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Benefits and Costs of Geologic Mapping Programs in Illinois: The case of Boone and Winnebago Counties and its statewide applicability

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C O N T E N T S

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Executive Summary

This study was conducted to meet the requirement of Illinois Senate Resolution 881 that the benefits and cost of geologic mapping programs be documented by the Illinois State Geological Survey. It was decided that Boone and Winnebago counties should be used as a case study because the most detailed geologic mapping to-date was done in those two counties. It was recognized from the outset, however, that the cost of geologic mapping in other parts of Illinois will depend on the complexity of geologic conditions, amount of additional data required, methods of data processing and map production, and the degree of detail required. Therefore, two cost scenarios were considered, one based on projection of the Boone and Winnebago experience and another based on cost estimation made by ISGS geologists for the statewide mapping program.

The cost of geologic mapping conducted in 1980 in Boone and Winnebago counties was recalculated in 1990 dollars by using 1990 salary levels and consulting drillers for current drilling costs.

The benefits of geologic mapping were far more difficult to quantify, partly because no past applied experience existed and partly because benefits occur for decades after geologic maps are used in decision-making. The basic economic premise in benefit assessment was that geologic mapping programs are a "public good" as against "private goods" such as consumer products. The implication of this difference is that the market demand curve for geologic mapping programs is a result of the vertical summation of individual demand curves as against a horizontal summation of individual demand curves for a private good. Furthermore, due to a lack of documentation on possible benefits, an indirect assessment of benefits had to be made based on the rationale that any future cost that could be avoided because of the knowledge gained through geologic mapping programs is equivalent to benefits and attributable to the program.

Data collection on such future avoidable costs was based on 55 personal interviews with actual or potential users of geologic information in Boone and Winnebago counties. Some of the information was quantifiable in dollars, but much more was of qualitative nature. **The results of this study must be used only in conjunction with appropriate weighing of qualitative benefit data.**

The quantifiable benefit data have been available only in the form of avoidable cost of cleaning up a portion of contaminated waste disposal sites and industrial sites. This is not to say

that geological mapping will result in avoidance of all costs at all future waste disposal sites and industrial sites. However, costs could be significantly reduced if geologic maps are used. There are at least a dozen other uses of geologic information and many potential sources of benefits. They all must be given appropriate weight in decision-making concerning geologic mapping programs. We emphasize that **the results of this study are based on a single type of benefits, discounted 50 percent, 70 percent and 90 percent in three scenarios to consider future use of geology.**

In scenario I, the benefits were discounted by 50 percent assuming that no dramatic change from past practices will occur in siting facilities and disposing of wastes. Regulations currently require consideration of geology in siting waste disposal facilities but do not include siting of industrial facilities. In Scenario II, the benefits were discounted by 75 percent to account for regulatory progress and for progress in designing safer waste disposal facilities that will help prevent contamination problems at many sites. Finally, in Scenario III it is assumed that regulatory changes in the near future and the already existing regulations on siting industrial and waste disposal facilities will be highly effective and the design of engineered structures highly successful. The Scenario III benefits were therefore discounted by 90 percent.

The quantifiable benefits were analyzed for the appropriate level of confidence to be vested in the data. Four categories of benefits were made with decreasing level of confidence. The highest confidence (±0% variability) was placed on expenses incurred by IEPA as of 6/30/1990. The next lower level of confidence (±10%) was assigned to expenses already incurred but not as well-documented as the IEPA expenses. The estimates of clean-up costs available from feasibility studies were assigned a ±30% confidence, as is commonly done for any feasibility report. Other estimates by experienced managers were classified into the ±50% confidence category. The confidence levels simply indicate the dollar ranges within which benefits are expected to fluctuate; they do not doubt that such benefits will accrue.

Because of the fact that most benefits will accrue in the future, and their occurrence will be dependent upon appropriate and timely use of geologic information, it was necessary to take a conservative approach to benefits estimation. No precedence was available to translate this conservative approach into a mathematical formula. Therefore, it was assumed that benefits would be delayed by 10 years due to technical, educational, organizational and political difficulties in making practical use of the geologic knowledge gained from the mapping program. The delayed benefits for avoidable costs were discounted at a 10 percent annual rate in order to convert the dollar amounts to the 1990 basis.

The adjusted benefits were then used to determine the benefit/cost (B/C) ratio in each one of the 4 benefit categories. The B/C ratios for Boone and Winnebago counties are summarized below:

	B/C ratio for Category 1	B/C ratio for Category 4
Scenario I	1.65	23.5 to 54.5
Scenario II	0.83	11.7 to 27.2
Scenario III	0.33	4.7 to 10.9

The statewide projection was based on county areas and an aquifer contamination potential score determined for each county using the location of aquifers and the number of sources of potential contamination as the basis. The projected total cost of mapping for Illinois was about $21 million. In the summary table below this cost of mapping is presented as the lower cost case.

An alternative statewide calculation of B/C ratios was made from a higher assessment of cost of geologic mapping by ISGS geologists. Due to differences in geology and the amount of additional work needed, the cost of statewide mapping would be $55 million instead of $21 million as projected from the Boone and Winnebago County experience. The projected statewide B/C ratios are summarized below.

	Statewide B/C ratio for Category 1		Statewide B/C ratio for Category 4	
	Lower Cost	Higher Cost	Lower Cost	Higher Cost
Scenario I	0.4	0.2	6 - 14	2.3 - 5.4
Scenario II	0.2	0.1	3 - 7	1.2 - 2.7
Scenario III	0.1	--	1.2 - 2.8	0.5 - 1.1

We believe that a realistic approach to interpretation of the results of this study would refer to the range of B/C ratios in category 4. With this reference point, the results can be summarized as follows:

	Cost (1990 $)	B/C ratio by scenario	Total benefits (million 1990 $)
Boone and Winnebago counties	$300,000	I 23.5 - 54.5 II 11.7 - 27.2 III 4.7 - 10.9	$7.0 - 16.3 $3.5 - 8.1 $1.4 - 3.3
Statewide projection from Boone/Winnebago counties	$21,000,000	I 6 - 14 II 3 - 7 III 1.2 - 2.8	$127 - 295 $ 63 - 147 $ 25 - 59
Alternative estimate based on ISGS assessment of costs	$55,000,000	I 2.3 - 5.4 II 1.2 - 2.7 III 0.5 - 1.1	$127 - 295 $ 63 - 147 $ 25 - 59

It is emphasized again that the B/C ratios shown in this table are for avoidable costs related only to soil and groundwater contamination. The ratios will increase as the numerous other benefits that could not be considered in this study are included.

1. Issue background and study objectives

Geologic information is widely used in mineral exploration and extraction. Geologic maps are a prerequisite for the search of minerals. In highly developed industrialized and urbanized societies, mineral extraction has increasingly become a less important economic factor because of the relatively small value contributed to the gross national product (GNP) by the mineral extraction industry and because of an increase in imports of many essential metallic and non-metallic minerals and fuels from overseas. The impression has grown therefore that detailed geologic mapping must be done in underdeveloped, unexplored and mineral-rich countries of the Third World, but not in the more developed countries like United States.

Although many minerals are imported into the United States at high rates, many others continue to be produced domestically in increasing amounts . Almost 90 percent (by value) of non-fuel mineral raw material needs of the U.S. are met by domestic production, and despite an oil import bill exceeding $50 billion in 1989, the U.S. continues to produce over 50 percent of its oil needs, all its coal needs and most of its gas needs.

In addition to the traditional minerals, water has become an extractable mineral commodity of vital importance for not only industrial and economic growth but more importantly for health and safety purposes. The potential for contaminating groundwater resources is a nationwide concern. Contamination may result from use of agricultural chemicals; disposal of municipal, hazardous, or radioactive waste; installation of septic systems; accidental spilling of chemicals or oil; leakage of underground storage tanks; spreading of sewage sludge; leachates from landfills or coal gas waste sites, or disposal of other waste. Potential health risks may arise when chemical or biological agents from the waste source enter the groundwater system and are subsequently extracted by public or private wells.

Another important problem is urban sprawl and competition for land use. More land is being subtracted from agricultural, forest and mining uses by urban growth than by any other activity. Urban growth exacerbates waste generation and pollution while rendering earth resources inaccessible.

It has been demonstrated that problems of mineral and water resource availability and contamination of the earth due to human activity can be mitigated with accurate and detailed knowledge of geology. However, knowledge alone will not suffice unless public and private decision makers are willing to use such knowledge effectively. One way to persuade people to use geologic knowledge for planning is to demonstrate that it makes economic sense to do so. Illinois Senate Resolution 881, passed on June 13, 1989 requires "that the ISGS...provide...a cost-benefit study of the recommended...(geologic) programs." The Illinois Groundwater Protection Act (IGPA)(P.A. 85-863) mandates that the Illinois State Geological Survey (ISGS) conduct a geologic mapping program. Section 7 (a) (2) states that the Department (ENR) shall conduct assessments to enhance the State's database concerning groundwater resources, mapping of aquifers, identification of appropriate recharge areas, and evaluation of baseline groundwater quality. The ISGS (Sections 14.1, 14.2, 14.3) must also assist the Illinois Environmental Protection Agency (IEPA) in acquiring geologic data that (1) identifies aquifers for determining wellhead setbacks, (2) provides hydrogeologic data to determine expansion of setback zones, and (3) (Sections 17.1, 17.2, 17.3 17.4) identifies hydrogeologic characteristics of materials and the depth to the uppermost aquifer for the assessment of groundwater protection needs, and for establishment of groundwater protection planning regions and regulated recharge areas.

Geologic mapping suitable for planning purposes was conducted in Boone and Winnebago counties in 1980. As discussed in section 3 of this study, the two-county area has been extensively mapped and could serve as a model for future geologic mapping programs. The broad objective of the present benefit/cost study is to document the potential and actual uses of the above geologic study and its benefits. As in any publicly funded programs, benefits of geologic mapping can be only partially quantified in terms of dollars. This study compares the quantifiable as well as non-quantifiable benefits of geologic mapping in Boone and Winnebago counties with the costs of mapping. The results are extrapolated to the entire state of Illinois.

2. Review of literature on benefit/cost studies in geosciences

Although benefit/cost studies have been prepared for public expenditure projects formally or informally for many decades, their application to geosciences is a relatively recent phenomenon[1,2]. Early applications of benefit/cost analysis in geosciences were largely anecdotal. For example, a 1979 study in Kentucky[3] relates the growth in Kentucky coal production to a simultaneous growth in number of published geologic maps. The study also presents a description of other uses of maps including specific examples by industry of their use of the maps; however, a satisfactory causal relationship is not sufficiently well established to enable quantification of benefits. Literature on benefit/cost studies in geosciences is limited and consists mostly of applications to projects or programs with single objectives. For example, a University of Maine study[4] applies the benefit/cost analysis to a geodetic reference system.

The 1980s saw the first meaningful attempts to develop methodologies for benefits versus cost evaluations of projects or programs in geosciences. These efforts benefitted from theoretical and practical work in the area of agricultural economics especially in conjunction with irrigation projects[5,6]. Clapp et al[7] attempted to develop an approach to the evaluation of land information systems based on criteria involving operational efficiency, operational effectiveness, program effectiveness and contribution to societal well-being. The first two criteria concern effective data collection and user access to the data. The third criterion refers to the degree of use of the data by those who ought to be using them, and the fourth criterion evaluates what the program has contributed to the well-being of the whole society. The approach by Clapp et al. makes sense but it is hard to apply if benefits are to be quantified in dollars. However, quantification in terms of dollars should not be the only (and sometimes not even the best) criterion for program evaluations because intangible benefits may heavily outweigh the tangible ones. Applying Clapp et al.'s approach to the Illinois Geographic Information System (GIS), Treworgy et al.[8] showed that the evaluation approach by Clapp et al. was useful in assessing the costs and benefits of developing and managing a geologic database.

The literature on benefit/cost studies for specific geologic applications is even more scarce than in geosciences in general. Applications have generally been limited to single issue case studies. Bernknopf et al.[9] have developed and applied a benefit/cost analysis approach to landslide hazards in Ohio. The approach is based on a technical assessment of factors causing landslides, their probability of occurrence on a site-by-site basis, the damage they may cause and estimates of costs involved in measures necessary to prevent the landslides. Another related study by Bernknopf et al.[10] deals with the benefits and costs of sending notices of volcanic and earthquake hazards to residents of certain areas of California based on geologic studies. The benefits of sending out such notices come from avoided physical and economic harm to the residents. The cost resulting from such notices may be in terms of lower housing prices, reduced tourism and other investments, as well as unnecessary panic.

Knight[11] describes, with a hypothetical case study, a method for evaluating the benefits and costs of different levels of geophysical (seismic) surveys in oil exploration. As the sophistication of seismic surveys increases so does their cost. On the other hand, a benefit is accrued as a result of more sophisticated seismic surveys because the probability of unproductive oil well drilling is lowered.

Geologic information is known to have wide applications for resource development, waste disposal issues, groundwater protection problems and public health in general. The United States Geological Survey (USGS) has attempted to develop an approach to apply the benefit/cost analysis to include all possible uses of topographic (primary base) maps[12]. The USGS study deals with the issue of revision and printing of maps and not with the mapping program itself. About 57,000 quadrangles at 1:24,000 scale cover the entire United States. It would take a half century and billions of dollars to replicate all the topographic quadrangle maps. The choice of quadrangles to be prioritized for revision and the number to be revised each year should depend upon benefits to be expected from the map revisions. The USGS study relies on nationwide interviews of federal, state and local government agencies and private sector firms to make a list of possible uses of topographic maps and to determine the alternatives that the interviewees would choose if the USGS did not revise the maps. Answers to questions regarding frequency of needed map revisions serve to prioritize revisions of topographic maps by geographic areas. The survey of potential users indicated at least 200 different uses of maps. Because of the multiplicity of uses of topographic maps, the USGS study of benefits and costs concentrates on five states and relies on answers to questionnaires given by the users. At the basis of benefit estimation were qualitative answers given by users based on a decision tree provided by the USGS. The decision tree elicited answers from users regarding steps the user would take to acquire topographic knowledge if maps were not revised. Each stage in the decision tree was assigned a cost by USGS researchers, which formed the basis of converting qualitative answers into dollar amounts.

3. Scope of the present study

3.1 Boone and Winnebago Counties as the basis of the study

In December, 1979, the ISGS was contracted by the boards of Winnebago and Boone Counties to conduct a geologic mapping program over a two-year period. The objectives of the study were to: (1) produce a map of the surficial deposits showing the sequence of materials to a depth of 20 feet and define the characteristics of the deposits to bedrock, (2) prepare a series of interpretive maps that show pollution potential of geologic materials, areas of probable natural recharge and those suitable for artificial recharge, construction suitability, and areas of mineral and groundwater resources, and (3) prepare a report on the geology of the counties to accompany the maps.

In late 1981 a contract report was provided to the counties satisfying the objectives of the contract. This report was subsequently published in 1984 as ISGS Circular 531, "Geology for Planning in Boone and Winnebago Counties." The final circular included more than the originally intended study. In addition to the map that shows the geology of surficial deposits within 20 feet of the surface (stack-unit map with sequence and areal distribution of units), the study provided the following basic geologic maps and cross-sections:

1) Areal geology of the bedrock surface, which delineates

aquifers and non-aquifers.

2) Thickness and elevation of the top of the Ironton-Galesville Sandstone, and the Ancell Group (St. Peter Sandstone), which are major regional aquifers.
3) Topography of the bedrock surface and drift thickness, indicating the depth to potential bedrock aquifers and the configuration of the bedrock terrain.
4) Numerous geologic cross-sections through the counties, principally concentrating on the Rock and Troy deep bedrock valleys, which contain major drift aquifers.

The following interpretive geologic maps were derived from the above maps and cross-sections on the nature and distribution of geologic materials in the counties :

1) Classification of geologic materials for land burial of wastes, which rates land areas and materials within 50 feet of the surface from high to low vulnerability to potential contamination from landfills and other waste disposal practices.
2) Classification of geologic materials for waste disposal by septic tank soil adsorption system, which rates land areas and materials within 20 feet of the surface from high to low vulnerability to potential contamination from septic systems, accidental surface spills and other near-surface disposal activities. Poorly drained soils were also included on the map.
3) General construction condition, which evaluates the suitability of geologic materials for ease of excavation, adequate bearing strengths to support structures, and drainage conditions.
4) Distribution of sand and gravel aquifers, which delineates all known drift groundwater resources.
5) Sand, gravel and peat resources, which illustrates areas containing these resources, their thickness and depth beneath the surface.
6) Dolomite resources, which illustrates dolomite exposed at the surface or buried at depths less than 20 feet.
7) Terrane, which is a combination of geologic materials and topography and can help determine groundwater gradient and permeability and therefore potential for natural recharge.

ISGS Circular 531 was widely distributed in Boone and Winnebago Counties, with copies provided to county boards, regional and municipal planning departments, health departments, highway departments, soil and water conservation districts, State regulatory agencies based in Rockford, well drillers, aggregate producers, geologic and engineering consultants and other interested parties. The ISGS also conducted workshops, field trips and training sessions in the two counties for using this geologic report for resources-based land use planning and decision making. Since 1979, the ISGS has backed-up this study by providing the citizens of Boone and Winnebago counties clarification and assistance related to the geology and hydrogeology of the counties.

3.2 Assessment of benefits and costs of geologic mapping in Boone and Winnebago Counties

Boone and Winnebago are the only two counties in Illinois where modern comprehensive large-scale lithostratigraphic and derivative (or interpretive) mapping has been conducted and published. Because of this intensive geologic mapping program, Boone and Winnebago counties were selected for the benefit/cost study. The benefits/cost study for the two counties will

a) identify actual and potential uses of the map products,
b) list the quantifiable and non-quantifiable benefits attributable to mapping, and
c) compare the benefits with costs of mapping.

3.3 Comparison for Boone/Winnebago counties with the rest of Illinois for statewide extrapolation of results

After the assessment of benefits and costs of geologic mapping in Boone and Winnebago counties, the data will be extrapolated for the entire State. This projection will be based upon a comparison of hydrogeologic, geologic and industrial data from all Illinois counties with Boone and Winnebago counties.

4. Taxonomy of benefits and costs associated with geologic mapping programs

The cost and benefits of geologic mapping programs go beyond the immediate dollar amounts spent in conducting the mapping work or the amounts saved in terms of avoided costs. The society pays for and benefits from publicly financed mapping programs in ways not amenable to immediate quantification. These social costs and benefits must be taken into account in the decision-making process.

4.1 Taxonomy of benefits of geologic mapping programs

A large portion of the benefits derived by society from geologic maps and their interpretations are in the form of "future avoided costs." The principle of avoided cost may be less obvious in case of mineral extraction industries that generate wealth and thus do not merely avoid future cost. However, in the absence of basic geologic maps each competing participant in the extraction industries will generate proprietary basic geologic information not available to others. This acquisition of geologic information represents a portion of costs that could be avoided if publicly funded geologic mapping is undertaken. The immediate beneficiaries may be industry or individual citizens. However, the ultimate gains are made by the society as a whole in terms of opportunities for investing the savings into projects and ventures of greater utility. Some of these benefits are listed below.

- Potential direct savings in terms of avoided costs for clean-up of a significant number but not all waste disposal sites and industrial contamination sites. These are immediate savings which could be invested profitably in other industrial ventures creating new wealth, or in other worthwhile public projects such as for health and education.
- Indirect benefits from avoided contamination of land and water are gained in terms of better health and longevity, which in turn translate into productivity gains by the society as a whole.
- Maps used in educating students and adults, politicians and planners can result in increased awareness of the consequences of human activity, and in a better educated generation. These benefits are intuitively clear but impossible to quantify.
- Cost savings by mineral producers, water supply companies, drilling contractors etc. translate into greater national and international competitiveness of the domestic industry, new jobs and security.
- Geologic maps with information on agronomic soil characteristics, slopes and watersheds serve the agriculture and community in various ways. Soil conservation is the most important long-term benefit because human existence depends on soil to grow food. Other benefits arise out of proper application of fertilizers and pesticides not only to optimize the economics of agricultural production but also to protect the surface and groundwater from contamination.
- Geologic maps supply useful information for urban development and infrastructure planning. The knowledge of soil and rock strength, subsurface geology and hydrology can reduce potential health and safety hazards as well as the cost of creating and maintaining the infrastructure.
- Geologic maps on county scales can not substitute for site specific detailed studies and, therefore, will not avoid those costs. However, maps can help eliminate undesirable sites, reduce site selection costs and improve the confidence level of decisions.

Many of the above benefits are not measurable. In Boone and Winnebago counties, maps have been available and accessible to anyone interested in them. However, decisions concerning public projects are often subject to political considerations and business rationale that do not always take advantage of the existing information, and rational decision-making in the overall interest of the society is not always achieved. It is hoped that a documentation of benefits and costs will help improve decision-making. If a political and business decisions must be made regarding land use, it is hoped that those decisions will be based on a solid geologic foundation.

4.2 Taxonomy of social costs of geologic mapping programs

The money spent on conducting geologic mapping constitutes only one type of cost, the direct monetary cost measurable by available accounting methods. Several other types of costs must be taken into account which do not lend themselves easily to conventional quantification. These costs, borne by society, are discussed below:

- The money spent on geologic mapping could be spent on some other, possibly more desirable, program involving human welfare.
- Preparing geologic studies through mapping programs may have to be followed by technology transfer or regulatory mechanisms that will ensure their use in the planning process. The cost of establishing such mechanisms must be accounted for as a social cost.
- Geologic maps may be used to determine ideal locations for waste disposal sites or the location of a new subdivision. Maps may also be used to ensure that certain natural resources such as minerals or water are not rendered unextractable. This could result in long transportation distances and higher costs to the society. Another social cost may arise if the geologically ideal site for waste disposal or for mining is located in an aesthetic area that potentially would be destroyed. Likewise, the individual owning the land at the geologically ideal site or people living in its vicinity may object to locating waste disposal or mineral extraction facilities there, because it may lead to a loss of property values and/or esthetics value of the neighborhood. What monetary compensation would they accept for the devaluation of their land or neighborhood? The required compensation would represent a social cost related to geologic mapping.
- Businesses may choose not to locate in a community, county, state or country if they perceive the application of geologic criteria for prevention of environmental contamination to be a deterrent to investment. The loss of employment and potential tax revenues represent a social cost. The more widespread the use of geologic maps, however, the more the chance that these social costs become irrelevant because businesses would have less choice of locations free of these social costs.

