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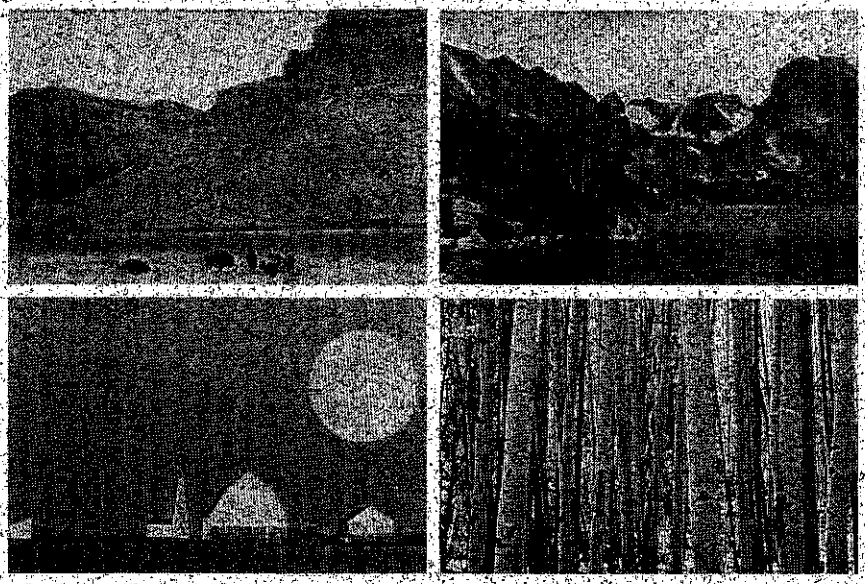

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Colorado Environment 2000

A Summary of the Technical Analysis of the Colorado Environment 2000 Project

Contents

STATE OF COLORADO

EXECUTIVE CHAMBERS
136 State Capitol
Denver, Colorado 80203-1792
Phone (303) 866-2471

Roy Romer
Governor

October 1989

Dear Coloradan:

As the 21st century approaches, we face many environmental challenges. All of us who live and work in Colorado value the diversity and quality of our resources -- plants, animals, rivers, lakes, mountains, plains and forests. But our valued resources are being stressed to the point where future generations may not enjoy the same Colorado we do.

Decisions we make now will have an enormous impact on the future health of Colorado's environment. We must recognize the integral nature of the economy and our environment. When the two flourish, Colorado as a whole will benefit and prosper.

Many Coloradans recognize that action is needed, but do not know where to begin. Information on environmental issues can seem overwhelming, and it is not immediately clear which problems pose the greatest risks and which should be given the greatest priority.

That is why I created Colorado Environment 2000. I hope that this Environmental Status Report, the result of six months work by Colorado Environment 2000 technical work groups, will provide basic information on Colorado's environment.

For the next phase of the Colorado Environment 2000 Project, which is already underway, I have asked a panel of community leaders from across the state to set environmental goals for Colorado and to instruct us on how to achieve them. The Colorado Environment 2000 Plan will be published in 1990.

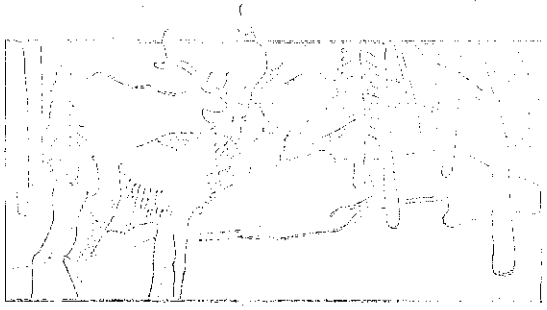
To all those who have contributed to this report, especially the volunteer members of the technical work groups, I offer my thanks. And to all those Coloradans who read this report, I hope it makes the issues clear and the need for action apparent.

Sincerely,

Roy Romer

Roy Romer
Governor

Introduction



The Colorado Environment 2000 Project was established to identify Colorado's most important environmental issues and to focus attention on ways we can combat problems and take advantage of opportunities. The project is coordinated by the Governor's Office, the Colorado Department of Health, and the Colorado Department of Natural Resources. Funding comes from the U.S. Environmental Protection Agency (EPA).

Colorado Environment 2000 will set goals and take actions to address environmental problems. The project will identify opportunities to supplement existing programs and to create new solutions; it will not duplicate current efforts. A project structure has been developed to ensure involvement from all levels of Colorado citizenry. Colorado Environment 2000 has recruited volunteers from a wide variety of government, business, and citizen organizations across the state to examine our environmental issues. The citizens serve on one of two types of committees, the Technical Work Groups or the Citizen Advisory Committee.

This report summarizes the work of the Technical Work Groups, whose 80 appointed members were divided into four work groups: Air, Land, Water and Natural Resources.

The Air, Land and Water Technical Work Groups examined risks associated with pollutants in these areas, while the Natural Resources Technical Work Group identified and evaluated the values of, and threats to, natural resources.

Similar projects previously sponsored by the EPA have focused only on analysis of air, land, and water pollution. Colorado Environment 2000 added the Natural Resources Work Group in recognition that Colorado's natural resources are an integral and important part of our environment, and must, therefore, be included in any environmental analysis.

Colorado Environment 2000 Issues List

The four Technical Work Groups met from November 1988 through June 1989, performing technical analyses of 31 environmental issues.

Air

- Acid Deposition
- Criteria Air Pollutants
- Hazardous and Toxic Air Pollutants
- Indoor Air Pollution
- Indoor Radon
- Noise Pollution
- Visibility Degradation in Rural & Pristine Areas

Land

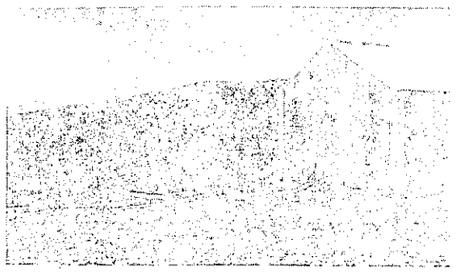
- Accidental Releases of Hazardous Materials
- Active & Inactive Mining & Milling Sites
- Environmental Lead
- Hazardous & Radioactive Waste Management
- Inactive Hazardous & Radioactive Waste Sites
- Natural & Geologic Hazards
- Pesticides
- Soil Erosion
- Solid Waste Management
- Underground Storage Tanks

Water

- Damages from Changes in Water Quantity
- Ground Water Contamination
- Nonpoint Source Surface Water Pollution
- Point Source Surface Water Pollution

Natural Resources

- Aquatic Habitats
- Critical Wildlife Habitats
- Forests
- Open Space
- Plains Land
- Recreation Opportunities
- Resources of Special Interest
- Threatened & Endangered Species Habitat
- Urban Environment
- Wetlands and Riparian Areas



CE2000 Methods

The efforts of three of the four Technical Work Groups consisted primarily of a risk evaluation process, whereby the persons serving on each of the Work Groups evaluated and ranked the issues based on three criteria—human health risk, ecologic damages, and economic/welfare damages.

Human health risk is defined as all health impacts resulting from exposure to a pollutant. The human health risk assessment process was designed to take into account the risk to individuals and populations, and whether the health effect is temporary or long-term.

The ecologic damage assessment attempted to examine the effects of pollutants on the structure and function of ecosystems. The structure refers to the diversity and quantity of life forms (e.g., fish, reptiles, and trees) that inhabit an ecosystem. An ecosystem must also be able to cycle the necessary chemicals and energy to support life. These supporting ingredients allow the system to function.

Economic damages are direct effects on the personal and financial welfare caused by pollution damages to property and resources used and enjoyed by humans. The economic damages include the cost of health care, material damages, soiling, and reduced recreation opportunities. Some of these damages cannot be easily or accurately expressed in dollar terms; however, the economic damage assessment provides a basis for determining people's behavioral responses to damages caused by pollution.

No new data collection was undertaken; the Work Groups relied on existing information to perform their assessments. In many cases, Work Group members had to rely on their technical expertise to make the qualitative judgments necessary to evaluate and compare the issues. Each Work Group produced a background report summarizing their analytical process and findings.

The Technical Work Groups performed their analyses by examining the current damages associated with the environmental issues. Therefore, the Work Group rankings do not explicitly incorporate factors such as costs of control, emerging technologies, adequacy of existing regulations, level of current funding, or public perception of the issues.

The Natural Resources Work Group did not analyze and rank issues based on pollution damages. The Natural Resource issues were ranked on the basis of ecological value, economic value, and vulnerability to degradation or destruction.

Limitations

The focus of the first phase of CE2000 was purposely confined to an evaluation of risks. Nevertheless, significant limitations were encountered that must be recognized when considering the results:

- The issue categories were not defined to be mutually exclusive. For example, pesticide exposure was evaluated by the Land Work Group, and was also considered by the Water Work Group in its evaluation of ground water contamination. Thus, there may be some "double counting" of risks among issues.
- In many cases, the data required to assess risks do not exist or are of poor quality. Even if the data are available, the causal relationships between exposures and health or ecologic effects are not well understood. In these cases, Work Group members had to rely more heavily on their "best professional judgment."
- The evaluations were based on residual risks, i.e. those risks still present after the beneficial effects of current programs are accounted for. For this reason, the rankings can be thought of as based on "net" risks, rather than "gross" risks.
- The evaluations were limited to risks that exist today. No attempt was made to project risks to the year 2000. This may mean that some issues that will emerge as serious concerns in coming years do not appear serious based on this evaluation. However, in the second phase of this project, the Citizen Advisory Committee will consider emerging issues, such as global warming and ozone depletion.
- Occupational risks were not calculated in this analysis. The standards for workplace exposure are often different from non-occupational standards.

The major conclusions of the Technical Work Groups are presented in the next section of this report, followed by a discussion of the next steps of the Colorado Enviroment 2000 Project. General discussions of each of the 31 environmental issues analyzed by the four Technical Work Groups comprise the rest of the document.

Major Technical Work Group Findings

After compilation, review, and analysis of available information, members of the Air, Land and Water Work Groups evaluated the relative degree of impacts and damages for each issue and compared them to the other issues within the Work Group subject area. These three work groups first ranked the issues based on three criteria—human health risk, ecologic damages, and economic/welfare damages. The Natural Resource work group, however, followed a different method, ranking the issues based on ecological values and vulnerability to threats. Using relative risk rankings from these three damage categories or, in the case of the Natural Resource work group, the degree to which the issues were being addressed by state and private citizens, issues within each Work Group subject area were then ranked on an overall basis.

