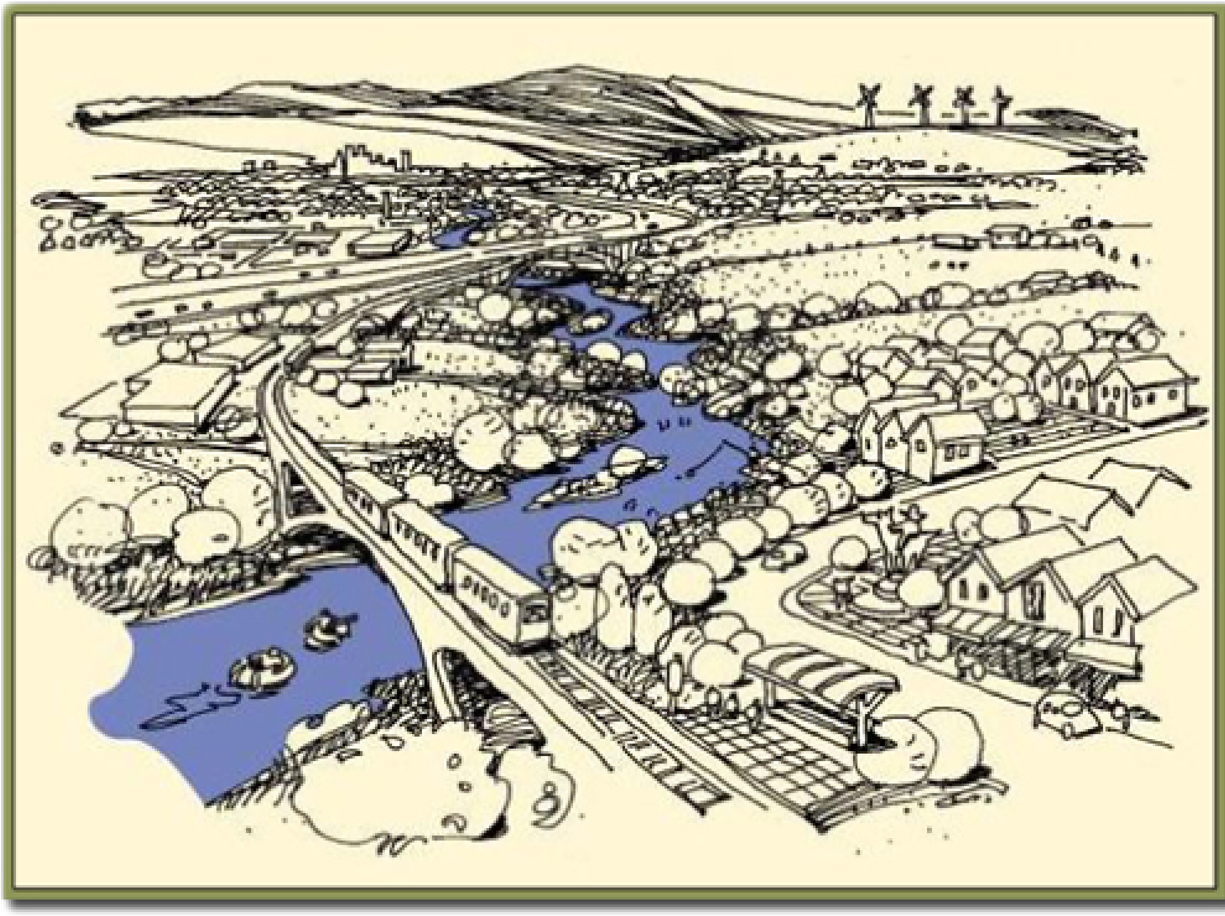
SUSTAINING NATURE AND COMMUNITY
IN THE PIKES PEAK REGION



A Sourcebook for Analyzing Regional Cumulative Effects

Colorado Department of Transportation

PANELS OF EXPERTS, AGENCY REPRESENTATIVES, AND CONSULTANTS WHO PARTICIPATED IN THIS STUDY

Natural Resources Expert Panel

Shannon Albeke, Colorado Division of Wildlife
Mark Bakeman, Ph.D. (Co-Chair), Ensight Technical Services, Inc.
Mike Bonar, El Paso County Natural Resources, Environmental Services
Robert Henke (Co-Chair), SAIC
Loren Hettinger, Ph.D., J.F. Sato Associates
Brian Mihlbachler, Ph.D., U.S. Air Force Academy
Rich Muzzy, Pike Peak Area Council of Governments
Roland Wostl, Colorado Department of Transportation, Division of Transportation Development

Community Resources Expert Panel

Morey Bean (Co-Chair), Colorado Architecture Partnership
Jan Doran, Council of Neighbors and Organizations
Joe Gorney, El Paso County Planning Department
Mike Hankard, Hankard Environmental Services
Robert Henke (Co-Chair), SAIC
David Litzelman, City of Colorado Springs Comprehensive Planning Department
Lisa Schoch, Colorado Department of Transportation, Environmental Programs

Agency Representatives

Dick Annand, Colorado Department of Transportation
Chris Horn, Federal Highway Administration

Consultant Staff

Doug Eberhart, Wilson & Company
Robert Henke, SAIC
Paul Cawood Hellmund, SAIC
Leslie Wildesen, Ph.D., ETCI

Sustaining Nature and Community in the Pikes Peak Region

A Sourcebook for Analyzing Regional Cumulative Effects

Colorado Department of Transportation

December 2003

WHAT YOU WILL FIND IN THIS REPORT

"Sustaining Nature and Community in the Pikes Peak Region: A Sourcebook for Analyzing Regional Cumulative Effects" provides both a general discussion of cumulative effects and sustainability, as well as an overview of issues specific to Colorado's Pikes Peak region. The first section introduces biodiversity and quality of life as twin components of sustainability. That section also describes the process that guided the preparation of this report, and a summary is given of the evolution of the Pikes Peak landscape over the last 100 years.

The second section – the Sourcebook – is a compendium of useful information about six key indicators of sustainability in the Pikes Peak region.

This report was designed for a wide range of readers (see below).

HOW YOU CAN USE THIS REPORT

Planners of Major Transportation Projects in the Pikes Peak Region
Use the information to gain additional background on cumulative effects as they relate to biodiversity, quality of life, and ultimately, sustainability. Use the more detailed discussions of key indicators of sustainability, especially the trend analyses, to target impact analyses on individual projects.

Local Governments
Use the information to help identify priorities, facilitate long-term visioning, allocate resources, and track your environmental performance.

- Evaluate land-use policies and regulatory framework. Consider environmental conditions during updates of your General Plan.
- Enhance accountability of agencies or departments with primary responsibility for an area of environmental performance.

Businesses
Use the information to understand how your company's actions impact the local environment.

- Benchmark your company's progress against regional performance.
- Reap the benefits of reduced environmental impacts, potentially including reduced costs and liabilities, enhanced community relations, and market access.

Community Organizations
Communicate to the public and decision-makers about local environmental trends.

- Use the information to advance the goal of environmental sustainability.
- Hold organizations and individuals accountable for improved environmental performance.

Individuals
Consider how your day-to-day activities can impact the environment.

- Make more informed purchasing decisions, voting choices and everyday actions.
- Better understand environmental conditions in your community.

Educators and the Media

- Integrate environmental sustainability into school curricula.
- Include coverage of environmental indicators in the media.

(Adapted from 1999 Silicon Valley Environmental Index.)

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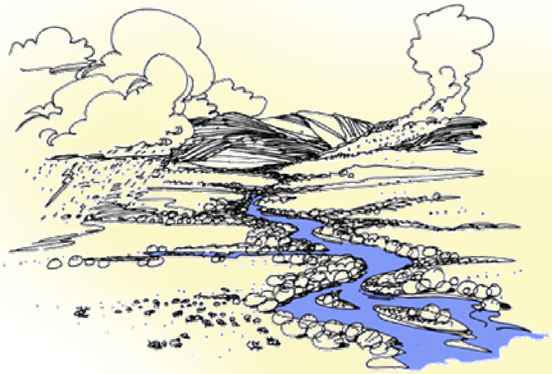
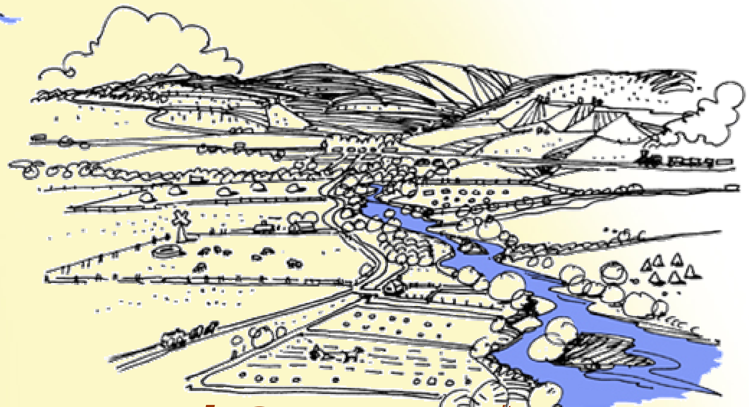
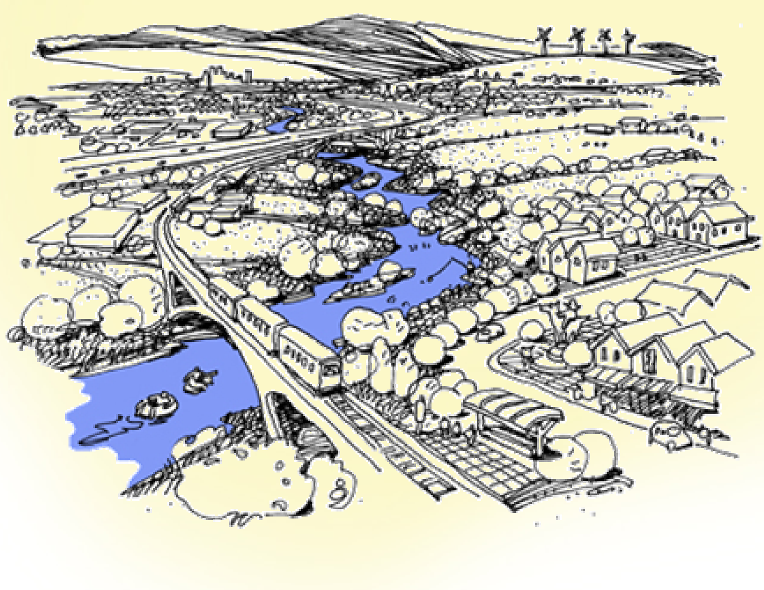




1.

Sustaining Nature and Community in the Pikes Peak Region



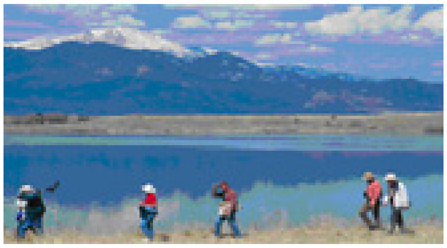
1. SUSTAINING NATURE AND COMMUNITY IN THE PIKES PEAK REGION

"Think globally, act locally."
— Rene Dubois

"Maintain a citywide context or perspective as an integral part of incremental land use decision making."
— Comprehensive Plan, City of Colorado Springs, 2001

"Sustainability: To meet the needs of the present without compromising the ability of future generations to meet their own needs."
— UN World Commission on Environment and Development. Our Common Future [Bruntland Report], 1987

Residents of the Pikes Peak region want to preserve their quality of life and sustain the natural environment. That message has come through loud and clear in a wide range of public forums. But will the region in the future be what its residents want it to be for themselves, their children and their grandchildren? This report focuses on overcoming some of the potential obstacles to sustaining such a future.



Our region is changing rapidly, and with new development and population come additional impacts to many aspects of the community and natural resources. Some of these impacts are obvious, while others are more subtle.

Some of the more subtle impacts are ones that hardly get noticed until you take a regional perspective or wait for years or decades. On a very local scale, these impacts may seem like small losses, such as the modest area of short-grass prairie replaced by new homes or the small amount of fertilizer running off a yard into a stream. The impacts of these losses to prairie birds and butterflies or water quality may not appear that great.

Perhaps it is only when looking across the region and over a wider time span that larger patterns are apparent. It may be that the impacts of the loss of that small piece of prairie or that small amount of fertilizer are really part of a serious trend. The small amount of fertilizer entering the stream from one location may in fact be part of a much greater accumulated volume of such pollutants. Collectively, many acres of grassland may be disappearing.

Such incremental impacts—known as cumulative effects—from diverse projects are particularly challenging because they can "sneak up" on a region, with a small loss here and there. To understand cumulative effects requires taking a systems view and recognizing the interrelated nature of things.

CUMULATIVE EFFECTS AND MAJOR TRANSPORTATION PROJECTS

The Colorado Department of Transportation (CDOT) initiated this study of potential cumulative effects due largely to the need to conduct environmental evaluation of proposed improvements to the four important corridors: Interstate 25, Powers Boulevard, Woodmen Road, and Drennan Road (now expanded to consider South Metro Area accessibility needs). The location of these corridors is depicted in Figure 1-1. Many other transportation projects, large and small, publicly or privately funded, are also planned in the Pikes Peak region.

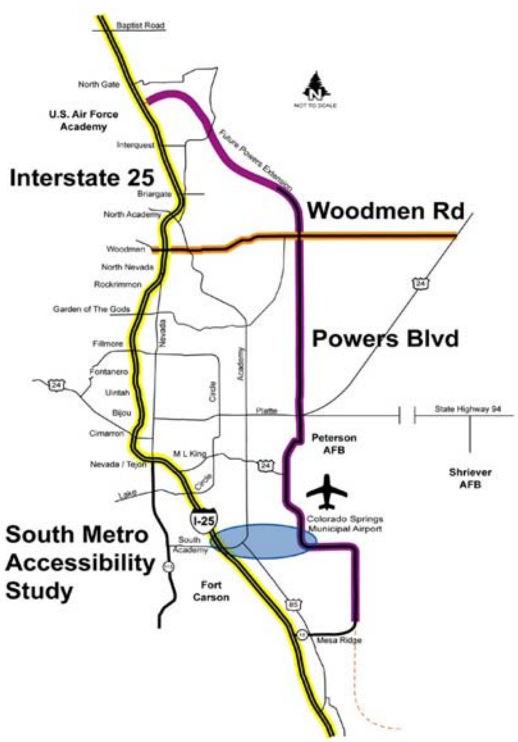


Figure 1-1. Four major transportation improvement projects provided the impetus for conducting a regional look at cumulative effects.

It is CDOT's hope that *"Sustaining Nature and Community in the Pikes Peak Region"* can give a broader regional perspective to planners working on its individual transportation projects, as well as other projects in the Pike Peak area. The study also acknowledges that responses to some impacts are beyond the level of any one project and may better be addressed by regional policy makers.

CONGESTION IS A PROBLEM TODAY AND EXPECTED TO WORSEN

Major transportation improvements in the Pikes Peak region are being considered at a time when an ever-increasing disparity is projected between a rapidly increasing population and a relatively static number of miles of roadway lane-miles (see Figure 1-2).

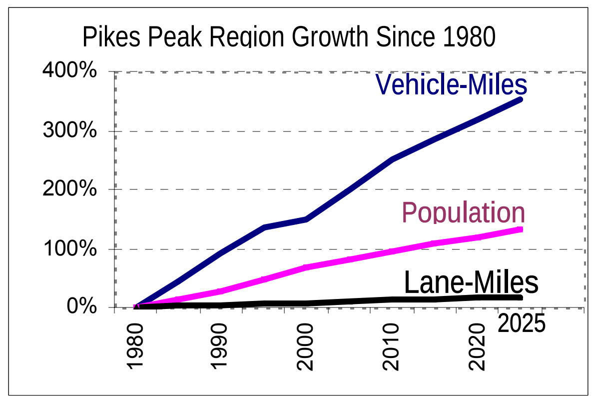


Figure 1-2. The number of new miles of road lanes built in the region or projected to be built is not proportional to the projected growth in population and vehicle miles traveled (VMT).

In the Texas Transportation Institute's annual survey of congestion in U.S. metropolitan areas, the Colorado Springs Urbanized Area recently has been ranked as the most congested area of its size (i.e., population under 500,000 residents).

The U.S. Decennial Census indicated that the population of El Paso County reached approximately 517,000 in the year 2000. Rapid growth is expected to add more than 200,000 additional residents to the region by the year 2025.

The region is not trying to "build its way out of congestion," but is endeavoring to provide a reasonable level of mobility with the limited financial resources available for transportation improvements. Even if the planned improvements are made, congestion that is considered a major problem today is projected to worsen significantly in the future.

By paying special attention to potential cumulative effects, the planned transportation improvements may be able to make positive contributions to sustaining quality of life and the environment of the Pikes Peak region.

MAJOR CORRIDORS AND OTHER TRANSPORTATION PROJECTS IN THE FORESEEABLE FUTURE

The future transportation system assumed in this look at the Pikes Peak region is the one specified in *Destination 2025*, the region's adopted long-range transportation plan, prepared by the Pikes Peak Area Council of Governments (PPACG).

The 2025 plan identifies $2.2 billion in Federal, State and local funding as being reasonably available during the fiscal years 2002-2025. Based on regional transportation needs, the PPACG plan identified the following funding levels for several major projects during that timeframe:

- $518 million for Interstate 25 capacity improvements
- $345 million for the Powers Boulevard Corridor
- $75 million for Woodmen Road Corridor improvements
- $1 million for the South Metro Accessibility Study, focusing on Drennan Road

The four roadway projects highlighted above comprise about 40 percent of the region's long-term foreseeable transportation funding. Each of these projects was the subject of active environmental analysis at the time that "*Sustaining Nature and Community in the Pikes Peak Region*" was begun, and these projects were the impetus for this CDOT study.

Interstate 25: An Environmental Assessment is underway to examine potential impacts of widening the region's only existing freeway (currently two through-lanes in each direction) to an ultimate cross-section of four lanes each way, with one lane each direction being reserved in peak periods for use by carpools and buses.

Powers Boulevard: An Environmental Assessment is underway for possible capacity improvements. For modeling purposes, the PPACG *Destination 2025* Plan reflects this existing expressway (three lanes each direction, with numerous stoplights) being upgraded to a freeway.

Woodmen Road: An Environmental Assessment is underway for possible capacity improvements. Additional lanes have been recommended for this busy principal arterial that currently has just two lanes each direction between Powers Boulevard and I-25, and one lane per direction in rapidly developing areas east of Powers.

South Metro Accessibility Study: The City of Colorado Springs and El Paso County are jointly seeking a long-term corridor solution to connect the main entrance to the Colorado Springs Municipal Area to I-25, or even further west to State Highway 115.

While the major corridors described above are important, numerous other transportation projects are planned that will also affect the region's future. For example, the *Destination 2025* Plan also programs $100 million for improvements to US Highway 24 (Midland Expressway), west of I-25 to Manitou Springs, and $250 million for future Bus Rapid Transit in four corridors (corridors being selected in a year 2003 City study). The balance of available funds is allocated to hundreds of street, transit and trail projects throughout the region.

PURPOSE AND APPROACH OF THIS REGIONAL STUDY

Two broad goals were identified for this study of the Pikes Peak region:

- To provide a regional framework for evaluating the cumulative effects of the major transportation improvement projects described at left.
- To develop comprehensive strategies that could be used by CDOT and other government and non-government organizations to reduce, mitigate or reverse negative environmental trends and support sustainability and quality of life in the Pikes Peak region.

CUMULATIVE IMPACTS DEFINED

The National Environmental Policy Act (NEPA) recognizes three types of effects or impacts: direct, indirect and cumulative.

A *direct effect* one caused by a project and that occurs at the same time and place as the project.

An *indirect effect* is caused by project actions but occurs later in time or farther removed in distance. Indirect effects may include growth-inducing effects and other effects related to induced changes to the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems including ecosystems.

A *cumulative effect* is an impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable actions.

Various examples of cumulative effects are presented below.

1. Time crowding
Frequent and repetitive effects on an environmental system. *Example: forest harvesting rate exceeds regrowth.*

2. Time lags
Delayed effects. *Example: exposure to carcinogens results in cancer years after the time of exposure.*

3. Space crowding
High spatial density of effects on an environmental system. *Example: pollution discharges into streams from non-point sources.*

4. Cross-boundary
Effects occur away from the source. *Example: air pollution in one region of the country produces acid rain in areas downwind.*

5. Fragmentation
Change in landscape pattern. *Example:* conversion *of homes to commercial uses in a residential area.*

6. Compounding
Effect arising from multiple sources or pathways. *Example: synergism among effects from pesticides*

7. Indirect effects
Secondary effects. *Example: commercial development following highway construction.*

8. Triggers and thresholds
Changes in system behavior or structure. *Example: global climate change.*

IDENTIFYING POTENTIAL CUMULATIVE EFFECTS ISSUES

The following questions should help planners for major transportation projects and others to identify potential cumulative effects:

1. What is the value of the affected resource or ecosystem? Is it:
   - protected by legislation or planning goals?
   - ecologically important?
   - culturally important?
   - economically important?
   - important to the well being of a human community?

2. Is the proposed action one of several similar past, present or future actions in the same geographic area? (Regions may be land-management units, watersheds, regulatory regions, states, ecoregions, etc.)

   Examples: timber sales in a national forest, U.S. Air Force Academy Programmatic Biological Assessment, incinerators in a community.

3. Do other activities (governmental or private) in the region have known environmental effects similar to those of the proposed action?

   Example: release of oxidizing pollutants to a river by a municipality, an industry or individual septic systems.

4. Will the proposed action (in combination with other planned activities) affect any natural resources, cultural resources, social or economic units, or ecosystems of regional, national or global public concern?

   Examples: release of chlorofluoro-carbons to the atmosphere, conversion of wetland habitat to farmland located in a migratory bird flyway.

5. Have any recent or ongoing NEPA analyses of similar or nearby actions identified important adverse or beneficial cumulative effect issues?

6. Has the impact been historically significant, such that the importance of the resource is defined by past loss, past gain or investments to restore resources?

   Example: loss and fragmentation of short-grass prairie remnants.

7. Might the proposed action involve any of the following cumulative effects issues?
   - Air pollutant emissions resulting in degradation of regional air quality
   - Loading large water bodies with discharges of sediment, thermal or toxic pollutants
   - Changes in hydrological regimes of major rivers and estuaries
   - Long-term containment and disposal of hazardous wastes
   - Mobilization of persistent or bio-accumulated substances through the food chain
   - Decreases in the quantity and quality of soils
   - Loss of natural habitats or historic character through residential, commercial and industrial development
   - Habitat fragmentation due to infrastructure construction or changes in land use
   - Habitat degradation due to grazing and other consumptive uses
   - Disruption of migrating wildlife populations
   - Loss of biological diversity.

AIMING FOR SUSTAINABILITY AS AN ANTIDOTE TO CUMULATIVE EFFECTS

In the broadest sense, when communities describe what they want for the future, they say it is to sustain the positive aspects of their communities and reduce or eliminate the negative ones. Cumulative effects, as here defined, are frequently included in those negative aspects.

Sustainability is an internationally recognized objective (but not the only objective) for community and resource stewardship. It means meeting the needs of the present without compromising the needs of the future. Harvard landscape ecologist Richard Forman (1995) defines a sustainable environment as "an area in which ecological integrity and basic human needs are concurrently maintained over generations." Thus, the concept is useful in bringing together both ecological and social concerns over a broad timeframe. See Figure 1-3 below.

Sustaining desirable natural and cultural aspects of the Pikes Peak region means working to meet our communities' needs and aspirations today, while sustaining the resources future generations will need to meet their own needs and aspirations. We are not thinking about sustainability if we allow major portions of our community or natural resources to be permanently lost or degraded today and thereby precluding or diminishing their use by our children and their children.

SUSTAINABILITY

Sustainability is achieved only through the simultaneous consideration of ecological, economic, and social factors. Ecological sustainability is comprised of maintaining and enhancing biological diversity and ecosystem integrity.
(Haufler et al, 2002)

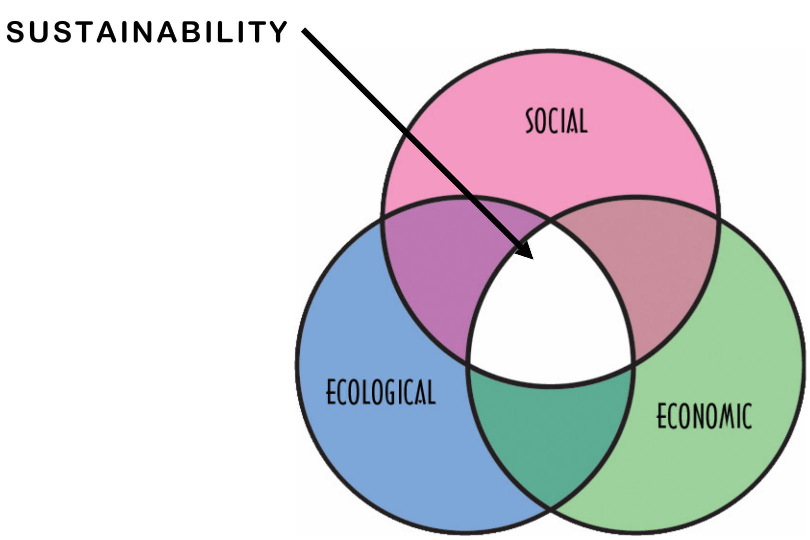


Figure 1-3. Sustainability Venn Diagram

STUDY AREA AND TIMEFRAME PICKED TO MATCH RESOURCES

For setting the broad parameters of the study, participants in this study followed the procedure regarding cumulative effects recommended by the Council of Environmental Quality (1977):

Step 1: Identify the significant cumulative effects issues associated with the proposed actions and define the assessment goals.

Step 2: Establish the geographic scope for the analysis.

Step 3: Establish the timeframe for the analysis.

Step 4: Identify other actions affecting the resources, ecosystems and human communities of concern.

In following these steps, two panels of experts—one panel including experts on the natural environment, the other experts on community resources:

- Guided agency and consultant project investigators in collecting and analyzing data and determining project direction.
- Identified the natural and community resource issues relevant to analyzing cumulative effects.
- Developed indicators or resource trends under two broad categories: biodiversity and quality of life.
- Identified appropriate scales of analysis in terms of both geography and time.
- Collected, evaluated and analyzed data using geographic information systems (GIS) as a principal means of spatial analysis.
- Identified strategies for sustaining key aspects of those natural and community resources most susceptible to community effects.

Because of the kinds of issues involved and the variable data available, two slightly different study areas were selected, one for natural resources and the other for quality of life (community) resources. These boundaries are depicted in Figure 1-4.

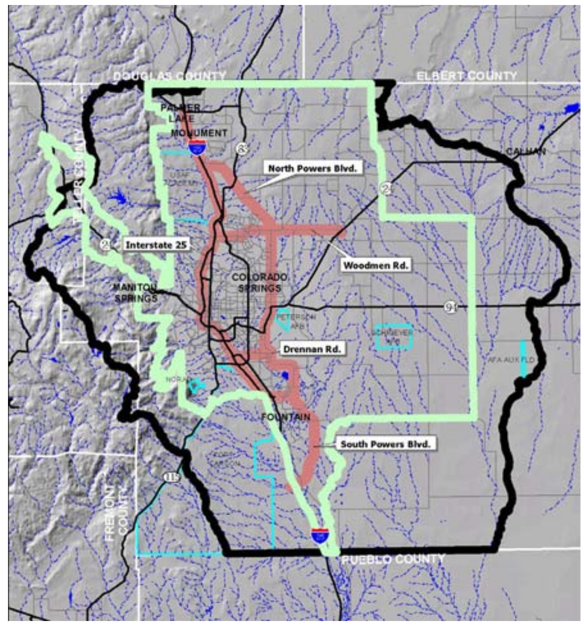


Figure 1- 4. The spatial limits of the study area were determined by defining the geographic extent of the affected resources.

In Figure 1-4, the black line shows the boundary of the area used to consider impacts on the natural environment. The natural resource boundary includes the Fountain Creek, Chico, Cherry Creek and Kiowa watersheds within El Paso and Teller counties. The green line shows the boundary used to consider impacts on community resources. This boundary corresponds to the urbanized planning area boundary of the Pikes Peak Area Council of Governments.

To select the appropriate timeframe for the study it was necessary to go back to significant points in history when human impacts caused noticeable changes in the condition of the resources, such as the development of I-25 in the early 1960s; and to determine the availability of reliable data.

Based on these factors, the analysis was taken back to 1955 and projected forward to 2025. The 1955 timeframe corresponds to the first major population increase in the county, while 2025 is the planning horizon year for the PPACG Long-Range Transportation Plan.

SUSTAINING THE PIKES PEAK REGION

Sustainability is an ambitious concept that needs better definition if it is to be useful in addressing cumulative effects. The resource panels for this study identified two broad concepts that can help define sustainability for a region: quality of life and biodiversity.

Biodiversity (biological diversity) is the variety of life in all its forms, levels and combinations, including ecosystem diversity, species diversity, and genetic diversity. (IUCN, UNEP and WWF, 1991)

Quality of life is people's overall well-being. (World Book, 2000

The expert panels selected six interrelated key indicators were used to understand these twin concepts, how they have changed over the years and how they are likely to change in the future. The indicators are:

A. Landscape pattern

B. Water quality and quantity

C. Air quality

D. Transportation patterns

E. Noise levels

F. Visual character

The natural resources panel examined these indicators with respect to land cover types (e.g., Shortgrass prairie ecosystems), and the community resources panel examined them with regard to the spatial relationship of key community resources (see Figure 1-5).

BROAD CONCLUSIONS

From their analyses, investigators broadly concluded that:

- The best way to mitigate effects of cumulative effects to these six key indicators—and more generally, sustainability—is by raising awareness of issues and coordinating strategies at the regional level, and then encouraging action locally on a project-by-project basis.
- While many important contributions can be made on a project-level basis, there are also regional policy choices that need to be made that can have considerable effect on sustainability.
- The pattern of landscapes—the relationships between and among land uses and land covers—can have particularly significant effects on biodiversity and quality of life. This is because of the important interactions between all of the inhabitants of the landscape and their settings.

EVOLUTION OF THE LANDSCAPE

Figures 1-6 through 1-9 provide a series of snapshots of the Pikes Peak region at various stages of development. They present a broad overview of how the region has changed over time. Each drawing includes a brief assessment of the six key indicators of sustainability at approximately that point in time. More details of the characteristics of each of these time periods are given in Section 2, *Sourcebook for Analyzing Regional Cumulative Effects*.

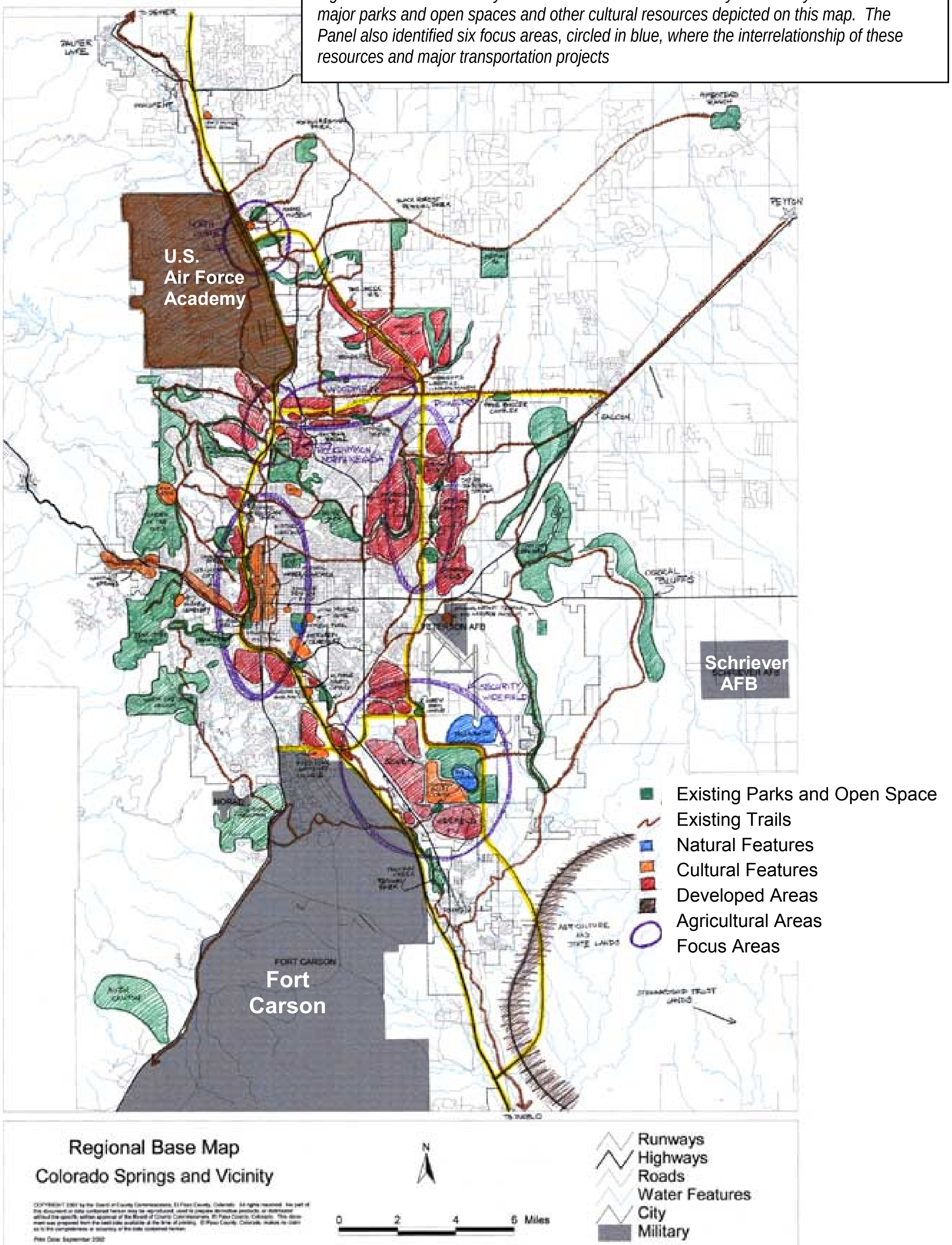


Figure 1-5. The Community Resources Panel identified as key community features the major parks and open spaces and other cultural resources depicted on this map. The Panel also identified six focus areas, circled in blue, where the interrelationship of these resources and major transportation projects

Figure 1-6

BEFORE MAJOR SETTLEMENTS BEGAN…

Landscape pattern…

was determined by forces of nature—water, wind and bison—with some intervention by Native Americans.

Air quality…

presumably was very good but occasionally was influenced by grass and forest fires and dust storms.

Water quality and quantity…

were dictated by the ebbs and flows of nature, including periods of drought. Plants and animals evolved and adapted with these patterns of water availability.

Transportation patterns…

were wide open, because they were not limited by fences or ownership. Trails and streams were used by Native Americans.

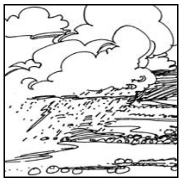
Noise levels…

were minimal and varied with the dynamics of nature, including wind and wildlife.

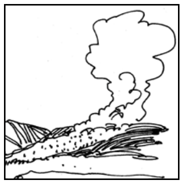
Visual character…

was shaped by natural factors operating on the landscape.