5. Economic rationale in benefits assessment

Geologic mapping programs generate information or knowledge that is used in numerous ways. The products of the program are not always tangible. The maps produced are tangible; however, the most important aspect is the composite knowledge generated on the maps. Because of the unusual nature of the "product" of geologic mapping programs, the economic rationale in the assessment of their benefits is discussed in this section of the report.

5.1 Private goods vs. public goods

Most goods, after being bought by a buyer, are inaccessible to others. For example, one cannot increase consumption of cars or candy without reducing their availability to others. Such goods are, therefore, called "private goods." There are other goods, however, which, once produced, benefit everyone regardless of whether everyone wants them. They are called "public goods" and they remain available to others even after one or more individuals have "consumed" them. Examples of such goods would be clean air, national defence, or public health care.

An increase in the production of a private good by one unit serves only the buyer of that unit. By contrast if more clean air is "produced" everyone benefits. Some goods such as air pollution or water pollution are undesirable byproducts of other economic activities. Production of undesirable goods (or "bads") can often be prevented at a cost, borne ultimately by the consumer. For example air pollution can be prevented by using so-called "scrubbers" in electricity generating plants. The cost of scrubbers is paid by those who consume electricity. Like "public bads," some public goods are produced as byproducts of other primary economic activities. For example: A home owner who spends his money to professionally landscape his yard may help increase the property values of neighboring houses. Such unintended effects are also called "externalities." Externalities can be both negative (e.g. air pollution) or positive (e.g. landscaping) and can occur in conjunction with the production of private as well as public goods.

The distinction between a private good and a public good also depends on the spatial context in which we view the problem. For example: An electricity generating plant in central Illinois may produce a public good, e.g. clean air by using a "scrubber". The main beneficiaries of this public good are residents of central Illinois and to a lesser extent those living to the east and northeast of Illinois. However, residents of the western United States may not be benefitting from the public good produced by this central Illinois plant, but may be able to do so if they pay the price of moving to the east. Since not everyone automatically benefits from the clean air "produced" by the scrubber, does this disqualify clean air as a public good? This might appear to be the case at first. However, the health and other benefits accrued to residents of eastern United States benefit all Americans as taxpayers who pay for health research and treatment regardless of their place of residence.

5.2 Geologic maps as public goods

Geologic mapping programs produce maps as tangible products that impart knowledge. In this sense, mapping programs generate products quite different from most other products. Geologic maps qualify for the designation of public good for reasons similar to those discussed above. Mapping, once carried out, benefits everyone who resides or does business in the geographic area of the map, regardless of whether every person purchases a geologic map. Maps represent knowledge and as such, remain available to all for simultaneous or successive uses, even though a particular printed copy of the map is purchased and used by a limited number of people. Although maps themselves have the characteristics of a private good, mapping programs which result in the production of maps have public good characteristics. Knowledge generated by mapping programs is accessible to all and is not diminished by consumption. And for reasons analogous to the case of clean air, geologic mapping creates benefits for people beyond the geographic area of mapping. The knowledge gained from geologic mapping, as discussed later in this report, contributes to environmental as well as economic well-being of not only the residents of the mapped areas but the adjoining counties and the entire State. Some benefits transcend state boundaries, such as the benefits of savings derived from avoided federal expenditures for environmental clean-up, or imports of raw materials, and even national security benefits if strategically critical minerals are discovered as a result of the mapping program.

The treatment of geologic mapping as a public good has important consequences in our efforts to assess the benefits of mapping. One important consequence of considering geologic mapping as a public good is the recognition that unlike private goods the decision-making process for geologic mapping is not limited to financial profitability alone. It involves a broader objective of social well-being with financial consequences that are unmeasurable or at least very difficult to measure in monetary terms.

5.3 Foundations in economic theory

How we measure well-being and how we determine whether society's well-being is enhanced through geologic mapping is subjective because well-being is a subjective entity. The satisfaction or "utility" derived from consumption of goods cannot be measured although it is indisputable that goods will not be consumed unless the individual "feels" that they are "worth" purchasing. In this regard, consumers treat private goods differently from public goods such as geologic mapping programs. Production will continue for a private good such as an automobile, as long as at least one individual is willing to buy that unit at the prevailing market price i.e. as long as at least one individual believes that buying that unit will enhance his or her "well-being". The concept of "consumer surplus" is used to understand consumer well-being as summarized below.

The consumer of a private good places different values on successive units of the good consumed. The first unit of consumption is generally "valued" more than the successive units. This value is expressed in consumer's "willingness to pay" the highest price for the first unit and the lowest price for the last unit consumed. The market price, however, is determined by the "marginal cost of production" or the cost of producing an additional unit demanded. As a result the consumer gets a higher "value" from the earlier units of the good than the market price he/she pays per unit. In **figure 1**, the consumer demands a quantity Q_1, when the price per unit is P. However, this consumer is willing to pay more for all units preceding the Q_1^{th}

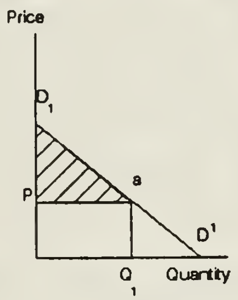
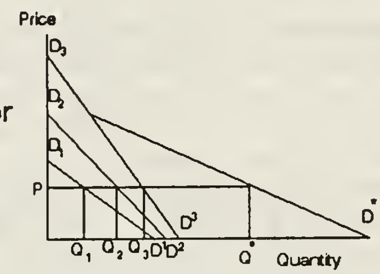


Figure 1: Consumer surplus

Figure 2: Market demand for a private good



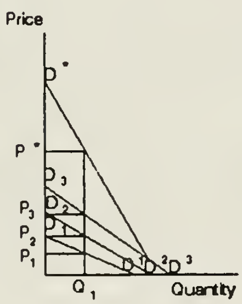


Figure 3: Market demand for a public good

unit (i.e. he/she gets a greater utility from consumption of Q_1 units of the private good than the amount (PxQ_1) paid by him/her indicates). This excess utility, represented in figure 1 by the area of the shaded triangle D_1Pa, is called consumer surplus, which consumers strive to maximize regardless of whether a private or a public good is consumed.

In figure 1, D_1D^1 represents the demand per time unit (year, month, etc.) at different price levels by this particular individual consumer. When there are many consumers of a private good, their individual demand schedules D_2D^2, D_3D^3, ...etc. can be horizontally summed to represent the "market demand schedule"

D_3D^* **(figure 2)** and the area under the demand schedule D_3D^* and above the price line P represents the total consumer surplus of all consumers in the market.

Unlike private goods, the market demand for a public good such as geologic mapping programs cannot be determined by horizontal summation of individual demands because when an additional unit of a public good is made available it benefits everyone at the same time. Therefore, the value of a quantity of public good to the society is the sum of values placed on that quantity of the public good by all the consumers. More elaborate theoretical treatment of the topic can be obtained from a number of textbooks and practical guides to benefit/cost analysis[13],[14],[15].

The vertical summation of individual demands for a public good (as against the horizontal summation for a private good) is depicted in **figure 3**. Assuming that there are three consumers of a public good with demand curves D_1D^1, D_2D^2, and D_3D^3, the values placed by these consumers per unit of a public good provided in quantity Q_1 will be P_1, P_2 and P_3, respectively. The cumulative value to the society is $P^* = P_1 + P_2 + P_3$ as every unit of the public good is available to all three consumers at the same time.

Because geologic mapping programs are a public good, their production depends upon whether the marginal cost (MC) of production is justified by the value the society cumulatively assigns that unit. This criterion of production decision for a public good often leads to the "Everyone Wants It--No One Will Pay For It" phenomenon[16]. Suppose in figure 3 that P^* does equal the marginal cost (MC). In that case it would be necessary to produce Q_1 units of the public good and price it at P^*. Unfortunately, none of the three consumers in figure 3 will buy the public good because their valuations (P_1, P_2 and P_3) of the good are lower than P^*. Because in reality there is generally at least one buyer in the society for the public good at a price P^* commensurate with the MC, the situation often leads to the "free rider" syndrome. For example: In figure 3, if a fourth consumer came forward and bought the public good at its designated price P^*, all other consumers would get the public good at little or no cost.

In case of geologic mapping a similar scenario can be expected in the decision making process because potential beneficiaries of the mapping programs may not want to pay for the program knowing that access to the results will be available once mapping is completed. Users of geologic maps may also benefit from the product's use to different degrees and may, therefore, willingly pay varying amounts (or nothing at all) to get the mapping done. Some users might even deliberately understate the value of the product in order to reduce their share of payment for the mapping program. Quantification of the actual utility of the mapping program to the user, therefore, remains elusive. Demand curves for individual map users are not easily established. The best possible approach to solving the difficulty is to quantify the demand and value where possible and make an inventory of uses where quantification is not possible.

In addition to individual consumers of geologic mapping, society as a whole must be considered as a user because the costs arising from non-use of geologic information is ultimately borne by the whole society. Collectively, the society must value public goods at least as highly as the costs of the alternatives available. As long as the cost of geologic mapping is lower than or equal to the cost of the alternatives such as geologic studies by individual users or clean-up and remedial actions, it is cost effective to conduct geologic mapping.

When benefits and costs concern users of the public good in a limited geographic area, the approach is called "partial equilibrium analysis." When the entire nation or society benefits, the effects of producing or not producing a public good on other segments of the economy and other regions of the nation are also considered; this latter approach is called "general equilibrium analysis." In case of geologic mapping, elements of "general equilibrium analysis" are applicable because, as we shall see in section 7, quantifiable data are available mainly in areas of the economy beyond individual consumers of maps.

5.4 Mechanics of benefit-cost assessment

The basic goal of a benefit-cost assessment is to maximize the net benefits or to minimize the net cost. Some public expenditure projects result in positive benefits to society, e.g. a vaccination program that drastically reduces the incidence of a disease. The cost is generally incurred now and the benefits gained later. The most commonly used approach to assess the benefits and cost is to determine the Present Value (PV) of future benefits and/or costs whenever they are measurable in dollar amounts and then calculate the ratio of benefits to cost (B/C).

To determine the PV of benefits or costs in future time periods, the estimated benefits, costs or net benefits are discounted to the present time by using an appropriate annual interest rate or discount rate. When an investment is made in a project like geologic mapping, the investor forgoes the opportunity to invest the same amount in another project. Each one of the other investment opportunities forgone offers a different rate of earnings. Therefore, the geologic mapping project must offer at least as high a rate of earnings, i.e. benefits, as the best alternative. The rate of earnings from the best of the alternative is called the "opportunity cost." It represents the "discount rate" or the rate at which future net benefits, i.e. benefits - cost, must be discounted annually to determine the PV of all the future net benefits. If the PV of future net benefits is higher than the original investment, the project should be accepted. Mathematically, the discounting occurs as follows:

$$NB_{pv}=\sum_{i=1}^{n}\frac{NB_i}{(1+r)^i}$$

where NB_{pv} = Present Value of Net Benefits
NB_i = Net Benefits in year i
r = Annual discount rate (e.g. r = 0.1 for a 10% discount rate)
n = number of years

In order to determine whether the present value of net benefits is higher than the original investment in geologic mapping, i.e. the original cost, one could subtract the original cost from the present value of net benefits and see if the result is positive. A more commonly used method is to determine the ratio:

$$\frac{NB_{pv}}{C_{map}}$$

Where C_{map} = Original cost of mapping program

For public expenditure projects such as geologic mapping, the magnitude of the B/C ratio is only one of the decision-making criteria. A B/C ratio of greater than 1 is not always necessary for a public expenditure project to be undertaken. Social or political considerations may justify execution of a project even when the B/C ratio is less than unity such as when human lives are in danger or when political necessities require the completion of a project within a constrained time frame or at a particular location.

In the present study we will use the B/C ratio to assess geologic mapping programs and supplement quantitative results with narratives concerning the benefits and the costs of the program.

6. Methodology used in data collection

The cost of geologic mapping in Boone and Winnebago counties is realistically reflected in the ISGS program budget that was presented to the counties. It consists of three parts 1) financing by counties provided to the ISGS, 2) direct payments by counties to drilling contractors and 3) ISGS matching contributions. The 1980 cost figures were recalculated in 1990 dollars to reflect current costs. Social costs resulting from loss of investment opportunities in areas other than geologic mapping (see section 4.2) are not quantifiable. This omission appears justifiable, however, because a number of benefits also are nonquantifiable and must be excluded from consideration.

Data on benefits attributable to geologic mapping had were, by necessity, collected on a case-by-case basis. The steps involved in data collection were:

1. Listing of potential map users.
2. Determination of specific map uses.
3. Personal interviews with potential users in Boone and Winnebago counties.
4. Determination of alternative sources used or planned to be used if maps were unavailable.
5. Monitoring the costs resulting from non-use or non-availability of geologic information.

Prior to the data collection in Boone and Winnebago counties, the ISGS mapping committee identified 80 potential map users (institutions, firms and individuals) in Illinois with the advice of members of the Illinois Geological Mapping Advisory Committee (IGMAC). A questionnaire was developed and mailed to the 80 potential map users to solicit information on how and how often maps are used, and of what value the information contained in the maps was to them. Their responses are summarized by Damberger in Appendix A to this study. The questionnaire results helped recognize the potential map users in Boone and Winnebago counties. The list was modified and enhanced with the help of J. Maichle Bacon, Director of the McHenry County Public Health Department, who formerly was Director of Environmental Health in Winnebago County when the "Geology for Planning" study and the accompanying mapping program was implemented in Boone and Winnebago counties in 1980-81. Users in the following major categories were contacted subsequently for data collection:

- County planning and public health departments
- City planning departments in Rockford and Belvidere
- Mineral extraction companies
- Real estate developers
- Well drilling contractors
- Illinois Environmental Protection Agency (Region I - Rockford)
- Managers of waste water and sewer treatment facilities
- Agricultural Extension Offices in the counties
- County highway departments
- Geological and engineering consultants

About 35 individuals were personally visited and data were collected during meetings. Another 20 individuals were interviewed on telephone. (For lists of individuals and their affiliations see Appendix B). The format of the interviews, both personal and on telephone, consistently included the following questions:

- For what purpose are geologic maps used and how often each year?
- Can you quantify the amount of money saved due to availability of geologic maps?
- If you can not identify dollar savings, can you describe how much time was saved in terms of manpower on an annual basis?
- Do you know of instances where availability of geologic maps would have improved planning and saved money? If yes, in what form i.e. labor, material, clean-up and remedial costs, transportation costs etc. and how much?
- How are these savings documented? i.e. records of past (avoidable) spending, reliable estimates through feasibility studies, internal estimates by professionals, or estimates by administrative personnel?
- How accurate were the maps you used? Give approximate percent of time maps proved accurate.
- What additional map features would you like to see in geologic maps in order to make them more useful to you?

Answers to the above questions enabled the authors to separate the quantifiable savings from non-quantifiable savings. Quantifiable savings can be categorized in levels of decreasing reliability. In section 7, different levels of reliability were accommodated in the benefits estimation.

7. Summary of benefits and costs of geologic mapping in Boone and Winnebago Counties

The benefits of geologic mapping programs in Boone and Winnebago counties are only partially measurable. Detailed geologic maps for the area have existed for only about ten years. As a result their use has yet to yield benefits measurable in dollar amounts. Documentable potential benefits--quantifiable and non-quantifiable--do exist however, in the form of expenditures that could have been significantly reduced, and in some instances completely avoided, had the same degree of geologic knowledge existed 25 to 50 years ago. In this section, the benefits and cost of mapping are summarized and, in the following section, the results of the two-county study are extrapolated to the entire State.

7.1 Cost of mapping in Boone and Winnebago counties

The cost to the counties of conducting this investigation was $68,919 ($24,122 - Boone County, $44,797 - Winnebago County), payable to the ISGS, plus $40,065 ($13,258 - Boone County, $26,807 - Winnebago County) in contractual drilling services paid by the counties to independent operators. In addition, the ISGS contributed matching funds covering state-funded personnel, travel and use of ISGS vehicles, ISGS drilling (in addition to county-contracted drilling), and other overhead expenses. The total ISGS contribution was $65,388 ($22,885 - Boone County, $42,503 - Winnebago County). Table 1 shows the actual 1980-81 cost and the conversion to 1990 dollars based on actual and estimated expenses.

The costs considered in this section are those directly measurable. Implementation of decisions based on geologic maps can also cause social costs as described in section 4.2. Such social costs are not measurable at this time because Boone and Winnebago counties are the first counties to be mapped in detail and cases of their use and the resulting social costs are not documented. A comparison of the non-quantifiable social costs from section 4.2 with non-quantifiable benefits described later in section 7.3 will indicate, however, that such benefits are likely to be high enough to offset costs.

Table 1: **Actual dollar cost of the Boone-Winnebago Counties mapping program in 1980-81 and estimated costs for 1990**

	1980-81		Total	1990		Total
	Boone	Winnebago		Boone	Winnebago	
Counties to ISGS	24,122	44,797	68,919	66,500	123,500	190,000[2]
Counties to drillers	13,258	26,807	40,065	23,000[1]	46,500	69,500
ISGS contribution	22,885	42,503	65,388	10,000	20,000	30,000[3]
TOTALS	60,265	114,107	174,372	99,500	190,000	289,500

1. Estimate of real cost made by original Boone County driller; percentage increase (73.48) extrapolated for Winnebago County.
2. Estimate based upon ISGS conducting this mapping program in 1990
Includes some of the amounts originally shown under ISGS contribution in 1980-81.
3. Cost includes 25% of 2 state-funded positions for 2 years. Many ISGS contribution costs in 1980-81 would now be part of "counties to ISGS".

7.2 Quantifiable benefits

Most quantifiable evidence of potential benefits comes from community waste disposal sites and industrial sites, and some septic and sewer systems in housing and commercial subdivisions. The data sources fall into the following categories:

a) Federal superfund sites
b) State superfund sites
c) Industrial voluntary clean-up sites
d) Other uncategorized sites
e) Septic and sewer systems needing remedial action
f) Estimates by individuals and/or firms.

There are a total of 9 federal Superfund sites--3 in Boone and 6 in Winnebago counties, 10 industrial voluntary clean-up sites--1 in Boone and 9 in Winnebago Counties -- 2 state Superfund sites

(SRAPL - State Remedial Action Priority List) and 4 other sites in the two counties studied (see Appendix C). Not all of these are waste disposal sites, many are contaminated industrial sites requiring clean-up action.

The most reliably quantifiable expenses, i.e. potential benefits from map use, incurred on these sites are amounts spent by the Illinois Environmental Protection Agency (IEPA) to document and investigate the extent of contamination, and in some cases to take remedial action. Table 2 below summarizes the IEPA expenditure by site from Appendix C. The exact present value of the IEPA expenditures is difficult to determine because the money was spent over the past several years. We assume, conservatively, that all the expenditures were made in 1990.

Table 2: IEPA expenditures on sites in Boone and Winnebago counties.

Site Name	IEPA Expenditure As of 6/30/1990
Belvidere Municipal #1	$149,307
Bonus (Mig)	45,651
Parson's Outside	413,487
Midwest Plating	1,461
Pagel's Pit	7,414
Acme Solvents	59,025
Beloit Corporation	12,659
Six Oaks (Pecatonica)	810,506
Illinois Pollution Control (IPC)	10,315
Illinois Water Treatment	2,288
Borg Warner Corp.	14,447
Sunstrand	5,894
Hydroline	27
Woodward Governor Co.	4,197
Mattison Machine Works	46
Kaney Transportation	1,351
Ipsen CHT	23,364
People's Avenue (Quaker Oats)	2,846
Frink's Industrial Waste	893,143
Total IEPA through 6/30/90	$2,478,018

In addition to the sum of about $2.5 million spent by IEPA, the following estimated amounts were spent by federal and state governments on management assistance:

Site Name	Amount Spent
Bonus (Mig)	$ 22,000
Beloit Corporation	20,000
IPC	100,000
Total	$142,000

Although the accuracy of the $142,000 spent on management assistance is not as high as that of the $2.5 million spending by the IEPA, the estimates were made by IEPA and can be considered acceptably close.

State, county and municipal authorities outlined additional spending categories for which only estimates are available. These categories are:

1. Money already spent on Remedial Investigation and Feasibility Studies (RIFS).
2. Money estimated to be needed for RIFS in the future.
3. Estimates of clean-up costs to be expected in decades to come.

The successive categories of cost estimation decrease in reliability as estimated spending time moves farther into the future. On the other hand future cost of remedial actions to clean-up contaminated groundwater aquifers may exceed estimates contained in the RIFS. Serious concerns have been raised that the commonly used "pump-and-treat" remedy may not be effective and final costs could be much higher than presumed[16]. Tables 3 and 4 summarize the clean-up costs in the above 3 categories.

Table 3: **Estimated costs of Superfund sites in Boone/Winnebago counties**

Site Name	Spent on RIFS	Future Estimated Spending on RIFS	Future Estimated Clean-up Cost		
			Min./year*	Max./year	# years
Belvidere Municipal #1	--	--	$ 500,000	$ 700,000	10
Bonus (Mig)	--	--	1,500,000	1,500,000	30
Parson's Outside	$1,200,000	--	2,000,000	3,000,000	25
Pagel's Pit	2,000,000[1]	--	(2)	(2)	(2)
Acme Solvents	1,000,000	--	1,000,000	1,000,000	25
Six Oaks (Pecatonica)	--	--	37,000	37,000	30
SE Rockford	400,000	--	3,550,000[3]	--	1
IPC	--	$ 750,000*	1,000,000[4]	--	1
Total Superfund Sites	$ 4,600,000	$ 750,000	$9,587,000		

* Spending is conservatively assumed to begin in 1992.

1 $1.0 million for RIFS and $1.0 million to plan an alternative site to Pagel's pit.

2 Despite being declared a Superfund site, Pagel's Pit has been targeted for expansion. Clean-up costs unknown at this time.

3 Least cost short term alternative.

4 Immediate soil clean-up. Additional annual expenses for pump and treatment of water needed.

Table 4: **Estimated costs of voluntary clean-up sites and other sites in Boone and Winnebago counties.**

Site Name	First years expenses[1] on investigations and remedial action	Recurrent annual expenses	No. of years
Illinois Water Treatment	?	?	?
Warner Brake	$4,000,000	(2)	(2)
Woodward Governor Co.	300,000	unknown	unknown
Kaney Transportation	100,000	unknown	unknown
American Brass	25,000	--	--
Peoples' Avenue (Quaker Oats)	500,000	unknown	unknown
Sand Park	2,000,000		

[1] Minimum amounts. First year expenses are conservatively assumed to occur in 1992. Estimates by IEPA and County officials.