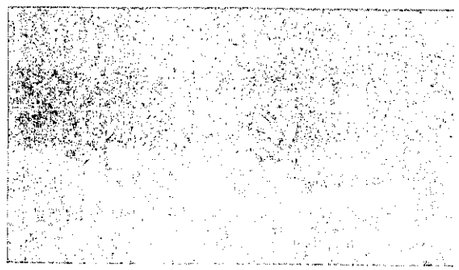
While it is recognized that each issue is important and merits attention, this comparative process allows for a determination of the member's judgment about the most important issues within each Work Group. Brief discussions of the environmental issue priorities as determined by each of the four Technical Work Groups follow.

Air

The Air Technical Work Group ranked Indoor Air Pollution and Indoor Radon as having the highest current risk from a health damage perspective. From an economic damage perspective, the Criteria Air Pollutants category was ranked as the issue posing the highest current risk. The Work Group did not perform a ranking of ecologic damages because Work Group members concluded that very minor ecologic damages are currently associated with the seven issues analyzed.

On an overall ranking basis, the Work Group concluded that the Criteria Air Pollutants issue was the highest priority issue. This conclusion was reached based on the Work Group's determination that the Criteria Air Pollutants category was the only one associated with relatively severe health effects and relatively severe economic damages.

Colorado residents are exposed to two Criteria Air Pollutants in levels well above the health-based federal standard: carbon monoxide and fine particulate matter. Fine particulate matter refers to the very small particles that if inhaled, may become lodged deep in the lungs and eventually cause lung cancer or other health problems. Carbon monoxide reduces the oxygen-carrying capacity



Several types of economic damages are associated with criteria air pollutants. These include damage to property, costs associated with health problems, visibility degradation, and negative impacts on economic development and quality of life.

Economic damage from visibility degradation in rural and pristine areas was examined as a separate issue because the federal standard for fine particulate matter is set to be protective of human health, not of visibility. However, in the ranking of Criteria Air Pollutants as the highest priority issue, the Work Group included visibility degradation in residential areas along the Front Range and in the mountains for several reasons:

- visibility degradation in urban areas, particularly that caused by Denver's Brown Cloud, is the source of the most severe economic damages associated with criteria air pollutants;
- fine particulate matter is the cause of visibility degradation as well as damages to human health; and
- it is likely that problems with visibility degradation in urban areas will persist even after the health-based standard has been met.

Land

The Land and Multi-Media Technical Work Group ranked Environmental Lead, Active and Inactive Mining and Milling Sites, and Pesticides as the issues posing the greatest current risks from a health effects perspective. Soil Erosion, Active and Inactive Mining and Milling Sites, and Pesticides were ranked by the group as those issues with the highest current ecologic damages. From an economic damages perspective, Soil Erosion, Environmental Lead, Active and Inactive Mining and Milling Sites, and Pesticides were ranked as those issues with the highest current damages.

The Work Group concluded that the current damages associated with Environmental Lead, Soil Erosion, Active and Inactive Mining and Milling Sites, and Pesticides have the highest overall current risks.

Environmental Lead ranked high because of risks to human health and related economic damages. Human exposure to lead can occur from a variety of different sources, and individuals in both urban and rural areas of Colorado are believed to be at risk of adverse health effects. The most significant economic damages from environmental lead are health care and other costs related to lead-induced health problems.

Soil Erosion was ranked high based on relatively severe economic and ecologic damages. The major adverse ecologic damages from soil erosion are:

- loss of riparian habitat due to streambank erosion and sediment deposition;
- reduced fisheries productivity due to high levels of suspended solids, salinity, and sediment deposition; and
- loss of wetland and upland habitat due to sediment deposition.

Economic damages from soil erosion include reduced crop yields, increased costs of agricultural inputs, lost water storage capacity, damages to recreational fishing, and increased water treatment costs.

Active and Inactive Mining and Milling Sites were included in the highest overall ranking because of relatively severe health, ecologic, and economic damages. Adverse health effects associated with active and inactive mining sites in Colorado are related to exposure to heavy metals (lead and cadmium), arsenic, and radioactive mine waste. The extraction and processing of natural resources have resulted in extensive degradation and loss of terrestrial wildlife habitat in Colorado, and have disrupted and degraded surface water and ground water resources. Ecologic damages from the thousands of inactive/abandoned mines in the state continue long after the sites are no longer being used. The most significant economic damages from mining sites are lowered soil productivity affecting ranch crops, row crops, and natural grasses; lost recreational opportunities; aesthetic impacts; property damage from mine subsidence; depreciation of property value near mining facilities; and costs of illness resulting from exposure to contaminants.

Finally, pesticides were included in the highest overall issues ranking within the Land and Multi-Media issues group based on relatively severe health, ecologic, and economic damages. Based solely on national data, the human health risk from exposure to pesticides is high to individuals and to the population because of numerous potential exposure pathways, including pesticide residues on food, pesticides in drinking water, and household, municipal, and commercial use of pesticides. The most severe ecologic damages from pesticide use in Colorado are likely to occur in critical habitats or to endangered species. Economic damages from pesticides include ground water contamination, health care costs, and lost recreational opportunities. The group noted than pesticides are applied for beneficial uses such as increased crop yield and pest reduction, but benefits were not included the analysis.

Water

From a health effects perspective, the Water Technical Work Group ranked Ground Water Contamination as the issue with the highest current damages. Nonpoint Source Surface Water Pollution and Damages from Changes in Water Quantity were ranked the issues with the highest current damages from both the ecologic damages and the economic damages perspectives.

Overall, the Work Group concluded that the current damages from Nonpoint Source Surface Water Pollution and Damages from Changes in Water Quantity are the most severe for the issues they examined. In ranking these issues together, the Work Group recognized the interrelationship between water quantity and water quality, particularly as they affect aquatic ecosystems.

The Work Group felt that Nonpoint Source Surface Water Pollution is the most damaging pollution source on ecosystems in Colorado. It is a very widespread problem, impacting over 3,000 stream miles in Colorado. Controlling nonpoint source pollution is very difficult, because the sources are numerous and diffuse; therefore this issue should be given special attention.

The Work Group noted that Damages from Changes in Water Quantity could also have significant impacts on the ecological systems in Colorado, especially when water is removed from drainages to the extent that animal and plant life is diminished. The group noted that there are many benefits from changes in water quantity, but the study analyzed the negatives impacts only of all issues.

Natural Resources

Because issues within the Natural Resources Technical Work Group area are assets rather than pollution types or sources, analysis of the human health effects, ecologic damages, and economic damages was not practical. Instead, natural resource issues were ranked on the basis of ecologic value, economic value, and vulnerability to degradation or destruction.

There was consensus among Work Group members that wetland and riparian zone protection is the most critical natural resource issue facing Colorado. The tremendous ecologic value provided by wetlands and riparian zones, combined with their scarcity in Colorado and the difficulty in restoring or creating a viable wetland one conversion has occurred, make this an urgent issue.

Acre for acre, wetlands are the most biologically productive lands in the state. Wetlands maintain themselves and provide their water quality and water quantity functions over a great number of years. The long-term social value of these functions can be significantly higher than the short-term dollar benefits obtained by converting wetlands to other uses. The loss or degradation of wetlands and riparian areas can have a variety of adverse effects on the natural ecology and socioeconomic well-being of an area, including reduced populations of numerous species. Many of these species are hunted, fished, photographed, or viewed by people who spend about $2 billion in Colorado each year on these activities.

Integrated Ranking Subcommittee

Once the Work Groups had completed their analysis, an Integrated Ranking Subcommittee was formed to consider the information and rankings from the four Technical Work Groups and to perform an integrated ranking of the 31 issues. The Subcommittee consisted of approximately three members from each Work Group. The Integrated Ranking Subcommittee completed an overall ranking that reflected the fact that the damages associated with an issue may have been severe when compared to the other issues being examined by one Work Group, but less severe than the damages associated with issues being examined by other Work Groups.

The integrated ranking was complicated by the overlap of issues and a fundamental difference between the Natural Resources Work Group and the Air, Land, and Water Work Groups. The issues were defined differently, the analysis was different, and the types of threats considered were different.

Given available information, the Subcommittee was able to define four issues as having the greatest current damages:

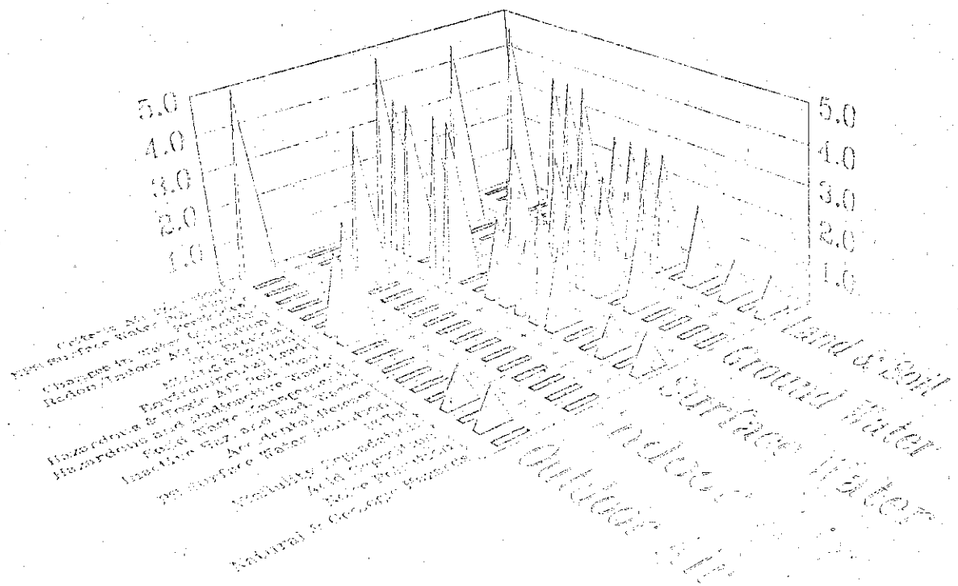
- Criteria Air Pollutants (including urban visibility degradation),
- Loss of Wetlands and Riparian Zones,
- Nonpoint Source Surface Water Pollution, and
- Pesticides.

The Subcommittee ranked Criteria Air Pollutants high because more people in Colorado are impacted by the health and economic effects of these pollutants than any other pollutants. The Denver metro region continues to violate the national standards, and both CO and particulates have been linked to serious health impacts. Economic impacts from the Denver Brown Cloud are thought to be significant along the Front Range.

The loss of wetlands was viewed as most important for two reasons: first, wetlands are scarce in Colorado, comprising less than three percent of our land; and secondly, wetlands are vital for plant and animal life.

Nonpoint source surface water pollution was ranked high because nonpoint source has the most significant impact of any pollutant on the ecological systems in Colorado. Water in Colorado, which is vital for all animals and plants, is polluted more by nonpoint sources than other sources.

The subcommittee raised concerns regarding pesticides because national data indicate that misuse of pesticides may be causing serious human and ecological health impacts. The subcommittee called for better Colorado data in order to accurately assess the harm pesticides may be causing Colorado.