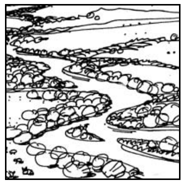
Key features of this landscape:



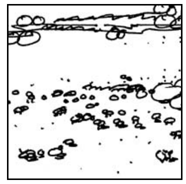
Naturally low rainfall and no imported water



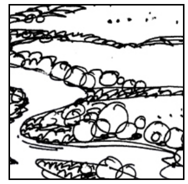
Forest and prairie fires are natural disturbances



Streams are frequently wide and shallow



Large herbivores: bison



Water dictates where vegetation is found

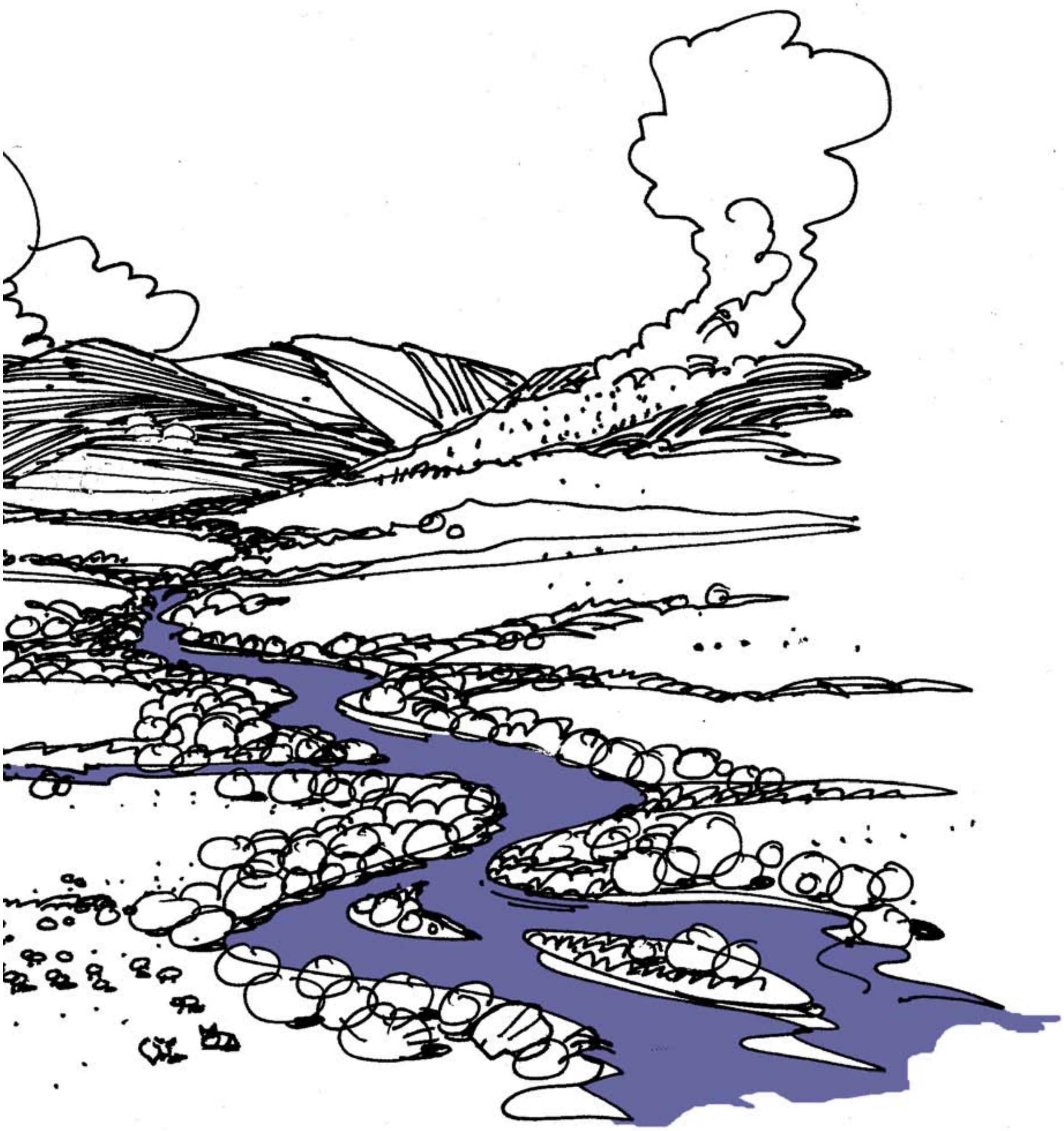


Figure 1-7

A CENTURY AGO…

Landscape pattern…

was beginning to be changed extensively by people. Forests were cut in support of mining and railroads. People used riparian areas for water and built homes nearby. Agricultural management (primarily ranching) was imposed on prairie areas. Attempts were made to stabilize and control dynamic landscape patterns when they interfered with human activities.

Air quality…

was influenced by some human activities but generally was so good as to attract health seekers.

Water quality and quantity…

were beginning to be impacted by people. Mining and other activities degraded water quality. People began to move water with irrigation canals to where they wanted to for agriculture or other uses.

Transportation patterns…

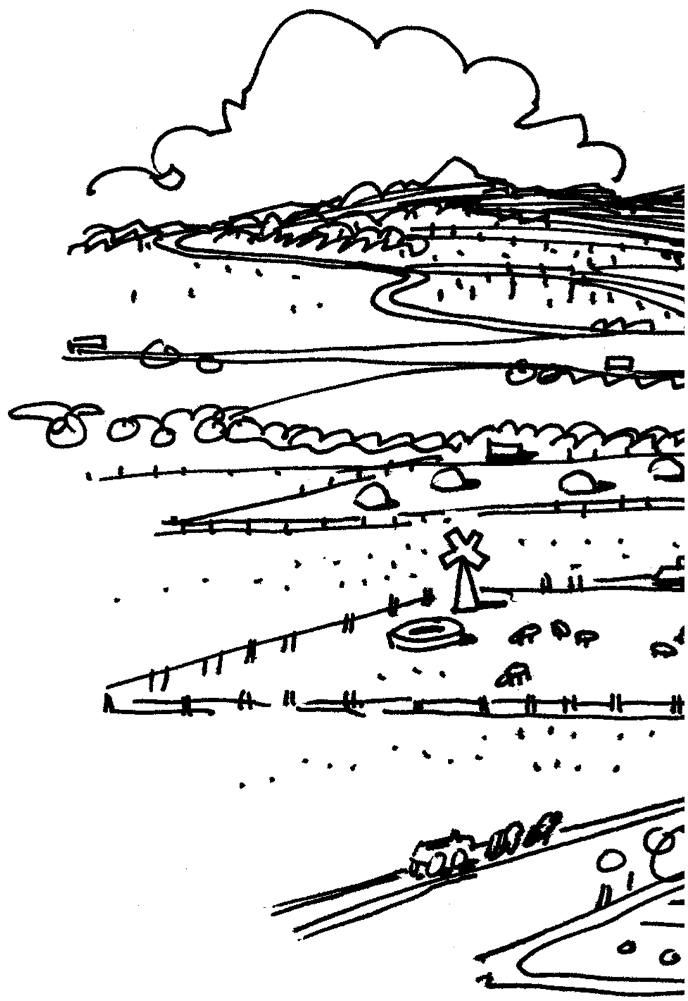
such as railroad lines, roads and trails cut across the patterns of the landscape.

Noise levels…

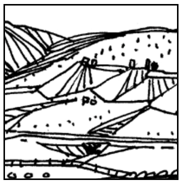
increased as people carried out new activities, but still the vastness of the landscape tended to dampen any of these sounds.

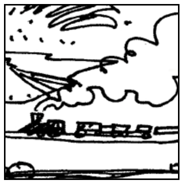
Visual character…

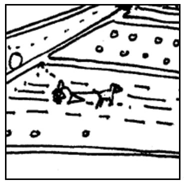
was changed as roads and buildings appeared, with the sense that the wilderness was being tamed and made more beautiful.



Key features of this landscape:


Mining cuts into mountain sides


Railroads and roads begin to fragment open spaces


Agriculture changes prairies


Water taken from the ground and other basins

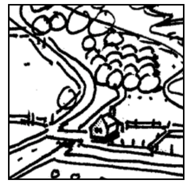

Modern development patterns begun

Figure 1-8

TODAY…

Landscape pattern…

is dominated by humans and natural patterns are largely overwhelmed with habitats fragmented.

Air quality…

is influenced by motor-vehicle emissions, street sanding, power plants, factories and wood burning in home fireplaces.

Water quality and quantity…

are dramatically changed with water imported from other basins and increased runoff from development's impervious surfaces. More water pollutants find their way into surface and underground waters.

Transportation patterns…

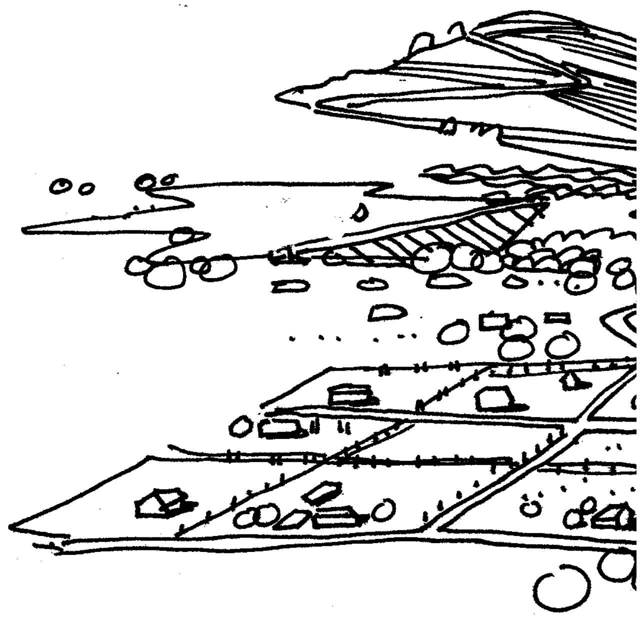
are well developed and crisscross the landscape.

Noise levels…

have been increased by motor-vehicle traffic, aircraft operations and other sources.

Visual character…

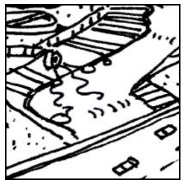
has been significantly altered by homes and mining scars on mountainsides, homogeneous development and the loss of historic structures.



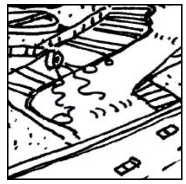
Key features of this landscape:

Development spreads across the landscape

Industry contributes to air and water pollution



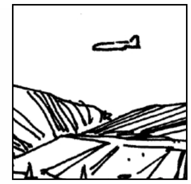
Transportation connects, but also divides



Streams are channelized

Urban forest transforms ecosystem

Stormwater changes nature of streams



Aircraft and other sources generate noise

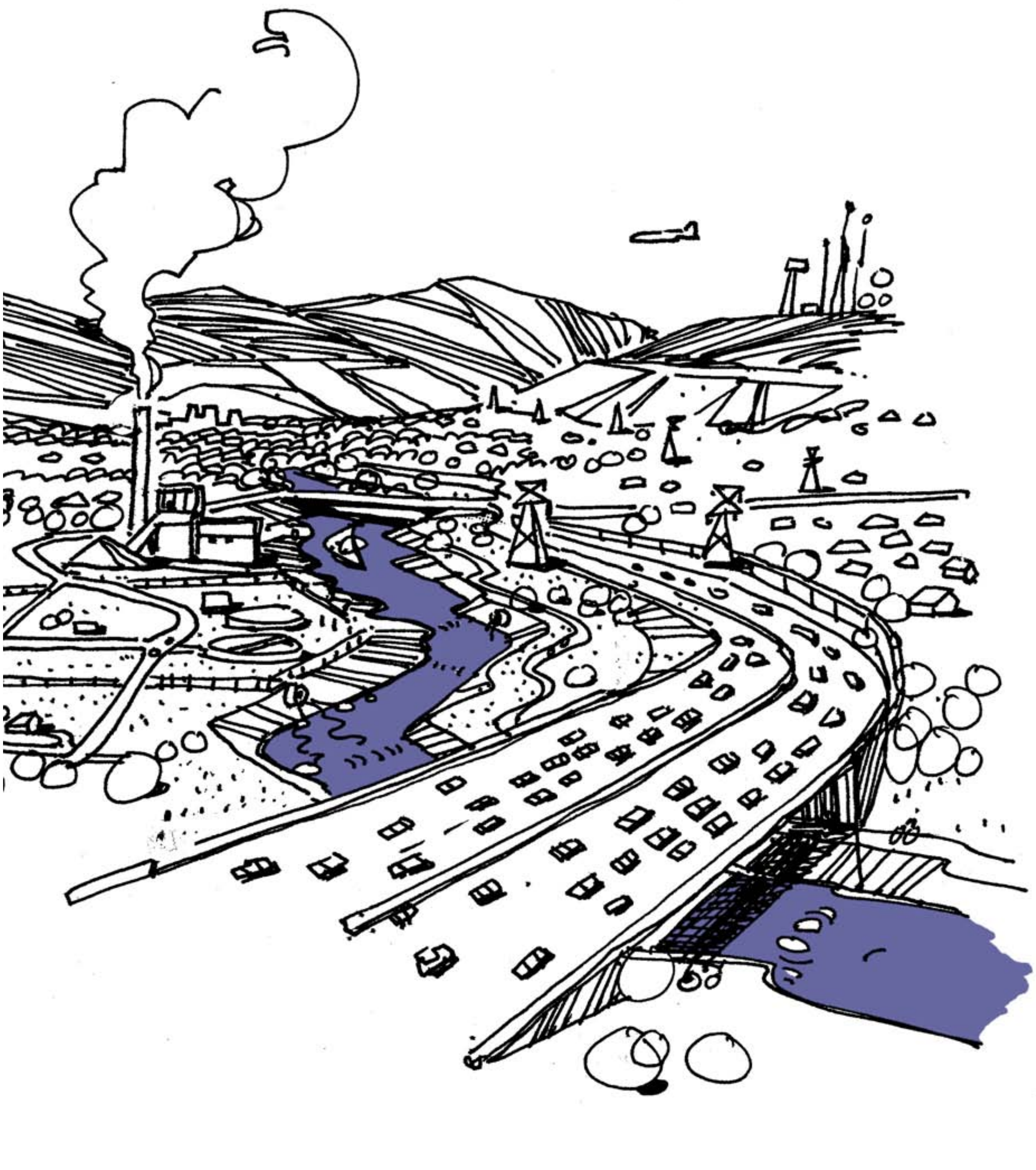
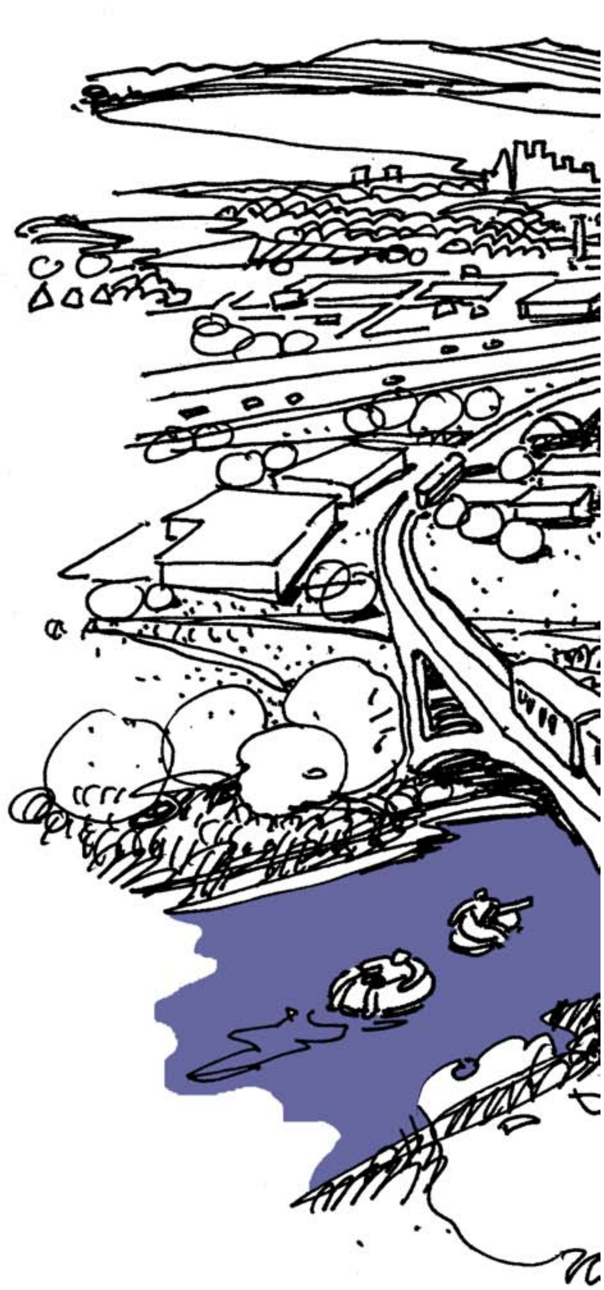


Figure 1-9

IN A SUSTAINABLE FUTURE…



Landscape pattern…

consists of carefully interwoven land uses for people and nature.

Air quality…

is improved because motor vehicles produce extremely clean emissions, the city is walkable and public transportation is convenient.

Water quality and quantity…

are enhanced because there is less non-point pollution and less impervious surface in new developments, as well as water-quality treating features, such as constructed wetlands.

Transportation patterns…

have public transportation at their core, and many multimodal options are available.

Noise levels…

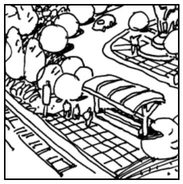
are carefully managed, with some land uses kept separate.

Visual character…

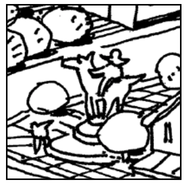
is strong because people appreciate historic buildings and places and work hard to protect important mountain views.

Key features of this landscape:

Space for dynamics of streams

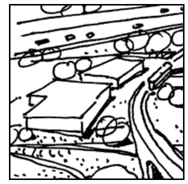


Residential development focused on public transportation

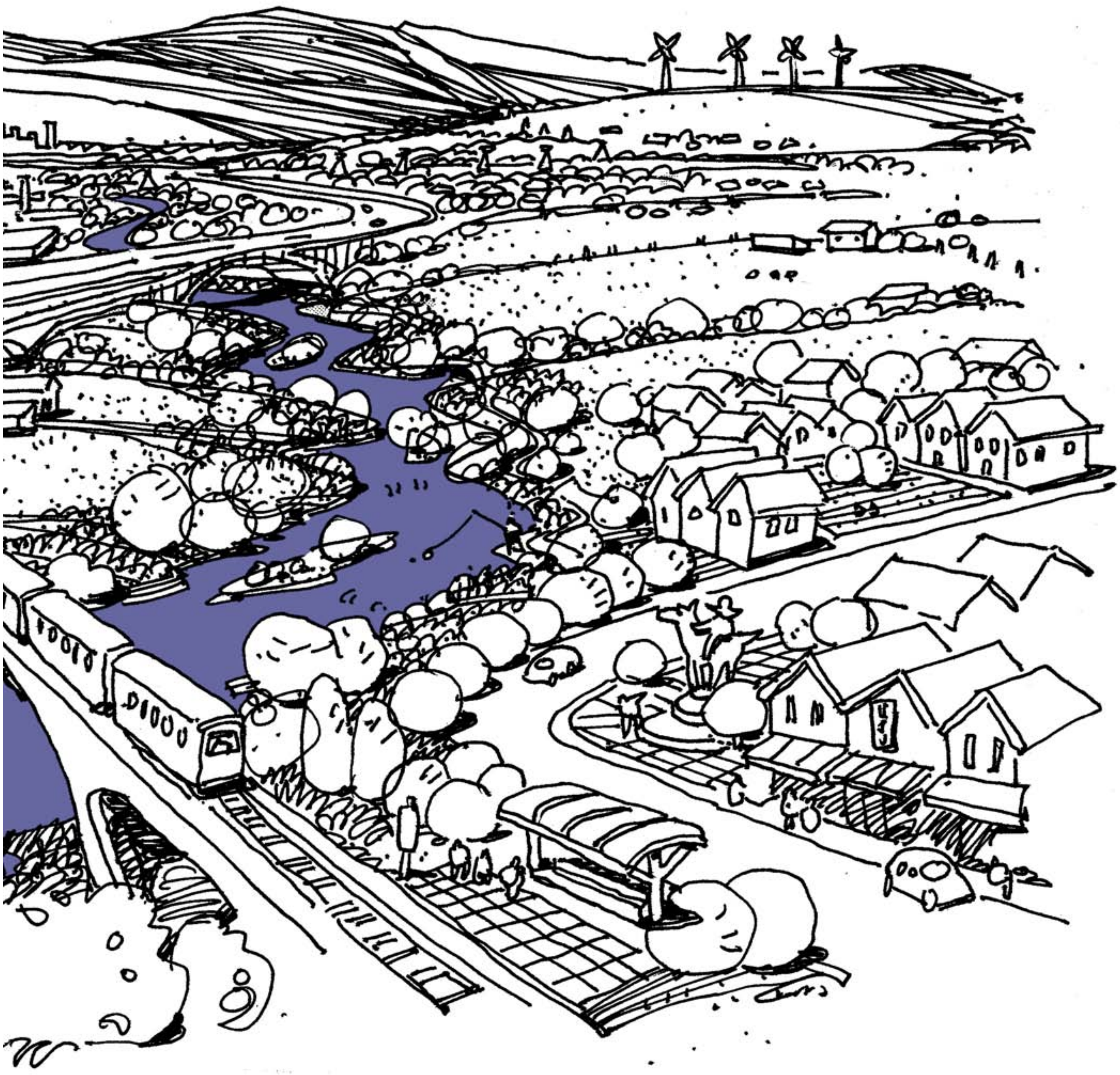


Public art, historic preservation, monuments

Revitalized town centers



Integrated activity centers instead of strips



CASE STUDIES

Much can be learned about cumulative effects and sustainability from the experiences of other communities. On the following pages and interspersed throughout this report are case studies and other reports from around the country that shed light on various topics related to sustainability and the Pikes Peak region.

On the following pages and inter-spaced throughout this report are case studies and other reports from around the country that shed light on various topics related to sustainability and the Pikes Peak region.

Case Study

Kansas City Region, Kansas and Missouri

20 PRINCIPLES FOR CREATING QUALITY PLACES

Homes and Neighborhoods Principles

1. **Choice and Diversity.** Quality neighborhoods offer a choice of well-designed and maintained housing types and sizes. This variety of housing choices within a community meets the needs of different economic levels and age groups.
2. **Linkages.** Quality neighborhoods are linked to surrounding areas and, when possible, share commercial spaces and open-space resources.
3. **Reinvestment.** Quality neighborhoods encourage actions to preserve, restore and reuse historic sites or structures; to conserve and restore environmental resources; to foster appropriate infill development; and to redevelop Brownfields.
4. **Identity.** Quality neighborhoods have a distinct identity that helps define their boundaries and fosters pride and belonging among residents.
5. **Pedestrian/Cyclist Friendly.** The streets of a quality neighborhood are pedestrian-friendly.
6. **Green Space.** A variety of public green spaces are within easy access of residents in a quality neighborhood.
7. **Live/Work.** Quality neighborhoods offer the opportunity for residents to work and live within the neighborhood when the scale, character and function of business settings are compatible with homes.

Commercial Development Principles

8. **Mixed Use.** Quality places include a variety of uses (e.g. retail stores, residences, civic buildings and offices) that create multi-purpose activity centers in neighborhoods, small towns, suburbs and cities.
9. **Scale.** The scale, character and function of a quality development are compatible and integrated with that of its surroundings while remaining flexible to accommodate the densities, mix of uses and infrastructure that the market demands.
10. **Durability.** Quality places are built to last with quality materials, are designed to allow for changing uses over time and provide for shifting markets and consumer needs.
11. **Walkability.** Quality shopping areas, small or large, are designed to make the pedestrian feel comfortable and safe by providing wide sidewalks, storefronts that open to the street, shade and shelter and a sense of spatial enclosure.
12. **Parking.** Quality shopping areas provide a variety of convenient parking choices consistent with the scale of development, the location and the types of stores.

Transportation and Public Places Principles

13. **Multimodal.** A quality transportation system accommodates automobiles, public transit, public-safety vehicles, freight, pedestrians

and bicycles in a balanced way to maximize access and mobility and to minimize congestion throughout the community.

14. **Local Streets.** Quality local streets are an integral part of a larger network of routes designed to provide access to homes, shops and businesses and to keep local traffic off major arterials and high-speed through-traffic off local roads.

15. **Bike/Pedestrian Access.** The design of a quality local street encourages pedestrian and bicycle use through such features as continuous sidewalks, outside tree planting and narrow street width and small turning radii at corners to slow down cars.

16. **Transit Supportive Development.** A system of quality local streets complements the planning and development of a regional public transit network.

17. **Public Spaces.** Quality public places are provided in urban and suburban area to encourage social interaction and to foster a distinct sense of place.

18. **Water and Air Quality.** The design of quality places incorporates features and amenities that minimize environmental impacts on water quality caused by stormwater runoff and erosion, and on air quality caused by motor vehicle traffic.

Environmental Quality Principles

19. **Resource Efficiency.** The design of buildings and properties maximizes the efficient use of environmental and economic resources by minimizing energy, water and material use.

20. **Natural Elements.** A quality place preserves major natural features in a neighborhood or a community (streams, slopes and natural habitats) as open space, and links those resources to public places by pedestrian and pike paths.

From: Mid-America Regional Council, www.qualityplaces.marc.org

Case Study

Greater Wasatch Area, Utah

ENVISION UTAH

"Formed in January of 1997, Envision Utah is a public/private community partnership dedicated to studying the effects of long-term growth in the Greater Wasatch Area of northern Utah. Sponsored by the Coalition for Utah's Future, Envision Utah and its partners—with extensive input from the public—have developed a publicly supported growth strategy that will preserve Utah's high quality of life, natural environment and economic vitality during the next 50 years.

The Envision Utah partnership includes state and local government officials, business leaders, developers, conservationists, landowners, academicians, church groups and general citizens.

This unique and diverse coalition is working together to implement a common vision for the Greater Wasatch Area as it faces the prospect of immense growth in the coming decades."

The coalition is addressing the following topics:

- Protecting sensitive lands
- Meeting household needs
- Making the community a good place to walk
- Reuse and infill
- Water conservation
- Urban forestry
- Energy conservation
- Strategies for walkable commercial development
- Public safety and residential street design

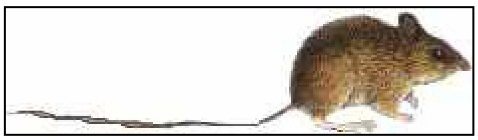
From: www.envisionutah.org

Case Study

State of Colorado

PREBLE'S MOUSE CONSERVATION AREA IN EL PASO COUNTY

Rapid development in northern El Paso County, Colo., is placing development pressure on the riparian habitat of the Preble's Meadow Jumping Mouse. While El Paso County itself is working with stakeholders to develop a Habitat Conservation Plan, the Colorado Department of Transportation (CDOT) has needed to make strong mitigation commitments to secure federal permits to proceed with several critically needed roadway improvement projects.



CDOT recognized a major opportunity in the form of a 65-acre parcel of vacant land in the southeast quadrant of the Interstate 25/Baptist Road interchange. Jackson Creek flows through this parcel of critical mouse habitat, which was slated for imminent development, and also would generate important right-of-way issues for the planned future reconstruction of the interchange. By purchasing the property in 2001, CDOT has protected a vital habitat resource and can ensure that upcoming roadway projects surrounding the property are designed to have minimal adverse impacts.

CDOT plans several habitat improvements on the property to benefit the threatened mouse, including conversion of dense cattail stands to shrub islands, the removal of a frontage road and a culvert under it and improvements to the culvert that carries Jackson Creek under I-25 to join Monument Creek.

From: *Programmatic Biological Assessment: Interstate 25 Corridor, Powers Boulevard North, and Shoup Road Projects in El Paso County* (CDOT, February 2003).

Case Study

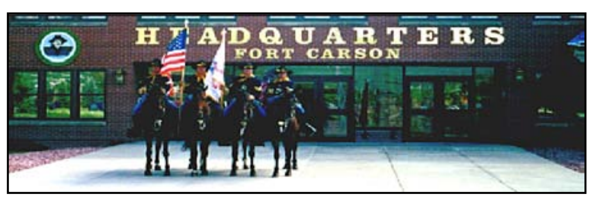
Fort Carson, Colorado

SUSTAINABILITY IS "IN THE ARMY NOW."

Fort Carson and other U.S. Army installations around the country are taking a serious look at sustainability, including the implications from and for the regional contexts for such bases. For what is being considered at Fort Carson, see: ***www.envquest.com/library-Carson.asp.***

"For the past 30 years, environmental management in the United States (and the Army) has been compliance-based, with the ultimate goal of any environmental program being to reduce releases of pollutants and avoid costly and painful violations. Yet while compliance with the law may provide the environment with some level of protection, it does not protect the ability of the Army to train and deploy soldiers.

The modern Army installation requires, among other things, thousands of acres of undamaged training lands, a plentiful source of drinking water, and affordable energy sources to power its buildings and vehicles. An installation subject to severe restrictions or a rapidly increasing cost of energy or water may not be able to maintain readiness. A Sustainable Installation is an installation that plans proactively for these issues to ensure that they never affect readiness and the mission."



The U.S. Army is steward of one of the largest single blocks of land in the Pikes Peak region—the 138,523 acres that make up Fort Carson.

Case Study

State of Colorado

CDOT'S SHORTGRASS PRAIRIE INITIATIVE SEEKS TO MITIGATE IN ADVANCE OF IMPACTS

In an innovative, $5 million agreement between the Colorado Department of Transportation (CDOT), the Federal Highway Administration, the U.S. Fish and Wildlife Service, the Colorado Division of Wildlife, and The Nature Conservancy, participants are working to mitigate impacts from future CDOT projects included in the 20-year State Transportation Plan.

By mitigating in advance of impacts, critical habitat will be preserved and requirements of the Endangered Species Act will be addressed on a system-wide basis. Through this advance mitigation, CDOT hopes to reduce right-of-way costs, regulatory time, and project uncertainty, while maximizing environmental benefits.

See: http://environment.fhwa.dot.gov/strmlng/comoa.htm

Case Study

City of Austin, Texas

SUSTAINABLE COMMUNITIES INITIATIVE

Austin, Texas, like most urban areas, is facing increasing pressures to maintain quality of life while fiscal constraints and population also are growing. The need is to find new development pathways to deal effectively with these pressures as they adapt to decreasing amounts of resources and increasing environmental quality concerns.

Austin's Sustainable Communities Initiative reflects the international trend to embrace sustainable development as a way to meet these challenges. The initiative recognizes that several characteristics form the basis of a sustainable community:

- Long-range outlook
- Equity
- Stewardship of the natural environment and living within its carrying capacity
- Economic, human and biological diversity
- Community self-reliance
- Recognition of social, environmental and economic interdependence

"In a sustainable neighborhood, economic prosperity does not come at the expense of social justice and a healthy community, nor does it compromise environmental quality. Likewise, efforts to protect environmental resources do not limit people's opportunities to achieve a decent lifestyle or receive basic services. And programs and projects to improve lives and communities are planned and implemented so that both economic and natural systems are enhanced. In short, people in a sustainable neighborhood find 'win-win' practices that avoid harming the economy, the environment, and the community."

From: www.ci.austin.tx.us/sustainable

Case Study

State of Colorado

COLORADO HERITAGE REPORTS ON SMART GROWTH

The concept of smart growth has emerged nationwide as an important planning concept. In Colorado, this topic is the focus of the Office of Smart Growth, in the Colorado Department of Local Affairs. Additionally, the Governor launched a project to identify and compile reports documenting successful smart growth policies that had been put in place around the State by county and municipal governments, as well as other organizations.

The outcome of this effort was the preparation of the **Colorado Heritage Reports**:

- Practices in Land Use Planning and Growth Management
- Intergovernmental Agreements
- Preservation of Open Space, Ranches and Farms.

Hundreds of actual Colorado plans, policies, programs and regulations are documented in these reports. For Colorado, the Heritage Reports could be considered "the mother of all case studies."

A number of the Smart Growth examples in the Colorado Heritage Reports are cited from programs within El Paso County. A partial listing of these examples includes the following:

- City of Colorado Springs: Open Space Plan, 1997
- City of Fountain: Trails Master Plan, 1996
- PPACG: Coordinated Regional Open Space Planning & Implementation, 1996
- City of Colorado Springs: Trails, Open Space and Parks (TOPS) Program, 1997
- El Paso County: Open Space and Parks Acquisition, 1997
- Teller County: Catamount Ranch Open Space Project
- City of Manitou Springs: Open Space Zone
- PPACG: Fountain Creek Watershed Project, 1996
- City of Colorado Springs: Hillside Area Overlay Zone District, 1996
- City of Fountain: Flood Damage Prevention Ordinance, 1996
- Town of Green Mountain Falls: Comprehensive Plan and Annexation Plan, 1997
- Town of Palmer Lake: Comprehensive Plan, 1993
- University of Colorado Corridor Transportation Management Association, 1997

For more information, see:
www.state.co.us/smartgrowth

SMART GROWTH

Citizens in many parts of the country, including Colorado, are speaking of and pursuing what they term "smart growth." Its principles include:

- Mix land uses
- Take advantage of compact building design
- Create housing opportunities and choices for a wide range of household types, family sizes and incomes
- Create walkable neighborhoods
- Foster distinctive, attractive communities with a strong sense of place
- Preserve open space, farmland, natural beauty, historic buildings and critical environmental areas
- Reinvest in and strengthen existing communities and achieve more balanced regional development
- Provide a variety of transportation choices
- Make development decisions predictable, fair and cost-effective
- Encourage citizen and stakeholder involvement in development decisions

From: www.smartgrowth.org

FISCAL IMPLICATIONS

It will cost money to mitigate cumulative effects through the wide variety of policy-level and project-level strategies presented later in this report. This is a critical issue to State and local government agencies, especially due to continued economic weakness in the post-September 11 era, as homeland-security needs place increased demands on scarce government resources. Also, growth in spending by local governments in Colorado is restricted under provisions of the state's Taxpayers Bill of Rights (TABOR) law.

Federal, State and local laws already require mitigation of many of the adverse impacts that might be associated with a transportation project. Compliance with requirements pertaining to resources such as air quality, water quality, wetlands and threatened or endangered species is not optional—if the project does not comply, its sponsor cannot obtain permits needed to initiate construction. The good news is the cumulative effects mitigation strategies presented in this report may actually save money.

If public-private partnerships and other synergistic strategies can be identified to address cumulative effects, it may be possible to achieve required mitigation in a more coordinated and cost-effective manner. Coordinated and partnership strategies result in cost savings by eliminating redundancies associated with individual and unrelated conservation efforts in the same region. In addition to cost savings, coordinated efforts can improve the functionality and sustainability of conservation efforts.

For example, if ten individual and unrelated projects in El Paso County are each required to mitigate for unavoidable impacts to an acre of wetlands, most likely it would be more cost-effective and produce a better quality wetland to create or restore ten acres of wetlands in one location, rather than ten one-acre locations. Cost savings would accrue by eliminating nine of the ten mitigation planning, land acquisition, construction and monitoring efforts.

The case study examples cited later in this report are predominantly "success stories" for which suitable funding mechanisms were found.

The scope of this cumulative effects analysis did not include estimating implementation costs.

The potential strategies listed in this report are numerous and could be implemented to varying degrees. Thus estimating their costs would have added minimal value to this study. Mitigation strategies should be assessed for fiscal impact on a case-by-case basis, when the affected agencies develop proposals or options in sufficient detail to facilitate meaningful cost estimates. At that time, it will be important—and feasible—to identify reasonably available funding as needed for strategy implementation, as well as any quantifiable cost savings attributable to coordinated mitigation efforts.

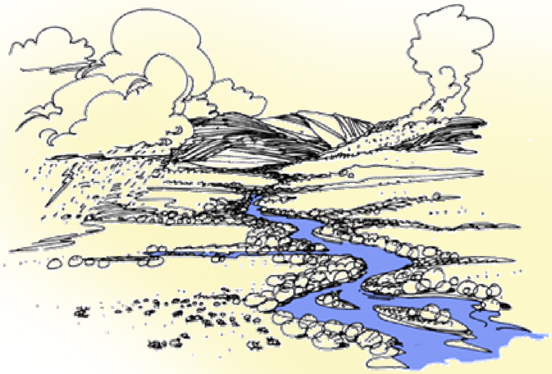
FROM HERE…

The first section of this report presented a broad overview of the changing characteristics of nature and community in the Pikes Peak region. It also described in general terms what a sustainable future might be like for the region.

The second section—A Sourcebook for Analyzing Cumulative Effects —provides a more detailed assessment of the past, present and possible future of the region and identifies a wide range of resources that should be of use to project planners who want to contribute to sustaining what people value about the region.

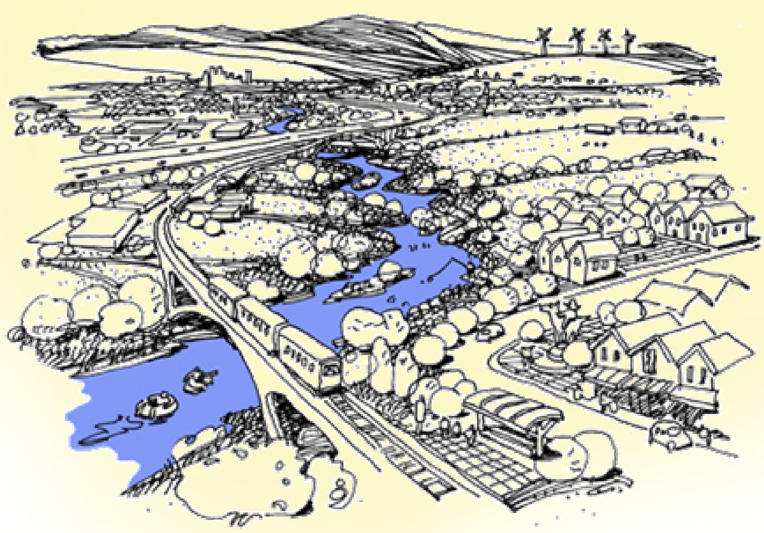
Much has been said and is being accomplished in the Pikes Peak region to sustain those aspects of community and environment that people value. In recent months and years, a trails and open-space tax was approved (then extended) by voters, wetland and habitat banking have begun, a streamside overlay zone has been created and more.

The discussion of cumulative effects presented here suggests it may take even greater levels of cooperation and collaboration to be able to offer our children and their children the high quality of life and biodiversity now found in the region. With that increased cooperation and collaboration, participants in projects of all kinds—public and private, large and small—should be able to gain some of the regional perspective that will help them anticipate and mitigate cumulative effects and make a positive contribution to the region's future.