[2] Warner Brake agreed to settle a $39 million lawsuit by State Attorney General. Expenses estimated to be at least $1 million per year for 10 to 20 years.

Data in tables 1, 2 and 3 in demonstrate that:

1) The IEPA has spent about $2,478,000 on contamination site studies.
2) An additional $4,742,000 have been spent on RIFS and management assistance.
3) RIFS and clean-up expenditures are conservatively assumed to begin in 1992. The expenditures in 1992 alone are <u>estimated</u> to be a minimum of $10,337,000 from federal and state sources and an additional $6,925,000 from voluntary industrial spending, totaling $17,262,000 in current dollars or $14,266,116 in 1990 dollars when discounted 10 percent annually.
4) Clean-up expenses on superfund sites will continue for 9 to 29 years beyond 1992. Those future expenses are estimated to total $37,000,000 in 1990 dollars.
5) Voluntary clean-up expenses by the industry in decades to come are unknown and not included in this study.

The above estimates under categories 1 through 4 must be adjusted with reliability factors. The only expenses that can be relied upon totally are those already paid for and documented exactly, i.e. expenses under category 1. Expenses already paid for but documented in rounded-off figures are assigned a ± 10 percent confidence range. Economic feasibility studies are considered by convention to be ± 30 percent accurate in their estimates, while estimates of expected future expenses over several decades have been assigned a ± 50 percent confidence range due to their lower reliability than that of a feasibility study. The estimates under categories 1 through 4 above are thus transformed into the following ranges:

1) ± 0 percent of $2,478,000 = $2,478,000
2) ± 10 percent of $4,742,000 = $4,267,800 - $5,216,200

3) ± 30 percent of $14,266,116 = $9,986,300 - $18,546,000
4) ± 50 percent of $37,000,000 = $18,500,000 - $55,500,000

The crucial question to be answered is: **How much of the expenditure estimated in each one of the four categories above could have been avoided had geologic maps existed and been used in the past?, and what portion of these costs may be incurred in the future under improved regulatory procedure and engineered designs of facilities?** With respect to the first question, determination of the usefulness of geologic maps in selecting sites for waste disposal requires an understanding of the criteria used to estimate the contamination potential. Contamination potential can be negligible where aquifers are deep or non-existent and it will be very low where relatively impermeable material underlies the site (see section 8 for details). It is, therefore, not unrealistic to expect that a portion of the remedial costs as documented above could be avoided and equivalent benefits credited to geologic mapping programs.

Obviously, there is no guarantee that knowledge of geology would have prevented all the above costs. However, two basic statements can be made with confidence:

1. While not guaranteeing that all problem disposal sites could have been avoided with proper geologic mapping and use of that information, the avoidable costs would have been significantly lower,if geology had been used, and
2. The time of incurring such avoidable costs would have been pushed into the future, perhaps by decades, if geologic mapping had been used.

The magnitude of cost reduction, and therefore of potential benefits, will also depend upon the applicability of environmental regulations already in place and to be put in place. In order to account for future uncertainties, we offer the following three scenarios:

1. About 50 percent of future clean-up costs would be avoided, assuming that past disposal practices will not change dramatically and there is less than satisfactory use of geology. This base-case scenario appears justified because regulation of industrial sites on a statewide basis requiring consideration of geologic conditions is yet to be introduced.

2. About 75 percent of future clean-up work would be unnecessary and the benefits reduced accordingly because environmental regulations in effect today and to be expected in near future can prevent many of the contaminated sites in the future. Also, knowledge of geology has contributed to improvements in design and

engineering of facilities.

3. About 90 percent of the future clean-up work would be unnecessary as statewide regulations for industrial sites are promulgated and implemented, and as improved engineered designs of disposal facilities prove highly successful. This would further reduce the potential benefits from geologic mapping. However, geologic knowledge would be essential for designing facilities that minimize contamination risk.

The present value estimates (in 1990 dollars) of benefits derived in the form of avoided costs under the above three scenarios are summarized in table 5:

Table 5: Present value of benefits of geologic mapping in Boone and Winnebago counties and the estimated ratios of benefits to cost of mapping

Category	PV of benefits	Cumulative PV of benefits	Ratio of cumulative quantifiable benefits to costs of mapping[1]
Scenario I			
1	$477,700	$477,700	1.65
2	$822,700 - $1,005,500	$1,300,400 - $1,483,200	4.5 - 5.0
3	$1,925,100 - 3,575,150	$3,225,500 - $5,058,350	11.0 - 17.5
4	$3,566,275 - $10,698,800	$6,791,775 - $15,757,150	23.5 - 54.5
Scenario II			
1	$238,844	$238,844	0.83
2	$411,355 - $502,768	$650,199 - $741,612	2.25 - 2.56
3	$962,538 - 1,787,571	$1,612,737 - $2,529,183	5.57 - 8.74
4	$1,783,138 - $5,349,413	$3,395,875 - $7,878,596	11.73 - 27.2
Scenario III			
1	$95,538	$95,538	0.33
2	$164,542 - $201,107	$260,080 - $296,645	0.9 - 1.02
3	$385,015 - $715,029	$645,095 - $1,011,674	2.22 - 3.49
4	$713,255 - $2,139,765	$1,358,350 - $3,151,439	4.69 - 10.89

[1] See section 7.1 for cost of mapping in Boone and Winnebago counties: $289,500 in 1990 dollar.

The evidence for the economic justifiability of geologic mapping programs in Boone and Winnebago counties is strong even without the inclusion of items such as future industry expenditures for voluntary clean-up, the other quantifiable items listed below and the entire list of non-quantifiable benefits discussed in section 7.3. The benefits to cost ratio is greater than unity for all but category 1 under the most rigorous criterion, i.e. when only 10 percent of the estimated potential benefits are realized as in Scenario III. **The benefit/cost ratio in Scenario III ranges from 4.7 to 10.9 when major future benefits (avoidable costs) are taken into account in category 4, even after discounting the benefits by 90 percent as explained earlier.**

Other quantifiable benefits arise from avoidable costs involved in emergency measures to help residents affected by contamination, finding new deposits of minerals closer to markets and other events not easily categorized or quantified. **Following is a list of such costs which** should be taken into account in computing benefit/cost ratios. These costs would be almost certainly avoidable in their entirety, although they **are not included in the ratios computed above:**

- The South-East Rockford superfund site in Winnebago County. Contaminated water wells requiring emergency measures such as supplying bottled drinking water and carbon filter to at least 250 households for about 2 years. Carbon filter costs were estimated at about $250,000 but no cost data on bottled water supply is available. We estimate a minimum of 2 gallons of water per household per day would be necessary, and would cost at least 50 cents per gallon. This results in a total cost of $182,500 over two years. The total emergency aid cost is thus estimated at **$432,500** at this site.
- At the Woodward Governor Co. site in Winnebago County **approximately $300,000 to $550,000** were spent to remedy a leaking tank, install a monitoring well, and pay the consultant's fees.
- The City of Rockford had to close down at least 5 city water wells in the area south of Harrison Avenue. Replacement costs per well would be $1.5 million each or about **$7,500,000** total.
- Rockford Sand and Gravel Co. used the geologic maps in their search for 50,000 cubic yards of clay needed to cap a landfill. The savings in transportation were estimated at 50 cents per cubic yard or **$25,000** because of proximity of a deposit to the demand location. In addition to these savings, the company estimated that about 1 month of a full time equivalent of manpower was saved because the maps provided information which otherwise would have been developed by the company geologist.
- About 60 cases of leaking underground storage tanks in Winnebago County need full scale hydrogeologic investigation and possibly pump and treat remedial action. Another 140 leaking tanks exist in the county. According to the IEPA, about 80 percent of underground storage tanks leak. Because no permits are required to install underground tanks, remedial action will be required on a large scale in the future. Proper use of geologic maps could have helped reduce these potential costs. About **$250,000** were spent on one site of 18 leaking underground storage tanks for study and remedial action, according to Missman, Stanley Associates, a consulting company in Rockford. This company also estimates that geologic maps save them about 1,000 person hours, worth at least **$75,000** each year.
- The Winnebago County Health Department reported that in 1989 alone a total of 179 septic systems had to be repaired at an average cost of about $3,000 per system or a total of

$537,000 that could have been avoided with good knowledge and appropriate use of geology during the system planning stage. The county also spent **$3,000,000** to build a water line to Roscoe, while 250 residences paid a total of about **$1,250,000** for hookups on water and sewer systems.

The above list is inherently incomplete because it is impossible to solicit information from all the cases of individuals or businesses affected. For example, water wells supplying less than 25 housing units are not monitored by the IEPA and the county does not have the money and manpower to monitor all the wells.

7.3 Non-quantifiable benefits

Public funding for projects is often necessary because benefits accrue to the society as a whole rather than a particular private enterprise. Typical examples of such projects are education, infrastructure such as road building or projects related to environmental or national defense. Often, the non-quantifiable benefits are so far reaching that they outweigh the near term quantifiable benefits. It is, therefore, necessary to recount the non-quantifiable benefits of the geologic mapping done in Boone and Winnebago counties. The following account is based on interviews with citizens and officials in the two counties.

- Planning of waste disposal sites involves gathering of knowledge about geology, hydrology and geologic material characteristics. On-site drilling is necessary, followed by laboratory testing of materials. Aquifer depths and groundwater recharge patterns must be considered. It is an expensive procedure requiring screening of multiple sites. In Winnebago County, the process of selecting an alternative for the Pagel's pit municipal landfill site required $1,000,000 although geologic maps were available. County planners stated that the process of site selection would have been considerably more expensive without the maps. In addition to the cost lowering effects, the maps also improved the confidence in the decision-making process, the value of which cannot be measured in dollars.
- In the Oak Crest subdivision in Rockford, housing development took place in an area underlain by a buried peat bog. Although the layers of soil directly under the homes seemed suitable for septic systems, the underlying bog caused severe problems because geologic maps were not used. Knowledge of geology can prevent such costs. Decisions made on the basis of such knowledge lead to cost prevention but can not be documented as benefits.
- Leaking underground storage tanks is a widespread problem in the two counties. Only a fraction of these have been identified and remedied. Damage caused by the contaminants from yet undetected leaking tanks to groundwater and public

health is not measurable. However, most of the damage could be prevented with proper use of geologic information.

- School teachers in Boone and Winnebago counties are using the geologic maps in courses on science and environment. The benefits of this action are immeasurable. An entire new generation of citizens is being influenced by the knowledge of earth science and of how to use geologic maps to mitigate environmental damage. The increased citizen awareness spreads from the school children to their parents. Future decision-makers are presently receiving earth science knowledge. They can be expected to make better-informed decisions when they grow up and prevent future costs. Such future cost prevention can not be measured at this point.
- Producers of sand and gravel and other construction materials in the two counties confirmed the use of geologic maps in their day-to-day planning, although they could not quantify how much money the use of the maps saves them. Rockford Sand and Gravel Co. geologists attested to using maps for searching for new areas containing sand and gravel. The growing demand for construction aggregates in rapidly growing McHenry county to the east presents an incentive to the company to use the maps in their efforts to find deposits closer to the demand area. The transportation cost savings could amount to at least $1 per ton compared with current aggregate locations.
- Consulting geologist Roberta Jennings reported that regional geology often constitutes 20 to 25 percent of her reports on waste disposal site studies or other study sites. She confirmed that county-wide geological maps are the prime source of information on regional geology. Although it is impossible to assess the value of such uses of maps in dollars it is obviously quite significant. County officials and consultants estimated that in Boone and Winnebago counties, $3 to $4 million are spent on environmental consulting contracts by government and private enterprise annually. Geology plays a prime role in these contracts.
- The provision of geologic information to facilitate public opinion in cases of environmental or zoning issues is an important task. As demonstrated in the case of the Pagel's pit issue in Winnebago County, geology should play an important role. Unfortunately in the case of Pagel's pit, which is a Superfund site, geology was not regarded as a significant factor. In spite of clear geologic indications that safer alternative sites for waste disposal were available, a decision seems to have been made to expand the Pagel's Pit Superfund site. This negative example of the cost of ignoring geologic knowledge may result in immeasurable damage that would have been preventable.
- Boone and Winnebago counties have developed "comprehensive county plans for the year 2000." The plans involve residential and industrial development as well as mineral resource considerations. The issue of materials supply to

Chicago and the resulting employment effect on Boone and Winnebago counties were included in the plan. Geological maps served as an important guideline in plan preparation.

- Application of sewage sludge to agricultural land is common practice in some parts of the counties. The superintendent of the South Beloit Waste Water treatment plant confirmed that sludge from the plant is applied to agricultural land. An ISGS study[17] on application of sludge to agricultural land and its effects on groundwater has been used in Boone and Winnebago counties in the formulation of county ordinances.
- Waterwell drillers commonly use geologic maps as a regional guide. Driller Gerald Rosenquist attested that he uses the existing maps at least 50 percent of the time. It helps improve the confidence in well siting.

8. Methodology for statewide projection of study results

The following is a discussion of how the results of the benefits and cost of geologic mapping from Boone and Winnebago counties were projected to the entire state of Illinois.

The factors critical for a valid extrapolation are:

- Geologic conditions in Boone and Winnebago counties in comparison with the conditions in other counties. The geology is important not only from a mineral resource viewpoint but also with respect to the extent and speed with which contaminates migrate. The risk of environmental damage may vary from one area of the state to another. For example, in some counties of Illinois the earthquake and landslide potential may assume importance. As will be explained below, the cost of geologic mapping is dependent upon the geology of the area to be mapped.
- Demographics of counties including how many people reside in a particular county, whether they live in urban or rural areas, what standard of living prevails and how fast the population is changing.
- Economic conditions, determined by the type of economic activity prevalent in an area such as agriculture, mining, manufacturing, service activities or residential use of land. These activities directly influence the number of potential contamination sources as well as points of consumption of natural resources such as minerals and water.

An investigation of consumption of construction aggregates in the Chicago area by Bhagwat[18] indicates that population, employment, interest rates and the Gross State Product most significantly influence the demand for construction aggregates. Consumption of water can also be presumed to be correlated to population density and industrial activity. Quantifiable benefits in Boone and Winnebago counties in the area of mineral and water resources could thus be extrapolated on the basis of population to other counties. However, quantifiable data was available only in the area of environmental pollution. **Initially, the contamination potential within the study area as compared to the rest of the state was taken as the basis for statewide projection of quantifiable data.** In an alternative case, the influence of geology on mapping costs was included.

The base case projection relies on a comparison of the vulnerability of geologic materials in Boone and Winnebago counties to potential contamination with the vulnerability of the other 100 counties in Illinois. The contamination potential stems from waste generators, landfills, and CERCLA (Comprehensive Environmental Resource Conservation Recovery Act or Superfund) sites. Keefer and Berg (1990)[19] evaluated the contamination potential to aquifers in their map "Potential for aquifer recharge in Illinois." Seven categories showing increasing potential for aquifer recharge or potential for contamination were produced. The highest potential for aquifer contamination occurs in regions that contain a major aquifer (100,000 gpd) within 1.5 m of the surface. The lowest potential for aquifer contamination occurs in regions that have no aquifers within 15 m of the surface and no major aquifer at any depth. This mapping is based on the principle that the closer the aquifer is to the surface, the higher is its potential vulnerability to contamination from waste sources.

The geologic information was combined with information compiled by the Illinois State Water Survey (ISWS) showing the statewide distribution of waste generators, landfills and CERCLA sites, per zip code per square mile[20]. The resulting map "Prioritization of aquifer recharge areas in Illinois" (ISGS-ISWS unpublished map on open-file) combines aquifer vulnerability with the locations of potential contamination sources. Highly vulnerable areas containing numerous potential waste sources are mapped as "very high"; areas containing fewer potential waste sources are ranked lower. A total of ten map units were produced and ranked from 1 to 10 according to vulnerability. The difference between rank levels is qualitative, i.e. unit number 10 is not necessarily twice as vulnerable as unit number 5 for example.

For each county the percent of land area in each rank was calculated, and then multiplied by the rank number. For example, if in a county with 54 percent of the land area is classified as rank 10 (540), 20 percent as rank 9 (180), 10 percent as rank 8 (80), 8 percent as rank 7 (56), and 8 percent as rank 1 (8), then the weighted average score derived by adding the percentaged rankings would be 864. This calculation of the contamination potential score was done for each county. The score represents the overall potential susceptibility of geologic materials and groundwater within each Illinois county to contamination from waste sources.

The calculated contamination potential score for a given county is a function of aquifer vulnerability, number of potential sources and the area affected. The higher the score the greater the contamination potential and therefore, the greater the potential benefits from geologic maps that could prevent contamination from occurring if used in decision-making.

The methodology of benefit and cost extrapolation must account for the county score as well as county size. The county scores range from a low of 18 to a high of 796. **Figure 4** is the frequency distribution of scores in groups of 50 with the mean score for all Illinois counties at 320.

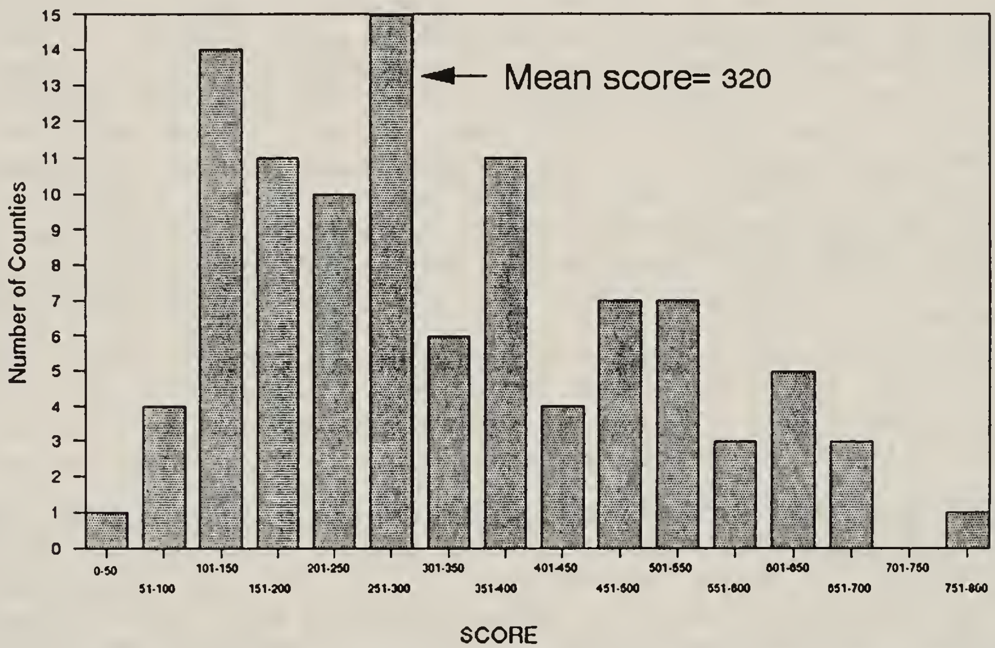


Figure 4:**Aquifer Contamination Potential Scores for Illinois Counties**

The contamination potential score incorporates the proportions (%) of county areas with their appropriate rank on a vulnerability scale of 1 to 10, based on sources of contamination per square mile per zip code; but it does not account for the county size in square miles, i.e. the scores are based on percentages of areas while benefit and cost are also influenced by square miles affected. In order to account for the square miles in each vulnerability category the following formula for Estimated Total Benefits for the State of Illinois was used:

$$\sum_{i-1}^{102}\left(\frac{B_{bw}}{(A_{bw}xS_{bw})}\right)A_i xS_i$$

where B_{bw} = Benefits in Boone and Winnebago counties in 1990 dollars.
A_{bw} = Area of Boone and Winnebago counties in square miles.
S_{bw} = Sum of contamination potential scores for Boone and Winnebago counties.
A_i = Area of county i.
S_i = Contamination potential score for county i.
i = County number 1 to 102.

The use of contamination potential scores for statewide projection of benefits of geologic mapping has its limitations but contamination potential scores are the only practical basis available for extrapolation. The limitations arise from two sources: 1) The vulnerability rankings are qualitative; for example: areas ranked 6 on vulnerability scale are not necessarily twice as vulnerable as areas ranked 3. 2) The number of potential sources in an area alone does not reflect the extent of potential contamination unless the amount of effluents from each source is known. There is no practical way of quantifying the vulnerability rankings relative to one another but there is no other known way of accounting for vulnerability to contamination. Therefore, the qualitative vulnerability rankings have been used. The size of the potential source of contamination is of secondary significance because as long as a plant location is attractive to a business there would be little reason why larger businesses should be concentrated in one location and smaller ones in another. It is also acknowledged that some kinds of businesses with high potential for contaminating the environment may be concentrated in one county while the same number of other businesses with lower potential for contaminating the environment may be located in another county. The resulting contamination potential scores for the two counties may, if the geology were identical, appear to be the same but in fact will not be the same. Having acknowledged the above limitations of the contamination potential scores, the scores represent the best available basis for benefit projection. **An indication of the usefulness of contamination potential scores for extrapolation is the closeness of projected and actual benefits from category 1 IEPA expenditures as discussed in section 9, paragraph 3 of this report.**

The cost of geologic mapping in this case is assumed to be primarily dependent upon county size, although the geological complexity and the type of mapping desired may require more or less work in other cases. The projection of mapping costs in the base case is therefore based on the following formula for <u>Estimated Total Costs of Mapping for State of Illinois</u>

$$\sum_{i-1}^{102} \frac{C_{bw}}{A_{bw}} x A_i$$

where C_{bw} = Cost of geologic mapping in Boone and Winnebago counties in 1990 dollars.

The geology of Boone and Winnebago counties is thought to be sufficiently different from other counties to justify an alternative cost scenario. According to ISGS geologists, the statewide mapping program will include activities that were not undertaken during the Boone and Winnebago county mapping. The statewide mapping program will include expanded data collection, more detailed subsurface and bedrock mapping, extensive computer processing, and the publication of maps of higher resolution (1:24,000 scale) than in Boone and Winnebago counties. A more intensive program of data collection through field study of outcrops and drilling of stratigraphic control borings is intended, which will allow mapping of Quaternary deposits from the ground surface to depths exceeding 400 feet. Computer processing of data from the archives of government and industry is expected to provide an initial database for the mapping team. Computer technology will be applied to digitize map products and assist in the publication of maps. Digitization of maps is expected to enhance their utility, making it easier to produce derivative map products. ISGS geologists estimate that the proposed statewide mapping program will cost about $55,000,000 or 2.6 times the cost estimate in the base case made from the Boone and Winnebago counties experience. Therefore, the B/C ratios in section 9 are presented in two parts: First, the Boone and Winnebago county benefits and costs are projected statewide, and then in an alternative scenario based on the higher mapping cost the B/C ratios are calculated again.