The Integrated Ranking Subcommittee graphically illustrated their ranking of pollution issues and resources. The three-dimensional graph shows how serious the effects of each pollutant are for each resource category. The Subcommittee gave each pollutant a ranking of one to five, and the number on the chart reflects the average numeric ranking. The graph also demonstrates how the pollutants rank relative to one another. The pollutants with the tallest triangles are the most important issues. The flat rectangles indicate that the pollutant does not have an impact on that resource area.

Other Important Conclusions

The risk evaluation and integrated ranking processes conducted by the Integrated Ranking Subcommittee yielded some important conclusions in addition to the rankings described above. These conclusions include:

- In Colorado, protecting against degradation of our natural resources is as important as protecting against pollution that threatens human health.
- In some cases, damages from physical alteration of our natural resources are more severe than damages caused by pollution.
- By focusing on specific pollutants or sources, we may fail to address the interrelationships between pollution issues and the natural resources they affect. Regulatory agencies should pursue management strategies that address the interrelationships between different environmental threats and their cumulative impacts on our natural resources.
- Many of our current environmental management strategies address symptoms and perpetuate a curative approach as opposed to a preventative approach.
- In general, the easier point source pollution problems are being monitored and in most cases controlled. Future environmental improvements will come from controlling diffuse nonpoint sources. This will require action at the individual level.
- Threats to human health do not necessarily endanger ecosystems; however, threats to ecosystems ultimately jeopardize our well-being. This recognizes the fact that human health is linked to the health of the entire ecosystem.

The Next Steps

The efforts of the four Technical Work Groups consisted primarily of a risk evaluation of the 31 environmental issues. The results of their analysis and conclusions are summarized in this document.

In phase two of Colorado Environment 2000, begun in the summer of 1989, the Citizen Advisory Committee has reviewed the technical information and conclusions of the technical work groups. They are currently setting environmental goals for Colorado and suggesting methods to reach those goals. The goals are based in part on technical information, but also on additional criteria such as:

- adequacy of existing regulatory programs,
- technical feasibility of further controls, and
- costs of control.

The goals are future-oriented, practical, but visionary statements of where Colorado should be by the year 2000.

These goals established by the Citizen Advisory Committee will provide a focus for government agencies, identify areas where help is needed from the business community, and give individual citizens an idea of how they can make a difference in environmental quality. The goals will be finalized in early 1990. The final report of the Colorado Environment 2000 Project will be published in 1990.

Summary of Environmental Issues

The 31 environmental issues analyzed by the Technical Work Groups include specific pollutant types (e.g., environmental lead), pollutant categories (e.g., criteria air pollutants), sources of pollutants (e.g., active and inactive mining and milling sites), management practices (e.g., solid waste management), and natural resource assets (e.g., wetlands and riparian zones). The issues were defined fairly broadly, but each has a unique component or approach that required analysis.

Note: The issues within each section are listed in alphabetical order, not in the order in which they were ranked by the Technical Work Groups.

Air Issues

The Air Technical Work Group identified seven issues of concern. Each of these issues is a specific type or category of pollution, as listed below:

- Acid Deposition
- Criteria Air Pollutants (including urban visibility degradation)
- Hazardous and Toxic Air Pollutants
- Indoor Air Pollution
- Indoor Radon
- Noise Pollution
- Visibility Degradation in Rural and Pristine Areas

The following sections give a description, the effects and damages, and a summary of impacts in Colorado for each air issue.

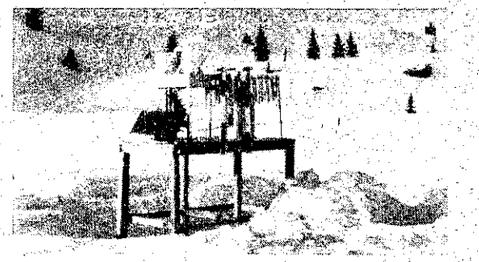
Acid Deposition

Description. Nitrogen and sulfur oxides, emitted primarily through the combustion of coal, petroleum products, natural gas and wood, can be transformed into strong acids in the atmosphere. These acids can be deposited on the earth's surface through the air, rain, or snow.

Effects and Damages. Once deposited in water or on land, these strong acids cause the loss of important nutrients and acidification, damaging plant and animal life in aquatic ecosystems, forests or agricultural areas. High altitude watersheds possessing low acid-neutralizing capacities are widely considered to be the resource most sensitive to acid deposition. In the northeastern United States and in Europe, ecosystems have been devastated by acid deposition.

Impacts in Colorado. The 1985 Western Lake survey conducted by EPA and USFS, found no evidence of acid deposition in Colorado. Recent studies (Hart's salamander study and spring pulse phenomenon) indicate impacts of acid deposition may be occurring to sensitive ecosystems, usually high alpine lakes ecosystems with few naturally occurring chemicals to neutralize the acids. These lakes, which will warn us of acid deposition problems in Colorado, are being closely monitored. The long range atmospheric transport of emissions from out of

Wet Atmospheric Deposition Monitor



state sources and future industrial growth in Colorado warrant maintaining a close watch on acid deposition impacts. Human health impacts were found to be negligible, and economic impacts could not be measured at this time.

Criteria Air Pollutants and Urban Visibility Degradation

Description. There are currently six outdoor air pollutants for which National Ambient Air Quality Standards (NAAQS) have been established under the Clean Air Act. These pollutants, commonly referred to as "criteria air pollutants", are carbon monoxide, fine particulate matter, nitrogen dioxides, ozone, sulfur dioxide, and lead. (Lead was examined as a separate issue by the Land Technical Work Group.) The phrase "fine particulate matter" refers to tiny dust particles suspended in the air. Urban visibility degradation was included in this section because it is caused by fine particulate matter.

Effects and Damages. While a direct link has not been established, epidemiological studies have found an association between high levels of particulate matter and "restricted activity days" (days on which an individual's normal activities are curtailed due to illness), increased emergency room visits, and human deaths. Individuals with existing respiratory ailments such as asthma and emphysema are at greatest risk, and are urged to restrict their activities on high pollution days.

When carbon monoxide enters the respiratory system, it reduces the oxygen carrying capacity of the blood which can result in cardiovascular and neurobehavioral effects. Fetuses and individuals with heart disease, chronic respiratory disease, or chronic anemia are believed to be at high risk.

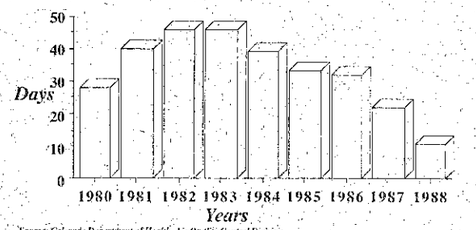
Economic damages from criteria air pollutants include materials damage (soiling, discoloration, etc.), visibility degradation, and costs of health effects. Ecologic impacts were not considered.

Impacts in Colorado. The major sources of criteria air pollutants in Colorado include transportation (motor vehicles, aircraft, and trains); fireplaces and wood stoves; unconfined particulate matter (street sanding, construction, etc.); boilers and furnaces (industrial, residential, and public utilities); forest fires; agricultural activity (dust); and sources of volatile organic compounds (paints and dry cleaning chemicals, which contribute to the formation of ozone). Colorado's most damaging criteria air pollutants are carbon monoxide (CO) and fine particulate matter. Metro Denver continues to violate CO standards *(see graphic on next page)*, as do other cities along the Front Range.

In addition, Denver's aesthetically unpleasant Brown Cloud is caused by high levels of fine particulate matter. High levels of fine particulate matter are also a problem in several other communities along the Front Range, in the mountains, and on the Western Slope.

Colorado suffers from material damage, visibility degradation, costs of health care, and reduced quality of life. Colorado also has a reputation for air quality problems that may detract from the desirability of our state as

Days in Violation of Carbon Monoxide Standards in Metro Denver



Source: Colorado Department of Health, Air Quality Control Division

a place to live and work. The economic impacts of criteria air pollutants in exact dollars are impossible to calculate. Ecologic impacts were not estimated.

Hazardous and Toxic Air Pollutants

Description. A number of hazardous and toxic outdoor air pollutants, commonly referred to as "air toxics," have been identified as having the potential to cause cancer and other health problems. There are approximately fifteen pollutants or pollutant groups that are responsible for most of the cancer risk from air toxics, including:

- chromium
- formaldehyde
- cadmium
- perchloroethylene
- arsenic
- trichlorethylene
- benzene
- products of incomplete combustion
- carbon tetrachloride
- asbestos
- chloroform
- radionuclides
- ethylene dibromide
- gasoline vapors
- ethylene oxide

An examination of emissions associated with these pollutants shows a diverse and complex group of sources including motor vehicles, power plants, industrial processes, wood burning, chemical and petroleum refining, solvent usage, dry cleaning facilities, and gasoline stations.

Effects and Damages. Exposure is generally caused by inhalation of one or more of these air toxics. However, the ability to accurately assess health risks is limited by inadequate data on concentrations of air toxics, inadequate exposure information, and a poor understanding of the effects of chemical mixtures on human health. Despite these limitations, many health and environmental professionals believe that current human health risks associated with air toxics are significant.

Impacts in Colorado. Both cancer and non-cancer health risks may be greatest in urban areas along the Front Range, where individuals are most likely to live or work close to a major source of air toxics.

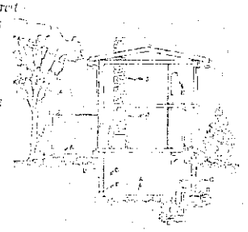
Only one major study of air toxics has been completed in Colorado. The study, which sponsored monitoring sites around the Denver Metro area, found that the highest toxic emissions were from benzene generated mainly from motor vehicle related sources. A follow-up risk assessment is currently being completed. More data collection would help determine sources and impacts. Health effects may exist in some mountain communities due to wood burning. Wood smoke has hundreds of chemicals, a number of which are thought to be carcinogenic. Ecologic and economic impacts were not estimated.

Indoor Air Pollution

Description. There are many potential sources of indoor air pollution in any home or building, including gases from oil, gas, kerosene, coal, or wood combustion; volatile organic compounds (solvents, paints, cleaning materials etc.); tobacco smoke; asbestos; biological contaminants; indoor use of pesticides; and personal use products such as hair spray and nail polish. Indoor radon is examined as a separate issue, although in the ranking, the issues were combined.

Major Radon Entry Routes

A. Cracks in concrete slabs
B. Spaces behind brick veneer walls that rest on unstopped hollow-block foundation
C. Pores and cracks in concrete blocks
D. Floor-wall joints
E. Exposed soil, as in a sump
F. Weeping (drain) tile, if drained to open sump
G. Mortar joints
H. Loose fitting pipe penetrations
I. Open tops of block walls
J. Building materials such as some rock
K. Water (from some wells)



Indoor Radon

Description. Radon comes from the natural breakdown (radioactive decay) of uranium. Uranium is a heavy metal which occurs naturally in almost all soil and rock. When radon gas is released from the earth, it migrates into the atmosphere. Outdoors, the radon mixes with the ambient air and concentrations remain low. However, when it enters a building through openings in the foundation, the radon gas can accumulate in higher concentrations.

