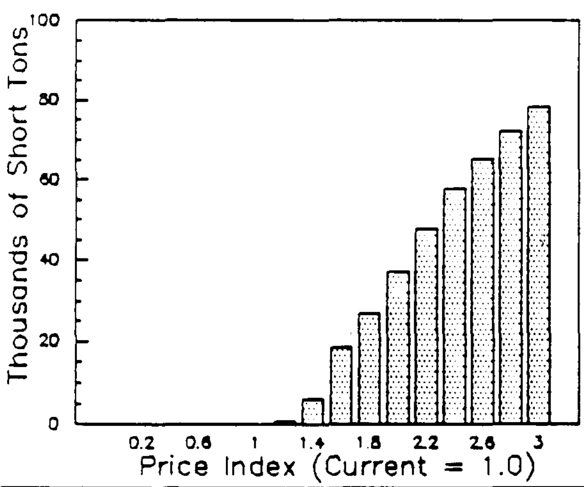


Average Net Present Value (Conditional)

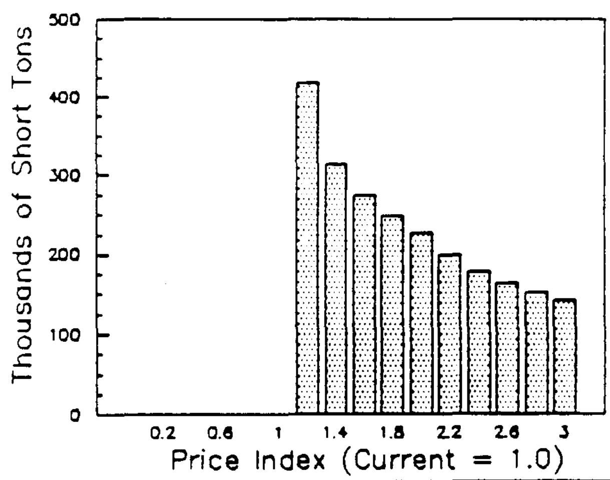


Quantities: Tin

Average Quantity Produced (Fully Risked)

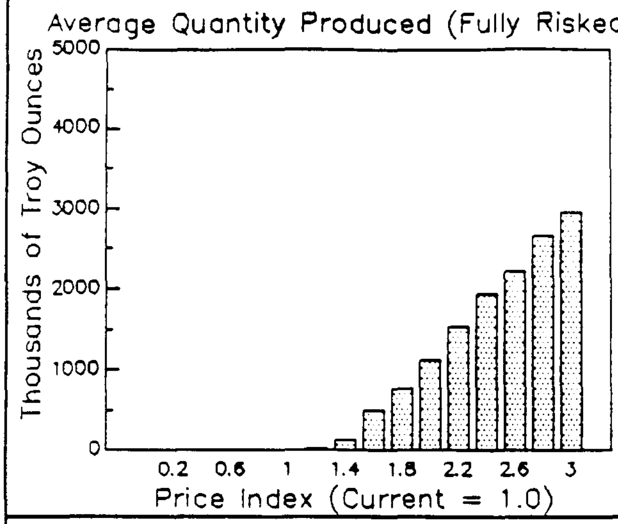


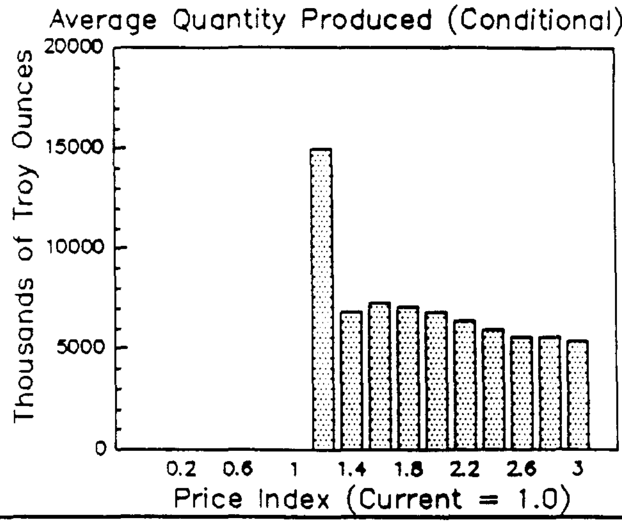
Average Quantity Produced (Conditional)



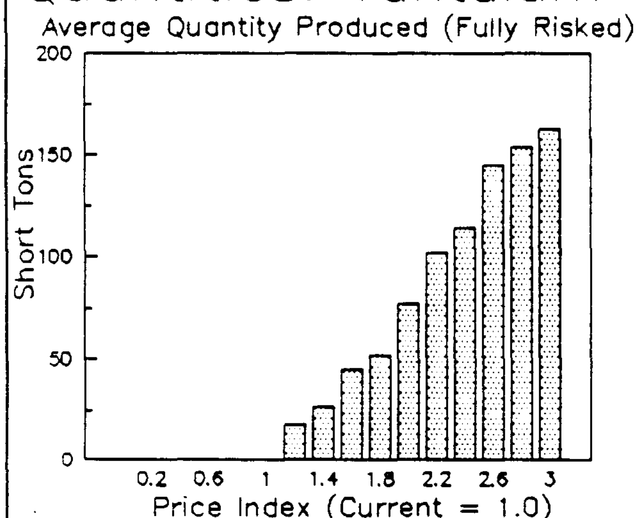
Block 5 Economic Analysis: Price Sensitivity

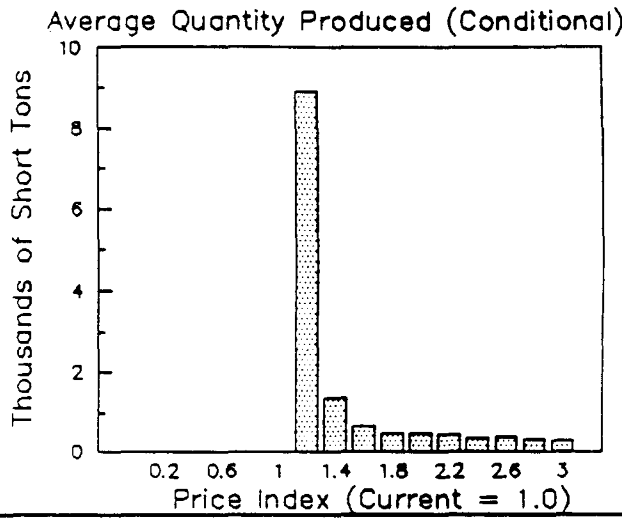
Quantities: Silver



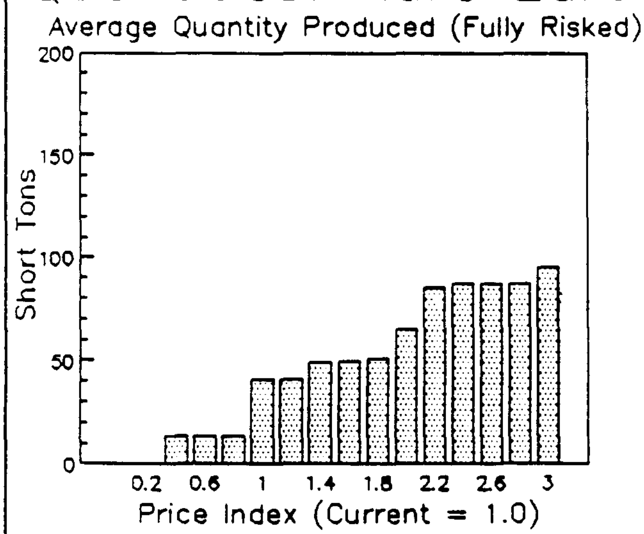


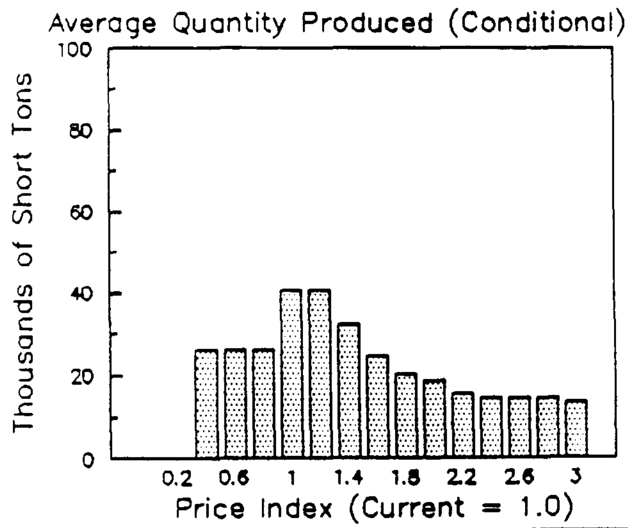
Quantities: Tantalum





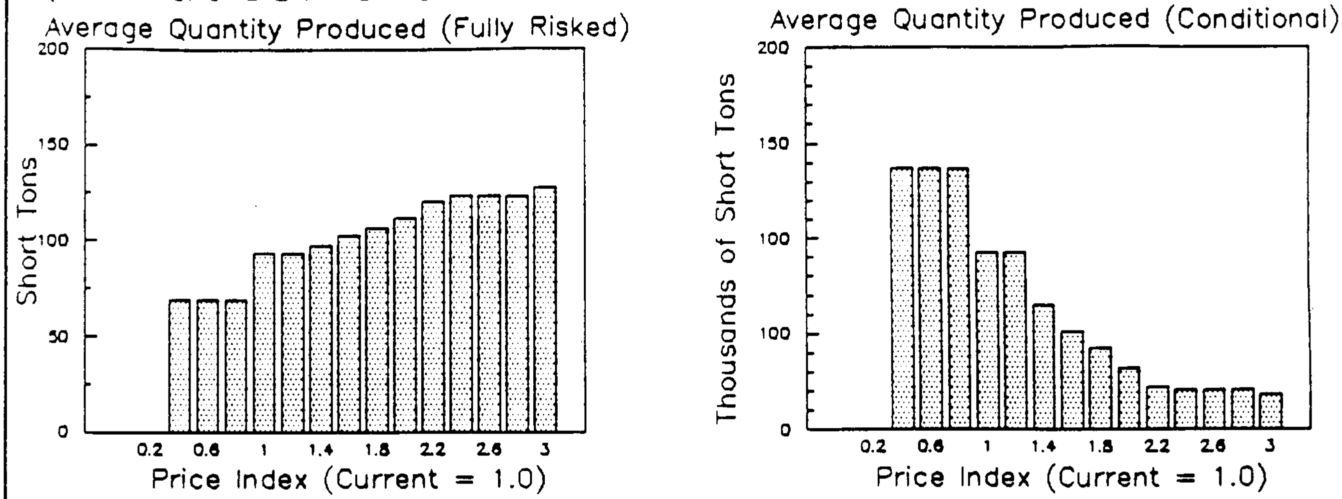
Quantities: Rare Earths





Block 5 Economic Analysis: Price Sensitivity

Quantities: Uranium



BLOCK 6

Block 6 is in central WMNRA. It has one terrane with the potential for rare earths deposits, containing uranium, thorium and rare earth oxides. Geologists were virtually certain that at least one deposit exists, and there may be as many as 3 deposits in the endowment. On average, the block is estimated to contain 4 thousand tons of uranium and 16 thousand short tons of rare earth oxides. There is a 5% chance that 15 thousand short tons of uranium and 62 thousand tons of rare earths are contained in the block.

The chances for an economic deposit are approximately one in fifty at current prices. If an economically recoverable deposit does exist, it will produce (on average) 21 thousand tons of uranium, and 12 thousand tons of rare earth oxides with a NPV of $27 million.

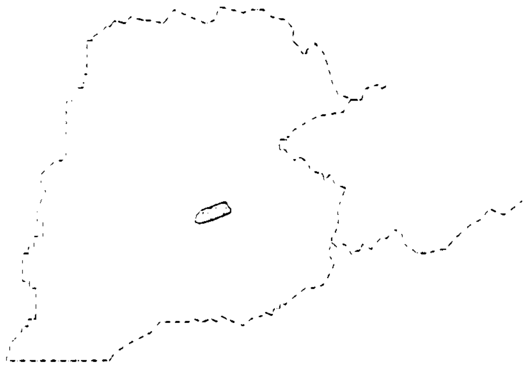
The probablility of economic activity increases to 3% as prices approach three times the current level. The fully risked NPV increases to approximately $3 million, and the conditional NPV to $81 million. Assuming an economic deposit is found, the approximate quantities of metal produced are: rare earths, from 12 to 22 thousand tons, and; uranium, from 7 to 21 thousand short tons.

This block is ranked fifth in terms of the likelihood of development at current prices, and seventh in terms of average NPV. At higher prices, it is the seventh most likely to be developed, and seventh in terms of average NPV.

Block 6 Mineral Resource Endowment

General

Location



Deposit Types:

Rare Earths

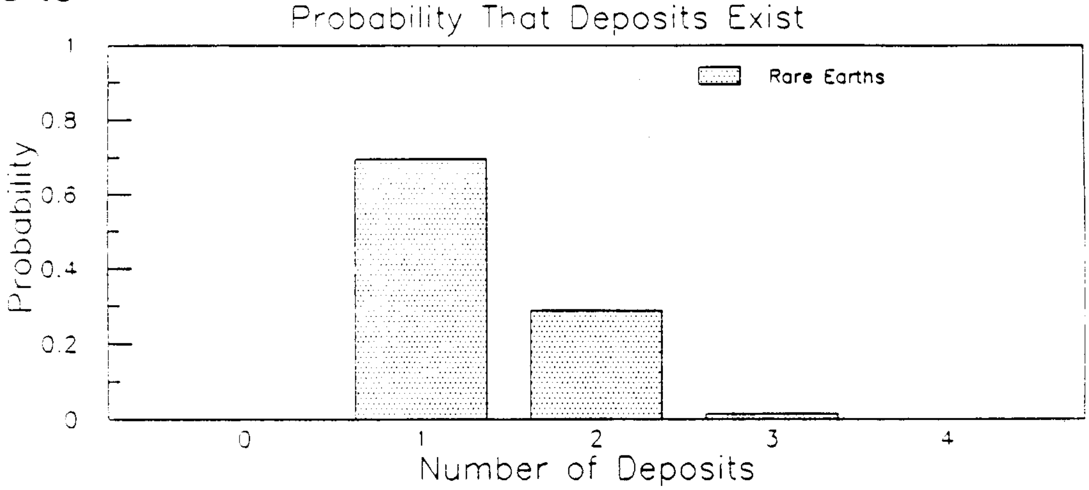
Contained Metals

Uranium

Rare Earths

Thorium

Deposits



Probability of One or More Deposits = 1.00

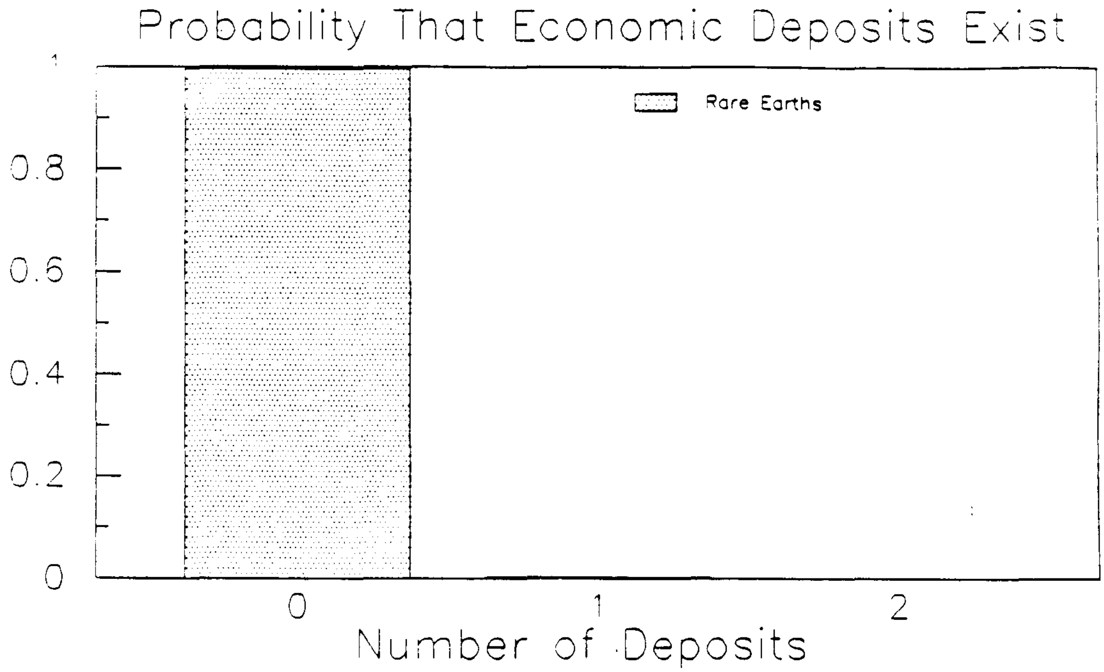
Quantities

Metals Contained in Endowment (Fully Risked)

	Average	95%	50%	5%
Uranium (Thousands of Short Tons)	4	.1	2	15
Rare Earths (Thousands of Short Tons)	16	.1	5	62
Thorium (Thousands of Short Tons)	4	0	0	16

Block 6 Economic Analysis: Current Prices

Economic Deposits



Probability of One or More Economic Deposits = 0.003

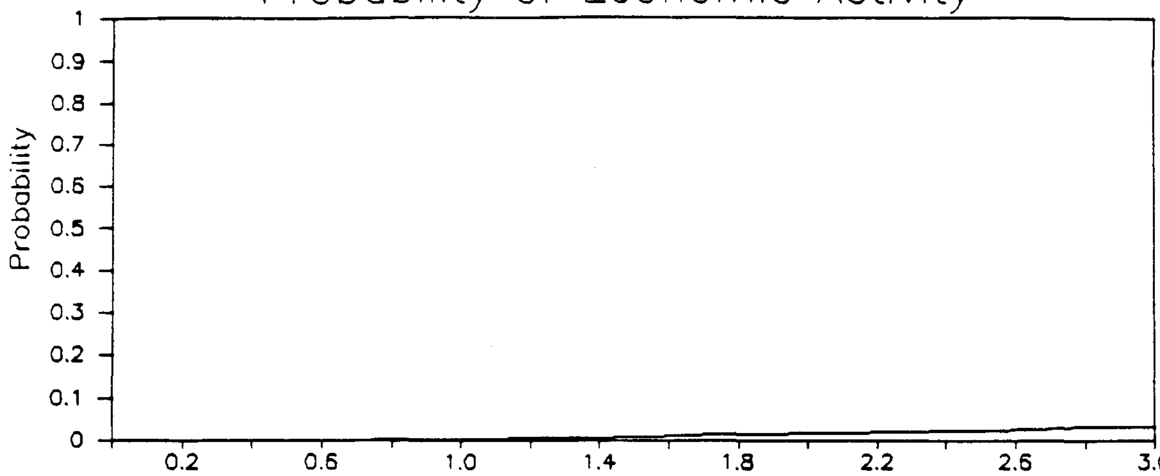
Quantities and Values

Total Recoverable Metals and NPV (Conditional)

Quantities	Average	95%	50%	5%
Rare Earths (Thousands of Short Tons)	12	*	*	*
Uranium (Thousands of Short Tons)	21	*	*	*
NPV (Millions of 1987 Dollars)	27	*	*	*

Block 6 Economic Analysis: Price Sensitivity

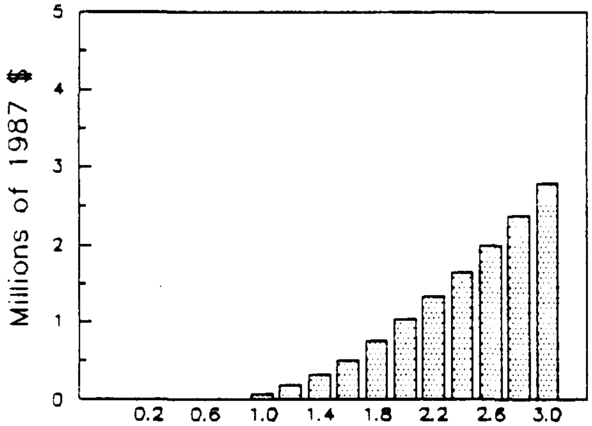
Probability of Economic Activity



Price Index (Current = 1.0)

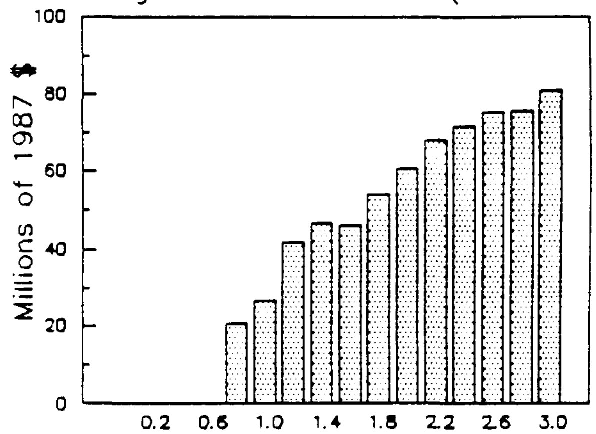
Values

Average Net Present Value (Fully Risked)



Price Index (Current = 1.0)

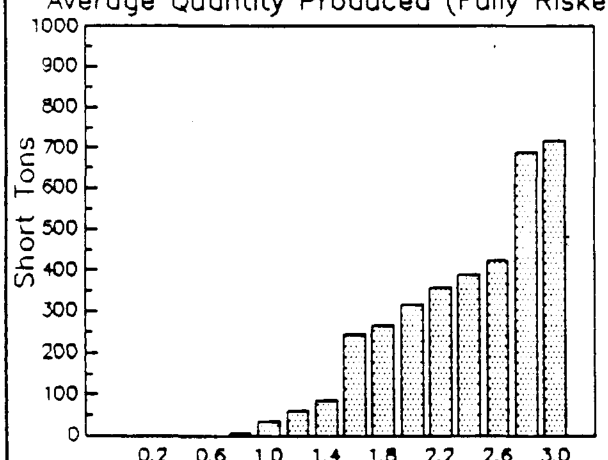
Average Net Present Value (Conditional)



Price Index (Current = 1.0)

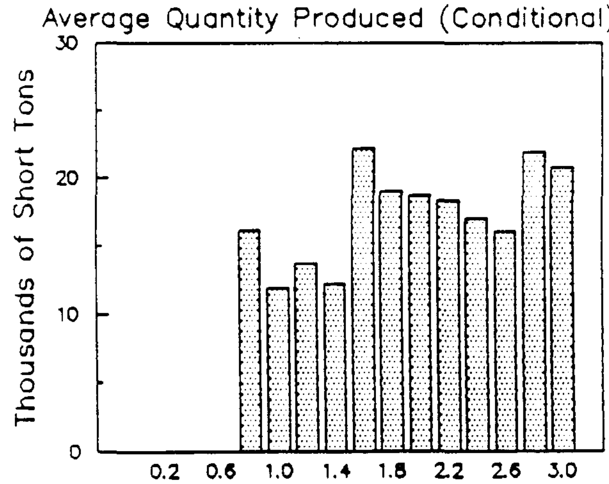
Quantities: Rare Earths

Average Quantity Produced (Fully Risked)



Price Index (Current = 1.0)

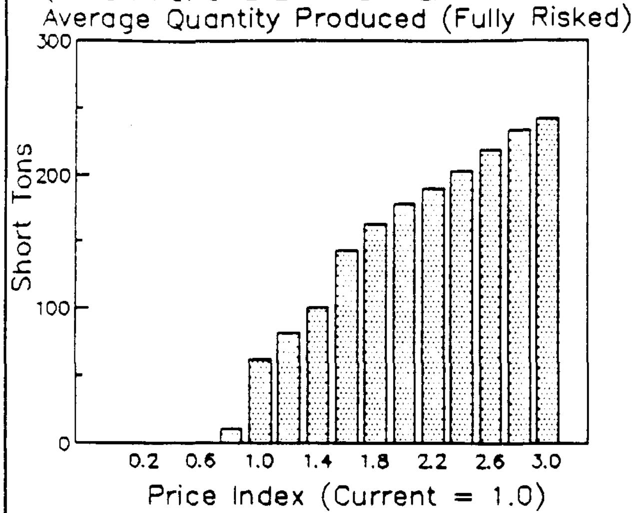
Average Quantity Produced (Conditional)

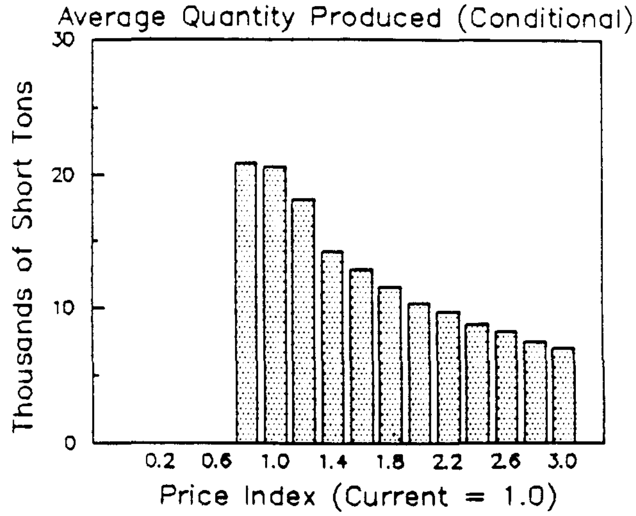


Price Index (Current = 1.0)

Block 6 Economic Analysis: Price Sensitivity

Quantities: Uranium





BLOCK 7

Block 7 is in east central WMNRA and western North SNCA. It contains four terranes with the potential for tin greisen, tungsten skarn, alkalic-associated gold and rare earth deposits. These types of deposits contain varying amounts of tin, silver, tantalum, gold, tungsten, uranium and rare earth oxides. Based on the results of the geologic assessments, there is a one in two chance that at least one undiscovered deposit exists, with tin greisen and tungsten skarn the most likely. Up to four deposits of all types may exist in the endowment. On average, the quantities of metals contained in all types of deposits in the block are: silver, 1.3 million troy ounces; gold, 86 thousand troy ounces; tin, 33 thousand short tons; tungsten, 8 thousand tons; rare earths, 600 tons; uranium, 300 tons, and tantalum, 100 short tons.

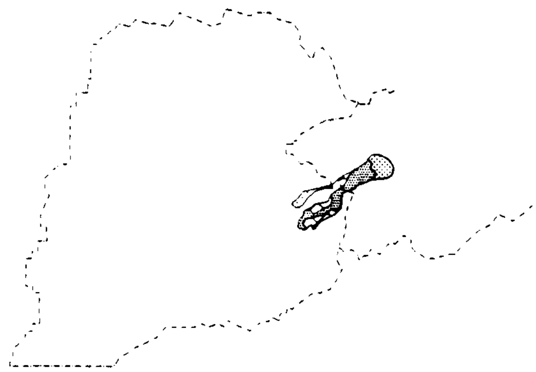
There is approximately one chance in one hundred for economically recoverable deposits at current prices, and there may be as many as 2 deposits (one rare earths and one alkalic-associated gold). If such deposits do exist, metals produced from the block include (on average) 3.8 million troy ounces of gold, 45 thousand tons of uranium, 47 thousand short tons of rare earth oxides. Average NPV for all types of deposits is $63 million.

The probablility of economic activity increases to approximately 14% as prices approach three times current prices. The fully risked average NPV increases to approximately $6 million, and the conditional average NPV to $175 million. Assuming that economic deposits are found, the approximate quantities of metal produced from the block are: gold, 2 to 4 million troy ounces; silver, from 1 to 10 million troy ounces; tantalum, from 100 to 600 thousand short tons; tungsten, from 3 to 5 thousand short tons; tin, from 150 to 400 thousand short tons; rare earths, from 60 to 100 thousand tons, and; uranium, from 18 to almost 90 thousand short tons.

Block 7 Mineral Resource Endowment

General

Location



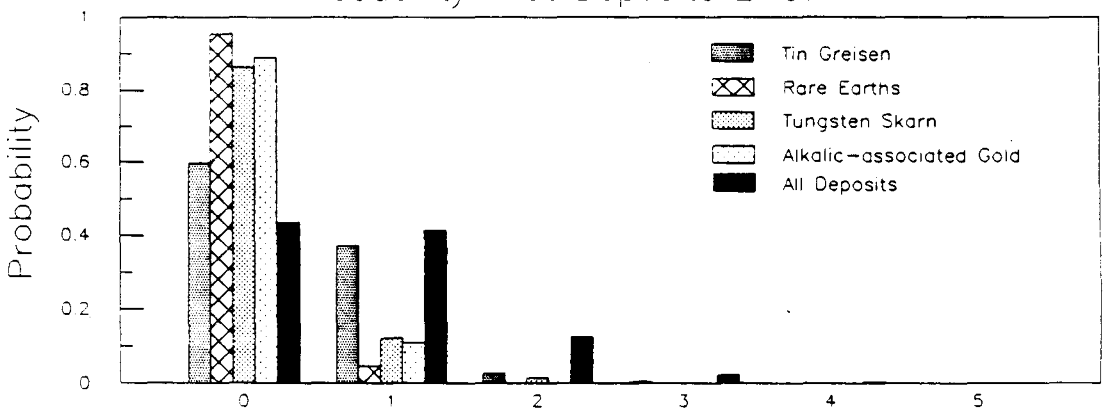
Deposit Types:
- Tin Greisen
- Tungsten Skarn
- Alkalic–associated Gold
- Rare Earths

Contained Metals

Tin	Tungsten
Silver	Uranium
Tantalum	Rare Earths
Gold	

Deposits

Probability That Deposits Exist



Probability of One or More Deposits = 0.56

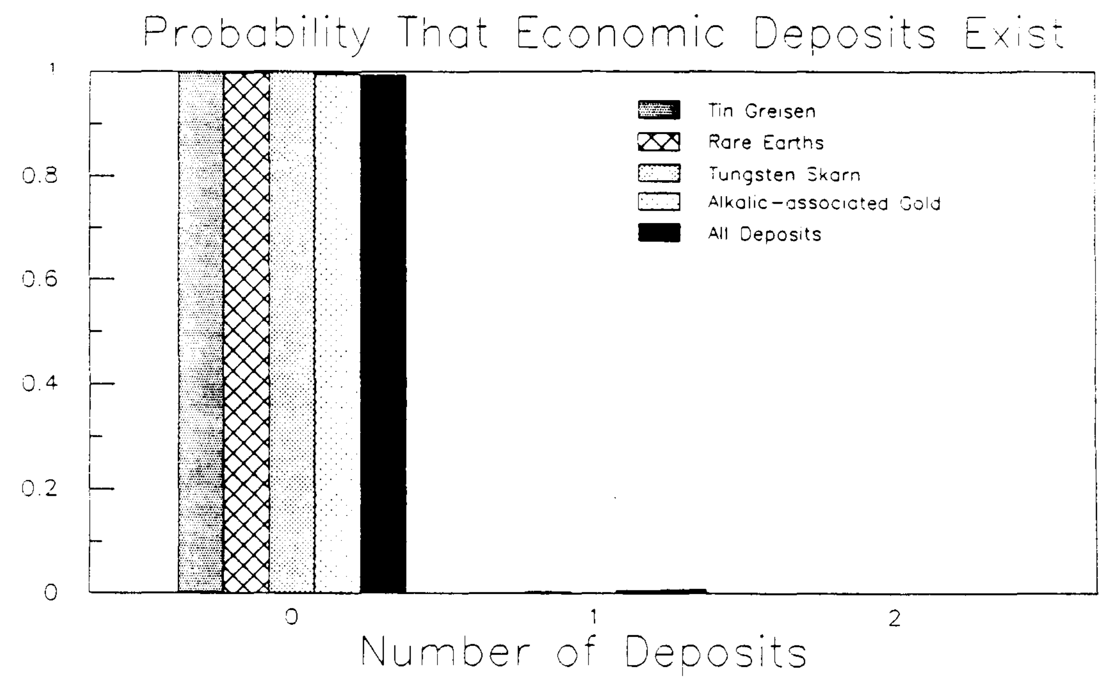
Quantities

Metals Contained in Endowment (Fully Risked)

	Average	95%	50%	5%
Tin (Thousands of Short Tons)	33	0	0	200
Silver (Thousands of Troy Ounces)	1302	0	0	7100
Gold (Thousands of Troy Ounces)	86	0	0	350
Tantalum (Thousands of Short Tons)	.1	0	0	0
Tungsten (Thousands of Short Tons)	8	0	0	39
Uranium (Thousands of Short Tons)	.3	0	0	0
Rare Earths (Thousands of Short Tons)	.6	0	0	0

Block 7 Economic Analysis: Current Prices

Economic Deposits



Probability of One or More Economic Deposits = 0.008

Quantities and Values

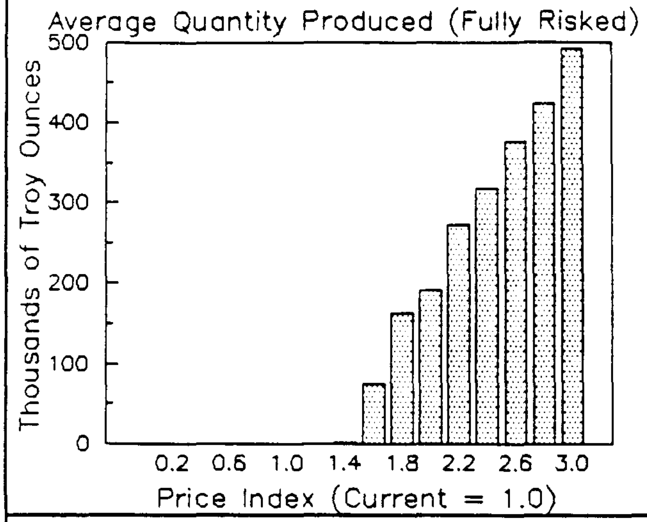
Total Recoverable Metals and NPV (Conditional)