2.

A Sourcebook for Analyzing Regional Cumulative Effects



2. A SOURCEBOOK FOR ANALYZING REGIONAL CUMULATIVE EFFECTS

This section of the report provides additional detail about the cumulative effects issues presented in the previous section. The contents of this section grew out of the work of two panels convened by the Colorado Department of Transportation to examine cumulative effects in the Pikes Peak region. This Sourcebook should be useful to anyone interested in sustaining the twin goals of quality of life and biodiversity identified by the panels, one of which focused on the natural environment and the other on community resources.

In this report, biodiversity (or biological diversity) is defined as "the variety of life in all its forms, levels and combinations, including ecosystem diversity, species diversity, and genetic diversity" (IUCN, UNEP and WWF, 1991) and quality of life is "people's overall well-being" (World Bank, 2000).

Consistent with recommendations of the Council on Environmental Quality (1997), the panelists established both the geographic scope (see Figure 1-4) and the timeframe for their examination of the region's potential cumulative effects. The panels identified 1955 as the approximate time in the past when the region shifted from a community of stable, slow growth to one of rapid expansion. They projected the Council on Environmental Quality's "reasonably foreseeable future" as that time in the future (2025) to which readily available regional planning documents also projected, but also considered the duration of potential project effects.

In their report entitled "Considering Cumulative Effects Under the National Environmental Policy Act" (1997), the Council on Environmental Quality (CEQ) suggests that indicators can be used as benchmarks of accumulated change as a method to assess cumulative effects. Several previous studies in the region have focused on identifying or using indicators to benchmark or measure changes in the environment and quality of life. To avoid redundancy and to take advantage of the work of others regarding indicators, panel members reviewed and considered other recent studies of environmental indicators in the Pikes Peak Region, including the following:

- Greenwood, Daphne. **Local Indicators of Quality of Life – A Preliminary Look at the Pikes Peak Region.** UCCS Center for Colorado Policy Studies, 2001.
- Clean Air Campaign. **Sustainable Indicators in Colorado Springs** (ongoing research).
- University of Colorado at Colorado Springs. Southern Colorado Economic Forum, 2001.
- The Colorado Forum on National and Community Indicators, 1997.
- Environmental Alliance of the Pikes Peak Region. **State of the Environmental Report for Colorado Springs**, April 1999 and 2000 Update.

This Sourcebook does not quantify environmental effects of specific projects (transportation or otherwise), but instead discusses overall trends in the region, assuming continued growth and development consistent with adopted regional transportation and land use plans.

SIX KEY INDICATORS

To make more practical the concepts of sustainability, biodiversity, and quality of life, panelists and project planners for this study identified six key indicators. They are:

A. Landscape patterns
B. Water quality and quantity
C. Air quality
D. Transportation patterns
E. Noise
F. Visual resources

Discussed in this Sourcebook for each of these six indicators are:

- What the issues has to do with sustainability;
- what the past and present status of the issue is;
- where trends seem to indicate things are going with this issue with respect to the Pikes Peak region;
- what a desired future state might be; and
- key strategies for moving toward that desired state.

The information and strategies in this study came from a wide range of sources. Some of the trends were developed during this study; others were developed by earlier studies. Desired future states and strategies were obtained from a number of sources, including the Colorado Springs Comprehensive Plan.

As an aid to readers, strategies for each indicator are grouped under two headings: policy-level and project-level. Readers involved or interested in setting policy that supports sustainability should see the first list. If your interests center on a particular project – such as one of the major transportation improvement projects for which this study was undertaken – and relevant sustainable practices, see the second list. In some cases strategies for the same topic are found on both lists.

Case studies, such as that for the Monument Creek Watershed Landscape Assessment described below, were also examined for useful suggestions. The Monument Creek Watershed Landscape Assessment (2002) is highlighted here because it is a recent scientific and comprehensive assessment covering the rapidly developing northern portion of Colorado Springs and El Paso County. The full report can be accessed on the Internet at *http:// www.cnhp.colostate.edu/ projects/mcwla*.

CUMULATIVE EFFECTS TIMEFRAMES FOR THE PIKES PEAK REGION

The expert panels participating in this study selected the following timeframes for looking at the region's past, present, and reasonably foreseeable future:

Past = circa 1955: Prior to opening Interstate 25 and the US Air Force Academy; Aerial photography available.

Present = circa 2000: Utilizing the decennial census and other latest available datasets.

Future = circa 2025: Horizon year for current regional long-range transportation plans; *2020 land uses identified in City Comprehensive Plan.*

Case Study

U.S. Air Force Academy, Colorado

Monument Creek Watershed Landscape Assessment

Initiated by the United States Air Force Academy, the 2002 "Monument Creek Watershed Landscape Assessment" describes the desired future condition of that part of the Pikes Peak region (Colorado Natural Heritage Program, 2002) from a landscape perspective. In following the goals of the plan, its authors anticipate a future watershed that would be characterized by the following future conditions.

Future condition of biological resources

Vegetation

1. Fundamental structures and ecological processes will be reestablished and maintained across landscape.

2. Plant habitat will be protected and restored.

3. Plant species composition and populations will be maintained.

4. Weeds will be controlled to mitigate potential impacts to native systems and habitats.

Wildlife

5. Wildlife habitat will be protected and restored.

6. Wildlife species composition and populations will be maintained.

7. Movement corridors and linkages will be established to encourage movement among populations and genetic diversity.

Rare and /or Imperiled Plants, Animals or Communities

8. Enhanced efforts will be made to restore imperiled populations or protect critical habitat.

Future condition of the physical domain soils

9. Efforts to mitigate against soil loss and associated impacts on landscape scale will be made.

Hydrology

10. Fundamental hydrologic regimes and processes will be reestablished on watershed scale.

Slope

11. Issues related to slope will be addressed on a watershed scale.

Future condition of the social domain

12. Opportunities for local economic development of sustainable extractive industries will exist.

13. Viewsheds will be maintained.

14. The amount of open space will be increased within the watershed.

15. The region will be managed under the auspices of regional and multi-jurisdictional planning efforts that include participation from a broad range of stakeholders, resource managers and public officials.

16. Development and population growth will occur under a comprehensive understanding of socio-economic needs, the importance of high quality habitat and the needs of the community for the long-term.

17. Recreational opportunities will be expanded under a system more sensitive to diverse public needs, balanced with needs to conserve resources, maintain wildlife habitat, viewshed, and watershed.

INFORMATION RELEVANT TO PROJECT-LEVEL ANALYSIS

Some readers may be using this report because they are preparing documents required by the National Environmental Policy Act (NEPA). Table 2-1 relates more traditional NEPA topics with the six key indicators identified in this study. Due to the interrelated nature of these indicators, not all pertinent discussion is included solely under one heading.

Table 2-1. Key Indicators versus NEPA topics

If you are looking for discussion about these issues traditionally addressed in National Environmental Policy Act (NEPA) documents…	**…the principal place to look in this report is under this topic:**
Land use	Landscape pattern
Traffic	Traffic pattern
Air quality	Air quality
Noise	Noise
Farmlands	Landscape pattern
Section 4(f) / 6(f)	Landscape pattern
Ecology	Landscape pattern
Threatened or endangered species	Landscape pattern
Wetlands	Landscape pattern
Floodplains	Landscape pattern
Hydrology	Landscape pattern Water quality and quantity
Water Quality	Water quality and quantity
Senate Bill 40 (Wetlands approval by the Colorado Division of Wildlife)	Landscape pattern
401 Permit (Clean air)	Air quality
402 Permit (Clean water)	Water quality and quantity
404 Permit (Wetlands)	Landscape pattern
Visual	Visual quality

2-A. LANDSCAPE PATTERNS

"In communities across the nation, there is a growing movement to improve development patterns and practices. Concerned by recurring problems, such as loss of open space, neglected infrastructure, growing commutes, and disinvestment in existing communities, many are turning to smart growth for new solutions."
—Smart Growth at Work, Carlton Eley and Javier Vélez-Arocho, 2000

"The Comprehensive Plan provides positive guidance by presenting a framework for creating livable, walkable neighborhoods, attractive and accessible shopping areas, conveniently located schools, parks, and public spaces, dynamic centers for employment, and a network of natural areas and greenways."
—Comprehensive Plan, City of Colorado Springs, 2001

WHAT ARE LANDSCAPE PATTERNS AND WHY ARE THEY IMPORTANT?

Landscape patterns refer to the type, size, arrangement and use of parcels of land. The arrangement of landscape components is critical from both a biological and human perspective. Appropriate landscape patterns can help sustain quality of life and biodiversity because people need access to such places as offices, schools and grocery stores. Wildlife need habitat areas for eating, finding cover, movement and reproduction. If the needed resources are not accessible, life can be hard or impossible.

Measurable indicators of landscape pattern. (What to look for in gauging what is happening to landscape patterns across the Pikes Peak region).

Changes in acreage (by watershed) of significant habitat types. Especially wetlands, riparian areas, forest and shortgrass prairie. Are these areas increasing, decreasing, or staying the same?

Analysis of patches and other structural components of the landscape.

Changes in the numbers of species of special concern, including federal and state listed plant and animal species.

Average distance from residences to open space or a public park.

In this section, changes in landscape patterns and processes in the study area are reviewed. We will look at landscapes in the study area from 1955, present day (circa 2000), and, in some cases, the future (2025). The impacts of the four proposed projects on future landscapes also will be assessed. There are desired future landscape conditions that are needed to maintain biodiversity and quality of life. We have used a conceptual model to help guide strategies for achieving these desired future landscapes.

Finally, in order to plan for desired landscapes, we need to understand both the natural and anthropogenic (man-caused) processes that shape land patterns. Some of the more important processes are highlighted below.

LANDSCAPE HISTORY AND PROCESSES IN THE STUDY AREA

Landscape processes are a series of factors that alter and shape natural communities and human environments. Important historical processes in the study area include prairies and forest fires, flooding, bison herds, drought and insect infestations. Theses natural processes affected landscape properties almost exclusively before human settlement (Figure 2-1).

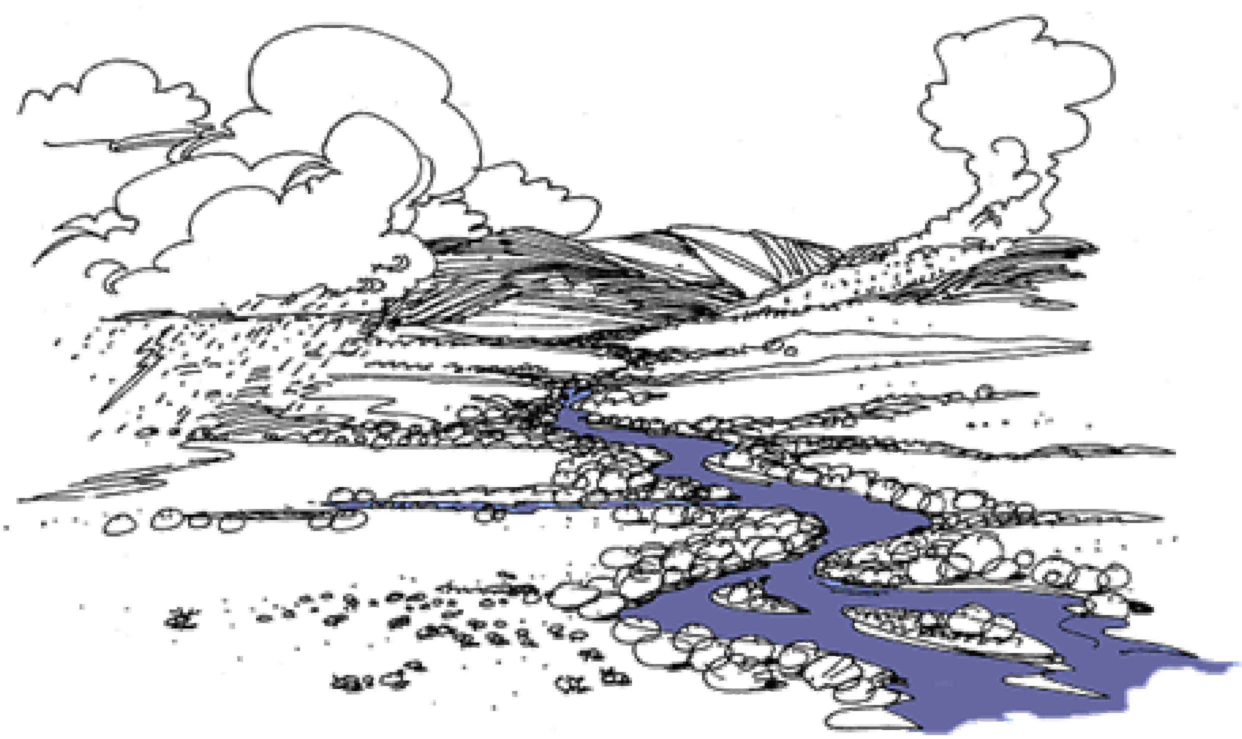


Figure 2-1. Before communities developed in the region, natural processes determined the patterns across landscapes.

Plants and animals co-evolved with those patterns and disturbances, and often became dependent upon them. For example, cottonwood seeds only will regenerate after flooding exposes bare, moist sand or point bars on streams and rivers.

Early development, in general, was sparse and not as intensive as today. Such development was less likely to affect the dynamics of nature (see Figure 2-2). Before large numbers of people lived in the region, most areas (e.g., rangeland and forests) were relatively unchanged, and development was limited and concentrated.

A major exception was mineral mining, which had a significant impact on montane riparian areas in the middle and late 1800s. Mining affected many of the nearby forest ecosystems by intensive logging for mine timbers, smelting and rail development. Communities then developed to support these activities, both in the mountains and along the Front Range (e.g., Colorado City, now the west side of Colorado Springs).

Later, fire suppression was implemented to protect commercial interests and residential developments. Historical fire suppression has now resulted in thick, even-aged stands that are susceptible to catastrophic fires.

In addition to fire suppression, attempts also were more frequently made to control flooding and other disturbances and to “freeze” desired human-created landscape patterns. Streams were channelized and dammed, and wildfires suppressed. These efforts were costly and tended to exacerbate situations when a large flood or fire came along, but were viewed as appropriate ways of keeping nature otherwise under control.

Anthropogenic resource management has changed the structure and function of natural communities. For example, a naturally curving stream dissipates water energy. Water in a straightened, channelized stream flows faster and will cut down through the channel bed, lowering the alluvial water table and affecting streamside vegetation. Prairies were grazed and farmed, reducing native biodiversity and resulting in native shortgrass prairie remnants on non-arable lands. Fires were suppressed in these communities as well.

Predators and other species (including the coyote, fox, grizzly bear and timber wolf) were hunted, some to extinction. This changed the mix of wildlife species, which in turn affected vegetation communities. For instance, with the removal of large predators, herds of elk and deer have increased above historic levels, and grazing/browsing pressures have increased on native vegetation.

Another example of a natural community that has been profoundly affected by human intervention is riparian zones and wetlands. People and wildlife have always needed water and in the arid west, both have always been attracted to riparian areas for water, as well as other resources. The early settlers of Colorado often built in or near riparian zones, and this development pattern continues today.

Additionally, it is estimated that riparian areas are used for at least part of the year by 73% of the state’s wildlife species (Colorado State Parks, 1998). This attraction of people has created substantial impacts to riparian zones and wetlands throughout the west, as well in the Pikes Peak region, and inevitably wildlife has suffered because of these changes. A more detailed discussion of riparian areas is given in the following section.

WETLANDS AND RIPARIAN ZONES

Riparian and wetland areas are found in areas affected by increased water availability. We've all seen riparian areas. In El Paso County, the riparian areas are the "green belts" associated with streams or lakes and contain plant species such as willows, cottonwoods, cattails and sedges. Wetland areas differ from riparian areas in that they are generally wetter for a longer time period during the growing season and often Wetlands and riparian areas are widely recognized for the significant and diverse roles they play in the landscape. They are considered valuable to humans because they clean the water, recharge water supplies, and reduce flood risks among other functions. In addition, riparian areas and wetlands provide recreational opportunities, aesthetic benefits, research and education sites, and wildlife habitat. The capability of a wetland or riparian area to perform one or more of these functions can be affected in whole or in part by a range of activities (Table 2-2). Predictably, the increased availability of water, increased humidity, more shade, high vegetative production and diversity, as well as other factors cause these areas to receive a disproportionate amount of use by wildlife, livestock, and humans. This has led to tremendous losses of riparian areas and wetlands in the past.

Direct Impacts to Wetland/Riparian Areas
Deposition of fill material (e.g., rip-rap); dredging and stream channelization; tilling for crop production; levees; diking and damming; logging; mining; construction/development; grazing by domestic animals; roads/highways
Indirect Impacts to Wetland/Riparian Areas
Drainage; increases or decreases in runoff volumes; Introduction of nonnative plant species (e.g., noxious weeds); water pollutants (e.g., sediment, nutrients, heavy metals, etc.); increase in noise levels; changes in water pH

Table 2-2. Selected examples of the types of direct and indirect impacts that typically affect riparian and wetland areas. (Adapted from www.epa.gov/owow/wetlands and www.ecosystemvaluation.org.

It is estimated that in the 1600s, there were 220 million acres of wetlands in the area now comprising America's "lower 48" states. By 1997, that number had plummeted to 105.5 million, a loss of 52% of the wetland area. Similarly, from the 1780s to the 1980s, it's estimated that half of Colorado's wetlands were lost (Mitch and Gosselink 2000). Currently, wetlands are estimated to occupy approximately 0.5% to 1.5% of the western U.S. landscape (Cooper 2002).

Most direct impacts to riparian areas are typically offset by compensatory mitigation due to regulatory requirements in Section 404 of the Clean Water Act. However, it is the indirect and ultimately, the cumulative effect of all impacts to riparian resources that threatens their sustainability. For example, excessive sediment loads in runoff water can lead to changes in streambed morphology, loss of aquatic habitat, reduction in storage capacity of reservoirs, and loss of aesthetic value. Conversely, increases in impervious surfaces, which increase runoff volumes entering streams and rivers, can increase stream power, or its ability to move sediment. Impervious surfaces also reduce the surface area available for precipitation to infiltrate soils and ultimately to recharge local aquifers.

Impacts to riparian areas have occurred since the region was first settled and water was diverted for irrigation. Indeed, water diversions continue to impact riparian areas in the region even though some riparian areas carry more water for longer periods of time today than they did historically. Though subtler, this too can be considered an impact to these systems.

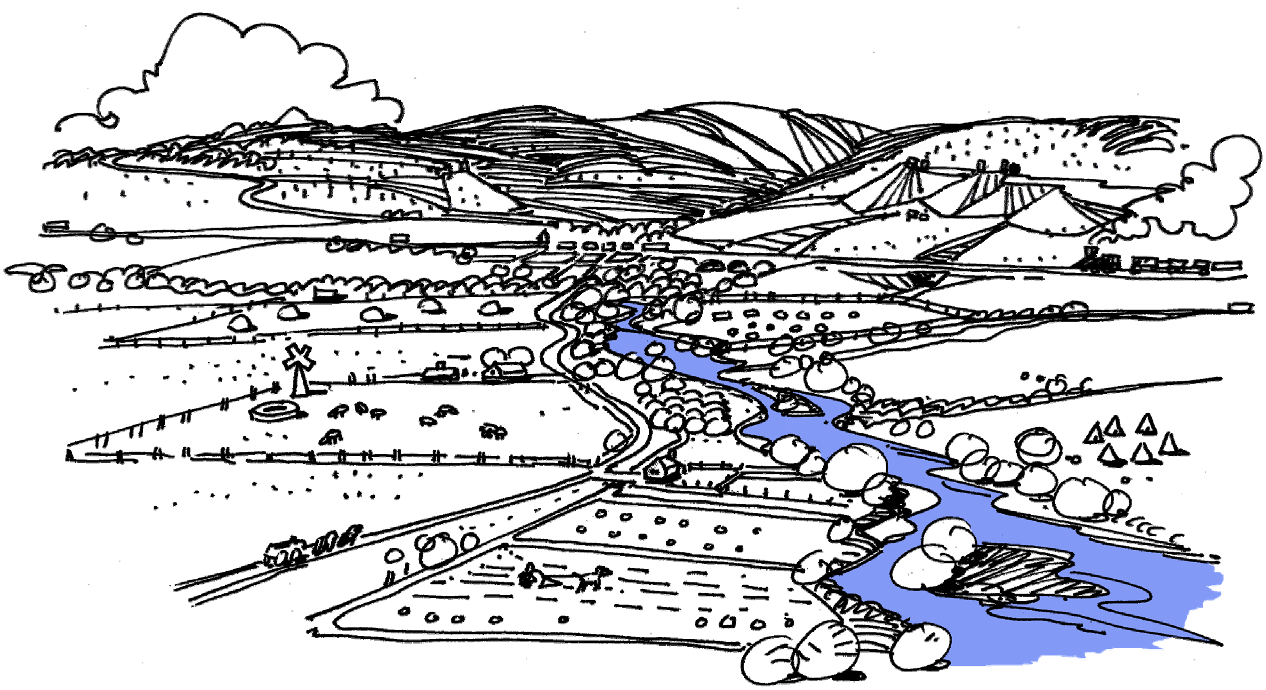


Figure 2-2. With settlers on the scene, attempts were more frequently made to control flooding, fires and other disturbances and to control and stabilize desired, often human-created landscape patterns.

Figure 2-3. Modern urban forest. View eastward over the I-25 crossing at Uintah Street. The large buildings in the upper right of the photo are part of the Colorado College, which was established in 1874. Dense summer foliage in this view hides the adjacent neighborhoods.

LANDSCAPES TODAY ARE FREQUENTLY FRAGMENTED BY ROADS AND OTHER LAND USES

Rapid growth and development trends since World War II have resulted in low density, suburban land use patterns or sprawl, which spreads the impacts of development more broadly across the region (Figure 2-5.) With sprawl comes more automobile use because development is spread out and not easily served by public transportation. More automobile use means more air and water pollution, more widespread infrastructure and more time spent in a car. This represents a degraded quality of life for many people. Gasoline, insurance and automobile maintenance costs contribute to a greater cost of living, thereby degrading quality of life even more.

Roads, in particular, have had an impact on the landscape, fragmenting natural areas and neighborhoods. These effects on natural systems include:

- direct loss of habitat;
- habitat fragmentation;
- degradation of habitat quality (e.g., introduction of exotic plants, air pollution, noise and contaminated runoff), which can extend for several hundred feet from the roadside;
- direct killing of wildlife by impact (road kill);
- road avoidance by wildlife due to aversion to noise and human activity;
- increased human access, which can lead to over hunting and poaching;
- reduced access to important habitat (e.g., summer and winter ranges, breeding sites, etc.);
- population fragmentation, leading to smaller populations that are more susceptible to genetic changes resulting from genetic drift or inbreeding, and extinction from single events (Jackson 1999).

Effects of highways and other roads on neighborhoods include:

- Loss of landmarks
- Degraded neighborhood identity
- Loss of community cohesion
- Interruption of local traffic flow within neighborhoods
- Increased noise

Figure 2-4. A sea of rooftops fills the vista east of Powers Boulevard on the fast-growing east side of Colorado Springs. These neighborhoods lack mature trees that would soften their stark visual impact.

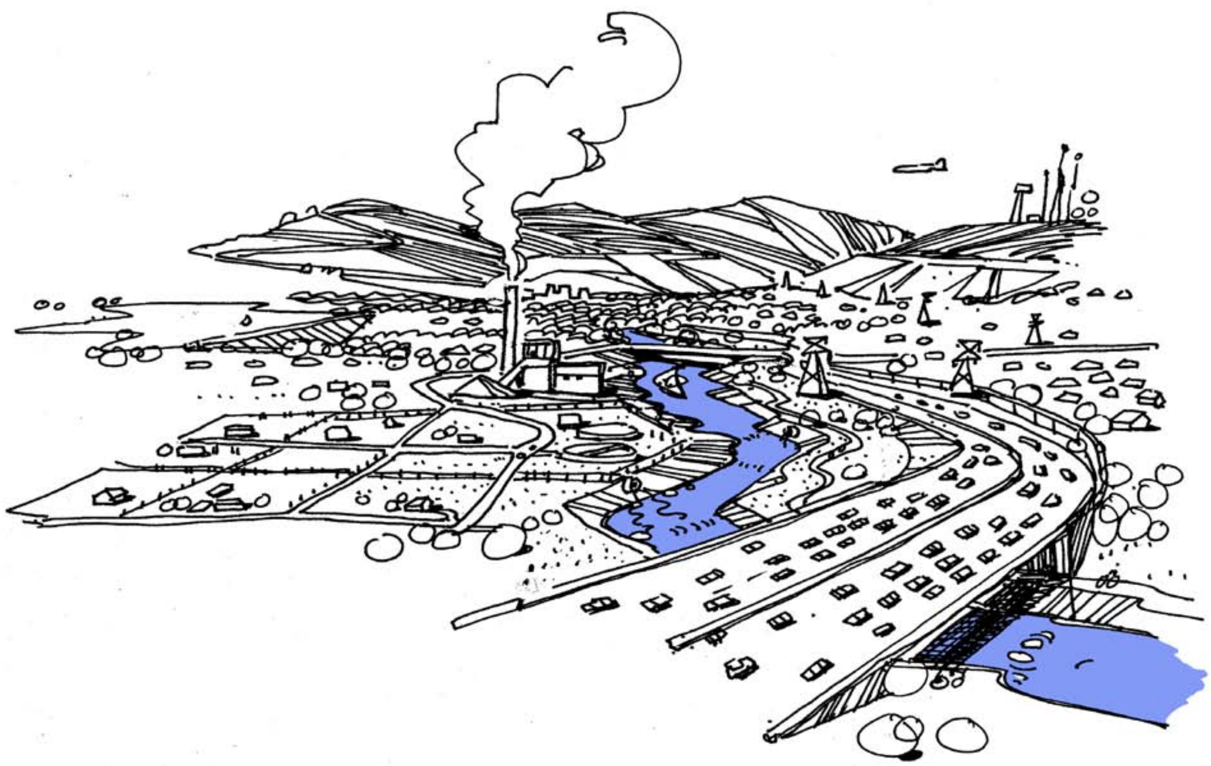


Figure 2-5. Rapid growth has resulted in sprawl, spreading development impacts more broadly across the region. Among other things, the increased area of impervious surfaces associated with new development and attendant roads has reduced water quality and increased the quantity of water reaching streams.

SPRAWL AND 35-ACRE DEVELOPMENT

Many parts of Colorado, including the Pikes Peak region, have seen extensive development of 35-acre lots because 35 acres is the 1972 statutory threshold above which development is exempted from subdivision requirements. In the last five years, 33% of all existing 35-acre parcels in El Paso County have been created. As seen in Table 2-3, parcels of this size add up to 200 square miles in El Paso County. By comparison, the City of Colorado Springs contains about 186 square miles, 40% of which is undeveloped.

ALTERED HYDROLOGY

Altered hydrology can lead to profound changes in ecological functions. Hydrological changes occur due to increased development because of growth in impervious surfaces. These surfaces prevent water from being adsorbed by the ground, causing greater amounts of run-off. More impervious surface increases the quantity and contamination of water reaching streams and drainages, thereby reducing water quality.

Another common scenario of many urban streams across the nation is for streams to downcut (Groffman et al. 2003, Paul and Meyer 2001), or become more gully-like as a result of the increased run-off. When incision occurs, one of the consequences is a drop in the riparian groundwater table, termed by Groffman et al. (2003) as 'hydrologic drought', which affects the ability of the existing riparian vegetation to persist (Figure 2-6). Downcutting also severs the connection between streams and their adjacent floodplains.

The loss of the floodplain not only impairs the health of the riparian area, but also its ability to provide many of the functions valued by humans (e.g., flood control, water quality improvement, etc.). These types of indirect impacts affect us all in the long run and become of greater concern and importance as more and more land is converted into roads, sidewalks, rooftops, and parking lots.

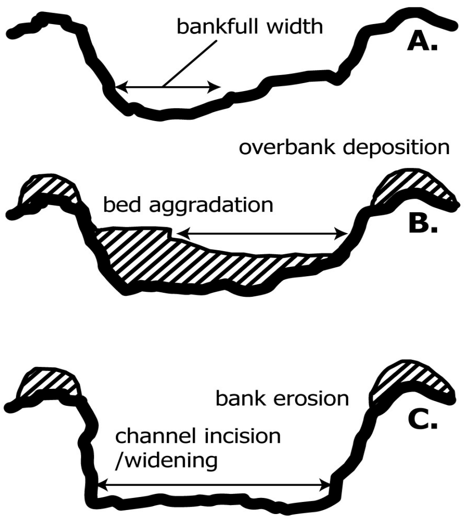
WEEDS

A relatively new but very important agent of change for landscape-level ecological functions is the spread of invasive weed species. Because vehicles and water are two of the most common methods by which noxious weeds are spread, both road construction and changes in hydrology are connected to the spread of weeds.

Roadsides, parking areas, construction zones, trails, irrigation ditches and stream banks are subject to frequent disturbance. Disturbance often results in soil exposure, creating favorable conditions for noxious weed establishment. Vehicles and water

Time Period	Number of 35-50 acre parcels	Acres in these parcels	Square miles in these parcels
Pre-1987	1,243	48,098	75.2
1987-1991	411	15,904	24.9
1992-1996	561	21,708	33.9
1997-2001	1,098	42,487	66.4
Total	3,313	128,197	200.4

Table 2-3. Thirty-five to fifty-acre parcels created in unincorporated El Paso County. Adapted from "Forty - Acre People," Carl F. Schueler, December 2002. Planning Matters, the newsletter of the Colorado Chapter of the American Planning Association. From www.apacolorado.org.



Pre-development

Aggradation Phase
- hillslope erosion is largest sediment source
- width-to-depth ratio may increase or stay constant
- cross-sectional area increasing

Erosional Phase
- channel erosion is largest sediment source
- width-to-depth ration increases eventually
- cross-sectional area increased to accommodate larger bankfull discharge

"Stream channels are changed by nearby urbanization. Pre-development a stream cross section might look like that shown in (A). During construction (B), hillslope erosion results in a greater quantity of sediment in the stream being deposited in the streambed and along the banks. While there are much smaller amounts of sediment reaching the stream after construction is finished (C), there is more water entering the stream because with urbanization comes more impervious surfaces and more run-off. These increased channel flows result in an incising and widening of the channel, which makes for increased channel erosion. (From Paul and Meyer, 2001.)"

Figure 2-6. Increased stormwater runoff due to development, has resulted in stream downcutting and erosion.

intersecting these disturbed sites become carriers for transporting weed seed and may infect new areas many miles away.

Noxious weeds impair ecological process because they out-compete native species, yet often provide little food or shelter for native wildlife. Additionally, some noxious weeds consume enough water to lower water tables or are poisonous to live stock and grazing wildlife. Some species of weeds have already become serious pests in El Paso County. A collaborative strategy for fighting the spread of weeds is given at the end of this chapter.

EVOLUTION OF THE BUILT ENVIRONMENT

This chapter is primarily focused on changes in landscape patterns and subsequent effects to the natural environment, but changes also are happening concurrently to the built environment.

Change to the built environment occurs in response to natural causes, community growth, economic changes and ever-improving construction technologies. In Colorado Springs, the first Antlers Hotel (built in 1881) burned down in 1898 following a dynamite explosion on the railroad behind it. The second Antlers Hotel was built in 1901 and was demolished in the late 1960s. The third and current version of the Antlers Hotel is more modern in construction, better meeting the needs of its owners and guests. Will this hotel someday be an historic structure worthy of preservation, or will it become economically obsolete and be replaced again?

Not all old buildings are worth preserving, but many that should be preserved instead get demolished. At the national level, guidance for identifying important historic resources has been developed in conjunction with the National Historic Preservation Act, passed by Congress in 1966 in recognition of the "ever-increasing extensions of urban centers, highways and residential, commercial and industrial developments." Federal agencies are required to consider and take prudent steps to avoid adverse impacts to historic resources. Local governments and private property owners are not required to be so careful.

Figure 2-7. On Pikes Peak Avenue, a home constructed in 1900 has as its neighbor a 1960s office building.

Most of the oldest buildings in Colorado Springs are located in the downtown area where the city started. After being founded in 1871, the City had expanded to a total of just less than 7.5 square miles by the year 1900 (compared to 186 square miles in 2002). Growth in the region was slow until World War II, when Camp Carson was established south of the city.
In the decade from 1950 to 1960, the population of El Paso County doubled, increasing by nearly 70,000 residents, and since that time, it has increased every decade by approximately 70,000 to 100,000 residents. The additional population has created more demand for goods and services, raising property values and creating pressure to use downtown land more intensively (including the need for more parking spaces for the intensified land uses). See Figure 2-7.

In an extensive December 1999 article entitled "Ghosts of Colorado Springs Past," Hazelhurst noted that in Colorado Springs, "historic buildings, even entire neighborhoods are often acquired by institutions and allowed to deteriorate, are moved or are simply demolished." He cited a list of examples, including:

- The second Antlers Hotel and the Burns Opera House in the late '60s;
- In the 70's, several dozen Victorian commercial buildings downtown along Colorado, Costilla and Cascade ("creating drab parking lots which were eventually replaced by drab, international-style buildings").
- In the 1980's, the viable, if shabby, historic working-class neighborhood that surrounded Lowell School with a grandiose public-private development.

More recent losses cited in the article include:

- All of the houses between Mesa and Monument Streets, on the west side of Cascade Avenue
- Nearly 200 houses on the west side of I-25, between the Uintah and Bijou Street exits, condemned for widening
- Half a dozen houses bordering the Colorado College campus, either moved or razed to clear the ground for implementation of the college's new master plan.
- More than 20 houses moved or razed to make room for the expansion of Penrose Hospital during the last two decades.

The article also listed a number of historic properties at risk, as well as a number of historic preservation success stories: "Over the last two decades, individual homeowners and small-business people have seen to the preservation, restoration, or adaptive re-use of thousands of historic structures in the Pikes Peak region."

One important step for historic preservation occurred just north of Colorado College. The Old North End Neighborhood obtained from the City a Historic Preservation Overlay designation intended to slow down or stop the loss of the neighborhood's historic and residential character.

Somehow, not mentioned in the article is a statue of City founder General William Jackson Palmer on horseback, located in the middle of the intersection of Nevada and Platte avenues downtown. This statue is depicted in Figure 2-8. At the time of its placement, this was the intersection of federal highways 85 and 24, indeed the most prominent intersection in town and by Council order was to remain in perpetuity until such time as the people in a general election should vote to remove and place it in an equally prominent location.

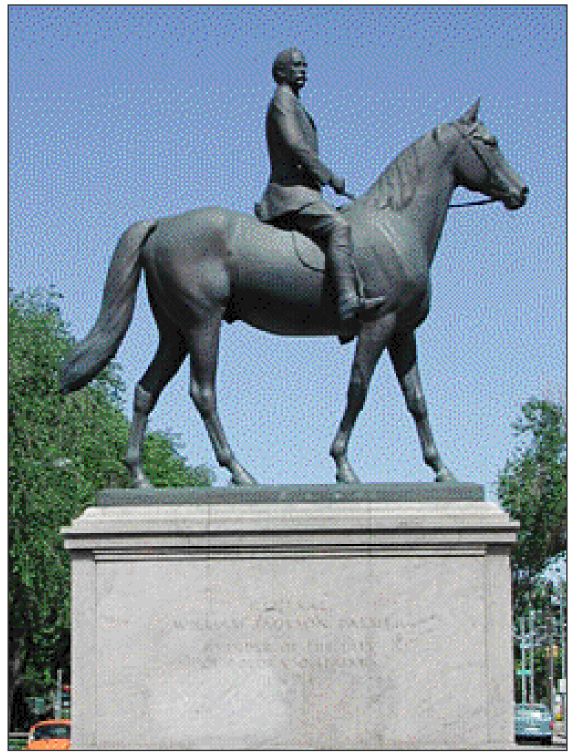


Figure 2-8. Statue of General William Jackson Palmer at the intersection of Nevada and Platte.

Today, the Palmer statue is controversial because it impedes driver vision, especially for left turns. Preservationists want the statute left in place while others with traffic flow and safety priorities urge it be relocated. Even as downtown has drastically changed over the decades, the statue has not moved and remains as the City's best known symbol in the struggle between growth and historic preservation.

WHAT IS THE DESIRED LANDSCAPE CONDITION?

Harvard landscape ecologist Richard Forman (1995) suggests that the optimal arrangement of land uses in a landscape—the most sustainable—may be found by applying his aggregate-with-outliers principle. This principle states: “One should aggregate land uses, yet maintain corridors and small patches of nature throughout developed areas, as well as outliers of human activity spatially arranged along major boundaries.”

As shown graphically in Figure 2-9, this model suggests that there should be major, separate blocks of development, natural areas, and agriculture. With this aggregation into larger blocks, each of these land use types can typically function more effectively than in smaller blocks.