Effects and Damages. Exposure to radon has the potential to cause death from lung cancer through inhalation of radon and its by-products. The risk is higher to individuals who smoke and to people exposed to environmental tobacco smoke in the home or at work. Property values can be reduced by the cost of correcting the problem when measurements indicate high radon concentrations.

Impacts in Colorado. During the winter and spring of 1986-87 and 1987-88, radon monitoring data were collected in Colorado through a joint effort of federal, state, and local governments and individual homeowners. These data demonstrated higher average levels of radon in Colorado than in other states. Specific individual levels varied from 1 to 100 picocuries per liter of air. EPA recommends corrective action at 4 picocuries per liter.

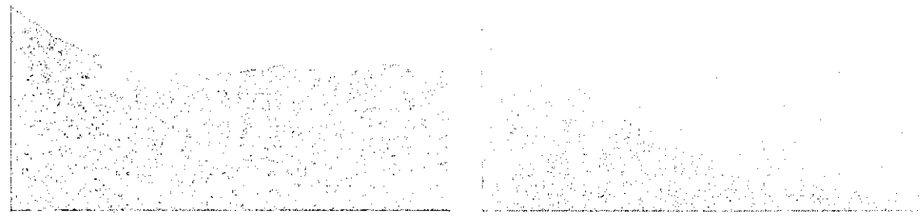
The market value of some properties with high radon levels may have decreased due to the costs of correcting the problem. Ecologic impacts are not applicable.

Effects and Damages. Indoor air pollution presents a threat to public health because of the length of potential exposure to a large mixture of chemicals (people are indoors most of the time) and the possibility of compounding effects among various chemicals. Levels of criteria air pollutants and hazardous and toxic air pollutants are often higher indoors than outdoors. There is a cancer risk from exposure to a wide variety of indoor air pollutants, including tobacco smoke, asbestos, pesticides, and volatile organic compounds. Non-cancer health effects of exposure to indoor air pollutants include nausea; headaches; dizziness; heart disease; eye, nose and throat irritation; bronchitis; asthma; and liver and kidney damage.

Impacts in Colorado. Indoor air pollution has the potential to adversely impact the health of all residents of the state. There have been occasional, dramatic incidences in Colorado of indoor air pollution where buildings have been abandoned (usually because of asbestos) or temporarily evacuated. There are also cases of "sick building syndrome" where workers complain of continual colds or irritations. At this time, the information is only anecdotal. No comprehensive data collection efforts are being undertaken.

Inadequate ventilation exacerbates the problem in Colorado. This is especially important in the winter in Colorado, where attempts to conserve energy through minimization of outdoor air entry into buildings has reduced ventilation, and may increase levels of indoor air pollution. Ecologic and economic impacts were not estimated.

Visibility Degradation in Rocky Mountain National Park (Left 10/25/88, Right 8/29/89)



Noise Pollution

Description. Noise pollution is defined as unwanted or unpleasant sound. Whether a sound is annoying is dependent upon many individual factors including age, sensitivity to noise, an individual's level of control over the noise, and duration of the noise. The most common sources of community noise are traffic, aircraft, trains, industry, and construction.

Effects and Damages. The most significant damage to human health from noise is a loss of hearing. Other recognized effects include annoyance, speech interference, sleep interference, cardiovascular and circulatory problems, psychological problems, and social behavioral problems. Noise effects on some species of animals can be similar to those found in humans. Economic impacts usually concern property depreciation where noise is very significant.

Impacts in Colorado. Effects on humans are generally from local sources such as highways or airports, with highways causing the greatest problem. The Department of Highways has a program to build fences along major interstate highways to mitigate noise. Moving the airport to rural Adams County will help to alleviate much of the aircraft noise in the Denver metro region. Excessive noise could impact animal species in two areas in Colorado — near Stapleton International Airport in Denver due to commercial aircraft, and in southwestern Colorado due to military aircraft, although site-specific data is lacking. Property depreciation may be found in residential areas near highways or airports.

Visibility Degradation in Rural and Pristine Areas

Description. Commonly referred to as "regional haze," visibility degradation in all areas of the state is the result of particulate matter suspended in the atmosphere. In urban areas and mountain communities in Colorado, visibility degradation is caused primarily by pollution sources in the immediate area such as woodburning stoves. Regional haze in rural areas, by contrast, is caused by numerous sources, such as power plants, factories, and automobile emissions, covering a wide geographic area.

Effects and Damages. Regional haze causes visibility changes at sites characterized by scenic beauty and long vistas (e.g., the Grand Canyon). These visual impacts include decreased visual range and changes in contrast and color. Recreation and tourism opportunities may decrease as a result of these visual changes, and the quality of these activities may be lessened.

Impacts in Colorado. Evidence suggests that people in Colorado value good visibility as a contributor to their quality of life. In recreation areas, people drive and hike considerable distances to reach prominent overlooks and view the scenery. Visibility degradation is being monitored by the National Park Service in some of Colorado's National Parks and Monuments, and by the U.S. Forest Service in wilderness areas. If visibility degradation in rural and pristine areas results in reduced recreational activity, reduced expenditures by visitors could have a negative impact on local and state economies. Human health and ecologic impacts were not applicable.

Land and Multi-Media Issues

The Land and Multi-Media Technical Work Group identified ten issues of concern. Types of issues include pollutant sources (sites or accidents), pollutant types, management practices, and natural hazards. The ten specific issues analyzed include:

- Accidental Releases of Hazardous Materials
- Active and Inactive Mining and Milling Sites
- Environmental Lead
- Hazardous and Radioactive Waste Management
- Inactive Hazardous and Radioactive Waste Sites
- Natural and Geologic Hazards
- Pesticides
- Soil Erosion
- Solid Waste Management
- Underground Storage Tanks

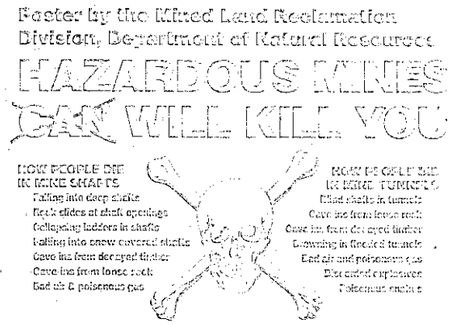
The following sections give a description, the effects and damages, and a summary of impacts in Colorado for each land and multi-media issue.

Accidental Releases of Hazardous Materials

Description. Large amounts of hazardous materials are transported across Colorado on highways, railroads and other transportation links each year. In addition, hazardous materials are stored at industrial and other facilities near highly populated areas. Human error or acts of nature could release these materials into the soil, air, or water with little or no warning.

Effects and Damages. Accidental releases of hazardous materials can result in a catastrophic event which could result in injury and death to a large number of people, as evidenced by international incidents such as the explosion at the Union Carbide facility in Bhopal, India. The greatest risk to human health from accidental releases is often from airborne toxics because they quickly disperse over a large area. Accidental releases can also cause aesthetic damages, economic losses, problems such as odors and water contamination, and lost recreational opportunities.

Impacts in Colorado. Most deaths and injuries from accidental releases in Colorado are caused in the workplace or as the result of a traffic accident. Approximately half of the known accidental releases to surface waters in Colorado involve discharges of petroleum products in amounts of less than 1,000 gallons. The ecologic damage from these small petroleum releases is localized and short-term because of good emergency response activities and the cleansing action of natural systems. Economic impacts were not estimated.



Active and Inactive Mining and Milling Sites

Description. Mining activities often last for many years and have the potential to disrupt large land areas, resulting in major changes to the surrounding environmental systems. Some mines have been abandoned without proper reclamation efforts, leaving environmental problems unresolved.

Effects and Damages. Mining operations have resulted in human exposure to heavy metals (lead and cadmium), arsenic, and radioactive mine and waste. Lead has been shown to cause adverse neurological effects in humans, particularly young children and fetuses. Cadmium is a probable human carcinogen, and can accumulate in the kidneys and lead to kidney dysfunction. Ingestion of arsenic is associated with increased incidence of lung, liver, bladder, and skin cancer. Exposure to these pollutants can result from consumption of contaminated water, inhalation of windblown tailings, and from metal contamination in the food chain. Physical hazards due to subsidence (a general lowering of the surface of the earth due to underground mining activity), open mine shafts, and discarded machinery exist at many inactive mine sites. Uranium tailings have been used as ingredients in cement and mortar for residential construction, causing concern over exposure to radon gas and radioactivity. Property values near dangerous or offensive sites will tend to be reduced until site stabilization or clean-up occurs. Future land use options for these sites will be limited unless clean-up and/or proper reclamation is performed.

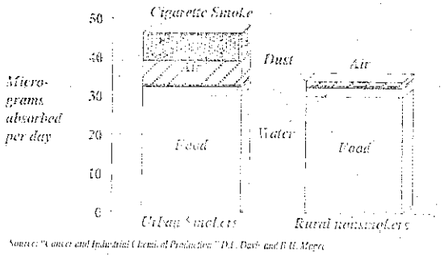
Impacts in Colorado. Colorado's history includes a wealth of past and present mining activities. Mineral development began in Colorado with the first gold rush in 1858 and has continued ever since. Coal mining began in the 1860's, supplying fuel to process metal ores. Large-scale production began in the late 1870's with the development of the railroad.

This history of mining activity has given Colorado wealth and a legacy of clean-up. The first reclamation laws were developed in the mid-1960's. In 1988, the Minerals Program of the Colorado's Mined Land Reclamation Division (MLRD) of the Department of Natural Resources regulated more than 1,972 active mining operations and 535 exploration operations (including sand and gravel, precious and base metals, oil shale and uranium) affecting more than 110,000 acres of land. In 1988, there were 57 permitted coal operations in Colorado affecting 94,096 acres of land. The mines produced more than 15 million tons of coal.

Inactive and abandoned mines are begin addressed by the Inactive Mine Reclamation Program of the MLRD. In 1988, 602 sites were safeguarded, 30 abandoned mine projects were completed and 65 acres were reclaimed through this program. There is not an estimate of the number of abandoned mines causing safety and subsidence problems statewide. Six major mining sites are also being cleaned up under Superfund.

The extraction and processing of natural resources have resulted in degradation and loss of terrestrial habitat in many parts of Colorado, as well as disruption and

Sources of Lead Absorption in Humans



Source: "Cancer and Industrial Chemical Production," D.L. Davis and B.H. Magee

degradation of surface and ground water resources. The major ecologic impacts caused by active and inactive metal mining activities are due to heavy metal-laden acid mine drainage, residual waste rock, and tailings piles.