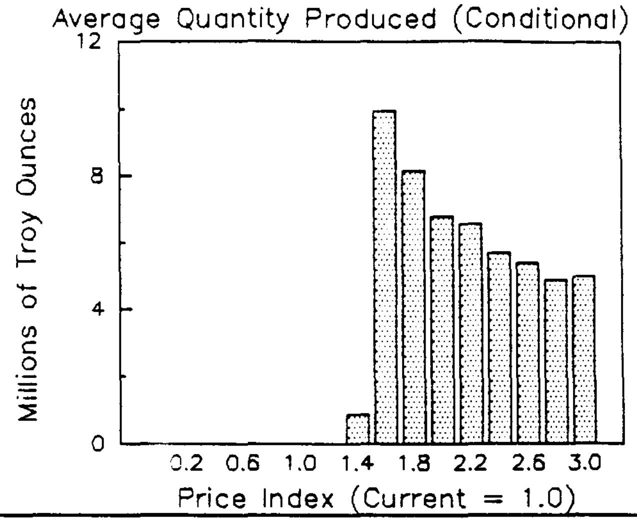
Quantities	Average	95%	50%	5%
Tin (Thousands of Short Tons)	0	0	0	0
Silver (Thousands of Troy Ounces)	0	0	0	0
Gold (Thousands of Troy Ounces)	3784	*	*	*
Tantalum (Thousands of Short Tons)	0	0	0	0
Tungsten (Thousands of Short Tons)	0	0	0	0
Uranium (Thousands of Short Tons)	47	*	*	*
Rare Earths (Thousands of Short Tons)	45	*	*	*
NPV (Millions of 1987 Dollars)	63	*	*	*

* Not Enough Observations for Meaningful Fractiles

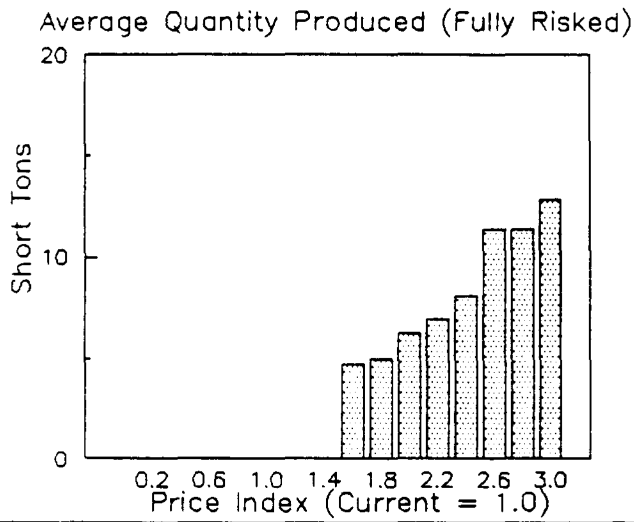
Block 7 Economic Analysis: Price Sensitivity

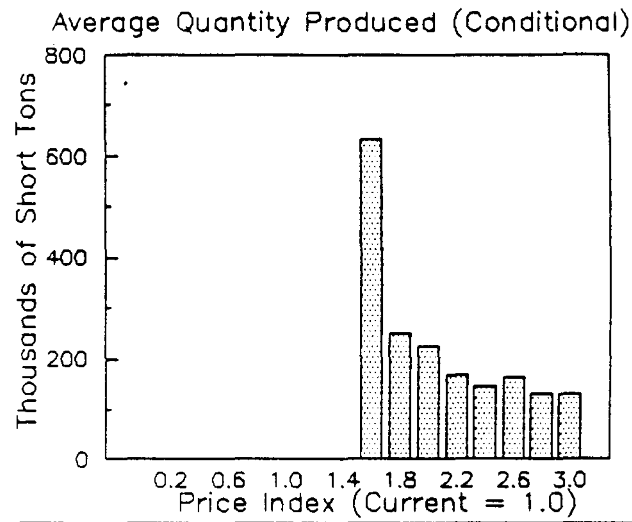
Quantities: Silver



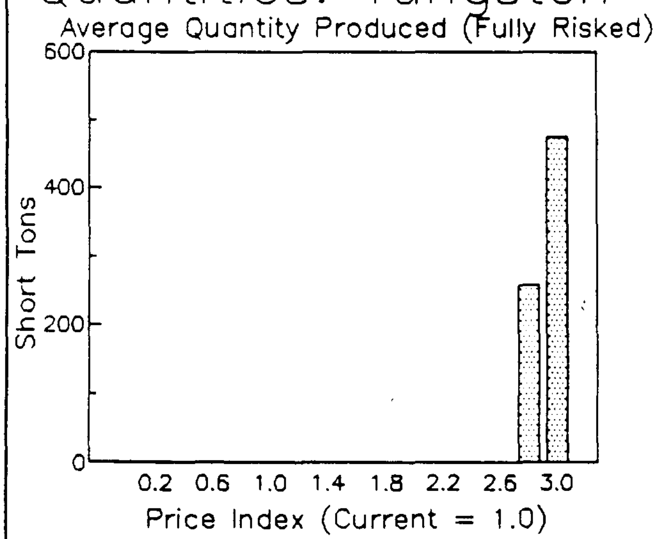


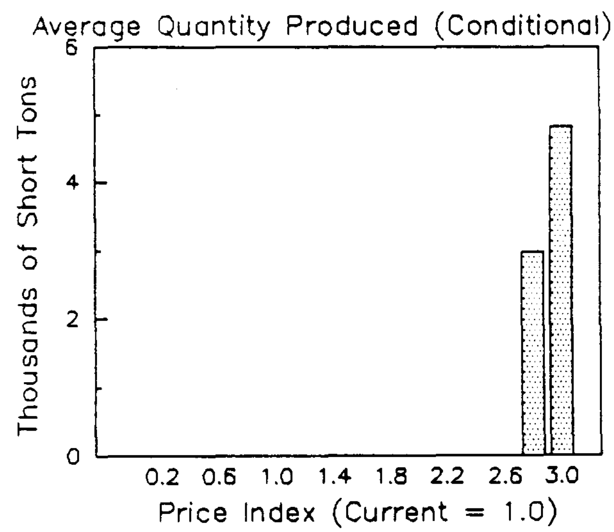
Quantities: Tantalum





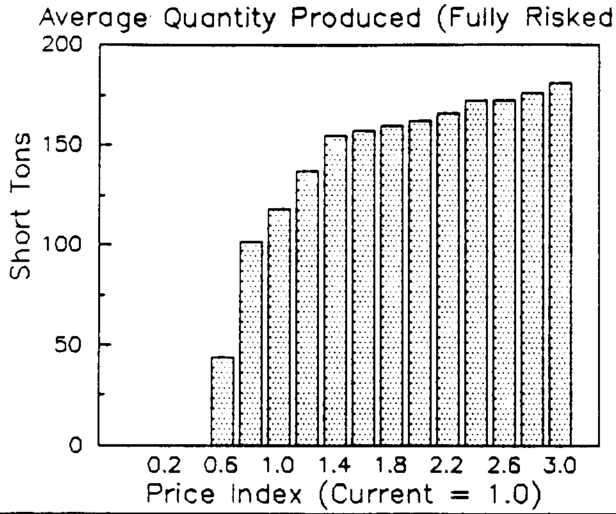
Quantities: Tungsten

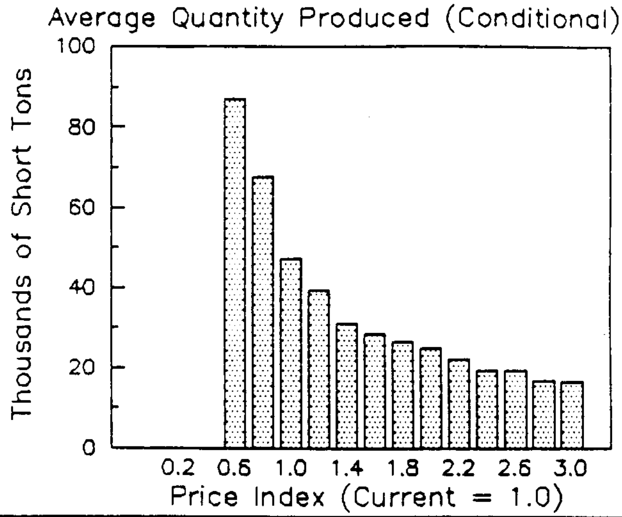




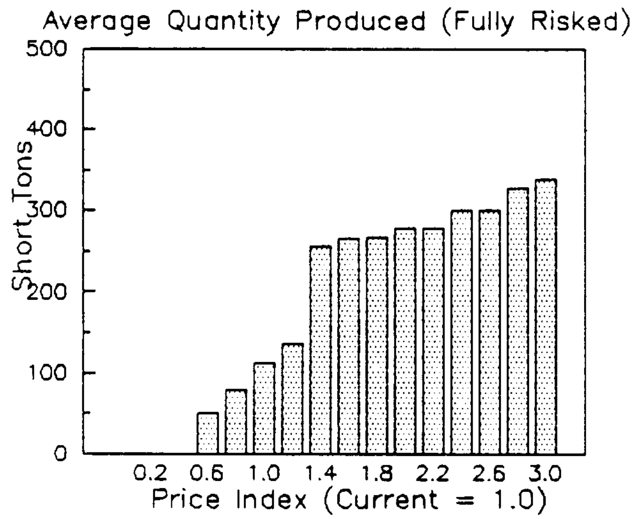
Block 7 Economic Analysis: Price Sensitivity

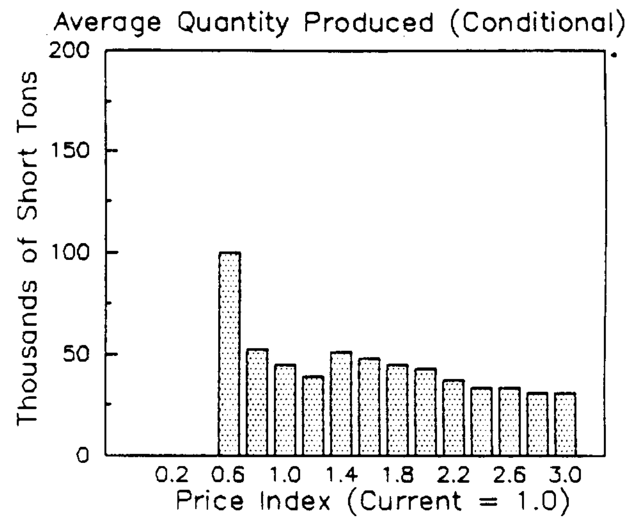
Quantities: Uranium



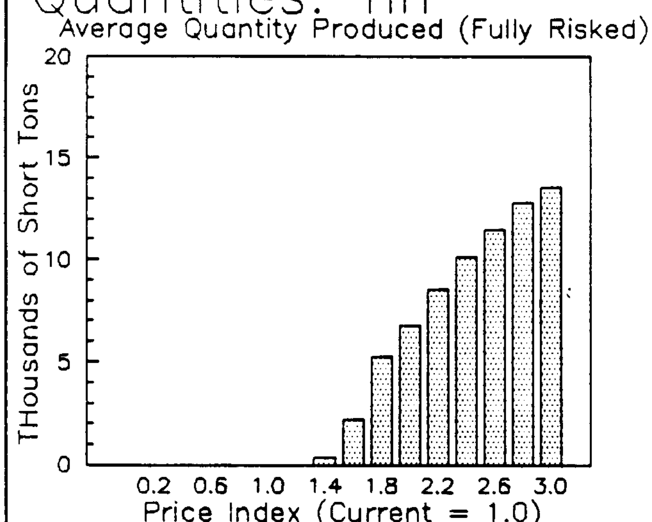


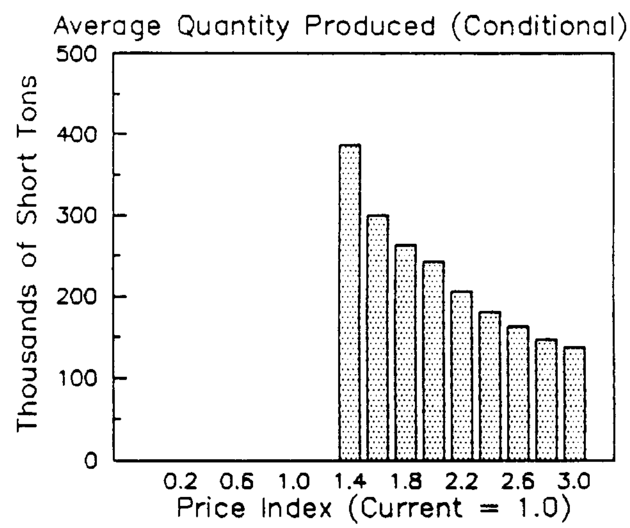
Quantities: Rare Earths



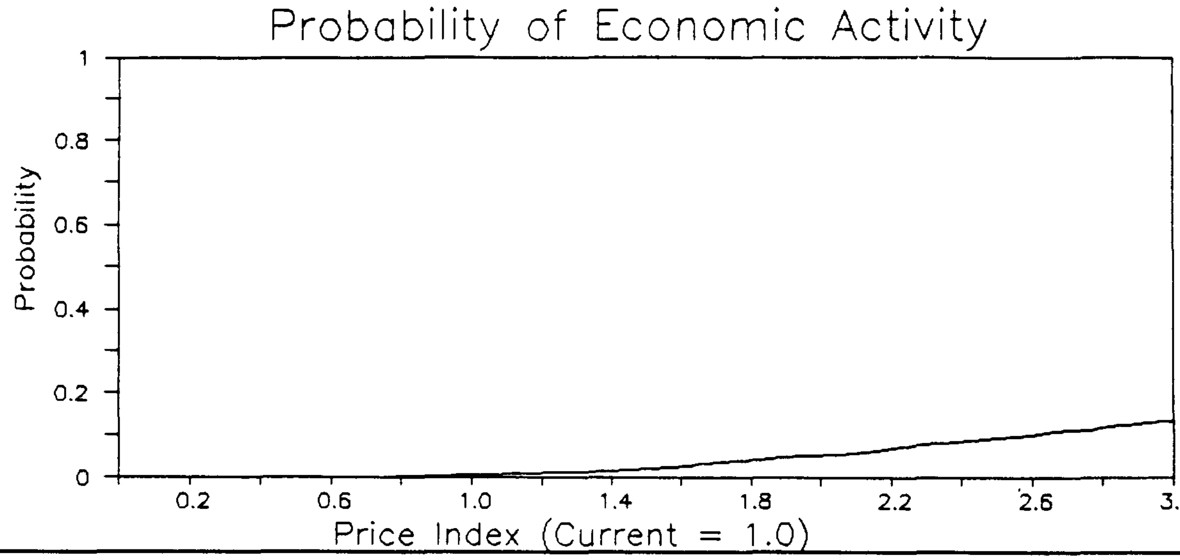


Quantities: Tin





Block 7 Economic Analysis: Price Sensitivity



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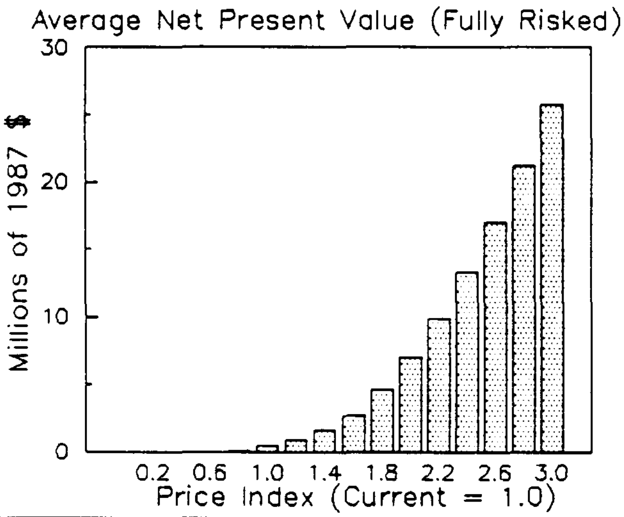
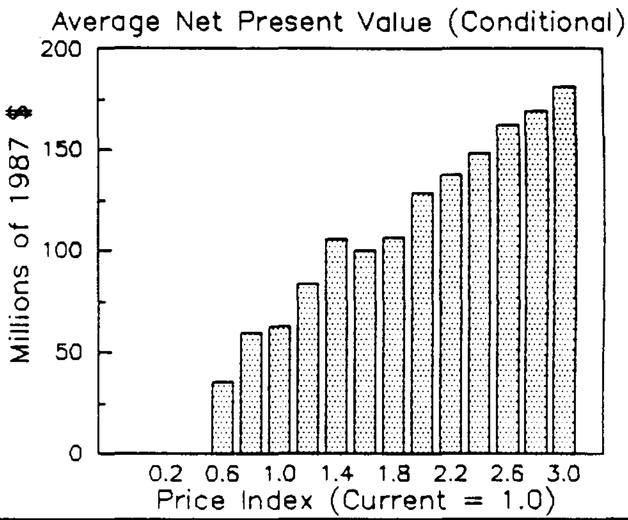
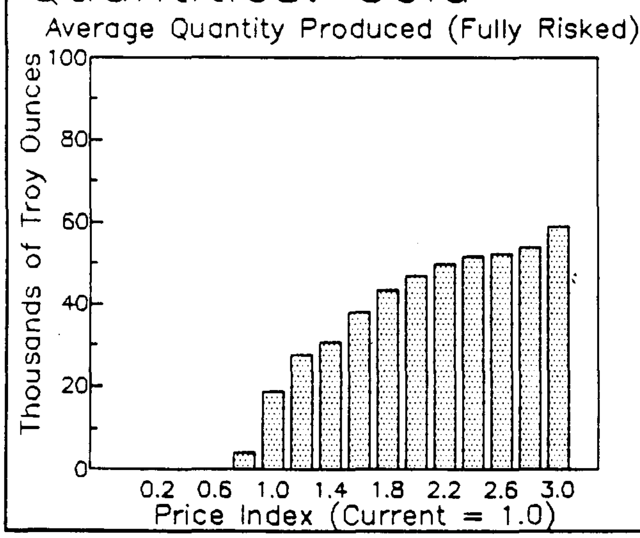
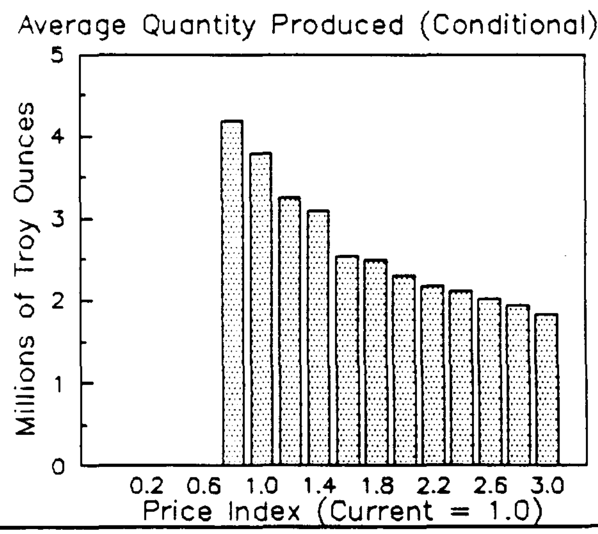




Quantities: Gold





BLOCK 8

Block 8, in the southern portion of the North SNCA, has three terranes with the potential for tungsten skarn, vein gold and alkalic-associated gold deposits. Contained metals include silver, tungsten and gold. It is almost certain that at least one deposit exists (a tungsten skarn deposit is most likely), and there may be as many as 17 deposits in the endowment. On average, the block contains almost 2 million troy ounces of gold, 370 thousand ounces of silver, and 23 thousand short tons of tungsten in all types of deposits.

The chance of one or more economic deposits at current prices is better than 1 in 10. If economic deposits do exist, production from the block could include (on average) 8.1 million troy ounces of gold, 2.1 million troy ounces of silver and 7 thousand tons of tungsten. The average NPV of recoverable deposits is $347 million.

The probablility of economic activity increases to more than 52% as prices approach three times current prices. The fully risked average NPV increases to approximately $240 million. The conditional average NPV to $300-$350 million. Assuming that economic deposits are found, the approximate quantities of metal produced are: gold, 3 to over 60 million troy ounces; silver, from 1 to 6 million troy ounces; and tungsten, from 7 to 37 thousand short tons.

Block 8 is ranked second in terms of the likelihood of development at current and higher prices, second in average net present value at current prices, and third in NPV at higher prices.

Block 8 Mineral Resource Endowment

General

Location

Deposit Types:

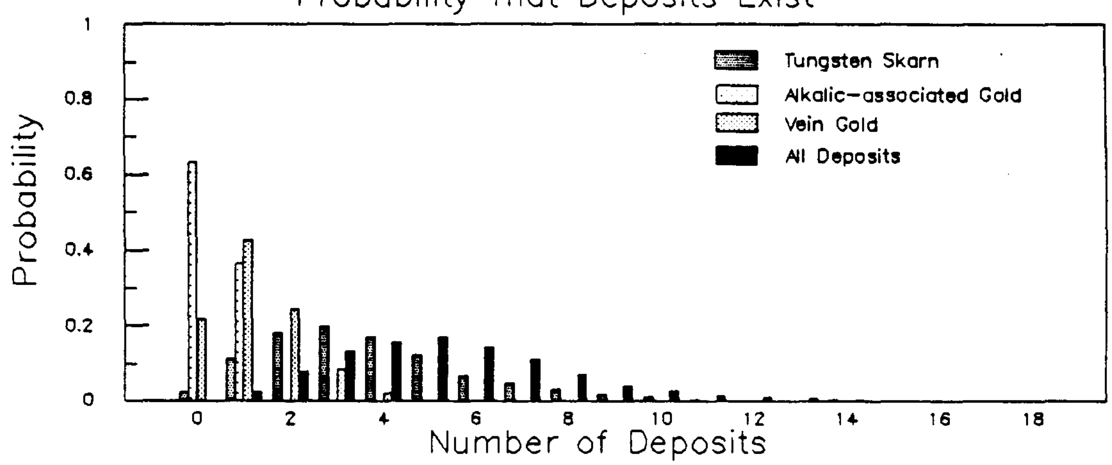
Tungsten Skarn
Alkalic–associated Gold
Vein Gold

Contained Metals

Tungsten
Gold
Silver

Deposits

Probability That Deposits Exist



Probability of One or More Deposits = 0.99

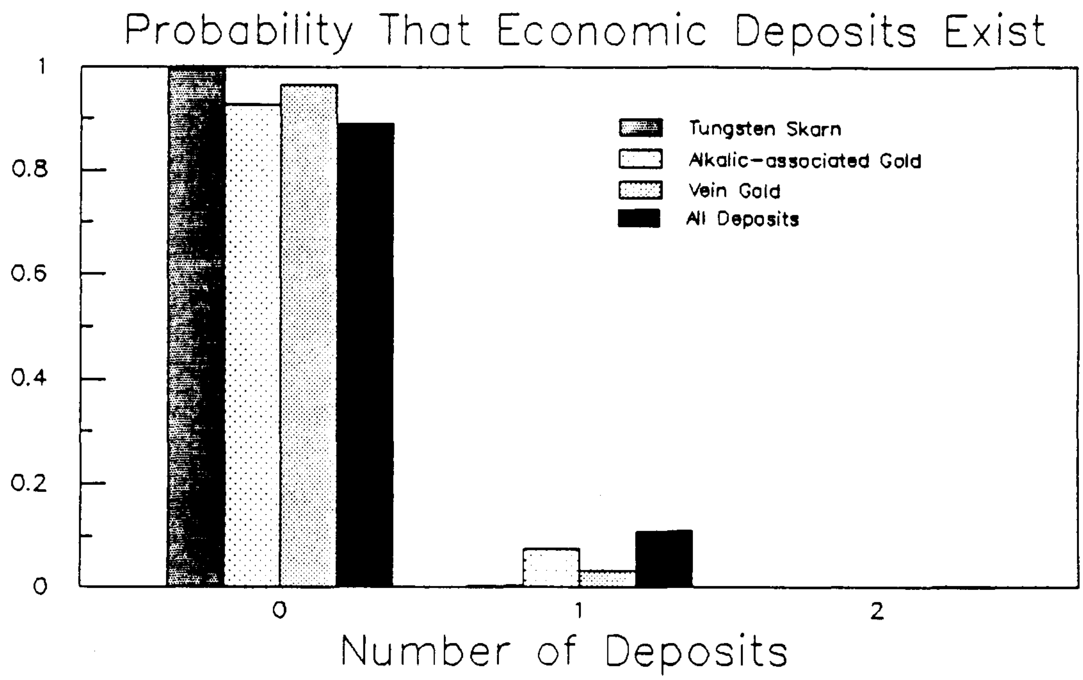
Quantities

Metals Contained in Endowment (Fully Risked)

	Average	95%	50%	5%
Tungsten (Thousands of Short Tons)	23	1	17	65
Silver (Thousands of Troy Ounces)	369	0	0	980
Gold (Thousands of Troy Ounces)	1928	7	540	20000

Block 8 Economic Analysis: Current Prices

Economic Deposits



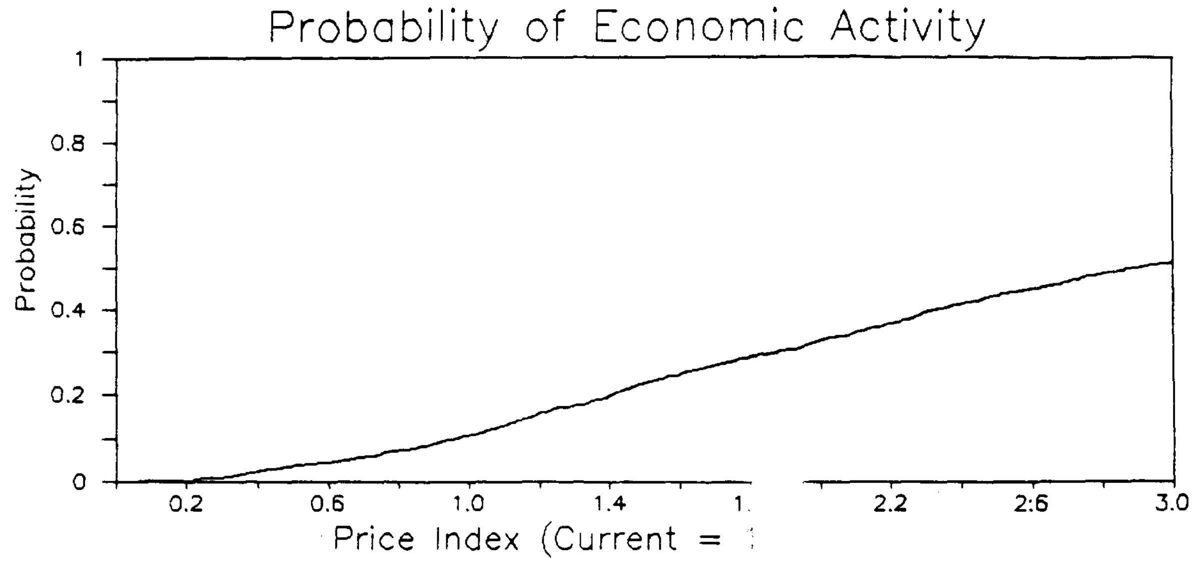
Probability of One or More Economic Deposits = 0.11

Quantities and Values

Total Recoverable Metals and NPV (Conditional)

Quantities	Average	95%	50%	5%
Gold (Thousands of Troy Ounces)	8071	1100	4300	39000
Silver (Thousands of Troy Ounces)	2051	0	100	6900
Tungsten (Thousands of Short Tons)	7	0	0	0
NPV (Millions of 1987 Dollars)	347	7	95	1600

Block 8 Economic Analysis: Price Sensitivity



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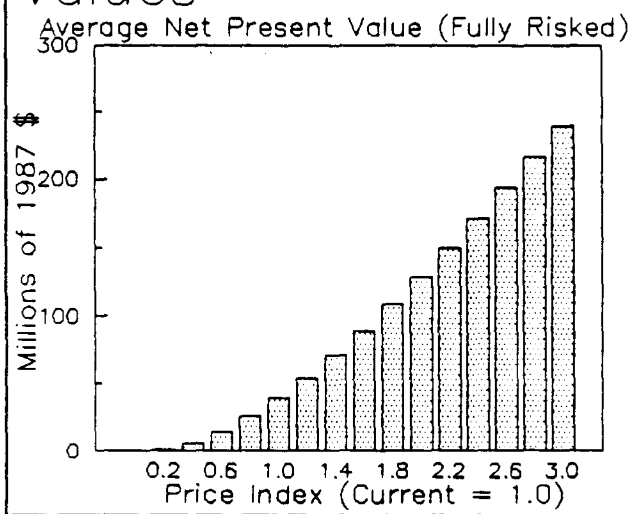
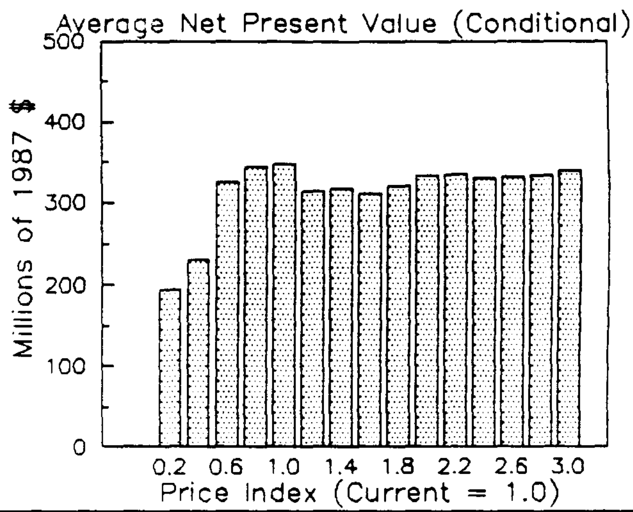
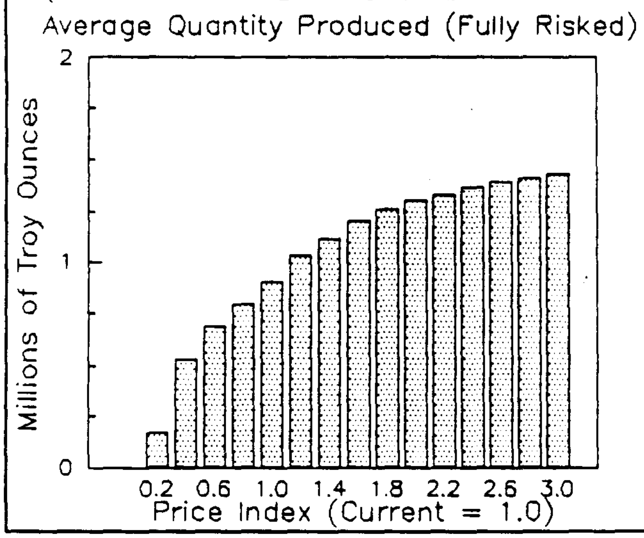
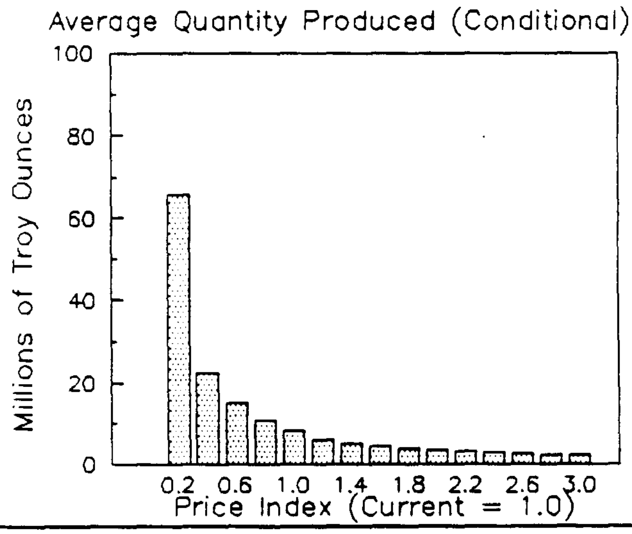




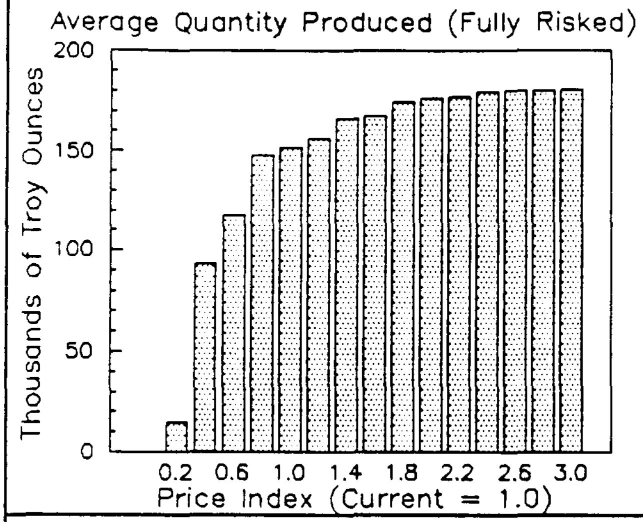
Quantities: Gold

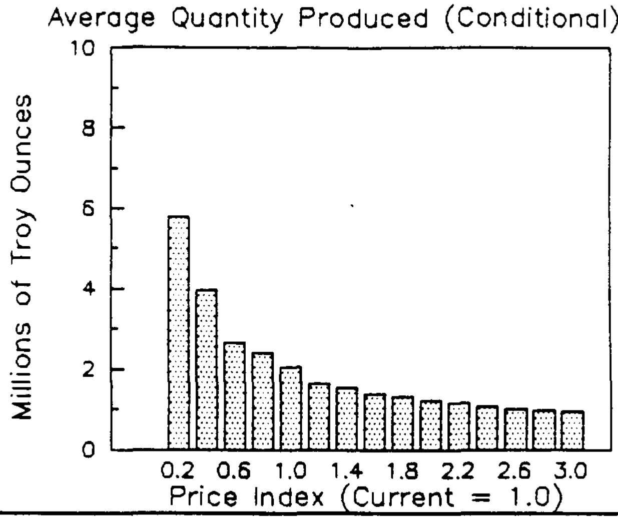




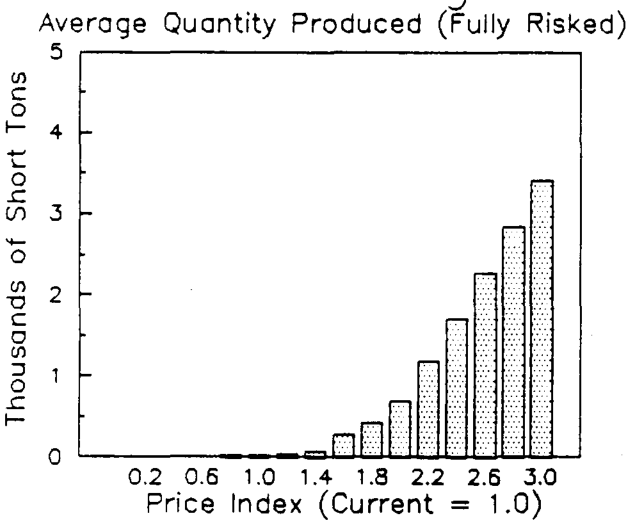
Block 8 Economic Analysis: Price Sensitivity

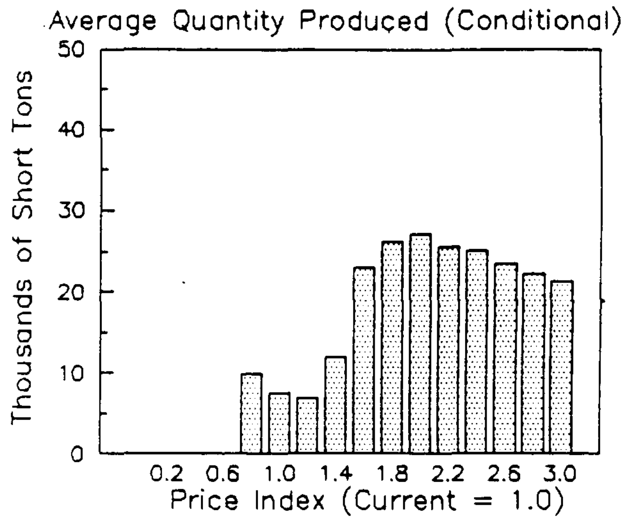
Quantities: Silver





Quantities: Tungsten





BLOCK 9

Block 9 is located in the southeastern portion of the WMNRA and the southwestern portion of the North SNCA. It includes two terranes having potential for tin greisen and rare earth deposits. Contained metals include tin, silver, tantalum, tungsten, uranium and rare earths. The probability that at least one deposit exists is 32%, and there may be as many as three tin greisens and one rare earth deposit. The block's endowment contains (on average), 24 thousand short tons of tin, over 1.1 million troy ounces of silver, 3 thousand tons of tungsten, 100 tons each of tantalum and uranium, and 200 tons of rare earth oxides.