9. Results of statewide benefits/cost estimates

In **Scenario I**, the benefits and cost of geologic mapping in Boone and Winnebago counties were projected to the entire state of Illinois using contamination potential scores and county areas. The contamination potential scores account for hydrogeologic conditions as well as the number of potential sources of contamination in counties. Together with county areas, the contamination potential scores permit a reasonable projection of results from Boone and Winnebago counties to the rest of the state. **Table 6** contains the county-by-county results of Scenario I benefits and costs. In table 6 the counties are listed in descending order of contamination potential scores (column 1). The county areas are listed in column 3 after the county names. The benefit categories 1 through 4 discussed in section 7.2 are denoted by numbers 1-4 at the top in table 6. (It may be recalled that categories 2, 3 and 4 are cumulative.) Total benefits and cost for the entire State are listed at the bottom of each column. These sums contain benefits and costs of Boone and Winnebago counties and projections for other counties.

The projected total cost of geologic mapping in 1990 dollars in **Scenario I** is about $21 million. The category 4 benefits of geologic mapping are expected to range from $127 million to $295 million.

Category 1 benefits for Boone and Winnebago counties were assigned the highest confidence level because these benefits were derived from documentable IEPA spending of the past. The benefits were conservatively assumed to be half the IEPA spending , and to occur with a 10 year delay because not all leaky sites or Superfund sites can be avoided in the future even with the best geologic mapping. Based on these assumptions, the projected statewide benefits in category 1 totaled about $9.0 million (Table 6). **According to IEPA, $55,267,052 were spent statewide as of 6/30/1990. Applying the same method of benefits estimation discussed above, the statewide category 1 benefits amount to $10.6 million compared with $9.0 million as a result of projection of category 1 benefits from Boone and Winnebago counties to the entire State. The closeness of the two benefit estimates supports the validity of the methodology used in projecting the benefits.**

The County-by-County B/C ratios for Scenario I are listed in descending order in **table 7.** The statewide B/C ratio in benefit category 4 ranged from 6 to 14. Winnebago and Boone county B/C ratios are not listed because the combined B/C ratio of Boone and Winnebago counties was discussed previously. Hamilton is the only county with B/C ratio lower than one in category 4.

In **table 8**, B/C ratios for Illinois counties have been determined under the assumption of a cost increase due to additional work required in other counties as discussed at the end of section 8. According to table 8, the B/C ratio for category 4 benefits range from 2.3 to 5.4 for the entire State.

The **Scenario II** projections for the entire state are presented in **tables 9, 10, and 11.** In this scenario, we assume that potential benefits will be discounted by 75 percent because of the success of existing environmental regulations and of improved engineering and design of disposal facilities in preventing future contamination. Under Scenario II, the statewide benefits would be $4.5 million in category 1 and from $64 million to $148 million in category 4 (table 9). If the cost of statewide mapping is $21 million, the B/C ratios for the entire state would be 0.2 in category 1 and range from 3 to 7 in category 4 (table 10). However, if the cost of mapping increases to $55 million, the B/C ratio declines to 0.1 in category 1 and to a range of 1.2 to 2.7 in category 4 (table 11). The category 4 B/C ratios indicate that the geologic mapping program for Illinois would pay for itself even when potential benefits are discounted by 75 percent and delayed by 10 years.

In **Scenario III**, presented in **tables 12, 13, and 14**, the projections were based on the assumption that 90 percent of the potential benefits will not materialize because of the effectiveness of current and future environmental regulations and improved engineering design of disposal facilities. The statewide benefits from the geologic mapping program in scenario III are projected to be $2.0 million in category 1 and $25 million to $59 million in category 4 (table 12). At the lower mapping costs of $21 million, the B/C ratio for the entire state would be 0.1 in category 1 and 1.2 to 2.8 in category 4 (table 13). At the higher mapping costs of $55 million, the ratio would decline to an insignificant level in category 1 and range from 0.5 to 1.1 in category 4 (table 14). The upper range estimate in category 4 remains greater than 1 in spite of the 90 percent discounting of benefits and exclusion of a number of benefits that are evident but not quantifiable.

The B/C ratios could be used to prioritize counties for geologic mapping. However, B/C ratios cannot be the sole criterion for prioritization. Geologic mapping is most beneficial when conducted in multi-county groupings. Therefore, mapping priorities should consider geographic contiguity along with the B/C ratios. In addition, other criteria may alter prioritization if information about probable occurrence of valuable minerals or geologic hazard such as earthquakes are taken into consideration. The B/C ratios will increase if as yet unquantified benefits are considered.

10. Summary

The benefits and cost of geologic mapping conducted in 1980 in Boone and Winnebago counties were estimated. The mapping program in 1980 cost about $174,000, or the equivalent of $300,000 in 1990 dollars. The benefits, some quantifiable but many more unquantifiable, are largely in the form of our ability to use the geologic knowledge to reduce or eliminate some of the future expenses. Such future expenses would be for cleaning up contaminated earth materials and groundwater, for mineral exploration, for urban waste disposal etc. Information about such future benefits was gained from interviews with some 55 individuals in the two counties. The quantifiable benefits data were available only on future estimated clean-up costs for contaminated sites. No other benefits were quantifiable.

The benefits were classified into 4 categories according to the level of variabilty expected in the estimated dollar amounts. Category 1 was for benefits that were certain, i.e. ±0% variability; category 2 with ±10% variability, category 3 with

±30% and category 4 with ±50% variability. It was deemed necessary to project three benefit scenarios based on applicability and effectiveness of existing and future environmental regulations in preventing future contamination problems. In **Scenario I,** the benefits were reduced by 50 percent to account for the fact that geologic information may not be used or requirements for siting industrial facilities are not yet in place. In **Scenario II,** the benefits were discounted by 75 percent under the assumption that some progress will be made in requiring the use of geology in siting industrial facilities, in improving the regulatory procedures, and in designing safer waste disposal facilities. In **Scenario III,** the benefits were, discounted by 90 percent assuming that most of the contamination will be prevented due to the success of existing and expected future regulatory rules on siting industrial and waste disposal facilities, and due to better designs of facilities. Furthermore, the realization of all the benefits was delayed by ten years to reflect the difficulties in implementing the geologic knowledge gained from the mapping program and any inherent inaccuracies in the data at the scale of compilation. Finally, the benefits were discounted back at a 10% annual rate to 1990 and the Benefit/Cost ratios (B/C) calculated.

The B/C ratios for Boone and Winnebago counties for category 1 and 4 are summarized below:

	B/C ratio for Category 1	B/C ration for Category 4
Scenario I	1.65	23.5 to 54.5
Scenario II	0.83	11.7 to 27.2
Scenario III	0.33	4.7 to 10.9

A statewide projection of Boone and Winnebago county results was made on the basis of county areas and a groundwater contamination potential score. The contamination potential score accounts for the vulnerability of groundwater to contamination and the number of potential sources of contamination per square mile. The projected statewide B/C ratios for geologic mapping programs are summarized below:

	Statewide B/C ratio for Category 1		Statewide B/C ratio for Category 4	
	Lower Cost	Higher Cost	Lower Cost	Higher Cost
Scenario I	0.4	0.2	6 - 14	2.3 - 5.4
Scenario II	0.2	0.1	3 - 7	1.2 - 2.7
Scenario III	0.1	--	1.2 - 2.8	0.5 - 1.1

The most conservative projection in Scenario III, with higher cost of mapping, indicates that after discounting the potential future benefits by 90 percent and delaying their realization by 10 years the benefits in category 4 would range from $27.5 million to 60.5 million on an investment of $55 million in statewide geologic mapping. It should be emphasized that all the B/C ratios are based on benefits from avoidance of expenses related only to soil and groundwater contamination. The ratios will increase as numerous other benefits are quantified and included in calculations.

Table 6: Projected benefits and cost of geologic mapping program for Illinois (Scenario I)

#	SCORE	COUNTY	AREA	CATEGORY 1 ESTIMATED BENEFITS (1990 $)	CATEGORY 1 ESTIMATED COST (1990 $)	CATEGORY 2 ESTIMATED BENEFITS (1990 $)	CATEGORY 2 RANGE	CATEGORY 3 ESTIMATED BENEFITS (1990 $)	CATEGORY 3 RANGE	CATEGORY 4 ESTIMATED BENEFITS (1990 $)	CATEGORY 4 RANGE
1	796	Winnebago	516	--	--	--	--	--	--	--	--
2	688	Whiteside	682	231,277	256,391	626,376	715,514	1,553,895	2,438,049	3,274,020	7,593,606
3	682	McHenry	606	203,751	227,820	551,826	630,355	1,368,953	2,147,877	2,884,352	6,689,830
4	673	Alaxander	236	78,304	88,722	212,073	242,253	526,105	825,455	1,108,492	2,570,983
5	649	Mason	536	171,516	201,504	464,522	530,627	1,152,371	1,808,062	2,428,019	5,631,433
6	621	Ogla	759	232,444	285,338	629,535	719,123	1,561,732	2,450,345	3,290,533	7,631,906
7	606	Kankakae	679	202,850	255,263	549,386	627,567	1,362,899	2,138,378	2,871,596	6,660,244
8	605	DuPaga	337	100,442	126,692	272,031	310,743	674,847	1,058,829	1,421,886	3,297,855
9	605	Rock Island	423	126,043	159,023	341,367	389,946	846,853	1,328,705	1,784,299	4,138,418
10	581	Kane	524	149,994	196,992	406,234	464,045	1,007,773	1,581,189	2,123,355	4,924,809
11	558	Cook	958	263,512	360,150	713,678	815,240	1,770,471	2,777,855	3,730,341	8,651,976
12	557	Staphanson	564	154,792	212,030	419,228	478,887	1,040,007	1,631,763	2,191,271	5,082,330
13	542	Carroll	444	118,592	166,917	321,187	366,895	796,791	1,250,159	1,678,821	3,893,777
14	539	Will	844	224,238	317,293	607,311	693,736	1,506,599	2,363,843	3,174,370	7,362,483
15	522	Monroe	388	99,913	145,865	270,598	309,106	671,291	1,053,250	1,414,394	3,280,477
16	518	Union	414	105,606	155,639	286,017	326,719	709,542	1,113,266	1,494,989	3,467,407
17	513	Marcar	559	141,338	210,150	382,789	437,263	949,612	1,489,934	2,000,810	4,640,585
18	510	Pulaski	203	51,058	76,316	138,283	157,962	343,048	538,240	722,795	1,676,417
19	502	Putnam	160	39,622	60,150	107,311	122,582	266,213	417,686	560,905	1,300,936
20	481	Hanry	824	195,262	309,774	528,836	604,093	1,311,919	2,058,391	2,764,183	6,411,114
21	478	Ford	486	114,503	182,707	310,113	354,245	769,319	1,207,056	1,620,938	3,759,526
22	477	JoDaviass	603	141,712	226,692	383,804	438,422	952,129	1,493,884	2,006,115	4,652,887
23	475	Laa	725	169,698	272,556	459,598	525,002	1,140,156	1,788,896	2,402,282	5,571,739
24	473	Tazawall	650	151,656	244,361	410,734	469,185	1,018,937	1,598,704	2,146,877	4,979,363
25	451	Buraau	869	193,110	326,692	523,007	597,435	1,297,461	2,035,706	2,733,720	6,340,460
26	450	Laka	454	100,761	170,677	272,894	311,729	676,988	1,062,189	1,426,398	3,308,319
27	424	Boone	282	--	--	--	--	--	--	--	--
28	415	Gallatin	325	66,434	122,180	179,926	205,531	446,355	700,328	940,460	2,181,259
29	409	Johnson	346	69,787	130,075	189,007	215,904	468,883	735,674	987,926	2,291,349
30	406	Grundy	423	84,667	159,023	229,308	261,940	568,860	892,536	1,198,574	2,779,915
31	399	Logan	619	121,809	232,707	329,899	376,846	818,403	1,284,068	1,724,356	3,999,389
32	397	Pika	830	162,311	312,030	439,593	502,151	1,090,530	1,711,032	2,297,720	5,329,224
33	387	Champaign	998	190,452	375,188	515,808	589,212	1,279,601	2,007,684	2,696,090	6,253,183
34	385	Massac	241	45,790	90,602	124,015	141,664	307,653	482,705	648,218	1,503,446
35	385	Hardin	181	34,303	68,045	92,903	106,124	230,472	361,608	485,598	1,126,273
36	380	Handarson	373	69,854	140,226	189,187	216,110	469,329	736,374	988,866	2,293,529
37	374	LaSalla	1139	210,017	428,195	568,795	649,739	1,411,049	2,213,926	2,973,048	6,895,547
38	371	Scott	251	45,846	94,361	124,165	141,835	308,025	483,289	649,002	1,505,265
39	361	Kandall	322	57,287	121,053	155,153	177,232	384,898	603,902	810,971	1,880,927
40	357	Fayatta	709	124,772	266,541	337,924	386,013	838,312	1,315,305	1,766,303	4,096,680
41	351	Cass	374	64,747	140,602	175,355	200,310	435,016	682,537	916,569	2,125,848
42	339	Iroquois	1118	186,995	420,301	506,446	578,517	1,256,375	1,971,243	2,647,153	6,139,681
43	333	Pope	374	61,475	140,602	166,494	190,187	413,032	648,044	870,249	2,018,414
44	332	DaWitt	397	64,918	149,248	175,821	200,842	436,171	684,349	919,003	2,131,491
45	328	Jarsay	373	60,321	140,226	163,370	186,618	405,282	635,885	853,920	1,980,542
46	322	Lawrenca	374	59,397	140,602	160,867	183,759	399,074	626,143	840,839	1,950,202
47	314	Livingston	1046	161,708	393,233	437,959	500,283	1,086,474	1,704,670	2,289,176	5,309,405
48	289	Jackson	590	83,915	221,805	227,271	259,614	563,807	884,609	1,187,929	2,755,225
49	288	DaKalb	634	90,030	238,346	243,831	278,530	604,888	949,065	1,274,485	2,955,980
50	287	Marshall	388	54,879	145,865	148,631	169,782	368,719	578,517	776,882	1,801,864
51	283	Piatt	439	61,136	165,038	165,577	189,140	410,759	644,477	865,459	2,007,305
52	277	Randolph	583	79,523	219,173	215,376	246,025	534,297	838,308	1,125,752	2,611,015
53	275	St. Clair	672	91,004	252,632	246,469	281,544	611,434	959,335	1,288,277	2,987,968
54	269	Graane	543	71,947	204,135	194,858	222,587	483,397	758,446	1,018,506	2,362,274
55	263	White	497	64,331	186,842	174,230	199,025	432,225	678,158	910,688	2,112,207
56	262	Montgomery	705	91,171	265,038	246,922	282,061	612,556	961,095	1,290,641	2,993,451
57	262	Macon	581	75,029	218,421	203,205	232,122	504,104	790,935	1,062,135	2,463,465
58	261	Christian	710	91,384	266,917	247,498	282,719	613,985	963,337	1,293,651	3,000,434
59	261	Woodford	527	67,796	198,120	183,615	209,744	455,505	714,684	959,739	2,225,974
60	257	Stark	288	36,479	108,271	98,798	112,858	245,095	384,552	516,409	1,197,735
61	255	Madison	728	91,472	273,684	247,737	282,992	614,579	964,270	1,294,904	3,003,338
62	252	Williamson	427	52,989	160,526	143,512	163,935	356,020	558,592	750,126	1,739,806
63	248	Calhoun	250	30,557	93,985	82,759	94,536	205,305	322,122	432,572	1,003,288
64	241	Warran	543	64,627	204,135	175,033	199,941	434,216	681,281	914,882	2,121,934
65	238	Crawford	446	52,320	167,669	141,699	161,864	351,523	551,537	740,652	1,717,832
66	236	Clinton	472	54,900	177,444	148,687	169,846	368,858	578,736	777,176	1,802,545
67	227	Washington	563	63,112	211,654	170,928	195,252	424,032	665,303	893,425	2,072,168
68	225	Marion	573	63,561	215,414	172,143	196,640	427,047	670,034	899,779	2,086,904
69	221	Menard	315	34,294	118,421	92,880	106,098	230,414	361,518	485,478	1,125,993
70	215	Paoria	621	65,953	233,459	178,622	204,041	443,119	695,251	933,642	2,165,446
71	211	Hancock	796	82,906	299,248	224,538	256,491	557,026	873,970	1,173,641	2,722,087
72	205	McLaan	1185	119,532	445,489	323,732	369,802	803,105	1,260,066	1,692,124	3,924,633
73	195	Adams	852	81,801	320,301	221,545	253,073	549,602	862,322	1,158,000	2,685,809
74	189	Wabash	224	20,866	84,211	56,512	64,554	140,194	219,963	295,385	685,103
75	183	Varmilion	900	81,322	338,346	220,246	251,589	546,380	857,266	1,151,210	2,670,062
76	179	Clay	469	41,481	176,316	112,344	128,331	278,698	437,276	587,211	1,361,950
77	172	Knox	720	61,083	270,677	165,432	188,974	410,399	643,913	864,701	2,005,547
78	166	Parry	443	36,150	166,541	97,907	111,840	242,885	381,085	511,754	1,186,938
79	164	Franklin	414	33,555	155,639	90,879	103,812	225,450	353,729	475,018	1,101,734
80	162	Moultria	325	25,983	122,180	70,370	80,385	174,573	273,903	367,821	853,106
81	159	Edgar	623	48,714	234,211	131,934	150,709	327,298	513,528	689,609	1,599,446
82	155	Clark	506	38,660	190,226	104,705	119,605	259,748	407,543	547,284	1,269,343
83	155	Saline	385	29,355	144,737	79,502	90,816	197,227	309,447	415,552	963,811
84	148	Jaffarson	570	41,496	214,286	112,386	128,379	278,803	437,440	587,432	1,362,462
85	142	Wayne	715	50,054	268,797	135,563	154,855	336,301	527,654	708,579	1,643,445
86	141	Brown	306	21,300	115,038	57,686	65,896	143,107	224,533	301,523	699,337
87	138	Jasper	496	33,787	186,466	91,505	104,527	227,003	356,166	478,291	1,109,325
88	137	Douglas	417	28,253	156,767	76,519	87,408	189,826	297,835	399,958	927,644
89	136	Fulton	871	58,579	327,444	158,653	181,230	393,581	617,526	829,266	1,923,360
90	136	Colas	509	34,065	191,353	92,259	105,388	228,874	359,101	482,232	1,118,465
91	133	Sangamon	866	56,574	325,564	153,222	175,027	380,108	596,387	800,879	1,857,521
92	132	Schuylar	436	28,470	163,910	77,107	88,080	191,284	300,124	403,031	934,772
93	119	Morgan	568	33,263	213,534	90,086	102,906	223,483	350,642	470,873	1,092,120
94	111	Richland	360	19,728	135,338	53,430	61,034	132,548	207,966	279,275	647,736
95	110	Effingham	478	25,994	179,699	70,401	80,419	174,648	274,022	367,980	853,474
96	109	Shalby	747	40,008	280,827	108,354	123,774	268,802	421,748	566,360	1,313,588
97	109	Cumberland	346	18,514	130,075	50,142	57,278	124,391	195,168	262,089	607,876
98	83	McDonough	590	24,128	221,805	65,348	74,647	162,112	254,353	341,566	792,213
99	82	Edwards	223	8,978	83,835	24,315	27,775	60,320	94,642	127,093	294,774
100	67	Macoupin	865	28,523	325,188	77,250	88,243	191,639	300,681	403,780	936,507
101	61	Bond	377	11,313	141,729	30,639	34,999	76,008	119,256	160,147	371,437
102	18	Hamilton	436	3,963	163,910	10,733	12,260	26,625	41,774	56,098	130,112
		TOTALS		$8,985,695	$20,921,429	$24,336,259	$27,799,495	$60,372,642	$94,724,207	$127,203,752	$295,030,335

Table 7: Projected B/C ratios by county
(Scenario I - Lower Cost Base)