Health impacts include those from direct exposure to mines and tailings (including entering old mines) to exposure to the dangerous byproducts of mining. There has been concern in recent years over the past use of uranium tailings in cement and mortar used in residential construction. A joint DOE and State program (UMPTRAP) is addressing clean-up of inactive mill sites, as well as residential and other nearby properties contaminated with tailings from those mill sites.

Efforts to identify and remove structures which pose potential physical hazards are underway. Economic impacts in Colorado include property damage due to mine subsidence, cost of remedial actions at uranium mill sites, and loss of recreation opportunities.

Environmental Lead

Description. Lead is a pervasive pollutant that is released into the environment by many different sources, including lead-based paint, lead solder on drinking water pipes, leaded gasoline, mining sites, and smelting and refining operations.

Effects and Damages. Lead has been shown to cause adverse neurological effects, including cognitive damages, especially in young children and fetuses. In addition, lead can interfere with normal growth and stature, blood-forming processes, vitamin D metabolism, and kidney function. Chronic hypertension in middle-aged men has also been associated with exposure to environmental lead.

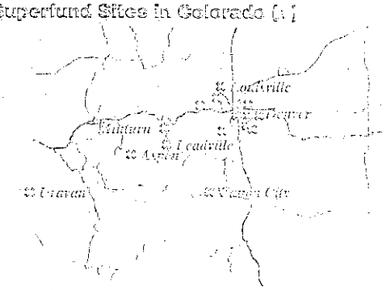
Impacts in Colorado. Individuals in both urban and rural areas of Colorado are believed to be at risk of adverse health effects from exposure to lead. Lead exposure from mining sites has been documented in several areas of Colorado. A study to quantify blood lead levels in lower income urban areas was initiated by the Colorado Department of Health this fall. Ecologic and economic impacts were not estimated.

Hazardous and Radioactive Waste Managment

Description. This issue addresses hazardous and radioactive wastes currently generated and handled by industrial activities in Colorado that come under the current laws and regulations. Proper management techniques are needed in each stage of handling hazardous wastes. Stages include waste generation, treatment, storage, disposal, transportation, and recycling.

Effects and Damages. Depending on site-specific conditions, individuals consuming untreated ground water contaminated by active hazardous waste facilities can be exposed to both cancer and non-cancer risks.

Superfund Sites in Colorado [1]



Other routes of exposure are inhalation of airborne contaminants and ingestion of contaminated soils. Most problems are the result of improper/illegal disposal or storage in unlined landfills and lagoons or waste ponds.

Impacts in Colorado. Recent Colorado statistics indicated that there are 51 treatment, storage, or disposal facilities; 524 generators; and 219 transporters of hazardous waste. There are thousands of small-quantity generators that must also comply with federal management regulations. While each of these is a potential pathway for exposure to hazardous materials, current regulations and enforcement practices minimize the risks.

Proper management for radioactive waste includes special care in storage and transportation by the approximately 100 low-level radioactive waste generators in Colorado, including hospital, university, and industrial research and service facilities as well as the Fort St. Vrain nuclear generating station. Colorado has a commercial low-level radioactive waste treatment and transfer facility and is required by federal and state law to develop a low-level radioactive disposal site by 1993.

Currently, the population exposed to hazardous and radioactive waste management facilities statewide is small. (In the case of improper management, those residing within close range of hazardous material generators or handlers may be at risk.)

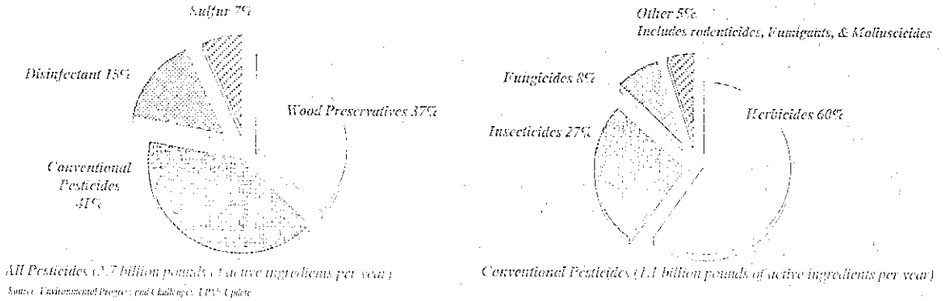
Ecosystems could be impacted if the hazardous materials came in contact with plants and animals. Economic impacts from disposal activities and facilities were not studied.

Inactive Hazardous and Radioactive Waste Sites

Description. Inactive hazardous and radioactive waste sites include designated Superfund sites, potential Superfund sites (i.e. identified but not designated), and all unidentified industrial and waste sites. The Superfund law (CERCLA) was established by Congress in 1980 to identify and clean up sites where hazardous wastes are located. If a site is abandoned before waste is properly disposed of, unmanaged hazardous materials may enter the air, water, and soil. Though the risks associated with these abandoned sites are usually localized, the types, quantities, and risks are unknown without extensive and costly site investigation.

Effects and Damages. Generally, the most important route of human exposure is consumption of contaminated ground water. Depending on site-specific conditions, individuals consuming untreated ground water contaminated by inactive hazardous waste sites can be exposed to both cancer and non-cancer health risks. Surface water, soils, and air may also be routes of exposure. Wildlife and aquatic organisms are also exposed to these risks. These inactive sites may be unusable for long periods of time, and potential future land uses may be constrained unless the contamination problems are corrected.

Impacts in Colorado. Sixteen hazardous waste sites have been designated as Superfund sites in Colorado to date. Health effects from these sites are generally localized, and only a small number of people may be affected. Of concern are the uncertainties about the number



and location of unidentified inactive hazardous and radioactive waste sites and, therefore, the number of people who may be exposed. Damage to plants and animals on and around Superfund sites may be occurring, and there may be property depreciation near Superfund sites.

Natural and Geologic Hazards

Description. Natural and geologic hazards include floods, avalanches, earthquakes, tornados, landslides, and swelling soils. The conditions producing natural and geologic hazards are a part of the Colorado environment, and for the most part cannot be changed. However, much can be done to decrease the problems with natural hazards in both developed and undeveloped areas. With identification of hazard areas, land use concepts including avoidance and mitigation can be used to decrease the risks.

Effects and Damages. Natural and geologic hazards cause loss of life and substantial economic and ecologic damages each year, primarily on a localized basis.

Impacts in Colorado. The major risks to human life in Colorado are from avalanches and floods. During the period 1970-1989, 76 people were killed and 60 people injured by avalanches in the state. At least 350 people have been killed in floods since Colorado became a state. Property damage in Colorado is primarily from floods, swelling and settling soils, landslides, and high winds. The Colorado Geological Survey estimates annual dollar damages from swelling soils and landslides to be $46 million. Ecologic impacts can be significant at specific, localized sites, especially in the case of floods and mudslides.

Pesticides

Description. Pesticides are defined to include insecticides, herbicides, fungicides, and rodenticides. Pesticides are used widely to treat crops, pastureland, rangelands and orchards, and for weed and insect control in and around residences and workplaces. Although pesticides help protect food crops and reduce pests, weeds, and diseases, most are potentially dangerous substances requiring careful control. Many pesticides are capable of harming non-target species, including humans.

Effects and Damages. Pesticide usage is a health concern if direct exposure occurs because of the potential toxicity of the compounds. In addition, some pesticides are suspected carcinogens, and if residues on food are ingested, the result could be an increased risk of cancer. The effects of pesticides on non-targeted organisms may involve immediate injury due to direct exposure, or may be due to long term consequences of environmental pollution.

Impacts in Colorado. No accurate data on the amount and types of pesticides presently being used in Colorado have been collected, nor is there a system for data collection in place. Information on the harmful human health impacts of pesticides can only be gained through extrapolation using broad assumptions. It is impossible to

accurately determine the number of deaths attributable to pesticides from these data. Overall, the negative impacts of pesticides on human health are not known for Colorado.

Ecological systems are also impacted by pesticides, including effects on wildlife populations, habitats and food sources. A first step in measuring the risks may be data collection on specific pesticides and continued research into ecologic effects of pesticide usage. Economic impacts were not estimated by the Technical Work Group. Because of the toxic nature of the substances, lack of data is cause for concern. Gaps in the data on human health risks from pesticides currently on the market are being filled in, which will result in the removal of most carcinogenic compounds. It is hoped that human health risks will diminish considerably by the year 2000 with better testing and enforcement.

Soil Erosion

Description. Soil erosion is the loss or displacement of soil. It can be caused by human activities and by natural processes. Major causes include winds, flooding, farming, logging, mining, livestock grazing, and construction.

Effects and Damages. Soil erosion adversely impacts both the structure and the function of aquatic and terrestrial ecosystems and, most importantly, affects reproduction of wildlife populations. The potential for ecosystem recovery once major soil losses occur is low or non-existent in many cases. Major adverse ecologic impacts from soil erosion include dissolution of nutrients in lakes and reservoirs; loss of riparian, wetland, and upland habitat (food and cover); and reduced fisheries productivity. Economic damages include reduced crop yields, damage to water storage, transportation, and treatment facilities.

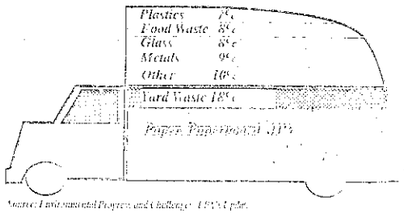
Impacts in Colorado. Soil erosion is a widespread problem in Colorado, affecting approximately 50 percent of the land, 25 percent of the stream miles, and 15 percent of the lakes and reservoirs. Streambank erosion alone affects over 12,000 bank miles, and may be threatening up to 312,000 acres of riparian habitat. Human health impacts were not applicable.

Solid Waste Management

Description. Many persons view the generation, treatment, and disposal of trash as a routine and automatic process. However, land constraints in some areas and awareness of environmental degradation from the rate and type of generation and improper disposal will increasingly require communities and businesses to employ safer solid waste management practices.

Effects and Damages. Improper solid waste management causes contamination of ground water and drinking water, and individuals consuming this contaminated water may be exposed to both cancer and non-cancer risks. Wildlife and aquatic organisms may also be exposed to these risks. Unmanaged decomposition of

Papers and Yard Waste Accounts for more than Half of our Trash (National Data)



Source: Environmental Progress and Challenges: EPA's Role.

solid waste into methane gas can cause explosions. Solid waste sites also cause significant aesthetic damage and nuisances such as odors. Property near solid waste disposal sites will likely be reduced in value, and future land uses on these disposal sites are likely to be limited. Given concerns about contamination, it is often difficult to find sites for solid waste disposal facilities. Therefore, our capacity to meet future solid waste management and disposal needs is becoming a major local and regional issue.