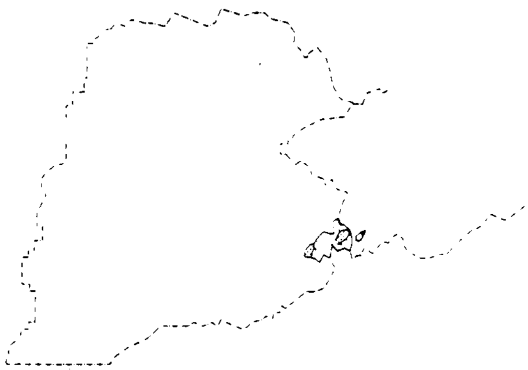
The chance of an economic deposit at current prices is 1 in 500. If an economically recoverable deposit does exist, it will be a rare earth deposit, and produce (on average) 9 thousands short tons of rare earths, 16 thousand short tons of uranium, with an average NPV of $34 million.

The probablility of economic activity within the block increases to approximately 8% as prices approach three times current prices. The fully risked average NPV increases to approximately $14 million, and the conditional average NPV to $175 million. Assuming that economic deposits exist, the approximate quantities of metal produced from the block are: tin, 200 to 350 thousand short tons; silver, from 7 to 22 million troy ounces; tantalum, from 100 to 400 short tons; rare earths, from 8 to 16 thousand short tons, and; uranium, from 10 to 19 thousand short tons.

Block 9 Mineral Resource Endowment

General

Location



Deposit Types:

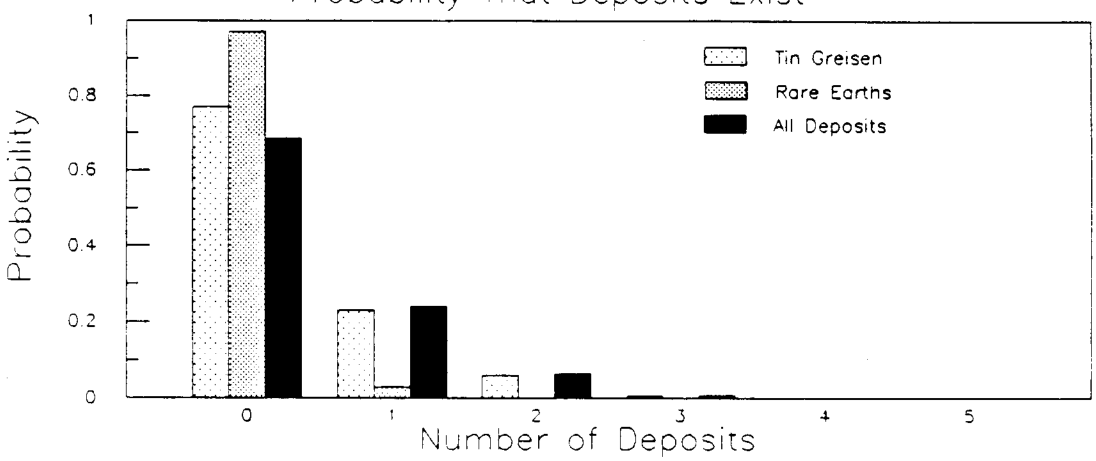
Tin Greisen
Rare Earths

Contained Metals

Tin	Tungsten
Silver	Uranium
Tantalum	Rare Earths

Deposits

Probability That Deposits Exist



Probability of One or More Deposits = 0.32

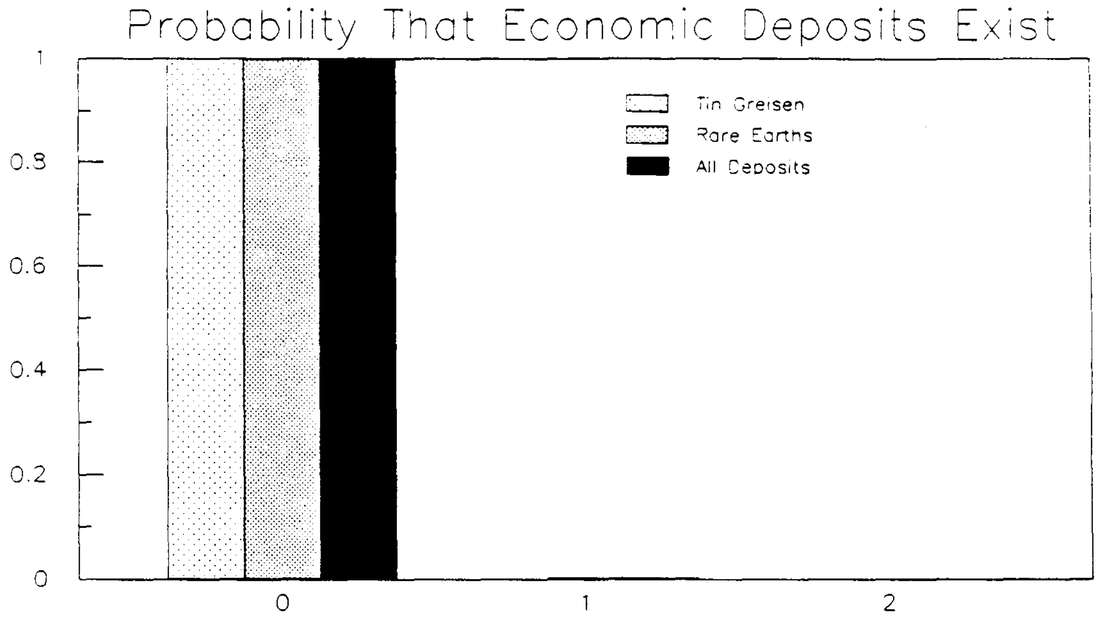
Quantities

Metals Contained in Endowment (Fully Risked)

	Average	95%	50%	5%
Tin (Thousands of Short Tons)	24	0	0	170
Silver (Thousands of Troy Ounces)	1140	0	0	5300
Tantalum (Thousands of Short Tons)	.1	0	0	0
Tungsten (Thousands of Short Tons)	3	0	0	0
Uranium (Thousands of Short Tons)	.1	0	0	0
Rare Earths (Thousands of Short Tons)	.2	0	0	0

Block 9 Economic Analysis: Current Prices

Economic Deposits



Probability of One or More Economic Deposits = 0.002

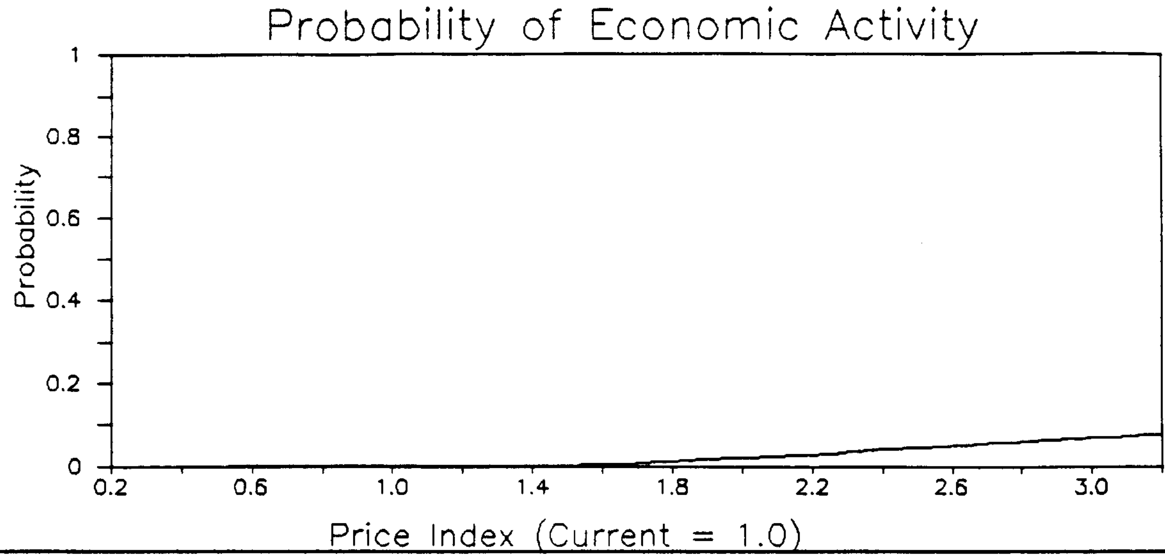
Quantities and Values

Total Recoverable Metals and NPV (Conditional)

Quantities	Average	95%	50%	5%
Tin (Thousands of Short Tons)	0	0	0	0
Silver (Thousands of Troy Ounces)	0	0	0	0
Tantalum (Thousands of Short Tons)	0	0	0	0
Tungsten (Thousands of Short Tons)	0	0	0	0
Uranium (Thousands of Short Tons)	16	*	*	*
Rare Earths (Thousands of Short Tons)	9	*	*	*
NPV (Millions of 1987 Dollars)	34	*	*	*

* Not Enough Observations for Meaningful Fractiles

Block 9 Economic Analysis: Price Sensitivity



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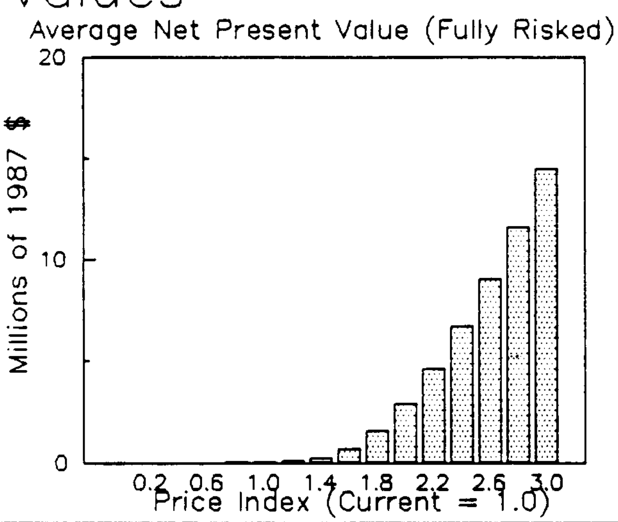
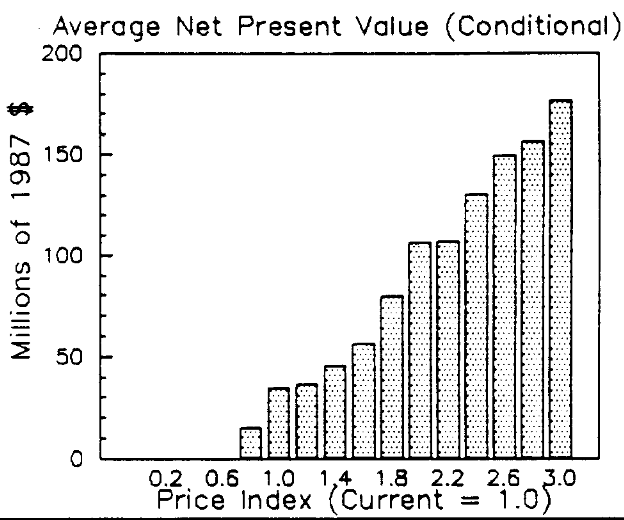
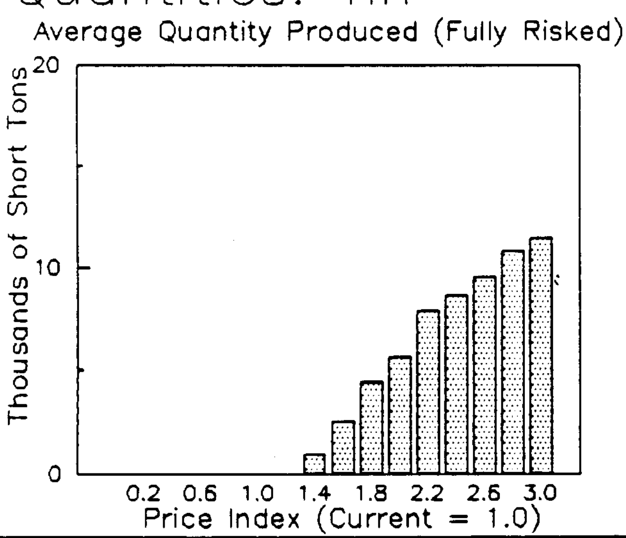
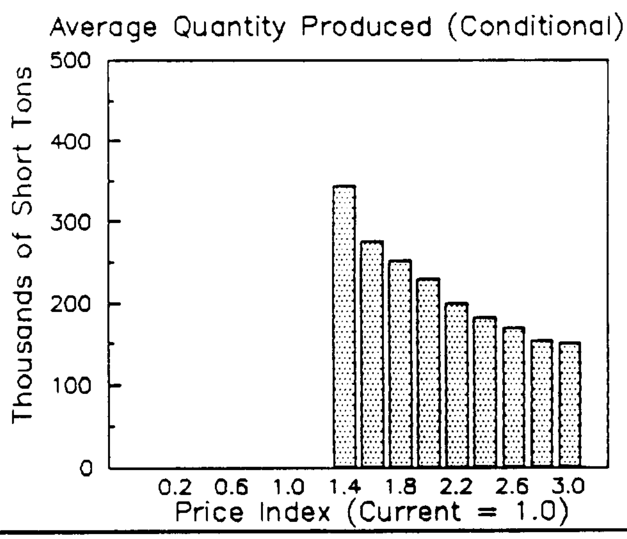




Quantities: Tin

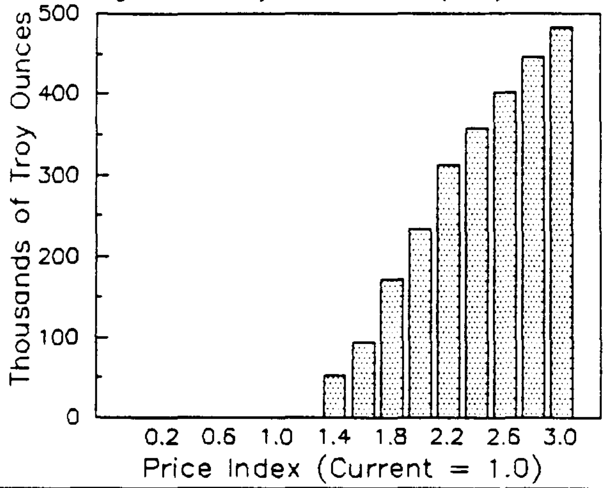




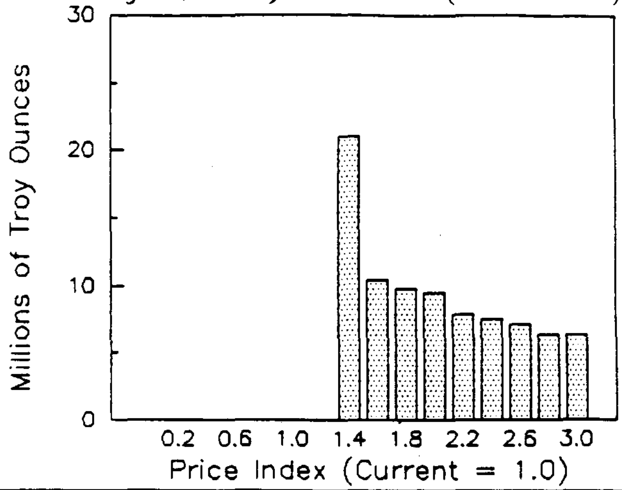
Block 9 Economic Analysis: Price Sensitivity

Quantities: Silver

Average Quantity Produced (Fully Risked)

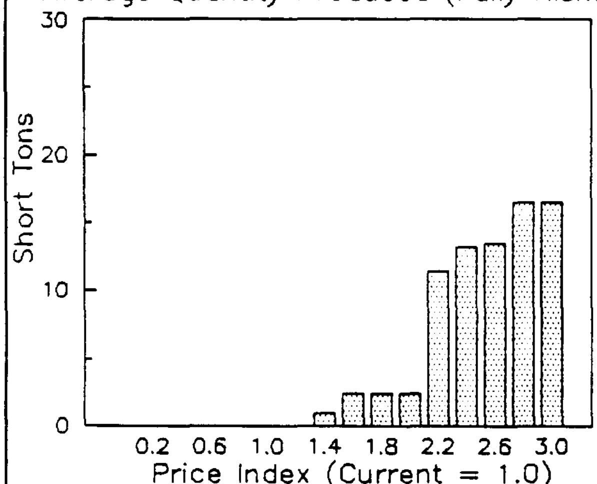


Average Quantity Produced (Conditional)

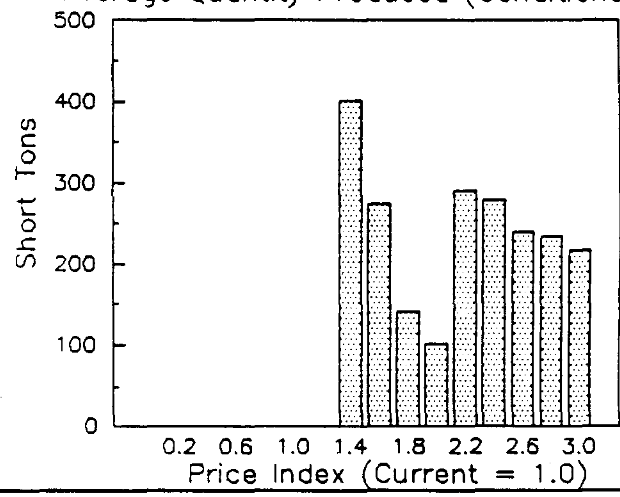


Quantities: Tantalum

Average Quantity Produced (Fully Risked)

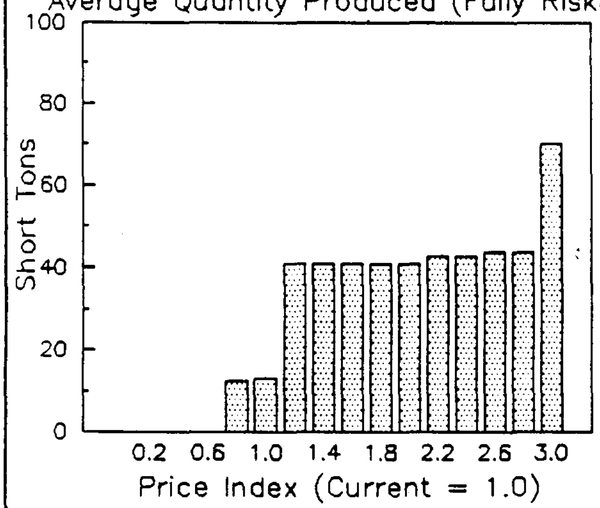


Average Quantity Produced (Conditional)

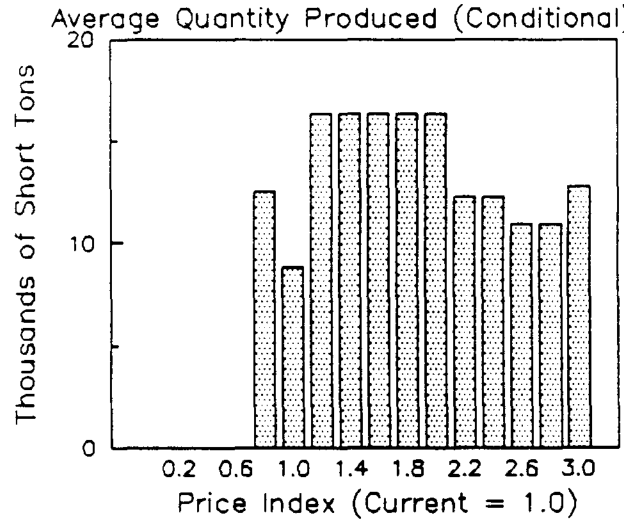


Quantities: Rare Earths

Average Quantity Produced (Fully Risked)

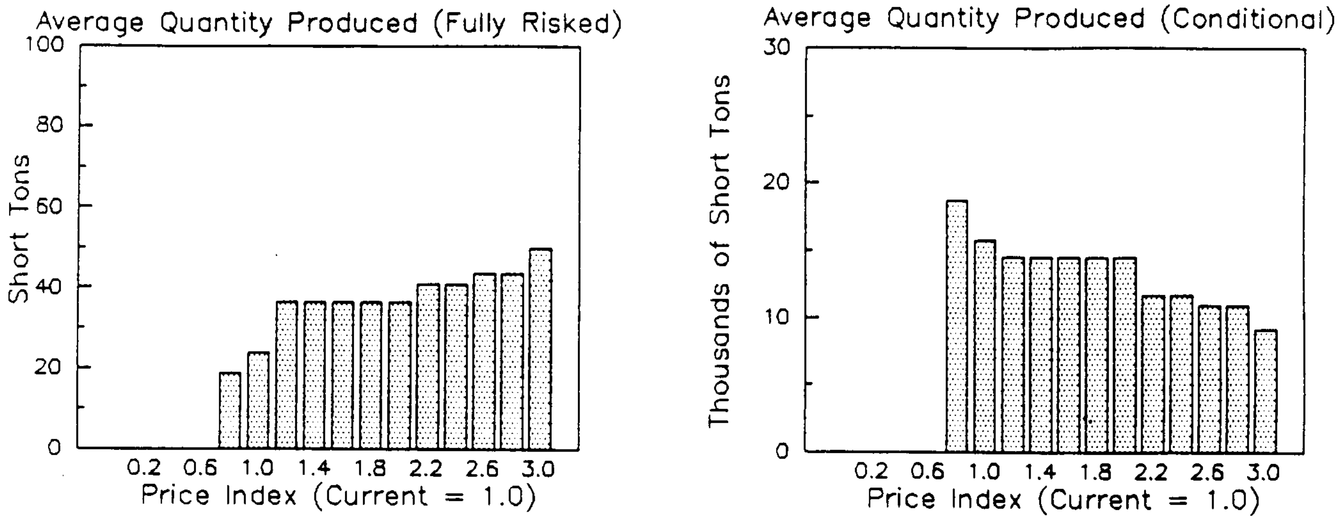


Average Quantity Produced (Conditional)



Block 9 Economic Analysis: Price Sensitivity

Quantities: Uranium



BLOCK 10

Block 10 is located in the southern portion of the WMNRA and has one terrane with the potential for lode gold deposits. The probability that at least one deposit exists is 9%, and there could be as many as two. The block contains an average of 42 thousand troy ounces of gold in the endowment.

The chance of an economic deposit at current prices is 1 in 500, and there is unlikely to be more than one. If an economically recoverable deposit does exist, it will produce (on average) almost 14 million troy ounces of gold with an average NPV of almost $600 million.

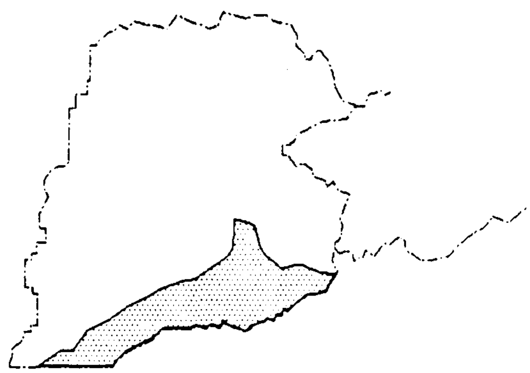
The probablility of economic activity remains less than 1% as prices approach three times current prices. The fully risked average NPV increases to approximately $6 million, and the conditional average NPV ranges from $150 to $600 million. Assuming an economic deposit is found, the approximate quantity of gold produced is 7 to 25 million troy ounces.

Block 10 ranks one or two in terms of net present value if an economic deposit exists (depending on the assumed prices), but in the lower 25% of the blocks in terms of the likelihood of economic activity.

Block 10 Mineral Resource Endowment

General

Location



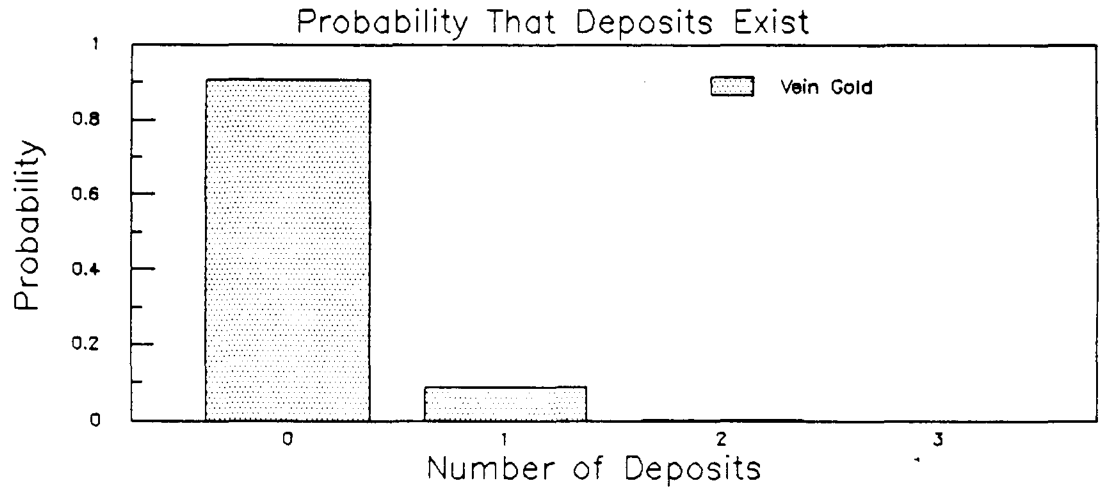
Deposit Types:

Vein Gold

Contained Metals

Gold

Deposits



Probability of One or More Deposits = 0.09

Quantities

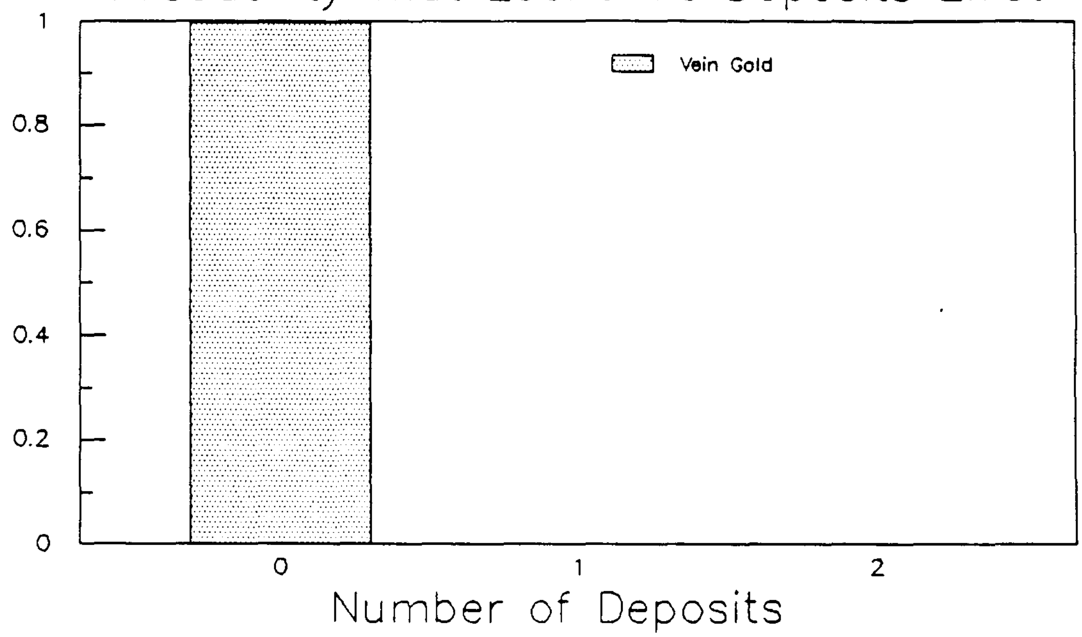
Metals Contained in Endowment (Fully Risked)

	Average	95%	50%	5%
Gold (Thousands of Troy Ounces)	42	0	0	5

Block 10 Economic Analysis: Current Prices

Economic Deposits

Probability That Economic Deposits Exist



Probability of One or More Economic Deposits = 0.002

Quantities and Values

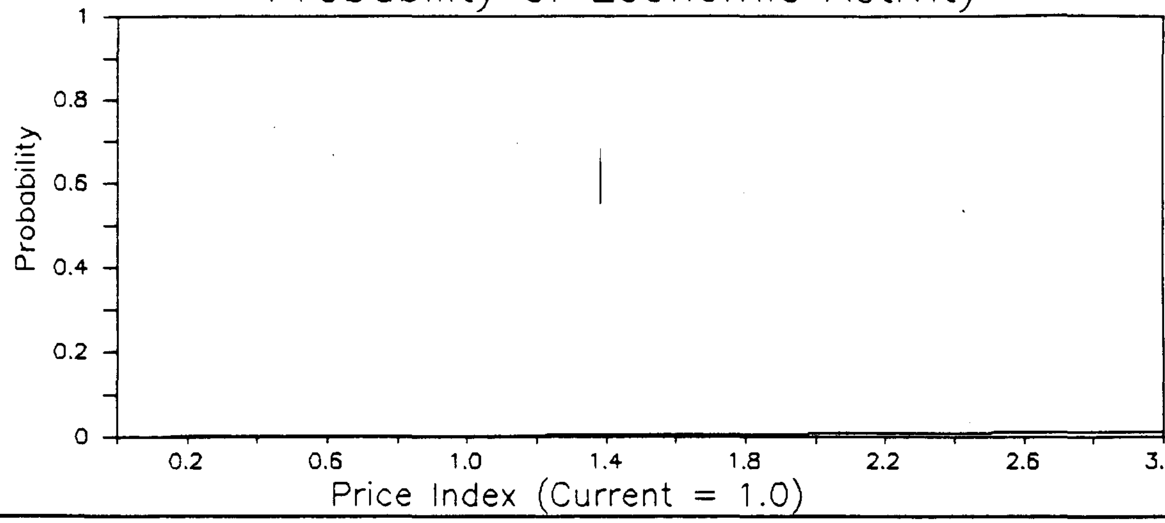
Total Recoverable Metals and NPV (Conditional)

Quantities	Average	95%	50%	5%
Gold (Thousands of Troy Ounces)	13621	*	*	*
NPV (Millions of 1987 Dollars)	597	*	*	*

* Not Enough Observations for Meaningful Fractiles

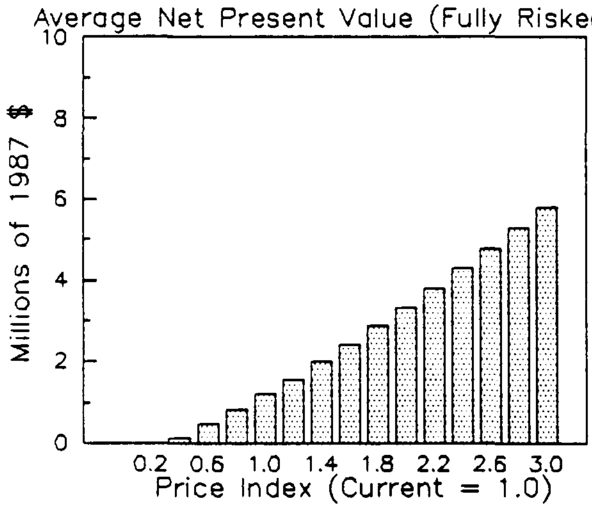
Block 10 Economic Analysis: Price Sensitivity

Probability of Economic Activity

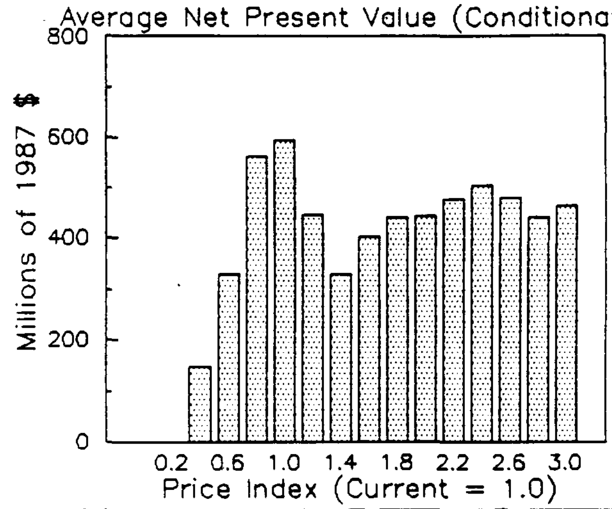


Values

Average Net Present Value (Fully Risked)

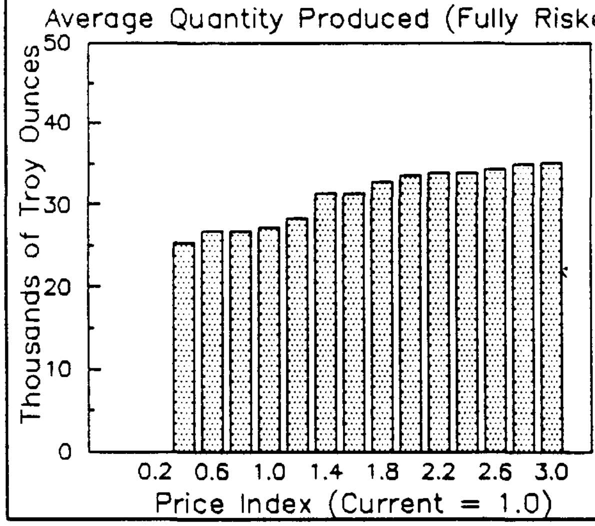


Average Net Present Value (Conditional)

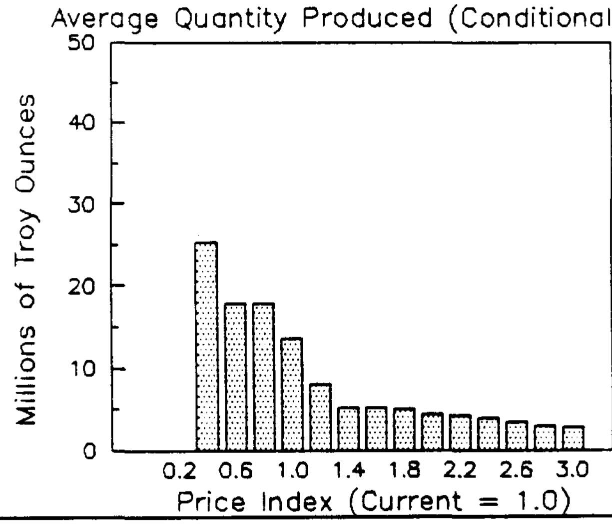


Quantities: Gold

Average Quantity Produced (Fully Risked)



Average Quantity Produced (Conditional)



BLOCK 11

Block 11 contains indications of gold placer potential throughout the WMNRA and in the eastern portion of the North SNCA. However, the majority of this potential is associated with upper Beaver Creek, Nome Creek and their tributaries, which generally coincide with Block 10 of the analysis. Placers were evaluated seperatelty since the RMPs treats placers differently than lode deposits. A leasing alternative is allowed for lode deposits in semi-primitive areas, but development of placers is limited to valid existing claims since the passage of ANILCA. It is certain that at least one deposit exists, and there may be as many as 23 placers in the study area. A fully risked average of 101 thousand troy ounces are contained in the endowment, with a 5% chance that there is more than 270 thousand ounces.