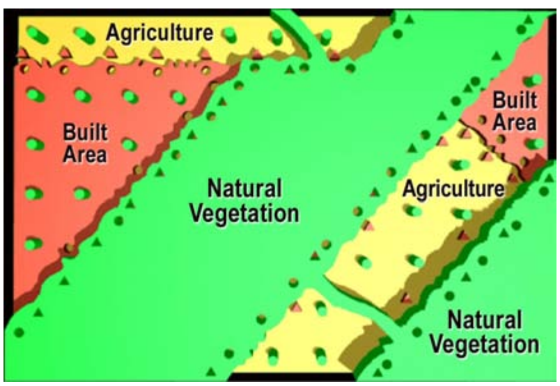


Figure 2-9. The aggregate-with-outliers principle suggests that generally land uses should be aggregated, but corridors and small patches of nature should also be maintained throughout developed areas, as well as outliers of human activity spatially arranged along major boundaries (Forman 1995).

For example, for protecting many—though not all—aspects of biodiversity, large patches of natural areas are very important. The fragmentation and isolation of habitat is frequently cited as the major threat to biodiversity. Similarly, large areas devoted to agriculture typically function more efficiently than small, scattered farms. When mixed development is aggregated, people can walk to work and more easily get to schools, shops, places of worship, and offices.

But big blocks are not enough to satisfy all desired spatial relationships, and Forman’s aggregate-with-outliers model addresses this, too. For example, within blocks of development, it is important to have areas of nature (i.e., open space) and agriculture (i.e., gardens) for people to enjoy. Some wildlife species prefer small areas of specialized habitat or require stepping stones of habitat between large blocks (note the outliers in Figure 2-9).

Even within large blocks of natural areas, it may be important to have carefully sited places for people to camp, hike or even live. The Forman model suggests that outliers of nature should be located throughout both developed and agricultural areas. In natural areas, however, outliers are more appropriately located near boundaries with other types of land uses, where they contribute less to the perforation of the large habitat blocks. Preserving movement corridors is also a part of the model. People need to move between blocks of development, as wildlife needs to move between blocks of habitat.

Following this approach, sprawling development would be discouraged because it can create landscape patterns that are less efficient and effective for both people and nature.

The overall approach of the Forman model is consistent with the Comprehensive Plan of the City of Colorado Springs, with its emphasis on a regional perspective and aggregated land uses.

MAKING DECISIONS BASED ON THE MODEL

Models like Forman's, however, are very general and do not reflect the specifics of any one place. Also, such models typically describe idealized relationships that might only be achieved if starting from scratch. Still, in the Pikes Peak region there are newly developing areas where these concepts can be applied directly.

For the major transportation improvement projects now undergoing environmental study, examining the Forman model suggests that reducing the barrier effect of the transportation corridors to the degree possible is paramount. This could be accomplished by finding ways of maintaining the integrity of neighborhoods and other adjacent areas that form blocks of development that otherwise would become disconnected and potentially isolated.

Also important is reducing how much a transportation corridor creates a barrier between large natural areas between which wildlife have traditionally moved. For example, given the regional significance of large open spaces, it is probably better to avoid such open areas as potential transportation corridors where possible. If such areas cannot be avoided, then it may be better to align a road corridor along the boundaries of such an area, rather than disturb its interior.

Without planning and actions based on a pattern-sensitive, regional perspective, such as Forman's model provides, cumulative impacts are more likely to diminish the quality of a region.

New transportation projects, inappropriate development, and incompatible land uses can degrade neighborhoods or natural systems when they:

- displace or degrade needed resources (e.g., when a neighborhood park or a prairie is replaced by development)
- break or degrade connections between needed resources or habitats (e.g., access to a nearby neighborhood or community center is lost or made difficult for residents, or wildlife access to a watering hole is severed by development).
- turn large blocks of resources into smaller, less useful fragments (e.g., when a large prairie block is cut into smaller areas that are not large enough to sustain pronghorn antelope or other species, or when parts of a neighborhood are separated from the rest of the neighborhood).

With such changes it is harder to sustain biodiversity (with more sensitive species disappearing first), although the new conditions may encourage certain, more common or exotic species that are more tolerant of human intrusion and modified habitats. Such species include magpie, starling, jay, raccoon, coyote, red fox, and skunk, as well as feral cats.

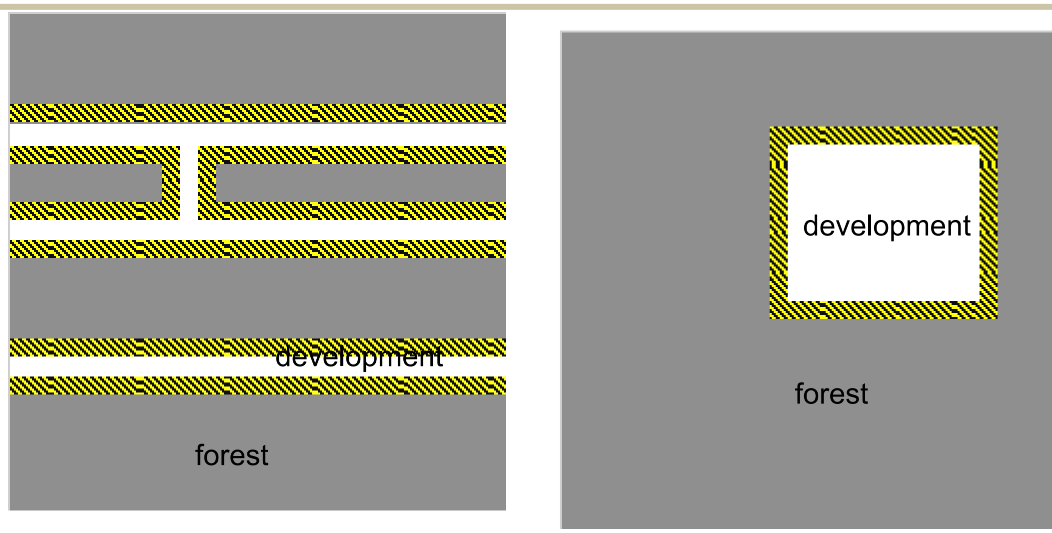
With these changes it is also harder to sustain the quality of life people desire because they find it harder to get to the resources they want, they may pollute air and water more in traveling greater distances, and increased development can degrade the visual environment.

On the other hand, carefully planned changes in landscape pattern can minimize or even improve the way a landscape functions for people and nature.

ROAD EFFECTS ON WILDLIFE AND LANDSCAPE PATTERN

Road density and pattern often affect wildlife populations. The specific effects on a particular species are dependent on several factors, such as the behavioral response to the road, habitat needs, and movement ability. Most species require multiple types of habitat patches, arranged in such a way that the organism has access to all needed areas for survival. The number of roads in an area (road density) and the placement of roads may both have cumulative impacts. Both the placement of new roads and additional development of existing roads usually reduce natural habitat patches adjacent to the road (see Figure 2-10). For many species, the full effect of the road on a local population may be many years removed from the impact (in some cases, by 30 to 40 years, from Forman et. al., 2003).

Figure 2-10. Loss of forest interior habitat due to road and block development.



EXAMPLE A – Fragmented

EXAMPLE B – Large Patches

Key:

Grey	=	*forest interior*
Yellow	=	*forest edge*
White	=	*development*

The amount of developed area is the same in both Example A and Example B.

A) Roads in forest where approximately 66% of the original forest-interior habitat remains,
B) Square block of development in forest where 84% of original forest interior remains in one large connected patch.

Source: Forman et al., 2003.

ANALYSIS OF LANDSCAPE CHANGE IN THE STUDY AREA

In an effort to understand the types of cumulative impacts the Pikes Peak region has experienced in the past and may experience in the future, an analysis of landscape pattern change within the study area was conducted.

The indicator of change considered was land-cover type and its potential associated impacts on biodiversity and quality of life. Three different analyses were conducted:

1. Past and present aerial photography of eight sites in the study area were qualitatively assessed for change in the type and amount of each land cover class present.
2. The amount of existing land cover types that will potentially be impacted by the four proposed transportation projects was estimated, using a GIS-based analysis. Cover type change was then linked to impacts to sensitive species that may occur within the study area.
3. Additional past and current data from county records were assessed to determine land cover changes within the study area, including projected future changes. These data include statistics on land use change in three areas associated with proposed roadway projects and County-wide agricultural statistics.

ANALYSIS OF COVER TYPE CHANGE, 1955-2000

Eight sites, listed in Table 2-4, were selected for detailed examination to compare the change in land-cover type from past to present. Black-and-white aerial photography from 1955 was used to characterize past conditions. Current conditions were interpreted from satellite imagery taken in 1995.

Current conditions of each of the sites also were verified with field visits in August and September 2002. The eight comparison sites were selected in locations known to have undergone some degree of land cover change. However, the exact locations for analysis were randomly selected for most sites.

Table 2-4. Information on eight sites selected for analysis of land cover type change, 1955-2000.

Site	Type	Name	Location (distance from downtown Colorado Springs)
1	Agriculture	Ellicott South	South of State Highway 94 (25 miles east)
2	Agriculture	Ellicott North	North of State Highway 94; (24 miles east)
3	Forest	Black Forest	West of Meridian Rd at Ayer Rd (14 miles northeast)
4	Riparian	Dirty Woman Creek	At the I-25/State Highway 105 Interchange in Monument (19 miles north)
5	Riparian	Pine Creek	East of State Highway 83, near the I-25/ Briargate interchange (10 miles north)
6	Shortgrass Prairie	Myers Road	Along Myers Road, east of Black Squirrel Creek (25 miles southeast)
7	Shortgrass Prairie	Marksheffel Road	Near the Marksheffel intersection with Drennan Road, 2 miles east of the municipal airport; (7 miles east-by-southeast)
8	Urban	Woodmen Road	Near Dublin Blvd, south of Woodmen Road and west of Academy Boulevard (7 miles north)

Over 50 different land-cover classes were identified on 1995 satellite imagery analyzed by the U.S. Bureau of Land Management and Colorado Division of Wildlife. These classes can be aggregated into various ways, depending on the complexity of the data analysis. For example, Figure 2-11 depicts the data aggregated into 31 types.

These vegetation classes can be broadly lumped into seven categories: agricultural lands, riparian systems, shrublands, forested areas, shortgrass prairie, urban areas and "other." The "other" class is a catchall for land-cover types that did not fit the other six definitions. On the black-and-white aerials, it was not possible to distinguish shrublands from forest areas, nor was it possible to distinguish land-cover types that fit into the "other" category. Therefore, for the comparison of change from 1955 to 1995 images, only five land-cover types could be considered. All quantitative analyses of changes to cover types were based on the seven cover type classes. See Table 2-5 for descriptions of these cover types. In addition, there is a summary of the important community types in Appendix 2.

Table 2-5. Descriptions of the land-cover types considered in the analysis of land cover change, 1955-1995.

Vegetation Type
Riparian/wetlands riparian, forested riparian, shrub riparian, herbaceous riparian, cottonwood, willow
Forest ponderosa pine, ponderosa pine/Gambel oak, ponderosa pine/aspen, ponderosa pine/Douglas fir, ponderosa pine/mesic mountain shrub, Douglas fir, aspen, ponderosa pine/aspen/mesic mountain shrub, Engelmann spruce/fir mix, spruce/fir/aspen, Douglas fir/aspen aspen/mesic mountain shrub, bristlecone pine, limber pine, spruce/fir/lodgepole/aspen mix
Shortgrass prairie grass dominated, grass/forb mix, sparse grass, grass/cactus mix, grass/cholla cactus mix, sparse grass (blowouts)
Urban/Other urban/built-up, residential, commercial
Agricultural agricultural land, agriculture, dryland agriculture, irrigated agriculture
Shrublands Gambel oak, greasewood, mesic mountain shrub mix, mountain shrub mix, sagebrush community, sagebrush/grass mx, shrub/grass/forb mix
Other rock, water, talus slopes, alpine grass, barren, soil

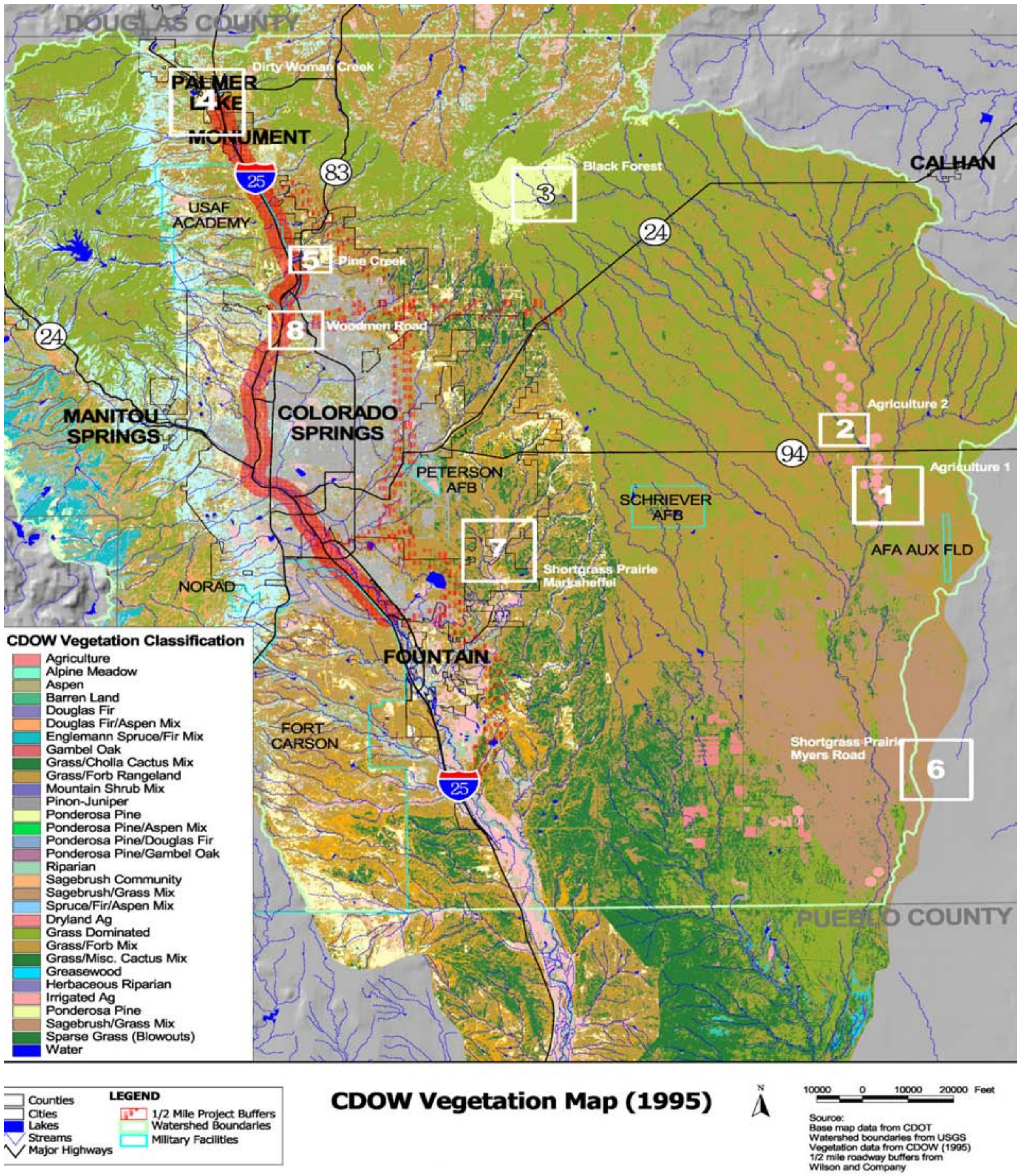


Figure 2-11. To understand better the specific changes in landscape pattern in the Pikes Peak region, eight sites were selected for more detailed examination. These sites are indicated in the map above as rectangles numbered 1 through 8. See Table 2-5 for acreages of each vegetation type. See sections for explanation of each of the eight sites.

The following section shows past (1955) and present (1995) aerial photographs/satellite imagery of eight sites in the study area and future projections of changes at three of those sites.

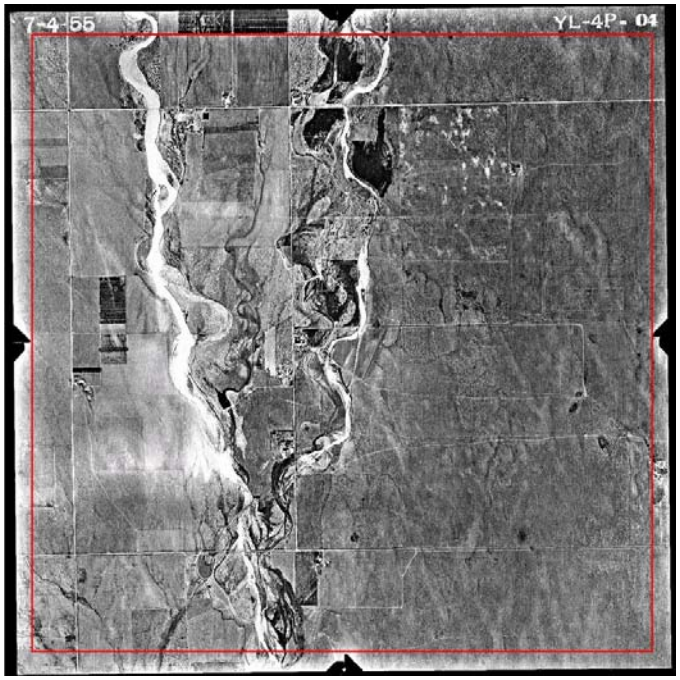


Figure 2-12. 1955 aerial photo of Site 1, Ellicott South.

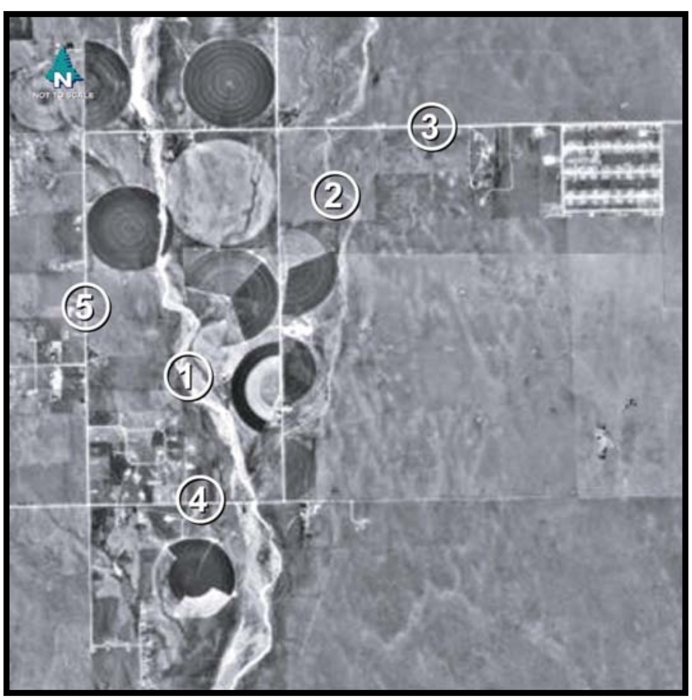


Figure 2-13. 2002 aerial photo of Site 1, Ellicott South.

Comparison Site 1

AGRICULTURE – ELLICOTT SOUTH

(two miles southeast of Ellicott): Small, quilt-work field patterns give way to large irrigation circles. This site is approximately 25 miles east of downtown Colorado Springs.

This section of land in eastern El Paso County currently includes several sod farms, but its western side contains a mixture of native grasses and weedy species. Much of the irrigated agriculture is located within parts of the drainages, such as Brackett Creek, which, in 1955, formed distinctive braided stream patterns.

Since 1955, ten full or partial center-pivot irrigation systems have been constructed. Now, much of the quiltwork field pattern shown in the 1955 photo is gone. The creek in the southern and northern section edges is composed of a dry, sandy wash.

Modern reference points:

1. Black Squirrel Creek
2. Brackett Creek
3. Big Spring Road
4. State Highway 94
5. Ellicott Highway

Figure 2-14. 1955 Aerial Photo of Site 2, Ellicott North 1955.

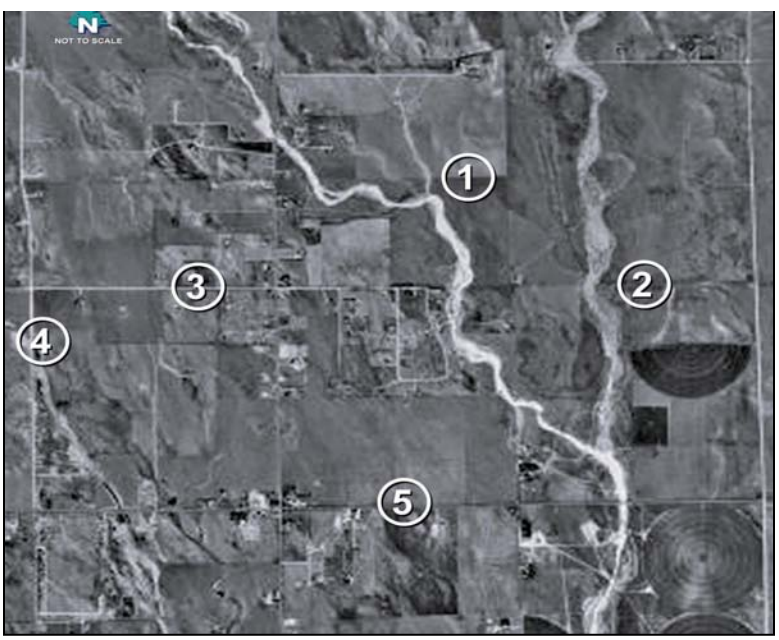


Figure 2-15. 2002 Aerial Photo of Site 2, Ellicott North.

Comparison Site 2

AGRICULTURE – ELLICOTT NORTH
(one mile north of Ellicott): Small, quiltwork field patterns gives way to rangeland. This site is approximately 24 miles east of downtown Colorado Springs.

From the 1955 aerial photo of this site (Figure 2-14) there was no irrigation in the area at that time. Since then, some of the small field patterns have disappeared.

The drainage system of today (See Figure 2-15) appears similar to that on the 1955 aerial photograph and is composed of a sandy wash bordered by several cottonwood trees.

This area currently is being used for livestock pasture, although some parts of it are being irrigated, including one central-pivot system.

Modern reference points:

1. Black Squirrel Creek
2. Brackett Creek
3. Big Spring Road
4. Ellicott Highway
5. State Highway 94

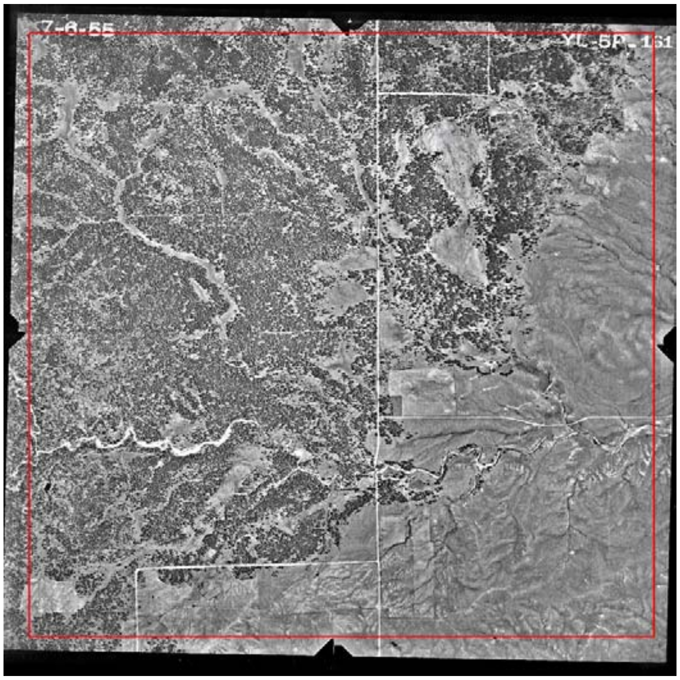


Figure 2-16. 1955 Aerial photo of Site 3, Black Forest. Ponderosa pine area (upper left) meets grasslands (lower right).

Figure 2-17. 2002 Aerial photo of Site 3, Black Forest.

Comparison Site 3

FOREST - BLACK FOREST (immediately west of Meridian Road, including Ayer Road): Trees replace grasslands in a dramatic increase in forest density and extent. This site is approximately 14 miles northeast of downtown Colorado Springs.

Comparing the aerial photos from 1955 and 1995 (Figures 2-16 and 2-17), there is a noticeable increase in density and area of ponderosa pine. This increase in forest cover is especially prominent to the south of Ayer Road and on the east side of Meridian Road, where trees have filled in many of the areas that contained open grassland in 1955.

Today, ponderosa pine occurs in open to relatively closed stands and in a wide range of sizes, from seedlings up to approximately 35 feet in height. The understory consists primarily of grasses, elk sedge and semi-woody forbs, as well as thickets of chokecherry and wild rose.

Note new residential road system northwest of Ayer Road (reference point #4).

Modern reference points:

1. Dawson Road
2. Meridian Road
3. Latigo Boulevard
4. Ayer Road

Figure 2-18. 1955 Aerial photo of Site 4, Dirty Woman Creek.

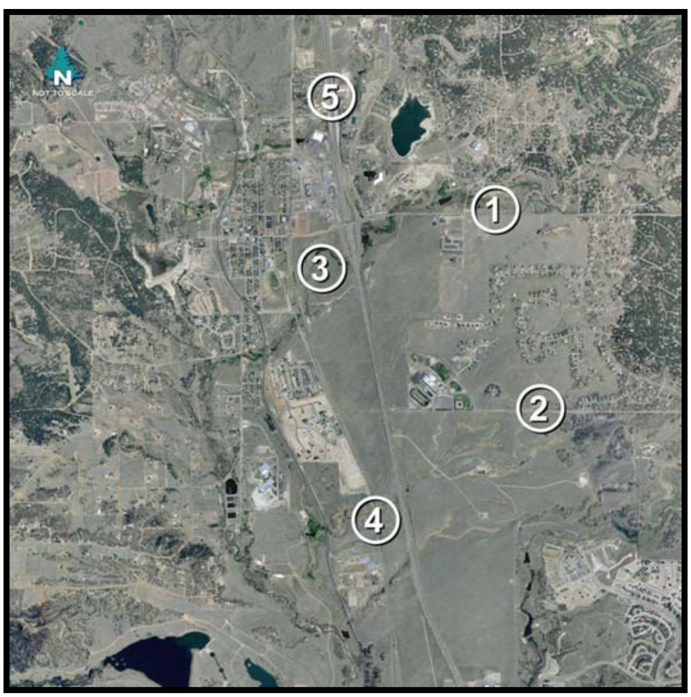


Figure 2-19. 2002 Aerial photo of Site 4, Dirty Woman Creek.

Comparison Site 4

RIPARIAN – DIRTY WOMAN CREEK
(immediately west of Meridian Road, including Ayer Road): Trees replace grasslands in a dramatic increase in forest density and extent. This site is approximately 14 miles north-east of downtown Colorado Springs.

Comparing Figures 2-18 and 2-19, the density and extent of riparian vegetation, with its 100 to 150-foot wide floodplain, appears to have increased during the 40 years between 1955 and 1995. The area covered by vegetation approximately doubled along a 6,550-foot reach from near Monument to the old railroad bed to the west. Several factors may be responsible for this riparian tree and shrub development, including reduced grazing and the development of control structures in the creek.

This area provides a diverse and productive habitat for a number of species, including the Preble's Meadow Jumping Mouse, which is federally listed as threatened. The vegetation currently consists of a tree canopy of large (to 50 feet tall and approximately 30 inches diameter at breast height) crack willow and peachleaf willow, with sandbar willow shrubs below. The canopy cover was from 70% to 80% but has been significantly reduced in the past few years by beavers (1999-2003). In and near the active channel, the willows are replaced by dense stands of broadleaved cattail and sedges. Adjacent upland grasslands contain an infestation of knapweed, a noxious weed.

Modern reference points:

1. State Highway 105
2. Higby Road
3. Dirty Woman Creek
4. Old Denver Highway
5. Interstate 25

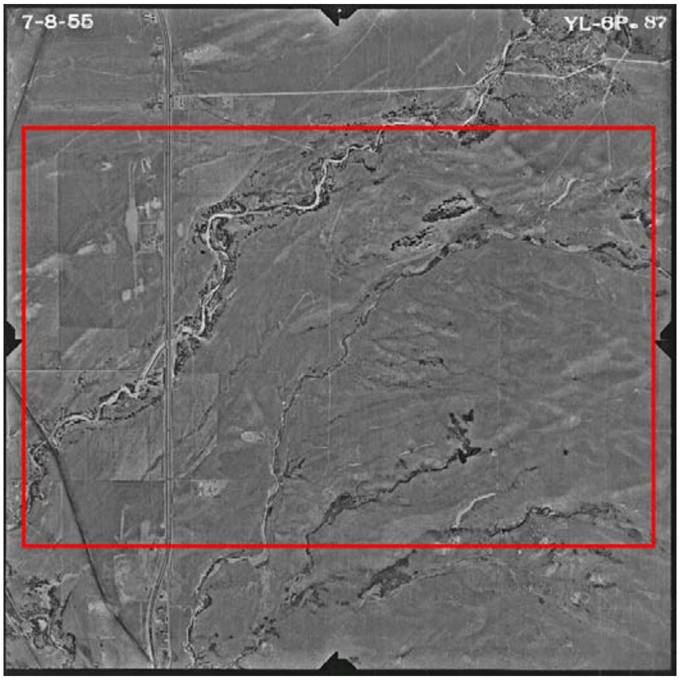


Figure 2-20. 1955 Aerial photo of Site 5, Pine Creek.

Figure 2-19. 2002 Aerial photo of Site 5, Pine Creek.

Comparison Site 5

RIPARIAN – PINE CREEK
Denser and more extensive riparian vegetation. This site is 11 miles north of downtown Colorado Springs.

This area was undeveloped at the time the U.S. Air Force Academy was being constructed (Figure 2-20), but now is largely developed (Figure 2-21). Pine Creek currently contains dense riparian shrub areas that are difficult to detect on the 1955 aerials. The riparian vegetation has apparently become more prominent since 1955. The riparian area near Highway 83 is approximately 30 to 40 feet wide and dominated primarily by sandbar willow. There are infrequent peachleaf and crack willows, roughly 20 to 30 feet tall. Willow species indicate that the stream is in early successional stages.

Although willows may have increased on the stream edges since 1955, the Preble's meadow jumping mouse population here is extremely small, with at least two known populations on Pine Creek that have become fragmented because of habitat barriers. Other prominent species included broadleaf cattails and bulrush at the edge of the active channel. Other less abundant species include curly dock, Canada thistle, prickly lettuce, duckweed and water speedwell. Such species are indicative of controlled or low-flow regimes.

The active channel is 10- to 15-feet wide and contains a slow, shallow flow. The creek contains several concrete drop structures to help control flows, but the stream is somewhat incised in this area. Planned development in the Pine Creek watershed will continue to reduce the amount of natural land cover.

Modern reference points:

1. Old Ranch Road
2. Railroad
3. Kettle Creek
4. Santa Fe Railroad
5. Interstate 25
6. Old Denver Highway

Comparison Site 5

RIPARIAN – PINE CREEK

(Continued)

Three of the eight sites used for land use comparison are within Colorado Springs city limits, and therefore have planned future land use designations in the City's 2001 Comprehensive Plan. These are comparison sites #5 (Pine Creek), #7 (Marksheffel Road), and #8 (Woodmen Road). Shown below from the Comprehensive Plan is an except for site #5, Pine Creek.

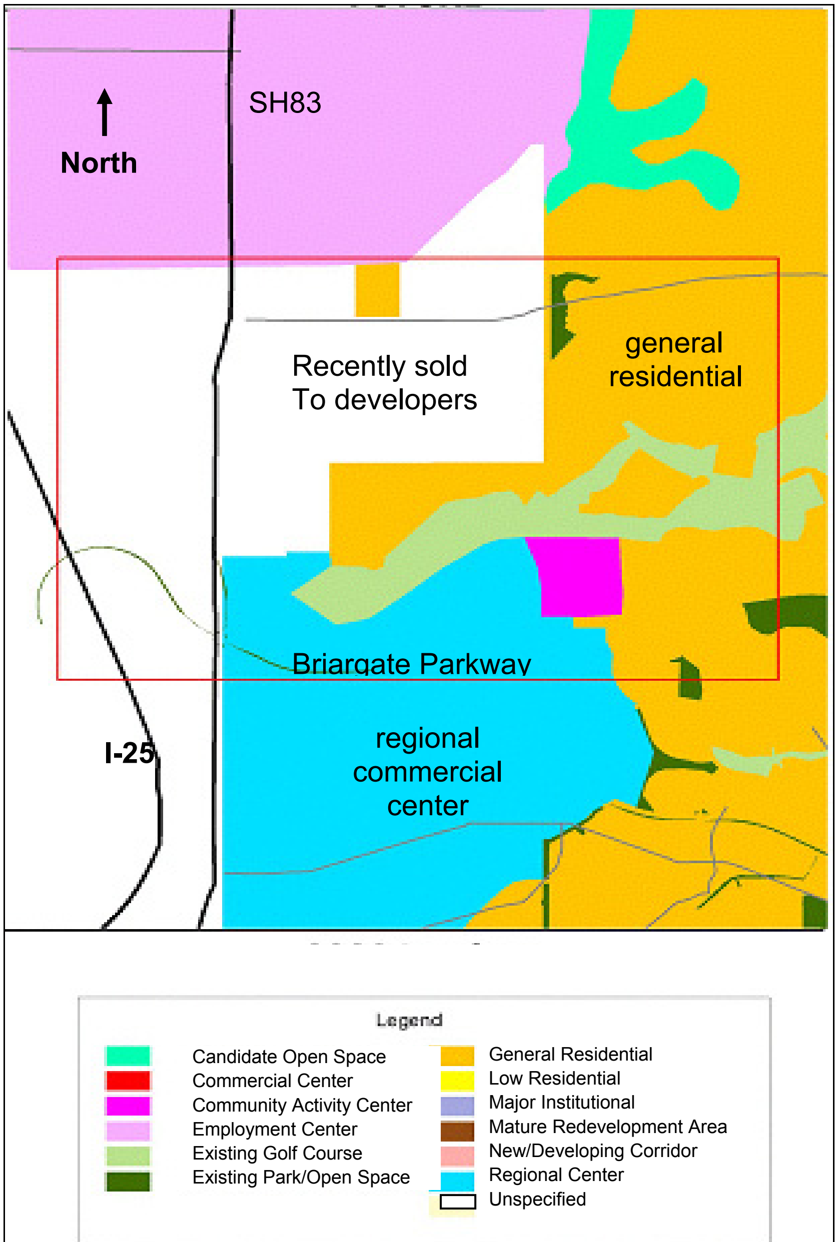
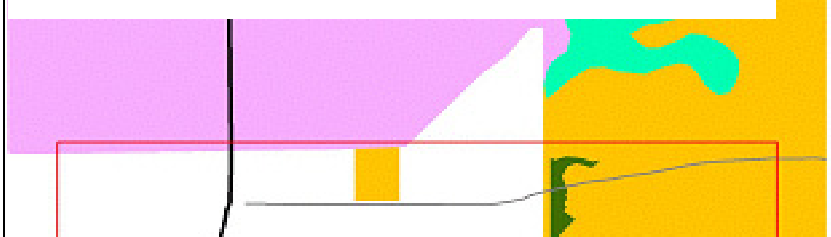


Figure 2-22. Planned future land use at Site 5, Pine Creek.
Source: Colorado Springs 20001 Comprehensive Plan.



In Figure 2-22, the location generally corresponding to the sites depicted on the two previous aerial photographs is outlined in red. Notable linear features are Interstate 25 (black curving line at left), Briargate Parkway (green curving line that crosses I-25) and State Highway 83 (dark vertical line near I-25).

Key land uses include a regional commercial center (blue), general residential (gold), a community activity center (magenta), and the Pine Creek Golf Course (light green).

The area shown in white was not within the City as of 2001, including the Air Force Academy (west of SH83) and a large parcel of adjacent private land. This large parcel of private land was sold to developers in 2003 and will likely be annexed by the City.

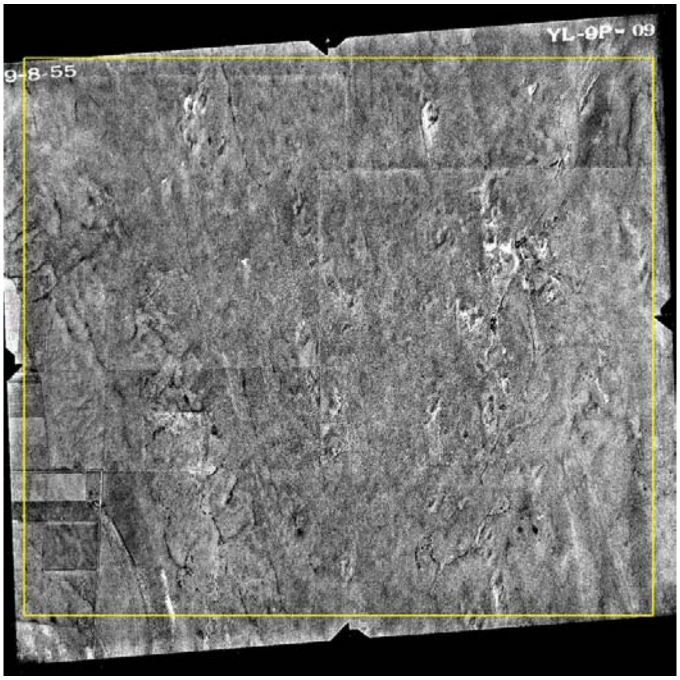


Figure 2-23. 1955 Aerial photo of Site 6, Myers Road.