COUNTY	CATEGORY 1	CATEGORY 2 RANGE		CATEGORY 3 RANGE		CATEGORY 4 RANGE	
Winnebago	--	--	--	--	--	--	--
Whiteside	0.9	2.4	2.8	6.1	9.5	12.8	29.6
McHenry	0.9	2.4	2.8	6.0	9.4	12.7	29.4
Alexander	0.9	2.4	2.7	5.9	9.3	12.5	29.0
Mason	0.9	2.3	2.6	5.7	9.0	12.0	27.9
Ogle	0.8	2.2	2.5	5.5	8.6	11.5	26.7
Kankakee	0.8	2.2	2.5	5.3	8.4	11.2	26.1
DuPage	0.8	2.1	2.5	5.3	8.4	11.2	26.0
Rock Island	0.8	2.1	2.5	5.3	8.4	11.2	26.0
Kane	0.8	2.1	2.4	5.1	8.0	10.8	25.0
Cook	0.7	2.0	2.3	4.9	7.7	10.4	24.0
Stephenson	0.7	2.0	2.3	4.9	7.7	10.3	24.0
Carroll	0.7	1.9	2.2	4.8	7.5	10.1	23.3
Will	0.7	1.9	2.2	4.7	7.5	10.0	23.2
Monroe	0.7	1.9	2.1	4.6	7.2	9.7	22.5
Union	0.7	1.8	2.1	4.6	7.2	9.6	22.3
Mercer	0.7	1.8	2.1	4.5	7.1	9.5	22.1
Pulaski	0.7	1.8	2.1	4.5	7.1	9.5	22.0
Putnam	0.7	1.8	2.0	4.4	6.9	9.3	21.6
Henry	0.6	1.7	2.0	4.2	6.6	8.9	20.7
Ford	0.6	1.7	1.9	4.2	6.6	8.9	20.6
JoDaviess	0.6	1.7	1.9	4.2	6.6	8.8	20.5
Lee	0.6	1.7	1.9	4.2	6.6	8.8	20.4
Tazewell	0.6	1.7	1.9	4.2	6.5	8.8	20.4
Bureau	0.6	1.6	1.8	4.0	6.2	8.4	19.4
Lake	0.6	1.6	1.8	4.0	6.2	8.4	19.4
Boone	--	--	--	--	--	--	--
Gallatin	0.5	1.5	1.7	3.7	5.7	7.7	17.9
Johnson	0.5	1.5	1.7	3.6	5.7	7.6	17.6
Grundy	0.5	1.4	1.6	3.6	5.6	7.5	17.5
Logan	0.5	1.4	1.6	3.5	5.5	7.4	17.2
Pike	0.5	1.4	1.6	3.5	5.5	7.4	17.1
Champaign	0.5	1.4	1.6	3.4	5.4	7.2	16.7
Massac	0.5	1.4	1.6	3.4	5.3	7.2	16.6
Hardin	0.5	1.4	1.6	3.4	5.3	7.1	16.6
Henderson	0.5	1.3	1.5	3.3	5.3	7.1	16.4
LaSalle	0.5	1.3	1.5	3.3	5.2	6.9	16.1
Scott	0.5	1.3	1.5	3.3	5.1	6.9	16.0
Kendall	0.5	1.3	1.5	3.2	5.0	6.7	15.5
Fayette	0.5	1.3	1.4	3.1	4.9	6.6	15.4
Cass	0.5	1.2	1.4	3.1	4.9	6.5	15.1
Iroquois	0.4	1.2	1.4	3.0	4.7	6.3	14.6
Pope	0.4	1.2	1.4	2.9	4.6	6.2	14.4
DeWitt	0.4	1.2	1.3	2.9	4.6	6.2	14.3
Jersey	0.4	1.2	1.3	2.9	4.5	6.1	14.1
Lawrence	0.4	1.1	1.3	2.8	4.5	6.0	13.9
Livingston	0.4	1.1	1.3	2.8	4.3	5.8	13.5
Jackson	0.4	1.0	1.2	2.5	4.0	5.4	12.4
DeKalb	0.4	1.0	1.2	2.5	4.0	5.3	12.4
Marshall	0.4	1.0	1.2	2.5	4.0	5.3	12.4
Piatt	0.4	1.0	1.1	2.5	3.9	5.2	12.2
Randolph	0.4	1.0	1.1	2.4	3.8	5.1	11.9
St. Clair	0.4	1.0	1.1	2.4	3.8	5.1	11.8
Greene	0.4	1.0	1.1	2.4	3.7	5.0	11.6
White	0.3	0.9	1.1	2.3	3.6	4.9	11.3
Montgomery	0.3	0.9	1.1	2.3	3.6	4.9	11.3
Macon	0.3	0.9	1.1	2.3	3.6	4.9	11.3
Christian	0.3	0.9	1.1	2.3	3.6	4.8	11.2
Woodford	0.3	0.9	1.1	2.3	3.6	4.8	11.2
Stark	0.3	0.9	1.0	2.3	3.6	4.8	11.1
Madison	0.3	0.9	1.0	2.2	3.5	4.7	11.0
Williamson	0.3	0.9	1.0	2.2	3.5	4.7	10.8
Calhoun	0.3	0.9	1.0	2.2	3.4	4.6	10.7
Warren	0.3	0.9	1.0	2.1	3.3	4.5	10.4
Crawford	0.3	0.8	1.0	2.1	3.3	4.4	10.2
Clinton	0.3	0.8	1.0	2.1	3.3	4.4	10.2
Washington	0.3	0.8	0.9	2.0	3.1	4.2	9.8
Marion	0.3	0.8	0.9	2.0	3.1	4.2	9.7
Menard	0.3	0.8	0.9	1.9	3.1	4.1	9.5
Peoria	0.3	0.8	0.9	1.9	3.0	4.0	9.3
Hancock	0.3	0.8	0.9	1.9	2.9	3.9	9.1
McLean	0.3	0.7	0.8	1.8	2.8	3.8	8.8
Adams	0.3	0.7	0.8	1.7	2.7	3.6	8.4
Wabash	0.2	0.7	0.8	1.7	2.6	3.5	8.1
Vermilion	0.2	0.7	0.7	1.6	2.5	3.4	7.9
Clay	0.2	0.6	0.7	1.6	2.5	3.3	7.7
Knox	0.2	0.6	0.7	1.5	2.4	3.2	7.4
Perry	0.2	0.6	0.7	1.5	2.3	3.1	7.1
Franklin	0.2	0.6	0.7	1.4	2.3	3.1	7.1
Moultrie	0.2	0.6	0.7	1.4	2.2	3.0	7.0
Edgar	0.2	0.6	0.6	1.4	2.2	2.9	6.8
Clark	0.2	0.6	0.6	1.4	2.1	2.9	6.7
Saline	0.2	0.5	0.6	1.4	2.1	2.9	6.7
Jefferson	0.2	0.5	0.6	1.3	2.0	2.7	6.4
Wayne	0.2	0.5	0.6	1.3	2.0	2.6	6.1
Brown	0.2	0.5	0.6	1.2	2.0	2.6	6.1
Jasper	0.2	0.5	0.6	1.2	1.9	2.6	5.9
Douglas	0.2	0.5	0.6	1.2	1.9	2.6	5.9
Fulton	0.2	0.5	0.6	1.2	1.9	2.5	5.9
Coles	0.2	0.5	0.6	1.2	1.9	2.5	5.8
Sangamon	0.2	0.5	0.5	1.2	1.8	2.5	5.7
Schuyler	0.2	0.5	0.5	1.2	1.8	2.5	5.7
Morgan	0.2	0.4	0.5	1.0	1.6	2.2	5.1
Richland	0.1	0.4	0.5	1.0	1.5	2.1	4.8
Effingham	0.1	0.4	0.4	1.0	1.5	2.0	4.7
Shelby	0.1	0.4	0.4	1.0	1.5	2.0	4.7
Cumberland	0.1	0.4	0.4	1.0	1.5	2.0	4.7
McDonough	0.1	0.3	0.3	0.7	1.1	1.5	3.6
Edwards	0.1	0.3	0.3	0.7	1.1	1.5	3.5
Macoupin	0.1	0.2	0.3	0.6	0.9	1.2	2.9
Bond	0.1	0.2	0.2	0.5	0.8	1.1	2.6
Hamilton	0.0	0.1	0.1	0.2	0.3	0.3	0.8
STATE B/C RATIO	0.4	1.2	1.3	2.9	4.5	6.1	14.1

Table 8: Projected B/C ratios by county
(Scenario I - Higher Cost Base)

COUNTY	CATEGORY 1	CATEGORY 2 RANGE		CATEGORY 3 RANGE		CATEGORY 4 RANGE	
Winnebago	--	--	--	--	--	--	--
Whiteside	0.3	0.9	1.1	2.3	3.6	4.8	11.2
McHenry	0.3	0.9	1.1	2.3	3.6	4.8	11.2
Alexander	0.3	0.9	1.0	2.3	3.5	4.7	11.0
Mason	0.3	0.9	1.0	2.2	3.4	4.6	10.6
Ogle	0.3	0.8	1.0	2.1	3.3	4.4	10.2
Kankakee	0.3	0.8	0.9	2.0	3.2	4.3	9.9
DuPage	0.3	0.8	0.9	2.0	3.2	4.3	9.9
Rock Island	0.3	0.8	0.9	2.0	3.2	4.3	9.9
Kane	0.3	0.8	0.9	1.9	3.0	4.1	9.5
Cook	0.3	0.8	0.9	1.9	2.9	3.9	9.1
Stephenson	0.3	0.8	0.9	1.9	2.9	3.9	9.1
Carroll	0.3	0.7	0.8	1.8	2.8	3.8	8.9
Will	0.3	0.7	0.8	1.8	2.8	3.8	8.8
Monroe	0.3	0.7	0.8	1.7	2.7	3.7	8.5
Union	0.3	0.7	0.8	1.7	2.7	3.6	8.5
Mercer	0.3	0.7	0.8	1.7	2.7	3.6	8.4
Pulaski	0.3	0.7	0.8	1.7	2.7	3.6	8.3
Putnam	0.3	0.7	0.8	1.7	2.6	3.5	8.2
Henry	0.2	0.6	0.7	1.6	2.5	3.4	7.9
Ford	0.2	0.6	0.7	1.6	2.5	3.4	7.8
JoDaviess	0.2	0.6	0.7	1.6	2.5	3.4	7.8
Lee	0.2	0.6	0.7	1.6	2.5	3.3	7.8
Tazewell	0.2	0.6	0.7	1.6	2.5	3.3	7.7
Bureau	0.2	0.6	0.7	1.5	2.4	3.2	7.4
Lake	0.2	0.6	0.7	1.5	2.4	3.2	7.4
Boone	--	--	--	--	--	--	--
Gallatin	0.2	0.6	0.6	1.4	2.2	2.9	6.8
Johnson	0.2	0.6	0.6	1.4	2.1	2.9	6.7
Grundy	0.2	0.5	0.6	1.4	2.1	2.9	6.6
Logan	0.2	0.5	0.6	1.3	2.1	2.8	6.5
Pike	0.2	0.5	0.6	1.3	2.1	2.8	6.5
Champaign	0.2	0.5	0.6	1.3	2.0	2.7	6.3
Massac	0.2	0.5	0.6	1.3	2.0	2.7	6.3
Hardin	0.2	0.5	0.6	1.3	2.0	2.7	6.3
Henderson	0.2	0.5	0.6	1.3	2.0	2.7	6.2
LaSalle	0.2	0.5	0.6	1.3	2.0	2.6	6.1
Scott	0.2	0.5	0.6	1.2	1.9	2.6	6.1
Kendall	0.2	0.5	0.6	1.2	1.9	2.5	5.9
Fayette	0.2	0.5	0.5	1.2	1.9	2.5	5.8
Cass	0.2	0.5	0.5	1.2	1.8	2.5	5.7
Iroquois	0.2	0.5	0.5	1.1	1.8	2.4	5.5
Pope	0.2	0.4	0.5	1.1	1.8	2.4	5.5
DeWitt	0.2	0.4	0.5	1.1	1.7	2.3	5.4
Jersey	0.2	0.4	0.5	1.1	1.7	2.3	5.4
Lawrence	0.2	0.4	0.5	1.1	1.7	2.3	5.3
Livingston	0.2	0.4	0.5	1.0	1.6	2.2	5.1
Jackson	0.1	0.4	0.4	1.0	1.5	2.0	4.7
DeKalb	0.1	0.4	0.4	1.0	1.5	2.0	4.7
Marshall	0.1	0.4	0.4	1.0	1.5	2.0	4.7
Piatt	0.1	0.4	0.4	0.9	1.5	2.0	4.6
Randolph	0.1	0.4	0.4	0.9	1.5	2.0	4.5
St. Clair	0.1	0.4	0.4	0.9	1.4	1.9	4.5
Greene	0.1	0.4	0.4	0.9	1.4	1.9	4.4
White	0.1	0.4	0.4	0.9	1.4	1.9	4.3
Montgomery	0.1	0.4	0.4	0.9	1.4	1.8	4.3
Macon	0.1	0.4	0.4	0.9	1.4	1.8	4.3
Christian	0.1	0.4	0.4	0.9	1.4	1.8	4.3
Woodford	0.1	0.4	0.4	0.9	1.4	1.8	4.3
Stark	0.1	0.3	0.4	0.9	1.3	1.8	4.2
Madison	0.1	0.3	0.4	0.9	1.3	1.8	4.2
Williamson	0.1	0.3	0.4	0.8	1.3	1.8	4.1
Calhoun	0.1	0.3	0.4	0.8	1.3	1.7	4.1
Warren	0.1	0.3	0.4	0.8	1.3	1.7	3.9
Crawford	0.1	0.3	0.4	0.8	1.2	1.7	3.9
Clinton	0.1	0.3	0.4	0.8	1.2	1.7	3.9
Washington	0.1	0.3	0.4	0.8	1.2	1.6	3.7
Marion	0.1	0.3	0.3	0.8	1.2	1.6	3.7
Menard	0.1	0.3	0.3	0.7	1.2	1.6	3.6
Peoria	0.1	0.3	0.3	0.7	1.1	1.5	3.5
Hancock	0.1	0.3	0.3	0.7	1.1	1.5	3.5
McLean	0.1	0.3	0.3	0.7	1.1	1.4	3.3
Adams	0.1	0.3	0.3	0.7	1.0	1.4	3.2
Wabash	0.1	0.3	0.3	0.6	1.0	1.3	3.1
Vermilion	0.1	0.2	0.3	0.6	1.0	1.3	3.0
Clay	0.1	0.2	0.3	0.6	0.9	1.3	2.9
Knox	0.1	0.2	0.3	0.6	0.9	1.2	2.8
Perry	0.1	0.2	0.3	0.6	0.9	1.2	2.7
Franklin	0.1	0.2	0.3	0.6	0.9	1.2	2.7
Moultrie	0.1	0.2	0.2	0.5	0.9	1.1	2.7
Edgar	0.1	0.2	0.2	0.5	0.8	1.1	2.6
Clark	0.1	0.2	0.2	0.5	0.8	1.1	2.5
Saline	0.1	0.2	0.2	0.5	0.8	1.1	2.5
Jefferson	0.1	0.2	0.2	0.5	0.8	1.0	2.4
Wayne	0.1	0.2	0.2	0.5	0.7	1.0	2.3
Brown	0.1	0.2	0.2	0.5	0.7	1.0	2.3
Jasper	0.1	0.2	0.2	0.5	0.7	1.0	2.3
Douglas	0.1	0.2	0.2	0.5	0.7	1.0	2.2
Fulton	0.1	0.2	0.2	0.5	0.7	1.0	2.2
Coles	0.1	0.2	0.2	0.5	0.7	1.0	2.2
Sangamon	0.1	0.2	0.2	0.4	0.7	0.9	2.2
Schuyler	0.1	0.2	0.2	0.4	0.7	0.9	2.2
Morgan	0.1	0.2	0.2	0.4	0.6	0.8	1.9
Richland	0.1	0.1	0.2	0.4	0.6	0.8	1.8
Effingham	0.1	0.1	0.2	0.4	0.6	0.8	1.8
Shelby	0.1	0.1	0.2	0.4	0.6	0.8	1.8
Cumberland	0.1	0.1	0.2	0.4	0.6	0.8	1.8
McDonough	0.0	0.1	0.1	0.3	0.4	0.6	1.4
Edwards	0.0	0.1	0.1	0.3	0.4	0.6	1.3
Macoupin	0.0	0.1	0.1	0.2	0.4	0.5	1.1
Bond	0.0	0.1	0.1	0.2	0.3	0.4	1.0
Hamilton	0.0	0.0	0.0	0.1	0.1	0.1	0.3
STATE B/C RATIO	0.2	0.4	0.5	1.1	1.7	2.3	5.4

Table 9: Projected benefits and cost of geologic mapping program for Illinois (Scenario II)

'#	SCORE	COUNTY	AREA	CATEGORY 1 ESTIMATED BENEFITS (1990 $)	ESTIMATED COST (1990 $)	CATEGORY 2 ESTIMATED BENEFITS (1990 $)	RANGE	CATEGORY 3 ESTIMATED BENEFITS (1990 $)	RANGE	CATEGORY 4 ESTIMATED BENEFITS (1990 $)	RANGE
1	796	Winnebago	516	--	193,985	--	--	--	--	--	--
2	688	Whiteside	682	115,639	256,391	313,188	357,516	777,188	1,219,024	1,636,287	3,796,803
3	682	McHenry	606	101,876	227,820	275,913	314,965	684,689	1,073,938	1,441,539	3,344,915
4	673	Alexander	236	39,152	88,722	106,037	121,045	263,134	412,728	554,001	1,285,492
5	649	Mason	536	85,758	201,504	232,261	265,135	576,364	904,031	1,213,474	2,815,716
6	621	Ogle	759	116,222	285,338	314,768	359,319	781,108	1,225,173	1,644,540	3,815,953
7	606	Kankakee	679	101,425	255,263	274,693	313,572	681,661	1,069,189	1,435,164	3,330,122
8	605	DuPage	337	50,221	126,692	136,016	155,267	337,528	529,415	710,629	1,648,928
9	605	Rock Island	423	63,022	159,023	170,683	194,842	423,558	664,353	891,755	2,069,209
10	581	Kane	524	74,997	196,992	203,117	231,866	504,043	790,594	1,061,209	2,462,405
11	558	Cook	958	131,756	360,150	356,839	407,346	885,510	1,388,928	1,864,347	4,325,988
12	557	Stephenson	564	77,396	212,030	209,614	239,282	520,165	815,882	1,095,152	2,541,165
13	542	Carroll	444	59,296	166,917	160,594	183,324	398,519	625,080	839,040	1,946,888
14	539	Will	844	112,119	317,293	303,656	346,635	753,533	1,181,921	1,586,484	3,681,241
15	522	Monroe	388	49,957	145,865	135,299	154,449	335,749	526,625	706,885	1,640,239
16	518	Union	414	52,803	155,639	143,009	163,250	354,881	556,633	747,165	1,733,703
17	513	Mercer	559	70,669	210,150	191,395	218,484	474,953	744,967	999,964	2,320,292
18	510	Pulaski	203	25,529	76,316	69,142	78,928	171,577	269,120	361,238	838,208
19	502	Putnam	160	19,811	60,150	53,655	61,250	133,148	208,843	280,329	650,468
20	481	Henry	824	97,631	309,774	264,418	301,843	656,163	1,029,195	1,381,481	3,205,557
21	478	Ford	486	57,252	182,707	155,057	177,003	384,779	603,528	810,111	1,879,763
22	477	JoDaviess	603	70,856	226,692	191,902	219,064	476,212	746,942	1,002,614	2,326,443
23	475	Lee	725	84,849	272,556	229,799	262,324	570,255	894,448	1,200,611	2,785,870
24	473	Tazewell	650	75,828	244,361	205,367	234,434	509,626	799,352	1,072,964	2,489,682
25	451	Bureau	869	96,555	326,692	261,504	298,517	648,932	1,017,853	1,366,256	3,170,230
26	450	Lake	454	50,380	170,677	136,447	155,760	338,599	531,094	712,884	1,654,160
27	424	Boone	282	--	106,015	--	--	--	--	--	--
28	415	Gallatin	325	33,217	122,180	89,963	102,696	223,247	350,164	470,023	1,090,630
29	409	Johnson	346	34,894	130,075	94,504	107,880	234,514	367,837	493,745	1,145,675
30	406	Grundy	423	42,334	159,023	114,654	130,882	284,518	446,268	599,022	1,389,958
31	399	Logan	619	60,904	232,707	164,949	188,296	409,328	642,034	861,797	1,999,694
32	397	Pike	830	81,156	312,030	219,797	250,906	545,434	855,516	1,148,353	2,664,612
33	387	Champaign	998	95,226	375,188	257,904	294,407	639,999	1,003,842	1,347,450	3,126,592
34	385	Massac	241	22,895	90,602	62,008	70,784	153,874	241,353	323,966	751,723
35	385	Hardin	181	17,151	68,045	46,452	53,026	115,272	180,804	242,692	563,137
36	380	Henderson	373	34,927	140,226	94,594	107,982	234,737	368,187	494,215	1,146,764
37	374	LaSalle	1139	105,008	428,195	284,398	324,651	705,744	1,106,963	1,485,868	3,447,774
38	371	Scott	251	22,923	94,361	62,083	70,870	154,060	241,645	324,358	752,632
39	361	Kendall	322	28,644	121,053	77,576	88,556	192,509	301,951	405,306	940,463
40	357	Fayette	709	62,386	266,541	168,962	192,877	419,286	657,652	882,762	2,048,340
41	351	Cass	374	32,373	140,602	87,678	100,087	217,576	341,269	458,082	1,062,924
42	339	Iroquois	1118	93,498	420,301	253,223	289,064	628,382	985,621	1,322,992	3,069,840
43	333	Pope	374	30,737	140,602	83,247	95,029	206,580	324,022	434,932	1,009,207
44	332	DeWitt	397	32,459	149,248	87,910	100,353	218,153	342,175	459,298	1,065,745
45	328	Jersey	373	30,161	140,226	81,685	93,246	202,704	317,942	426,772	990,271
46	322	Lawrence	374	29,699	140,602	80,433	91,818	199,599	313,072	420,234	975,101
47	314	Livingston	1046	80,854	393,233	218,979	249,973	543,406	852,335	1,144,083	2,654,703
48	289	Jackson	590	41,958	221,805	113,636	129,719	281,991	442,305	593,702	1,377,612
49	288	DeKalb	634	45,015	238,346	121,915	139,171	302,538	474,532	636,961	1,477,990
50	287	Marshall	388	27,440	145,865	74,315	84,834	184,417	289,259	388,270	900,932
51	283	Piatt	439	30,568	165,038	82,789	94,506	205,443	322,239	432,539	1,003,653
52	277	Randolph	583	39,762	219,173	107,688	122,930	267,231	419,154	562,627	1,305,508
53	275	St. Clair	672	45,502	252,632	123,235	140,677	305,812	479,667	643,854	1,493,984
54	269	Greene	543	35,974	204,135	97,429	111,219	241,773	379,223	509,028	1,181,137
55	263	White	497	32,166	186,842	87,115	99,445	216,180	339,079	455,143	1,056,104
56	262	Montgomery	705	45,586	265,038	123,461	140,935	306,373	480,548	645,036	1,496,726
57	262	Macon	581	37,515	218,421	101,602	115,983	252,130	395,467	530,833	1,231,732
58	261	Christian	710	45,692	266,917	123,749	141,264	307,088	481,669	646,540	1,500,217
59	261	Woodford	527	33,898	198,120	91,807	104,802	227,823	357,342	479,658	1,112,987
60	257	Stark	288	18,240	108,271	49,399	56,391	122,585	192,276	258,091	598,867
61	255	Madison	728	45,736	273,684	123,869	141,401	307,385	482,135	647,166	1,501,669
62	252	Williamson	427	26,495	160,526	71,756	81,912	178,065	279,296	374,897	869,903
63	248	Calhoun	250	15,278	93,985	41,379	47,236	102,684	161,061	216,191	501,644
64	241	Warren	543	32,314	204,135	87,516	99,903	217,175	340,640	457,239	1,060,967
65	238	Crawford	446	26,160	167,669	70,850	80,878	175,816	275,769	370,162	858,916
66	236	Clinton	472	27,450	177,444	74,344	84,866	184,486	289,368	388,416	901,272
67	227	Washington	563	31,556	211,654	85,464	97,560	212,082	332,651	446,515	1,036,084
68	225	Marion	573	31,780	215,414	86,072	98,254	213,590	335,017	449,691	1,043,452
69	221	Menard	315	17,147	118,421	46,440	53,013	115,243	180,759	242,632	562,997
70	215	Peoria	621	32,976	233,459	89,311	101,952	221,628	347,626	466,615	1,082,723
71	211	Hancock	796	41,453	299,248	112,269	128,159	278,599	436,985	586,561	1,361,044
72	205	McLean	1185	59,766	445,489	161,866	184,776	401,677	630,033	845,689	1,962,316
73	195	Adams	852	40,901	320,301	110,773	126,451	274,886	431,161	578,744	1,342,905
74	189	Wabash	224	10,433	84,211	28,256	32,255	70,119	109,982	147,627	342,551
75	183	Vermilion	900	40,661	338,346	110,123	125,710	273,275	428,633	575,351	1,335,031
76	179	Clay	469	20,740	176,316	56,172	64,122	139,392	218,638	293,476	680,975
77	172	Knox	720	30,541	270,677	82,716	94,424	205,263	321,956	432,160	1,002,773
78	166	Perry	443	18,075	166,541	48,954	55,882	121,480	190,543	255,764	593,469
79	164	Franklin	414	16,778	155,639	45,440	51,871	112,760	176,865	237,404	550,867
80	162	Moultrie	325	12,991	122,180	35,185	40,165	87,313	136,952	183,829	426,553
81	159	Edgar	623	24,357	234,211	65,967	75,304	163,700	256,764	344,652	799,723
82	155	Clark	506	19,330	190,226	52,352	59,762	129,914	203,772	273,521	634,672
83	155	Saline	385	14,677	144,737	39,751	45,377	98,644	154,723	207,684	481,906
84	148	Jefferson	570	20,748	214,286	56,193	64,146	139,445	218,720	293,586	681,231
85	142	Wayne	715	25,027	268,797	67,782	77,375	168,203	263,827	354,133	821,722
86	141	Brown	306	10,650	115,038	28,843	32,926	71,576	112,267	150,695	349,669
87	138	Jasper	496	16,893	186,466	45,753	52,228	113,537	178,083	239,040	554,662
88	137	Douglas	417	14,127	156,767	38,259	43,675	94,942	148,917	199,891	463,822
89	136	Fulton	871	29,290	327,444	79,326	90,554	196,852	308,763	414,450	961,680
90	136	Coles	509	17,032	191,353	46,130	52,659	114,472	179,551	241,009	559,233
91	133	Sangamon	866	28,287	325,564	76,611	87,454	190,113	298,193	400,263	928,761
92	132	Schuyler	436	14,235	163,910	38,553	44,010	95,672	150,062	201,427	467,386
93	119	Morgan	568	16,631	213,534	45,043	51,418	111,776	175,321	235,332	546,060
94	111	Richland	360	9,864	135,338	26,715	30,496	66,294	103,983	139,576	323,868
95	110	Effingham	478	12,997	179,699	35,200	40,183	87,351	137,011	183,909	426,737
96	109	Shelby	747	20,004	280,827	54,177	61,845	134,443	210,874	283,055	656,794
97	109	Cumberland	346	9,757	130,075	25,071	28,620	62,215	97,584	130,986	303,938
98	83	McDonough	590	12,064	221,805	32,674	37,298	81,081	127,176	170,708	396,107
99	82	Edwards	223	4,489	83,835	12,158	13,878	30,169	47,321	63,519	147,387
100	67	Macoupin	865	14,262	325,188	38,625	44,092	95,849	150,340	201,801	468,254
101	61	Bond	377	5,656	141,729	15,319	17,488	38,016	59,628	80,038	185,718
102	18	Hamilton	436	1,981	163,910	5,366	6,126	13,317	20,887	28,037	65,056
		TOTALS		$4,492,848	$20,921,429	$12,168,129	$13,890,388	$30,195,681	$47,362,103	$63,573,796	$147,515,167
		B/C RATIO		0.2		0.6	0.7	1.4	2.3	3.0	7.1