There is a 60% chance of an economic deposit at current prices, and there may be as many as five. On average, 29 thousand troy ounces of gold could be produced from economically recoverable deposits, yielding $3 million in NPV.

The probablility of economic activity approaches certainty (98%) as prices approach three times current prices. The fully risked NPV increases to approximately $13 million, as does the conditional NPV (since there is very little chance that no placers would be produced). In economic deposits, the quantity of recoverable gold ranges from 20 to over 70 thousand troy ounces.

Block 11 is the most likely to generate economic activity under any price assumption, but ranks low in terms of average net present value.

Block 11 Mineral Resource Endowment

General

Location

Deposit Types:

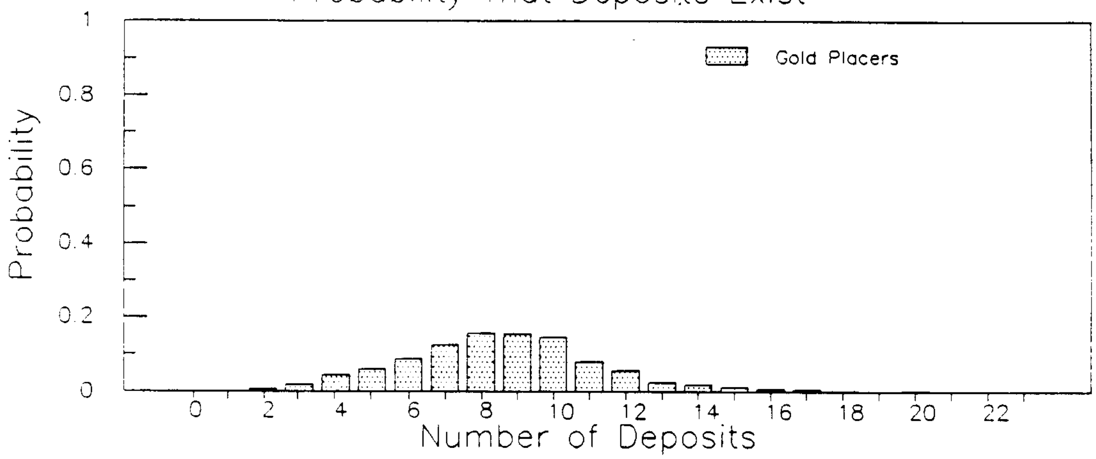
Gold Placers
---- Higher Potential

Contained Metals

Gold

Deposits

Probability That Deposits Exist



Probability(One or More Deposits) = 1.00

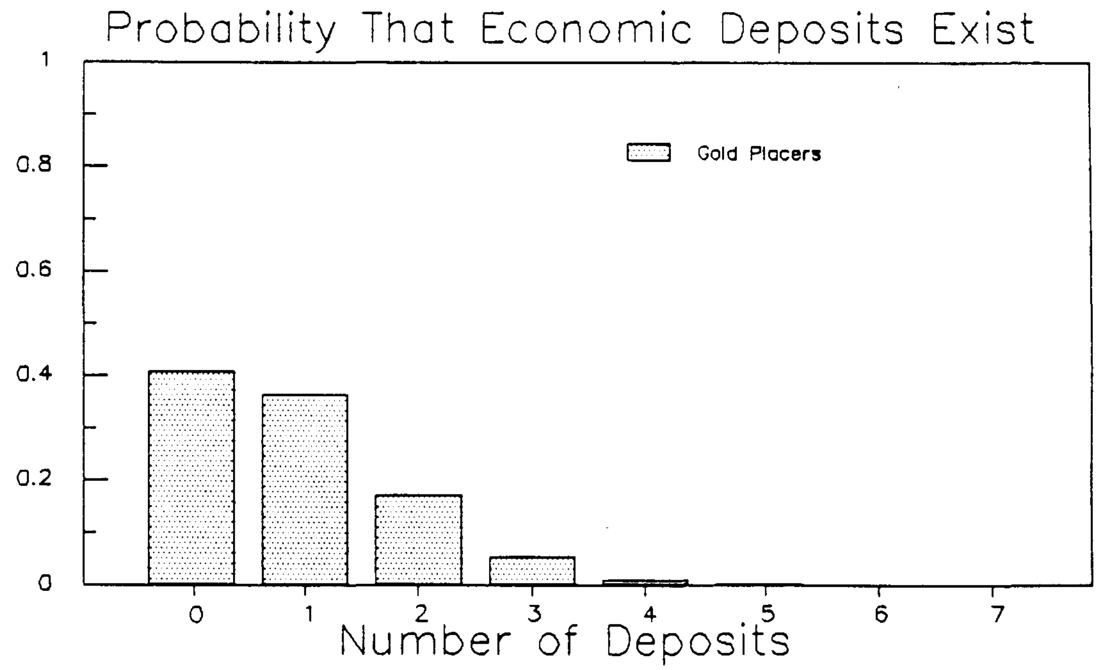
Quantities

Metals Contained in Endowment (Fully Risked)

	Average	95%	50%	5%
Gold (Thousands of Troy Ounces)	101	22	82	270

Block 11 Economic Analysis: Current Prices

Economic Deposits



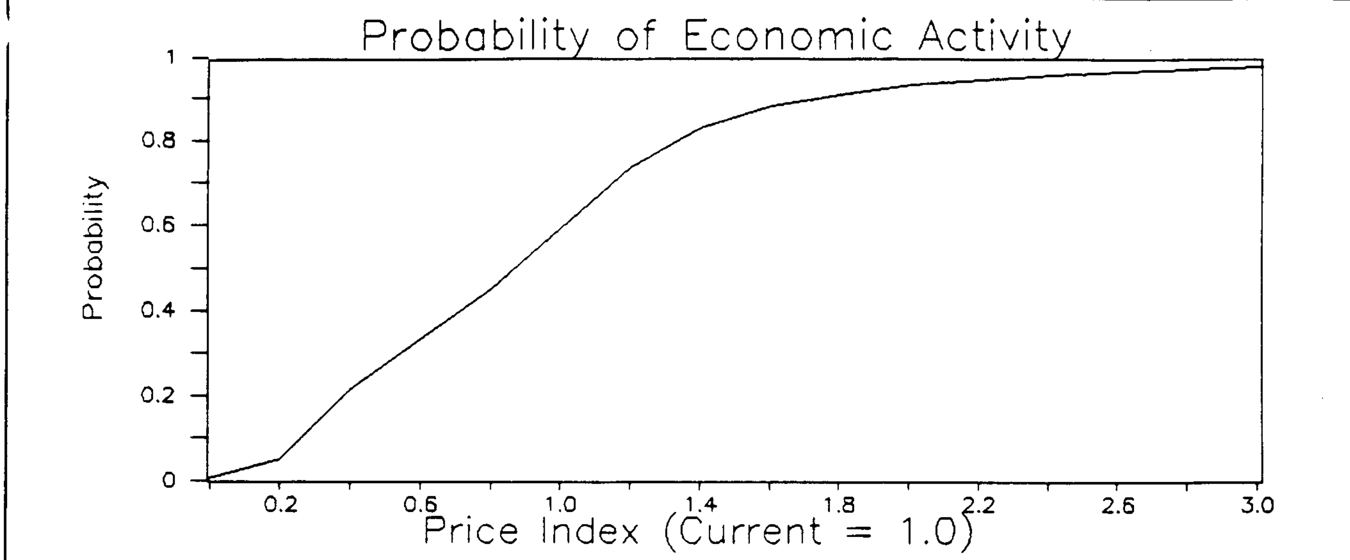
Probability of One or More Economic Deposits = 0.60

Quantities and Values

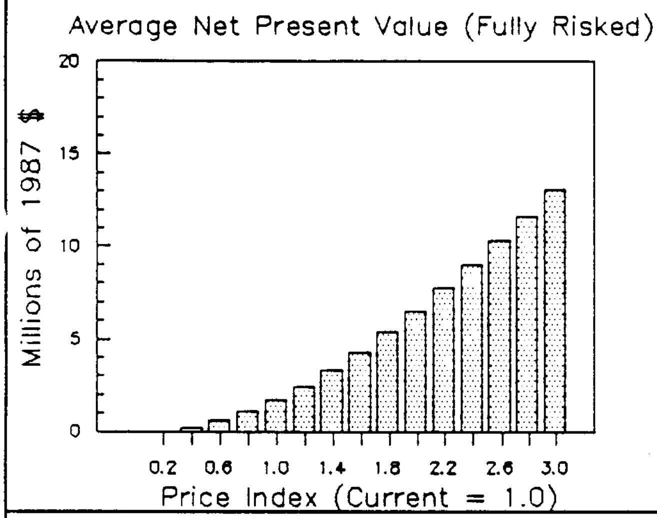
Total Recoverable Metals and NPV (Conditional)

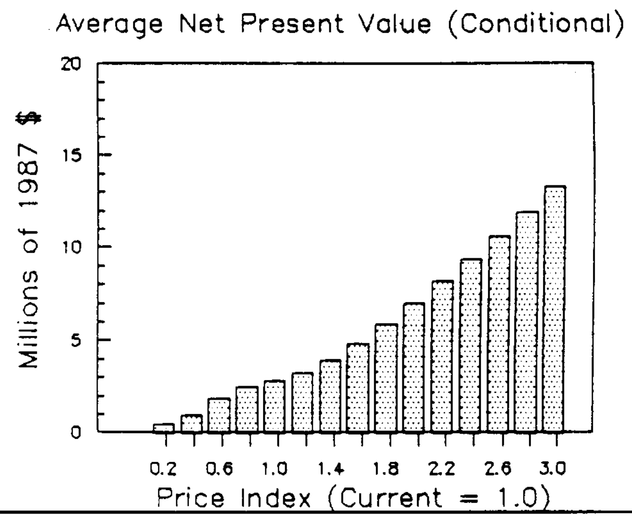
	Average	95%	50%	5%
Gold (Thousands of Troy Ounces)	46	2	14	200
NPV (Millions of 1987 Dollars)	3	.05	1	12

Block 11 Economic Analysis: Price Sensitivity

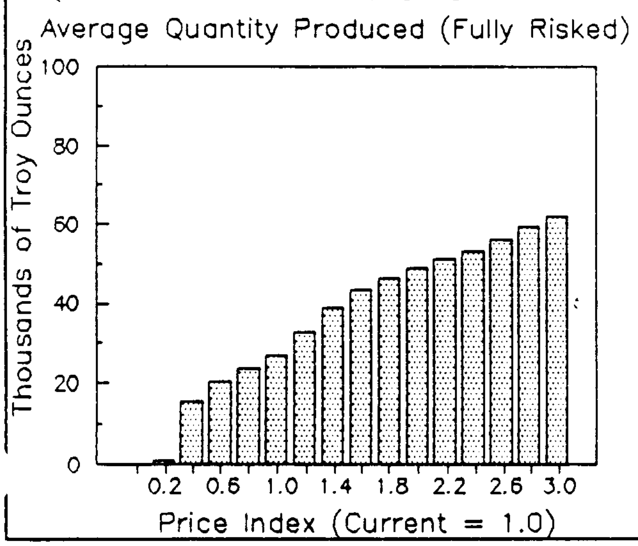


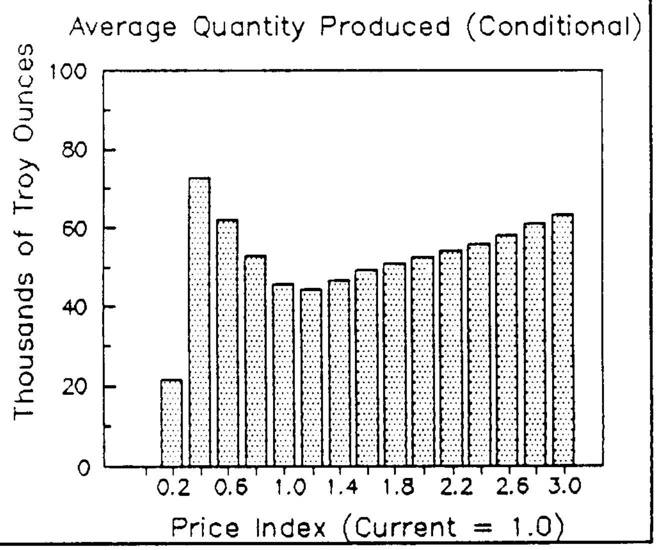
Values





Quantities: Gold





APPENDIX G-- ESTIMATION OF DIRECT AND INDIRECT REGIONAL ECONOMIC IMPACTS ON THE ALASKAN ECONOMY AS A RESULT OF MINERAL DEVELOPMENT IN THE WMNRA/SCNA STUDY AREA

This appendix describes the methodology used to allocate to various sectors of the Fairbanks regional economy, the construction and operating expenditures associated with potentially profitable mineral deposits in the WMNRA/SNCA study area, and to estimate the resultant employment, earnings, and output impacts upon the regional economy. The profitability of prospective deposits is determined by the PSAS (Appendix A) and the associated regional economic impacts are estimated using IPASS (Appendix H). Potential direct and total impacts (direct plus indirect) are presented for the four deposit types considered to be most significant in the Steese-White study area.

The methodology is presented, by example, using a hypothetical sedimentary-exhalative lead-zinc deposit having the following geologic characteristics:

Size: 77.2 million metric tons

Depth: 2 meters

Grade of zinc: 5.8%

Grade of silver: 60 g/metric ton

Grade of lead: 5.2%

Profitability of Hypothetical Deposit

Mining and Milling Costs

Capital and annual operating costs were estimated for the above deposit using the mine, mill, and infrastructure cost models described in Appendix C. The mining method used is open pit. The mine is assumed to operate 350 days per year at an annual production rate of 3,903,103 metric tons of ore.

The milling method used is lead-zinc flotation. The mill is assumed to operate 365 days per year at a daily mill feed rate of 10,693 metric tons. The metal recovery rates are assumed to be 83.5% for zinc, 95% for silver and 95% for lead.

Infrastructure costs include construction of access roads, a campsite for the work force, and waste water treatment facilities.

Table 1 shows the capital costs associated with the construction of the mine, mill, and infrastructure, and annual operating costs on a dollar per metric ton of ore mined or processed. Table 2 shows the annual operating costs by cost category for the mine, mill and infrastructure, the annual reinvestment costs, and the total annual costs (annual operating costs plus reinvestment costs).

Post-mill Considerations

The post mill recovery rates are assumed to be 98% for zinc, 98% for silver and 98% for lead.

The "revenue rate" is a factor included in smelter contracts which indicates how much revenue is received by the mine operator from the operator of the smelter or processor. The amount of the revenue rate depends on market conditions for metals. The amount of revenue paid by the processor is prior to deductions for treatment and transportation charges. The revenue rate is assumed to be 80% for zinc, 90% for silver and 90% for lead.

The treatment charges for each metal are assumed to be $300.00 per metric ton of zinc, nothing for silver, and $200.00 per metric ton of lead.

The transportation charges for each metal are assumed to be $163.00 per metric ton of zinc, nothing for silver, and $131.00 per metric ton of lead.

TABLE 1. Mine, Mill and Infrastructure Costs by Cost Category

Cost Category	Mine Costs(1) Capital Costs(4)	Mine Costs(1) Operating Costs(5)	Mill Costs(2) Capital Costs(4)	Mill Costs(2) Operating Costs(5)	Infrastructure Costs(3) Capital Costs(4)	Infrastructure Costs(3) Operating Costs(5)
Labor	$10,528,293	$2.10	$45,822,507	$1.61	$31,501,386	$0.30
Equipment	$19,840,323	$2.29	$25,829,549	$1.71	$18,279,820	$0.32
Steel	$280,992	$0.07	$13,471,809	$0.02	$89,027	$0.00
Lumber	$0	$0.00	$0	$0.00	$0	$0.00
Fuel and Lube Oil	$703,712	$0.13	$7,760,675	$0.14	$1,510,138	$0.63
Industrial Mtls	$78,461	$0.09	$742,471	$0.09	$1,892,757	$0.76
Construction Mtls	$4,171,952	$0.00	$11,528,188	$0.00	$892,720	$0.53
Chemicals	$1,122,245	$0.23	$0	$0.00	$31,343,263	$0.00
Total	$36,725,978	$4.91	$105,155,199	$3.57	$85,509,111	$2.54

Notes:

(1) The mine costs are based on the open pit method of mining.

(2) The mill costs are based on the shale hosted lead zinc float method of milling.

(3) The infrastructure costs are based on the open pit method of mining.

(4) Capital costs are total expenditures.

(5) Operating costs are presented in dollars per metric ton of ore mined or processed.

Table 2. Annual Operating Costs by Cost Category

Cost Category	Annual Operating Costs(1)	Annual Reinvestment Costs(2)	Total Annual Operating Costs(3)
Labor	$17,936,398	$2,951,415	$20,887,813
Equipment	$19,356,779	$2,513,700	$21,870,479
Steel	$442,049	$423,684	$865,733
Lumber	$0	$0	$0
Fuel and Lube Oil	$4,255,417	$320,347	$4,575,764
Industrial Mtls	$3,390,434	$53,764	$3,444,198
Construction Mtls	$0	$1,536,460	$1,536,460
Chemicals	$4,795,948	$124,118	$4,920,066
Total	$50,177,025	$7,923,488	$58,100,513

Notes:

(1) Annual Operating Costs are calculated by summing together mine, mill, and infrastructure operating costs for each cost category then multiplying by annual production rate.

(2) Reinvestment of capital costs are additional funds to cover replacement of work equipment, spare parts, etc., and are computed as follows:

  6 percent of mine capital cost item
+ 3 percent of mill capital cost item
+ 3 percent of infrastructure capital cost item

(3) Annual operating expenses are computed by summing together annual operating costs and reinvestment cost factor for each cost

Calculation of Annual Costs

A. Mining and Milling Costs

Costs associated with the construction of the mine begin in year 4. In years 1 through 3, exploration and permitting activities take place. These costs are not estimated. One-half of the capital costs for the construction of the mine ($36,725,978) is spent in each year of the mine construction phase (years 4 and 5). One half of the capital costs of the mill construction ($105,155,199) and one half of the capital costs of the infrastructure construction ($85,509,111) is spent in year 4. The remaining 50% of construction costs for the mill and infrastructure are spent in year 5.

In year 6, the mine begins operating. Annual operating costs total $50,177,025 of which $23,877,200 is for the mine, $13,966,658 is for the mill and $12,333,167 is for the infrastructure. In addition, there are reinvestment expenses totaling $7,923,488. Reinvestment costs are based on 6 percent of the mine capital cost ($2,203,559); 3 percent of the mill capital cost ($3,154,656); and 3 percent of the infrastructure capital cost ($2,565,273).

Total annual operating expenses are the sum of the capital reinvestment expenses and the annual operating costs. The annual operating expenses associated with this mineral deposit is $58,100,513.

B. Treatment and Transportation Charges

Treatment and transportation charges are calculated by multiplying the annual production of the mine times the grade of the commodity times the mill recovery rate times the post mill recovery rate times the treatment and transportation charge.

Treatment charges for zinc, for example, are calculated in the following manner:

3,903,103	mine production (metric tons of ore)
x .05756	grade of zinc
224,663	metric tons of contained zinc
x .835	mill recovery rate
187,593	metric tons of recovered zinc
x .98	post mill recovery rate
183,841	metric tons of recovered zinc
x $ 300	dollars per metric ton of recovered zinc
$55,152,424	treatment charges for zinc

The transportation charge calculation for zinc is as follows:

3,903,103	mine production (metric tons of ore)
x .05756	grade of zinc
224,663	metric tons of contained zinc
x .835	mill recovery rate
187,593	metric tons of recovered zinc
x .98	post mill recovery rate
183,841	metric tons of recovered zinc
x 163	dollars per metric ton of recovered zinc
$29,966,150	transportation charges for zinc

Total annual treatment and transportation charges for zinc are $85,118,574. Annual treatment charges ($37,521,777) and transportation charges ($24,576,764) are calculated in a similar manner for lead, with total treatment and transportation charges for lead equalling $62,098,541. It is assumed there are no treatment and transportation charges for precious metals (gold and silver).

Calculation of Annual Revenues

It is assumed that the prices paid for each metal recovered (zinc, silver, and lead) are 2 times the current average annual 1987 price of these metals:

Zinc-	$.84 per pound	or	$1,680.00 per short ton
Silver-	$14.40 per troy ounce	or	$419,990.40 per short ton
Lead-	$.72 per pound	or	$1,440.00 per short ton

Revenues from the mine begin in year 6, the first year of production. Years 1 through 3 are used for permitting and exploration. Year 4 is the first year of mine construction, mill construction, and infrastructure construction. Year 5 is the second year of mine, mill, and infrastructure construction.

Revenues are generated for 18 years (the life of the mine) and are calculated by multiplying the annual ore production of the mine (3,903,103 metric tons) times the grade of the ore times 1.102 (to convert from metric tons to short tons) times the mill recovery rate times the post mill recovery rate times the revenue rate times the price of the commodity in dollars per short ton of metal. The revenue calculation for zinc is shown below:

3,903,103	mine production (metric tons of ore)
x .05756	grade of zinc
224,663	metric tons of contained zinc
x 1.102	conversion factor (metric tons to short tons)
247,578	short tons of contained zinc
x .835	mill recovery rate
206,728	short tons of recovered zinc
x .98	post mill recovery rate
202,593	short tons of recovered zinc
x .80	revenue rate (pct zinc smelter operator pays for)
162,075	short tons of recovered zinc
x 1,680.0	dollars per short ton of zinc
$272,285,310	Annual Revenue for zinc

Using similar procedures for silver and lead, annual revenue for silver is $90,818,530 and annual revenue for lead is $267,941,511. Annual revenues from the deposit total approximately $631.0 million.

Calculation of Discounted Cash Flow

Annual cash flow during the production years of the mine is equal to annual revenues minus annual operating costs, treatment charges and transportation charges, or, in this example, $425.7 million. Assuming a discount rate of 15 percent, total net present value (NPV) for this deposit at twice current prices is $1.351 billion.

Allocation of Construction and Operating Expenditures to Sectors of the Alaskan Regional Economy

Once a deposit has been determined profitable, the regional economic impacts associated with its construction and operation can be estimated using the Interactive Policy Analysis Simulation System (IPASS), a regional input-output economic model.

The IPASS model estimates growth in the entire regional economy, as a result of introducing new mining activity into the region. Specifically, IPASS estimates changes in employment, earnings, and output for all industries in the region due to mineral development and operation over the life of the project (on a year-by-year basis) (see Appendix H).

Inputs to the IPASS Model

Input to the IPASS model is determined by expenditures occurring in the two phases of deposit development (mine construction and mine operation). During Phase I (years 4 and 5), the capital costs associated with the construction of the mine, mill and infrastructure are expended. During Phase 2 (years 6 through the life of the deposit) production takes place. During each year of phase 2, expenditures include mine, mill, and infrastructure operating costs plus reinvestment expenses of 6 percent of mine capital cost, 3 percent of mill capital cost, and 3 percent of infrastructure capital cost.

Annual expenditures associated with each phase are divided into nine broad categories: labor, equipment, steel items, lumber, fuel and lube oil, industrial materials, construction materials, chemicals, and food

(Table 3). Expenditures in these categories are then broken down to show purchases from specific industrial sectors of the regional economy.

Distribution of Expenditures Among Industrial Sectors

To estimate the economic impacts on regional industrial sectors from mineral deposit development and operation, expenditures can be allocated to 75 sectors of the regional economy, to indicate which specific industries received increased purchases as a result of the new mining activity. When this distribution is made, ratios showing the dollar amount purchased from each industry versus the total mineral industry expenditures are computed and used to develop the mineral industry's production function. These production functions are then used to compute total impacts in the IPASS model (Appendix H). To facilitate computations in IPASS, these 75 sectors were reclassified into 28 sectors.

The expenditure distribution scheme to the 75 sectors in the Fairbanks regional economy is shown in Table 4. Some categories of expenditures are fully allocated to a single sector. For example, 100 percent of fuel and lube oil costs are assigned to petroleum refining (sector 41). Other categories of expenditures, such as construction material expenditures, are allocated to several industrial sectors.

Table 5 shows the distribution of costs in the example of the lead zinc deposit. These levels and patterns of industry purchases, as well as any constraints within the regional economy, such as the number of available workers, are used by IPASS to estimate changes in employment, earnings and output.

Table 3. Annual Expenditures by Phase of Development

Cost Category	Phase 1 (1)	Phase 2 (2)
Labor	$43,926,093	$20,887,813
Equipment	$31,974,846	$21,870,479
Steel	$6,920,914	$865,733
Lumber	$0	$0
Fuel and Lube Oil	$4,987,263	$4,575,764
Industrial Mtls	$771,144	$3,099,778
Construction Mtls	$23,521,701	$1,536,460
Chemicals	$1,507,501	$4,920,066
Food	$85,683	$344,420
Total	$113,695,145	$58,100,513

Notes:
(1) Phase 1 covers the activities in years 4 and 5, the first and second years of mine, mill, and infrastructure development

(2) Phase 2 covers year 6 and beyond until the deposit is exhausted. The activities include mine, mill, and infrastructure operation and reinvestment of capital expenses.

Table 4. Allocation of Costs by Industrial Sector

Sector Number	Sector Description	Cost Allocation
1	Agricultural Products	20 % of Food
2	Forestry	
3	Fisheries	
4	Agricultural Services	
5	Copper Mining	
6	Lead and Zinc Mining	
7	Gold Mining	
8	Silver Mining	
9	Dummy Sector	
10	Dummy Sector	
11	Dummy Sector	
12	Dummy Sector	
13	Dummy Sector	
14	Dummy Sector	
15	Dummy Sector	
16	Dummy Sector	
17	Dummy Sector	
18	Other Metal Mining	
19	Metal Mining Services	
20	Coal Mining	
21	Crude Petroleum	
22	Natural Gas	
23	Limestone	5 % of Construction Materials
24	Other Stone	
25	Sand and Gravel	5 % of Construction Materials
26	Miscellaneous Minerals	
27	Non-Metal Services	
28	Chemical Fertilizer	
29	Mining Construction	10 % of each cost category (labor, equipment, etc.)
30	Other New Construction	10 % of Construction Materials
31	Oil and Gas Repair and Maint.	
32	Other Repair and Maintenance	

Table 4. Allocation of Costs by Industrial Sector (continued)

Sector Number	Sector Description	Cost Allocation
33	Preserved Seafood	5 % of Food
34	Fresh and Frozen Seafood	
35	Other Food Processing	
36	Textiles	
37	Logging	20 % of Lumber
38	Wood Products	80 % of Lumber 10 % of Construction Materials
39	Pulp and Paper	
40	Printing and Publishing	
41	Petroleum Refining	100 % of Fuel and Lube Oil
42	Chemicals, Rubber, Plastics, Leather, and Tires	10 % of Construction Materials 100 % of Chemicals
43	Manufactured Stone Products including Cement and Glass	15 % of Construction Materials
44	Primary Metals	20 % of Steel
45	Fabricated Metals	80 % of Steel 25 % of Construction Materials
46	Non-Electrical Machinery	50 % of Equipment
47	Electrical Machinery	20 % of Equipment 10 % of Construction Materials
48	Transportation Equipment	30 % of Equipment
49	Other Manufacturing	100 % of Industrial Materials 10 % of Construction Materials

Table 4. Allocation of Costs by Industrial Sector (continued)

Sector Number	Sector Description	Cost Allocation
50	Railroads	5 % of Sum 1 (1)
51	Local Transportation	20 % of Sum 1
52	Truck Transportation	10 % of Sum 1
53	Water Transportation	20 % of Sum 1
54	Air Transportation	35 % of Sum 1
55	Pipelines	
56	Transportation Services	10 % of Sum 1
57	Communication	1 % of each cost category (labor, equipment, etc.)
58	Electrical Utilities	
59	Gas Utilities	
60	Water Services	
61	Wholesale Trade	10.2 % of Sum 2 (2) + 19 % of Food
62	Eating and Drinking Estab.	5.1 % of Sum 2
63	Other Retail Trade	10.2 % of Sum 2 + 56 % of Food
64	Finance and Insurance	12.3 % of Sum 2
65	Real Estate	18.4 % of Sum 2
66	Lodging	5.1 % of Sum 2
67	Personal Services	2 % of Sum 2
68	Business Services	15.3 % of Sum 2
69	Auto Services	12.3 % of Sum 2
70	Movies and Recreation	1 % of Sum 2
71	Health Services	1 % of Sum 2
72	Education and Non-Profit	
73	Government Enterprises	1 % of Sum 2
74	Used Goods	6.1 % of Sum 2
75	Administrative Government	

Notes:

(1) Sum 1 = 28.6 % of the sum of Sectors 1 through 49

(2) Sum 2 = 21.5 % of the sum of the cost categories (labor, equipment, etc.) plus communication

Table 5. Distribution of Costs Among Industrial Sectors
(Costs are presented in January 1987 dollars)

Sector Number	Sector Description	Phase 1	Phase 2
1	AGRICULTURAL PRODUCTS	$12,235	$49,183
2	FORESTRY		
3	FISHERIES		
4	AGRICULTURAL SERVICES		
5	COPPER MINING		
6	LEAD AND ZINC MINING		
7	GOLD MINING		
8	SILVER MINING		
9	MINE-DUMMY		
10	MINE-DUMMY		
11	MINE-DUMMY		
12	MINE-DUMMY		
13	MINE-DUMMY		
14	MINE-DUMMY		
15	MINE-DUMMY		
16	MINE-DUMMY		
17	MINE-DUMMY		
18	OTHER METAL MINING		
19	METAL MINING SERVICES		
20	COAL MINING		
21	CRUDE PETROLEUM		
22	NATURAL GAS		
23	LIMESTONE	$839,725	$54,852
24	OTHER STONE		
25	SAND AND GRAVEL	$839,725	$54,852
26	MISCELLANEOUS MINERALS		
27	NON-METAL SERVICES		
28	CHEMICAL FERTILIZER		
29	MINING CONSTRUCTION	$8,117,833	$4,148,377
30	OTHER NEW CONSTRUCTION	$1,679,449	$109,703
31	OIL AND GAS REPAIR AND MAINTENANCE		
32	OTHER REPAIR AND MAINTENANCE		

Table 5. Distribution of Costs Among Industrial Sectors (continued)
(Costs are presented in January 1987 dollars)

Sector Number	Sector Description	Phase 1	Phase 2
33	PRESERVED SEAFOOD	$3,059	$12,296
34	FRESH AND FROZEN SEAFOOD		
35	OTHER FOOD PROCESSING		
36	TEXTILES		
37	LOGGING	$0	$0
38	WOOD PRODUCTS	$1,679,449	$109,703
39	PULP AND PAPER		
40	PRINTING AND PUBLISHING		
41	PETROLEUM REFINING	$3,560,905	$3,267,096
42	CHEM, RUBBER, PLAS, LEATH, TIRES	$2,755,805	$3,622,630
43	MAN. STONE PROD INCL. CEMENT, GLASS	$2,519,174	$164,555
44	PRIMARY METALS	$988,307	$123,627
45	FABRICATED METALS	$8,151,850	$768,765
46	NON-ELECTRICAL MACHINERY	$11,415,020	$7,807,761
47	ELECTRICAL MACHINERY	$6,245,457	$3,232,808
48	TRANSPORTATION EQUIPMENT	$6,849,012	$4,684,657
49	OTHER MANUFACTURING	$2,230,046	$2,322,945
50	RAILROADS	$1,159,363	$611,531
51	LOCAL TRANSPORTATION	$4,637,450	$2,446,126
52	TRUCK TRANSPORT	$2,318,725	$1,223,063
53	WATER TRANSPORT	$4,637,450	$2,446,126
54	AIR TRANSPORT	$8,115,538	$4,280,720
55	PIPELINES	$0	$0
56	TRANSPORTATION SERVICES	$2,318,725	$1,223,063
57	COMMUNICATION	$1,136,951	$581,005
58	ELECTRICAL UTILITIES		
59	GAS UTILITIES		
60	WATER SERVICES		

Table 5. Distribution of Costs Among Industrial Sectors (continued)
(Costs are presented in January 1987 dollars)

Sector Number	Sector Description	Phase 1	Phase 2
61	WHOLESALE	$2,534,548	$1,352,325
62	EATING AND DRINKING	$1,259,134	$643,443
63	OTHER RETAIL	$2,566,250	$1,479,761
64	FINANCE AND INSURANCE	$3,036,735	$1,551,833
65	REAL ESTATE	$4,542,758	$2,321,441
66	LODGING	$1,259,134	$643,443
67	PERSONAL SERVICE	$493,778	$252,331
68	BUSINESS SERVICES	$3,777,402	$1,930,329
69	AUTO SERVICES	$3,036,735	$1,551,833
70	MOVIES AND RECREATION	$246,889	$126,165
71	HEALTH SERVICES	$246,889	$126,165
72	EDUCATION AND NON-PROFIT	$0	$0
73	GOVERNMENT ENTERPRISES	$246,889	$126,165
74	USED GOODS	$1,506,023	$769,608
75	ADMINISTRATIVE GOVERNMENT	$0	$0
	TOTALS		
	Expenditures in Sectors 1 - 75	$106,964,417	$56,220,284
	Labor Expenditures	$43,926,093	$20,887,813
	Total	$150,890,510	$77,108,097

Note: The total expenditures spent in the local economy are greater than the expenditures shown in Table 3 due to the fact that services, construction management and communication are additional items, not accounted for in the cost estimating method used to estimate items such as labor, fuel, and equipment. Services, construction management, and communication add 32.7% to the total expenditures in the local economy.