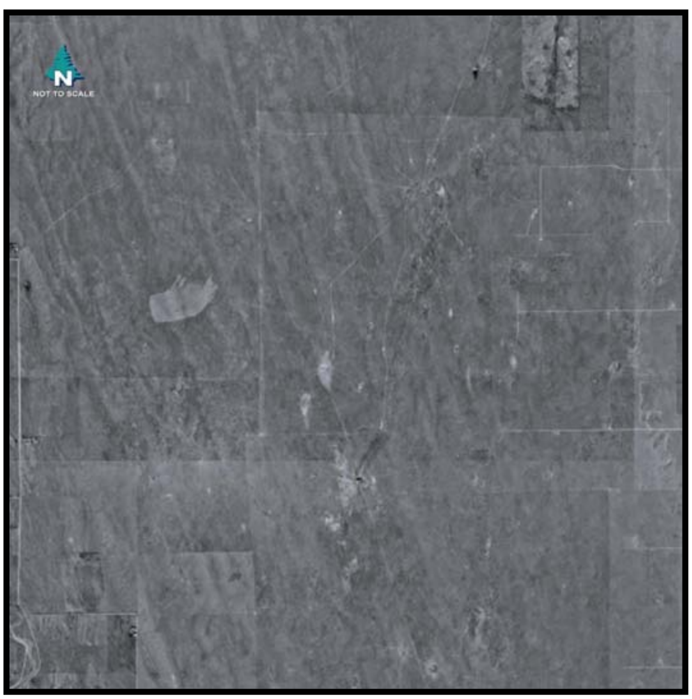


Figure 2-24. 1955 Aerial photo of Site 6, Myers Road.

Comparison Site 6

SHORTGRASS PRAIRIE – MYERS ROAD

No major differences in pattern between 1955 and 1995. This site is just east of Black Squirrel Creek (Arkansas River watershed), about 25 miles east-by-southeast of downtown Colorado Springs.

Figure 2-23, the 1955 aerial photo of Site 6 depicts primarily open grassland.

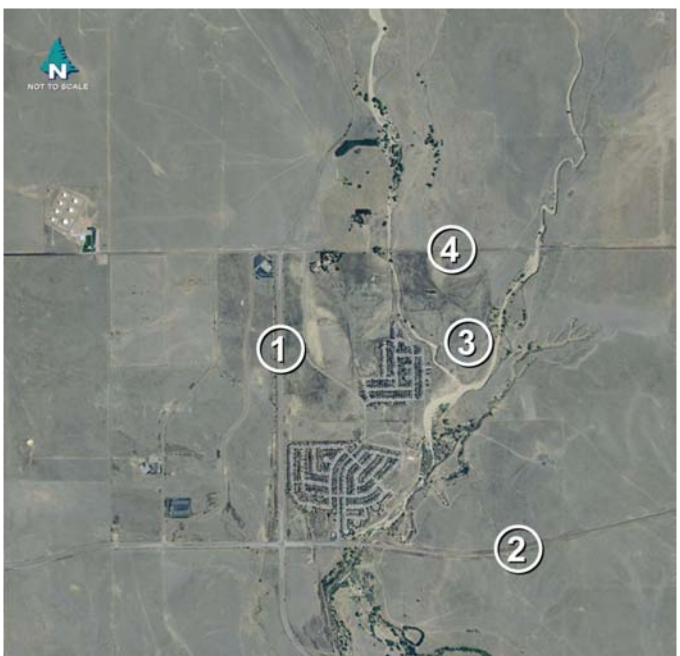
The 2002 aerial photo, Figure 2-24, illustrates that the land use has not changed appreciably.

Shortgrass prairie occurs here where the area is relatively flat. Hilly terrain, with its very sandy soil, is dominated by sand sagebrush. This site is characterized by blue grama grass, with scattered sand sagebrush, yucca and native thistle.

This grassland has been severely grazed and, combined with the dry summer, was only several inches high and a yellow-brown color when visited in 2002. The only wildlife observed was horned larks. Prairie dog towns would be expected in this area, but soils are sandy, and a slightly different eco-system of sand sage is formed.

No modern reference points are distinguishable on the two aerial photos.

Figure 2-25. 1955 Aerial photo of Site 7, Marksheffel Road.



Fiigure 2-26. 2002 Aerial photo of Site 7, Marksheffel Road.

Comparison Site 7

SHORTGRASS PRAIRIE – MARKSHEFFELROAD

No major differences in pattern between 1955 and 1995. This site is just east of Black Squirrel Creek (Arkansas River watershed), about 25 miles east-by-southeast of downtown Colorado Springs.

In 1955 a quiltwork pattern of croplands was evident along Marksheffel Road (Figure 2-25). By 1995 that agricultural pattern had been replaced by commercial and residential development centered at the intersection of Marksheffel Road and Drennan Road (Figure 2-26). Approximately 179 acres were developed over this 40-year period, representing a 40% increase in land development.

The area west of Marksheffel Road hadn't been grazed for a number of years. It has more species diversity and a greater biomass than the Myers Road shortgrass prairie site. The plant community is characterized by blue grama, needle-and-thread, little bluestem, prickly-pear cactus, scurf pea and scattered yucca. Less common species include scarlet globe-mallow, fringed sage and stemless goldenweed. Wildlife species noted included meadowlark, red-tailed hawk and prairie dogs (50 to 60 burrows). Nine pronghorn antelope were observed just north of Drennan Road.

Modern reference points:

1. Marksheffel Road
2. Bradley Road
3. Jimmy Camp Creek
4. Drennan Road

Comparison Site 7

SHORTGRASS PRAIRIE – MARKSHEFFEL ROAD

(Continued)

According to the Colorado Springs 2001 Comprehensive Plan, future land use for Site 7 includes an extensive employment center (lavender) primarily west of Marksheffel Road. East of Marksheffel, the Jimmy Camp Creek drainage is identified as candidate open space (shown in turquoise color), and adjacent land to the east is primarily designated for general residential use. Adopted population forecasts for the year 2025 indicate 4,000 additional residents in the area shown.

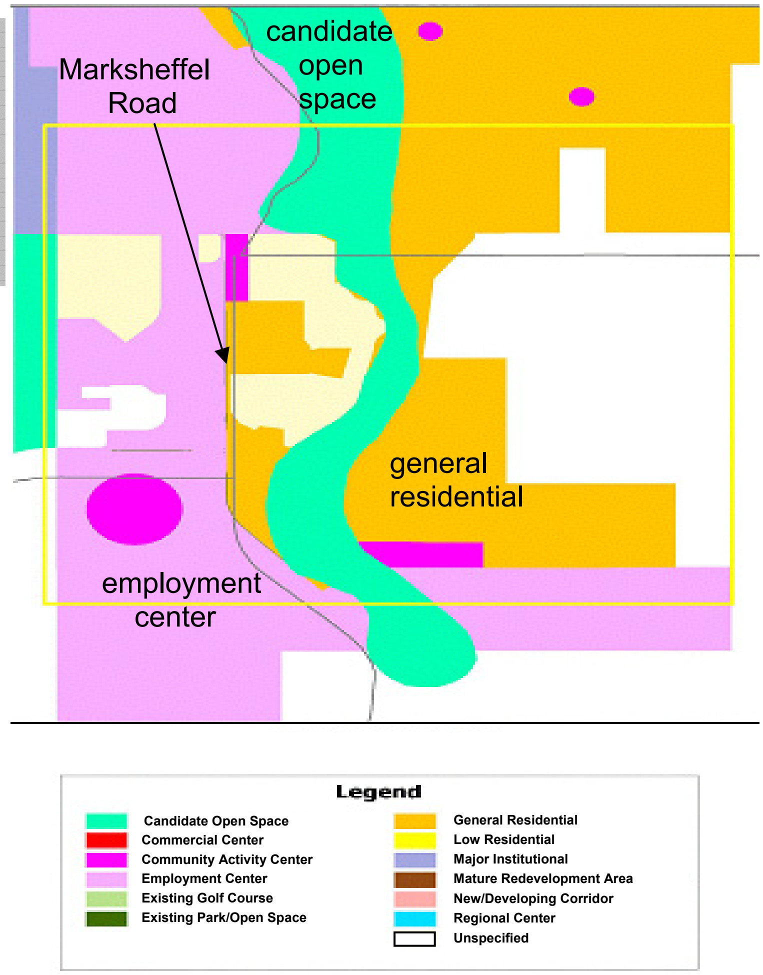


Figure 2-27. Planned future land use at Site 7, Marksheffel Road. Source: Colorado Springs 20001 Comprehensive Plan.

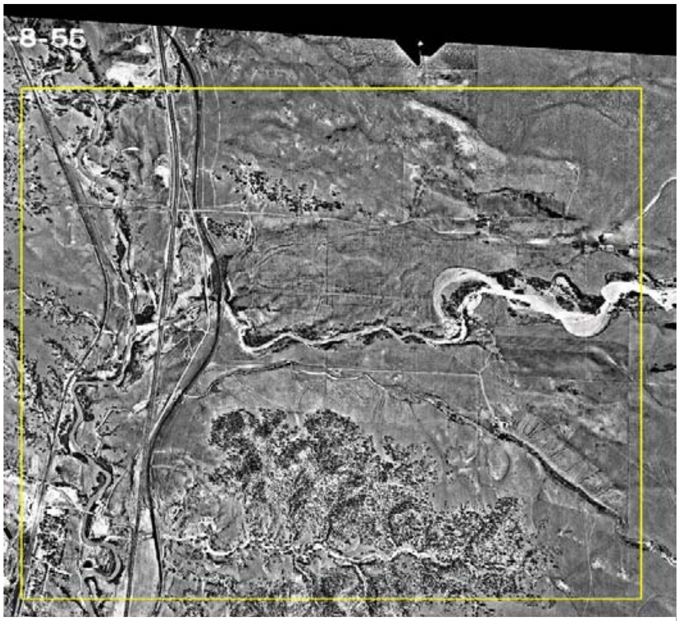


Figure 2-28. 1955 Aerial photo of Site 8, Woodmen Road.

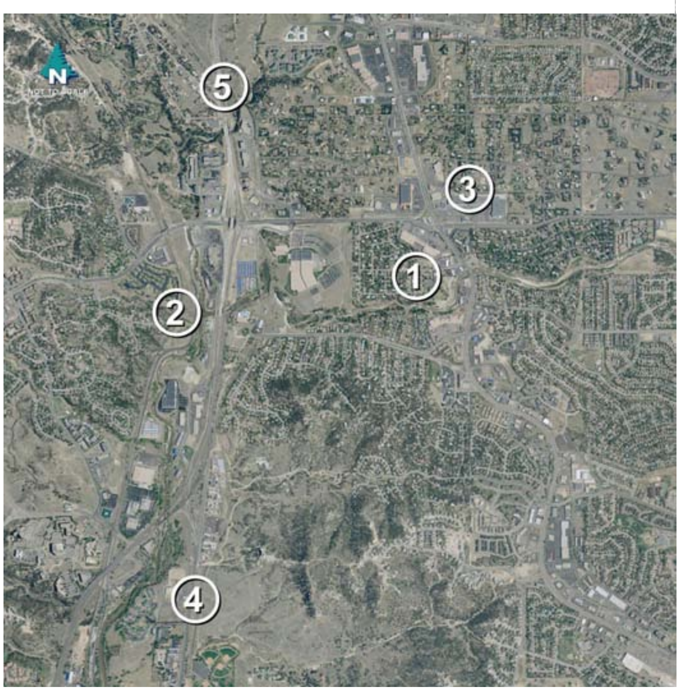


Figure 2-29. 1995 Aerial photo of Site 8, Woodmen Road.

Comparison Site 7

URBAN – WOODMEN ROAD

This site has seen a 436% increase in development. The site, which includes Woodmen Road, is centered on Dublin Road, east of Academy Boulevard, seven miles north of downtown Colorado Springs.

In 1955, prior to construction of the U.S. Air Force Academy, there was little development in the vicinity of today's Woodmen Road. Out of the 283 acre area shown, only about 28 acres were developed, these being near what today is Woodmen Road at Interstate 25.

Forty years later, at least 150 acres (53%) of the area is developed for commercial and residential uses. The land use pattern is typical for I-25 in suburban Colorado Springs.

Gambel oak and sagebrush-grass mixed vegetation are present. The riparian corridors along Monument and Cottonwood Creeks have been impacted by development to the extent that they do not support the Prebles meadow jumping mouse, which can be found in drainages further north.

Modern reference points:

1. Cottonwood Creek
2. Railroad
3. Academy Blvd/Woodmen Road
4. Nevada Avenue
5. Interstate 25

Comparison Site 7

URBAN – WOODMEN ROAD

(Continued)

Figure 2-28 depicts future land uses in the vicinity of Site 8, Woodmen Road. Woodmen is shown as the horizontal black line one quarter of the distance down from the top of the site area highlighted in red. Residential areas, shown in gold, comprise the center of this study site.

Interstate 25 is shown as the thick black line at left, fed by Nevada Avenue. To the east is Academy Boulevard, a heavily commercial corridor. These are among the busiest roadways in the region.

Cottonwood Creek flows westerly, south of Woodmen, to its confluence with Monument Creek. Parks and open spaces in this area utilize topography that is largely unsuitable for development.

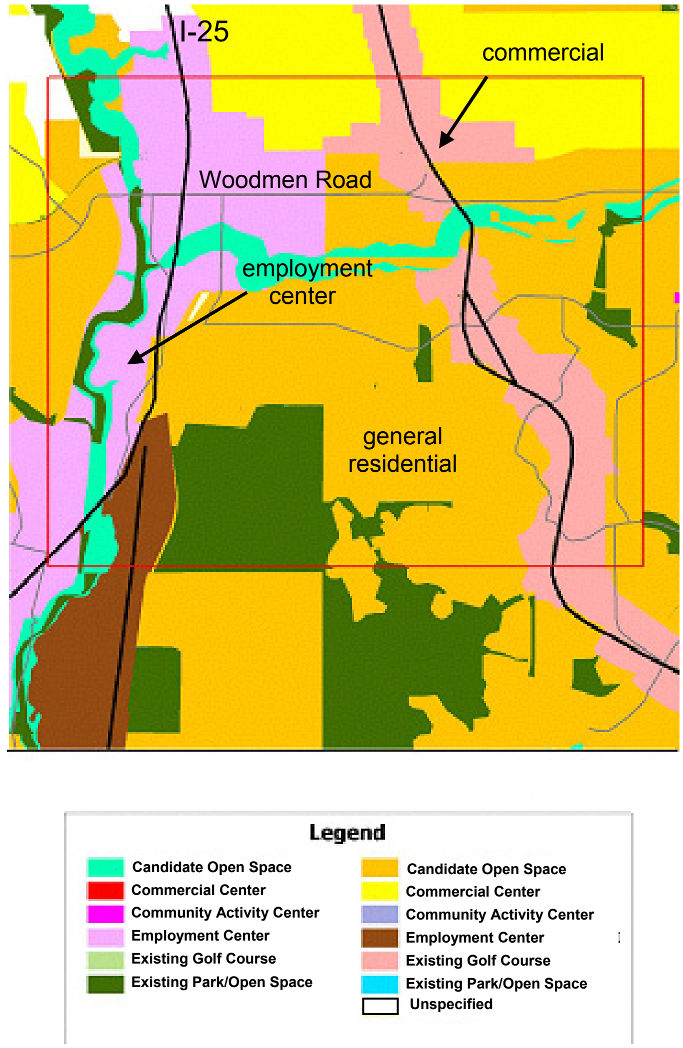


Figure 2-30. Planned land use at Site 8, Woodmen Road. Source: Colorado Springs 2001 Comprehensive Plan.

ANALYSIS OF PROJECT IMPACT AREAS BY COVER TYPE

A potentially important source of landscape change in the Pikes Peak region is the set of four transportation projects in the Colorado Springs area. These projects and other development may be a source of cumulative impacts the region will experience as it continues to develop. An analysis of the magnitude of impact area from these projects was conducted by comparing the landscape directly affected by the projects to the landscape throughout the study area.

Land-cover type, as indicated by the 1995 satellite imagery, was the component of the landscape considered for analysis. All of the major land-cover categories, consisting of urban, riparian, forest, shortgrass prairie, agriculture, shrub and other (open water and miscellaneous features) were considered in this analysis (Figure 2-31). It can be seen that shortgrass prairie is the predominant cover type in the study area.

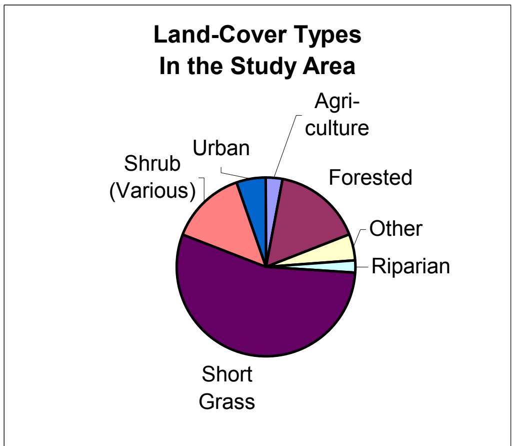


Figure 2-31. The seven major cover types present in the entire study area, by percent.

A Geographic Information System (GIS) was the tool used to conduct the analysis. Specifically, GIS was used to measure the amount of area (in acres) of each cover type over the entire study area and within each of the four project areas (Table 2-6).

The relative degree of impact to areas of each land-cover type was then determined for the project areas. Cumulative changes to landscape patterns throughout the study were then extrapolated to identify potential effects on various sensitive animal and plant species that depend on each land-cover type.

The amount of area that each project would affect was calculated by assuming the boundary of a project area corresponded to a 100-meter (328-foot) area extending from both sides of the centerline of the existing roadway (total width examined = 656 feet).

Even though the proposed roadways are unlikely to exceed 300 feet in width, a 328-foot (100 meter) area was chosen because it encompasses all potential direct impacts. The precise locations of these planned roadways have not been surveyed yet. Consequently, even though these projects will follow the pathway of the existing roadway, final centerline locations may deviate from the existing centerlines upon construction.

Direct project impacts were defined as the conversion of natural cover types to impervious surfaces and other types of related, managed area (e.g., mowed right-of-way, storm water detention ponds). Indirect impacts by definition occur at a different location or different time from the causative factor and are therefore more difficult to quantify.

Table 2-6. Land Cover Type (acres) by Project Area and for the Entire Study Area.

Land Cover Type	Drennan Road	I-25	Powers Boulevard	Woodmen Road	Total for All Project Areas	Total Study Area
Agricultural	0.9 (1.1%)	18.2 (1.9%)	18.5 (2.0%)	0.7 (0.4%)	38.3 (1.7%)	28,342 (3.0%)
Forest	0 (0.0%)	3.8 (0.4%)	0.1 (0.0%)	0.4 (0.2%)	4.3 (<1.0%)	152,436 (16.0%)
Riparian	0.7 (0.9%)	46.4 (4.8%)	24.7 (2.6%)	5.2 (2.8%)	77.0 (3.5%)	19,334 (2.0%)
Grassland	33.4 (42.0%)	359.3 (36.9%)	547.8 (58.3%)	80.7 (43.5%)	1,021.2 (46.8%)	514,304 (55.0%)
Shrub	0.7 (0.9%)	52.1 (5.3%)	47.3 (5.0%)	20.7 (11.1%)	120.8 (5.5%)	132,802 (14.0%)
Urban	43.6 (54.8%)	477.4 (49.0%)	300.3 (32.0%)	77.8 (41.9%)	899.1 (41.2%)	48,374 (5.0%)
Other	0.2 (0.3%)	17.8 (1.8%)	1.1 (0.1%)	0.2 (0.1%)	19.3 (<1.0%)	43,951 (4.7%)
Total Area	79.5 (100.0%)	975.0 (100.0%)	939.8 (100.0%)	185.7 (100.0%)	2,180.0 (100.0%)	939,546 (100.0%)

Indirect impacts include chemical inputs from roadway operation, noise, and altered hydrology from the run-off of the expanded impervious surface area. These types of impacts can be far reaching, but are particularly concentrated close to the roadside. Therefore, it is reasonable to assume that the entire 656 foot-wide analysis area will experience some degree of direct or indirect impact as a result of the proposed projects.

While the incremental impact to different cover types identified in Table 2-6 appear relatively small, it is the cumulative impact of these projects and other development within the study area over an extended timeframe that can ultimately and affect biological diversity and the quality of life in the region. Moreover, while the direct impact to cover types appears relatively small, the indirect impact to natural and community resources due to fragmentation of cover types into smaller patches and the formation of barriers between these smaller patches may be greater, albeit more difficult to quantify.

IMPACTS TO LAND COVER TYPES

A brief summary of the potential magnitude of the four projects' impacts to each cover type, and consequent contributions to region-wide impacts is provided below. The contribution of these impacts to loss of biodiversity throughout the study area is also discussed, by analyzing the effect of cover-type specific impacts on sensitive species associated with those cover types. Effects to selected sensitive species are summarized in Table 2-7, and a more comprehensive list of species (18 animals, 11 plants) and potential effects from projects are provided in Appendix 3.

Table 2-7. Summary of Species of Concern and Their Potential Habitats near Major Transportation Projects in El Paso County, Colorado

AGRICULTURE				
	Drennan	**I-25**	**Powers**	**Woodmen**
Percentage of agricultural cover type in each project area	1.1%	1.9%	2.0%	0.4%
Species	**Potential to be Impacted and Type of Effect**			
Ferruginous hawk, *Buteo regalis*	Low potential; project area is within known range of this species and suitable habitat is present. However, this species probably uses the Colorado Springs area sparingly. Potential for direct habitat loss and indirect habitat loss due to increased development and disturbance.			
Long-billed curlew, *Numenius americanus*	Low potential. Curlews may use stock ponds as water sources, but such farms or ranches are east of the project areas. This species is most likely present in the Colorado Springs area only during migration.			
Bald eagle, *Haliaeetus leucoccephalus*	Low potential; likely present only at active prairie dog towns with adjacent perches, and only in winter. Direct habitat loss and indirect habitat loss due to increased development and disturbance are possible.			
Black-tailed prairie dog, *Cynomys ludovicianus*	Moderate potential; this species is known to exist in the project area. Direct habitat loss possible, indirect habitat loss due to increased development and disturbance.			
FOREST				
	Drennan	**I-25**	**Powers**	**Woodmen**
Percentage of forest cover type in each project area	0.0%	0.4%	0.0%	0.2%
Species	**Potential to be Impacted and Type of Effect**			
Common hog-nosed skunk, *Conepatus mesoleucus*	Very low potential; very small amounts of suitable habitat present in project area and last confirmed record of this species El Paso County dates from the 1920s.			
Townsend's big-eared bat, *Plecotus townsedii pallescens*	Low potential; suitable habitat is widespread but there are no records of this species in the project area.			

Table 2-7, continued

RIPARIAN				
	Drennan	**I-25**	**Powers**	**Woodmen**
Percentage of riparian cover type in each project area	0.9%	4.8%	2.6%	2.8%
Species	**Potential to be Impacted and Type of Effect**			
Preble's meadow jumping mouse, *Zapus hudsonius preblei*	High potential for effect; species is known to be present within the I-25 project area.			
Northern leopard frog, *Rana pipiens*	Moderate potential for effect; suitable habitat present within project area buffers and species is known to be present in Colorado Springs area. Potential for habitat loss, indirect effects due to water quality issues.			
Ute Ladies' tresses orchid, *Spiranthes diluvialis*	Very low potential for occurrence; suitable habitat may occur in the study area but there are no records of this species in El Paso County			
SHORTGRASS PRAIRIE				
	Drennan	**I-25**	**Powers**	**Woodmen**
Percentage of shortgrass cover type in each project area	42.0%	36.9%	58.3%	43.5%
Species	**Potential to be Impacted and Type of Effect**			
Ferruginous hawk, Buteo regalis	Low-moderate potential; project area is within known range of this species and suitable habitat is present. This species probably uses the Colorado Springs area sparingly, but look for prairie dog towns which the hawk is associated with, especially from the more undisturbed Powers Boulevard corridor.			
Mountain plover, Charadrius montanus	Suitable habitat is present, but there is a low potential for effect. Such habitat is probably rare in project areas.			
Black-tailed prairie dog, Cynomys ludovicianus	Moderate potential for effect; this species is known to exist in project areas. Direct habitat loss possible, indirect habitat loss due to increased development and disturbance.			
Black-footed ferret, Mustela nigripes	Very low potential for effect; there are no current records of this species on the Front Range. Existing prairie dog towns in the Colorado Springs area are too small to support this species.			
SHRUB				
	Drennan	**I-25**	**Powers**	**Woodmen**
Percentage of shrub cover type in each project area	0.9%	5.3%	5.0%	11.1%
Species	**Potential to be Impacted and Type of Effect**			
Brandegee wild buckwheat, *Eriogonum brandegeei*	Very low potential to affect; preferred habitat does not occur in project area.			

Table 2-7 lists the species with status that could potentially occur in El Paso County. In addition, it lists: the preferred habitat of each species; the vegetation type that corresponds to each habitat; the percent of each roadway project area that is comprised of that habitat; an estimation of the species' potential to be impacted; and the type of impact that is most likely to occur to each species. It is important to note that in many cases, species habitat preferences are much narrower than the vegetation classes defined in this report. Therefore, even a suitable vegetation class indicates only the potential for a species preferred habitat to be present. A detailed on-site analysis is needed to determine the actual extent of preferred habitat. Also note that the phrase "project area" refers to an undefined area associated with the four roadway projects.

DESCRIPTION OF COVER TYPES AND PROJECT IMPACT AREAS

Each of the cover type categories is described in more detail below, together with information about how they could be impacted by major transportation projects. It is important to note that specific proposed actions have not yet been defined for some of the transportation projects. Therefore the potential roadway impact acreages discussed below are speculative, worst-case scenarios. The impacts of land development to serve 200,000 additional residents by 2025 will far surpass any habitat loss attributable to the major roadway projects.

AGRICULTURE

The total acreage of agriculture cover type represents just 3 % of the 939,546-acre, two-watershed study area. The total acreage of agriculture cover types with the project areas is only about 1.6% (94.6 acres). The proposed roadways will not disproportionately impact agricultural cover types in the RCEA study area.

Table 2-7 lists the species that prefer agriculture habitat and describes the type of impact that could occur to these species. For example, the Ferruginous hawk utilizes open grasslands that may also be used as agricultural pasture. Although some agricultural land may be impacted by each of the four corridor projects, there is a low potential to adversely impact this species because most agricultural lands have low densities of rodents, especially the black-tailed prairie dog, their preferred prey. Additionally, Ferruginous hawks usually avoid areas with high levels of human activity.

The long-billed curlew also uses agricultural lands if they have water sources such as stock ponds or reservoirs. However, although long-billed curlews have been recorded within the study area, these records are all from areas east of the proposed projects.

FOREST

Forest cover types account for about 16% of the study area, and for less than 1% (about 25 acres) in the transportation project areas. Therefore, these projects will have negligible direct impact on forest cover types in the study area. Most impacts to forested cover types in the study area are associated with I-25, an area that is undergoing rapid population growth. Affected forested areas are primarily ponderosa pine habitat with graminoid and/or shrub understory.

Population growth and increased road capacity are related, and the major roadway projects also contribute to some forest cover reduction indirectly through associated residential and commercial development. Illegal off-road use is also becoming a problem in some of the forests within the study area, and may also be related to population growth pressures.

Only two of the sensitive species listed in Table 2-7, the hog nosed skunk and Townsend's big-eared bat, are associated with forested cover types. There are no recent records for the hog-nosed skunk in the study area. Townsend's big-eared bat however, probably does occur within the study area. These bats are somewhat sedentary and live their life cycle within relatively small areas. They are known to be associated with human developments as well as forested areas. Low-density housing developments should not negatively affect bats currently using forested cover types in the study area, and may even improve those habitats for bats. Water sources are often a limiting factor for bats, and constructed landscaping ponds and birdbaths can be important sources. High-density housing developments may have a detrimental impact if more trees are removed then are planted and/or insect populations are controlled.

RIPARIAN AREAS

Riparian areas are associated with streamsides and the banks of rivers. Because of the presence of water, the vegetation in riparian areas tends to be thick and lush. In arid regions, riparian zones may be the only places with sufficient moisture for trees to grow. Because of their proximity to water, riparian zone often contain wetlands. However, the terms "wetland" and "riparian" are not interchangeable. Wetlands are legally defined as having a specific hydrological, soil and vegetation conditions, and only rarely will an entire riparian zone qualify as a wetland.

Additionally, many wetlands, such as those formed by groundwater, are not associated with riparian areas and may be located many miles from a watercourse. However, for the purpose of this analysis, the riparian cover type was considered a surrogate for wetlands, because riparian areas, but not wetlands, could be accurately identified from the imagery used. Actual wetland impacts from the various projects will almost certainly be less than the riparian areas reported here. Cooper (2002) states "Wetlands occupy approximately 0.5 to 1.5 percent of the landscape in most western states…" The 19,334 acres of riparian cover type in the study area represents approximately 2% of the 939,546-acre study area.

According to Table 2-6, each of the four transportation projects has the potential to directly affect riparian areas. In addition to direct disturbance, the existing and impervious surface of each project has the potential to increase the amount of surface water runoff into nearby riparian areas. Surface water runoff carries pollutants from roads and other impervious surfaces and erodes adjacent uplands, thereby adding sediment and pollutants to the riparian area (see hydrology discussion in Section 2-B, Water Quality and Quantity). Impervious surfaces also reduce the surface area available for precipitation to infiltrate into soils, and ultimately to recharge local aquifers.

A cumulative effect of Front Range development is an increase in the flow and velocity of surface waters, resulting in erosion and down-cutting of streams (Figure 2-6). Down-cutting and lowering of ground water tables in turn combine to sever the connection between streams and adjacent floodplains. This can indirectly affect a much larger area of habitat than directly affected by any one project.

Although riparian and wetland areas within the four major transportation projects represent only 1% to 5% of each of the project areas, these projects, combined with other planned development in the study area could cause adverse cumulative effects on the existing riparian and wetland resources.

The I-25 improvements and the northern extension of Powers Boulevard (from Woodmen Road to I-25) will have impacts to riparian areas. These projects are within the Monument Creek watershed, part of the larger Arkansas watershed. Streams here have a wide range of conditions, with Monument Creek the largest drainage in the watershed with reliable flow during the entire growing season. Both I-25 and Powers will intersect (or already do) several tributaries of Monument Creek. Stream crossings are common along I-25 and many crossings will be enlarged. The Powers Boulevard northern extension is a new road that will cross smaller Monument Creek tributaries, most with ephemeral flow.

Table 2-7 identifies six animal species and one plant associated with riparian zones that could potentially occur within one or more of the four project areas. Because of its protected status and documented occurrence in project areas, the Preble's Meadow Jumping Mouse (Preble's) is of particular interest for this cumulative effects analysis. The program that has been implemented to reduce impacts to Preble's as a result of CDOT projects serves as an example of the type of measures that can be created to reduce cumulative impacts to focal resources throughout the study area (see case study end of chapter). CDOT projects will be affecting up to 62 acres of Preble's habitat in northern El Paso County, within both riparian and upland habitat areas.
In addition to aggressively working to avoid and minimize impacts, CDOT is using on-and off-site habitat restoration, as well as restoration of habitat linkages. These efforts will provide a wide array of benefits to many riparian species.

Planned restoration projects include using sediment dams on a stream channel to restore groundwater levels needed for maintaining riparian vegetation, and using no-grazing areas on a stream to allow for re-growth of the native shrub layer.

SHORTGRASS PRAIRIE

Short grass cover types account for about 55% of the study area, and about 47% (1,021 acres) of the total impact area for the four transportation projects. Although the majority of sensitive birds and mammals listed in Table 2-7 are associated with short grass habitats, direct impacts to them as a result of the transportation projects should be relatively low.

Most of the short grass habitats in the project corridors probably have low-use by wildlife. This is because of relatively poor habitat quality, due to current levels of disturbance and degradation from the existing highway alignments and associated development. An exception is the northern extension of Powers Boulevard, where there is no existing roadway, and a thus far only a low amount of existing development (but massive development plans have been approved). There is a relatively large undisturbed area of shrub and shortgrass within this corridor and up to 547.8 acres of shortgrass may be disturbed by the planned roadway (about 54% of the total project-related shortgrass disturbance).

Most additional impacts to higher quality short grass cover types in the study area will be a result of population growth and associated development, especially home building. Because population growth and the need for increased road capacity are related, the major roadway projects contribute to some short grass cover impact indirectly.

Sensitive species that may use short-grass prairie habitats include a number of birds (ferruginous hawk, mountain plover, bald eagle, peregrine falcon, long-billed curlew), mammals (Gunnison's prairie dog, black-tailed prairie dog, black-footed ferret), and plants (plains ragweed, prairie violet). Many of these species have restricted ranges within the study area (e.g., long-billed curlew in eastern El Paso County only), or have special habitat requirements that could not be identified within project areas based on the data available (e.g., cliff areas needed by peregrine falcons for nesting). Other species, such as the black-tailed prairie dog may be either expanding or contracting their ranges within specific project areas. Suitable habitat may exist for some species (Massasauga rattlesnake, black-footed ferret) but there are no recent records of these species within the study area.

SHRUB

Shrub cover types account for about 14% of the study area, and about 5% (120.8 acres) of the four transportation project areas. Therefore, these projects will have only a small direct impact on shrub cover types in the study area. The shrub cover type includes a number of plant species associations, covering a wide range of moisture conditions. The three shrub types that are most common in the project areas are Gambel oak, mixed sagebrush, and the mountain shrub mix. There is only one sensitive plant species listed in Table 2-7 associated with shrub habitats (brandegee wild buckwheat), but it is not known to occur in the project areas. There are no sensitive mammals, birds, or reptiles associated with this cover type.

URBAN

Urban cover types account for only about 5% of the two-watershed study area, but for about 41% of the four major roadway project areas. Therefore, these projects will have a disproportionate direct impact on urban area in the study area. However, the effect of infrastructure impacts to urban areas is different from impacts to natural cover types. Urban areas require infrastructure such as highways to function, and this type of infrastructure is part of what defines urban areas. Urban project effects are more clearly expressed on the human environment and are covered in Sections 2-B through 2-Fof this report, where air and water quality, noise, traffic and visual resources are discussed.

OTHER

"Other" cover types include alpine cover types, open water, barren areas (rock, soil, existing paved areas) and a variety of cover types that covered less than 0.01% each with in the areas analyzed. "Other" cover types account for 4.7% of the study area, and for less then 1% of the four major roadway project areas.

ADDITIONAL DATA

In addition to comparison of past and present aerial photography and project specific analysis of recent satellite imagery, data from other sources was used to discern trends in landscape pattern. These data include a more detailed look at land-use changes for three selected areas, changes in agricultural land use throughout El Paso County and estimates on increases in impervious surfaces as a result of the four projects (reviewed in the hydrology section).

Three sites were examined in more detail because of their proximity or other relationship to the four proposed transportation improvement projects. The following summarizes important characteristics and changes for each site.

Dirty Woman Creek

Study area stream channel	6550 ft. long
1955 Riparian area	12.47 acres
1995 Riparian area	25.34 acres
Increase in Riparian area	12.87 acres
Percentage change	103%

Woodmen Road

Study area	283.23 acres
1955 Urban area	28.11 acres
1995 Urban area	150.61 acres
Increase in Urban area	122.50 acres
Percentage change	436%

Marksheffel Road

Study area	473.35 acres
1955 prairie/agriculture	473.35 acres
1995 prairie/agriculture	298.80 acres
Decrease in prairie/agriculture	174.55 acres
Percentage change	-37%

Other changes in landscape pattern are indicated in the agricultural statistics and projections for El Paso County from the Colorado Department of Agriculture (Table 2-8). The numbers show that from 1950 to 1997 both the number of farms in El Paso County as well as the amount of land in farming decreased by nearly a third. Even more dramatic was the decline in overall cropland, with a 70% reduction.

Within that cropland, 91% of the woodland area, including windbreaks and riparian vegetation on farms, were converted to other uses. Loss of this vegetation is particularly significant because of the role it plays in supporting birds and other wildlife. The far right column shows what changes can be expected if current trends continue to 2025.