Impacts in Colorado. Data from the Colorado Department of Health indicate that there are an approximately 170 active and 624 inactive solid waste landfills in Colorado. Although the exposed population statewide is thought to be relatively small, there is uncertainty about the number and location of inactive landfills in the state. Ecologic and economic impacts are limited to areas near the site.

Underground Storage Tanks

Description. When underground tanks corrode or are installed improperly, the materials they store can leak into the surrounding soil and contaminate ground water supplies. The vast majority of underground storage tanks in the state and nation contain petroleum products.

Effects and Damages. Releases of petroleum products from underground storage tanks can result in contamination of drinking water. However, since public water sources are tested and treated, this is usually only a problem if contamination affects private, untested wells. Individuals are also exposed to high concentrations of contaminants through inhalation and may face explosion risks when vapor releases contaminate the air in homes or other buildings.

Impacts in Colorado. There are approximately 25,000 underground storage tanks located at 8,700 facilities in Colorado. The Colorado Department of Health estimates that 99 percent of the underground storage tanks in the state contain petroleum products. Specific data on the number and effects of leaks are not available. Economic impacts were not estimated.

Water Issues

The Water Technical Work Group identified four issues of concern:

- Damages from Change in Water Quantity
- Ground Water Contamination
- Nonpoint Source Surface Water Pollution
- Point Source Surface Water Pollution

The following sections give a description, the effects and damages, and a summary of impacts in Colorado for each water issue.

Damages From Change in Water Quantity

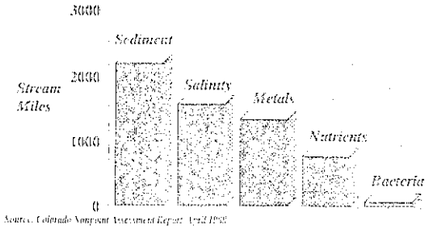
Description. Water is the ecologic and economic life-giving force in the arid West. There is often an imbalance between water supply and demand. When water is diverted or stored, or when precipitation and spring runoff are lower than normal, downstream water flows can be reduced in quantity and quality.

Effects and Damages. While diverting and storing water has clear benefits for flood control, municipal water supplies and agricultural uses, the resulting changes in water flows can significantly alter the ecologic structure and function of streams, lakes, and wetlands. These changes may involve not only the total quantity of water but also changes in streamflow patterns. Damages to aquatic habitat resulting from changes in water quantity or changes in streamflow patterns are usually due to factors such as changes in water quality, changes in temperature, or reduced habitat availability. Changes in water quantity also can cause lost recreation opportunities, increased agricultural costs, higher water prices, and reduced development opportunities in areas with limited water resources.

Impacts in Colorado. Because Colorado's average annual precipitation level is only 17 inches, storage of water in reservoirs and lakes and diversions from streams is necessary to provide a year-round water supply . Nearly 653,000 acre feet of water are moved through trans-mountain diversions on average each year. About 10 million acre feet flow out of the state annually. There are 1,750 dams in Colorado and five water storage projects currently in the planning stages. The federal government, which has bankrolled many water storage projects in the West, has drastically reduced its funding in recent years.

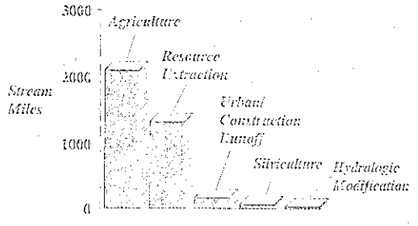
Storage or diversion of water affects water quantity and streamflow patterns, which may result in damage to aquatic habitat, and reduce water supply for other uses such as recreation. Human health impacts were not estimated.

Impacts by Nonpoint Source Pollutants to Streams (in miles)



Source: Colorado Nonpoint Assessment Report, April 1988

Impacts by Category to Streams (in miles)



Ground Water Contamination

Description. Ground water within deep and shallow aquifers is presently used for public and private drinking water supplies, irrigation, livestock, agricultural, commercial, and industrial purposes. Many environmental influences can affect ground water quality, including hazardous waste disposal, municipal landfills, underground storage tanks, and agricultural chemicals.

Effects and Damages. Types and sources of pollutants most likely to have a negative impact on ground water include pesticides, nitrates, heavy metals, organic chemicals, fluoride and other naturally occurring pollutants, hazardous materials, pathogens, oil and gas drilling wastes, and petroleum products. Cancer and non-cancer risks are highest to those consuming untreated, contaminated ground water. Once contaminated, ground water is technically difficult and expensive to clean up.

Impacts in Colorado. Approximately one-third of the state's residents, mostly in rural areas, use ground water as their source of drinking water. This is also where the chances of contamination are potentially greatest due to use of agricultural chemicals. Shallow and, to a lesser degree, deep aquifers in Colorado are potentially affected by overlying surface and sub-surface activities such as farming and mining. Given the scarcity of water supplies in Colorado, ground water is a valuable resource that will be relied on more heavily in the future. There is no statewide database on ground water quality or a monitoring program to provide a comprehensive database on ground water quality. Ecologic impacts were not estimated.

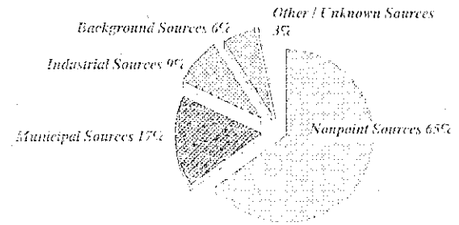
Nonpoint Source Surface Water Pollution

Description. Nonpoint source surface water pollution refers to contamination from numerous dispersed sources that all contribute to water pollution, but cannot be targeted for control in the same way as a specific point source conveyance, such as a discharge pipe from a factory.

Effects and Damages. Pollutants discharged by nonpoint sources can result in human exposure from ingestion of contaminated drinking water or food, and from direct contact through activities such as swimming and boating. Ecologic damages include loss of aquatic habitat, reduced species diversity, reduced fisheries productivity, aquatic toxicity, loss of wetland habitat, and dissolution of nutrients in lakes and reservoirs.

Impacts in Colorado. Major nonpoint pollution sources in Colorado include heavy metals from mining sites; streambank erosion; soil erosion; fertilizers and pesticides from farms, golf courses and lawns; and soil and chemicals from urban runoff. Four major nonpoint source pollutants have been identified as causing damage to aquatic ecosystems in Colorado: sediment, salinity, metals, and nutrients affecting over 3,000 stream miles. Sediment problems affect the greatest number of stream

Major Causes of Stream Pollution
(National Data for 370,000 stream miles not meeting designated uses)



Source: Environmental Progress and Challenges: EPA's Update

miles, over 2,000. Salinity is a problem on 1,500 stream miles, metals on 1,300, and nutrients on 750 stream miles. A stretch of stream may have more than one nonpoint source problem. The Colorado, Platte and Arkansas rivers are the most impacted, although nonpoint source problems can be found in all parts of Colorado.

While it is known that nonpoint source pollution causes ecologic damages, very little data on the exact impacts to overall ecosystems are currently available to quantify the magnitude of this effect.

Point Source Surface Water Pollution

Description. Point sources of surface water pollution include pipes, outfalls, and other specific discharges to surface water. Major point sources include sewage treatment plants, industrial facilities, and mining activities.

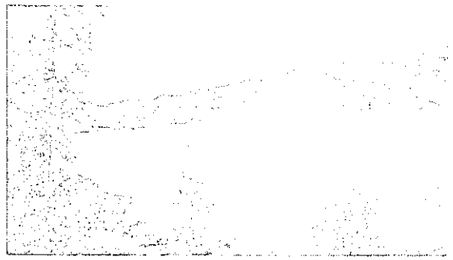
Effects and Damages. Pollutants discharged by point sources can result in human exposure from ingestion of contaminated drinking water or food, and from direct contact through activities such as swimming and boating. Ecologic damages include reduced species diversity, reduced fisheries productivity, aquatic toxicity, and dissolution of nutrients in lakes and reservoirs. Risks may be affected by reductions in streamflows.

Impacts in Colorado. Six major point source pollutants have been identified as causing damage to aquatic ecosystems in Colorado: nutrients (phosphates and nitrates), metals, organics, ammonia, chlorine, and biochemical oxygen demand. The human health risks from contaminated drinking water are thought to be relatively low because most surface water is treated by a regulated drinking water system.

Approximately ten percent of stream miles and three percent of lake and reservoir acres in Colorado have been affected by point source pollution. In streams, the most serious impacts are to aquatic wildlife from heavy metals, organics, and ammonia. Most of these discharges are from active mining sites. The biggest problem in lakes is eutrophication caused by nutrients, which causes the oxygen in the water to be depleted.

The state's Water Quality Control Division has issued approximately 865 discharge permits under Colorado's Water Quality Control Act, the federal Clean Water Act and EPA regulations. The permits are for industrial sources (mines, power plants, refineries, fish hatcheries, oil producers etc.), and domestic sources (sewage, usually from municipal treatment facilities). The permits are renewed every five years. Permitted treatment facility capacity ranges from zero to 210 million gallons of treated water per day. About six percent of the industrial discharge permit holders and 37 percent of domestic facilities did not meet the effluent standards as of April 1989.

Economic impacts from point source pollution include reduced recreational opportunities, as well as lowered suitability of water for agricultural uses, industrial uses, and drinking water supplies.



Natural Resource Issues

The Natural Resources Technical Work Group followed a somewhat different method of analysis than the Air, Land, and Water Work Groups. Rather than analyzing health, ecologic, and economic damages, the Natural Resources Work Group defined issues based on ecologic values and vulnerability to threats. The issues were defined as natural resource assets most vulnerable either due to stresses imposed by the cumulative impact of human activities, or because of their inherent scarcity and value. As in the other work groups, no attempt was made to evaluate the benefits of the activities, or in this case the natural resources. This resulted in a list of ten resource areas of concern:

- Aquatic Habitats
- Critical Wildlife Habitats
- Forests
- Open Space
- Plains
- Recreation Opportunities
- Resources of Special Interest: Rare Plants and Native Ecosystems, Wilderness Areas, Wild & Scenic Designation for Certain River Stretches, Roadless Areas, and Cultural Resources
- Threatened and Endangered Species Habitat
- Urban Environment: Urban Wildlife, Riparian Ecosytems, Visual Corridors, Urban Forests, and Wildfire
- Wetlands and Riparian Zones

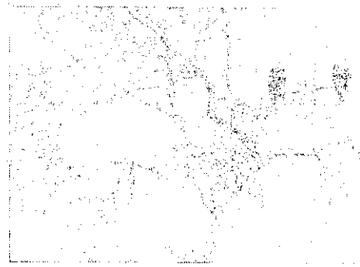
The following sections give a description of the values and uses, and a summary of impacts in Colorado for each natural resource issue.