Estimated Direct and Total Regional Economic Impacts Associated with Various Types and Sizes of Mineral Deposits

This section shows estimates of direct and total regional economic impacts associated with the development of four types of deposits in the WMNRA/SNCA study area: alkalic-associated gold deposits; gold placer deposits; sedimentary exhalative lead-zinc deposits; and tin greisens. An array of deposit sizes were evaluated (Table 6). The estimates were developed singly for each size and type of mine. Analyses of different types and sizes of mines are possible but were not developed as part of this effort since they would require assumptions regarding the timing of exploration and development. Tables 7 through 17 show the annual number of workers employed at the mine and in the region as a result of the development of the deposit (includes the workers at the mine), the amount of wages paid to the workers at the mine and in the region, and the total dollar output of product generated at the mine and in the region economy.

Table 6. Description of Mineral Deposits Analyzed

Deposit Type	Recoverable Metals	Size of Deposit (in million mt)	Mining Method	Milling Method	Net Present Value (in million 1987 $)
Alkalic Gold	Gold	16.000	VCR (1)	CIP (2)	$50.200
		58.400	VCR	CIP	$102.000
		89.100	VCR	CIP	($7.500)
Placer Gold	Gold	0.145	Placer	Placer	$0.040
		0.566	Placer	Placer	$0.516
		1.231	Placer	Placer	$0.854
Sedimentary Lead Zinc	Zinc, Silver Lead	13.800	R-P (3)	Pb-Zn Float (4)	$331.90
		77.180	OP (5)	Pb-Zn Float	$1,352.00
Tin Greisen	Tin, Silver	46.700	VCR	Sn Float (6)	$88.60
		69.300	OP	Sn Float	$80.00
		95.500	VCR	Sn Float	$39.60

Notes:
(1) Vertical Crater Retreat
(2) Carbon in Pulp Leaching
(3) Room and Pillar
(4) Lead - Zinc Flotation
(5) Open Pit
(6) Tin Float - Gravity

Table 7. Estimate of Impacts resulting from Development of Small Alkalic Gold Deposit (16 million metric tons)

	Direct Impacts of Development			Total Impacts Upon Regional Economy		
	Employment	Earnings (000's $)	Output (000's $)	Employment	Earnings (000's $)	Output (000's $)
1987	0	$0.0	$0.0	0	$0.0	$0.0
1988	0	$0.0	$0.0	0	$0.0	$0.0
1989	0	$0.0	$0.0	0	$0.0	$0.0
1990	0	$0.0	$0.0	0	$0.0	$0.0
1991	35	$4,078.0	$24,510.0	121	$5,942.5	$30,576.5
1992	463	$27,576.0	$108,004.0	1019	$36,400.3	$135,626.5
1993	463	$27,576.0	$108,004.0	1261	$42,742.8	$155,525.8
1994	245	$23,485.0	$65,656.0	774	$38,045.7	$108,989.0
1995	245	$23,485.0	$65,656.0	725	$36,636.6	$101,766.8
1996	245	$23,485.0	$65,656.0	728	$36,871.5	$104,393.0
1997	245	$23,485.0	$65,656.0	715	$36,401.8	$103,736.5
1998	245	$23,485.0	$65,656.0	706	$36,401.8	$103,079.9
1999	245	$23,485.0	$65,656.0	706	$36,401.8	$103,736.5
2000	245	$23,485.0	$65,656.0	698	$36,401.8	$103,736.5
2001	245	$23,485.0	$65,656.0	679	$35,697.2	$101,110.2
2002	245	$23,485.0	$65,656.0	688	$36,401.8	$104,393.0
2003	245	$23,485.0	$65,656.0	654	$34,992.7	$98,484.0
2004	245	$23,485.0	$65,656.0	649	$34,992.7	$99,140.6
2005	245	$23,485.0	$65,656.0	639	$34,757.8	$98,484.0
2006	245	$23,485.0	$65,656.0	630	$34,523.0	$97,827.4
Average	259	$22,783.4	$68,377.9	712	$34,600.7	$103,162.9
Cumulative		$364,535.0	$1,094,046.0		$553,611.4	$1,650,606.2

Note: Earnings and Output figures are presented in 1982 dollars.
Construction period - 1991 to 1993
Mine Operation period - 1994 to 2006

Table 8. Estimate of Impacts resulting from Development of Medium Alkalic Gold Deposit (58.4 million metric tons)

	Direct Impacts of Development			Total Impacts Upon Regional Economy		
	Employment	Earnings (000's $)	Output (000's $)	Employment	Earnings (000's $)	Output (000's $)
1987	0	$0.0	$0.0	0	0	0
1988	0	$0.0	$0.0	0	0	0
1989	0	$0.0	$0.0	0	0	0
1990	0	$0.0	$0.0	0	0	0
1991	61	$7,349.0	$42,168.0	209	$10,535.8	$52,530.3
1992	877	$48,620.0	$190,320.0	1886	$63,692.2	$239,803.2
1993	877	$48,620.0	$190,320.0	2315	$75,361.0	$274,060.8
1994	439	$43,208.0	$129,417.0	1387	$69,132.8	$207,067.2
1995	439	$43,208.0	$129,417.0	1348	$67,836.6	$199,302.2
1996	439	$43,208.0	$129,417.0	1343	$67,836.6	$201,890.5
1997	439	$43,208.0	$129,417.0	1335	$67,836.6	$201,890.5
1998	439	$43,208.0	$129,417.0	1321	$67,836.6	$201,890.5
1999	439	$43,208.0	$129,417.0	1317	$67,836.6	$201,890.5
2000	439	$43,208.0	$129,417.0	1313	$67,836.6	$203,184.7
2001	439	$43,208.0	$129,417.0	1264	$66,540.3	$196,713.8
2002	439	$43,208.0	$129,417.0	1282	$67,836.6	$203,184.7
2003	439	$43,208.0	$129,417.0	1216	$64,812.0	$191,537.2
2004	439	$43,208.0	$129,417.0	1207	$65,244.1	$194,125.5
2005	439	$43,208.0	$129,417.0	1190	$64,379.9	$191,537.2
2006	439	$43,208.0	$129,417.0	1172	$63,947.8	$190,243.0
2007	439	$43,208.0	$129,417.0	1159	$63,947.8	$190,243.0
2008	439	$43,208.0	$129,417.0	1150	$63,947.8	$190,243.0
2009	439	$43,208.0	$129,417.0	1141	$63,515.8	$190,243.0
2010	439	$43,208.0	$129,417.0	1133	$63,515.8	$190,243.0
Average	464	$41,956.3	$131,144.9	1284	$63,671.5	$195,591.2
Cumulative		$839,125.0	$2,622,897.0		$1,273,429.1	$3,911,823.8

Note: Earnings and Output figures are presented in 1982 dollars.
Construction period - 1991 to 1993
Mine Operation period - 1994 to 2010

Table 9. Estimate of Impacts resulting from Development of Large Alkalic Gold Deposit (89.1 million metric tons)

	Direct Impacts of Development			Total Impacts Upon Regional Economy		
	Employment	Earnings (000's $)	Output (000's $)	Employment	Earnings (000's $)	Output (000's $)
1987	0	$0.0	$0.0	0	$0.0	$0.0
1988	0	$0.0	$0.0	0	$0.0	$0.0
1989	0	$0.0	$0.0	0	$0.0	$0.0
1990	0	$0.0	$0.0	0	$0.0	$0.0
1991	73	$8,917.0	$50,788.0	250	$12,751.2	$63,250.8
1992	1080	$58,599.0	$229,735.0	2300	$76,764.7	$286,729.9
1993	1080	$58,599.0	$229,735.0	2819	$91,414.4	$333,115.8
1994	532	$53,062.0	$162,582.0	1676	$84,368.6	$255,253.7
1995	532	$53,062.0	$162,582.0	1660	$83,838.0	$250,376.3
1996	532	$53,062.0	$162,582.0	1655	$83,838.0	$252,002.1
1997	532	$53,062.0	$162,582.0	1644	$83,838.0	$252,002.1
1998	532	$53,062.0	$162,582.0	1633	$83,838.0	$252,002.1
1999	532	$53,062.0	$162,582.0	1623	$83,838.0	$253,627.9
2000	532	$53,062.0	$162,582.0	1617	$83,838.0	$253,627.9
2001	532	$53,062.0	$162,582.0	1559	$81,715.5	$247,124.6
2002	532	$53,062.0	$162,582.0	1580	$83,838.0	$255,253.7
2003	532	$53,062.0	$162,582.0	1500	$80,123.6	$240,621.4
2004	532	$53,062.0	$162,582.0	1484	$80,123.6	$242,247.2
2005	532	$53,062.0	$162,582.0	1463	$79,593.0	$240,621.4
2006	532	$53,062.0	$162,582.0	1442	$79,062.4	$238,995.5
2007	532	$53,062.0	$162,582.0	1426	$78,531.8	$237,369.7
2008	532	$53,062.0	$162,582.0	1415	$78,531.8	$237,369.7
2009	532	$53,062.0	$162,582.0	1404	$78,531.8	$238,995.5
2010	532	$53,062.0	$162,582.0	1394	$78,531.8	$238,995.5
2011	532	$53,062.0	$162,582.0	1383	$78,531.8	$238,995.5
2012	532	$53,062.0	$162,582.0	1373	$78,001.1	$238,995.5
Average	561	$51,558.8	$163,605.3	1559	$78,338.3	$243,071.5
Cumulative		$1,134,293.0	$3,599,316.0		$1,723,442.7	$5,347,574.0

Note: Earnings and Output figures are presented in 1982 dollars.
Construction Period - 1991 to 1993
Mine Operation period - 1994 to 2012

Table 10. Estimate of Impacts resulting from Development of Small Placer Gold Deposit (145,184 metric tons)

	Direct Impacts of Development			Total Impacts Upon Regional Economy		
	Employment	Earnings (000's $)	Output (000's $)	Employment	Earnings (000's $)	Output (000's $)
1987	0	$0.0	$0.0	0	$0.0	$0.0
1988	0	$0.0	$0.0	0	$0.0	$0.0
1989	4	$64.0	$490.0	6	$103.7	$615.6
1990	3	$48.0	$107.0	4	$72.0	$176.4
1991	3	$48.0	$107.0	4	$68.2	$157.0
1992	3	$48.0	$107.0	4	$66.7	$158.6
1993	3	$48.0	$107.0	4	$65.8	$154.7
1994	3	$48.0	$107.0	4	$65.8	$156.7
1995	3	$48.0	$107.0	4	$65.3	$154.7
1996	3	$48.0	$107.0	4	$63.8	$151.2
1997	3	$48.0	$107.0	4	$64.8	$154.5
1998	3	$48.0	$107.0	4	$63.4	$150.8
1999	3	$48.0	$107.0	4	$63.4	$150.0
Average	3	$49.5	$141.8	4	$69.3	$198.2
Cumulative		$544.0	$1,560.0		$762.7	$2,180.3

Note: Earnings and Output figures are presented in 1982 dollars.
Construction period - 1989
Mine Operation period - 1990 to 1999

Table 11. Estimate of Impacts resulting from Development of Medium Placer Gold Deposit (556,236 metric tons)

	Direct Impacts of Development			Total Impacts Upon Regional Economy		
	Employment	Earnings (000's $)	Output (000's $)	Employment	Earnings (000's $)	Output (000's $)
1987	0	$0.0	$0.0	0	$0.0	$0.0
1988	0	$0.0	$0.0	0	$0.0	$0.0
1989	4	$92.0	$685.0	6	$147.5	$860.4
1990	5	$116.0	$264.0	7	$160.2	$392.7
1991	5	$116.0	$264.0	7	$163.9	$392.6
1992	5	$116.0	$264.0	7	$163.6	$399.9
1993	5	$116.0	$264.0	7	$163.6	$397.6
1994	5	$116.0	$264.0	7	$166.3	$405.9
1995	5	$116.0	$264.0	7	$164.9	$401.7
1996	5	$116.0	$264.0	7	$162.6	$393.6
1997	5	$116.0	$264.0	7	$163.6	$403.4
1998	5	$116.0	$264.0	7	$161.8	$394.0
1999	5	$116.0	$264.0	7	$161.5	$393.0
Average	5	$113.8	$302.3	7	$161.8	$439.5
Cumulative		$1,252.0	$3,325.0		$1,779.4	$4,834.7

Note: Earnings and Output figures are presented in 1982 dollars.
Construction period - 1989
Mine Operation period - 1990 to 1999

Table 12. Estimate of Impacts resulting from Development of Large Placer Gold Deposit (1.23 million metric tons)

	Direct Impacts of Development			Total Impacts Upon Regional Economy		
	Employment	Earnings (000's $)	Output (000's $)	Employment	Earnings (000's $)	Output (000's $)
1987	0	$0.0	$0.0	0	$0.0	$0.0
1988	0	$0.0	$0.0	0	$0.0	$0.0
1989	4	$115.0	$836.0	7	$181.7	$1,047.6
1990	7	$199.0	$464.0	10	$262.7	$652.4
1991	7	$199.0	$464.0	10	$280.6	$691.4
1992	7	$199.0	$464.0	10	$282.6	$709.9
1993	7	$199.0	$464.0	10	$286.4	$709.9
1994	7	$199.0	$464.0	10	$288.6	$723.8
1995	7	$199.0	$464.0	10	$286.6	$719.2
1996	7	$199.0	$464.0	10	$282.6	$705.3
1997	7	$199.0	$464.0	10	$287.5	$723.8
1998	7	$199.0	$464.0	10	$282.7	$705.3
1999	7	$199.0	$464.0	10	$282.5	$705.3
Average	7	$191.4	$497.8	10	$273.1	$735.8
Cumulative		$2,105.0	$5,476.0		$3,004.3	$8,093.9

Note: Earnings and Output figures are presented in 1982 dollars.
Construction period - 1989
Mine Operation period - 1990 to 1999

Table 13. Estimate of Impacts resulting from Development of Small Sedimentary Exhalative Lead Zinc Deposit (13.82 million metric tons)

	Direct Impacts of Development			Total Impacts Upon Regional Economy		
	Employment	Earnings (000's $)	Output (000's $)	Employment	Earnings (000's $)	Output (000's $)
1987	0	$0.0	$0.0	0	$0.0	$0.0
1988	0	$0.0	$0.0	0	$0.0	$0.0
1989	0	$0.0	$0.0	0	$0.0	$0.0
1990	0	$0.0	$0.0	0	$0.0	$0.0
1991	23	$2,623.0	$21,322.0	97	$4,316.7	$26,841.3
1992	541	$22,149.0	$86,201.0	1066	$29,015.2	$108,613.3
1993	541	$22,149.0	$86,201.0	1239	$33,666.5	$122,405.4
1994	276	$18,615.0	$54,486.0	679	$29,784.0	$87,722.5
1995	276	$18,615.0	$54,486.0	657	$29,039.4	$83,363.6
1996	276	$18,615.0	$54,486.0	657	$29,039.4	$84,998.2
1997	276	$18,615.0	$54,486.0	651	$29,039.4	$84,998.2
1998	276	$18,615.0	$54,486.0	643	$28,853.3	$84,453.3
1999	276	$18,615.0	$54,486.0	640	$28,853.3	$84,453.3
2000	276	$18,615.0	$54,486.0	635	$28,853.3	$84,453.3
2001	276	$18,615.0	$54,486.0	621	$28,294.8	$82,818.7
2002	276	$18,615.0	$54,486.0	624	$28,853.3	$84,998.2
2003	276	$18,615.0	$54,486.0	599	$27,550.2	$80,094.4
2004	276	$18,615.0	$54,486.0	596	$27,736.4	$81,184.1
2005	276	$18,615.0	$54,486.0	588	$27,550.2	$80,639.3
Average	294	$18,020.1	$56,503.7	666	$27,363.0	$84,135.8
Cumulative		$270,301.0	$847,556.0		$410,445.1	$1,262,037.0

Note: Earnings and Output figures are presented in 1982 dollars.
Construction period - 1991 to 1993
Mine Operation period - 1994 to 2005

Table 14. Estimate of Impacts resulting from Development of Large Sedimentary Exhalative Lead Zinc Deposit (77.2 million metric tons)

	Direct Impacts of Development			Total Impacts Upon Regional Economy		
	Employment	Earnings (000's $)	Output (000's $)	Employment	Earnings (000's $)	Output (000's $)
1987	0	$0.0	$0.0	0	$0.0	$0.0
1988	0	$0.0	$0.0	0	$0.0	$0.0
1989	0	$0.0	$0.0	0	$0.0	$0.0
1990	0	$0.0	$0.0	0	$0.0	$0.0
1991	1008	$39,858.0	$146,965.0	2388	$49,896.7	$179,429.9
1992	1008	$39,858.0	$146,965.0	2695	$57,827.2	$202,983.1
1993	443	$18,953.0	$75,249.0	1045	$35,442.1	$124,160.8
1994	443	$18,953.0	$75,249.0	944	$32,788.7	$113,626.0
1995	443	$18,953.0	$75,249.0	917	$32,220.1	$113,626.0
1996	443	$18,953.0	$75,249.0	895	$31,462.0	$112,121.0
1997	443	$18,953.0	$75,249.0	882	$31,272.4	$111,368.5
1998	443	$18,953.0	$75,249.0	873	$31,082.9	$110,616.0
1999	443	$18,953.0	$75,249.0	868	$31,082.9	$111,368.5
2000	443	$18,953.0	$75,249.0	859	$30,893.4	$111,368.5
2001	443	$18,953.0	$75,249.0	837	$30,135.3	$108,358.6
2002	443	$18,953.0	$75,249.0	837	$30,514.3	$110,616.0
2003	443	$18,953.0	$75,249.0	806	$29,187.6	$104,596.1
2004	443	$18,953.0	$75,249.0	802	$29,187.6	$105,348.6
2005	443	$18,953.0	$75,249.0	793	$28,998.1	$104,596.1
2006	443	$18,953.0	$75,249.0	780	$28,619.0	$103,843.6
2007	443	$18,953.0	$75,249.0	775	$28,429.5	$103,091.1
2008	443	$18,953.0	$75,249.0	766	$28,429.5	$103,091.1
2009	443	$18,953.0	$75,249.0	762	$28,429.5	$103,091.1
2010	443	$18,953.0	$75,249.0	758	$28,240.0	$103,091.1
Average	500	$21,043.5	$82,420.6	1014	$32,706.9	$117,019.6
Cumulative		$420,870.0	$1,648,412.0		$654,138.9	$2,340,392.0

Note: Earnings and Output figures are presented in 1982 dollars.
Construction period - 1991 to 1992
Mine Operation period - 1993 to 2010

Table 15. Estimate of Impacts resulting from Development of Small Tin Greisen Deposit (46.7 million metric tons)

	Direct Impacts of Development			Total Impacts Upon Regional Economy		
	Employment	Earnings (000's $)	Output (000's $)	Employment	Earnings (000's $)	Output (000's $)
1987	0	$0.0	$0.0	0	$0.0	$0.0
1988	0	$0.0	$0.0	0	$0.0	$0.0
1989	0	$0.0	$0.0	0	$0.0	$0.0
1990	0	$0.0	$0.0	0	$0.0	$0.0
1991	56	$6,708.0	$38,474.0	191	$9,614.1	$47,924.8
1992	1250	$53,019.0	$185,911.0	913	$67,334.1	$232,388.8
1993	1250	$53,019.0	$185,911.0	1463	$81,649.3	$275,148.3
1994	500	$37,223.0	$121,100.0	1585	$66,629.2	$209,503.0
1995	500	$37,223.0	$121,100.0	1365	$61,045.7	$186,494.0
1996	500	$37,223.0	$121,100.0	1320	$59,929.0	$185,283.0
1997	500	$37,223.0	$121,100.0	1290	$59,184.6	$184,072.0
1998	500	$37,223.0	$121,100.0	1280	$59,184.6	$185,283.0
1999	500	$37,223.0	$121,100.0	1275	$59,184.6	$185,283.0
2000	500	$37,223.0	$121,100.0	1270	$59,184.6	$186,494.0
2001	500	$37,223.0	$121,100.0	1230	$57,695.7	$180,439.0
2002	500	$37,223.0	$121,100.0	1240	$58,812.3	$186,494.0
2003	500	$37,223.0	$121,100.0	1180	$56,206.7	$175,595.0
2004	500	$37,223.0	$121,100.0	1170	$56,579.0	$176,806.0
2005	500	$37,223.0	$121,100.0	1155	$55,834.5	$175,595.0
2006	500	$37,223.0	$121,100.0	1140	$55,462.3	$174,384.0
2007	500	$37,223.0	$121,100.0	1125	$55,090.0	$173,173.0
2008	500	$37,223.0	$121,100.0	1115	$55,090.0	$173,173.0
2009	500	$37,223.0	$121,100.0	1110	$55,090.0	$174,384.0
2010	500	$37,223.0	$121,100.0	1105	$55,090.0	$174,384.0
Average	553	$37,276.9	$123,449.8	1176	$57,194.5	$182,115.0
Cumulative		$745,537.0	$2,468,996.0		$1,143,890.3	$3,642,300.8

Note: Earnings and Output figures are presented in 1982 dollars.
Construction period - 1991 to 1993
Mine Operation period - 1994 to 2010

Table 16. Estimate of Impacts resulting from Development of Medium Tin Greisen Deposit (69.3 million metric tons)

	Direct Impacts of Development			Total Impacts Upon Regional Economy		
	Employment	Earnings (000's $)	Output (000's $)	Employment	Earnings (000's $)	Output (000's $)
1987	0	$0.0	$0.0	0	$0.0	$0.0
1988	0	$0.0	$0.0	0	$0.0	$0.0
1989	0	$0.0	$0.0	0	$0.0	$0.0
1990	0	$0.0	$0.0	0	$0.0	$0.0
1991	958	$49,915.0	$185,872.0	2385	$62,524.7	$226,708.1
1992	958	$49,915.0	$185,872.0	2823	$73,921.5	$260,622.9
1993	522	$27,566.0	$121,781.0	1420	$52,099.7	$194,849.6
1994	522	$27,566.0	$121,781.0	1300	$49,067.5	$182,671.5
1995	522	$27,566.0	$121,781.0	1274	$48,516.2	$182,671.5
1996	522	$27,566.0	$121,781.0	1242	$47,689.2	$180,235.9
1997	522	$27,566.0	$121,781.0	1221	$47,137.9	$179,018.1
1998	522	$27,566.0	$121,781.0	1211	$46,862.2	$179,018.1
1999	522	$27,566.0	$121,781.0	1201	$46,862.2	$180,235.9
2000	522	$27,566.0	$121,781.0	1195	$46,862.2	$180,235.9
2001	522	$27,566.0	$121,781.0	1154	$45,483.9	$174,146.8
2002	522	$27,566.0	$121,781.0	1159	$46,310.9	$177,800.3
2003	522	$27,566.0	$121,781.0	1107	$44,105.6	$169,275.6
2004	522	$27,566.0	$121,781.0	1096	$44,105.6	$170,493.4
2005	522	$27,566.0	$121,781.0	1081	$43,554.3	$169,275.6
2006	522	$27,566.0	$121,781.0	1065	$43,278.6	$166,840.0
2007	522	$27,566.0	$121,781.0	1054	$43,003.0	$166,840.0
2008	522	$27,566.0	$121,781.0	1044	$42,727.3	$166,840.0
2009	522	$27,566.0	$121,781.0	1039	$42,727.3	$166,840.0
2010	522	$27,566.0	$121,781.0	1028	$42,451.6	$166,840.0
Average	566	$29,800.9	$128,190.1	1305	$47,964.6	$182,072.9
Cumulative		$596,018.0	$2,563,802.0		$959,291.3	$3,641,458.9

Note: Earnings and Output figures are presented in 1982 dollars.
Construction period - 1991 to 1992
Mine Operation period - 1993 to 2010

Table 17. Estimate of Impacts resulting from Development of Large Tin Greisen Deposit (95.5 million metric tons)

	Direct Impacts of Development			Total Impacts Upon Regional Economy		
	Employment	Earnings (000's $)	Output (000's $)	Employment	Earnings (000's $)	Output (000's $)
1987	0	$0.0	$0.0	0	$0.0	$0.0
1988	0	$0.0	$0.0	0	$0.0	$0.0
1989	0	$0.0	$0.0	0	$0.0	$0.0
1990	0	$0.0	$0.0	0	$0.0	$0.0
1991	75	$9,224.0	$52,438.0	258	$13,180.6	$65,302.9
1992	1796	$73,631.0	$257,388.0	1922	$93,511.4	$318,579.3
1993	1796	$73,631.0	$257,388.0	2640	$112,655.4	$378,360.4
1994	706	$54,177.0	$180,491.0	2146	$93,184.4	$297,810.1
1995	706	$54,177.0	$180,491.0	1956	$88,308.5	$277,956.1
1996	706	$54,177.0	$180,491.0	1906	$87,225.0	$274,346.3
1997	706	$54,177.0	$180,491.0	1871	$86,683.2	$274,346.3
1998	706	$54,177.0	$180,491.0	1864	$86,683.2	$274,346.3
1999	706	$54,177.0	$180,491.0	1850	$86,683.2	$276,151.2
2000	706	$54,177.0	$180,491.0	1843	$86,683.2	$276,151.2
2001	706	$54,177.0	$180,491.0	1779	$84,516.1	$268,931.6
2002	706	$54,177.0	$180,491.0	1800	$86,141.4	$277,956.1
2003	706	$54,177.0	$180,491.0	1716	$82,349.0	$261,711.9
2004	706	$54,177.0	$180,491.0	1694	$82,349.0	$263,516.9
2005	706	$54,177.0	$180,491.0	1673	$81,807.3	$261,711.9
2006	706	$54,177.0	$180,491.0	1645	$81,265.5	$259,907.0
2007	706	$54,177.0	$180,491.0	1631	$80,723.7	$258,102.1
2008	706	$54,177.0	$180,491.0	1617	$80,723.7	$258,102.1
2009	706	$54,177.0	$180,491.0	1610	$80,723.7	$258,102.1
2010	706	$54,177.0	$180,491.0	1596	$80,182.0	$258,102.1
2011	706	$54,177.0	$180,491.0	1581	$80,182.0	$258,102.1
2012	706	$54,177.0	$180,491.0	1567	$80,182.0	$258,102.1
2013	706	$54,177.0	$180,491.0	1553	$79,640.2	$258,102.1
Average	773	$53,914.2	$181,610.2	1727	$82,416.7	$265,817.4
Cumulative		$1,240,026.0	$4,177,034.0		$1,895,583.8	$6,113,800.7

Note: Earnings and Output figures are presents in 1982 dollars.
Construction period - 1991 to 1993
Mine Operation period - 1994 to 2013

APPENDIX H. REGIONAL ECONOMIC MODELS USED IN THE WMNRA/SNCA STUDY

The Bureau of Mines has regional economic models for three areas of Alaska: the entire state, Greater Fairbanks, and Greater Anchorage. These models are year recursive, multisector simulation models in the Keynesian tradition. Potential mining activity impacts are estimated by incorporating mine development and production scenarios in the base forecast of regional demand. The costs of the new mining activity must be specified in detail.

Since the regional economic impacts of mineral development in the WMNRA/SNCA study area are expected to be concentrated in the Fairbanks area, the Greater Fairbanks model was used to estimate these impacts.

Overview of model structure

The Fairbanks regional model is an interactive policy analysis simulation system (IPASS).[1] The model is driven by exogenously forecasted demand. Mining scenarios are added to exogenous demand for any or all years of the forecast. Model outputs provide estimates of the changes in regional employment, income, taxes, and output (production) as a result of alternative mineral development policies.

1/This model was developed by Wilbur Maki and Associates, with support from the U.S. Forest Service and is documented in a report entitled "Role of Mining and Mineral Development in the Alaska Economy Analyzed by the Interindustry Method", June 1987.

The model consists of several modules for data handling and for reporting results as well as a number of modules which contain equations representing economic relationships. The economic modules are: (1) the primary inputs module, (2) the final demands module, (3) the investments module, (4) the other government module, (5) the regional outputs module, (6) the population module, and (7) the labor force and employment module. Each of these modules is described briefly below.

Primary inputs module

The primary inputs module calculates value added to industries by sector, imports to the region, depreciation, business income, and personal income. Value added is a function of outputs times sector value added factors.

Imports required by each industry sector are equal to sector output times a sector import rate.

Depreciation of capital stock equals sector output levels times sector depreciation factors.

Business income (before income taxes) is defined as value added less employee compensation and indirect business taxes.

Income taxes for businesses are calculated as business income less depreciation times the income tax rate. Net business income is defined as business income less income taxes. If sector net business income is negative, there is not enough money to cover taxes and wages. The deficit is subtracted from previous year's accumulated net business income. Indirect business taxes equal sector output times the indirect tax rate (which may be updated annually).

Income from labor is defined as employee compensation and equals earnings per worker multiplied by actual employment for each industry sector. Total employee compensation for all sectors is related to total personal income. Transfers such as welfare payments are implicitly taken account of in the final demands calculations.

Final demands module

Mining scenarios and other exogenous forces driving the regional models enter via the final demands module. The final demands module calculates the levels of following seven types of demand for each year of the forecast period:

1. Personal consumption expenditures (PCE) include current consumption and household durable goods. Total PCE is a function of population and income levels over time. It equals the previous year PCE total plus the portion of added disposable personal income not saved. Disposable personal income for the current year is a function of income elasticities and the previous year personal income. A linking variable that relates increase in PCE and increase in numbers of wage earners is calculated. PCE is broken out by sector by taking the corresponding vector for the previous year and modifying it by the linking PCE/employment variable and the population change for the previous two years.

2. Gross private capital formation (GPCF) includes tangible business investments. Capital for pollution abatement may be specified separately. Total GPCF for each industry is the sum of expansion and replacement investment as well as capital. This module breaks out those goods and services consumed as capital. The investment module is concerned with the other catregories of investment. The total GPCF vector is multiplied by a matrix of capital coefficients. The resulting vector gives the investment goods demanded by sector.

3. Changes in business inventories are estimated as changes in industry sector outputs for the previous 2 years times a ratio of inventories to output levels.