Attribute	Changes, 1955-2000	Projected, 2000-2025
Land in Farms	Decreased 30%	Decrease 6%
Average Size of Farm	Decreased 2%	Decrease 45%
Total Cropland	Decreased 69%	Decrease 14%
Harvested	Decreased 76%	Decrease 39%
Pasture/ Grazing	Decreased 60%	Decrease 20%
Woodland	Decreased 91%	Decrease 70%
PERCENTAGES		
% Harvested	Decreased 22%	Decrease 29%
% Pasture/ Grazing	Decreased 28%	Decrease 40%
% Woodland	Decreased 70%	Decrease 66%

Table 2-8. Historic and projected changes in agricultural lands in El Paso County, Colorado.

TRENDS RELATED TO BIODIVERSITY AND SUSTAINABILITY

Unless road systems and other development that are planned with some recognition of how natural areas function, they will continue to contribute to habitat fragmentation and other unsustainable landscape patterns. Some important current trends:

- Riparian areas are being converted to non-riparian habitat or are being severely altered. This trend is especially evident in the tributaries to Monument Creek. This is particularly important because riparian areas in northern El Paso County are habitat for the federally listed Preble's Meadow Jumping Mouse. Habitat loss was one of the primary reasons for listing the Preble's mouse as a threatened species.
- Preble's mice also use upland sites that are often affected by residential development. These mice use upland habitat up to 300 feet or more

from stream edges, including grasslands for feeding and shrublands for hibernation sites. Trails in riparian areas may have significant impacts on small mammals and birds, and there is increasing public demand for recreation trails of all kinds.

- Increased stormwater runoff is contributing to downcutting of streams and the lowering of groundwater levels. Lowered groundwater levels can lead to the demise of shrub riparian communities because shrub roots can no longer reach water sources. The decline of riparian communities has severe effects on many wildlife species that depend on these water-rich areas.
- Trees are invading grasslands because fires have been suppressed. This increase in woody plant cover may lead to changes in the avian community including introducing exotic bird species, increasing nest predators/parasites and habitat generalists and decreasing species that depend on grasslands, such as the meadowlark. Forest fires are increasing in size, severity and effect, due to a buildup of fuels and the popularity of building in forested areas. Severe fires remove both vegetation and litter layers that protect soil from erosion.
- Many species requiring undeveloped habitats are being pushed to the edges of the urban area as development proceeds. This is illustrated by some of the shortgrass prairie species, such as swift fox, lark bunting (state bird), mountain plover and pronghorn antelope. These species have coexisted with agricultural (e.g., livestock grazing) use but not with urban development.
- Habitat blocks (required to sustain a functioning ecosystem) are decreasing in size and becoming more fragmented. One large habitat block of shortgrass and shrub cover types will have a major new road, Powers Boulevard. However, it does not appear that there are sensitive vertebrate or plant species in this area.
- The small patches of natural systems that remain within the urban area support few natural species, and instead contain exotic or weedy species and suffer from lack of connectivity.
- Increased development is resulting in increased impervious surfaces leading to increased stormwater runoff higher peak flows in streams and lower water quality.
- Increased trans-basin diversions and runoff are causing excess water to be incorporated into the Fountain Creek and other area stream systems and watersheds. This causes unnatural erosion and deposition, including flooding and erosion of manmade structures near streams.
- Total acres of agricultural lands are projected to continue to decrease within the county in the decades ahead. Harvested crop production will decline, but grazed land will increase. Agricultural lands in eastern El Paso County are being converted to residential housing.

TRENDS RELATED TO QUALITY OF LIFE AND SUSTAINABILITY

- Scattered development is resulting in more roads. Road use is causing noise and other impacts to the environment. Roads can also form barriers to neighborhood connections.
- Residential development in former agricultural areas will change the rural area of the county from agricultural production to urban-related services.
- Residential development in former agricultural areas may cause new conflicts between farmers and new residents, including disputes about animal odors, water quality and farm machinery use of roads.
- Inappropriately planned development may lead to complete urbanization in the future except for areas that are uneconomical or restricted. This can result in the preservation of open space with little human or habitat value and limited use for active and passive recreation.

Figure 2-32. Birding at Big Johnson Open Space, a shortgrass prairie habitat west of Powers Boulevard. See the related case study in 2- F, Visual Resources.

VISION FOR THE FUTURE: COLORADO SPRINGS COMPREHENSIVE PLAN

Several of the main issues addressed by the *Colorado Springs 2001 Comprehensive Plan* relate to landscape patterns and suggest future sustainable patterns for the Pikes Peak region. The Comprehensive Plan is an important resource to help guide the community toward a healthier, sustainable future. That plan specifically lists the following overall strategies for preserving and improving quality of life:

- Develop a coordinated land use pattern that efficiently uses land by encouraging mixed-use activity centers rather than segregated land uses.
- Create opportunities for travel modes that can reduce the rate of growth in automobile use.
- Continually improve the community's stewardship of its natural setting.
- Strengthen the quality of development's visual character and appearance.
- Maintain a citywide context or perspective as an integral part of incremental land use decision-making.
- Recognize the central importance of all neighborhoods.

Figure 2-33. Colorado Springs founder General William Jackson Palmer designed the city with wide streets. The City Parks, Recreation and Cultural Services Department plants and maintains the medians and flowerbeds within City limits.

Our Community Envisions a Colorado Springs that:

- respects its heritage and natural setting,
- projects a highly attractive image and protects its unique character and scenic beauty,
- provides an incomparable system of open spaces, natural areas and greenways,
- is truly a city of neighborhoods—with affordable housing, walkable destinations, convenient parks and quality schools,
- successfully integrates the uses and activities that meet the daily needs of residents, including housing, shops, work places, schools, parks and civic facilities,
- has a transportation system with a high degree of efficiency, mobility, accessibility, connectivity and a range of real choices for traveling between destinations within the community,
- that is equitable and fiscally responsible in providing, maintaining and upgrading services and infrastructure.

Source: *City of Colorado Springs 2001 Comprehensive Plan*

To achieve and sustain anything close to the City's vision as detailed at left will require changing the spatial relationships among future areas of development and between development and natural areas. For example, uncoordinated and scattered development will not likely result in mixed-use activity centers or allow residents to move away from dependency on the automobile. The same uncoordinated and scattered development also will likely be more disruptive of the interconnectedness of natural systems.

"Green infrastructure" is an example of one model for developing an integrated, connected system of open space sufficient to sustain key ecological functions and major components of biodiversity as a complement to "gray" infrastructure (e.g., roads and power lines). This is explained more fully on the U.S. Department of Agriculture sponsored web site, www.greeninfrastructure.net.

Another useful model is the more comprehensive model described by Richard Forman's aggregate-with-outliers principle (see discussion on page 2-16.) Forman suggests keeping uses (natural or developed) primarily in large blocks because it is more efficient and effective, and leaving connections between some blocks with outliers in others.

KEY STRATEGIES FOR SUSTAINING EFFECTIVE LANDSCAPE PATTERNS IN THE PIKES PEAK REGION

The following strategies are drawn (as for each of the six indicators) from a range of sources, including the *City of Colorado Springs 2001 Comprehensive Plan* and the two panels that were convened for this study. The list is not exhaustive and is offered to give an idea of the range of strategies that can be enlisted to help include sustainability in decisions. What these strategies might look like on the ground in the Pikes Peak region is suggested in Figure 2-34.

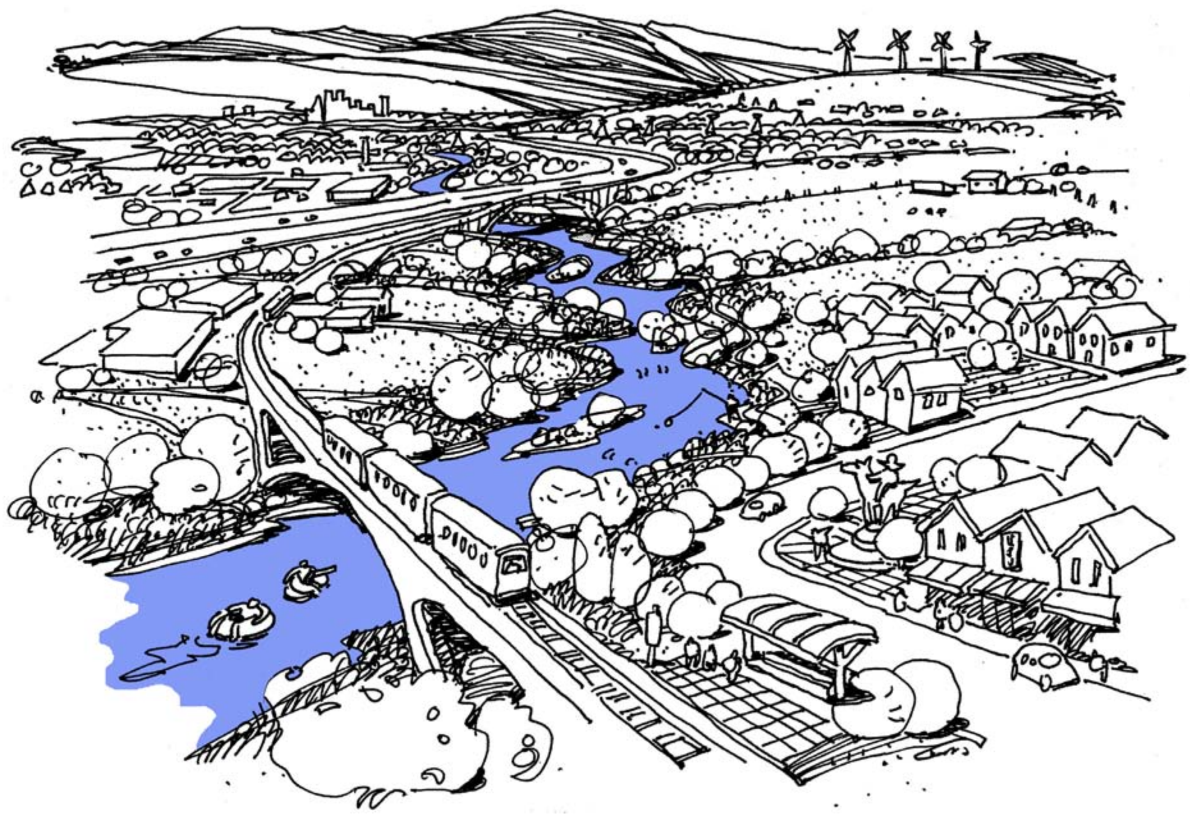


Figure 2-34. A hypothetical future landscape. If the strategies suggested in this report and related documents were vigorously pursued, the Pikes Peak region of the future would be more likely to sustain high-quality biodiversity and a healthy and vibrant quality of life. Broadly speaking, new development would be aggregated in mixed-use blocks and efficiently served by public transportation, large blocks of natural areas would be protected and interconnected by greenways that permeate development and agriculture would be maintained in blocks large enough to be productive.

POLICY-LEVEL STRATEGIES: LANDSCAPE PATTERNS

- ☑ Reduce the negative cumulative effects of growth by:
  - o Encouraging mixed-use development instead of zoning that separates uses.
  - o Encouraging activity centers instead of corridor development.
  - o Balancing distribution of employment and residential opportunities.
  - o Continuing to incorporate land use and traffic planning in development review.
  - o Ensuring that components of the transportation system are compatible with adjacent uses.
  - o Developing land-use patterns that are mutually supportive of an intermodal transportation system.
  - o Identifying and conserving a system of green infrastructure for the region.
- ☑ Generally aggregate broad uses (development, natural areas, agriculture) but have outliers of nature in developed and agricultural areas and allow outliers of development in natural areas near their borders with development.
- ☑ Improve air quality by developing intermodal transportation systems.
- ☑ Manage noxious weeds regionally so they do not threaten biodiversity.
- ☑ Improve stormwater runoff control by maintaining riparian corridors in a natural state whenever possible.
- ☑ Avoid severing connections of wildlife habitat blocks with development by setting aside habitats and connecting them to similar habitats with riparian systems.

PROJECT-LEVEL STRATEGIES: LANDSCAPE PATTERNS

- ☑ Use alternatives to impervious surfaces whenever possible to encourage percolation of stormwater rather than runoff. Use vegetated swales and other green solutions to intercept and treat runoff from paved surfaces, such as roadways and parking lots.
- ☑ Promote the use of native and locally adapted plants in urban areas where appropriate to promote water use reduction.
- ☑ Reduce sedimentation by following appropriate best management practices (BMPs) for controlling erosion and intercepting runoff.
- ☑ Protect and restore riparian areas because of their tremendous significance to biodiversity and water quality.
- ☑ Manage noxious weeds aggressively to reduce their spread and impacts.
- ☑ Maintain large contiguous habitat blocks because they are crucial for species that are affected by habitat fragmentation.
- ☑ Maintain greenways or other habitat connections between habitat blocks to maximize the value and productivity of those larger areas of habitat.
- ☑ Avoid severing habitat connections with roads, trails, or other disruption.
- ☑ Carefully plan and implement a system of wildlife crossings to maximize the porosity of road corridors for wildlife movement. Remember that different kinds of wildlife may require different types of crossing structures.
- ☑ Create large, contiguous-area, wetland mitigation sites to mitigate the loss or degradation of smaller, isolated wetlands.

IMPLEMENTING THE STRATEGIES: CASE STUDIES

Case Study

State of Colorado

PROGRAMMATIC APPROACH TO HABITAT CONSERVATION

One of the most serious effects of urban development on wildlife populations is loss of natural habitat areas and fragmentation of these same areas. Fragmentation refers to the breaking of large habitat areas into smaller ones.

These habitat effects manifest themselves on wildlife populations in several ways: less habitat supports fewer animals and fragmented habitat does not allow animals movement between remaining habitat patches to the extent that pre-fragmented habitat did. Animal movements between adjacent habitat patches are especially important to maintaining genetic diversity in the population, as well as allowing an influx or efflux of suitable mating partners. If habitat patches become isolated, the animals remaining there are more susceptible to genetic maladies, catastrophic events and lowered breeding potential.

The Colorado Department of Transportation (CDOT) has recognized the importance of “linking” habitat patches to allow for animals movements. Habitat linkages have been studied in detail for the Preble’s Meadow Jumping Mouse in El Paso County. This study found there were at least six separate Preble’s populations in the county, and these populations were separated by various types of habitat barriers. CDOT was obligated to mitigate for impacts to Preble’s habitat from several highway projects but devised a novel way to mitigate. Rather than simply replacing habitat that would be affected by the projects, CDOT committed to several conservation practices using a programmatic process that viewed entire landscapes rather than just project areas.

The major conservation measures that will be used include restoring at least two habitat linkages and protecting at least 50 acres of Preble’s habitat in northern El Paso County. If successful, the habitat linkages will allow separate populations to once again mingle and exchange individuals and genes. The restored riparian corridors also will benefit many other wildlife species that will use them for breeding habitat and movement corridors.

CDOT has cooperated with El Paso County and the U.S. Air Force Academy on these conservation measures, and such partnerships are almost necessary when managing landscapes. One of the proposed habitat linkages is on academy property, and to be successful, linkage restoration will require cooperation among biologists, engineers and hydrologists from both agencies.

Case Study

El Paso County, Colorado

CNHP WETLAND AND RIPARIAN POTENTIAL CONSERVATION AREAS IN EL PASO COUNTY

The report, Survey of Critical Wetlands and Riparian Areas in El Paso and Pueblo Counties, Colorado (CNHP 2001), was prepared by the Colorado Natural Heritage Program (CNHP) in 2001 for the Colorado Department of Natural Resources under a grant from the U.S. Environmental Protection Agency. This report provides the most recent, comprehensive evaluation of wetlands and riparian areas in El Paso County, Colo. Highlights from this report are summarized below; however, readers interested in wetlands and riparian areas in El Paso County are encouraged to review the entire CNHP report (**www.cnhp.colostate.edu).**

The CNHP 2001 study delineated 17 Potential Conservation Areas (PCAs) occurring either partially or completely within El Paso County. PCAs contain significant elements of biodiversity including biologically significant wetlands. Designation and delineation of PCAs does not carry with it any regulatory protection. Nor does PCA designation restrict land use or activities -- it is strictly a conservation planning tool. To this end, future actions proposed to occur in or adjacent to these PCAs can use the CNHP 2001 report to assess whether their activities adversely affect these elements of biodiversity. This is one of nine recommendations made in the report for the conservation of biological diversity. Each PCA has a biological diversity rank, as shown in the table below. These rankings are explained on the CNHP website.The CNHP 2001 report cites Dahl (2000) to emphasize the rate of wetland habitat loss in the continental U.S. since 1986 (58,500 acres/year) and Dahl (1990) to describe the loss of wetlands in Colorado. Dahl (1990) states approximately 50% (1 million acres) of the wetlands in Colorado were lost prior to 1980. As the CNHP 2001 report indicates, calculating the rate of wetland habitat loss in El Paso County is difficult to quantify; however, without protection, wetlands in El Paso County will continue to be lost or altered.

Wetland and Riparian Potential Conservation Areas in El Paso County, Colorado

Rank	**Potential Conservation Area**	Acres	Location
Very High	Buffalograss Playas	55,332	Southeastern El Paso County
Very High	Cheyenne Cañon	18,520	Western El Paso County
Very High	Judge Orr Road	25,026	Eastern El Paso County
Very High	Monument Creek	12,709	Northern El Paso County
Very High	Schriever Playas	514	Eastern El Paso County
Very High	Severy Creek	2,264	North of Pikes Peak
High	Big Sandy Creek at Calhan	4,342	Northeastern El Paso County
High	Boehmer Creek	5,688	West of Pikes Peak
High	Bohart Playas	235	Southeastern El Paso County
High	Chico Creek	N/A	Mostly south of El Paso County
High	East Chico Basin Ranch	3,118	Southeastern El Paso County
High	Farish Recreation Area	752	North of Pikes Peak
High	Riser at Calhan	2,564	Northeastern El Paso County
High	West Kiowa Creek at Elbert	N/A	Mostly north of El Paso County
Moderate	Big Johnson Reservoir	3,700	South of Colorado Springs Airport
Moderate	Fountain/Jimmy Camp Creek	5,221	South central El Paso County
Moderate	Rasner Ranch Playas	435	Southeastern corner, El Paso County

Case Study

Denver Metropolitan Area

CHATFIELD BASIN CONSERVATION NETWORK

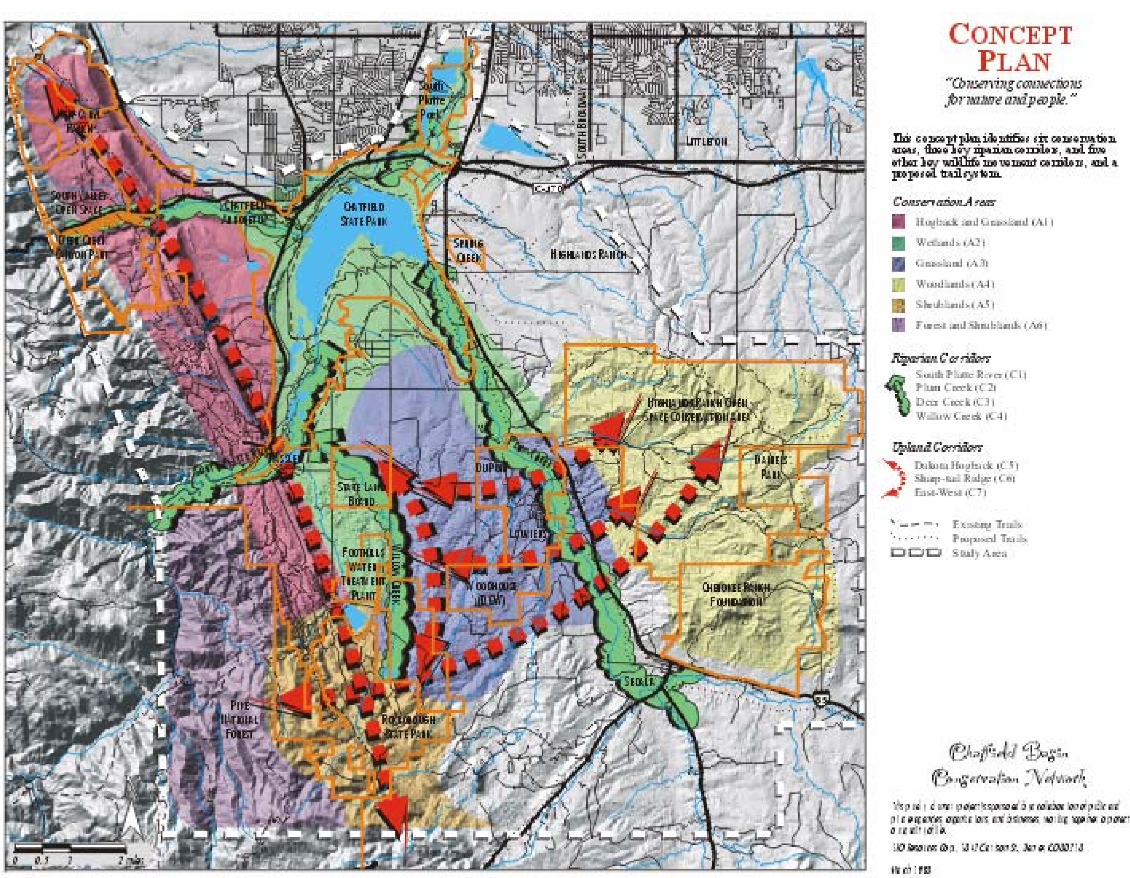
More than 50 public and private agencies, organizations and companies have banded together to conserve an interconnected system of open space for wildlife and people in southwestern metro Denver surrounding Chatfield Reservoir. They have created a plan to coordinate the efforts of developers and conservationists to protect connections and conserve major parts of the ecological vitality of the Chatfield Basin.

Their plan identifies a conservation network for the Chatfield Basin that utilizes large blocks and major connections. Project participants believe that protecting these connections and significant portions of the conservation areas will be a major step toward conserving the ecological integrity of the basin.

The stated goal is to work collaboratively—with public agencies, private landowners, and developers. The plan outlines a range of strictly voluntary actions.

The basin's riparian areas provide important habitat and allow a variety of wildlife to move north and south and east and west, into and through the basin's conservation areas.

See www.chatfieldbasin.org



Case Study

State of Colorado

WEED CONTROL: MANAGING LANDSCAPES

The State of Colorado developed a strategic plan to stop the spread of noxious weeds after recognizing the negative impacts caused by noxious weeds to the environment, agriculture, public health and the economy. CDOT supports this vision and is committed to participating in collaborative efforts to implement the Strategic Plan. Twelve working groups with various functions in both the private and public sectors work on common goals (see below).

Goals	Working Groups
▸ Curb the introduction of new noxious weeds ▸ Prevent the establishment of newly introduced noxious weeds ▸ Stop the spread of noxious weed species that are already so well-established within Colorado that statewide eradication is no longer possible. ▸ Restore lands of exceptional agricultural and environmental value.	▸ Leadership, Coordination and Partnerships ▸ Prevention, Early Detection and Rapid Response ▸ Management: Eradication, Containment and Suppression ▸ Restoration of Exceptional Lands ▸ Integrated Weed Management ▸ Education and Awareness ▸ Financial and Technical Resources ▸ Inventory and Mapping Technology ▸ Monitoring and Assessment ▸ Research and Technology-Transfer ▸ Community Standards and Implementation/Enforcement ▸ Community Involvement

One of these Working Groups—Integrated Weed Management (IWM)—is particularly relevant to transportation projects in the Pikes Peak region. IWM is a multidisciplinary ecological approach to managing unwanted plant species—weeds. The objective of this Working Group is to promote the active management of noxious weeds across jurisdictional boundaries through the use of established IWM processes and principles. IWM considers all available methods for containing and controlling weeds including: education, prevention, physical or mechanical methods, biological control agents, herbicides, cultural and general land management.

Planners of transportation projects in the Pikes Peak Region should consult the Strategic Plan (www.ag.state.co.us) and contact members of the appropriate Working Group or El Paso County's Weed Supervisor to learn about collaborative opportunities for their project.

Other relevant case studies to see in this report:

- *State* of Colorado: Shortgrass Prairie Initiative
- Colorado Springs: Monument Creek Watershed Landscape Assessment
- Colorado Springs: Streamside Overlay Ordinance
- Greater Wasatch Area, Utah: Envision Utah
- Kansas City region, Kansas and Missouri

Key written resources (see the end of this report for full citations):

Above and Beyond: Visualizing Change in Small Towns and Rural Areas, Julie Campoli, et al.

Alternatives to Sprawl, Dwight Young

Conservation Design Through Subdivisions, Randall Arendt

Designing Open Space Subdivisions: A Practical Step-by-Step Approach, Randall Arendt

Ecology of Greenways, Daniel Smith and Paul Cawood Hellmund

The Image of the City, Kevin Lynch

An Introduction to Sustainable Development, Jennifer Elliott

Land Mosaics: The Ecology of Landscapes and Regions, Richard T.T. Forman

Landscape Ecology Principles, Dramstad, et al.

Managing the Sense of a Region, Kevin Lynch

Monument Creek Watershed Landscape Assessment, US Air Force Academy

Road Ecology, Richard T.T. Forman

Rural By Design: Maintaining Small Town Character, Randall Arendt

Streams in the Urban Landscape, Michael J. Paul and Judy L.Meyer.

When City and Country Collide, Tom Daniel

Water is of paramount importance in our semi-arid environment. It requires special attention to sustain its positive aspects and to manage those aspects that can be harmful to people and communities, such as water pollution and flooding.

Colorado Springs receives an average of only 16 inches of precipitation per year. Nevertheless, there is more water in the Pikes Peak region today—flowing through faucets in homes, on to trees and lawns in yards and parks, off yards and parking lots and out of wastewater treatment plants—than there was historically. In 2001, Colorado Spring utilities provided an annual average of 83 million gallons of clean water per day, and received back and treated an average of 44 million gallons of wastewater daily.

Increased flows in the regions-watersheds are due to several reasons. First and foremost, water is imported from other basins in the state to be used for municipal and agricultural purposes. According to the Pikes Peak Area Council of Governments (PPACG), 85% of the city's water is pumped in from west of the Continental Divide. Second, with development have come more impervious surfaces such as roofs, parking lots and roads that increase runoff to the region's drainages. Water that previously would have been stored in the soil from undisturbed areas, now runs of these impervious surfaces and is drained quickly into stream channels.

Such runoff carries a range of pollutants and sediment into stream systems, degrading water quality. The higher levels of flows also cause changes. With their newfound volumes and associated energy, these streams cut deeper and narrower channels, often lowering the water table of the riparian zone and making it unavailable to streamside vegetation.

Measurable indicators of water quality (what to look at when gauging what is happening to water quality in the Pikes Peak region).

- Fecal coliform
- Dissolved sulfate
- Dissolved fluoride
- Total iron
- Dissolved manganese
- Dissolved selenium

Measurable indicators of water quantity

- Stream flow
- Base flow
- Snowmelt
- Summer flow

For this study, the additional impervious surface area that would result from the four proposed projects was estimated, and it is a large amount—437 acres (see Table 2-9). This is an estimate of new surfaces that will not be available for soil infiltration and will contribute to new runoff volume in area streams, as well as additional pollutant loads. For Interstate 25 only, additional loads of sediment, metals and other indicators of water quality were also estimated from the increase in impervious surface area and are given in Table 2-10.

Table 2-9. Estimates of existing and potential additional impervious surfaces for four transportation projects in El Paso County, Colorado.

	Impervious Surfaces (acres)		
Roadway Project	Existing	Additional	Total
Interstate 25	235	128	363
Powers Boulevard	142	219	361
Woodmen Road	44	51	95
Drennan Road	4.4	39	43.4
Total for these road segments	**425.4**	**437**	**862.4**

[1]Calculation of additional impervious surface areas is preliminary and represents a best estimate based on existing plans for these proposed projects as of Oct. 1, 2003.

Table 2-10. Estimated existing and potential additional pollutant loading for the Interstate 25 improvement project in El Paso County, Colorado.

Pollutant	Estimated Existing Annual Mass Load (kilograms/year)	Annual kilograms Per acre of road surface[1] Existing Case (kg/acre)	Additional (kg/acre)	Total (kg/acre)
Total Suspended Solids (TSS)	26,056	111.0	203.6	314.6
Total Organic Carbon	4,587	19.5	35.8	55.4
Chemical Oxygen Demand	20,919	89.1	163.4	252.6
Nitrate	140	0.6	1.1	1.7
Phosphorus	73	0.3	0.6	0.9
Copper	10	<0.1	0.1	0.1
Lead	73	0.3	0.6	0.9
Zinc	60	0.3	0.5	0.7

[1]Estimate Assumes a homogeneous density of traffic per acre. Estimate of additional loading based on best estimates of increases in impervious surfaces for the I-25 project.

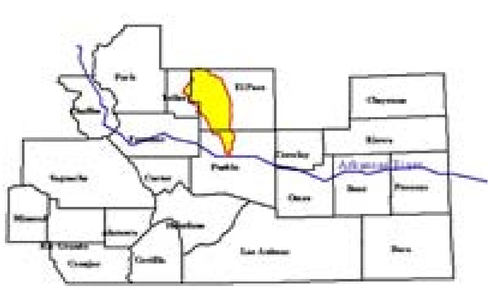
In addition to the indirect, physical changes to riparian areas caused by increases in impervious surfaces is the indirect and cumulative impact from non-point source and point source pollutants reaching these areas (Paul and Meyer 2001). As shown in Table 2-10, modeling of pollutant loading for I-25 suggests that the total amount of pollutants found in stormwater runoff will increase as impervious surfaces increase. It is not known how much of these pollutants actually will reach riparian and wetland areas, but because of their inherent functionality to trap sediment and other pollutants, riparian and wetland ecosystems could receive increased pollutant levels.

This becomes of particular concern when taking into consideration all of the planned growth and development in the region (e.g. more than 200,000 additional residents by year 2025).

Without intervention, the cumulative effect of pollutant loading over time may cause loss of ecosystem health and diversity, eutrophication (over-enrichment of water with nutrients) and/or sterilization.

HISTORIC WATER PATTERNS IN THE PIKES PEAK REGION

The Fountain Creek watershed includes Colorado Springs, Fountain and areas south to Pueblo. Fountain Creek flows into the Arkansas River, which then flows eastward through Kansas, Oklahoma and Arkansas to reach the Mississippi River (see Figure 2-35). El Paso County is by far the most populous Colorado county in the Arkansas River Valley.



Arkansas River

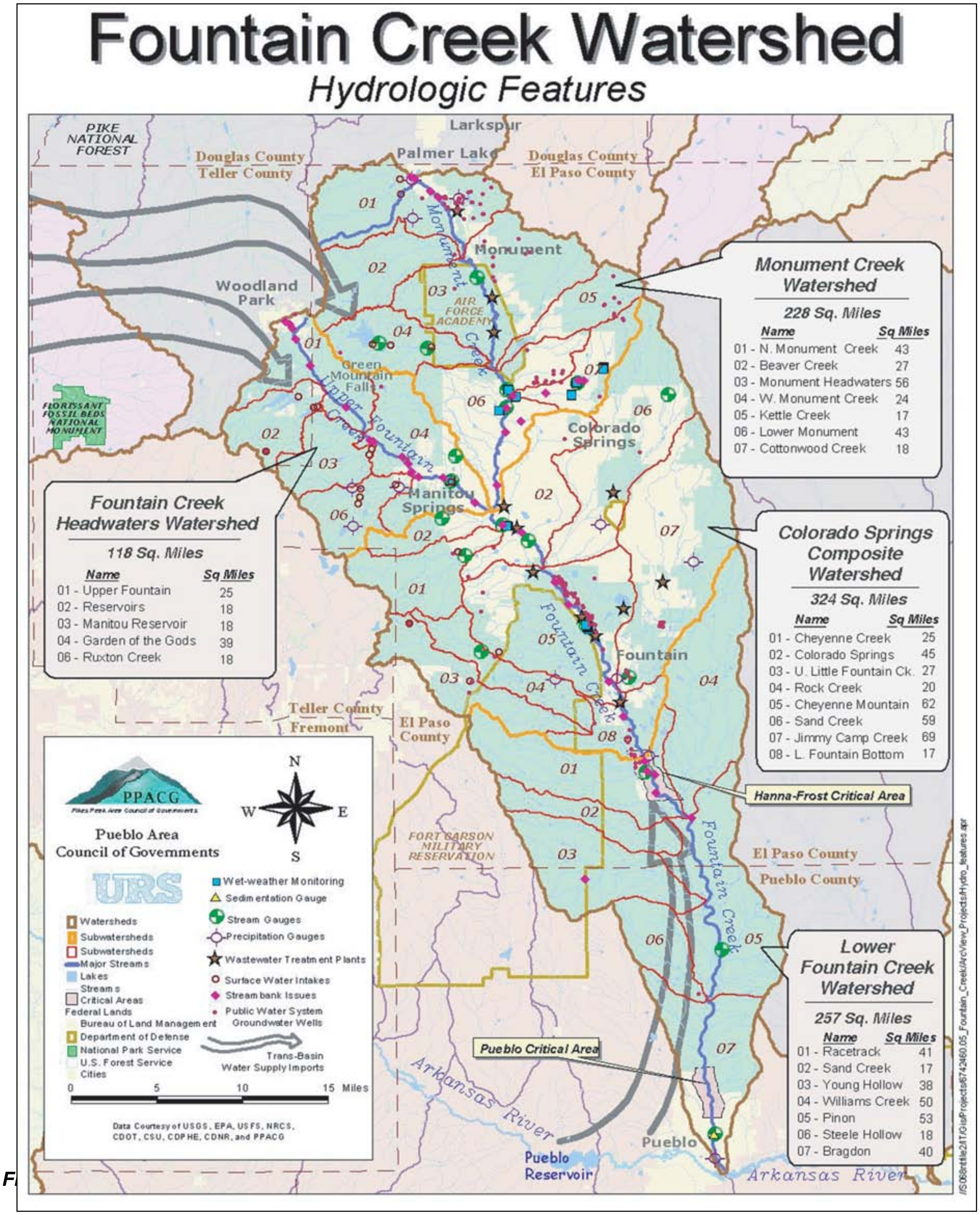
Historically, snowmelt from higher elevations in El Paso County combined with precipitation events to cause annual high-peak flows and annual flooding during spring and early summer months. These peak flows and annual flooding were essential to the establishment and maintenance of riparian and aquatic systems in the Pikes Peak Region.

Except for summer storm events, stream flow in this region historically reverted to very low or no flow during the summer and fall months. Flora and fauna of this region adapted to and depended on the dynamic nature of this hydrologic cycle. Indeed, some plant species (e.g., cottonwood) require spring flooding to provide the proper seedbed for new seedling establishment. Other species of plants (i.e., hydrophytic) are only found in areas where the soil is saturated for extended periods to create anaerobic (i.e., lack of free oxygen) conditions. Moreover, some wetland communities evolved with spring flooding or high groundwater levels associated with peak flows. Many wetland-dependent animal species (e.g., beaver) also relied on the historic water regime of high spring peak flows and annual flooding.

With development, water diversions and dams were designed to capture and control the annual flooding events. Stream stabilization and channelization projects further altered the region's historic water patterns. Changes in streams dynamics, water diversions /impoundments and general urbanization have all contributed to major changes in historic water patterns in the Pikes Peak Region. Urbanization has increased the amount of impervious surface in the area thereby increasing the amount of stormwater runoff. More stormwater runoff has led to increases in erosion and an increased level of concern regarding pollutants and water quality.

A report on Fountain Creek streamflow published by the US Geological Survey contained the following key trend information (USGS 2000). Since 1977, the high flows of the year have been getting higher and the low flows have also been getting higher. These trends in streamflow were not detected prior to 1977.

The Fountain Creek Watershed can be examined in terms of five subwatersheds as shown in Figure 2-36.