Table 10: Projected B/C ratios by county (Scenario II - Lower Cost Base)

COUNTY	CATE-GORY 1	CATEGORY 2 RANGE		CATEGORY 3 RANGE		CATEGORY 4 RANGE	
Winnebago							
Whiteside	0.5	1.2	1.4	3.0	4.8	6.4	14.8
McHenry	0.4	1.2	1.4	3.0	4.7	6.3	14.7
Alexsnder	0.4	1.2	1.4	3.0	4.7	6.2	14.5
Mason	0.4	1.2	1.3	2.9	4.5	6.0	14.0
Ogls	0.4	1.1	1.3	2.7	4.3	5.8	13.4
Ksnksks	0.4	1.1	1.2	2.7	4.2	5.6	13.0
DuPsge	0.4	1.1	1.2	2.7	4.2	5.6	13.0
Rock Islsnd	0.4	1.1	1.2	2.7	4.2	5.6	13.0
Kane	0.4	1.0	1.2	2.6	4.0	5.4	12.5
Cook	0.4	1.0	1.1	2.5	3.9	5.2	12.0
Stephenson	0.4	1.0	1.1	2.5	3.8	5.2	12.0
Carroll	0.4	1.0	1.1	2.4	3.7	5.0	11.7
Will	0.4	1.0	1.1	2.4	3.7	5.0	11.6
Monroe	0.3	0.9	1.1	2.3	3.6	4.8	11.2
Union	0.3	0.9	1.0	2.3	3.6	4.8	11.1
Mercer	0.3	0.9	1.0	2.3	3.5	4.8	11.0
Pulaski	0.3	0.9	1.0	2.2	3.5	4.7	11.0
Putnam	0.3	0.9	1.0	2.2	3.5	4.7	10.8
Henry	0.3	0.9	1.0	2.1	3.3	4.5	10.3
Ford	0.3	0.8	1.0	2.1	3.3	4.4	10.3
JoDsviess	0.3	0.8	1.0	2.1	3.3	4.4	10.3
Lee	0.3	0.8	1.0	2.1	3.3	4.4	10.2
Tazewell	0.3	0.8	1.0	2.1	3.3	4.4	10.2
Bureau	0.3	0.8	0.9	2.0	3.1	4.2	9.7
Laks	0.3	0.8	0.9	2.0	3.1	4.2	9.7
Boone							
Gallstin	0.3	0.7	0.8	1.8	2.9	3.8	8.9
Johnson	0.3	0.7	0.8	1.8	2.8	3.8	8.8
Grundy	0.3	0.7	0.8	1.8	2.8	3.8	8.7
Logan	0.3	0.7	0.8	1.8	2.8	3.7	8.6
Pike	0.3	0.7	0.8	1.7	2.7	3.7	8.5
Champaign	0.3	0.7	0.8	1.7	2.7	3.6	8.3
Massac	0.3	0.7	0.8	1.7	2.7	3.6	8.3
Hsrdin	0.3	0.7	0.8	1.7	2.7	3.6	8.3
Henderson	0.2	0.7	0.8	1.7	2.6	3.5	8.2
LaSalle	0.2	0.7	0.8	1.6	2.6	3.5	8.1
Scott	0.2	0.7	0.8	1.6	2.6	3.4	8.0
Kendall	0.2	0.6	0.7	1.6	2.5	3.3	7.8
Fsyetts	0.2	0.6	0.7	1.6	2.5	3.3	7.7
Csss	0.2	0.6	0.7	1.5	2.4	3.3	7.6
Iroquols	0.2	0.6	0.7	1.5	2.3	3.1	7.3
Pope	0.2	0.6	0.7	1.5	2.3	3.1	7.2
DeWitt	0.2	0.6	0.7	1.5	2.3	3.1	7.1
Jerssy	0.2	0.6	0.7	1.4	2.3	3.0	7.1
Lswrence	0.2	0.6	0.7	1.4	2.2	3.0	6.9
Livingston	0.2	0.6	0.6	1.4	2.2	2.9	6.8
Jackson	0.2	0.5	0.6	1.3	2.0	2.7	6.2
DeKalb	0.2	0.5	0.6	1.3	2.0	2.7	6.2
Msrshall	0.2	0.5	0.6	1.3	2.0	2.7	6.2
Piatt	0.2	0.5	0.6	1.2	2.0	2.6	6.1
Randolph	0.2	0.5	0.6	1.2	1.9	2.6	6.0
St. Clslr	0.2	0.5	0.6	1.2	1.9	2.5	5.9
Greene	0.2	0.5	0.5	1.2	1.9	2.5	5.8
White	0.2	0.5	0.5	1.2	1.8	2.4	5.7
Montgomery	0.2	0.5	0.5	1.2	1.8	2.4	5.6
Macon	0.2	0.5	0.5	1.2	1.8	2.4	5.6
Christisn	0.2	0.5	0.5	1.2	1.8	2.4	5.6
Woodford	0.2	0.5	0.5	1.1	1.8	2.4	5.6
Stsrk	0.2	0.5	0.5	1.1	1.8	2.4	5.5
Madison	0.2	0.5	0.5	1.1	1.8	2.4	5.5
Williamson	0.2	0.4	0.5	1.1	1.7	2.3	5.4
Cslhoun	0.2	0.4	0.5	1.1	1.7	2.3	5.3
Warren	0.2	0.4	0.5	1.1	1.7	2.2	5.2
Crswford	0.2	0.4	0.5	1.0	1.6	2.2	5.1
Clinton	0.2	0.4	0.5	1.0	1.6	2.2	5.1
Washington	0.1	0.4	0.5	1.0	1.6	2.1	4.9
Marion	0.1	0.4	0.5	1.0	1.6	2.1	4.8
Menard	0.1	0.4	0.4	1.0	1.5	2.0	4.8
Peoria	0.1	0.4	0.4	0.9	1.5	2.0	4.6
Hancock	0.1	0.4	0.4	0.9	1.5	2.0	4.5
McLsan	0.1	0.4	0.4	0.9	1.4	1.9	4.4
Adams	0.1	0.3	0.4	0.9	1.3	1.8	4.2
Wabash	0.1	0.3	0.4	0.8	1.3	1.8	4.1
Vermilion	0.1	0.3	0.4	0.8	1.3	1.7	3.9
Clsy	0.1	0.3	0.4	0.8	1.2	1.7	3.9
Knox	0.1	0.3	0.3	0.8	1.2	1.6	3.7
Perry	0.1	0.3	0.3	0.7	1.1	1.5	3.6
Franklin	0.1	0.3	0.3	0.7	1.1	1.5	3.5
Moultris	0.1	0.3	0.3	0.7	1.1	1.5	3.5
Edgsr	0.1	0.3	0.3	0.7	1.1	1.5	3.4
Clsrk	0.1	0.3	0.3	0.7	1.1	1.4	3.3
Saline	0.1	0.3	0.3	0.7	1.1	1.4	3.3
Jefferson	0.1	0.3	0.3	0.7	1.0	1.4	3.2
Wsyne	0.1	0.3	0.3	0.6	1.0	1.3	3.1
Brown	0.1	0.3	0.3	0.6	1.0	1.3	3.0
Jasper	0.1	0.2	0.3	0.6	1.0	1.3	3.0
Douglas	0.1	0.2	0.3	0.6	0.9	1.3	3.0
Fulton	0.1	0.2	0.3	0.6	0.9	1.3	2.9
Coles	0.1	0.2	0.3	0.6	0.9	1.3	2.9
Sangamon	0.1	0.2	0.3	0.6	0.9	1.2	2.9
Schuyler	0.1	0.2	0.3	0.6	0.9	1.2	2.9
Morgsn	0.1	0.2	0.2	0.5	0.8	1.1	2.6
Richlsnd	0.1	0.2	0.2	0.5	0.8	1.0	2.4
Effingham	0.1	0.2	0.2	0.5	0.8	1.0	2.4
Shelby	0.1	0.2	0.2	0.5	0.8	1.0	2.3
Cumberlsnd	0.1	0.2	0.2	0.5	0.8	1.0	2.3
McDonough	0.1	0.1	0.2	0.4	0.6	0.8	1.8
Edwards	0.1	0.1	0.2	0.4	0.6	0.8	1.8
Macoupin	0.0	0.1	0.1	0.3	0.5	0.6	1.4
Bond	0.0	0.1	0.1	0.3	0.4	0.6	1.3
Hamilton	0.0	0.0	0.0	0.1	0.1	0.2	0.4
STATE B/C AVERAGE	0.2	0.3	0.7	1.4	2.3	3	7.1

Table 11: Projected B/C ratios by county (Scenario II - Higher Cost Base)

COUNTY	CATE-GORY 1	CATEGORY 2 RANGE		CATEGORY 3 RANGE		CATEGORY 4 RANGE	
Winnebago							
Whiteside	0.2	0.5	0.5	1.2	1.8	2.4	5.6
McHenry	0.2	0.5	0.5	1.1	1.8	2.4	5.6
Alexsnder	0.2	0.5	0.5	1.1	1.8	2.4	5.5
Mason	0.2	0.4	0.5	1.1	1.7	2.3	5.3
Ogls	0.2	0.4	0.5	1.0	1.6	2.2	5.1
Kankskss	0.2	0.4	0.5	1.0	1.6	2.1	5.0
DuPage	0.2	0.4	0.5	1.0	1.6	2.1	4.9
Rock Island	0.2	0.4	0.5	1.0	1.6	2.1	4.9
Ksne	0.1	0.4	0.4	1.0	1.5	2.0	4.7
Cook	0.1	0.4	0.4	0.9	1.5	2.0	4.6
Stephenson	0.1	0.4	0.4	0.9	1.5	2.C	4.6
Csrroll	0.1	0.4	0.4	0.9	1.4	1.9	4.4
Will	0.1	0.4	0.4	0.9	1.4	1.9	4.4
Monroe	0.1	0.4	0.4	0.9	1.4	1.8	4.3
Union	0.1	0.3	0.4	0.9	1.4	1.8	4.2
Mercsr	0.1	0.3	0.4	0.9	1.3	1.8	4.2
Pulaski	0.1	0.3	0.4	0.9	1.3	1.8	4.2
Putnam	0.1	0.3	0.4	0.8	1.3	1.8	4.1
Henry	0.1	0.3	0.4	0.8	1.3	1.7	3.9
Ford	0.1	0.3	0.4	0.8	1.3	1.7	3.9
JoDsviess	0.1	0.3	0.4	0.8	1.3	1.7	3.9
Lee	0.1	0.3	0.4	0.8	1.2	1.7	3.9
Tszewell	0.1	0.3	0.4	0.8	1.2	1.7	3.9
Buresu	0.1	0.3	0.3	0.8	1.2	1.6	3.7
Lske	0.1	0.3	0.3	0.8	1.2	1.6	3.7
Boone							
Gsllstin	0.1	0.3	0.3	0.7	1.1	1.5	3.4
Johnson	0.1	0.3	0.3	0.7	1.1	1.4	3.3
Grundy	0.1	0.3	0.3	0.7	1.1	1.4	3.3
Logan	0.1	0.3	0.3	0.7	1.0	1.4	3.3
Pike	0.1	0.3	0.3	0.7	1.0	1.4	3.2
Champaign	0.1	0.3	0.3	0.6	1.0	1.4	3.2
Msssac	0.1	0.3	0.3	0.6	1.0	1.4	3.2
Hardin	0.1	0.3	0.3	0.6	1.0	1.4	3.1
Henderson	0.1	0.3	0.3	0.6	1.0	1.3	3.1
LsSslle	0.1	0.3	0.3	0.6	1.0	1.3	3.1
Scott	0.1	0.2	0.3	0.6	1.0	1.3	3.0
Kendall	0.1	0.2	0.3	0.6	0.9	1.3	3.0
Fsyetts	0.1	0.2	0.3	0.6	0.9	1.3	2.9
Csss	0.1	0.2	0.3	0.6	0.9	1.2	2.9
Iroquois	0.1	0.2	0.3	0.6	0.9	1.2	2.8
Pope	0.1	0.2	0.3	0.6	0.9	1.2	2.7
DeWitt	0.1	0.2	0.3	0.6	0.9	1.2	2.7
Jersey	0.1	0.2	0.3	0.5	0.9	1.2	2.7
Lawrence	0.1	0.2	0.2	0.5	0.8	1.1	2.6
Livingston	0.1	0.2	0.2	0.5	0.8	1.1	2.6
Jackson	0.1	0.2	0.2	0.5	0.8	1.0	2.4
DeKslb	0.1	0.2	0.2	0.5	0.8	1.0	2.4
Msrshall	0.1	0.2	0.2	0.5	0.8	1.0	2.3
Pistt	0.1	0.2	0.2	0.5	0.7	1.0	2.3
Randolph	0.1	0.2	0.2	0.5	0.7	1.0	2.3
St. Clsir	0.1	0.2	0.2	0.5	0.7	1.0	2.2
Greene	0.1	0.2	0.2	0.4	0.7	0.9	2.2
White	0.1	0.2	0.2	0.4	0.7	0.9	2.1
Montgomery	0.1	0.2	0.2	0.4	0.7	0.9	2.1
Mscon	0.1	0.2	0.2	0.4	0.7	0.9	2.1
Christisn	0.1	0.2	0.2	0.4	0.7	0.9	2.1
Woodford	0.1	0.2	0.2	0.4	0.7	0.9	2.1
Stsrk	0.1	0.2	0.2	0.4	0.7	0.9	2.1
Madison	0.1	0.2	0.2	0.4	0.7	0.9	2.1
Williamson	0.1	0.2	0.2	0.4	0.7	0.9	2.1
Cslhoun	0.1	0.2	0.2	0.4	0.7	0.9	2.0
Warren	0.1	0.2	0.2	0.4	0.6	0.9	2.0
Crswford	0.1	0.2	0.2	0.4	0.6	0.8	1.9
Clinton	0.1	0.2	0.2	0.4	0.6	0.8	1.9
Washington	0.1	0.2	0.2	0.4	0.6	0.8	1.9
Marion	0.1	0.2	0.2	0.4	0.6	0.8	1.8
Menard	0.1	0.1	0.2	0.4	0.6	0.8	1.8
Peoris	0.1	0.1	0.2	0.4	0.6	0.8	1.8
Hancock	0.1	0.1	0.2	0.4	0.6	0.7	1.7
McLean	0.1	0.1	0.2	0.3	0.5	0.7	1.7
Adams	0.0	0.1	0.1	0.3	0.5	0.7	1.6
Wabash	0.0	0.1	0.1	0.3	0.5	0.7	1.5
Vermilion	0.0	0.1	0.1	0.3	0.5	0.6	1.5
Clay	0.0	0.1	0.1	0.3	0.5	0.6	1.5
Knox	0.0	0.1	0.1	0.3	0.5	0.6	1.4
Perry	0.0	0.1	0.1	0.3	0.4	0.6	1.4
Frsnklin	0.0	0.1	0.1	0.3	0.4	0.6	1.3
Moultrie	0.0	0.1	0.1	0.3	0.4	0.6	1.3
Edgsr	0.0	0.1	0.1	0.3	0.4	0.6	1.3
Clsrk	0.0	0.1	0.1	0.3	0.4	0.5	1.3
Saline	0.0	0.1	0.1	0.3	0.4	0.5	1.3
Jefferson	0.0	0.1	0.1	0.2	0.4	0.5	1.2
Wayne	0.0	0.1	0.1	0.2	0.4	0.5	1.2
Brown	0.0	0.1	0.1	0.2	0.4	0.5	1.2
Jasper	0.0	0.1	0.1	0.2	0.4	0.5	1.1
Douglss	0.0	0.1	0.1	0.2	0.4	0.5	1.1
Fulton	0.0	0.1	0.1	0.2	0.4	0.5	1.1
Coles	0.0	0.1	0.1	0.2	0.4	0.5	1.1
Sangamon	0.0	0.1	0.1	0.2	0.3	0.5	1.1
Schuyler	0.0	0.1	0.1	0.2	0.3	0.5	1.1
Morgan	0.0	0.1	0.1	0.2	0.3	0.4	1.0
Richlsnd	0.0	0.1	0.1	0.2	0.3	0.4	0.9
Effingham	0.0	0.1	0.1	0.2	0.3	0.4	0.9
Shelby	0.0	0.1	0.1	0.2	0.3	0.4	0.9
Cumberland	0.0	0.1	0.1	0.2	0.3	0.4	0.9
McDonough	0.0	0.1	0.1	0.1	0.2	0.3	0.7
Edwards	0.0	0.1	0.1	0.1	0.2	0.3	0.7
Macoupin	0.0	0.0	0.1	0.1	0.2	0.2	0.5
Bond	0.0	0.0	0.0	0.1	0.2	0.2	0.5
Hamilton	0.0	0.0	0.0	0.0	0.0	0.1	0.2
STATE B/C AVERAGE	0.1	0.2	0.3	0.5	0.9	1.2	2.7

Table 12: Projected benefits and cost of geologic mapping program for Illinois (Scenario III)