4. Exports from the region are the product of U.S. output and regional market share for the current year.

5. State and local government expenditures for all purposes (transfers such as welfare payments are excluded) are a function of previous year's expenditures times change in population, change in personal incomes, and a parameter for growth not otherwise accounted for.

6. Federal government expenditures for all purposes (except transfers) forecasted using an exogenous growth rate.

7. Other exogenously specified demands, such as the levels of mining activities in scenarios are written into the final demands module directly for each year.

Investment module

Estimates of capital stock variables affect both demand and supply sides of the model. The investment module calculates investment by industrial sector for expansion, which is triggered by excess demand for the sector in the previous year, and for replacement, which is a function of depreciation.

For each sector of industry there is a current year investment limit. This limit is a function of previous year's net business income times the borrowings leverage ratio, plus accumulated earnings times the liquidity preference ratio. Although normally positive, the limit can be zero or negative for a sector that is chronically loosing money; in such a case, no investment in that sector is permitted.

When investment is possible, reinvestment, which is equal to the previous year's depreciation, has priority over expansion investment. Expansion investment equals the previous year's excess demand for the sector times the ratio of capital to output. It is zero when excess demand is less than or equal to zero.

The total capital stock for each industry sector equals the previous year's stock plus investments net of depreciation. Current year stock times the capital-output ratio yields the maximum output for that sector permitted by the current year stock. The model distinguishes between capital stocks and investments in productive and pollution control capital.

Other government module

This module estimates activity levels of certain public sectors. "Other" government refers to government related variables other than expenditure and taxes. Current year public sector civilian employment equals previous year's employment multiplied by change in population, income, and a parameter for growth not otherwise accounted for. Public sector employment and output are not constrained by capital or labor availability. Total wages and salaries in public sectors are a function of employment and earnings per worker for that sector.

Regional output module

The regional output module uses the interindustry matrix to calculate demands for industrial products and services. Capacities for industry sectors in the current year are defined as the maximum outputs possible with the given capital stocks. They are estimated as current year productive capital stocks divided by the capital-output ratios for each sector.

Output demanded is a function of final demands. The vector of total final demands for industry sectors is multiplied by the matrix of inverse coefficients for industry sectors. If output demanded is less than the output permitted by the capacity constraint, output is set equal to that demanded. If output demanded is greater than the output permitted by the capacity constraint, then the model balances demand to supply by adjusting the exogenous demand, exports. As a result local demands have higher priority over exports.

Population module

The population module estimates regional population for 66 one year age classes. The 66th class includes ages 65 and over. Migration of workers in and out of the region is summed over occupational classes, and total migrations are equal to total worker migrations modified by ratios of numbers of average household members to numbers of workers migrating. These total migrations are broken out by the 66 age classes distinguished by male and female. Migration is then added to population of the previous year aged one year. Births are a function of female population. Deaths are estimated for both male and female population.

Labor force and employment module

This module calculates labor force and industry employment by sector and occupational category. Employment demanded by industry sector in the current year equals industry output divided by output per worker. Output per worker in the current year equals that of the previous year modified by annual change in worker output per hour, change in hours worked per week, and change in weeks worked per year. Sector employment demanded is broken out by occupational class using distribution parameters. The distribution of workers by occupational class for the current year is estimated from the previous year's estimate modified by migration characteristics. The total labor force is estimated by applying labor force participation rates (which are adjusted for annual growth) to the population and distributing workers to the various occupational classes.

Employment demanded by occupation and labor force by occupation are compared, and employment is equal to the lesser of the two. Employment is broken out by industry sectors using distribution parameters. Therefore, a shortfall in any one occupation class has negative effects on all industries. Where employment is constrained, a labor-constrained level of sector output is calculated as employment times output per worker. Sector excess demand and constrained supply must be balanced by reducing export demand. Where there is excess labor supply, there is unemployment, equal to the labor force minus actual employment. In the event of excess demand (positive or negative) for labor, migration is induced. The numbers of in or outmigrants are calculated as a function of excess demand.

Specifying Mining Activity Scenarios

A mining activity scenario for the WMNRA/SNCA study is specified in terms of the annual expenditures required to develop a prospective type and sized deposit within the study area. For instance, one scenario specified was for a small placer mining operation and another scenario specified was for a large tin greisen deposit. Overall, 11 representative types and sizes of mining operations were analyzed. Three important assumptions are made concerning mining-related expenditures:

(1) Regional impacts are a function of purchases of supplies and services, and earnings by mine workers. These are included in their entirety in total expenditures; in subsequent calculations, the regional model spearates out those purchases made from suppliers outside the region. Property taxes and other taxes paid to local or state governments, if any, are assumed to have regional impacts; therefore, these are included in expenditures; federal government taxes are omitted. Because future mining activities are not significantly determined by locally retained earnings, since needed capital can be obtained from outside the region, and since most households receiving dividends are outside the region it is assumed that profits have no regional impact and are omitted from total expenditure.

(2) Whereas, in the engineering model, the various types of costs are independently related to mine size, the same approach is not feasible in the regional models. Instead, costs of all types must be directly proportional to mine size, or (in other words) they must have fixed shares of total expenditure. Each deposit type, therefore, has costs and expenditures specified for several sizes, e.g. large, medium and small.

(3) Output of mining sectors in the WMNRA/SNCA is not endogenously constrained by capital or labor availability. It is assumed that any such constraints are taken into account when scenarios are exogenously specified.

The programming that allows exogenous mining scenarios to drive the model has been designed by the Bureau of Mines, and it continues to evolve with experience in simulating minerals development. At the present time, it is contained in a program named "Prefin" (for the Fairbanks area). In Appendix G, the preparation of cost equations for mining activities is described. The cost equations are based on typical mines defined in terms of commodities mined, technologies used, and capacities.

In "Prefin," the cost equation for the mining activity to be simulated is written, and earnings and numbers of workers are also specified. A vector of import parameters is used to reduce inputs by the amount not purchased locally. Mining output as specified in scenarios need not match that specified for the "typical" mine defined for data preparation purposes, since "Prefin" expresses costs as a fraction of output.

Inputs are aggregated to the model's sector scheme and written into the interindustry matrix for the region. Further calculations yield inverse coefficients for the 28 sectors. If desired, employment is converted to "full time equivalent" units; in the version of the program called "Pretest," employment remains expressed in numbers of workers. (This difference is significant only for seasonal mining activities.) The inverse coefficients and employment and earnings ratios are recorded in a separate file to be called upon during simulations.

In IPASS simulations, the first steps involve writing the inverse coefficient files that are required by the simulation into the 1987 database. Levels of output are specified annually in the course of the simulation.

Overview of the Database

The Fairbanks IPASS model includes over a hundred parameters and variables, some of which have been mentioned in the preceding paragraphs. The database contains values for these variables for the Fairbanks region for the base year. The Fairbanks model has 28 industrial sectors (the Alaska state model has 75 sectors and the greater Anchorage model has 28 sectors). For some variables there are several sources of data; for others, there are only data at the national level, and the regional values must be estimated from these.

An important source of data are the U.S. Forest Service "IMPLAN" models, which include interindustry tables for various regions. The IMPLAN models are described in Forest Service publications, such as, IMPLAN Version 2.0 (USDA Forest Service, Ft. Collins, Colorado).

The benchmark year for the databases is 1985. Since the base year for simulations is 1987, the 1985 databases were calibrated to 1987. That is, forecasts from 1985 to 1987 were made and the results checked against data on employment and earnings for 1987; where significant discrepancies were noted, certain database values were modified, and another forecast made. Updating the databases to 1987 by this method is necessary until final 1987 data becomes available. The updates to 1987 encountered unique difficulties due to the recession in Alaska in this period.

In the final databases, all dollars are 1982 dollars. Where necessary, regional producer or consumer price indices were used for conversions.

Remarks on the IMPLAN data used

IMPLAN system was used to derive absorption and byproducts matrices for the regions, as well as final demand and primary inputs data. These two matrices are provided by IMPLAN for the year 1985. The initial versions of the matrices are for year 1982. They are "altered" to 1985 using IMPLAN programming.

The initial IMPLAN interindustry data were based mainly on national and local census data. Additional data for 1982 and 1985 were obtained from the Alaska Department of Labor Research and Analysis Section for employment and earnings. Data on outputs of certain sectors (i.e. agriculture, mining, forestry, and fishing) were gathered and transportation industry variable values adjusted.

These new data replaced values given by IMPLAN. Industry outputs were reestimated (by means of output/earnings ratios) using State earnings data and other income variables were adjusted to retain their original proportion of output. Employment also was set equal to State data. Imports and exports were adjusted to equalize total inputs and total outputs for all sectors.

Database for the Fairbanks model

The following pages, reproduced from the contractor report cited earlier in this Appendix, provide additional information on the output, employment, earnings and income variables that are used in the IPASS model. The database for 1985 for the Greater Fairbanks model is also presented.

Data sources for selected variables and parameters

Output, employment, earnings, and incomes data that are part of the regional interindustry models are discussed in the preceding paragraphs. More details on those and other data are given in the following pages, reproduced from the University of Minnesota contract report cited in the section on "Background."

IPASS CONVENTIONS

"Bookkeeping" Parameters

The IPASS database includes several parameters that are not used in calculations, but which serve as a framework for the rest of the model. They are:

2.1 NAMER: The first ten characters of the name of the region.

2.2 NAMER1: The rest of the name of the region (up to ten more characters).

2.3 IYEAR: The "base year" of the simulation--that is, the year of record for the variables in the database.

2.4 NIS: The number of industrial sectors to be modelled. NIS may not exceed 75.

2.5 NOC: The number of occupational groups to be modelled. There must be a minimum of six and no more than nine (the Census Bureau uses the latter).

2.6 $INDUSN_i$: The name given to each industrial sector i. $INDUSN_i$ may not exceed 18 characters.

2.7 $NOCUP1_j$: The first six characters of the name given to occupational group j.

2.8 $NOCUP2_j$: The rest of the name given to occupation j (up to six more characters).

Subscripts Used

A variety of subscripts are used with the variables and parameters discussed in this manual.

The years for which the simulation is run are denoted with the subscript t. By IPASS convention, the most recently-completed year of simulation is denoted by "t"; the year previous by "t-1"; and the current year of the simulation by "t+1". Also by convention, t=0 for the simulation's base year, t=1 for the first year, and so on.

Industrial sector is denoted by i and sometimes also by k. The subscripts j and sometimes m are used for occupational group. The subscript representing age is a and ranges from 1 to 66, where a=1 corresponds to age 0-1, 2 to age 1-2, ..., 64 to age 64-65, and 65 to age 65 and above. (Note that a is greater by one than the chronological age of those in each age class.) Some variables are divided into age groups, with a subscript of g. Sex is subscripted by s. Finally, certain parameters are allowed to vary across four or fiv time intervals, which are denoted by v.

"M1" Variables"

A number of IPASS variables represent "last year's" value of some other variable. All of these contain the letters "M1," for current year minus one, in their data name.

Other IPASS Conventions:

All variables and parameters refer specifically to the study region, unless their definition states otherwise.

All monetary variables not otherwise specified are expressed in thousands of dollars ($1000's).

"Census" is used in this manual as shorthand for the decennial Census of Population.

Rates of Change

Certain parameters in the database represent the expected annual rate-of-change in particular variables. Note that all of these parameters are expressed as fractional increases (or, if negative, fractional decreases) in the related variable. The rate-of-change parameters are used by IPASS in the following manner (where VAR is the associated variable and v stands for the appropriate time interval):

$$VAR_{t+1} = VAR_t * (1 + RATE\text{-}OF\text{-}CHANGE_v).$$

Manual Organization

For the IPASS variables and parameters that were collected from outside sources, the format is:

Variable or parameter name:

Data:

Procedure: compilation or calculation procedure.

Identity: the equation used to formulate the variable or paramenter

Investment Module

Data Sources and Derivation Methods

3.1 X_i (Regional gross output for the base year, for each industrial sector i):

Data: Obtained from the gross output column of the Alaska regional I/O table.

Procedure: X_{NIS}, by IPASS convention, was set equal to employee earnings in sector NIS ($EARN_{NIS}$).

3.2 $XM1_i$ (Regional gross output for the year before the base or the current year, for each sector i):

Procedure: In the absence of data for XM1, this was approximated by setting it to $0.97*X_i$.

3.3 XD_i (Gross output required to meet final demand, for each sector i):

Procedure: Initially this variable was set to $1.03*X_i$.

3.4 XS_i (Maximum gross output given current capital stocks, for each sector i):

Procedure: This was set equal to $1.06*X_i$.

3.5 XL_i (Maximum gross output given current labor force constraints, for each sector i):

Procedure: This was set to X_i for the base year.

3.6 XTOT (Total regional gross output for all sectors):

Procedure: This variable is the sum of X_i (3.1) for all sectors.

3.7 $PRCAP_i$ (Production capital stock, for each sector i):

Data: Production capital/output ratio derived for parameter $CAPPRR_i$(3.9).
Alaska regional gross output (Xs_i (3.4)).

Procedure: The national production capital/output ratio was multipled by the output supply constraint Xs_i. The resulting number is production capital stock for each regional industry. Units are in thousands of dollars.

Identity: $PRCAP_i = CAPPRR_i * Xs_i$

3.8 $PACAP_i$ (Pollution-abatement capital stock, for each sector i):

Data: Pollution abatement capital/output ratio derived for parameter CAPPAR (3.10).
Alaska regional gross output (Xs_i (3.1)).

Procedure: The national production capital/output ratio was multipled by the output supply constraint Xs_i. The resulting number is pollution abatement capital stock for each Alaska industry. Units are in thousands of dollars.

Identity: $PACAP_i = CAPPAR_i * Xs_i$

3.9 $CAPPRR_i$ (Production capital/output ratio at full capacity, for each sector i:

Data: U.S. Capital Stocks Database 1985, Office of Business Analysis (OBA), USDC, Washington D.C.
Unpublished Data, Office of Economic Growth and Projections, BLS, U.S. Department of Labor, Washington D.C.

Procedure: The OBA gross private capital stocks for plant and equipment data and the BLS data was resectored to 28 Alaska regional industries using a LOTUS conversion program. Nonmanufacturing data was not available for 1981 and 1982 so the 1980 values for each industry were inflated to 1981 and 1982 values using a U.S. output deflater.

Using the period 1979 to 1982, total U.S. gross stocks were divided by U.S. output for each year. The lowest value from the period was selected for each industry representing full capacity capital/output.

Identity: $CAPPRR_i$ = U.S. Private Gross $Stocks_i$ / $USGO_i$

<u>3.10 $CAPPAR_i$</u> (Pollution-abatement capital/output ratio at full capacity, for each sector i):

Data: Capital Stocks Database 1985, Office of Business Analysis, USDC, Washington D.C.
Unpublished Data, Office of Economic Growth and Projections, B.L.S., Washington D.C.

Procedure: The OBA pollution abatement gross capital stocks for plant and equipment data and the BLS data was resectored to 28 Alaska regional industries using a LOTUS conversion program. Nonmanufacturing pollution abatement data is not available on the OBA tapes.

Pollution abatement capital for nonmanufacturing was estimated by using data from two Survey of Current Business articles: "Plant and Equipment Expenditures by Business for Pollution Abatement, 1981 and Planned 1982", June 1982; "Plant and Equipment Expenditures by Business for Pollution Abatement, 1973-80 and Planned 1981", June 1981.

The percent of pollution abatement capital stock to private capital stock was derived for nonmanufacturing. This percentage was then applied to U.S. pollution abatement gross stocks data for nonmanufacturing for the period 1979 to 1982. The result was a pollution capital estimate for the missing nonmanufacturing sectors.

Using the period 1979 to 1982, total pollution abatement capital stocks were divided by U.S. output for each year. The lowest value was selected for each industry, representing full capacity pollution abatement capital/output. The U.S. ratio was applied to the Alaska subregions.

Identity: $CAPPAR_i$ =U.S. Pollution Abatement Gross $Stocks_i/USGO_i$

<u>3.11 $DEPRPR_i$</u> (Depreciation rate for production capital, expressed as a fraction of gross output, for each sector i):

Data: U.S. Capital Stocks Database 1985, Office of Business Analysis, USDC, Washington D.C.
U.S. Output Data, Office of Economic Growth and Projections, B.L.S., Washington D.C.

Procedure: Data from the period 1979 to 1982 was used. Private capital replacement investment was divided by U.S. gross output lagged one period. The average for the period for each industry was calculated. The average depreciation rate formed the capital depreciation parameter.

Identity: $DEPRPR_i$=Replacement $Investment_{i\ (t)}$ / $USGO_{i(t-1)}$

3.12 $DEPRPA_i$ (Depreciation rate for pollution-abatement capital, expressed as a fraction of the product of gross output and the ratio $PACAP_i/PRCAP_i$, for each sector i):

Data: U.S. Capital Stocks Database, Office of Business Analysis, USDC, Washington D.C.
U.S. Output Data, Office of Economic Growth and Projections, B.L.S., Washington D.C.

Procedure: The OBA replacement investment in plant and equipment for pollution abatement, data was resectored to 28 Alaska regional industries using a LOTUS conversion program.

One problem with the capital stocks data is that nonmanufacturing pollution abatement data is not available on the OBA tapes. To counter this, pollution abatement replacement investment for nonmanufacturing was estimated by using data from two Survey of Current Business articles: Plant and Equipment Expenditures by Business for Pollution Abatement, 1981 and Planned 1982, June 1982; Plant and Equipment Expenditures by Business for Pollution Abatement, 1973-80 and Planned 1981, June 1981.

The percent of pollution abatement capital stock to private capital stock was derived for nonmanufacturing from the Survey of Current

Business articles. This percent was then applied to the remaining nonmanufacturing sectors to derive an estimate of Replacement investment.

Replacement investment was then divided by U.S. gross output lagged one period. The average for the period for each industry was calculated. The average depreciation rate formed the pollution abatement depreciation rate parameter.U.S.

3.13 $EINVPR_i$ (Expansion investment in production capital, for each sector i):

Procedure: This variable was initially set to zero.

3.14 $EINVPA_i$ (Expansion investment in pollution-abatement capital, for each sector i):

Procedure: This variable was initially set to zero.

3.15 $RINVPR_i$ (Replacement investment in production capital, for each sector i):

Procedure: This variable was initially set to zero.

3.16 $RINVPA_i$ (Replacement investment in pollution abatement capital, for each sector i):

Procedure: This variable was initially set to zero.

3.17 $PCHCOR_i$ (Annual rate of change in $CAPPRR_i$):

Procedure: This parameter is not currently used and was set to zero.

3.18 $INVLMA_i$ (Liquidity preference --that is, investment limit for accumulated net business income [retained earnings], expressed as the fraction reinvested, for each sector i):

Procedure: The value for this parameter, prior to calibration, was set to 0.5 for all sectors.

3.19 $INVLMC_i$ (Investment leverage ratio) This represents the investment limit for current net business income, expressed as a multiple of net business income, for each sector i):

Procedure: The pre-calibration value for this coefficient was set to 12.0.

Note: $INVLMA_i$ and $INVLMC_i$ are used to determine the maximum capital available for investment, as follows:

$$(\text{Maximum capital investment})_{i,t} = [(NBUSINC_{i,t} * INVLMA_i] + (ACNETBI_{i,t} * INVLMC_i).$$

$NBUSINC_{i,t}$ (which does not appear in the database) is simulated net (that is, after-tax) business income plus depreciation from year t. $ACNETBI_{i,t}$ is accumulated net business income over time (that is, retained earnings). $ACNETBI_{i,t}$ can become negative to account for debt incurred for capital expenditures.

Final Demand Module

Data Sources and Derivation Methods:

4.1 $USGO_i$ (U.S. gross output for each industrial sector i):

Data: Unpublished data, Office of Economic Growth and Projections, B.L.S., Washington D.C. Data set 5: WBRBJFQ.HIST DATA.

Procedure: 155 sector tabulation was converted to 28 Alaska regional sectoring. USGO for sector NIS (administrative government) was obtained separately. By IPASS convention, gross output for sector NIS is equated to sector-NIS earnings. Government earnings were obtained from unpublished REIS data.

4.2 $REGMKS_i$ (Regional market share for each sector i):

Data: Exports from Alaska regional I/O. $USGO_i$.

Procedure: Alaska regional exports were divided by national gross output (USGO).

Identity: $REGMKS_i = EXPORT_i / USGO_i$.

4.3 $EXPORT_i$ (Exports from the study region, including final purchases by all firms, tourists and other entities not residing within the study region, for each sector i):

Data: Alaska regional I/O model

<u>4.4 EXPORTT</u> (Total exports for all sectors):

Procedure: Sum of the vector, $EXPORT_i$.

<u>4.5 $BINCH_i$</u> (Business inventory change for each sector i):

Data: Alaska regional I/O model.

Procedure: Sum the vector of business inventory change, BINCH.

<u>4.7 PCE_i</u> (Personal consumption expenditure for output of each sector i):

Data: This variable was directly obtained from the personal consumption expenditure (PCE or household) column of the Alaska regional I/O table.

<u>4.8 PCESUBT</u> (Total personal consumption expenditure for outputs of industries in the region):

Procedure: This variable is the sum of PCE_i for sectors 1 to NIS. (See also PCET)

<u>4.9 PCET</u> (Total personal consumption expenditure, base year):

Procedure: This variable was obtained from the PCE column of the transactions table and includes consumption of imports and other primary inputs which are not included in PCESUBT.

Identity: PCET = PITM1 + PIDITR + PCER

$\underline{\text{4.10 PCETM1}}$ (Total personal consumption expenditure for the year before the base or current year):

Procedure: This variable may be approximated by the value of PCET.

Indentity: PCETM1=0.97 * PCET

$\underline{\text{4.11 FGOVE}_i}$ (Federal government purchases from regional industry i):

Data: This variable was obtained from the federal government expenditures column of the Alaska regional I/O table.

$\underline{\text{4.12 FGOVET}}$ (Total federal government purchases from regional industries):

Procedure: Sum FGOVEi for all sectors.

$\underline{\text{4.13 SGOVE}_i}$ (State and local government purchases from regional industry i):

Data: Obtained from Alaska regional I/O .

$\underline{\text{4.14 SGOVET}}$ (Total state and local government purchases from regional industries)

Procedure: This variable is the sum of SGOVEi for all sectors.

$\underline{\text{4.15 GPCF}_i}$ (Gross private capital formation; that is, the amount of each sector's output which is purchased as investment capital by other industries in the region):

Data: This was obtained from the gross private capital formation column of the Alaska regional I/O table.

4.16 GPCFT (Total gross private capital formation, all sectors):

Procedure: This variable is the sum of GPCFi for all sectors.

4.17 FD_i (Final demand for each sector i):

Procedure: This variable is the sum of all final demand vectors ($BINCH_i$, $EXPORT_i$, PCE_i, $FGOVE_i$, $SGOVE_i$, and $GPCF_i$) for each sector.

4.18 FDT (Total final demand, all sectors)

Data: FD_i

Procedure: This variable is the sum of FD_i for all sectors.

4.19 GROWTHRi,v (Annual growth rate for USGO, for each sector i, for time intervals (v) 1970-79, 80-84, 85-90, and 1990+):

Data: Same as $USGO_i$.

Procedure: The rate of growth for four time periods was estimated based on the formula:

Identity: $A_{t+n} = A_t (1 + rog)^n$, where rog = rate of growth.

time periods: 1970-79; 80-84; 85-90; 90 +

4.20 REGMKSR$_i$ (Annual rate of change in REGMKS, for each sector i):

Data: BEA Regional Projections, State Projections to 2035. U.S. Department of Commerce, Bureau of Economic Analysis.

Procedure: U.S. and Alaska regional employment data was obtained from BEA. The rate of change in employment was calculated for both the U.S. and Alaska for periods: 1973-1978; 1978-1983; 1983-1990; 1990-1995; 1995-2035. There is a slight disclosure problem in the Alaska OBERS data base. The missing sectors were estimated using REIS data.

The rate of change of regional market share for Alaska's regions was derived by subtracting the rate of change in employment in the U.S. from the rate of change in employment in the Alaska regions.

Identity: Rate of Change Employment Alaska - Rate of Change of Employment in the U.S. (for each period)

4.21 BINCHR$_i$ (Ratio of change in business inventory to change in gross output for each industrial sector i):

Data: Unpublished data, Office of Economic Growth and Projections, BLS, USDC, Washington D.C. Row 227 of the final demand matrix of the (change in business inventory) was converted to Alaska regional 28 industries (1982) Data set 5:FDK1977.HISTDATA.

Procedure: The business inventory change data was resectored to 28 regional Alaska industries. The parameter was then created by dividing business inventory change by Alaska regional output.

Identity: $BINCHR_i = BINCH_i / (X_{i,t} - X_{i,t-1})$.

4.22 PIDITR (Ratio of disposable income to personal income):

Data: From Survey of Current Business (January 1985 and 1987, p. S1)

Procedure: Average for the years 82-85.

4.23 PCER (Ratio of personal comsumption expenditure to disposable income):

Data: From Survey of Current Business (January 1985 and 1987, p.S1).

Procedure Average for the years 1982-85.

4.24 $ELASIN_i$ (Income elasticity of demand for each sector i):

Data: Obtained from Alaska regional I/O.

Procedure: The personal expenditure data was resectored to 28 regional Alaska industries. The data was then normalized by dividing personal consumption expenditure by the number of households in each income class.

The income elasticity of demand was created by dividing the percent change in per capita expenditure for each industry by the percent change between the average income of each income class. The average income for the three classes, low, medium and high is $5,500, $20,306 and $40,000 respectively.

Identity: $((PCE_{iM} - PCE_{iL}) / (PCE_{iM} + PCE_{iL}) / 2)$
$/((AVE\ INC_{iM} - AVE\ INC_{iL}) / (AVE\ INC_{iM} +$
$AVE\ INC_{iL}) / 2)$

The same identity was calculated for medium income to high income class. The average between low to medium and medium to high was used for the final IPASS parameter.

4.25 INVMATk,i (Investment matrix, representing the fraction of sector k capital purchases supplied by capital goods producing sector i):

Data: The basic data source for the investment matrix is the U.S. investment matrix which is prepared either by the BLS or by the BEA. The BLS Growth Model has a series of matrices. The "FD" matrix(156*241) is the final demand "bridge" table which shows detailed purchases for 241 expenditures. Columns 83-226 of this matrix is PDE and construction vector which is included in the "use" matrix, i.e., an investment matrix. The BEA investment matrix has 77 sectors, capital-goods purchasing industries, and either 155 or 43 rows, capital goods producing industries (depending on which version is used.)

Procedure: A three step procedure was used as follows:

The first step was to get the fraction of each purchasing sector from the column total. Thus, each row of the new matrix has the column total of one.

The second step was to adjust the new matrix to reflect the capital-goods-producing industries in the region by eleminating thoes rows which do not produce in the region. This can be accomplished by multiplying each row by the appropriate location quotient(LQ) subject to the constraint that LQ<=1.

Step three required the resectoring of the result

in step two to adapt the table to Alaska which in this case is a matrix of 74 by 74.

NOTE: The BEA investment matrix of 1977 and LQ of 1977 of each study region were used.

The Production and Regional Output Modules

The only database item introduced in the production module is the Leontief matrix, also called the $(I-A)^{-1}$ or inverse matrix. This matrix is derived mathematically from the Alaska regional I/O

To best approximate the interindustry transaction matrix and final demand vectors, IMPLAN data were modified (e.g., Alaska regional industry-specific data series for gross output and primary inputs were introduced). A staff person from the Alaska Department of Labor, Research and Analysis Section, participated in the project. This person provided access to nondisclosable earnings and employment data for the 4-digit SIC sectoring of the IMPLAN output.

Before reducing the IMPLAN 528-industry tables to 28-industry tables for the IPASS system, disclosable 1982 estimates for output, earnings, and employment were estimated.

The income payments for primary inputs--namely indirect business taxes, proprietorial income, and property income--were adjusted to the new gross output values and IMPLAN ratios. In addition, the final demands were converted from commodity demands to industry demands by multiplying the vectors of final demands by the market share matrix (the make coefficient matrix, where the sum of the column is equal to one (1) as opposed to the absorption matrix where the sum of the row equals one (1)). The I/O model was then rebalanced so that the sum of the industry outlay equaled the sum of output.

The final adjustment involved internalizing truck, water and air transportation activities to reflect the higher transportation costs of doing business in Alaska. One third of IMPLAN exports for truck, water and air transportation was redestributed to Alaska origins.

5.1 LEMAT$_{i,k}$: (The Leontief inverse matrix):

Data: U.S. I/O Transaction matrix.

Procedure: This matrix was derived by inverting the I/O transactions matrix.

The Employment Module

Data Sources and Derivation Methods

6.1 $EMPLOY_i$ (employment for each sector i):

Data: A staff person from the Alaska Department of Labor Research and Analysis Section participated in the project, providing access to non-disclosable earnings and employment data for four-digit SIC code sectoring.

Primary ES-202 data (covered employment data) from the Alaska Department of Labor does not include the commercial fish harvesting and agricultural sectors. Alaska Department of Labor provided, however, unpublished employment data. Earnings were then calculated by assuming that the average crewman worked 4.2 months and earned an average of $9,000. This equated to an annual amount of approximately $214 million. Output for the agricultural sectors (Alaska regional I/O sectors 1-23) was from U.S. Census of Agriculture for Alaska. Earnings and employment estimates were derived using Alaska regional I/O earnings and employment to output ratios.

6.2 EMPLOYT (Total employment for all sectors):

Procedure: This variable is the sum of the $EMPLOY_i$ vector.

6.3 $OUTPWK_i$ (Annual output per worker for each sector i):

Data: Output(X_i) is from the Alaska regional I/O model, and employment is $EMPLOY_i$.

Procedure: The first step was to put the output data in dollars by multiplying by one thousand, then divide output by employment.

Identity: $OUTPWK_i = X_i * 1000 / EMPLOY_i$

<u>6.4 HRWPW</u>$_i$ (Hours worked per week per worker for each sector i):

Data: ES202 data, Alaska Economic Trends, Alaska Department of Labor.

Procedure: The hours worked per week data was disaggregated to 28 regional Alaska industries.

<u>6.5 WKWPY</u>$_i$ (Weeks worked per year per worker for each sector i):

Data: Assumed 52 weeks per year.

<u>6.6 HRWPY</u>$_i$ (Hours worked per year per worker for each sector i):

Data: Hours worked per week-HWRPW, weeks worked per year-WKWPY.

Procedure: Multiply hours worked per week by weeks worked per year.

Identity: $HRWPY_i = HWRPW_i * WKWPY_i$

<u>6.7 OUTPHW</u>$_i$ (Gross output per hour worked, for each sector i):

Data: Output per worker data is from OUTPWK. Hours worked per year data is from HRWPY.

Procedure: Divide output per worker by hours worked per year.

Identity: $OUTPHW_i = OUTPWK_i / HRWPY_i$

6.8 SGEMP (State and local administrative-government employment):

Data: This data was provided by the Alaska Department of Labor Research and Analysis Section.

6.9 FCEMP (Federal civilian administrative-government employment):

Data: This data was provided by the Alaska Department of Labor Research and Analysis Section.

6.10 FMEMP (Federal military, that is, non-civilian, employment):

Data: Estimates for military employment were obtained from unpublished REIS data.

6.11 OUTPHWRi,v(Annual rate of change in $OUTPHW_i$):

Data: Unpublished Data, Office of Economic Growth and and Projections, B.L.S., Washington D.C.

Procedure: Output per hour worked was derived for several time periods. The standard rate of change equation was applied to the data.

<u>6.12 $HRWPWR_i$</u> (Annual rate of change in HRWPWi):

Data: This parameter was set equal to zero.

<u>6.13 $WKWPYR_i$</u> (Annual rate of change in $WKWPY_i$):

Data: This parameter was set to zero.

<u>6.14 RSGEMP</u> (Annual rate of change in SGEMP)

Procedure: In IPASS, state and local government employment (SGEMP) changes in proportion to total personal consumption expenditure. RSGEMP is initially set equal to zero.

<u>6.15 RFCEMP</u> (Annual rate of change in FCEMP):

Procedure: IPASS projects change in Federal civilian employment (FCEMP) in proportion to change in regional population. RFCEMP is initially set equal to zero.

The Labor Force Module

The Labor Force module's chief function is to model the interaction between the demand for, and the supply of, available workers by occupational category. In so doing, it serves as a bridge between the Employment and Population modules.

Data Sources and Derivation Methods

7.1 $LFPARF_g$ (Female labor force participation rates for 12 age groups, subscripted "g"):

Data: Census of Population, 1980. Detailed Population Characteristics, Alaska, and General Population Characteristics, Alaska, U. S. Department of Commerce, Bureau of Census, Washington D.C.

Procedure: Male population and labor force by age group was regrouped into 12 Alaska IPASS age classes as follows: 0 -13, 14 - 15, 16 - 17, 18 - 19, 20 - 24, 25 - 29, 30 - 34, 35 - 44, 45 - 54, 55 - 59, 60 - 64, and 65+. The labor force participation rate, then, was estimated for each of the age group as a ratio of labor force over population.

Identity: LFPARM = LFM / POPM for each age group.

7.2 $LFPARM_g$ (Male labor force participation rates):

Data: Census of Population, 1980. Detailed Population Characteristics, Alaska, and General Population Characteristics, Alaska, U. S. Department of Commerce, Bureau of Census, Washington D.C.

Procedure: Male population and labor force by age group was regrouped into 12 Alaska IPASS age classes as follows: 0 -13, 14 - 15, 16 - 17, 18 - 19, 20 - 24, 25 - 29, 30 - 34, 35 - 44, 45 - 54, 55 - 59, 60 - 64, and 65+. The labor force participation rate, then, was estimated for each of the age group as a ratio of labor force over population.

Identity: LFPARM = LFM / POPM for each age group.

7.3 $LBFAGEG_g$ (Number in labor force by age group g, as defined for $LFPARM/F_g$ above):

Procedure: $LBFAGE_N$ = summation of {i=1 through number in age class} [$LFPARM_N$*$POPM_n$+$LFPARF_n$*$POPF_n$]

where, $LBFAGEG_n$ is the number of persons male and female who make up the labor force by age class n.