Fountain Creek Watershed
Hydrologic Features
Monument Creek Watershed
228 Sq. Miles
Name Sq Miles
01 - N. Monument Creek 43
02 - Beaver Creek 27
03 - Monument Headwaters 56
04 - W. Monument Creek 24
05 - Kettle Creek 17
06 - Lower Monument 43
07 - Cottonwood Creek 18
Fountain Creek Headwaters Watershed
118 Sq. Miles
Name Sq Miles
01 - Upper Fountain 25
02 - Reservoirs 18
03 - Manitou Reservoir 18
04 - Garden of the Gods 39
06 - Ruxton Creek 18
Colorado Springs Composite Watershed
324 Sq. Miles
Name Sq Miles
01 - Cheyenne Creek 25
02 - Colorado Springs 45
03 - U. Little Fountain Ck. 27
04 - Rock Creek 20
05 - Cheyenne Mountain 62
06 - Sand Creek 59
07 - Jimmy Camp Creek 69
08 - L. Fountain Bottom 17
Lower Fountain Creek Watershed
257 Sq. Miles
Name Sq Miles
01 - Racetrack 41
02 - Sand Creek 17
03 - Young Hollow 38
04 - Williams Creek 50
05 - Pinon 53
06 - Steele Hollow 18
07 - Bragdon 40
Hanna-Frost Critical Area
Pueblo Critical Area
PIKE NATIONAL FOREST
Larkspur
Palmer Lake
Douglas County
Teller County
Douglas County
El Paso County
Monument
Woodland Park
AIR FORCE ACADEMY
Green Mountain Falls
Colorado Springs
Manitou Springs
Fountain
FLORISSANT FOSSIL BEDS NATIONAL MONUMENT
Monument Creek
Upper Fountain Creek
Fountain Creek
Teller County
Fremont
El Paso County
FORT CARSON MILITARY RESERVATION
El Paso County
Pueblo County
Arkansas River
Pueblo
Pueblo Reservoir
PPACG
Pikes Peak Area Council of Governments
Pueblo Area Council of Governments
URS
N
W
E
S
Wet-weather Monitoring
Sedimentation Gauge
Stream Gauges
Precipitation Gauges
Wastewater Treatment Plants
Surface Water Intakes
Streambank Issues
Public Water System Groundwater Wells
Trans-Basin Water Supply Imports
Watersheds
Subwatersheds
Subwatersheds
Major Streams
Lakes
Streams
Critical Areas
Federal Lands
Bureau of Land Management
Department of Defense
National Park Service
U.S. Forest Service
Cities
0 5 10 15 Miles
Data Courtesy of USGS, EPA, USFS, NRCS, CDOT, CSU, CDPHE, CDNR, and PPACG

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WATER QUALITY IN THE PIKES PEAK REGION

The United States Geological Survey began monitoring water quality in the early 1960s. Today, a number of stations monitor characteristics such as water flow, fecal coliform, pH and dissolved oxygen, sedimentation and the presence of heavy metals.

Maintaining acceptable water quality in the region's surface waters is important for many reasons, including the following:

- Concentrations of heavy metals, especially a two-fold increase in selenium, may have serious health effects on both aquatic life and humans.
- Diminished water quality reduces recreational uses such as fishing and their attendant economic benefits.
- Limitations in drinking water availability restrict sustainable growth and development of the region.

A variety of fish habitats have been found within the Fountain Creek drainage, including riffles, runs and pools, which support different species of fish, vegetation and other aquatic life, but much of the native fish population, has been eliminated in the watershed.

The following table indicates the current water quality suitability for various uses designated for specific watershed portions of the study area. Note that a stream may be unsuitable to support aquatic life either due to poor water quality or due to inadequate amounts and frequency of water flows.

Table 2-11. Uses for segments of the Fountain Creek Watershed.

Segment Description	**Size**	**Assessed Use***
Mainstem of Fountain Creek – source to Monument Creek	165 miles	AC1, R1A, WS, Ag
Mainstem of Fountain Creek from a point above the confluence With Monument Creek to State Hwy 47 Bridge	40 miles	AW2, R1A,WS, Ag
Mainstem of Fountain Creek from Highway 4 Bridge to Arkansas River	14 miles	AW2, R1A, WS, Ag
Fountain Creek – all tributaries on National Forest or Air Force Academy lands	180 miles	AC1, R1A, WS, Ag
Fountain Creek – all tributaries not on National Forest or Air Force Academy lands	860 miles	AW2, R1A,Ag
Marshland Jimmy Creek and unnamed tributary	6 miles	AW1, R2, Ag
Mainstem of Monument Creek-NF boundary to Fountain Creek	27 miles	AW2 ,R1A,WS, Ag
Pikeview Reservoir, Willow Springs Ponds #1 and #2	78 acres	AW2, R1B, WS, Ag
Prospect lake, Quail Lake, Monument Lake	78 acres	AW2, R1A, Ag
Chico and Black Squirrel Creeks	679 miles	AW2, R2 WS, Ag

*Assessed use classifications:

AG	suitable for agricultural use
WS	suitable, after treatment, for human water supply
AC1 (AW1)	supports cold water (warm water) biological communities
AC2 (AW2)	does not support cold water (warm water) biological communities
R1A (R1B)	suitable (or potentially suitable) for recreation uses involving extensive contact with the water
R2	suitable for recreation uses with incidental contact with the water.

GROUNDWATER QUALITY

Much of the discussion on water quality has centered on effects to surface water supplies. Groundwater supplies both potable and irrigation water to locations within the study area.

Occasionally, groundwater quality becomes locally important. Groundwater pollution can occur due to improper handing, storage or use of certain chemicals. In some cases, due to local soil and water table conditions, the chemicals fortuitously remain a localized soil contamination problem. Such is the case for many leaking underground storage tanks at gasoline stations throughout the United States. In other cases, however, chemicals can reach an underground aquifer and contaminate wells and other downstream receptors. A well-knows case of this in the Pikes Peak region is a plume of contaminated groundwater in the Widefield area immediately south of Colorado Springs. This plume is several miles long and affects a drinking water aquifer.

The Schlage Lock Company operates a manufacturing plant where the chemical perchloroethylene (PCE) was used as a metal degreasing agent.

According to the Colorado Springs Gazette, Schlage is the 14th largest employer in El Paso County, with 1,100 workers. In 1979 and 1980, the company reportedly disposed of used PCE by dumping it onto the ground.

Over time, the PCE plume has contaminated the area's groundwater, as well as public and private wells. The plume of underwater contamination flowed southwesterly from the plant to the former Little Johnson Reservoir, then flowed south-easterly, generally paralleling U.S. Highway 85-87, finally reaching the Willow Springs fishing ponds in Fountain Creek Regional park near State Highway 16 (Fountain/Fort Carson) exit of Interstate 25.

After discovering elevated levels of PCE in fish at the Willow Springs ponds, El Paso County posted warning signs that anglers shouldn't eat fish caught there. PCE can cause liver and kidney damage in high enough concentrations. When the posted warning signs were apparently ignored by some park users, the County closed the ponds to fishing in late 1997. The Fountain Creek Regional Park was the site of a large heron rookery at that time. The herons have subsequently moved their nesting sites about seven miles to the north.

Schlage has been conducting groundwater testing and remediation to various degrees since the late 1980s to address the problem and has assured local residents that their health is not endangered by the contamination of their drinking water. Nevertheless, the matter remains a matter of contention and negotiation between the company and the County and possibly an ongoing source of anxiety for users of the affected water supply.

This case is one in which industrial activities had indirect effects (miles away from and years after the original chemical dumping) and potential cumulative effects on the community and on nature. With increased development in the region, come from ever-increasing opportunities for future groundwater contamination.

WATER QUANTITY IN THE PIKES PEAK REGION

Flooding has been a persistent problem for people in the Pikes Peak region, causing dramatic changes in aquatic habitats and damage to buildings and infrastructure. The five largest streamflow event that have occurred within the Fountain Creek Watershed in the past century have been in 1921, 1935, 1945, 1965 and 1999 (see Table 2-12).

Figure 2-37. Flooding in Palmer Lake, 1999.

Figure 2-38. Flooding in Manitou Springs, 1999.

Figure 2-39. Flood damage on Fountain Creek Trail, Colorado Springs, 1999.

Population growth has caused an increase in impervious surfaces, increased water use and increased stormwater runoff. These factors have contributed to flooding, erosion and sedimentation. Flooding combined with increases in impervious surfaces since 1962 have caused increased water quantity in streams. This has increased total suspended solids and sedimentation and flooding severity. It has also damaged stream habitats, as well as buildings and infrastructure.

Table 2-12. El Paso County Flood Events. Note: the floods of 1935 and 1965 both exceeded 500-year flood magnitudes.

Date	Location	Event
June 10, 1864	Colorado Springs	Torrential rains, 3-inch hail, extensive flooding
May 20, 1878	El Paso County	Cloudburst, hail, heavy losses
July 26, 1885	Templeton Gap Basin	Localized estimate of 16 inches of rain, apparently The most severe storm in the basin
May 30, 1894	Colorado City	Fountain Creek Flooding, bridge and house washed away
June 2-7, 1921	Shooks Run, Sand and Fountain Creeks	Worst storm in 25 years, extensive regional flooding
May 27, 1922	Templeton Gap Basin, Eastern Colorado Springs	6-inch rainfall recorded, extensive damage in Colorado Springs, eastern neighborhoods inundated
July 27-30, 1932	El Paso County	Flooding in most of northern Colorado Springs, Black Forest and along all of Fountain Creek, maximum known flood in Templeton Gap
May 31, 1935	Monument Valley, Eastern Colorado Springs	Greatest known flood on Monument Creek, which reached flood stage in less than one hour, personal property damage of $1.2 million throughout city ($15.7 million in 2002 dollars), flooding killed 18
June, 1965	El Paso County	Flood levels far in excess of 500-year intervals, exceeded all known floods in County history, 15 days and over 14 inches of rain
August 14, 1977	Colorado Springs	2.78 inches of rain in one hour
August 13, 1989	Northern Colorado Springs	Street flooding
May 30, 1990	Colorado Springs	3 inches of rain in 3 hours
June 17, 1993	Colorado Springs	4 inches of rain, flash flooding, Fountain Creek overflowing
April-May, 1995	El Paso County	Black Squirrel Creek inundated, railroad track and bed washed away, 40 roads damaged, 3" hail, 3 inches of rain, 24 roads closed due to heavy May rains
July 30, 1998	Security-Widefield	3-4 inches of rain
May 1, 1999	El Paso County and 11 other counties	Extensive flooding, disaster declared

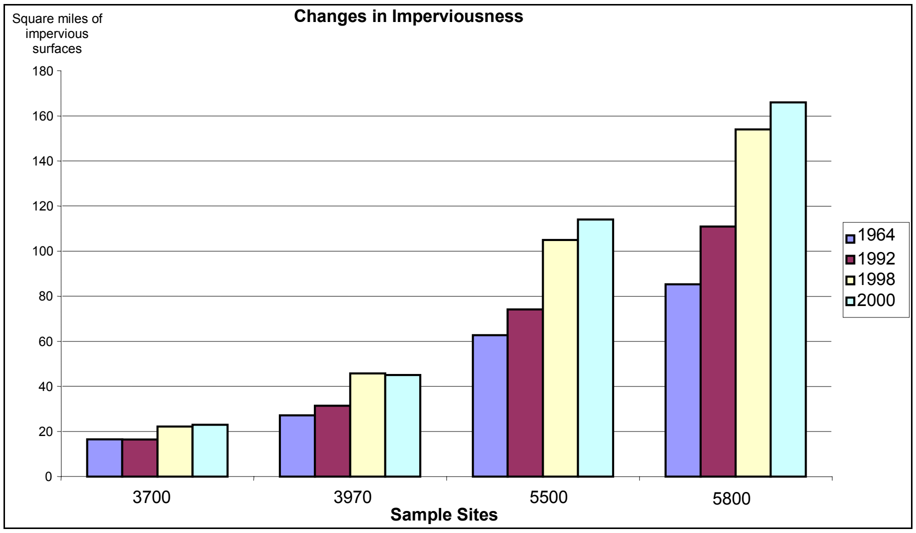


Figure 2-40. Changes in Imperviousness. Based on data from Edelmann, et al. (2002) for four drainages in the Fountain Creek Watershed.

A recent study by the U.S. Geological Survey (Edelman et al. 2002) estimated the amount of impervious surface area in the drainage basins that contribute to the flow that passes at various monitoring stations in the Fountain Creek Watershed. The results are shown in Figure 2-40. The site locations are shown in Figure 2-41.

The first sample site, station 3700, represents flow from Fountain Creek above its confluence with Monument Creek. Areas contributing to this flow (western Colorado Springs and Ute Pass communities) saw little development for several decades (1964 to 1992, shown) and thus saw little change in impervious surface over that time period. Growth in this area increased markedly during the 1990s, as reflected by the increase in impervious surface from 1992 to 1998.

Sample site 3970 monitors water flowing in Monument Creek, for the area north of Cottonwood Creek. This is the northern portion of El Paso County that is currently experiencing rapid growth. As with the first sample site, it is again estimated that impervious surface area contributing to flows at this station increased significantly during 1992 to 1998 – clearly a greater amount than in the preceding 28 years.

Sample site 5500 monitors the flow of Fountain Creek south of its confluence with Monument Creek. Flows here, and their associated drainage basin area and impervious surfaces, thus represent the combined efforts of western Colorado Springs, northern El Paso County, plus central Colorado Springs. Again, the rapid growth in the 1990s is reflected in the impervious surface estimates.

Sample Site 5800 reflects all of the factors and trends noted for site 5500, with the addition of impervious surface from eastern, southwestern and southeastern portions of the urbanized area. Cumulative effects to water quality and quantity of lower Fountain Creek logically result from all of the upstream development.

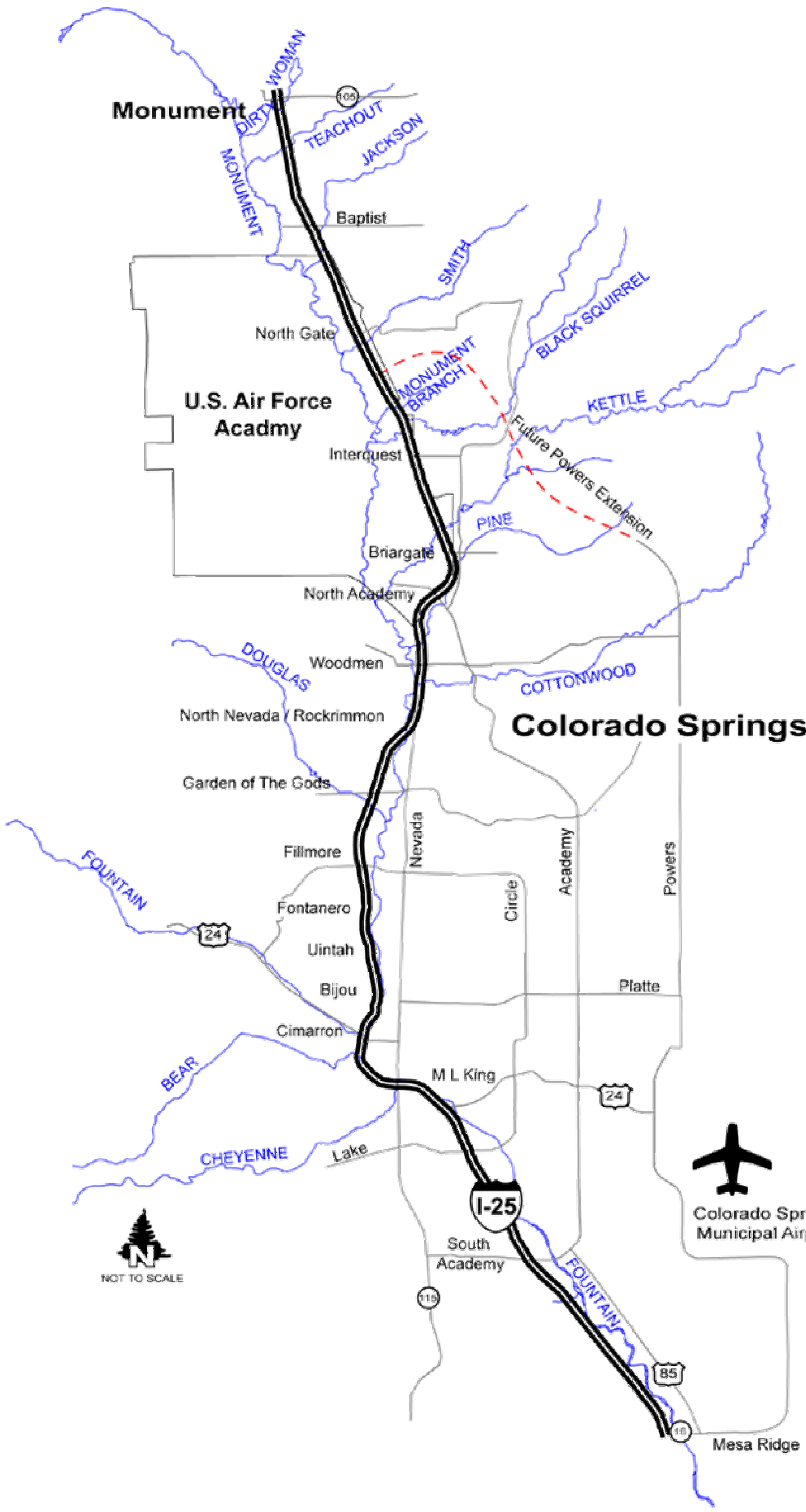
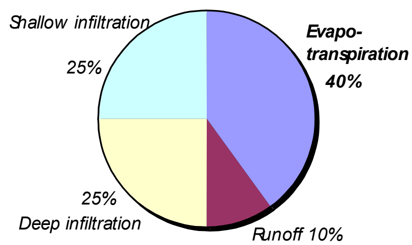


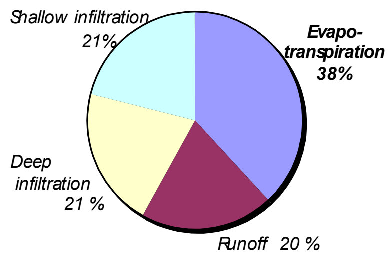
Figure 2-41. Location of USGS Gauges Measuring Water Quantity and Quality in the Fountain Creek Watershed

Changes in Imperviousness

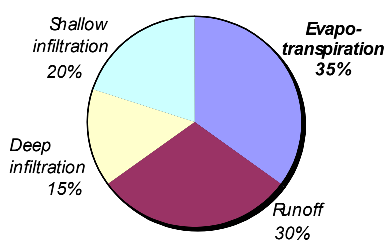
Forested Conditions:



10-20% Imperviousness:



35-50% Imperviousness:



75-100% Imperviousness:

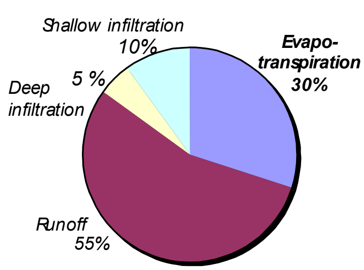


Figure 2-42. Changes in hydrologic flows with Increasing impervious surface cover in urbanizing Catchments (based on Arnold & Gibbons. 1996.

Figure 2-42 conceptually depicts the degree to which changes in impervious surface affect the immediate destination of rainfall in a given landscape.

The first pie chart represents a forested area with minimal (less than 10%) impervious surface. Here, as in all four pie charts, much of the water returns to the air by the process of evapo-transpiration. That is, the water evaporates and increases the ambient humidity of the air. One quarter of the water infiltrates deep into the ground to recharge groundwater, and another one quarter achieves only shallow infiltration, keeping the ground moist to benefit vegetation. Only 10% of the water runs off the land into surface drainages.

In the second pie chart, 10-20% impervious surface doubles the runoff to 20%, resulting in decreases to other outcomes, primarily reducing infiltration.

In the third pie chart, 35-50% impervious surface yields even higher runoff and further reduced infiltration. This can have serous downstream impacts in surface drainages, such as erosion, scouring and flooding. At the same time, it inhibits natural recharging of underground aquifers.
The fourth pie chart, reflecting 75% or more impervious surface, yields even higher runoff and further reduced infiltration. This can have serious downstream impacts in surface drainages (e.g. erosion, scouring, flooding) while at the same time inhibiting natural recharges of underground aquifers.

The estimate of impervious surface area covering much of the 927 square-mile Fountain Creek watershed was about 170 square miles. Using these numbers, a ballpark estimate for imperviousness in this watershed would be about 18%, corresponding to the second pie chart. Imperviousness in the Chico Creek watershed, to the east, would be much lower, corresponding to the first pie chart.

TRENDS IN WATER QUALITY AND QUANTITY

Just as there are major floods in the region from time to time, there are also occasional periods of drought. The drought in 2002 (possibly just the beginning of a multi-year drought cycle) dramatically reduced water levels in the region's reservoirs, and necessitated water use restrictions enacted by various local governments. Clearly, long-range planning of the water supply system, and long-term conservation planning are important to regional sustainability.

Moreover, trends in water quality and quantity suggest it may be hard to sustain biodiversity and quality of life with current approaches. Some parameters in the Fountain Creek watershed, such as Total Suspended Solids (TSS) and selenium, may be harmful for maintenance of biodiversity and quality of life.

Continued impairment of water quality in the Pikes Peak Region can result in a loss in the abundance and diversity of aquatic habitat and fish species, damage to the reproductive functions and population dynamics in fishes, a loss of recreation opportunities, and higher costs to treat drinking water, while increased water quantity can result in a greater loss of public and private property and damage to infrastructure.

Regarding water quantity, Figure 2-43 shows an overall increase in stream flows at five monitoring stations in the Fountain Creek Watershed. The flows, measured in cubic feet per second (cfs) vary dramatically by time of year. Therefore, the reader is advised to note the differing scales of the three line plots comprising the figure.

For each of the line plots, an overall trend line has been determined and appears as the solid black line. For every season, there is a clear upward trend in flows over the 14-year period analyzed.

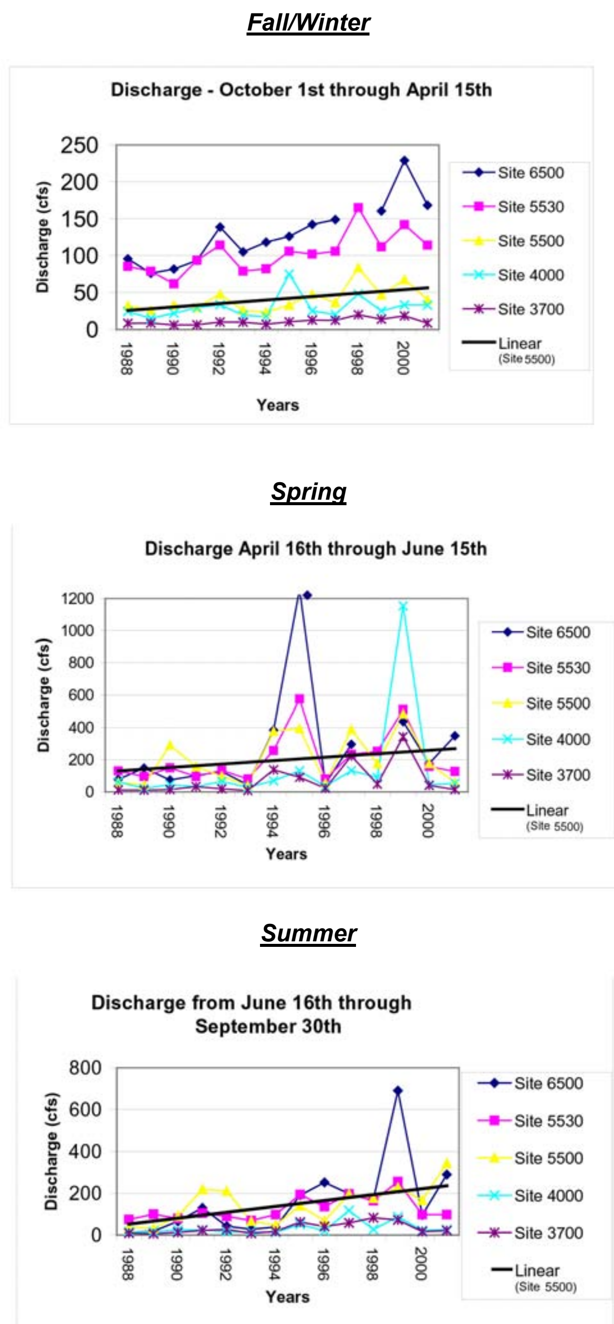


Figure 2-43. Temporal trends in flow for five monitoring stations in the Fountain Creek watershed show increased flow from 1988 to 2001.

THE VISION FOR WATER QUALITY AND QUANTITY IN THE FUTURE IN THE PIKES PEAK REGION

The Federal Water Pollution Control Act (Clean Water Act) was enacted in 1972 as a result of a growing concern over water pollution, and today it form the foundation of surface water protection in the United States. A goal of the Clean Water Act is to restore and maintain the chemical, physical, and biological integrity of the nation's waters.

Among other things, the Clean Water Act prohibits the discharge of any pollutant from a point source into navigable waters, including wetlands, without a permit. Section 404 of the Clean Water Act regulates these discharges and is jointly administered by the U.S. Army Corps of Engineers and the U.S. Environmental Protection Agency.

Although the Clean Water Act initially focused on individual pollutants and individual sources, the focus has shifted towards a more holistic watershed-based approach. The watershed-based approach is commonly used by most federal agencies to assess impacts to water resources. The natural resource expert panel to define the natural resource study area consequently used this same approach.

Several important points from the Colorado Springs Comprehensive Plan relate to water Issues and suggest what sustainable patterns might be:

- *Continually improve the community's stewardship of its natural setting.*
- *Maintain a citywide context or perspective as an integral part of incremental land use decision-making.*

KEY STRATEGIES FOR SUSTAINING WATER QUALITY AND CONTROLLING WATER QUANTITY IN THE PIKES PEAK REGION

POLICY-LEVEL STRATEGIES
WATER QUALITY AND QUANTITY

- ☑ Control creation of new impervious cover to enable continued groundwater contribution to streamflow during low flow conditions and to minimize flooding impacts from increased surface runoff.
- ☑ Enhance public knowledge of the importance of maintaining vegetative cover.
- ☑ Develop policies such as streamside setbacks that control development such as parking lots and roadways adjacent to streams, to protect or enhance water quality.
- ☑ Institute a local policy requiring no net loss of wetland for projects involving impacts to wetland habitat, even though the wetlands in question may not be regulated under the Clean Water Act.

PROJECT-LEVEL STRATEGIES
WATER QUALITY AND QUANTITY

- ☑ Ensure that bet management practices (BMPs) are appropriately applied. (A Best Management Practice is any program, process, citing criteria, operating method, measure or device, which controls, prevents, removes, or reduces pollution.)
- ☑ Enforce existing local water quality regulations.
- ☑ Ensure that all contractors are properly applying erosion control measures.
- ☑ Ensure that a National pollution Discharge Elimination System (MPDES) permit is obtained for all projects affecting one acre or more.
- ☑ Apply BMPs to target runoff associated with roads, highway related nonpoint source water quality related issues.
- ☑ Minimize impervious surfaces associated with parking lots, buildings, and roads, as well as the amount of vegetation and soil removal.
- ☑ Avoid impacts to wetlands, floodplains, and riparian corridors which a practicable alternative exists.

Case Study

Colorado Springs, Colorado
Streamside overlay ordinance approved

On October 24, 2002, the Colorado Springs City Council approved a streamside overlay ordinance that establishes jurisdictional limits, application processes, physical standards, suitable land uses, and qualitative review criteria for development in the vicinity of streams within the City. The primary objectives of the ordinance and overlay are to conserve natural features of streams and promote development that is compatible with its stream setting.

The ordinance should help protect streams, adjacent floodplains, intact natural slopes and riparian vegetation, all very important components of landscape pattern.

Fountain Creek through Colorado Springs

Case Study

Castle Rock, Colorado
CDOT/FHWA restoration of an Urban affected stream

The Colorado Department of Transportation (CDOT) owns about 25 acres of riparian and wetland area in the town of Castle Rock, Douglas County. While determining future Impacts from I-25 improvements in this area, CDOT discovered that riparian communities on East Plum Creek were declining rapidly. Further investigation showed that the threatened Preble's meadow jumping mouse lived in willow stands on the edge of the stream, and that willows were dying because their root systems were no longer in contact with the water table. The depression of the water table was due to severe stream downcutting in the past decade, which was caused by additional water in the stream channel flowing from impervious surfaces in the watershed.

CDOT devised a series of nine check dams on the stream to restore the natural stream profile and raise the water table, reversing the decline of the riparian vegetation. Initial results have been very promising, with ground water levels rising and being maintained. CDOT/FHWA worked with the U.S. Fish and Wildlife Service to protect this area as a conservation bank, and CDOT will also receive conservation credits for their efforts.

This project illustrates an innovative, but costly, solution to stream degradation in a riparian area.

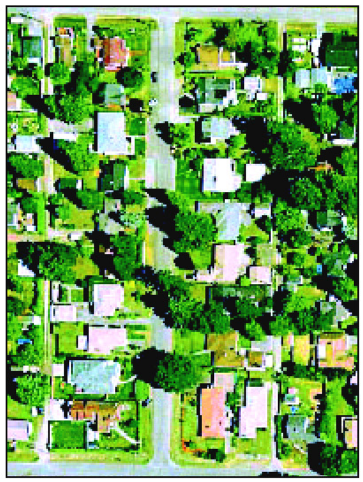
Case Study

Seattle Post-Intelligencer

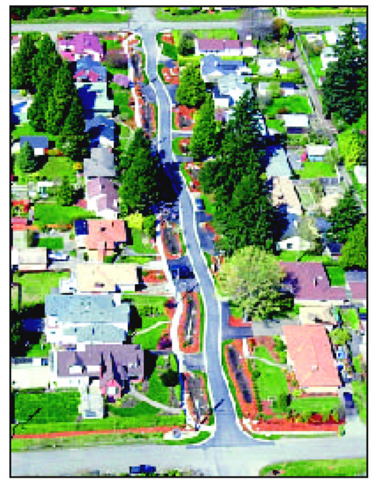
A PILOT PROJECT TO REDUCE RUNOFF

In a pilot project using "green" engineering, a block in Seattle's Broadview neighborhood reduced stormwater runoff by 98 percent. Seattle Public Utilities spent $800,000 to create a natural drainage system in place of the traditional curb-and-gutter designs that send tainted runoff into area waters.

BEFORE



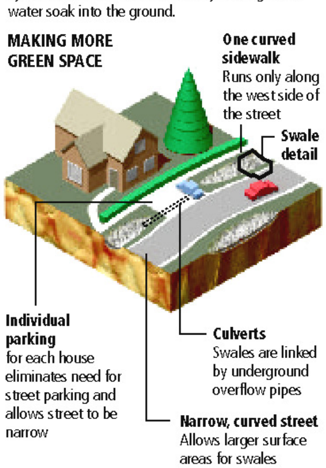
AFTER



DESIGN FEATURES OF A NATURAL DRAINAGE SYSTEM

Urban development removed many of the trees and natural surfaces that soaked up rain like a sponge. Without those natural barriers, rain not only has the potential to cause flooding and erosion, but it collects pollution and can overwhelm sewer systems. A natural drainage system slows the flow of runoff by making more water soak into the ground.

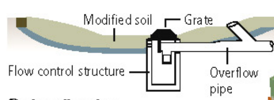
MAKING MORE GREEN SPACE



SWALES: STEERING STORMWATER

A major feature of the project involved creating carefully graded and landscaped swales along the street to collect most of the runoff. Three types of swales were used on this project. All swales are filled with modified soils to speed absorption and vegetation to slow runoff but they serve different purposes during larger storms.

▸ Flow control swale
Regulates flow of stormwater for all swales

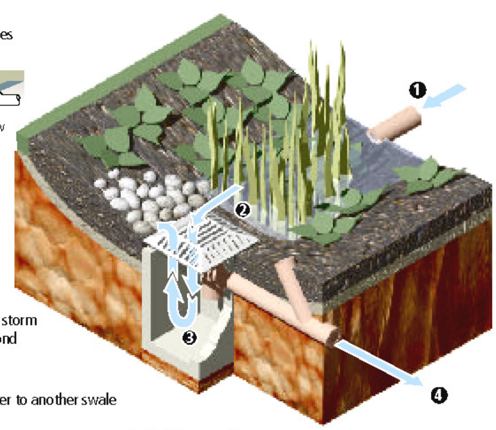


❶ Flow direction
Water from other swales flows downstream through underground overflow pipes into flow control swale

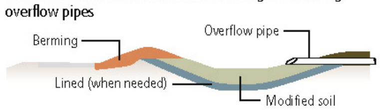
❷ Absorption
Modified soil absorbs water until it begins to pool

❸ Ponding
During heavy rains the catch basin backs storm water up through the grate, creating a pond in the swale

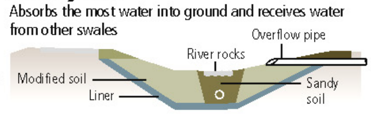
❹ Overflow port
Another overflow pipe carries excess water to another swale



▸ Conveyance swale
Drains excess water to other swales through connecting overflow pipes



▸ Holding swale
Absorbs the most water into ground and receives water from other swales



Source: Seattle Public Utilities

DAVID BADDERS/SEATTLE POST-INTELLIGENCER

Other relevant case studies to see in this report:

- City of Austin, Texas: Sustainable Communities Initiative
- Fort Carson, Colorado
- Greater Wasatch Area, Utah: Envision Utah
- Kansas City region, Kansas and Missouri

Key written resources:

"Evaluation of Water Quality, Suspended Sediment, and Stream Morphology with an Emphasis on Effects of Stormwater on Fountain and Monument Creek Basins, Colorado Springs and Vicinity, Colorado, 1981-2001," P. Edelmann, et al.

"Summary of Water Quality Data, October 1987 through September 1997, for Fountain and Monument Creeks, El Paso and Pueblo Counties Colorado," Clifford Bossong.

"Trends in Precipitation and Streamflow and Changes in Stream Morphology in the Fountain Creek Watershed, Colorado 1939-1999," Robert Stogner, Sr.

"Water Quality management Plan for the Pikes Peak Region," Pikes Peak Area Council of Governments.

"Fountain Creek Watershed Plan (Phase I)," Pikes Peak Area Council of Governments.

2-C. AIR QUALITY

Good air helps sustain quality of life for humans and is a key element for biodiversity. Air pollution impairs human and animal respiratory functions and may lead to lung disease and death. Clean air also is an important part of the Pikes Peak area's famous scenic quality.

Air quality is affected by population growth, housing and other development, transportation patterns, and pollution control policies and technology. The causes of air pollution include motor vehicle emissions, street sanding, power plants, factories, and wood burning.

Measurable indicators of air quality (what to look at when gauging what is happening to air quality in the Pikes Peak region).

- Carbon monoxide (CO)
- Particulate matter 10 microns or less in aerodynamic diameter (PM_{10})
- Particulate matter 2.5 microns or less in aerodynamic diameter ($PM_{2.5}$)
- Nitrogen Dioxide (NO_2)
- Sulfur dioxide (SO_2)
- Lead (Pb)
- Ozone (O_3)

CLEAN AIR AND DRAMATIC VIEWS LONG-ASSOCIATED WITH COLORADO SPRINGS

Colorado Springs has long been known for its healthy environment, clean air and scenic views. In fact, clean air was one reason many tuberculosis sanatoria were built here at the turn of the 20th century.

With the Clean Air Act of 1970 and its 1977 amendments, Congress tasked the U.S. Environmental Protection Agency with establishing and enforcing national air quality standards. States with areas violating the National Ambient Air Quality Standards (NAAQS) were required to submit and implement plans detailing how they would accomplish emissions reductions sufficient to meet the standards by applicable mandated deadlines.

The EPA established air quality standards for six criteria pollutants. The primary standard, established to protect human health, are listed in Table 2-13.

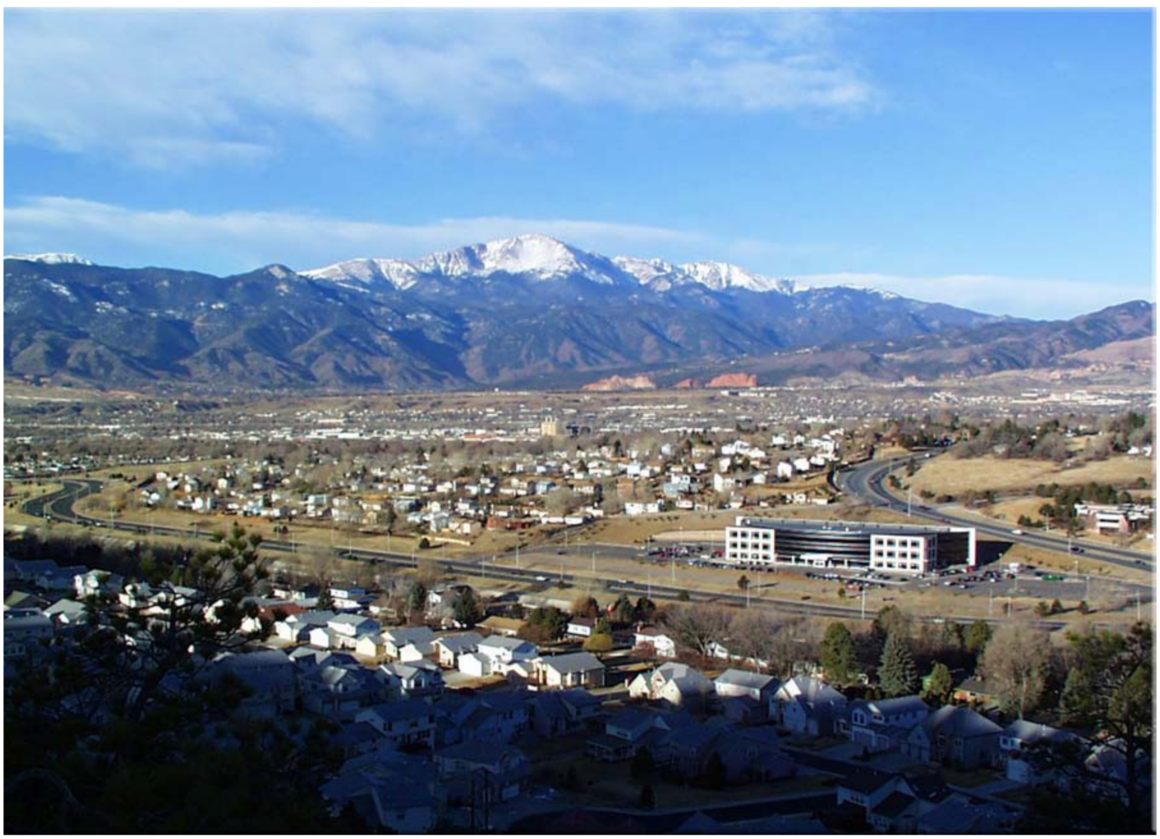


Figure 2-42. Good air quality enhances enjoyment of the region's viewsheds. This view includes Union Boulevard, north central Colorado Springs, and the Garden of the Gods (red-rock formations) nestled at the base of Pikes Peak.