Aquatic Habitats

Description. Aquatic habitats support plant and animal life in and near rivers, ponds, streams, reservoirs, and lakes. Aquatic habitat is lost or degraded by reduced streamflows, lower lake and reservoir water levels, pollution, temperature changes and loss of adjacent riparian zones. These problems are caused by a variety of development activities (e.g., urban, water, transportation, and recreation development), silviculture, and agricultural practices.

Values and Uses. As habitat is degraded or lost, aquatic organism populations are reduced or eliminated, resulting in ecologic changes in the surrounding area. Recreational uses can also be negatively affected.

Impacts in Colorado. There are approximately 26,000 linear miles of streams in Colorado, more than 2,900 man-made reservoirs, and over 1,000 natural lakes.



About 78 percent of stream miles, 62 percent of reservoirs and most lakes provide significant habitat for the insects, plants, and fish which comprise aquatic communities. Reservoirs account for 75 percent of all aquatic habitat in Colorado and represent the largest component of the state's sport fishing industry. Aquatic habitat has been degraded or lost in Colorado through water right transfers or conversions, water pollution from point and nonpoint sources, and reduced streamflows from dams and diversions.

Critical Wildlife Habitat

Description. Critical habitat is an area essential to the survival of a species at some time during its life cycle. If the habitat is protected, species will take care of themselves. Critical habitat is a limiting factor on size and occurrence of animal and plant populations. Critical habitat areas attract high concentrations of animals during certain times of the year.

Values and Uses. All species and habitats that support them are part of a complex ecosystem dependent for their overall well-being on the health of the components. When critical habitat is lost, the ability of wildlife to find cover for protection, food sources, and mating and nesting grounds is reduced. Animal populations are therefore reduced in size and health.

Impacts in Colorado. Examples of critical habitats in Colorado are south-facing slopes in mountain valleys (elk, deer, and bighorn sheep), riparian areas and wetlands (waterfowl, shore birds, and song birds) and native grasslands (ground nesting birds, wild turkeys, raptors, other carnivores and their prey). Nesting areas for sandhill cranes, display areas for sage grouse and prairie chickens, and heron rookeries are other examples.

Human activities result in the loss or degradation of over 100,000 acres of wildlife habitat in Colorado each year. Grassland plowout is a major cause of this loss. Significant amounts of other habitats critical to animal species are also lost each year. For example, urban development may cause disruption of migration routes.

The long-term health of animal and plant species depends upon the availability of habitat types. Damages to wildlife habitats reduce opportunities for hunting and recreational opportunities for those who enjoy wildlife non-consumptively.

Forests

Description. Nearly one-third of Colorado's land is forested. Though the majority of forested land is found in the western two-thirds of the state, forests are found in all parts of Colorado, from shrublands and grasslands on the plains and plateaus, to coniferous and deciduous forests in the mountains and along the Front Range. Forests provide valuable habitat for wildlife and plants, contain tremendous biological diversity, and play an important role in water quality. They are an important component of cities as well as rural areas.

Values and Uses. Forests are used and valued by people for a variety of commodities such as timber, and amenities, such as wildlife viewing. Many forests in the western United States are managed under the multiple-use principle, which seeks simultaneous protection and management of fish and wildlife, watersheds, outdoor recreation, range, timber and wilderness. Site-specific forest management practices determine to a large extent which commodities and amenities will prevail. The economic well-being of some communities is closely tied to forest-based recreation or resource extraction. Competing uses often cause reductions in one type of use or function at the expense of others.

Impacts in Colorado. The U.S. Forest Service is currently revising its ten-year plan for the Rocky Mountain Region, which includes all of Colorado. The major issue for Colorado forests is the need to balance multiple uses in response to the needs and values of the citizens. The traditional multiple-use prescription may inhibit the continued existence of some "special" features or activities. Some Technical Work Group members feel that the highest and best use of the National Forests in Colorado is often not a resource extractive use, such as commercial timber harvesting. The CE2000 Natural Resources Technical Work Group and the Colorado Department of Natural Resources have recommended that in its management plans, the Forest Service put a greater emphasis on recreation and protection of stands of old timber.

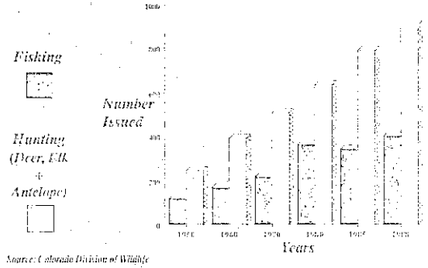
Open Space

Description. Open space includes land set aside in an essentially natural state usually in perpetuity, and agricultural lands. This resource serves many functions, including buffers to contain urban sprawl and enhance community identity, protection of significant or unique natural areas such as stream corridors, preservation of farmlands close to urban areas, wildlife habitat, and passive recreational opportunities.

Values and Uses. Current patterns of urban growth are often diffused instead of clustered. Diffuse growth, leapfrog annexation, and development result in a patchwork pattern of urban and rural land. This kind of development is not only more expensive in terms of the cost of providing services, but also causes fragmentation of increasingly scarce open land in and around communities. Once land is converted, it is unlikely and often impossible to be returned to its former natural state or agricultural use. The loss of open space can result in increases in traffic congestion and pollution, a reduced ability to attract quality business, loss of species habitat, loss of human visual and psychological relief, and other effects of urban sprawl.

Impacts in Colorado. Undeveloped lands are under intense pressure in Colorado's urban areas, particularly along the Front Range. For example, over 400,000 acres of agricultural lands were developed along the Front Range between 1976 and 1986. While this problem is most acute along the Front Range, it is also a concern in other parts of the state. Examples of urban expansion are found outside the Front Range with the continued development of such areas as Evergreen, Genesee, Vail, Durango, Grand Junction, and Steamboat Springs. Wherever development occurs, there are impacts to the natural environment which must be planned for, avoided, or mitigated.

Hunting Licenses Sold by Colorado Division of Wildlife (in thousands)



Source: Colorado Division of Wildlife

Plains Land

Description. The plains grasslands were once a diverse and complex ecosystem that supported many species of plants and animals.

Values and Uses. Intensive agricultural and grazing practices are destructive to the natural ecosystems of the plains land, resulting in damage to wildlife habitat, water resources, and soils.

Impacts in Colorado. The eastern third of Colorado consists of gently rolling plains land, sloping downhill in elevation from 5,000 feet at the foot of the Rocky Mountains to 3,500 feet at the Kansas border. Most plains land is privately owned. A century of farming and grazing has left little of the eastern plains untouched. With the exception of parts of the national grasslands, little plains land remains in its native state. Specific effects of these activities include soil erosion, loss of wildlife habitat, and depletion of the Ogallala ground water aquifer.

Recreation Opportunities

Description. It is difficult to meet the demand for a wide variety of land and water-based recreational activities without overusing the resources and causing conflicts among uses. There are many conflicts built into recreation planning and resource usage.

Values and Uses. Colorado offers millions of acres of recreational lands spread throughout the state. The U.S. Forest Service and Bureau of Land Management control about 23 million acres, much of which is accessible for recreational use. Another 600,000 acres are part of the National Parks. 200,000 acres are managed by the state Division of Parks and Outdoor Recreation. The Division of Wildlife, local governments and private operations provide more than one million additional acres for recreational use. There are about 30 ski areas in the state, 54 mountain peaks over 14,000 feet high, and more than 2,900 reservoirs and 26,000 miles of streams. Thousands of miles of dirt roads and trails weave throughout the mountains, plains, and urban areas. All of these resources combine to make Colorado one of the premier recreation sites in the country. Nearly $5.5 billion were spent in 1988 in Colorado on all forms of recreation activities.

Impacts in Colorado. Some resources are currently being stressed. Stretches of river, back-country trails, and campsites suffer from overuse. A lower quality experience and physical damage to the resource result. Overuse is a particular concern along the Front Range, where more than 60 percent of the state's total recreation activity occurs on about 15 percent of the recreation

acreage. Virtually everyone in Colorado benefits from the availability of recreation resources, personally and economically; if recreational opportunities diminish, these benefits will be reduced.

The consequences of failure to address these problems will be an erosion of the quantity and quality of recreation resources. Recreation development to meet future demand will be haphazard and perhaps destructive of important natural resources.

Resources of Special Interest

Description. Resources of special interest include rare plants and native ecosystems, wilderness areas, wild and scenic designation of certain river stretches, roadless areas, and cultural resources such as the historical and archeological ruins.

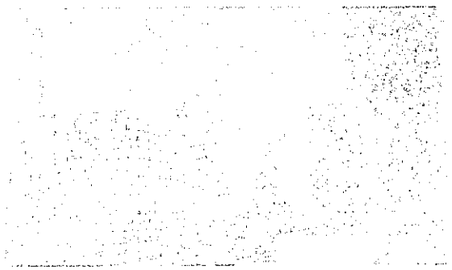
Values and Uses. Justification for protection of resources of special interest lies in the desire to maintain biological and genetic diversity, to enhance recreational opportunities, and to preserve our cultural and natural heritage. These resources are irreplaceable.

Impacts in Colorado. Colorado has experienced rapid and widespread losses of rare species habitats and remnant plant communities in the past 20 years due to development pressures and consumptive/extractive land uses. Wilderness issues include identification, designation of more areas, and the need to protect waterflows for the streams and rivers flowing through these areas. Many of Colorado's rivers have been altered with dams, resulting in declining natural streamflows and river-based recreational opportunities. Roadless areas are important sanctuaries for many species of plants and wildlife. Vandalism of archeological sites is a commonplace occurrence; the loss of these resources makes research, interpretation, and visitor use difficult or impossible.

Threatened and Endangered Species Habitat

Description. A species is designated as "endangered" if evidence suggests that it is currently in danger of extinction throughout all or a significant portion of its natural range. Designation as "threatened" means the species is not in immediate jeopardy of extinction but is vulnerable due to reduced population size or severely restricted range. The US. Fish and Wildlife Service is responsible for national threatened and endangered species designation, and each each state can also make its own designations. *(See next page for Colorado list).*

Values and Uses. Healthy ecosystems depend on a rich diversity of plant and animal species interacting in ways that have evolved over long periods of time. The extinction of species diminishes the diversity which has played so central a role in natural and human history. Preserving the gene pool is important for future scientific



research, ecosystem health and diversity, and human uses. Moreover, as habitat losses lead to species extinction, the proportion of opportunistic species (those that adapt quickly to changing circumstances) will tend to increase. Unlike pollution, which can be halted and cleaned up in most cases, the extinction of a species is permanent.

Impacts in Colorado. At present, 23 animal species historically found in Colorado are included on the federal and state lists of threatened or endangered species. Nine plant species are classified as threatened or endangered. Many other plant and animal species are of "special concern" because of diminishing numbers or ranges. In Colorado, threatened and endangered species contribute to our natural heritage, thereby enriching the wildlife and recreation values which are so attractive to residents and visitors alike. No state law exists to protect rare plants in Colorado.