7.4 LBFT (Total number of persons in the labor force):

Data: $LBFAGE_n$

Procedure: LBFT = summation of {n=1 though 12} $LBFAGE_n$

7.5 $LBFOCUR_j$ (Fraction of total labor force represented by each occupation j):

Data: Census of Population, 1980. Detailed Population Characteristics, Alaska, and General Population Characteristics, Alaska, U. S. Department of Commerce, Bureau of Census, Washington D.C.

Identity: $LBFOCUR_j$ = $LBFOCU_j$ / LBFT.

7.6 $EMPLOYS_j$ (Employment supplied, by occupation j):

Identity: $EMPLOYS_j$ + (Regional labor force, by occupational group j) + ($COMIN_j$ - $COMOUT_j$).

<u>7.7 EMPLOYD</u>$_j$ (Employment demanded, by occupation j):

Data: $EMPLOY_i$ and $OCCU_{i,j}$, the industry by occupational matrix--i.e., the proportion of occpation j required by each sector i.

Procedure: Calculation based on current employment by industry and the occupational matrix ($OCUP_{ij}$, 7.18 below).

Identity: $EMPLOYD_j$ = summation (i=1 to nis) of $EMPWFD_i$* $OCUP_{i,j}$,

where,

$EMPWFD_1$ = (X_1 * 1000) / $OUTPWK_1$,

<u>7.8 UNEMP</u>$_j$ (unemployment by occupation j):

Data: Census of Population, 1980. Detailed Population Characteristics, Alaska, and General Population Characteristics, Alaska, U. S. Department of Commerce, Bureau of Census, Washington D.C.

Procedure: Occupational distribution of unemployed persons was calculated (at the state level) from 1980 Census data. To do this, data in Table 219 ("Detailed Occupation of Employed Persons...") was subtracted from the figures in Table 218 ("Detailed Occupation of the Experienced Labor Force...").

<u>7.9 UNEMPT</u> (Total regional unemployment):

Data: $UNEMP_i$

Procedure: This variable is the sum of the $UNEMP_j$ vector.

7.10 $COMIN_j$ (Number of incommuters by occupation j):

Data: Assumed to be zero for Alaska.

7.11 $COMOUT_j$ (Number of outcommuters by occupation j):

Data: Assumed to be zero for Alaska.

7.12 $COMINR_j$ (Fraction of otherwise-vacant jobs filled by incommuters, by occupation j):

Data: Assumed to be zero for Alaska.

7.13 $COMOUTR_j$ (and those otherwise unemployed who commute to jobs outside the region, by occupation j)

Data: Assumed to be zero for Alaska.

7.14 $INMIGOC_j$ (Number of inmigrants by occupation j):

Data: Set equal to zero for the base year and adjusted when calibrating the model.

7.15 $OTMIGOC_j$ (Number of outmigrants by occupation j):

Data: Set to zero for the base year and adjusted during calibration.

7.16 $LFPARFR_{g,v}$ (Annual rate of change in $LFPARF_g$ during time intervals (v) 1970-80, 81-85, 86-90, and 1990+) and 1990+):

Data: Data for 1985 and 1990 obtained from BLS Bulletin #2030.

Procedure: U.S. rates from 1980 Census was used to break down broad age classes in the BLS projections.

7.17 LFPARMR$_{g,v}$ (Annual rate of change in LFPARM$_g$):

Data: Data source same as for 7.16.

7.18 OCUP$_{i,j}$ (Industry-occupation matrix; i.e., the fraction of employment for each industry i supplied by members of occupation j):

Data: Census of Population, 1980. Detailed Population Characteristics, Alaska, and General Population Characteristics, Alaska, U. S. Department of Commerce, Bureau of Census, Washington D.C.

Procedure: For the regional models, census occupation profile has been aggregated to eight IPASS occupation categories as: Managerial, Professional, Technician, Service, Operatives, Clerical, sales, and Farm, the occupational categories were delineated by the 28 regional Alaska industrial sectors. In the final step each row entry was divided by the row total.

7.19 RCOMINR (Annual rate of change in COMINR$_j$) and

7.20 RCOMOTR Annual rate of change in COMOTR$_j$):

Data: These rates of change may be set to zero in the absence of judgmental estimates, and adjusted during model calibration.

7.21 INMIGR$_j$ (Fraction of any unfilled jobs (net of those filled by incommuters) which will be filled by inmigrants during the coming year, by occupation j):

Data: Initially set at 1.0 and then adjusted during calibration of the model.

7.22 $OTMIGR_j$ (Fraction of any unemployed workers (net of those who out-commute) migrating out of the region during the coming year, by occupation j):

Data: Initially set at .10 and then adjusted during the calibration of the model.

Population

Data Sources and Derivation Methods

8.1 $POPM_a$ (Male population, subdivided into 66 one-year age classes (age 0-1, 1-2,...,64-65 and 65+):

Data: Table 2.3, Alaska Population Projections, Alaska Department of Labor, October 1986.

Procedure: The population data by age and gender is available from the above mentioned publication for age class of under one to 85 and over. The male population was subdivided into 66-one year age class (age 0-1, 1-2, ...65+)

8.2 $POPF_a$ (Female population, subdivided as is $POPM_a$):

Data: Table 2.3, Alaska Population Projection, Alaska Department of Labor, October 1986.

Procedure: The population data by age and gender is available from the above mentioned publication for age class of under one to 85 and over. The female population was subdivided into 66-one year age class (age 0-1, 1-2, ...65+)

8.3 POPMT (Total male population):

Data: $POPM_a$.

Procedure: Sum $POPM_a$ for all ages.

8.4 POPFT (Total female population):

Data: $POPF_a$.

Procedure: Sum $POPF_a$ for all ages.

8.5 POPT (Total population, base or current year):

Data: POPMT and POPFT.

Procedure: Sum POPMT and POPFT.

8.6 POPTM1 (Total population for the year before the base or current year):

Data: Alaska Population Projections and Alaska Population Overview, Alaska Department of Labor (1986).

Procedure: The total population (male + female), 1981.

8.7 $FERTILY_a$ (Fertility rate in births per thousand females, by 66 one-year age classes):

Data: Unpublished Data, Department of Health and Social Services, Division of Planning, State of Alaska 1982
Alaska Population projections, Alaska Department of Labor.

Procedure: The data is already in 1982 births per thousand women by one year age class.

8.8NMIGDISa,s (Age-sex distribution of any net in-migrants from the rest of the nation and world):

Data: Migration Between State Economic Areas, Bureau of the Census, United States (1970). The data is from the 1970 census, and is based on persons changing their place of residence between 1965 and 1970.
Gross Migration for Counties, 1975 to 1980, Bureau of the Census, Department of Commerce.

Procedure: The 1970 data is available for in and out migration by males and females for five year age classes. Data is also available for total in and out migration for 1980 by age class; however, the data source does not break down migration between males and females.

Since the 1980 migration data did not include a breakdown by sex, we had to estimate migration based on 1980 numbers, and 1970 distributions. The 1970 data was used to create a distribution between male and female migrants by age class. The distribution was created for each age class by dividing male and female in-migration the total male and female in-migrants. From the age/sex distribution, a differential was calculated between males and females for 1970.

The next step was to obtain an estimate of 1980 migration patterns. The same distribution procedure was applied to the 1980 migration data to create total migration distribution by age. The 1970 differential between male and female in-migrants was then applied to the 1980 total migration distribution data. The result is a breakdown of in-migration to Alaska by age and sex class for 1980.

8.9 RMIGDISa,s (Age/sex distribution of net out-migrants from the rest of the nation and world):

Data: Migration Between State Economic Areas, Bureau of the Census United States (1970). The data from the 1970 census gives the migration classified by age and five year age classes, and is based on persons changing their place of residence between 1965 and 1970. Data is also available for total in and out migration for 1980 by age class; the data source, however, does not classify migration by sex (Gross Migration for Counties, 1975 to 1980, Bureau of the Census, Department of Commerce).

Procedure: Since the 1980 migration data is not classified by sex, estimates were derived from 1980 gross totals by age and 1970 distributions by age and sex. That is, the 1970 data were used to distribute 1980 total migration distribution by sex and age classes. Ratios representing the age-class distributions for 1970 were created by dividing each age class by the total for male and female inmigrants forming an age/sex distribution. The differential between male and female migration distribution was then calculated.

The 1980 outmigration distribution by age was formed by dividing each column entry by the column total. The 1970 differential between male and female outmigrant distribution was applied to the 1980 total migration distribution by age to form a 1980 migration distribution by age and sex. The 1980 migration distribution by five year age-class was then disaggregated into 66 one year age classes.

<u>8.10 NEMDEPR</u> (National employee dependent rate, that is, the average population per member of the U.S. labor force of age 20 or greater):

Data: Current Population Report 1980, Census of Population, Bureau of the Census, Washington D.C.

Procedure: Total U.S. population was divided by total U.S. labor force of age 20 and over.

Identity: U.S. population/Labor force of age 20+.

8.11 REMDEPR (Regional employee dependent rate):

Data: Current Population Report 1980, Census of Population, Bureau of the Census, Washington D.C. Alaska regional Population Projection, Alaska department of Labor.

Procedure: Total Alaska population was divided by total AK labor force of age 20 and over.

Identity: AK population/Labor force of age 20+.

8.12 $INMIGM_a$ (The number of male inmigrants by one year age class.):

Data: The variable was initially set to 0.

8.13 $INMIGF_a$ (The number of female inmigrants by one year age class.):

Data: The variable was initially set to 0.

8.14 $OUTMIGM_a$ (Number of outmigrating males, by one-year age class)

Data: The variable was initially set to 0.

8.15 $OUTMIGF_a$ (number of outmigrating females):

Data: The variable was initially set to 0.

8.16 ACFERTYa,v (Annual rate of change in the fertility rate ($FERTILY_a$) by one-year age class over time intervals):

Data: Alaska Population Projections Table 1.3, Alaska Department of Labor, Alaska.

Procedure: Data is available for 1970 to 2000 by year and by five year age classes. The time periods for the parameter are 1970-79, 1980-84, 1985-89, 1990-95 and 1995+. The parameter was created by the five year age class and the standard rate of change equation for the two years in each time period. The age classes are 0-66, with 0 being less than one year and 66 being 65 years and over.

Identity:

$$ACFERTY_a = \left(\left(FERTILY_a(t1)/FERTILY_a(to)\right)^{(1/(t1-to))}\right)-1$$

8.17 MFBIRTR (Ratio of male births to total births):

Data: Unpublished data, Department of Health and Social Services, Division of Planning, State of Alaska 1982
Alaska Population projections, Alaska Department of Labor.

Procedure: Male births for Alaska was divided by total Alaska births.

Identity: MFBIRTR = Male births / total births.

8.18 $DEATHRM_a$ (Male death rates, per-capita, by one-year age class)

Data: Unpublished data, Department of Health and Social Services, Division of Planning, State of Alaska 1982

Alaska Population projections, Alaska Department of Labor.

Procedure: Overall deaths for male and female for 1982 were obtained from the Vital Statistics publication. The data was available in ten year age classes. Population data came from the Alaska regional population projections and was available by one year age class for 1982.

The number of deaths were divided by the total number of people in each age class. The result was a per capita death rate for each ten year age class (age class less than one year and one to four years were seperate from the ten year break down). The death rate was disaggregated to one year age classes based on the ten year figure. The age classes in the data set are 0 to 66 with 66 being 65 years and over and 0 being less than one year.

Identity: $\text{DEATHRM}_a = \text{Male Deaths}_a / \text{Male Population}_a$

<u>8.19 DEATHRF</u>$_a$ (Female death rate by one year age class):

Data: Unpublished data, Department of Health and Social Services, Division of Planning, State of Alaska 1982
Alaska regional Population projections, Alaska Department of Labor.

Procedure: Overall deaths for male and female for 1982 were obtained from the Vital Statistics publication. The data was available in ten year age classes.

Population data came from the Alaska regional population projections and was available by one year age class for 1982.

The number of deaths were divided by the total number of people in each age class. The result was a per capita death rate for each ten year age class (age class less than one year and one to four years were seperate from the ten year break down). The death rate was disaggregated to one year age classes based on the ten year figure. The age classes in the data set are 0 to 66 with 66 being 65 years and over and 0 being less than one year.

Identity: $DEATHRF_a$ = Female $Deaths_a$ / Female $Population_a$

8.20 NMIGDIRa,s (Annual rate of change in $NMIGDIS_{a,s}$) and

8.21 RMIGDIRa,s (Annual rate of change in $RMIGDIS_{a,s}$):

Procedure: These parameters were set equal to zero and may be adjusted during calibration.

8.22 RNEMDEP (Annual rate of change in NEMDEPR) and

8.23 RREMDEP (Annual rate of change in REMDEPR):

Procedure: These rates of change were set equal to zero and may be adjusted during the calibration.

8.24 $CORTMVM_a$ The proportion of each of the region's male cohorts, by single year age class, which moves in (+) or out (-) of the region for reasons other than job availability (for example, college, retirement, lack of information on job availability, or the region's attractiveness)

and

<u>8.25 $CORTMVF_a$</u> (Same as $CORTMVM_a$ for females):

Procedure: These parameters were set equal to zero and may be adjusted during calibration as needed.

Value Added

Data Sources and Derivation Methods

9.1 $IMPORT_i$ ([Gross] imports from outside the region, by industrial sector i):

Data: This variable may be obtained from the Alaska regional I/O transactions table.

9.2 $BUSTAXR_i$ (Ratio of business income taxes to pre-tax business income, for each sector i):

Data: U.S. Corporate Income Tax Returns, 1977, U.S. Internal Revenue Service.
Alaska General Corporate Net Income Taxes: 1978, 1979, 1980, and 1982, Alaska Department of Revenue.

Procedure: Data was obtained for number of returns, net taxable income, foreign credits and income taxes paid after credit for the United States.

The average net income per return was calculated as well as the average income tax paid after credit (foreign tax credit was added back into taxes paid) for each return. The income tax rate for Alaska regional was applied to the average income per return to get an estimate of Alaska taxes per firm.

Alaska uses a progressive corporate income tax structure that was introduced in 1981. In addition, the state uses apportionment and only taxes the portion of a firm's income that is derived from operations within Alaska, in the case of multi-state or multi-national firm. To approximate the rate structure for Alaska data from the Alaska Department of Revenue was used.

This information included total Alaska net taxable income, and total taxes paid by industry. The Alaska tax rate then was calculated by dividing total taxes paid by sector by total income of firms showing net taxable income for 1982. This information approximates the average tax rates faced by different industries under the apportionment scheme. The data was then disaggregated to 75 Alaska sectors.

The ratio was calculated by dividing total coorporate income taxes paid by total pre-tax income. The ratio that was used for the state was also used for the regions.

Identity: $BUSTAXR_i$ = Total taxes $paid_i$ / Total $income_i$

<u>9.3 ACNETBI</u>$_i$ (Accumulated net business income after taxes, including depreciation allowances, minus funds already leveraged for investment, by industrial sector i):

Procedure: This variable was set equal to zero prior to calibration. (This implicitly assumes that all sectors are at equilibrium with respect to the tradeoff between liquid and fixed assets. This assumption could be relaxed during calibration).

<u>9.4 EARN</u>$_i$ (Employee earnings, by sector i):

Data: This variable comes from the primary earnings data base provided by the Alaska Department of Labor.

<u>9.5 EARNT</u> (Total employee wage and salary earnings):

Procedure: Sum $EARN_i$ for all sectors.

9.6 $EARPWK_i$ (Average earnings per worker, by sector i):

Data: Earnings and Employment data provided by Alaska Department of Labor.

Procedure: Divide total earnings by total employment. Units in dollars.

Identity: $EARPWK_i = (EARN_i * 1000) / EMPLOY_i$

9.7 $NBUSINC_i$ (Current net business income after taxes, including depreciation allowances, by industrial sector i):

Procedure: This variable is set equal to zero.

9.8 $VALADR_i$ (Value-added/Output ratio, by sector i)

Data: This variable is derived from the total value-added row of the Alaska regional I/O table:

Procedure: Divide value added by output for each sector i.

Identity: $VALADR_i = (\text{Total Value-Added})_i / X_i$.

9.9 $REGIMPR_i$ (Ratio of regional imports to gross output, by sector i):

Data: This variable is derived from the imports-to-region ($IMPORT_i$) row of the I/O table:

Procedure: Divide regional imports by output for each sector i.

Identity: $REGIMPR_i = IMPORT_i / X_i$.

<u>9.10 $IBTR_i$</u>	(Ratio of indirect business taxes to gross output, by sector i):
Data:	This variable is derived from the "indirect business taxes" row of the I/O table:
Procedure:	Divide indirect business taxes by regional gross output.
Identity:	$IBTR_i$ = (Indirect Business Taxes)$_i$/X_i.
Note:	Corporate returns in dollars tax paid includes both state and federal taxes
<u>9.11 $PCHITR_i$</u>	(Annual rate of change in BUSTAXRi):
Procedure:	This variable was set equal to zero.
<u>9.12 $EARPWKR_i$</u>	(Annual rate of change in earnings per worker, including sector NIS):
Data:	BEA Regional Projections, State Projections to 2035. U.S. Department of Commerce, Bureau of Economic Analysis.
Procedure:	Alaska Data was obtained from BEA. The rate of change in employment was calculated for Alaska for periods: 1973-1978; 1978-1983; 1983-1990; 1990-1995; 1995-2035. Due to a disclosure problem in the Alaska OBERS data base, estimates for missing sectors were derived from REIS data. Earnings per worker was calculated for each period by dividing earnings*1000 by employment, putting earnings per worker in dollars.

The rate of change in earnings per worker for Alaska was derived by the usual rate of change equation found in the data base manual.

Identity: $EARPWK_i = (EARNINGS_i * 1000) / EMPLOY_i$
Then
$EARPWKR_{t1} = (EARPWK_{t1} / EARPWK_{to})(1/(t1 - to)) - 1$

9.13 PIEARNR (Personal income/earnings ratio):

Data: Both personal income and earnings were obtained from unpublished REIS data.

Procedure: Personal income divided by earnings gives the PIEARNR variable.

9.14 UNCOMPR (Ratio of unemployment compensation payments to earnings):

Procedure: NOT USED.

9.15 TRANPR (Ratio of transfer payments to earnings):

Procedure: NOT USED

9.16 PROPINR (Ratio of proprietors' income to earnings):

Procedure: NOT USED

9.17 PIT (Total personal income for the base year):

Data Obtained from unpublished REIS data for Alaska.

9.18 PITM1 (Total personal income for the year before the base year)

Data Obtained from unpublished REIS data for Alaska.

Database for the Fairbanks model

The following pages give the actual database for 1985 for the Greater Fairbanks model. Only the inverse and capital coefficient matrices are omitted. Variable names are those used in the preceding pages describing the data.

NAMER	NAMER1	IYEAR	NIS	NOC
Fairbanks, Alaska		1985	28	8

	POPM (NO)	POPF (NO)	DEATHRM (RATE)	DEATHRF (RATE)	FERTILY (BIRTH/ 1000 F)	ACFERTY (RATE) 1970-79	ACFERTY (RATE) 1980-84	ACFERTY (RATE) 1985-89	ACFERTY (RATE) 1990+
1	824.1	729.3	0.018666	0.011049	0.000000	0.000000	0.000000	0.000000	0.000000
2	843.7	741.8	0.001438	0.011049	0.000000	0.000000	0.000000	0.000000	0.000000
3	837.8	730.7	0.003100	0.011049	0.000000	0.000000	0.000000	0.000000	0.000000
4	747.6	705.4	0.003100	0.011049	0.000000	0.000000	0.000000	0.000000	0.000000
5	691.8	664.8	0.003100	0.011049	0.000000	0.000000	0.000000	0.000000	0.000000
6	642.3	631.9	0.003100	0.011049	0.000000	0.000000	0.000000	0.000000	0.000000
7	611.6	590.3	0.003100	0.011049	0.000000	0.000000	0.000000	0.000000	0.000000
8	574.9	550.7	0.003100	0.011049	0.000000	0.000000	0.000000	0.000000	0.000000
9	575.9	528.4	0.003100	0.011049	0.000000	0.000000	0.000000	0.000000	0.000000
10	559.7	506.2	0.001919	0.011049	0.000000	0.000000	0.000000	0.000000	0.000000
11	541.3	484.4	0.001919	0.011049	0.706713	-0.045910	0.000000	-0.015910	-0.014280
12	517.0	477.4	0.001919	0.011049	0.706713	-0.045910	0.000000	-0.015910	-0.014280
13	523.8	487.1	0.002074	0.011049	0.706713	-0.045910	0.000000	-0.015910	-0.014280
14	461.1	428.1	0.002074	0.011049	0.695469	-0.045910	0.000000	-0.015910	-0.014280
15	485.9	453.3	0.002074	0.002433	0.695469	-0.045910	0.000000	-0.015910	-0.014280
16	484.8	461.0	0.002074	0.002433	63.968970	-0.046540	0.007460	-0.000890	-0.002390
17	460.7	433.3	0.002079	0.002433	63.968970	-0.046540	0.007460	-0.000890	-0.002390
18	440.8	413.5	0.002079	0.004618	63.968970	-0.046540	0.007460	-0.000890	-0.002390
19	463.8	412.6	0.001869	0.002227	63.968970	-0.046540	0.007460	-0.000890	-0.002390
20	484.8	411.8	0.001763	0.002109	63.968970	-0.046540	0.007460	-0.000890	-0.002390
21	508.7	437.2	0.002877	0.002109	195.080648	-0.029250	-0.001570	-0.005950	0.000420
22	559.8	460.3	0.001300	0.001703	195.080648	-0.029250	-0.001570	-0.005950	0.000420
23	591.9	485.3	0.001300	0.001703	195.080648	-0.029250	-0.001570	-0.005950	0.000420
24	720.3	560.1	0.001300	0.001703	195.080648	-0.029250	-0.001570	-0.005950	0.000420
25	791.4	597.9	0.004566	0.001703	195.080648	-0.029250	-0.001570	-0.005950	0.000420
26	859.9	651.5	0.002478	0.002808	133.134485	-0.028370	-0.004510	0.004030	0.000480
27	880.1	699.2	0.004956	0.002808	133.134485	-0.028370	-0.004510	0.004030	0.000480
28	885.0	723.4	0.001228	0.002631	133.134485	-0.028370	-0.004510	0.004030	0.000480
29	817.7	730.4	0.001234	0.001336	133.134485	-0.028370	-0.004510	0.004030	0.000480
30	820.7	766.3	0.001219	0.001336	133.134485	-0.028370	-0.004510	0.004030	0.000480
31	827.7	779.6	0.002642	0.001336	94.618534	-0.009520	0.009160	0.029020	0.000050
32	818.1	760.1	0.001321	0.001522	94.618534	-0.009520	0.009160	0.029020	0.000050
33	828.0	756.9	0.001312	0.001538	94.618534	-0.009520	0.009160	0.029020	0.000050
34	764.1	695.0	0.004195	0.001620	94.618534	-0.009520	0.009160	0.029020	0.000050
35	762.0	669.1	0.004043	0.001612	94.618534	-0.009520	0.009160	0.029020	0.000050
36	765.0	662.0	0.004431	0.001805	38.215323	-0.040250	0.040240	0.027320	0.002070
37	710.9	619.0	0.004431	0.002096	38.215323	-0.040250	0.040240	0.027320	0.002070
38	737.8	621.6	0.003787	0.002252	38.215323	-0.040250	0.040240	0.027320	0.002070
39	675.3	555.7	0.001869	0.002288	38.215323	-0.040250	0.040240	0.027320	0.002070
40	564.9	479.2	0.001934	0.002288	38.215323	-0.040250	0.040240	0.027320	0.002070
41	530.1	446.4	0.001934	0.002288	4.466027	-0.054240	-0.017860	-0.011720	-0.001920
42	536.8	439.4	0.002444	0.002288	4.466027	-0.054240	-0.017860	-0.011720	-0.001920
43	514.4	416.6	0.010443	0.002288	4.466027	-0.054240	-0.017860	-0.011720	-0.001920
44	423.4	366.9	0.002865	0.002288	4.466027	-0.054240	-0.017860	-0.011720	-0.001920
45	403.8	341.6	0.012084	0.003636	4.466027	-0.054240	-0.017860	-0.011720	-0.001920
46	378.2	322.7	0.012084	0.003921	0.000000	0.122170	-0.097110	0.000000	0.000000
47	340.4	294.3	0.003484	0.004098	0.000000	0.122170	-0.097110	0.000000	0.000000
48	324.4	273.4	0.007326	0.004255	0.000000	0.122170	-0.097110	0.000000	0.000000
49	294.1	253.5	0.015625	0.004444	0.000000	0.122170	-0.097110	0.000000	0.000000
50	280.3	242.5	0.003968	0.004444	0.000000	0.122170	-0.097110	0.000000	0.000000
51	267.5	233.6	0.004347	0.004444	0.000000	0.000000	0.000000	0.000000	0.000000
52	253.7	221.3	0.004444	0.015228	0.000000	0.000000	0.000000	0.000000	0.000000
53	247.5	215.2	0.012931	0.010204	0.000000	0.000000	0.000000	0.000000	0.000000
54	223.9	190.8	0.013761	0.005494	0.000000	0.000000	0.000000	0.000000	0.000000
55	217.9	194.5	0.009345	0.005847	0.000000	0.000000	0.000000	0.000000	0.000000
56	225.5	194.4	0.010101	0.005847	0.000000	0.000000	0.000000	0.000000	0.000000
57	212.8	179.1	0.005263	0.006329	0.000000	0.000000	0.000000	0.000000	0.000000
58	208.6	168.2	0.010695	0.006410	0.000000	0.000000	0.000000	0.000000	0.000000
59	193.9	160.2	0.005681	0.006711	0.000000	0.000000	0.000000	0.000000	0.000000
60	178.9	155.3	0.043478	0.006711	0.000000	0.000000	0.000000	0.000000	0.000000
61	170.2	150.6	0.043478	0.024000	0.000000	0.000000	0.000000	0.000000	0.000000
62	155.3	141.3	0.036496	0.024000	0.000000	0.000000	0.000000	0.000000	0.000000
63	142.4	127.5	0.041322	0.018348	0.000000	0.000000	0.000000	0.000000	0.000000
64	137.9	117.9	0.019047	0.018348	0.000000	0.000000	0.000000	0.000000	0.000000
65	126.5	115.6	0.019047	0.011494	0.000000	0.000000	0.000000	0.000000	0.000000
66	886.6	905.5	0.071146	0.061146	0.000000	0.000000	0.000000	0.000000	0.000000

POPMT (NO)	POPFT (NO)	POPT (NO)	POPTM1 (NO)	MFBIRTR (RATIO)	NEMDEPR (RATIO)	REMDEPR (RATIO)	RNEMDEP (RATE)	RREMDEP (RATE)
34537.7	30420.3	64957.9	63946.6	0.532442	2.320000	2.120000	0.000000	0.000000

	INMIGM (NO)	INMIGF (NO)	OUTMIGM (NO)	OUTMIGF (NO)	RMIGDIS (RATE)	RMIGDIS (RATE)	RMIGDIR (RATE)	RMIGDIR (RATE)
1	0.6	0.8	1.4	1.6	0.005533	0.006158	0.000000	0.000000

2	0.6	0.8	1.4	1.6	0.005533	0.006158	0.000000	0.000000
3	0.6	0.8	1.4	1.6	0.005533	0.006158	0.000000	0.000000
4	0.6	0.8	1.4	1.6	0.005533	0.006158	0.000000	0.000000
5	0.6	0.8	1.4	1.6	0.005533	0.006158	0.000000	0.000000
6	0.6	0.8	1.4	1.6	0.005533	0.006158	0.000000	0.000000
7	0.6	0.8	1.4	1.6	0.005533	0.006158	0.000000	0.000000
8	0.6	0.8	1.4	1.6	0.005533	0.006158	0.000000	0.000000
9	0.6	0.8	1.4	1.6	0.005533	0.006158	0.000000	0.000000
10	0.6	0.8	1.4	1.6	0.005533	0.006158	0.000000	0.000000
11	1.0	1.2	2.1	2.5	0.008009	0.009891	0.000000	0.000000
12	1.0	1.2	2.1	2.5	0.008009	0.009891	0.000000	0.000000
13	1.0	1.2	2.1	2.5	0.008009	0.009891	0.000000	0.000000
14	1.0	1.2	2.1	2.5	0.008009	0.009891	0.000000	0.000000
15	1.0	1.2	2.1	2.5	0.008009	0.009891	0.000000	0.000000
16	1.1	1.2	2.3	2.7	0.009010	0.010328	0.000000	0.000000
17	1.1	1.2	2.3	2.7	0.009010	0.010328	0.000000	0.000000
18	1.1	1.2	2.3	2.7	0.009010	0.010328	0.000000	0.000000
19	1.1	1.2	2.3	2.7	0.009010	0.010328	0.000000	0.000000
20	1.1	1.2	2.3	2.7	0.009010	0.010328	0.000000	0.000000
21	3.4	1.9	3.2	2.9	0.012330	0.011200	0.000000	0.000000
22	3.4	1.9	3.2	2.9	0.012330	0.011200	0.000000	0.000000
23	3.4	1.9	3.2	2.9	0.012330	0.011200	0.000000	0.000000
24	3.4	1.9	3.2	2.9	0.012330	0.011200	0.000000	0.000000
25	3.4	1.9	3.2	2.9	0.012330	0.011200	0.000000	0.000000
26	2.7	3.0	5.5	3.3	0.021234	0.012994	0.000000	0.000000
27	2.7	3.0	5.5	3.3	0.021234	0.012994	0.000000	0.000000
28	2.7	3.0	5.5	3.3	0.021234	0.012994	0.000000	0.000000
29	2.7	3.0	5.5	3.3	0.021234	0.012994	0.000000	0.000000
30	2.7	3.0	5.5	3.3	0.021234	0.012994	0.000000	0.000000
31	1.9	2.1	3.4	3.1	0.013173	0.012025	0.000000	0.000000
32	1.9	2.1	3.4	3.1	0.013173	0.012025	0.000000	0.000000
33	1.9	2.1	3.4	3.1	0.013173	0.012025	0.000000	0.000000
34	1.9	2.1	3.4	3.1	0.013173	0.012025	0.000000	0.000000
35	1.9	2.1	3.4	3.1	0.013173	0.012025	0.000000	0.000000
36	0.9	0.9	2.1	1.8	0.008062	0.007176	0.000000	0.000000
37	0.9	0.9	2.1	1.8	0.008062	0.007176	0.000000	0.000000
38	0.9	0.9	2.1	1.8	0.008062	0.007176	0.000000	0.000000
39	0.9	0.9	2.1	1.8	0.008062	0.007176	0.000000	0.000000
40	0.9	0.9	2.1	1.8	0.008062	0.007176	0.000000	0.000000
41	0.9	0.9	2.1	1.8	0.008062	0.007176	0.000000	0.000000
42	0.9	0.9	2.1	1.8	0.008062	0.007176	0.000000	0.000000
43	0.9	0.9	2.1	1.8	0.008062	0.007176	0.000000	0.000000
44	0.9	0.9	2.1	1.8	0.008062	0.007176	0.000000	0.000000
45	0.9	0.9	2.1	1.8	0.008062	0.007176	0.000000	0.000000
46	0.3	0.3	1.0	0.8	0.003688	0.003249	0.000000	0.000000
47	0.3	0.3	1.0	0.8	0.003688	0.003249	0.000000	0.000000
48	0.3	0.3	1.0	0.8	0.003688	0.003249	0.000000	0.000000
49	0.3	0.3	1.0	0.8	0.003688	0.003249	0.000000	0.000000
50	0.3	0.3	1.0	0.8	0.003688	0.003249	0.000000	0.000000
51	0.3	0.3	1.0	0.8	0.003688	0.003249	0.000000	0.000000
52	0.3	0.3	1.0	0.8	0.003688	0.003249	0.000000	0.000000
53	0.3	0.3	1.0	0.8	0.003688	0.003249	0.000000	0.000000
54	0.3	0.3	1.0	0.8	0.003688	0.003249	0.000000	0.000000
55	0.3	0.3	1.0	0.8	0.003688	0.003249	0.000000	0.000000
56	0.1	0.2	0.6	0.6	0.002371	0.002473	0.000000	0.000000
57	0.1	0.2	0.6	0.6	0.002371	0.002473	0.000000	0.000000
58	0.1	0.2	0.6	0.6	0.002371	0.002473	0.000000	0.000000
59	0.1	0.2	0.6	0.6	0.002371	0.002473	0.000000	0.000000
60	0.1	0.2	0.6	0.6	0.002371	0.002473	0.000000	0.000000
61	0.1	0.2	0.6	0.6	0.002371	0.002473	0.000000	0.000000
62	0.1	0.2	0.6	0.6	0.002371	0.002473	0.000000	0.000000
63	0.1	0.2	0.6	0.6	0.002371	0.002473	0.000000	0.000000
64	0.1	0.2	0.6	0.6	0.002371	0.002473	0.000000	0.000000
65	0.1	0.2	0.6	0.6	0.002371	0.002473	0.000000	0.000000
66	0.2	0.3	1.6	1.5	0.006165	0.005770	0.000000	0.000000