				CATEGORY 1		CATEGORY 2		CATEGORY 3		CATEGORY 4	
#	SCORE	COUNTY	AREA	ESTIMATED BENEFITS (1990 $)	ESTIMATED COST (1990 $)	ESTIMATED BENEFITS (1990 $)	RANGE	ESTIMATED BENEFITS (1990 $)	RANGE	ESTIMATED BENEFITS (1990 $)	RANGE
1	796	Winnebago	516	--	193,985	--	--	--	--	--	--
2	688	Whiteside	682	46,255	256,391	125,275	143,103	310,779	487,610	654,322	1,518,239
3	682	McHenry	606	40,750	227,820	110,365	126,071	273,791	429,575	576,446	1,337,541
4	673	Alexander	236	15,661	88,722	42,415	48,451	105,221	165,091	221,535	514,033
5	649	Mason	536	34,303	201,504	92,904	106,125	230,474	361,612	485,247	1,125,929
6	621	Ogla	759	46,489	285,338	125,907	143,825	312,346	490,069	657,622	1,525,897
7	606	Kankakea	679	40,570	255,263	109,877	125,513	272,580	427,676	573,897	1,331,626
8	605	DuPage	337	20,088	126,692	54,406	62,149	134,969	211,766	284,168	659,362
9	605	Rock Islsnd	423	25,209	159,023	68,273	77,989	169,371	265,741	356,597	827,421
10	581	Kane	524	29,999	196,992	81,247	92,809	201,555	316,238	424,359	984,649
11	558	Cook	958	52,702	360,150	142,736	163,048	354,094	555,571	745,519	1,729,846
12	557	Stephenson	564	30,958	212,030	83,846	95,777	208,001	326,353	437,932	1,016,143
13	542	Csrroll	444	23,718	166,917	64,237	73,379	159,358	250,032	335,517	778,508
14	539	Will	844	44,848	317,293	121,462	138,747	301,320	472,769	634,407	1,472,029
15	522	Monroe	388	19,983	145,865	54,120	61,821	134,258	210,650	282,671	655,887
16	518	Union	414	21,121	155,639	57,203	65,344	141,908	222,653	298,778	693,261
17	513	Mercer	559	28,268	210,150	76,558	87,453	189,922	297,987	399,868	927,822
18	510	Pulsski	203	10,212	76,316	27,657	31,592	68,610	107,648	144,453	335,177
19	502	Putnam	160	7,924	60,150	21,462	24,516	53,243	83,537	112,098	260,105
20	481	Henry	824	39,052	309,774	105,767	120,819	262,384	411,678	552,430	1,281,816
21	478	Ford	486	22,901	182,707	62,023	70,849	153,864	241,411	323,949	751,667
22	477	JoDaviess	603	28,342	226,692	76,761	87,684	190,426	298,777	400,928	930,282
23	475	Lee	725	33,940	272,556	91,920	105,000	228,031	357,779	480,103	1,113,994
24	473	Iszawell	650	30,331	244,361	82,147	93,837	203,787	319,741	429,059	995,557
25	451	Buresu	869	38,622	326,692	104,601	119,487	259,492	407,141	546,342	1,267,690
26	450	Lake	454	20,152	170,677	54,579	62,346	135,398	212,438	285,070	661,454
27	424	Boone	282	--	106,015	--	--	--	--	--	--
28	415	Gsllstin	325	13,287	122,180	35,985	41,106	89,271	140,066	187,954	436,113
29	409	Johnson	346	13,957	130,075	37,801	43,181	93,777	147,135	197,440	458,124
30	406	Grundy	423	16,933	159,023	45,862	52,388	113,772	178,507	239,538	555,807
31	399	Logsn	619	24,362	232,707	65,980	75,369	163,681	256,814	344,617	799,624
32	397	Pike	830	32,462	312,030	87,919	100,430	218,106	342,206	459,206	1,065,507
33	387	Champaign	998	38,090	375,188	103,162	117,842	255,920	401,537	538,821	1,250,240
34	385	Massac	241	9,158	90,602	24,803	28,333	61,531	96,541	129,548	300,594
35	385	Hsrdin	181	6,861	68,045	18,581	21,225	46,094	72,322	97,048	225,183
36	380	Henderson	373	13,971	140,226	37,837	43,222	93,866	147,275	197,628	458,560
37	374	LsSslle	1139	42,003	428,195	113,759	129,948	282,210	442,785	594,172	1,378,672
38	371	Scott	251	9,169	94,361	24,833	28,367	61,605	96,658	129,705	300,957
39	361	Kendall	322	11,457	121,053	31,031	35,446	76,980	120,780	162,075	376,066
40	357	Fayetta	709	24,954	266,541	67,585	77,203	167,662	263,061	353,001	819,076
41	351	Csss	374	12,949	140,602	35,071	40,062	87,003	136,507	183,179	425,035
42	339	Iroquois	1118	37,399	420,301	101,289	115,703	251,275	394,249	529,041	1,227,547
43	333	Pope	374	12,295	140,602	33,299	38,037	82,606	129,609	173,922	403,555
44	332	DeWitt	397	12,984	149,248	35,164	40,168	87,234	136,870	183,665	426,163
45	328	Jersey	373	12,064	140,226	32,674	37,324	81,056	127,177	170,658	395,983
46	322	Lawrence	374	11,879	140,602	32,173	36,752	79,815	125,229	168,044	389,917
47	314	Livingston	1046	32,342	393,233	87,592	100,057	217,295	340,934	457,498	1,061,544
48	289	Jackson	590	16,783	221,805	45,454	51,923	112,761	176,922	237,411	550,870
49	288	DeKalb	634	18,006	238,346	48,766	55,706	120,978	189,813	254,709	591,008
50	287	Marshsll	388	10,976	145,865	29,726	33,956	73,744	115,703	155,262	360,258
51	283	Piatt	439	12,227	165,038	33,115	37,828	82,152	128,895	172,964	401,334
52	277	Randolph	583	15,905	219,173	43,075	49,205	106,859	167,662	224,985	522,037
53	275	St. Clair	672	18,201	252,632	49,294	56,309	122,287	191,867	257,466	597,404
54	269	Greene	543	14,389	204,135	38,972	44,517	96,679	151,689	203,551	472,305
55	263	White	497	12,866	186,842	34,846	39,805	86,445	135,632	182,004	422,307
56	262	Montgomery	705	18,234	265,038	49,384	56,412	122,511	192,219	257,938	598,500
57	262	Mscon	581	15,006	218,421	40,641	46,424	100,821	158,187	212,271	492,537
58	261	Christian	710	18,277	266,917	49,500	56,544	122,797	192,667	258,540	599,896
59	261	Woodford	527	13,559	198,120	36,723	41,949	91,101	142,937	191,807	445,054
60	257	Stark	288	7,296	108,271	19,760	22,572	49,019	76,910	103,206	239,471
61	255	Madison	728	18,294	273,684	49,547	56,598	122,916	192,854	258,790	600,477
62	252	Williamson	427	10,598	160,526	28,702	32,787	71,204	111,718	149,915	347,851
63	248	Calhoun	250	6,111	93,985	16,552	18,907	41,061	64,424	86,451	200,594
64	241	Warren	543	12,925	204,135	35,007	39,988	86,843	136,256	182,842	424,252
65	238	Crawford	446	10,464	167,669	28,340	32,373	70,305	110,307	148,021	343,457
66	236	Clinton	472	10,980	177,444	29,737	33,969	73,772	115,747	155,321	360,395
67	227	Washington	563	12,622	211,654	34,186	39,050	84,806	133,061	178,554	414,302
68	225	Marion	573	12,712	215,414	34,429	39,328	85,409	134,007	179,823	417,248
69	221	Menard	315	6,859	118,421	18,576	21,220	46,083	72,304	97,024	225,127
70	215	Peoris	621	13,191	233,459	35,724	40,808	88,624	139,050	186,591	432,952
71	211	Hancock	796	16,581	299,248	44,908	51,298	111,405	174,794	234,555	544,245
72	205	McLesn	1185	23,906	445,489	64,746	73,960	160,621	252,013	338,176	784,678
73	195	Adams	852	16,360	320,301	44,309	50,615	109,920	172,464	231,430	536,991
74	189	Wabash	224	4,173	84,211	11,302	12,911	28,039	43,993	59,034	136,977
75	183	Vermilion	900	16,264	338,346	44,049	50,318	109,276	171,453	230,073	533,843
76	179	Clay	469	8,296	176,316	22,469	25,666	55,740	87,455	117,356	272,303
77	172	Knox	720	12,217	270,677	33,086	37,795	82,080	128,783	172,813	400,982
78	166	Perry	443	7,230	166,541	19,581	22,368	48,577	76,217	102,276	237,312
79	164	Franklin	414	6,711	155,639	18,176	20,762	45,090	70,746	94,934	220,277
80	162	Moultria	325	5,197	122,180	14,074	16,077	34,915	54,781	73,510	170,567
81	159	Edgsr	623	9,743	234,211	26,387	30,142	65,460	102,706	137,820	319,788
82	155	Clark	506	7,732	190,226	20,941	23,921	51,950	81,509	109,376	253,788
83	155	Saline	385	5,871	144,737	15,900	18,163	39,445	61,889	83,049	192,701
84	148	Jefferson	570	8,299	214,286	22,477	25,676	55,761	87,488	117,400	272,406
85	142	Wayne	715	10,011	268,797	27,113	30,971	67,260	105,531	141,612	328,585
86	141	Brown	306	4,260	115,038	11,537	13,179	28,621	44,907	60,260	139,823
87	138	Jssper	496	6,757	186,466	18,301	20,905	45,401	71,233	95,588	221,795
88	137	Douglss	417	5,651	156,767	15,304	17,482	37,965	59,567	79,933	185,470
89	136	Fulton	871	11,716	327,444	31,731	36,246	78,716	123,505	165,731	384,550
90	136	Coles	509	6,813	191,353	18,452	21,078	45,775	71,820	96,375	223,622
91	133	Sangamon	866	11,315	325,564	30,644	35,005	76,022	119,277	160,058	371,386
92	132	Schuyler	436	5,694	163,910	15,421	17,616	38,257	60,025	80,547	186,895
93	119	Morgan	568	6,653	213,534	18,017	20,581	44,697	70,128	94,105	218,355
94	111	Richland	360	3,946	135,338	10,686	12,207	26,510	41,593	55,814	129,506
95	110	Effingham	478	5,199	179,699	14,080	16,084	34,930	54,804	73,542	170,641
96	109	Shelby	747	8,002	280,827	21,671	24,755	53,760	84,350	113,189	262,634
97	109	Cumberland	346	3,703	130,075	10,028	11,456	24,878	39,034	52,379	121,537
98	83	McDonough	590	4,826	221,805	13,070	14,929	32,422	50,871	68,263	158,392
99	82	Edwards	223	1,796	83,835	4,863	5,555	12,064	18,928	25,400	58,936
100	67	Macoupin	865	5,705	325,188	15,450	17,649	38,328	60,136	80,696	187,242
101	61	Bond	377	2,263	141,729	6,128	7,000	15,202	23,851	32,006	74,264
102	18	Hamilton	436	793	163,910	2,147	2,452	5,325	8,355	11,211	26,014
				$1,797,139	$20,921,429	$4,867,252	$5,559,899	$12,074,528	$18,944,841	$25,422,030	$58,987,347
		B/C RATIO		0.1		0.2	0.3	0.6	0.9	1.2	2.8

Table 13: Projected B/C ratios by county (Scenario III - Lower Cost Base)

COUNTY	CATEGORY 1	CATEGORY 2 RANGE		CATEGORY 3 RANGE		CATEGORY 4 RANGE	
Winnebago							
Whiteside	0.2	0.5	0.6	1.2	1.9	2.6	5.9
McHenry	0.2	0.5	0.6	1.2	1.9	2.5	5.9
Alexander	0.2	0.5	0.5	1.2	1.9	2.5	5.8
Mason	0.2	0.5	0.5	1.1	1.8	2.4	5.6
Ogle	0.2	0.4	0.5	1.1	1.7	2.3	5.3
Kankakee	0.2	0.4	0.5	1.1	1.7	2.2	5.2
DuPage	0.2	0.4	0.5	1.1	1.7	2.2	5.2
Rock Island	0.2	0.4	0.5	1.1	1.7	2.2	5.2
Kane	0.2	0.4	0.5	1.0	1.6	2.2	5.0
Cook	0.1	0.4	0.5	1.0	1.5	2.1	4.8
Stephenson	0.1	0.4	0.5	1.0	1.5	2.1	4.8
Carroll	0.1	0.4	0.4	1.0	1.5	2.0	4.7
Will	0.1	0.4	0.4	0.9	1.5	2.0	4.6
Monroe	0.1	0.4	0.4	0.9	1.4	1.9	4.5
Union	0.1	0.4	0.4	0.9	1.4	1.9	4.5
Mercer	0.1	0.4	0.4	0.9	1.4	1.9	4.4
Pulaski	0.1	0.4	0.4	0.9	1.4	1.9	4.4
Putnam	0.1	0.4	0.4	0.9	1.4	1.9	4.3
Henry	0.1	0.3	0.4	0.8	1.3	1.8	4.1
Ford	0.1	0.3	0.4	0.8	1.3	1.8	4.1
JoDaviess	0.1	0.3	0.4	0.8	1.3	1.8	4.1
Lee	0.1	0.3	0.4	0.8	1.3	1.8	4.1
Tazewell	0.1	0.3	0.4	0.8	1.3	1.8	4.1
Bureau	0.1	0.3	0.4	0.8	1.2	1.7	3.9
Lake	0.1	0.3	0.4	0.8	1.2	1.7	3.9
Boone							
Gallatin	0.1	0.3	0.3	0.7	1.1	1.5	3.6
Johnson	0.1	0.3	0.3	0.7	1.1	1.5	3.5
Grundy	0.1	0.3	0.3	0.7	1.1	1.5	3.5
Logan	0.1	0.3	0.3	0.7	1.1	1.5	3.4
Pike	0.1	0.3	0.3	0.7	1.1	1.5	3.4
Champaign	0.1	0.3	0.3	0.7	1.1	1.4	3.3
Massac	0.1	0.3	0.3	0.7	1.1	1.4	3.3
Hardin	0.1	0.3	0.3	0.7	1.1	1.4	3.3
Henderson	0.1	0.3	0.3	0.7	1.1	1.4	3.3
LaSalle	0.1	0.3	0.3	0.7	1.0	1.4	3.2
Scott	0.1	0.3	0.3	0.7	1.0	1.4	3.2
Kendall	0.1	0.3	0.3	0.6	1.0	1.3	3.1
Fayette	0.1	0.3	0.3	0.6	1.0	1.3	3.1
Cass	0.1	0.2	0.3	0.6	1.0	1.3	3.0
Iroquois	0.1	0.2	0.3	0.6	0.9	1.3	2.9
Pope	0.1	0.2	0.3	0.6	0.9	1.2	2.9
DeWitt	0.1	0.2	0.3	0.6	0.9	1.2	2.9
Jersey	0.1	0.2	0.3	0.6	0.9	1.2	2.8
Lawrence	0.1	0.2	0.3	0.6	0.9	1.2	2.8
Livingston	0.1	0.2	0.3	0.6	0.9	1.2	2.7
Jackson	0.1	0.2	0.2	0.5	0.8	1.1	2.5
DeKalb	0.1	0.2	0.2	0.5	0.8	1.1	2.5
Marshall	0.1	0.2	0.2	0.5	0.8	1.1	2.5
Piatt	0.1	0.2	0.2	0.5	0.8	1.0	2.4
Randolph	0.1	0.2	0.2	0.5	0.8	1.0	2.4
St. Clair	0.1	0.2	0.2	0.5	0.8	1.0	2.4
Greene	0.1	0.2	0.2	0.5	0.7	1.0	2.3
White	0.1	0.2	0.2	0.5	0.7	1.0	2.3
Montgomery	0.1	0.2	0.2	0.5	0.7	1.0	2.3
Macon	0.1	0.2	0.2	0.5	0.7	1.0	2.3
Christian	0.1	0.2	0.2	0.5	0.7	1.0	2.2
Woodford	0.1	0.2	0.2	0.5	0.7	1.0	2.2
Stark	0.1	0.2	0.2	0.5	0.7	1.0	2.2
Madison	0.1	0.2	0.2	0.4	0.7	0.9	2.2
Williamson	0.1	0.2	0.2	0.4	0.7	0.9	2.2
Calhoun	0.1	0.2	0.2	0.4	0.7	0.9	2.1
Warren	0.1	0.2	0.2	0.4	0.7	0.9	2.1
Crawford	0.1	0.2	0.2	0.4	0.7	0.9	2.0
Clinton	0.1	0.2	0.2	0.4	0.7	0.9	2.0
Washington	0.1	0.2	0.2	0.4	0.6	0.8	2.0
Marion	0.1	0.2	0.2	0.4	0.6	0.8	1.9
Menard	0.1	0.2	0.2	0.4	0.6	0.8	1.9
Peoria	0.1	0.2	0.2	0.4	0.6	0.8	1.9
Hancock	0.1	0.2	0.2	0.4	0.6	0.8	1.8
McLean	0.1	0.1	0.2	0.4	0.6	0.8	1.8
Adams	0.1	0.1	0.2	0.3	0.5	0.7	1.7
Wabash	0.0	0.1	0.2	0.3	0.5	0.7	1.6
Vermilion	0.0	0.1	0.1	0.3	0.5	0.7	1.6
Clay	0.0	0.1	0.1	0.3	0.5	0.7	1.5
Knox	0.0	0.1	0.1	0.3	0.5	0.6	1.5
Perry	0.0	0.1	0.1	0.3	0.5	0.6	1.4
Franklin	0.0	0.1	0.1	0.3	0.5	0.6	1.4
Moultrie	0.0	0.1	0.1	0.3	0.4	0.6	1.4
Edgar	0.0	0.1	0.1	0.3	0.4	0.6	1.4
Clark	0.0	0.1	0.1	0.3	0.4	0.6	1.3
Saline	0.0	0.1	0.1	0.3	0.4	0.6	1.3
Jefferson	0.0	0.1	0.1	0.3	0.4	0.5	1.3
Wayne	0.0	0.1	0.1	0.3	0.4	0.5	1.2
Brown	0.0	0.1	0.1	0.2	0.4	0.5	1.2
Jasper	0.0	0.1	0.1	0.2	0.4	0.5	1.2
Douglas	0.0	0.1	0.1	0.2	0.4	0.5	1.2
Fulton	0.0	0.1	0.1	0.2	0.4	0.5	1.2
Coles	0.0	0.1	0.1	0.2	0.4	0.5	1.2
Sangamon	0.0	0.1	0.1	0.2	0.4	0.5	1.1
Schuyler	0.0	0.1	0.1	0.2	0.4	0.5	1.1
Morgan	0.0	0.1	0.1	0.2	0.3	0.4	1.0
Richland	0.0	0.1	0.1	0.2	0.3	0.4	1.0
Effingham	0.0	0.1	0.1	0.2	0.3	0.4	0.9
Shelby	0.0	0.1	0.1	0.2	0.3	0.4	0.9
Cumberland	0.0	0.1	0.1	0.2	0.3	0.4	0.9
McDonough	0.0	0.1	0.1	0.1	0.2	0.3	0.7
Edwards	0.0	0.1	0.1	0.1	0.2	0.3	0.7
Macoupin	0.0	0.0	0.1	0.1	0.2	0.2	0.6
Bond	0.0	0.0	0.0	0.1	0.2	0.2	0.5
Hamilton	0.0	0.0	0.0	0.0	0.1	0.1	0.2
STATE B/C AVERAGE	0.1	0.2	0.3	0.6	0.9	1.2	2.8

Table 14: Projected B/C ratios by county (Scenario III - Higher Cost Base)

COUNTY	CATEGORY 1	CATEGORY 2 RANGE		CATEGORY 3 RANGE		CATEGORY 4 RANGE	
Winnebago							
Whiteside	0.1	0.2	0.2	0.5	0.7	1.0	2.2
McHenry	0.1	0.2	0.2	0.5	0.7	1.0	2.2
Alexander	0.1	0.2	0.2	0.5	0.7	0.9	2.2
Mason	0.1	0.2	0.2	0.4	0.7	0.9	2.1
Ogle	0.1	0.2	0.2	0.4	0.7	0.9	2.0
Kankakee	0.1	0.2	0.2	0.4	0.6	0.9	2.0
DuPage	0.1	0.2	0.2	0.4	0.6	0.9	2.0
Rock Island	0.1	0.2	0.2	0.4	0.6	0.9	2.0
Kane	0.1	0.2	0.2	0.4	0.6	0.8	1.9
Cook	0.1	0.2	0.2	0.4	0.6	0.8	1.8
Stephenson	0.1	0.2	0.2	0.4	0.6	0.8	1.8
Carroll	0.1	0.1	0.2	0.4	0.6	0.8	1.8
Will	0.1	0.1	0.2	0.4	0.6	0.8	1.8
Monroe	0.1	0.1	0.2	0.3	0.5	0.7	1.7
Union	0.1	0.1	0.2	0.3	0.5	0.7	1.7
Mercer	0.1	0.1	0.2	0.3	0.5	0.7	1.7
Pulaski	0.1	0.1	0.2	0.3	0.5	0.7	1.7
Putnam	0.1	0.1	0.2	0.3	0.5	0.7	1.6
Henry	0.0	0.1	0.1	0.3	0.5	0.7	1.6
Ford	0.0	0.1	0.1	0.3	0.5	0.7	1.6
JoDaviess	0.0	0.1	0.1	0.3	0.5	0.7	1.6
Lee	0.0	0.1	0.1	0.3	0.5	0.7	1.6
Tazewell	0.0	0.1	0.1	0.3	0.5	0.7	1.5
Bureau	0.0	0.1	0.1	0.3	0.5	0.6	1.5
Lake	0.0	0.1	0.1	0.3	0.5	0.6	1.5
Boone							
Gallatin	0.0	0.1	0.1	0.3	0.4	0.6	1.4
Johnson	0.0	0.1	0.1	0.3	0.4	0.6	1.3
Grundy	0.0	0.1	0.1	0.3	0.4	0.6	1.3
Logan	0.0	0.1	0.1	0.3	0.4	0.6	1.3
Pike	0.0	0.1	0.1	0.3	0.4	0.6	1.3
Champaign	0.0	0.1	0.1	0.3	0.4	0.5	1.3
Massac	0.0	0.1	0.1	0.3	0.4	0.5	1.3
Hardin	0.0	0.1	0.1	0.3	0.4	0.5	1.3
Henderson	0.0	0.1	0.1	0.3	0.4	0.5	1.2
LaSalle	0.0	0.1	0.1	0.3	0.4	0.5	1.2
Scott	0.0	0.1	0.1	0.2	0.4	0.5	1.2
Kendall	0.0	0.1	0.1	0.2	0.4	0.5	1.2
Fayette	0.0	0.1	0.1	0.2	0.4	0.5	1.2
Cass	0.0	0.1	0.1	0.2	0.4	0.5	1.1
Iroquois	0.0	0.1	0.1	0.2	0.4	0.5	1.1
Pope	0.0	0.1	0.1	0.2	0.4	0.5	1.1
DeWitt	0.0	0.1	0.1	0.2	0.3	0.5	1.1
Jersey	0.0	0.1	0.1	0.2	0.3	0.5	1.1
Lawrence	0.0	0.1	0.1	0.2	0.3	0.5	1.1
Livingston	0.0	0.1	0.1	0.2	0.3	0.4	1.0
Jackson	0.0	0.1	0.1	0.2	0.3	0.4	0.9
DeKalb	0.0	0.1	0.1	0.2	0.3	0.4	0.9
Marshall	0.0	0.1	0.1	0.2	0.3	0.4	0.9
Piatt	0.0	0.1	0.1	0.2	0.3	0.4	0.9
Randolph	0.0	0.1	0.1	0.2	0.3	0.4	0.9
St. Clair	0.0	0.1	0.1	0.2	0.3	0.4	0.9
Greene	0.0	0.1	0.1	0.2	0.3	0.4	0.9
White	0.0	0.1	0.1	0.2	0.3	0.4	0.9
Montgomery	0.0	0.1	0.1	0.2	0.3	0.4	0.9
Macon	0.0	0.1	0.1	0.2	0.3	0.4	0.9
Christian	0.0	0.1	0.1	0.2	0.3	0.4	0.9
Woodford	0.0	0.1	0.1	0.2	0.3	0.4	0.9
Stark	0.0	0.1	0.1	0.2	0.3	0.4	0.8
Madison	0.0	0.1	0.1	0.2	0.3	0.4	0.8
Williamson	0.0	0.1	0.1	0.2	0.3	0.4	0.8
Calhoun	0.0	0.1	0.1	0.2	0.3	0.3	0.8
Warren	0.0	0.1	0.1	0.2	0.3	0.3	0.8
Crawford	0.0	0.1	0.1	0.2	0.2	0.3	0.8
Clinton	0.0	0.1	0.1	0.2	0.2	0.3	0.8
Washington	0.0	0.1	0.1	0.2	0.2	0.3	0.7
Marion	0.0	0.1	0.1	0.2	0.2	0.3	0.7
Menard	0.0	0.1	0.1	0.1	0.2	0.3	0.7
Peoria	0.0	0.1	0.1	0.1	0.2	0.3	0.7
Hancock	0.0	0.1	0.1	0.1	0.2	0.3	0.7
McLean	0.0	0.1	0.1	0.1	0.2	0.3	0.7
Adams	0.0	0.1	0.1	0.1	0.2	0.3	0.6
Wabash	0.0	0.1	0.1	0.1	0.2	0.3	0.6
Vermilion	0.0	0.0	0.1	0.1	0.2	0.3	0.6
Clay	0.0	0.0	0.1	0.1	0.2	0.3	0.6
Knox	0.0	0.0	0.1	0.1	0.2	0.2	0.6
Perry	0.0	0.0	0.1	0.1	0.2	0.2	0.5
Franklin	0.0	0.0	0.1	0.1	0.2	0.2	0.5
Moultrie	0.0	0.0	0.0	0.1	0.2	0.2	0.5
Edgar	0.0	0.0	0.0	0.1	0.2	0.2	0.5
Clark	0.0	0.0	0.0	0.1	0.2	0.2	0.5
Saline	0.0	0.0	0.0	0.1	0.2	0.2	0.5
Jefferson	0.0	0.0	0.0	0.1	0.2	0.2	0.5
Wayne	0.0	0.0	0.0	0.1	0.1	0.2	0.5
Brown	0.0	0.0	0.0	0.1	0.1	0.2	0.5
Jasper	0.0	0.0	0.0	0.1	0.1	0.2	0.5
Douglas	0.0	0.0	0.0	0.1	0.1	0.2	0.4
Fulton	0.0	0.0	0.0	0.1	0.1	0.2	0.4
Coles	0.0	0.0	0.0	0.1	0.1	0.2	0.4
Sangamon	0.0	0.0	0.0	0.1	0.1	0.2	0.4
Schuyler	0.0	0.0	0.0	0.1	0.1	0.2	0.4
Morgan	0.0	0.0	0.0	0.1	0.1	0.2	0.4
Richland	0.0	0.0	0.0	0.1	0.1	0.2	0.4
Effingham	0.0	0.0	0.0	0.1	0.1	0.2	0.4
Shelby	0.0	0.0	0.0	0.1	0.1	0.2	0.4
Cumberland	0.0	0.0	0.0	0.1	0.1	0.2	0.4
McDonough	0.0	0.0	0.0	0.1	0.1	0.1	0.3
Edwards	0.0	0.0	0.0	0.1	0.1	0.1	0.3
Macoupin	0.0	0.0	0.0	0.0	0.1	0.1	0.2
Bond	0.0	0.0	0.0	0.0	0.1	0.1	0.2
Hamilton	0.0	0.0	0.0	0.0	0.0	0.0	0.1
STATE B/C AVERAGE	0	0.1	0.1	0.2	0.3	0.5	1.1