Colorado Threatened (T) or Endangered (E) Plants and Animal Species

Plants*		Birds	
Mancos Milkvetch	T	Bonytail Chub	E
Aguadero Hedgehog Cactus	T	Razorback Sucker	E
Clay-loving Wild Buckwheat	T	Pygmy Shrew	T
Knowlton Cactus	T	Colorado Squawfish	E
North Park Phacelia	T	Black-Tailed Prairie Dog	T
Nuttall's Harebell	T	Spotted Bat	T
Mesa Verde Cactus	T	American Peregrine Falcon	E
		Bald Eagle	T
Birds		Least Tern	E
Aplomado Falcon	E	Mammals	
Greenback Cutthroat Trout	T	Gray Wolf	E
Knowlton's Cactus	E	Wood Bison	E
Peregrine Falcon	E	Kit Fox	T
Piping Plover	E	Ferret	E
Colorado Squawfish	E	Gray Wolf	E
Amphibians		Black-footed Ferret	E
Wood Frog	T		

** Denotes Colorado plant species of special concern due to their rarity within the state.*

Urban Environment

Description. Major environmental challenges are emerging in the face of continuing population growth and development in urban areas. Natural resources are an important component of urban areas. Streams, trees, and wildlife all coexist with humans and are an integral component of the quality of the urban setting.

Values and Uses. The concentration of the population in a confined area has clear economic benefits, but there are also costs when the congestion results in detrimental impacts on the natural resource base. Natural resources are important contributors to quality of life and should be considered in planning for development. When these values are not considered, the quality of the urban setting will be lessened.

Impacts in Colorado. About 82 percent of Colorado's population — 2.7 million people — reside along the Front Range of the Rocky Mountains from Fort Collins to Pueblo. Environmental challenges within urban areas in Colorado include conflicts between human and animal populations that place the wildlife in stressed situations, destruction of plant and animal habitat through stream channelization, degradation of visual corridors, health and quantity of urban forests, and risk of property damage or loss of life due to wildfire in and around forests.

Wetlands and Riparian Areas

Description. Certain plant species, including a variety of grasses and shrubs, have adapted to soils which are saturated or periodically inundated with water. The resulting wetland areas perform a number of important natural functions, including capturing sediment and filtering nutrients and chemicals from water as it passes through the wetland; providing shelter, breeding habitat, and food to a wide variety of animal species; enhancing ground water recharge; storing and releasing flood flows; and providing recreation, open space, aesthetic, research, and educational values. Riparian zones are the banks lying above rivers and streams, and around ponds, lakes, and reservoirs. Riparian zones support hundreds of aquatic and terrestrial species, and perform various water quality and quantity functions. They also have important recreational value and may serve as greenbelts within developed areas.

Values and Uses. Conversion of wetlands to other uses results in the loss of important wetland functions. Wetland values and habitats are degraded by a variety of activities on or near the wetlands (e.g., grazing and urban runoff).

Impacts in Colorado. Two distinct categories of wetlands are found in the state. Alpine wetlands occur at elevations above approximately 10,000 feet and are predominantly wet meadows scattered throughout the mountains. They occur in areas where drainage patterns have not yet converged into stream channels. Lower elevation wetlands typically occur in conjunction with or along riparian corridors. Low-elevation wetlands along the Front Range, near urbanized areas, and in the foothills, are the most subject to loss or degradation by development. In the mountainous regions of the state, urban, recreation, and water development impact wetlands. Development, water projects, road building, mining, grazing, channelization, pollution, and other activities all contribute to the loss or degradation of riparian zones. Recent studies by the U.S. Fish and Wildlife Service and the U.S. Soil Conservation Service estimate that Colorado loses about 5,000 acres of wetlands and riparian areas annually. Since over 70 percent of vertebrate species in Colorado rely on wetlands and riparian areas during at least one stage of their life cycles, the loss of these areas may have severe consequences.

Technical Work Group Members

The project would like to thank the members of the four technical work groups. These individuals volunteered their time and expertise to set the direction of the analysis, provide sources, review the reports provided by consultants and staff, and vote on a ranking of the issues. The opinions expressed within this document do not reflect the minority views expressed by technical work group members.

Colorado Environment 2000

Dept. of Natural Resources
1313 Sherman St. Room 718
Denver, CO 80203
303/866-3311

Colo. Dept. of Health
4210 E. 11th Ave. Room 350
Denver, CO 80220
303/331-4510

Staff:
Kate Kramer, Project Manager
Patrick Cummins, Assistant Director
Tina Nielsen, Economist
Andrew Sussman, Assistant

Air

Paul Adams, Environmental Affairs, Coors, Golden
Steve Arnold, Air Pollution Control Division, CDH
Brad Beckham, Air Pollution Control Division, CDH
Ben Bryan, Manager, Transportation/Environment, Greater Denver Chamber of Commerce
Steven Foute, Director, Air Quality/Environmental Protection, Denver Dept. of Health and Hospitals
John Leary, Air Pollution Control Division, CDH
Bill Malm, Research Physicist, Air Quality Division, National Park Service, Ft. Collins
Richard Mauro, Policy Analyst, Denver Regional Council of Governments
Sharon Norman, Disease Control and Epidemiology, CDH
Dave Ouimette, Air Pollution Control Division, CDH
Robert Pearson, Administrator for Environmental Affairs, Public Service Company of Colorado
Roger Pielke, Department of Atmospheric Science, Colorado State University
Charlie Unseld, Department of Local Affairs, DNR
Wayland Walker, City of Denver, Planning Department
Dale Wells, Environmental Engineer, EPA, Region VIII, Denver

Land

Fred Banta, Director, Mined Land Reclamation Division, DNR
Barbara Barry, Office of Environmental Review and Analysis, Dept. of Highways, Denver
Bill Chappell, Director, Center for Environmental Sciences, CU Denver
Linda Coulter, Colorado Department of Agriculture, Denver
Jack DeBell, Director, CU Recycling, Boulder
Bob Duprey, Director, Waste Mgmt. Div., EPA Region VIII, Denver
Al Hazle, Radiation Control Division, CDH
Terry Johnson, Environmental Specialist, National Environmental Health Association, Denver
George R. Larsen, Manager, Compliance Programs, Martin Marietta Astronautics Group, Denver
Paul Nazaryk, Hazardous Materials and Waste Division, CDH
Daniel Parker, Soil Conservation Board, DNR
Nancy Prince, Geologist, Jacobs Engineering, Lakewood
Susan Richstone, Senior Environmental Planner, City of Aurora
Pat Rogers, Colorado Geological Survey, DNR
Howard Roitman, Hazardous Materials and Waste Division, CDH
Diana Shannon, EPA Region VIII, Denver
Bernard Smith D.V.M., Member, Colorado State Soil Conservation Board, Leadville
Don Smith, Division of Wildlife, DNR
Karen Wiley, Associate Professor, Humanities & Social Sciences Department, Colorado School of Mines
Mike Wilson, Disease Control and Epidemiology, CDH

Water

Don Bachman, President, High Country Citizen's Alliance, Crested Butte
Jerry Biberstine, Water Quality Control Division, CDH
Steve Boand, Principle Hydrologist, Aquasan Network, Inc., Englewood
Steve Bonowski, Past-President, Colorado Environmental Coalition, Denver
Lynn Cudlip, High Country Citizen's Alliance, Gunnison
Ralph Curtis, General Manager, Rio Grande Water Conservation District, Alamosa
Kathy Dolan, Water Quality Control Division, CDH
Jerald Fifield, Hydrologist, HydroDynamics Inc., Parker
Roger Frenette, Deputy Director, Water Management Division, EPA Region VIII, Denver
Paul Frohardt, Water Quality Control Division, CDH
Ann Janicki, Colorado Water Conservation Board, DNR
William Lewis, Director, Center for Limnology, CU Boulder
Bill McKee, Water Quality Control Division, CDH
Timothy W. Mueller, Sr. Engineer, Compliance Programs, Martin Marietta Astronautics Group, Denver
Steven Rhodes, Scientist, National Center for Atmospheric Research, Boulder
Doug Ryan, Assistant Director, Environmental Health Division,
Jefferson County Health Department, Lakewood
Theodora Tsongas, Disease Control and Epidemiology, CDH
John Woodling, Division of Wildlife, DNR
Robert Zebroski, Soil Conservation Board, DNR

Natural Resources

Lee Baker, Colo. Mountain Club, Colo. Environmental Coalition, Dept. of Highways (Accounting Div.)
George Beeker, Professor, Dept. of Biology, Metropolitan State College, Denver
Steve Blomeke, Executive Director, Colorado Wildlife Federation, Denver
James Borland, Plant Propagator, Flora West, Representative of Colorado Native Plant Society, Denver
Dale Brubaker, Bureau of Land Management, Denver
Ed Byrne, Colorado Ski Country, Denver
Dave Carlson, Colorado Department of Agriculture, Denver
Richard Fox, Forester, Colorado Forestry Association, Durango
Ron Gosnell, Past-President, Colorado Forestry Association, Lyons
John Hale, Fish and Wildlife Biologist, Board of Directors, Colorado Wildlife Federation, Denver
Dave Hause, Division of Parks and Outdoor Recreation, DNR
Tom Hendricks, Gold Cross Gold Mine, Nederland
Jay Hughes, Dean, College of Forestry & Natural Resources, Colorado State University, Fort Collins
William Killip, State Board of Land Commissioners, DNR
Kirk Koepsel, Public Lands Coordinator, Colorado Environmental Coalition, Denver
Dave Kuntz, Program Director, Colorado Natural Areas Program, DNR
Dave Lorenz, South Suburban Recreation District Director, DNR Littleton
Ken Mesch, Consumer Protection Division, CDH
Jim Miller, Colorado Department of Agriculture, Denver
Steve Norris, Executive Director's Office, DNR
Jim Ruch, formerly Executive Director's Office, DNR
Ralph Schell, Division of Parks and Outdoor Recreation, DNR
Barbara Sharrow, Bureau of Land Management, Denver
Dave Stark, U.S. Forest Service, Lakewood
Jack Steck, Permits and Land Use Coordinator, Governmental and Environmental Affairs, Public Service Company of Colorado, Denver
Linda Strand, Senior Management Analyst, Department of Planning, City of Aurora
Tony Trumbly, Conservation Chair, Sierra Club, Denver
Bob Tully, Division of Wildlife, DNR
Ann Vickery, Colorado Mountain Club, Boulder
Bettie Willard, Ecologist, retired Professor, Colorado School of Mines, Board Member, Thorne Ecological Institute, Boulder
Dick Yeatts, Physics Professor, Colorado School of Mines, Golden

** CDH: Colorado Department of Health*
** DNR: Colorado Department of Natural Resources*

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