	NMIGDIS (RATE)	NMIGDIS (RATE)	NMIGDIR (RATE)	NMIGDIR (RATE)	CORTMVM (RATE)	CORTMVF (RATE)
1	0.004322	0.005969	0.000000	0.000000	0.000000	0.000000
2	0.004322	0.005969	0.000000	0.000000	0.000000	0.000000
3	0.004322	0.005969	0.000000	0.000000	0.000000	0.000000
4	0.004322	0.005969	0.000000	0.000000	0.000000	0.000000
5	0.004322	0.005969	0.000000	0.000000	0.000000	0.000000
6	0.004322	0.005969	0.000000	0.000000	0.000000	0.000000
7	0.004322	0.005969	0.000000	0.000000	0.000000	0.000000
8	0.004322	0.005969	0.000000	0.000000	0.000000	0.000000
9	0.004322	0.005969	0.000000	0.000000	0.000000	0.000000
10	0.004322	0.005969	0.000000	0.000000	0.000000	0.000000
11	0.007086	0.008878	0.000000	0.000000	0.000000	0.000000
12	0.007086	0.008878	0.000000	0.000000	0.000000	0.000000
13	0.007086	0.008878	0.000000	0.000000	0.000000	0.000000
14	0.007086	0.008878	0.000000	0.000000	0.000000	0.000000
15	0.007086	0.008878	0.000000	0.000000	0.000000	0.000000
16	0.007890	0.008276	0.000000	0.000000	0.000000	0.000000
17	0.007890	0.008276	0.000000	0.000000	0.000000	0.000000
18	0.007890	0.008276	0.000000	0.000000	0.000000	0.000000
19	0.007890	0.008276	0.000000	0.000000	0.000000	0.000000

20	0.007890	0.008276	0.000000	0.000000	0.000000	0.000000
21	0.024374	0.013943	0.000000	0.000000	0.000000	0.000000
22	0.024374	0.013943	0.000000	0.000000	0.000000	0.000000
23	0.024374	0.013943	0.000000	0.000000	0.000000	0.000000
24	0.024374	0.013943	0.000000	0.000000	0.000000	0.000000
25	0.024374	0.013943	0.000000	0.000000	0.000000	0.000000
26	0.019449	0.021216	0.000000	0.000000	0.000000	0.000000
27	0.019449	0.021216	0.000000	0.000000	0.000000	0.000000
28	0.019449	0.021216	0.000000	0.000000	0.000000	0.000000
29	0.019449	0.021216	0.000000	0.000000	0.000000	0.000000
30	0.019449	0.021216	0.000000	0.000000	0.000000	0.000000
31	0.013469	0.015147	0.000000	0.000000	0.000000	0.000000
32	0.013469	0.015147	0.000000	0.000000	0.000000	0.000000
33	0.013469	0.015147	0.000000	0.000000	0.000000	0.000000
34	0.013469	0.015147	0.000000	0.000000	0.000000	0.000000
35	0.013469	0.015147	0.000000	0.000000	0.000000	0.000000
36	0.006533	0.006420	0.000000	0.000000	0.000000	0.000000
37	0.006533	0.006420	0.000000	0.000000	0.000000	0.000000
38	0.006533	0.006420	0.000000	0.000000	0.000000	0.000000
39	0.006533	0.006420	0.000000	0.000000	0.000000	0.000000
40	0.006533	0.006420	0.000000	0.000000	0.000000	0.000000
41	0.006533	0.006420	0.000000	0.000000	0.000000	0.000000
42	0.006533	0.006420	0.000000	0.000000	0.000000	0.000000
43	0.006533	0.006420	0.000000	0.000000	0.000000	0.000000
44	0.006533	0.006420	0.000000	0.000000	0.000000	0.000000
45	0.006533	0.006420	0.000000	0.000000	0.000000	0.000000
46	0.002010	0.002407	0.000000	0.000000	0.000000	0.000000
47	0.002010	0.002407	0.000000	0.000000	0.000000	0.000000
48	0.002010	0.002407	0.000000	0.000000	0.000000	0.000000
49	0.002010	0.002407	0.000000	0.000000	0.000000	0.000000
50	0.002010	0.002407	0.000000	0.000000	0.000000	0.000000
51	0.002010	0.002407	0.000000	0.000000	0.000000	0.000000
52	0.002010	0.002407	0.000000	0.000000	0.000000	0.000000
53	0.002010	0.002407	0.000000	0.000000	0.000000	0.000000
54	0.002010	0.002407	0.000000	0.000000	0.000000	0.000000
55	0.002010	0.002407	0.000000	0.000000	0.000000	0.000000
56	0.000955	0.001154	0.000000	0.000000	0.000000	0.000000
57	0.000955	0.001154	0.000000	0.000000	0.000000	0.000000
58	0.000955	0.001154	0.000000	0.000000	0.000000	0.000000
59	0.000955	0.001154	0.000000	0.000000	0.000000	0.000000
60	0.000955	0.001154	0.000000	0.000000	0.000000	0.000000
61	0.000955	0.001154	0.000000	0.000000	0.000000	0.000000
62	0.000955	0.001154	0.000000	0.000000	0.000000	0.000000
63	0.000955	0.001154	0.000000	0.000000	0.000000	0.000000
64	0.000955	0.001154	0.000000	0.000000	0.000000	0.000000
65	0.000955	0.001154	0.000000	0.000000	0.000000	0.000000
66	0.001457	0.002207	0.000000	0.000000	0.000000	0.000000

	LFPARM (RATE)	LFPARF (RATE)	LFPARMR (RATE)				LFPARFR (RATE)				LBFAGEG (NO)
			1970-79	1980-84	1985-89	1990+	1970-79	1980-84	1985-89	1990+	
1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.0
2	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.0
3	0.412865	0.413595	0.008000	0.008000	0.005650	0.005650	0.027451	0.027451	0.005650	0.005650	722.4
4	0.690213	0.666883	0.008000	0.008000	0.000547	0.000547	0.021198	0.021198	0.000547	0.000547	1204.5
5	0.885867	0.731793	0.008000	0.008000	0.000000	0.000000	0.023478	0.023478	0.000000	0.000000	4669.4
6	0.931594	0.766584	0.008000	0.008000	0.000000	0.000000	0.034182	0.034182	0.000000	0.000000	6709.1
7	0.950608	0.849602	0.008000	0.008000	-0.000105	-0.000105	0.058574	0.058574	-0.000105	-0.000105	6912.5
8	0.943926	0.843015	0.008000	0.008000	-0.000522	-0.000522	0.051686	0.051686	-0.000522	-0.000522	9705.2
9	0.900246	0.683648	0.008000	0.008000	-0.001743	-0.001743	0.029942	0.029942	-0.001743	-0.001743	4215.1
10	0.773212	0.510299	0.008000	0.008000	-0.005996	-0.005996	0.004611	0.004611	-0.005996	-0.005996	1225.9
11	0.555482	0.358550	0.008000	0.008000	-0.014736	-0.014736	0.000000	0.000000	-0.014736	-0.014736	640.9
12	0.228536	0.148831	0.008000	0.008000	-0.025202	-0.025202	-0.007721	-0.007721	-0.025202	-0.025202	337.4

	LBFOCUR (RATE)	INMIGOC (NO)	OTMIGOC (NO)	COMIN (NO)	COMOUT (NO)	COMINR (RATE)	COMOUTR (RATE)	RCOMINR (RATE)	RCOMOTR (RATE)
1	0.161526	111.1	0.0	0.0	0.0	0.000000	0.000000	0.000000	0.000000
2	0.133426	0.0	3.6	0.0	0.0	0.000000	0.000000	0.000000	0.000000
3	0.054613	13.8	0.0	0.0	0.0	0.000000	0.000000	0.000000	0.000000
4	0.121900	0.0	0.0	0.0	0.0	0.000000	0.000000	0.000000	0.000000
5	0.235407	0.0	62.4	0.0	0.0	0.000000	0.000000	0.000000	0.000000
6	0.218764	150.8	0.0	0.0	0.0	0.000000	0.000000	0.000000	0.000000
7	0.068821	0.0	2.1	0.0	0.0	0.000000	0.000000	0.000000	0.000000
8	0.005541	4.9	0.0	0.0	0.0	0.000000	0.000000	0.000000	0.000000

NOCUP1NOCUP2 123456123456	EMPLOYS (NO)	EMPLOYD (NO)	UNEMP (NO)	INMIGR (RATE)	OTMIGR (RATE)
1 MANA- GERS	5870.2	5629.1	241.2	1.000000	0.120000
2 PROFESSIONAL	4849.0	4382.5	466.5	1.000000	0.120000
3 TECH-NICIAN	1984.8	1879.5	105.3	1.000000	0.120000
4 SER- VICE	4430.1	4153.0	277.2	1.000000	0.120000
5 INDUS TECHS	8555.3	7265.4	1289.9	1.000000	0.120000
6 CLER- ICAL	7950.4	7624.1	326.4	1.000000	0.120000

7	SALES	2501.1	2258.8	242.3	1.000000	0.120000
8	FARM	201.4	194.2	7.1	1.000000	0.120000

INDUSN	X ($1000)	XD ($1000)	XM1 ($1000)	XS ($1000)	XL ($1000)	XHOLD ($1000)
1 Ag,Fs,Fish	6106.727	6106.728	6046.947	9747.175	6106.789	6106.728
2 Mining	158715.264	158715.265	169886.929	330358.411	158715.265	158715.265
3 Oil & Gas	376.638	376.638	394.997	744.015	376.638	376.638
4 Mines(Dum)	0.000	0.000	0.000	0.000	0.000	0.000
5 Mines(Dum)	0.000	0.000	0.000	0.000	0.000	0.000
6 Mines(Dum)	0.000	0.000	0.000	0.000	0.000	0.000
7 Mines(Dum)	0.000	0.000	0.000	0.000	0.000	0.000
8 Mines(Dum)	0.000	0.000	0.000	0.000	0.000	0.000
9 Mines(Dum)	0.000	0.000	0.000	0.000	0.000	0.000
10 Mines(Dum)	0.000	0.000	0.000	0.000	0.000	0.000
11 Mines(Dum)	0.000	0.000	0.000	0.000	0.000	0.000
12 Mines(Dum)	0.000	0.000	0.000	0.000	0.000	0.000
13 New Cons	187330.546	187330.546	182645.407	282995.979	187330.546	187330.546
14 R&M Cons	178004.839	178004.882	147668.293	238491.372	178004.882	178004.882
15 Manufact	101488.397	101488.432	84573.262	113150.118	101488.432	101488.432
16 Rail Trans	1452.392	1452.393	1397.762	2214.376	1452.393	1452.393
17 Lcl Trans	11607.501	11607.504	11417.159	18729.621	11607.504	11607.504
18 Truck Tran	21926.118	21926.145	21172.288	35100.803	21926.364	21926.145
19 Water Tran	2526.708	2526.709	1522.665	4741.629	2526.709	2526.709
20 Air Trans	106176.031	106176.039	98160.355	147020.825	106176.039	106176.039
21 Pipe Trans	0.000	0.000	0.000	0.000	0.000	0.000
22 Comm&Util	197473.002	197473.303	190249.550	429463.995	197473.303	197473.303
23 Trade	283234.335	283236.605	265356.731	364279.950	283233.772	283236.605
24 FIRE	234605.396	234607.281	217696.100	311347.310	234604.935	234607.281
25 Bus Serv	44661.676	44661.815	65017.339	83547.962	44661.815	44661.815
26 Serv (nec)	169603.084	169603.165	162497.870	304154.239	169604.861	169603.165
27 Scrap	0.000	0.000	0.000	0.000	0.000	0.000
28 Admin Govt	523501.083	523506.318	500756.453	523506.318	523501.083	523506.318

	PCE ($1000)	GPCF ($1000)	BINCH ($1000)	EXPORT ($1000)	SGOVE ($1000)	FGOVE ($1000)	FD ($1000)
1	1347.451	4.260	0.000	3893.786	14.694	15.629	5275.780
2	284.546	266.115	0.000	144209.872	0.049	31.108	144791.687
3	0.000	0.002	0.000	256.700	0.000	0.000	256.649
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	0.000	22147.688	0.000	302.899	137928.184	26692.135	187330.546
14	0.000	0.000	0.000	28229.652	70889.408	7074.057	163854.496
15	11582.443	3340.052	0.000	24794.566	2.219	1744.786	72316.070
16	455.723	26.848	0.000	113.236	0.000	49.811	546.534
17	4185.232	4.191	0.000	5793.231	0.004	54.208	10036.870
18	2814.612	328.735	0.000	5330.548	15.990	786.772	4374.358
19	370.167	0.527	0.000	68.677	0.000	81.199	1804.531
20	18253.560	26.207	0.000	65573.272	2597.733	868.408	100019.940
21	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22	2615.616	735.199	0.000	80346.754	6263.899	1870.041	91831.626
23	113861.365	5078.659	0.000	125128.372	32.366	1483.995	245581.961
24	23823.600	43.549	0.000	186591.057	11356.489	272.808	222085.031
25	7711.055	0.148	0.000	22455.437	31.196	1926.557	0.000
26	134001.606	140.224	0.000	141784.836	720.038	4120.998	138973.516
27	0.000	0.000	0.000	0.000	0.000	0.000	0.000
28	0.000	0.000	0.000	0.000	459435.092	64071.227	523506.318

XTOT ($1000)	PCESUBT ($1000)	GPCFT ($1000)	BINCHT ($1000)	EXPORTT ($1000)	SGOVET ($1000)	FGOVET ($1000)	FDT ($1000)
2228789.737	321306.977	32142.404	0.000	758386.299	689287.361	111143.739	1912585.913

	USGO ($1000)	GROWTHR (RATE) 1970-79	GROWTHR (RATE) 1980-84	GROWTHR (RATE) 1985-89	GROWTHR (RATE) 1990-94	GROWTHR (RATE) 1995+	REGMKS (RATE)	REGMKSR (RATE)
1	213136224.8	0.021311	0.004513	0.019044	0.019044	0.017591	0.000018269	0.012000
2	44875369.4	0.019326	-0.008754	0.022557	0.022557	0.020506	0.003213564	0.001993
3	205031916.2	-0.001825	0.002591	0.011608	0.011608	0.011103	0.000001252	0.007489
4	0.0	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000000	0.000000
5	0.0	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000000	0.000000
6	0.0	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000000	0.000000
7	0.0	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000000	0.000000
8	0.0	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000000	0.000000
9	0.0	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000000	0.000000

10	0.0	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000000	0.000000
11	0.0	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000000	0.000000
12	0.0	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000000	0.000000
13	252416167.3	0.014883	0.016680	0.031257	0.031257	0.027334	0.000001200	0.012000
14	99009721.2	0.045544	-0.011928	0.016413	0.016413	0.015344	0.000285120	0.012000
15	2057640307.9	0.033964	0.016588	0.030870	0.030870	0.027043	0.000012050	0.012000
16	28028758.8	0.020354	-0.024445	0.006666	0.006666	0.006527	0.000004040	0.012000
17	12071444.5	0.018523	-0.031179	0.018445	0.018445	0.017070	0.000479912	0.012000
18	74993643.8	0.044595	0.024595	0.033439	0.033439	0.028971	0.000071080	0.012000
19	22082606.6	0.031601	-0.034154	0.011969	0.011969	0.011424	0.000003110	0.012000
20	41504435.0	0.051129	-0.029689	0.032078	0.032078	0.027954	0.001579910	0.012000
21	8485692.2	0.038867	-0.009834	0.020767	0.020767	0.019101	0.000000000	0.000000
22	357594136.5	0.036975	0.004976	0.043968	0.043968	0.036429	0.000224687	0.012000
23	791010518.4	0.038484	0.038166	0.026061	0.026061	0.023319	0.000158188	0.012000
24	725442467.3	0.040722	0.017264	0.041104	0.041104	0.034466	0.000257210	0.012000
25	327100317.5	0.060749	0.069068	0.051960	0.051960	0.041669	0.000068650	0.012000
26	575448823.6	0.035958	0.020320	0.027398	0.027398	0.024369	0.000246390	0.012000
27	0.0	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000000	0.000000
28	0.0	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000000	-0.003860

	ELASIN (RATE)	INVLMA (RATE)	INVLMC (RATE)
1	0.507588	0.500000	12.000000
2	0.229296	0.500000	12.000000
3	0.000000	0.500000	12.000000
4	0.000000	0.500000	12.000000
5	0.000000	0.500000	12.000000
6	0.000000	0.500000	12.000000
7	0.000000	0.500000	12.000000
8	0.000000	0.500000	12.000000
9	0.000000	0.500000	12.000000
10	0.000000	0.500000	12.000000
11	0.000000	0.500000	12.000000
12	0.000000	0.500000	12.000000
13	0.000000	0.500000	12.000000
14	0.000000	0.500000	12.000000
15	0.600946	0.500000	12.000000
16	0.727836	0.500000	12.000000
17	0.758316	0.500000	12.000000
18	0.496176	0.500000	12.000000
19	0.727823	0.500000	12.000000
20	0.750709	0.500000	12.000000
21	0.628243	0.500000	12.000000
22	0.415594	0.500000	12.000000
23	0.654010	0.500000	12.000000
24	0.746729	0.500000	12.000000
25	0.758102	0.500000	12.000000
26	0.620123	0.500000	12.000000
27	0.628243	0.500000	12.000000
28	0.000000	0.000000	0.000000

	EMPLOY (NO)	OUTPWK ($)	OUTPHWR (RATE) 1970-79	OUTPHWR (RATE) 1980-84	OUTPHWR (RATE) 1985-89	OUTPHWR (RATE) 1990-94	1995+
1	73.2	83476.6	0.022970	0.053680	0.024390	0.023580	0.023580
2	1743.6	91029.0	-0.013900	0.051710	0.026360	0.034590	0.034590
3	3.2	119176.2	-0.045840	0.008380	0.008380	0.009250	0.009250
4	0.0	0.0	0.000000	0.000000	0.000000	0.000000	0.000000
5	0.0	0.0	0.000000	0.000000	0.000000	0.000000	0.000000
6	0.0	0.0	0.000000	0.000000	0.000000	0.000000	0.000000
7	0.0	0.0	0.000000	0.000000	0.000000	0.000000	0.000000
8	0.0	0.0	0.000000	0.000000	0.000000	0.000000	0.000000
9	0.0	0.0	0.000000	0.000000	0.000000	0.000000	0.000000
10	0.0	0.0	0.000000	0.000000	0.000000	0.000000	0.000000
11	0.0	0.0	0.000000	0.000000	0.000000	0.000000	0.000000
12	0.0	0.0	0.000000	0.000000	0.000000	0.000000	0.000000
13	882.4	212285.0	-0.022740	0.023430	0.014290	0.015860	0.015860
14	1405.4	126659.3	-0.012220	0.042020	0.017540	0.003690	0.003690
15	614.2	165227.2	0.025190	0.026110	0.022860	0.024320	0.024320
16	11.3	128280.2	0.034700	0.036170	0.036170	0.036970	0.036970
17	180.9	64174.2	0.031790	0.049800	0.014980	0.014680	0.014680
18	337.3	65005.0	0.021690	0.014650	0.021960	0.019300	0.019300
19	8.8	288253.1	0.028930	0.028820	0.011040	0.004650	0.004650
20	720.6	147349.9	0.028060	0.017800	0.018780	0.016570	0.016570
21	0.0	0.0	0.022190	0.022110	0.010860	0.024020	0.024020
22	877.4	225077.4	0.013060	0.015970	0.037630	0.027340	0.027340
23	4802.2	58979.7	0.018520	0.029540	0.012080	0.020120	0.020120
24	1174.9	199674.6	0.009550	0.004110	0.024970	0.026560	0.026560
25	612.3	72939.7	-0.000650	0.007900	0.007900	0.013120	0.013120
26	3581.5	47354.7	0.010560	0.002470	0.010370	0.013570	0.013570
27	0.0	0.0	0.000000	0.000000	0.000000	0.000000	0.000000
28	16357.5	32003.7	0.000000	0.000000	0.000000	0.000000	0.000000

	OUTPHW	HRWPW	HRWPWR	WKWPY	WKWPYR	HRWPY

1	38.221873	42.00	0.000000	52.00	0.000000	2184.00
2	33.991419	51.50	0.000000	52.00	0.000000	2678.00
3	52.325323	43.80	0.000000	52.00	0.000000	2277.60
4	0.000000	51.50	0.000000	52.00	0.000000	2678.00
5	0.000000	51.50	0.000000	52.00	0.000000	2678.00
6	0.000000	51.50	0.000000	52.00	0.000000	2678.00
7	0.000000	51.50	0.000000	52.00	0.000000	2678.00
8	0.000000	51.50	0.000000	52.00	0.000000	2678.00
9	0.000000	51.50	0.000000	52.00	0.000000	2678.00
10	0.000000	51.50	0.000000	52.00	0.000000	2678.00
11	0.000000	51.50	0.000000	52.00	0.000000	2678.00
12	0.000000	51.50	0.000000	52.00	0.000000	2678.00
13	93.205545	43.80	0.000000	52.00	0.000000	2277.60
14	55.610844	43.80	0.000000	52.00	0.000000	2277.60
15	82.317264	38.60	0.000000	52.00	0.000000	2007.20
16	65.262600	37.80	0.000000	52.00	0.000000	1965.60
17	32.648668	37.80	0.000000	52.00	0.000000	1965.60
18	33.071324	37.80	0.000000	52.00	0.000000	1965.60
19	146.648896	37.80	0.000000	52.00	0.000000	1965.60
20	74.964335	37.80	0.000000	52.00	0.000000	1965.60
21	0.000000	37.80	0.000000	52.00	0.000000	1965.60
22	114.508219	37.80	0.000000	52.00	0.000000	1965.60
23	32.686620	34.70	0.000000	52.00	0.000000	1804.40
24	106.960871	35.90	0.000000	52.00	0.000000	1866.80
25	38.963527	36.00	0.000000	52.00	0.000000	1872.00
26	26.019060	35.00	0.000000	52.00	0.000000	1820.00
27	0.000000	40.00	0.000000	52.00	0.000000	2080.00
28	15.386374	40.00	0.000000	52.00	0.000000	2080.00

	EARN ($1000)	EARPWK ($)	EARPWKR (RATE) 1970-79	EARPWKR (RATE) 1980-84	EARPWKR (RATE) 1985-89	EARPWKR (RATE) 1990-94	EARPWKR (RATE) 1995+
1	1131.2	15463.2	0.037300	0.037300	0.000000	0.000000	0.000000
2	46768.9	26823.7	0.013110	0.013110	0.008200	0.019100	0.005970
3	139.6	44184.8	0.026540	0.026540	-0.001080	0.003350	0.006000
4	0.0	0.0	0.000000	0.000000	0.000000	0.000000	0.000000
5	0.0	0.0	0.000000	0.000000	0.000000	0.000000	0.000000
6	0.0	0.0	0.000000	0.000000	0.000000	0.000000	0.000000
7	0.0	0.0	0.000000	0.000000	0.000000	0.000000	0.000000
8	0.0	0.0	0.000000	0.000000	0.000000	0.000000	0.000000
9	0.0	0.0	0.000000	0.000000	0.000000	0.000000	0.000000
10	0.0	0.0	0.000000	0.000000	0.000000	0.000000	0.000000
11	0.0	0.0	0.000000	0.000000	0.000000	0.000000	0.000000
12	0.0	0.0	0.000000	0.000000	0.000000	0.000000	0.000000
13	51569.6	58439.2	0.005830	0.005830	0.008660	0.003480	0.003300
14	65086.3	46312.1	0.005830	0.005830	0.008660	0.003480	0.003300
15	16509.8	26878.6	0.005090	0.005090	0.016730	0.010460	0.009730
16	624.0	55113.0	0.036770	0.036770	0.006670	0.005990	0.005810
17	5311.4	29364.8	-0.007620	-0.007620	0.000570	-0.009550	-0.004550
18	9102.6	26986.8	0.029000	0.029000	-0.010150	-0.008940	-0.003260
19	282.5	32224.0	0.028280	0.028280	0.018950	0.023590	0.009380
20	25621.2	35556.8	0.011530	0.011530	0.023670	0.013310	0.014200
21	0.0	0.0	0.028930	0.028930	0.022510	0.016710	0.011800
22	41098.3	46843.4	0.016130	0.016130	0.017510	0.009460	0.008400
23	117458.1	24459.1	-0.003240	-0.003240	-0.001560	0.000370	0.001780
24	32705.1	27835.6	0.002840	0.002840	0.011300	0.006530	0.005870
25	18350.0	29968.6	0.003570	0.003570	0.012910	0.010410	0.009580
26	75294.6	21022.9	0.025240	0.025240	0.009700	0.006750	0.005130
27	0.0	0.0	0.000000	0.000000	0.000000	0.000000	0.000000
28	560672.7	34276.1	0.027650	0.027650	0.014150	0.011380	0.011150

SGEMP (NO)	FCEMP (NO)	FMEMP (NO)	RSGEMP (RATE)	RFCEMP (RATE)
6452.7	2768.6	6268.0	0.076056	0.000000

PIT ($1000)	PITM1 ($1000)	UNCOMPR ($1000)	TRANPYR (RATE)	PROPINR (RATE)	PIEARNR (RATE)	PCER (RATE)	EARNT ($1000)	PCET ($1000)	PCETM1 ($1000)
1377708.2	1316316.2	0.000000	0.000000	0.000000	1.290320	0.952800	1067726.0	1062013.4	1002104.9

LBFT (NO)	EMPLOYT (NO)	EMPM1T (NO)	UNEMPT (NO)	PIDITR (RATE)
36342.4	33386.7	32344.7	2955.8	0.846775

	VALADR (RATE)	IBTR (RATE)	REGIMPR (RATE)	BUSTAXR (RATE)	PCHITR (RATE)	IMPORT ($1000)	ACNETBI ($1000)	BINCHR (RATE)
1	0.421011	0.016679	0.445246	0.273800	0.000000	2719.0	1657.7	0.000000
2	0.550761	0.059800	0.309688	0.181100	0.000000	49152.2	37177.9	0.000000
3	0.558831	0.000000	0.345759	0.093000	0.000000	130.2	104.5	0.000000

4	0.000000	0.000000	0.000000	0.113000	0.000000	0.0	0.0	0.000000
5	0.000000	0.000000	0.000000	0.113000	0.000000	0.0	0.0	0.000000
6	0.000000	0.000000	0.000000	0.113000	0.000000	0.0	0.0	0.000000
7	0.000000	0.000000	0.000000	0.113000	0.000000	0.0	0.0	0.000000
8	0.000000	0.000000	0.000000	0.113000	0.000000	0.0	0.0	0.000000
9	0.000000	0.000000	0.000000	0.113000	0.000000	0.0	0.0	0.000000
10	0.000000	0.000000	0.000000	0.113000	0.000000	0.0	0.0	0.000000
11	0.000000	0.000000	0.000000	0.113000	0.000000	0.0	0.0	0.000000
12	0.000000	0.000000	0.000000	0.113000	0.000000	0.0	0.0	0.000000
13	0.325274	0.012560	0.428298	0.096200	0.000000	80233.3	8080.0	0.000000
14	0.490206	0.012970	0.374663	0.317200	0.000000	66691.8	23374.1	0.000000
15	0.278967	0.017838	0.591377	0.281500	0.000000	60017.9	11203.1	0.000000
16	0.535909	0.032740	0.213211	0.161200	0.000000	309.7	-168.4	0.000000
17	0.708285	0.061232	0.174715	0.229700	0.000000	2028.0	1602.9	0.000000
18	0.593881	0.024688	0.155299	0.330700	0.000000	3405.1	2232.0	0.000000
19	0.222657	0.009721	0.521044	0.361000	0.000000	1316.5	21.3	0.000000
20	0.312715	0.032588	0.488815	0.168900	0.000000	51900.4	-14189.0	0.000000
21	0.000000	0.000000	0.000000	0.493300	0.000000	0.0	0.0	0.000000
22	0.507647	0.023164	0.450000	0.257000	0.000000	88862.9	83506.4	0.000000
23	0.706810	0.141245	0.173020	0.407000	0.000000	49005.2	47367.4	0.000000
24	0.754610	0.121553	0.170848	0.418100	0.000000	40081.9	171116.8	0.000000
25	0.697741	0.007970	0.202020	0.327700	0.000000	9022.6	26816.1	0.000000
26	0.502004	0.019634	0.357603	0.350400	0.000000	60650.6	2406.8	0.000000
27	0.000000	0.000000	0.000000	0.000000	0.000000	0.0	0.0	0.000000
28	1.000000	0.000000	0.000000	0.000000	0.000000	0.0	0.0	0.000000

	PRCAP ($1000)	CAPPRR (RATE)	EINVPR ($1000)	RINVPR ($1000)	PCHCOR (RATE)	DEPRPR (RATE)
1	15360.7	1.575913	0.0	521.6	0.000000	0.086253
2	527128.8	1.595627	0.0	16661.3	0.000000	0.098073
3	1281.1	1.721874	0.0	40.3	0.000000	0.101969
4	0.0	0.000001	0.0	0.0	0.000000	0.000000
5	0.0	0.000001	0.0	0.0	0.000000	0.000000
6	0.0	0.000001	0.0	0.0	0.000000	0.000000
7	0.0	0.000001	0.0	0.0	0.000000	0.000000
8	0.0	0.000001	0.0	0.0	0.000000	0.000000
9	0.0	0.000001	0.0	0.0	0.000000	0.000000
10	0.0	0.000001	0.0	0.0	0.000000	0.000000
11	0.0	0.000001	0.0	0.0	0.000000	0.000000
12	0.0	0.000001	0.0	0.0	0.000000	0.000000
13	53701.6	0.189761	0.0	2667.7	0.000000	0.014606
14	51715.9	0.216846	0.0	2100.4	0.000000	0.014224
15	57896.2	0.511676	0.0	2186.6	0.000000	0.025854
16	3995.2	1.804210	0.0	142.0	0.000000	0.101598
17	34648.3	1.849920	0.0	1086.3	0.000000	0.095147
18	61550.1	1.753524	0.0	2013.8	0.000000	0.095113
19	8324.4	1.755599	0.0	146.2	0.000000	0.096029
20	266512.0	1.812750	0.0	8669.3	0.000000	0.088318
21	0.0	1.893806	0.0	0.0	0.000000	0.100076
22	1224178.1	2.850479	0.0	18586.8	0.000000	0.097697
23	183713.3	0.504319	0.0	6445.5	0.000000	0.024290
24	140603.2	0.451596	0.0	3403.5	0.000000	0.015634
25	28591.7	0.342219	0.0	1794.4	0.000000	0.027599
26	352129.4	1.157733	0.0	6605.4	0.000000	0.040649
27	0.0	0.000001	0.0	0.0	0.000000	0.000000
28	0.5	0.000001	0.0	0.0	0.000000	0.000000

	PACAP ($1000)	CAPPAR (RATE)	EINVPA ($1000)	RINVPA ($1000)	DEPRPA (RATE)
1	0.0	0.000001	0.0	0.0	0.000000
2	15350.8	0.046467	0.0	15.5	0.003138
3	34.7	0.046654	0.0	0.0	0.003239
4	0.0	0.000001	0.0	0.0	0.000000
5	0.0	0.000001	0.0	0.0	0.000000
6	0.0	0.000001	0.0	0.0	0.000000
7	0.0	0.000001	0.0	0.0	0.000000
8	0.0	0.000001	0.0	0.0	0.000000
9	0.0	0.000001	0.0	0.0	0.000000
10	0.0	0.000001	0.0	0.0	0.000000
11	0.0	0.000001	0.0	0.0	0.000000
12	0.0	0.000001	0.0	0.0	0.000000
13	200.6	0.000709	0.0	0.0	0.000055
14	0.2	0.000001	0.0	0.0	0.000000
15	2484.1	0.021954	0.0	5.5	0.001505
16	31.7	0.014329	0.0	0.0	0.001089
17	312.2	0.016668	0.0	0.1	0.001143
18	563.1	0.016041	0.0	0.2	0.001134
19	76.9	0.016224	0.0	0.0	0.001152
20	2371.9	0.016133	0.0	0.9	0.001040
21	0.0	0.017455	0.0	0.0	0.001200
22	40742.0	0.094867	0.0	22.0	0.003471
23	209.5	0.000575	0.0	0.0	0.000035
24	0.3	0.000001	0.0	0.0	0.000000
25	31.7	0.000379	0.0	0.0	0.000041
26	430.7	0.001416	0.0	0.0	0.000070

27	0.0	0.000001	0.0	0.0	0.000000
28	0.5	0.000001	0.0	0.0	0.000000

	MANA-GERS	PROFES SIONAL	TECH-NICIAN	SER-VICE	INDUS TECHS	CLER-ICAL	SALES	FARM
1	0.054500	0.111380	0.029130	0.034880	0.075310	0.058070	0.007530	0.629210
2	0.119890	0.134140	0.081950	0.028090	0.475790	0.145670	0.012790	0.001680
3	0.119890	0.134140	0.081950	0.028090	0.475790	0.145670	0.012790	0.001680
4	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
5	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
6	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
7	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
8	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
9	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
10	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
11	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
12	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
13	0.102610	0.034740	0.022170	0.016000	0.728800	0.089740	0.004420	0.001520
14	0.102610	0.034740	0.022170	0.016000	0.728800	0.089740	0.004420	0.001520
15	0.086000	0.043190	0.021550	0.043580	0.585560	0.096340	0.058170	0.065610
16	0.126170	0.013740	0.107080	0.059270	0.394540	0.265890	0.030160	0.003150
17	0.126170	0.013740	0.107080	0.059270	0.394540	0.265890	0.030160	0.003150
18	0.108370	0.004380	0.001640	0.017520	0.720310	0.140670	0.007120	0.000000
19	0.126170	0.013740	0.107080	0.059270	0.394540	0.265890	0.030160	0.003150
20	0.126170	0.013740	0.107080	0.059270	0.394540	0.265890	0.030160	0.003150
21	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
22	0.143140	0.121280	0.072310	0.033030	0.363680	0.237960	0.027940	0.000660
23	0.127270	0.017810	0.004760	0.194890	0.201590	0.111940	0.341320	0.000410
24	0.259900	0.017890	0.013240	0.029820	0.018960	0.424740	0.234490	0.000950
25	0.190190	0.116530	0.040160	0.299830	0.078100	0.228870	0.046320	0.000000
26	0.106360	0.382090	0.031890	0.224950	0.086240	0.154700	0.011800	0.001980
27	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
28	0.210040	0.144710	0.081330	0.121550	0.130160	0.297650	0.009180	0.005370