Appendix A

Report on the responses to a questionnaire on the

Use of Requirements for and Priorities for Geologic Maps in Illinois

by Heinz H. Damberger
Illinois State Geological Survey

The following summarizes the responses to a questionnaire that was mailed in spring, 1990, to members of the Illinois Geologic Mapping Advisory Committee (IGMAC) and some other known users of geologic maps.

Response rate. Of the 80 questionnaires distributed 37 were returned; 4 recipients called to indicate that they felt they were not in a position to respond, because they had not used or produced geologic maps for some time. Thus, the response rate was about 50%, generally considered a good response rate to mailed questionnaires.

Background of respondents	No.
Federal and state research and service agencies	11
Planning/development agencies/departments	7
Consulting engineers/geologists	7
State or federal environmental or health agencies	6
Mineral extraction industry	3
Universities	2
	36

1. Use of geologic data/maps

Siting:	54	Resource development & exploration:	36	Planning/environmental protection:	37
Waste disposal:	11	Soil:	9	Groundwater:	13
Hydrologic proj:	11	Water:	9	Geologic hazards:	10
Industry proj.	10	Sand & gravel:	4	Land use:	9
Transportation:	7	Lead, zinc, fluorsp:	4	Mineral protect:	2
Commerc. proj:	6	Stone:	9	Other:	2
Resident. proj.:	2	Coal:	2		
Other:	8	Oil & gas:	2		
		Other:	4		

2. Specific geologic information required

Location on mines, quarries, etc.:	16	Thickness of strata:	11
Character of earth materials to bedrock:	14	Character of bedrock surface:	11
Depth to bedrock:	14	Regional structure:	7
Character of earth Materials at surface:	13	Outcrop of coal seams:	3
Location of faults:	12	Other:	4

3. Map products used in recent 2 years

Topographic maps:	7	Aerial photos:	1
Quaternary maps(s):	6	Atlas/state maps:	1
ISGS/USGS geol. maps:	7	DLG file:	1
ISGS potential contamination map	2	Plot books:	1
IL Wetlands map:	2	Zoning maps:	1
		Highway maps:	1
		Rail maps:	1
		Rail maps:	1

4. Projects identified requiring geologic maps

A. General

- Highway soil surveys
- Foundation investigations
- Aggregate exploration projects

- Numerous construction projects
- Determination of setback zones around PWS well-heads
- Groundwater hazard reviews for public water supplies (PWS)
- Permitting PWS wells after effective date of IL Groundwater Protection Act
- Numerous US EPA pre-remedial sites in IL
- Environmental assessment projects
- Hazardous waste investigations
- Geotechnical engineering reports
- Foundation investigations for buildings, dams, levees, bridges
- Highway soil surveys
- Quarry appraisals in Will County
- Feasibility of injection of industrial wastes in deep wells, IL
- Groundwater monitoring projects
- Watershed analyses in many counties
- Numerous purchases and exchanges of land, Shawnee National Forest
- Capital improvement projects, City of Chicago
- Paleobotanical research, W. IL
- Study till and loess stratigraphy, SW IL
- Develop contamination potential maps
- Develop groundwater quality trend maps
- Landuse versus rainfall runoff, modeling studies

B. Specific projects

- Superconducting Super Collider (SSC)
- Core drilling project in Fluorspar Mining District of SE IL
- Winnebago County groundwater study
- Available coal resources of Middletown quad, Logan County
- Coal resources of Paducah 1° x 2° quad (CUSMAP), S. IL
- Compilation of non-coal mines of IL
- Correlation of stratigraphic data for National Coal Res. Data System (NCRDS)
- IL EPA Remedial Investigations and Feasibility Studies in Rockdale
- Solid Waste Agency of Northern Cook County (SWANCC), balefill, Cook County
- CUP-O'Hare Reservoir, Cook County
- Wooddale-Itasca Reservoir, DuPage County
- Investigation of hazardous chemical dump NW of Rockford,
- Winnebago County
- Waterwell methane explosion in Kane County
- Petroleum releases in Winnebago and Warren Counties
- Air storage reservoir exploration in LaSalle County
- Site assessment & environmental audit in DuPage County
- Remedial assessment of groundwater contamination, Champaign County
- Develop regional groundwater monitoring program, Cook County
- Regional groundwater quality characterization, Winnebago County
- Landfill siting, Kane County
- Siting municipal wells, Kane County
- Develop land use plan, Kane County
- Siting of coal gasification plant
- Develop Land Management Plan for Shawnee National Forest
- Groundwater contamination assessments in Boone, Winnebago, Kendall and McLean Counties
- Hydrologic budget study, Joliet Army Ammunition Plant
- Archeological site investigation, McLean County
- Study of archeology of State Parks, IL
- Sites for low level nuclear waste facility, Clark and Wayne Counties

5. <u>Importance of geological maps in these projects</u>

Useful: 13 Critical: 12 Not needed: 0

6. <u>Order of priority by area</u>

Regions	Average Priority	#	Urban areas	Average Priority	#		Average Priority	#
Northeast	1.0	8	Chicago	1.2	5	Aurora	4.0	1
Southwest	2.3	9	Chicago suburbs	1.6	6	Rockford	3.0	1
Southeast	3.0	8	Quad Cities	3.0	3	Bloomington	4.0	1
Central	3.0	5	Springfield	4.0	3	Kankakee	6.0	1
East Central	3.2	4	Joliet	4.0	2	Elgin	11.0	1

West Central	3.3	6	Peoria	5.0	2	Galesburg	14.0	1
Northwest	3.7	4	Decatur	7.5	2	Champaign	15.0	1
			Danville	7.5	2			

Counties	Average Priority	#		Average Priority	#
Cook	1.0	4	Sangamon	1.0	2
DuPage	2.0	4	McLean	3.0	2
Lake	2.3	4	Kane	5.0	2
Rock Island	6.0	4	Kendall	6.0	2
Will	7.0	4	Logan	7.0	2
Dekalb	4.0	3	McHenry	7.0	2
Jo Davies	8.0	3	Brown	11.0	2
Tazewell	12.0	3	Schuyler	11.0	2
Peoria	16.0	3	Hancock	12.0	2
Ogle	20.0	3	McDonough	12.0	2
			Jersey	12.0	2
			Madison	13.0	2
			Henry	15.0	2
			Kankakee	17.0	2

Other counties mentioned once

Adams	DeWitt	Lee	St. Clair
Alexander	Franklin	Macon	Saline
Bond	Gallatin	Macoupin	Shelby
Boone	Green	Menard	Stephenson
Bureau	Grundy	Mercer	Union
Calhoun	Henderson	Moultrie	Warren
Cass	Jasper	Piatt	Whiteside
Champaign	Jefferson	Pike	Winnebago
Christian	Johnson	Pope	Woodford
Clinton	LaSalle	Putnam	

Average Priority = average priority given to these areas by respondents who provided priorities (many respondents did not prioritize)
= number of times mentioned by respondents

7. Map scales needed

	Average Priority	#		Average Priority	#
1:24K:	1.4	15	1:250K:	2.7	4
1:100K:	1.5	6	1:500K:	3.7	5
1:50K:	2.2	6	Other:	-	1

Average Priority - average priority given to these areas by respondents who provided priorities (many respondents did not prioritize)
= number of times mentioned by respondents

8a. Cost/year of lack of adequate geologic maps

<$5K:	7	$100K-1,000K:	4	>$1,000K:	1(?)
$10K-100K:	5	$5K-10K:	2	Unknown:	17

Cumulative extra cost per year estimated by 19 respondents answering this question is $1.5 to 5.5 Mill.

8b. Savings from availability of adequate geologic maps

$10-100K:	6	<$5K:	2	$100K-1,000K:	1
$ 5-10K:	3	>$1,000K:	2	unknown or no answer:	22

Cumulative savings per year estimated by 14 respondents answering question is $2.2 to 3.6 Mill.

9. Number of people using geologic maps in organization of respondents

11-50: 10	6-10: 6	No answer: 8
<5: 8	>50: 4	

Estimated number of regular users of geologic maps by 28 respondents answering questions is 390 to 800

10. Sources of geologic information in work

	Average rank	#
Basic geologic maps:	1.9	20
Publications:	2.5	19
Drilling records:	3.0	13
Interpretive/derivative maps:	3.3	7
Own geologic database:	3.8	10
Unpubl. data at ISGS:	5.1	11
Consultants:	5.8	7
Field mapping:	5.9	7
Unpubl. data at USGS:	7.0	6
Unpubl. data at university geology depts.:	7.5	4
Other:		2

Average rank = average rank of all answers that provided rank
= number of times mentioned

11. Degree of satisfaction with currently available geologic maps

	Geol. Maps			Geol. Data (paper)			Geol. Data (electronic)		
	A	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
Type of data	6	9	2	5	8	1	2	2	3
Format of data	7	10	0	4	6	2	2	2	1
Accuracy of data	8	6	3	6	5	3	1	3	2
Level of detail	4	9	4	5	5	4	1	3	3
Areal coverage	3	9	5	1	9	4	1	3	2

A = satisfied **B** = neutral **C** = dissatisfied
Numbers give number of responses in each category

12. No answers provided

13. Additional geologic maps required that were mentioned

- Bedrock surface maps of Chicago area (±5' contours) (mentioned 2x)
- Quaternary map 1:1 Mill. scale or larger, joined accurately with neighboring states, incl. digital file (mentioned 2x)
- Till sheet extent, incl. engineering properties
- Possible targets for future fluorspar, zinc and lead exploration
- Protection of natural resources in NE IL is critical now, (requiring adequate geologic maps); entire state in future
- Geologic maps needed to establish wellhead protection (setback zones, regulate recharge areas, groundwater protection needs assessment, hazard reviews)
- Large-scale geologic maps of glacial surface deposits, glacial thickness, glacial till member isopachs, bedrock surface topography, bedrock surface geology, bedrock structure, potentiometric maps of major aquifers
- Sand & gravel isopach maps, for groundwater assessments
- Large-scale geologic maps of Kane County to help in protection of shallow aquifers
- More detailed maps showing sub-surficial features in developed areas, especially relative to groundwater
- Maps helping in assessment of hazards resulting from major earthquake along New Madrid fault zone
- Maps of aquifers, groundwater flow patterns, particularly in densely populated and industrialized areas
- Geologic maps in digital form are needed (several times mentioned)
- County geologic maps for SCS field offices
- More complete coverage by geologic maps of Alexander, Jackson, Johnson, and Union Counties needed by Shawnee Nat. Forest administration
- Areas of state with greatest susceptibility to groundwater contamination need to be mapped thoroughly
- Till sheet (near surface) extent (differentiated by engineering properties) in NE IL
- Reef locations, near bedrock surface, in NE IL (mentioned 2x)
- 1:24K or 1:12K scale hydrostratigraphic maps
- Large-scale geologic mapping needed; also update old maps, and automate (digitize) maps
- 1:24K surficial geology, surficial materials, and aquifers, all down to bedrock

14. Laws, regulations, and ordinances that require use of geologic maps

Chicago building code
IL Dept. of Transporation (IDOT) regulations
National Environmental Protection Act (NEPA)
Resources Conservaton and Recovery Act (RCRA)
UMTA
FHWA regulations

List of individuals interviewed

Affiliation	Name	Phone number
Illinois Environmental Protection Agency (IEPA)	Davis, Steve	(815) 987-7404
IEPA	Wengrow, Bob	(815) 987-7404
IEPA	Keller, Kerry	(815) 987-7404
IEPA	Meyer, Carol	(815) 782-6760
IEPA	Takacs, Paul	(815) 782-6760
IEPA	Dollins, Dave	(815) 782-6760
IEPA	Lanham, Rick	
IEPA	Moyer, Scott	(217) 782-3335
IEPA	Corley, Charles	(815) 987-7760
IEPA	Chièn, Harris J.	
IEPA	Retzlaff, David S.	
Winnebago County Solid Waste Disposal Director	Blaney-Baechle, Mary	(815) 987-3057
Winnebago County Solid Waste Disposal Specialist	Pasteris, Allen	(815) 987-2506
Winnebago County Highway Department	Mohaupt, Rick	(815) 965-9431
Winnebago County Planning Director	Noel, David	(815) 987-2506
Winnebago County Health Department	Andersen, Jim	(815) 962-5092
City of Rockford	Tullock, Thomas R.	(815) 987-5571
Rockford City Planning Department	Petratti, Russ	(815) 987-5624
South Beloit Waste Water Treatment Plant, Superintendent	Teges, Bill	(608) 389-3070
Boone County Regional Planning Com.	Slitkas, Dave	(815) 544-5271
Boone County Soil & Water Conservation District	Kane, Daniel	(815) 544-2677
Boone County Public Health Dept.	Carlson, Debbie	(815) 544-2951
Boone County Soil & Water Conservation District	Gustavson, Roger	(815) 544-2677
McHenry County Public Health Director	Bacon, Maichle	
McHenry County Environmental Health	McNulty, Pat	(815) 338-2514
McHenry County Planning Department	Layer, Bob	
McHenry County Solid Waste Manager	Fischer, Hank	
U.S. Dept. of Agriculture Soil Conservation Service	Nichols, Lewis	(815) 544-2677
USEPA	Hiltner, Allisen	(312) 353-6417
USEPA	Schorly, Bernard	(312) 353-6417
Agricultural Extension Service 4311 W. State St., Rockford, IL	Specht, Ed	(815) 987-7379
Illinois State Water Survey	Wehrmann, Al	(217) 333-0493
Rock River Reclamation	Prieve, Dennis	(815) 397-9700
Brittany Builders, 1903 S. Rt. 31, Ringwood, IL	Ladd, David	
Consulting Hydrogeologist 2926 N. Shorewood Dr., McHenry, IL 60050	Jennings, Roberta	(815) 344-0017
Rockford Sand and Gravel Inc. 5290 Nimitz Road, Loves Park, IL 61111	Fischer, Dan	(815) 654-4765
Rockford Blacktop Co.	McNamara, John	(815) 654-4770
William C. Charles Co. (Law Firm) 4920 Forest Hills Road Loves Park, IL 61111	Holmstrom, John	(815) 654-4711
Eldridge Engineering Associates 1601 N. Bond St., Naperville, IL 60540	Aronson, Paul R.	(708) 369-2901
Missman, Stanley & Associates 414 E. State St., Box 4327 Rockford, IL 61110	Zuroske, Patrick M. Knox, Robert W.	(815) 965-6400
Drilling Contractor 1441 S. Meridian Rd., Rockford, IL	Rosenquist, Jerald	(815) 963-5916
Drilling Contractor, 5205 S. Rt. 31 Ringwood, IL	Huemann, John	(815) 385-0414
Testing Engineers 57 Airport Drive, Dixon, IL	Hersch, Frank	(815) 964-8030
Golder Associates 1809 North Mill St., Suite C Naperville, IL 60563	Miller, Joe	(815) 544-6994 (708) 357-2066

In addition to the individuals listed above 11 other individuals were interviewed in context with private cleanup sites.

Appendix C

List of Sites in Boone and Winnebago Counties for Which Quantifiable Cost Estimates are Available[1]

BOONE COUNTY SUPERFUND SITES

• **Belvidere Municipal #1**

$149,307 IEPA

$5-7 million for remedial action

Assumed over a 10 year period

• **Bonus (Mig)**

$45,651 IEPA

$22K for management assistance

$45 million clean-up cost estimate

• **Parson's Outside (Parson's Casket)**

$413,487 IEPA

$1.2 million RIFS

Pump and treat, strip or no action as alternatives

(1) Pump and treat $2-3 million for 25 to 30 years

(2) Operation and Maintenance $10K/year for 30 years

BOONE COUNTY VOLUNTARY CLEANUP SITES

• **Midwest Plating**, Herbert

· $1,461 IEPA $

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[1] Data source: Personal interviews with individuals listed in Appendix B.

WINNEBAGO COUNTY SUPERFUND SITES

• **Pagel's Pit (Winnebago Recl.Serv.)**

$1 x 10^6 RIFS

$7,414 State EPA (as of 6/30/90)

$1 million cost of planning alternative for Pagel's pit

• **ACME**

$1 x 10^6 RIFS (1984)

$15-17 million future clean-up

$10 million - Other resp. parties

$59,025 IEPA

• **Beloit Corporation**

$14,659 IEPA

$20 K management assistance and federal funds

Only solvents found - minimal remediation

• **Six Oaks in Pecatonica (Trailor Park)**

$37 K/year Maintenance Cost

30 years assumed

$810,506 IEPA

• **SE Rockford**

$400 K RIFS

Alternatives:

(1) Water Line Extension $3.3 - 4.3 million
(2) 2 new deep municipal wells -$8-9 million
(3) New private wells for everybody (250-300) $8.6 - 10.6 million
(4) Treat contaminated well $3.5 - 5.5 million
(5) Treat each private well $30 million

Supplied water in bottles for about two years

$250 K for carbon filters for households

(No state dollars spent)

• **IPC (Interstate Pollution Control (Roto Rooter)**

$10,315 IEPA (1983-84)

$0.75-1.0 million RIFS

$100 K IEPA oversight

$1 million soil clean-up
Several million $ for pumping and treatment

WINNEBAGO COUNTY VOLUNTARY CLEANUP SITES

- **Illinois Water Treatment** - Rockford

· sampling - 50K
· $2,288 IEPA

- **Warner Brake** - delisted site

· $1 million for well and waterline
· $3-10 million for treatment system spent by company
· $39 million lawsuit by Attorney General (settled out-of-court)
· company agreed to clean up

- **Borg-Warner Corp.** Rockford

· 2020 Harrison Ave., well contamination problem
· Borg-Warner installed a well-nest - $3 K apiece
· not aware of other on going things
· $14,447 IEPA

- **Sunstrand**

· $5,894 IEPA

- **Hydroline**

· $27 IEPA

- **IEPA - Summary of Boone-Winnebago**

· $2,478,018 - IEPA expenditures as of June 30, 1990. Includes labor costs, contractual (laboratory, consultant, etc.)
Carol Meyer, IEPA

- **American Brass**

Waste site caused 10-12 houses to abandon wells and hookup to city water supply.

$2.5 - 5.0 K per hookup

- **Hononega Country Estates**

$27,000 in 1982 for a nitrate study
Septic systems

- **Oak Crest Subdivision**

At Rock River Water Reclamation Center

$1.6 million to construct sewer lines

- **Woodward Governor Co., Loves Park**

· tank leak - putting in a stripper tower - $100-200 K
· total $200-350 K including monitoring well and consultant
· 5001 North Second Street
· conservative estimate
· $4,197 IEPA

- **Mattison Machine Works, Rockford**

· just in initial stages - $46 state
· Sunstrand Corp. will take lease
· Magnolia Landfill, People Ave. kitty corner from IPC

- **Kaney Transportation**, 7222 Cunningham Rd., Rockford

· $1,351 IEPA
· $100 K for study
· disposal ($100 K) dug-up drums and disposal

- **Alloy Plating**, Rockford

· $20,590 IEPA

- **Ipsen CHT**

· $23,364 IEPA

OTHER SITES

- **People's Avenue (Quaker Oats)**

No action

$500 K RIFS

$2,846 IEPA

- **Sand Park (SRAPL)**

$2 million before remedies are designed just preliminary storing - no action cost included

- **Frink's Industrial Waste (SRAPL)**

$893,143 IEPA

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