Table 2-13. National Ambient Air Quality Standards

Pollutant	Standard
Carbon Monoxide (CO) 8-hour average 1-hour average	9 ppm 35 ppm
Nitrogen Dioxide (NO_2) Annual arithmetic mean	.053 ppm
Ozone (O_3) 1-hour average 8-hour average	.12 ppm .08 ppm
Lead (Pb) Quarterly average	1.5 $\mu g/m^3$
Particulate (PM_{10}) Particles with diameters of 10 micrometers or less Annual arithmetic mean 24-hour average	50 $\mu g/m^3$ 150 $\mu g/m^3$
Particulate ($PM_{2.5}$) Particles with diameters of 2.5 micrometers or less Annual arithmetic mean 24-hour average	15 $\mu g/m^3$ 65 $\mu g/m^3$
Sulfur Dioxide (SO_2) Annual arithmetic mean 24-hour average	.030 ppm .014 ppm

$\mu g/m^3$ = micrograms per cubic meter
ppm = parts per million

Source: www.epa.gov.

Air quality has been monitored in the Colorado Springs area since the late 1970s (see Figure 2-45 and Table 2-14). Air quality has been affected primarily by the following sources:

- Automobiles and other vehicles emit carbon monoxide, nitrous oxides and lead
- Burning coal and wood for energy and home heating emits particulates.
- Factories and service facilities emit urban air toxics (hazardous air pollutants such as benzene, carbon tetrachloride and methylene chloride).

Carbon monoxide levels regularly exceeded federal standards of 9 parts per million throughout the 1970s and early 1980s. No violation of the carbon monoxide standard has been recorded since 1989. After a decade with no violations, the region was allowed to discontinue mandatory use of wintertime oxygenated fuels.

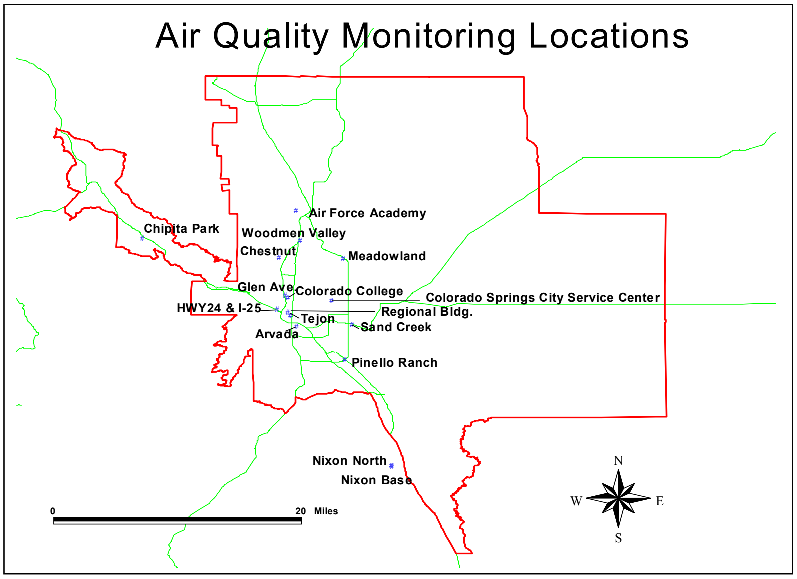


Figure 2-45. Location of air quality monitoring sites in the Pikes Peak region. Air quality has been monitored in the Colorado Springs area only since the late 1970s.

Table 2-14. Monitoring locations and parameters in the Pikes Peak region.

Site Name	CO	PM_{10}	$PM_{2.5}$	Agency*	Status
Nixon Base		X		CSU	Active
Nixon North	X			CSU	Inactive
Woodmen Valley	X	X		CSU	Active
Pinello Ranch	X	X		CSU	Active
Chipita Park	X	X		CSU	Active
Colorado College	X	X		CSU	Active
Meadowland	X	X	X	CSU, CDPHE, EPCDHE	Active
Sand Creek	X	X		CSU	Inactive
Glen Ave.	X			CDPHE, EPCDHE	Active
C S City Service Center		X		CDPHE, EPCDHE	Inactive
Regional Bldg. Dept.		X	X	CDPHE, EPCDHE	Active
Air Force Academy				CDPHE, EPCDHE	Active
Highway at I-25	X			CDPHE, EPCDHE	Active
Arvada	X	X		CSU	Active
Tejon St.	X			EPA, EPCDHE	Inactive
Chestnut				EPCDHE	Inactive

CSU = Colorado Springs Utilities;
CDPHE = Colorado Department of Public Health and Environment;
EPCDHE = El Paso County Department of Health and Environment;
EPA = U.S. Environmental Protection Agency.

NITROGEN IMPACTS

Nitrogen is a key element in all biological systems. All proteins contain nitrogen, including the enzymes that catalyze biological reactions and allow for normal life-processes. Nitrogen can occur in both organic forms (carbon-nitrogen compounds), and inorganic forms (nitrate {NO_3^-}, nitrite {NO_2^-}, ammonium {NH_4^+}, ammonia {NH_3}, and others). There are many potential pathways that cycle nitrogen between these organic and inorganic forms. These pathways can be found in the atmosphere and in aquatic and terrestrial systems.

There has been concern that increases in nitrogen emissions from a variety of sources has caused effects on both aquatic and terrestrial biological systems. The Colorado Front Range has seen an increase in nitrogen deposition in the past few decades from a variety of sources, including agriculture (animal emissions and fertilizers) and automobiles. These increases are greater on the east side of the Front Range compared to the west side and are estimated to be 3 to 5 kg (or 6 to 11 pounds) of nitrogen deposition per hectare per year. The Colorado Springs emission rate of nitrous oxide species (NO_x) is greater than 5 Mg annually, with about 50% of that from mobile sources. The deposition rate of inorganic N averaged 2.5 to 3.5 kg per hectare per year for sites greater than 2500 meters elevation on the east side of the continental divide (about 5-10 times greater than background sites on the west side).

Although this load is considerably less than emissions from areas that have documented ecological effects (of around 10 kg N per hectare per year), there is concern that chronic, low additions in nitrogen also will have ecological effects (Baron et. al., 2000). There is increasing evidence that these low, chronic additions have caused changes to terrestrial forest systems (changes in soil nitrogen, tree foliar chemistry and microbial mineralization rate) and alpine lakes (water chemistry and algal populations).

Although many of the documented effects area related to soil and water nitrogen-cycling processes, they will ultimately affect plant and animal resources. Such changes would include changes in plant composition (some plants are better adapted to high nitrogen soils), tree winter damage, changes in aquatic invertebrates/zooplankton, fish sensitivity and amphibian development.

URBAN AIR TOXICS

In addition to the national air quality standards set forth by the EPA for the six criteria pollutants, EPA also has established a list of 33 urban air toxics. Urban air toxics, also known as hazardous air pollutants, are those pollutants that cause or may cause cancer or other serious health effects or adverse environmental and ecological effects. Most air toxics originate from human-made sources, including road mobile sources (e.g., cars, trucks, buses), non-road mobile sources (e.g., airplanes, lawnmowers, etc.), and stationary sources (e.g., factories, refineries, power plants), as well as indoor sources (e.g., building materials). Some air toxics also are released from natural sources such as volcanic eruptions and forest fires.

Science has been providing more evidence about the risks these pollutants pose to human health. The health risks for people exposed to urban air toxics at sufficiently high concentrations or lengthy duration include an increased risk of cancer or other serious health effects, including damage to the immune system and neurological, reproductive, developmental, respiratory and other health problems.

To better understand the harmful effects urban air toxics from road sources have on human health, in 1996 the EPA developed a list of 22 mobile source air toxics, such as acetaldehyde, benzene, formaldehyde, diesel exhaust, acrolein and 1,3-butadiene and assessed the risks of various kinds of exposures to these pollutants on human health.

In July 1999, the EPA published a strategy to reduce urban air toxics, and subsequently, in March 2001, the EPA issued regulations for the producers of urban air toxics to decrease the amounts of these pollutants by target dates in 2007 and 2020. Under these regulations, between 1990 and 2020, on-highway emissions of benzene, formaldehyde, 1,3-butadiene and acetaldehyde will be reduced by 67% to 76%. On-highway diesel particulate matter emissions will be reduced by 90%. These reductions will be the result of national mobile source control programs, including the reformulated gasoline program, a new cap on the toxics content of gasoline, the national low-emission vehicle standards, the Tier 2 motor vehicle emissions standards and gasoline sulfur control requirements, and the heavy-duty engine and vehicle standards and on-highway diesel fuel sulfur control requirements. These are net emission reductions; that is, the reductions will be experienced even after growth in vehicle miles traveled is taken into account.

The EPA has not yet determined how best to evaluate the impact of future roads and intersections on the ambient concentrations of urban air toxics. There are no standards for mobile source air toxics and there are no tools to determine the significance of localized concentrations or of increases or decreases in emissions.

Throughout the United States, emissions of air toxics can be expected to decrease over time due to EPA's national control programs.

AIR QUALITY TODAY

The results of ongoing air-quality monitoring efforts indicate the Pikes Peak region currently meets State and Federal air-quality standards (i.e., it is "in attainment") for all six major air quality pollutants.

Levels of sulfur dioxide, nitrogen dioxide and lead have remained relatively unchanged and far below the State and Federal standards. These pollutants have never been a serious problem in the region, except lead, which was a problem in the late 1970s when leaded gasoline was still being used.

- The last violations were of the carbon monoxide standard in 1989 and the ozone standard in 1980.
- The highest levels of carbon monoxide have been reported at the Highway 24 monitoring station just west of I-25 and are probably a result of construction and traffic delays that result in more idling and sporadic acceleration and braking.
- The highest levels of PM_{10} were detected at the Meadowland station near Academy Boulevard and probably are primarily a result of street sanding before and after winter storms.

Other pollutants vary from year to year, with no discernible trend up or down.

The toxic release inventory for Colorado shows an 80 percent decrease of toxic manufacturers since 1988.

Carbon monoxide (CO) is a colorless, odorless gas that results from incomplete combustion of carbon-based fuels (such as gasoline, used by motor vehicles and wood burned in fireplaces).

Concentrations of CO typically are highest in winter months, when climatic conditions, called thermal inversions, trap polluted air close to the ground. The Federal eight-hour standard for CO was violated regularly in the late 1970s and 1980s. Thanks to improved motor-vehicle emission technology, together with cleaner fuels and state-mandated emission inspections, no CO violations have been recorded in the region since 1989.

Particulate matter consists of dust and other particles suspended in the air. Street sanding during winter storm events contributes to particulate pollution when motor vehicles crush the sand and kick up the dust into the air.

Air pollution standards for particulate matter have evolved over time. Initially, the focus was on Total Suspended Particulates, regardless of their size. Later, a second standard was established to focus on particles 10 microns or smaller in diameter, because these smaller PM_{10} particles were more likely to be inhaled into the respiratory system. Later, a third standard was developed, called $PM_{2.5}$, which focused on particles 2.5 microns or smaller in diameter. These smaller particles are understood to be especially adverse for human health. Particles of this small size typically are more closely associated with chemical processes (e.g. motor fuel combustion) than larger particles. Figure 2-45 depicts estimated source contributions of PM_{10} in the Pikes Peak region.

The Pikes Peak region has not had problems with ozone, but needs to remain vigilant regarding this possibility. Ozone is a pungent, poisonous gas consisting of molecules with three oxygen atoms (O_3).

Stratospheric ozone helps protect Earth from dangerous solar radiation, but ground-level ozone is a respiratory irritant. Ground-level ozone is not directly emitted by human activities but instead forms as the result of atmospheric chemical processes in the presence of sunlight. Ozone is the chemical smog that has plagued southern California and other highly congested, highly industrialized metropolitan areas.

The chemical precursor ingredients for ozone are hydrocarbons (especially the volatile organic compounds) and oxides of nitrogen. Both of these are contained in motor vehicle exhausts. Power plants, industry, fuel use and chemical solvents also release these chemicals into the air. Ozone formation is more typically a problem in summer than in other parts of the year.

A case study in this air quality section provides a menu of ozone-oriented pollution reduction strategies promoted by Denver's Regional Air Quality Council.

Air quality improvement has involved a variety of programs at the Federal, State and local level. For example, a main contributor to improved air quality in El Paso County has been improved vehicle technology mandated by Federal Motor Vehicle Emission Standards. Oxygenated fuel requirements and motor vehicle emission testing required by Colorado Law has helped reduce mobile source emissions.

Federal air quality standards and noncompliance sanctions have been one of the bigger weapons in the war on pollution. Generally, the control measures with the biggest impacts are those that are mandatory and cannot be avoided. Voluntary programs and initiatives targeting only a portion of motor vehicle emissions (e.g., focusing only on work trips) tend to have significantly smaller identifiable benefits.

El Paso County has the authority to regulate and monitor stationary emission sources and area sources of pollutants. The owners of stationary sources (e.g., Colorado Springs Utilities, which operates the area's electrical power plants) ultimately are responsible for reducing their own emissions to stay within mandated allowable limits.

Another tool used to protect air quality is the requirement that the regional transportation planning agency project future mobile source emissions and compare them to an adopted allowable emissions budget (see Figure 2-46). Under these Federal conformity requirements, the Pikes Peak Area Council of Governments is prohibited from approving a short-term Transportation Improvement Program or long-range transportation plan unless there is analysis indicating that future air quality will remain within acceptable levels.

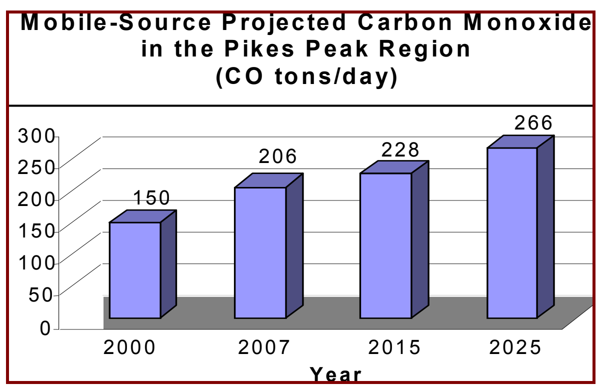


Figure 2-46. As the population increases, carbon monoxide levels are also expected to increase. The region is required to stay within a conformity budget of 270 CO tons per day.

Slow, congested traffic produces unnecessarily high rates of tailpipe emissions. Air quality improvement is produced if the regional transportation plan can find ways to reduce congestion and even moderately increase average travel speeds. In the regional transportation plan, certain corridors such as I-25 have been designated as part of a Congestion Management System. With this system, cameras are used to monitor traffic to detect incidents and variable message signs are used to alert motorists to potential problems. These steps can help minimize delay and therefore unnecessary emissions.

TRENDS IN AIR QUALITY

Carbon Monoxide: As seen in Figure 2-47, the predominant source of carbon-monoxide emissions has been and will continue to be on-road mobile sources, meaning tailpipe emissions from motor vehicles. Improved vehicle technology is helping to reduce the emissions per vehicle mile traveled (VMT), even as the region's VMT per day increases. With increased population comes increased use of gasoline-powered generators, construction vehicles, snowblowers, chainsaws and other non-road mobile sources. Stationary area sources include primarily woodburning in fireplaces. Stationary point sources include power generating facilities and industrial plants.

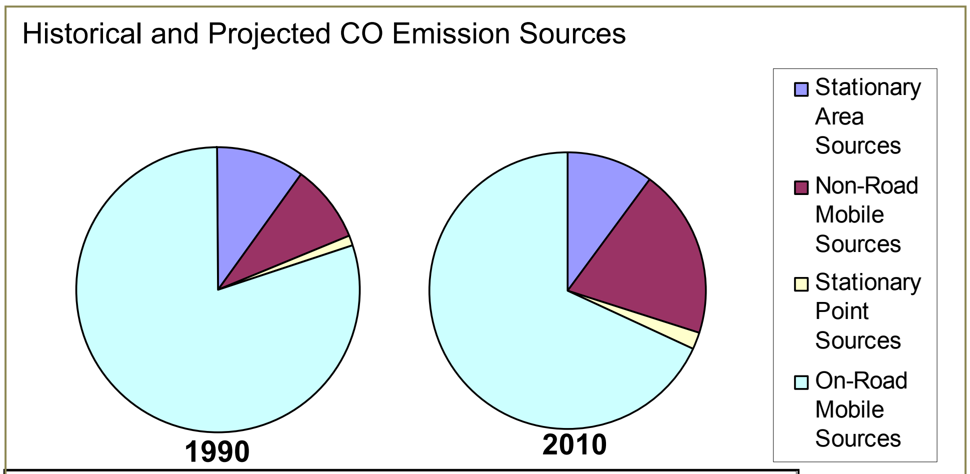
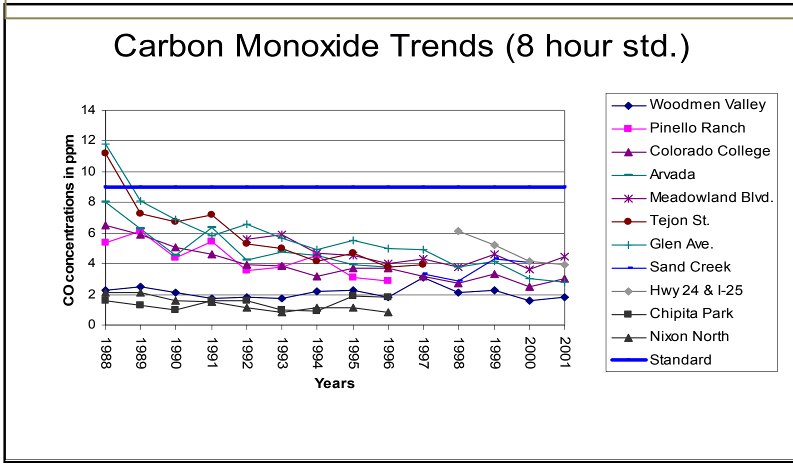


Figure 2-47. The percentages of different carbon monoxide sources have changed over time and are expected to continue to do so.



An average ambient carbon monoxide (CO) concentration of more than nine parts per million (ppm) over any eight-hour period constitutes an exceedance of the national air quality standard for CO. The Pikes Peak region has not experienced a violation of the national CO standard since 1989, thanks to cleaner motor-vehicle technology, vehicle inspections programs and oxygenated winter fuels. The highest concentration recorded n 2001 was about half of the standard.

Figure 2-48. The late 1980s showed significant decreases in carbon monoxide trends. The solid blue line depicts the federal standard.

Ozone: The national ambient air quality standard for ozone is 0.12 parts per million. The Pikes Peak region has not experienced a violation of the one-hour ozone standard since 1983, and over the past decade recorded concentrations have not been greater than about 75% of the allowable concentration. However, the outlook with respect to the eight-hour ozone standard suggests that population growth is leading the region in the direction of future ozone problems.

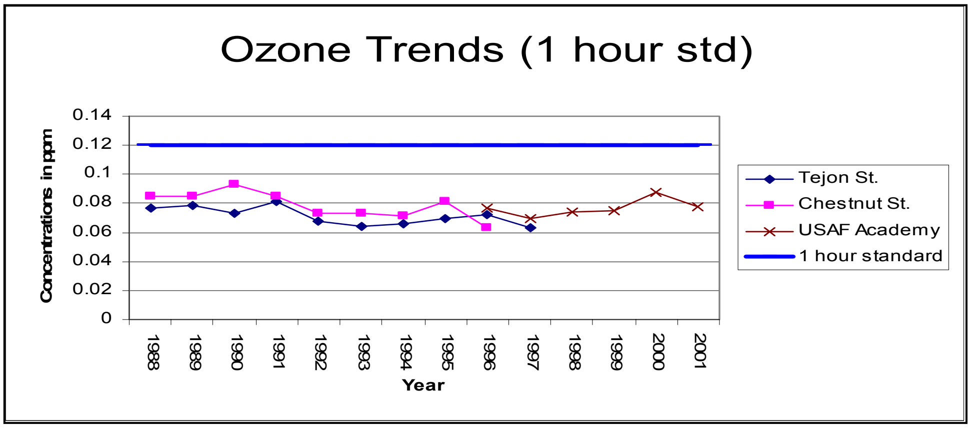


Figure 2-49. Monitored ozone levels in the Pikes Peak region as compared to the one-hour allowable concentration.

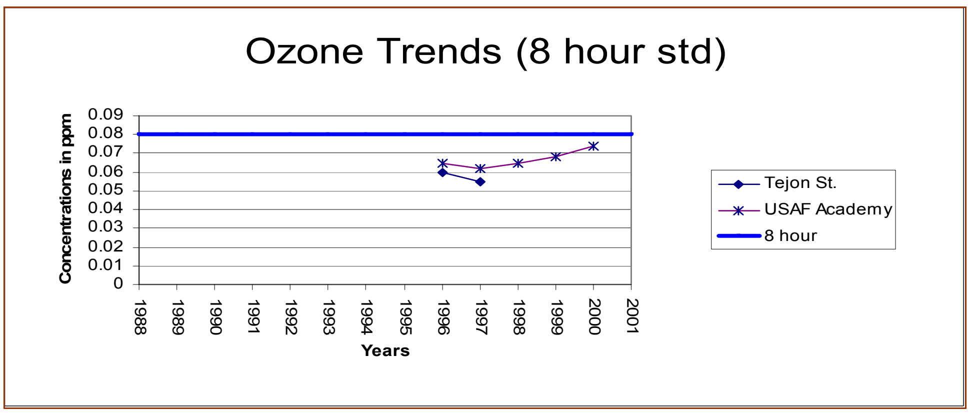


Figure 2-50. Eight-hour average ozone levels, monitored only since 1996, show an increase in the northern part of the Pikes Peak region. (Air Force Academy monitor)

Much newer than the one-hour ozone standard is an eight-hour standard promulgated by the U.S. Environmental Protection Agency in the mid 1990s. As seen in Figure 2-50, monitoring of eight-hour ozone concentrations in the region began in 1996 and has indicated an apparent upward trend. The Pikes Peak Area Council of Governments has examined this trend and concluded that a violation of this standard appears likely by 2007.

Particulate Matter: Figure 2-51 depicts the sources of particulate matter in the air as determined in a regional inventory in 1988. At that time, the U.S. Environmental Protection Agency promulgated a new PM10 standard focusing attention of fine, inhalable particulates ten microns or smaller in diameter. Previously, the agency had focused on total suspended particles, which included the fine particles as well as larger particles.

Based on chemical analysis of particles collected on air filters, it was determined that geologic sources (dust, due to our semi-arid climate) were the leading source of PM_{10}, followed closely by woodburning as the second major source. Together, all other sources accounted for about 21% of the pollutant emissions. Diesel engines are used heavily in construction equipment and other non-road mobile sources, but do not account for a large portion of the on-road motor vehicle fleet.

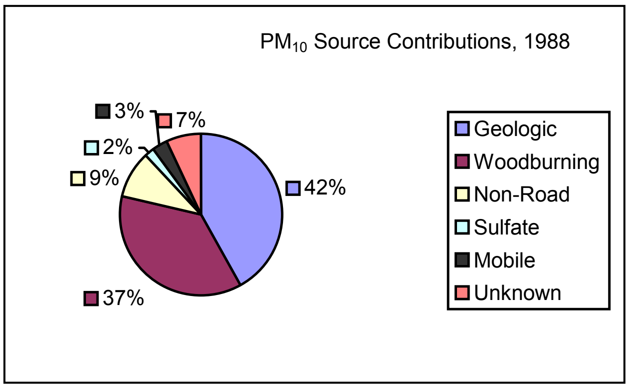


Figure 2-51. The region's dry climate contributes to the large percentage of geologic PM_{10} source contributions.

Particulate matter is measured not in parts per million but in micrograms per cubic meter (ug/m^3). Over a 24-hour period, the national standard is that PM_{10} should not exceed 150 micrograms per cubic meter. As seen in Figure 2-52, measured concentrations of PM_{10} reached a high of about 120 ug/m^3 in 1992 (about 80% of the standard), but in recent years have been no higher than 60 percent of the standard. In addition to woodburning restrictions, useful strategies for PM_{10} control include watering of disturbed surfaces at construction sites and use of load covers for the truck transport of dirt and rock products.

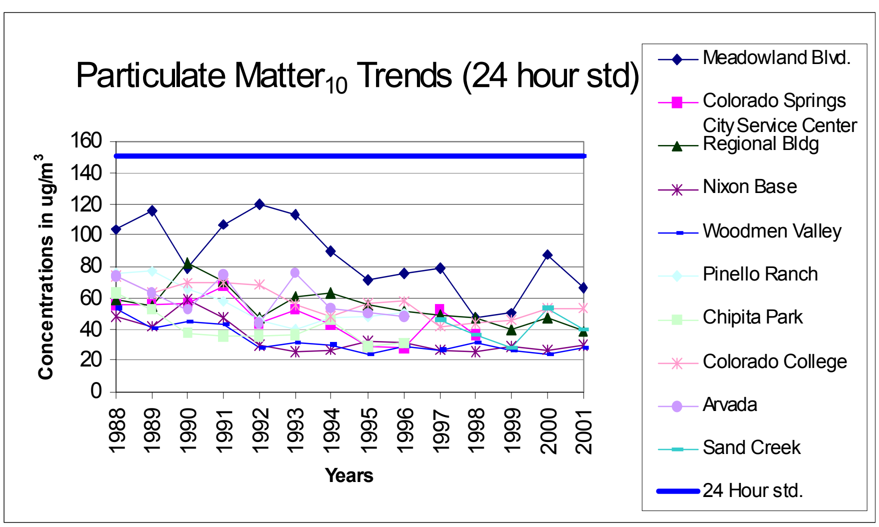


Figure 2-52. Measured PM_{10} concentrations in the Pikes Peak region seem to have trended downward over the past 14 years.

AIR QUALITY IN THE FUTURE

Of the six air pollutants for which there are national ambient air quality standards, the Pikes Peak region has no current or projected difficulties in meeting four of them, but has reason for concern about two of them: ozone and carbon monoxide.

Ozone is the most immediate problem, as current trends suggest the strong likelihood the region could violate the eight-hour ozone standard within the next five years.

Carbon-monoxide emissions are expected to increase over time as growth in vehicle travel in the region outpaces currently foreseen improvements in vehicle emissions control technology.

For both ozone and carbon monoxide, emissions from motor vehicles are the primary source of pollutants. Note that ozone is not emitted directly from vehicle tailpipes, but is the result of chemical reactions in the atmosphere, for which vehicular exhausts of volatile organic compounds (hydrocarbons) and oxides of nitrogen are the precursors.

For ozone, in addition to vehicle technology improvements and alternate mode use, control strategies address a very wide range of everyday chemical processes both for industry and in private homes, including the use of solvents and paints. Ozone control efforts include the transportation sector but also reach into every facet of modern urban living.

For carbon monoxide, control efforts will focus on motor vehicle use, but also address woodburning and portable gas-powered equipment. Residents in the Pikes Peak region currently are not subject to fireplace use restrictions (“No-Burn Days”) that have long been used in the Denver region.

The bottom line is rapid population growth in the region is increasing the amount of human activity that causes air pollution. As more such activities occur within the confines of the region’s airshed, the concentration of these pollutants increases. To remain in compliance with air quality standards, ways must be found to reduce the amount of pollution generated per person as the number of people in the region continues to grow.

Good air quality is one of the factors that attract visitors and new residents to the Pikes Peak Region. Therefore, protecting our air quality is important to the health of the region’s residents as well as to the region’s economic well-being.

Several of the main points of the Colorado Springs Comprehensive Plan relate to air quality issues and suggest what sustainable patterns might be:

- Develop a coordinated land use pattern that efficiently uses land by encouraging mixed-use activity centers rather than segregated land uses.
- Create opportunities for travel modes that can reduce the rate of growth in automobile use.
- Continually improve the community’s stewardship of its natural setting.
- Maintain a citywide context or perspective as an integral part of incremental land use decision-making.

Figure 2-53. Monitoring stations in key areas of the region help keep track of air pollution concentrations.

KEY STRATEGIES FOR SUSTAINING GOOD AIR QUALITY IN THE PIKES PEAK REGION

POLICY-LEVEL STRATEGIES: AIR QUALITY

- ☑ Encourage mixed-use development along transportation corridors to reduce vehicle miles traveled (VMT).
- ☑ Support higher density residential and mixed use development in growth areas.
- ☑ Encourage intermodal transportation system development to reduce influence of automobile emissions.
- ☑ Support increasing fuel economy requirements for motor vehicles.
- ☑ Support voluntary programs such as car/van pooling.

PROJECT-LEVEL STRATEGIES: AIR QUALITY

- ☑ Incorporate ozone-reducing strategies in project planning. (See case study, next page.)
- ☑ Improve street sanding techniques that produce less PM_{10}.
- ☑ Switch to cleaner burning fuels, such as electricity, natural gas and propane.
- ☑ Use of clean power technologies by Colorado Springs Utilities.
- ☑ Federal installations in the area can continue to fully comply with Executive Order 13149, Greening the Government through Federal Fleet and Transportation Efficiency (2000).

Case Study

Denver, Colorado

REGIONAL AIR QUALITY COUNCIL

The following are suggested ways businesses in the Denver metro area can voluntarily help to keep air healthy and the Denver metro region in compliance with federal health standards for ozone pollution. These strategies help reduce summer air pollution by limiting VOC and NOx emissions. www.raqc.org/ozone/ozone-busi.htm

	Be Ozone Aware All Summer Long	**Use Extra Effort on Ozone Action Days**
Fleet operations	**1**. Keep fleet vehicles well tuned up, regularly check and correct tire pressure. **2**. Pressure test fuel caps to ensure seal. **3**. Avoid overfilling or "topping off" gas tanks on fleet vehicles when refueling. **4**. Avoid idling vehicles when making deliveries or in rounds to customers.	**1**. Turn off delivery vehicles during loading and unloading and while in lines. **2**. Refuel fleet vehicles after 6 p.m. **3**. Reschedule discretionary activities such as equipment/vehicle degreasing.
Staff issues and work styles	**1**. Reduce travel--Allow telecommuting, compressed work schedules, and teleconferencing. **2**. Encourage on-site lunches. **3**. Promote biking to work, carpooling and transit use. **4**. Encourage employees to maintain their cars and reduce vehicle travel through trip linking.	**1**. Postpone discretionary auto trips. **2**. Support telecommuting.
Buildings maintenance/ custodial operations	**1**. Encourage use of low VOC paints & stains. **2**. Suggest use of low VOC products for custodial care. **3**. Use "Best Management Practices" in emissions control for company operations--tightly seal all solvents, properly dispose of rags with solvent waste, and use substitutes for solvents where possible. See web site resources, such as http://es.epa.gov/ssds/issds.htm	Reschedule discretionary maintenance, such as painting, varnishing, and stripping.

Grounds maintenance	**1**. Reduce lawn areas—xeriscape to reduce mowing, or change to native western grasses to reduce the need for irrigation and mowing. **2**. Reduce or eliminate the use of gas- powered blowers, trimmers and weeders, especially on high ozone days. **3** Avoid using gasoline powered yard equipment, most of which have high emissions. **4**. Ask contractors who do company grounds maintenance to observe these guides.	Reschedule discretionary maintenance such as: • Landscape operations that utilize gas-powered mowers and equipment. • Parking lot/driveway paving or painting lane stripes. Building and grounds painting, varnishing, and stripping.
Staff and customer awareness	**1**. Alert all company departments, employees and customers about metro Denver's summer air pollution problem. **2**. Share information on pollution advisory system announcements. **3**. Promote summertime pollution reduction strategies through staff newsletters, web pages, email, and bulletin boards. **4**. Underscore your commitment to ozone reduction through a memo or letter from your owner, president or CEO.	Share information on Ozone Action Days.

Other relevant case studies to see in this report:

- City of Austin, Texas: Sustainable Communities Initiative
- Fort Carson, Colorado
- Greater Wasatch Area, Utah: Envision Utah
- Kansas City region, Kansas and Missouri

Key written resources:

Colorado Air Quality Control Commission Report to the Public 2000-2001, 2001, Colorado Department of Public Health and Environment

Colorado Springs Revised Carbon Monoxide Plan, Colorado Department of Public Health and Environment.

"Important Trends in Air Quality," Steve Blanchard (Clean Air Campaign)

"1995 National Air Quality: Status and Trends," www.epa.gov/oar/aqtrnd.

"Summary of Spatial and Temporal Trends of EPA Air Quality Pollutants in the Pikes Peak Region," Rich Muzzy (PPACG).

2-D. TRANSPORTATION

The high level of mobility we enjoy as a society enables people to access a larger number of destinations and have more choices of places to live, work, shop or recreate, all of which are important components of quality of life.

But this mobility—as we currently achieve it, largely through private automobiles—comes at a cost. The negative impacts of motorized transportation are well known. They include air and water pollution, noise, energy consumption, accidents and visual impacts. Also, a transportation corridor can bisect neighborhoods or habitat and can be a barrier to movement of people and wildlife.

Measurable indicators for transportation patterns *(what to look at to gauge what is happening to traffic patterns in the Pikes Peak region).*

- Vehicle miles traveled (VMT)
- Road widths
- Miles of road/highway/freeway
- Increases in vehicle registration by vehicle type and gross vehicle weight from 1955 to 2002
- Number of buses per capita
- Motor vehicles registered per capita in El Paso County
- Traffic level-of-service on selected arterial links
- Number of miles of streets with bike lanes per 1,000 persons
- Number of annual bus boardings

HOW EFFECTIVE TRANSPORTATION PATTERNS HELP QUALITY OF LIFE

While providing mobility is vital to a community, so are planning and design efforts to minimize the adverse impacts of transportation facilities. It's important for a transportation system to fit well with the needs of the community. Adequate freeway capacity, for example, is needed to keep longer, regional trips off local streets. Similarly, an adequate local street system is needed to keep local trips off I-25.

Public transit service provides needed mobility for those who want an alternative to the automobile or who cannot afford or physically cannot operate a motor vehicle. Transit use can reduce air pollution and reduce the amount of land needed for automobile parking spaces.

Non-motorized travel modes (walking and biking) offer valuable exercise opportunities for a populace that has grown increasingly sedentary.

Historic Transportation Patterns in the Pikes Peak Region

Railroad builder General William J. Palmer founded the Fountain Colony, now Colorado Springs, in July 1871, just months before his Denver & Rio Grande Railway reached the site. Palmer staked out his model city with a grid system of dirt roads a hundred feet wide and began selling lots for $100 each.

Public transit arrived with the advent of horse car service in 1887, replaced with electric streetcars in 1890. In 1900, gold miner Winfield Stratton bought the system and spent $2 million to build it into a 41-mile first-class street railway.

The Auto Age began in the early 1900s. Crippled in his early 70s after being thrown from his horse, Gen. Palmer bought a 1907 White Steamer. By 1911, the street railway was getting in the way, and the time had come for paving the streets.

The automobile ascended in popularity as affordable, mass-produced automobiles came onto the scene. Autos made it possible for people to live farther away from the central city. Researchers suggest that nationally, the period of most rapid urban decentralization occurred between 1920 and 1950.

Declining patronage evident as early as 1911 led to the demise of the trolley system in 1932, replaced at that time by privately operated bus service. This bus company expanded to serve the newly established Camp (now Fort) Carson during the gasoline-rationing days of World War II. Congress established the National Interstate Highway Program in 1944, designating as one of the new routes U.S. Highway 87 from New Mexico to Wyoming, through Colorado Springs. Among three alternative routes considered in a 1947 study, downtown business owners successfully lobbied for selection of the western-most route (the "Walnut Line").

Figure 2-54. Highway 85 87 to Denver, circa 1920. Cheyenne Mountain in the background. Photo courtesy of the Pikes Peak Library District.

Work on today's I-25, then called the Monument Valley Freeway, began in the mid-1950s, concurrent with construction of the U.S. Air Force Academy.

For Colorado Springs, sheer growth has fueled rapid land consumption since 1950. El Paso County's population from the 1950 Census was just short of 75,000 residents. Spurred first by military and later by high-tech jobs, the county's population has grown by nearly that amount or more every decade since then.

Aerial photography shows that by 1955, development had not progressed eastward much farther than Union Boulevard. Since then, continued eastward suburbanization resulted in the need for first Circle Drive, then Academy Boulevard, focus of commercial development in the 1970s.

After years of financial losses, the Colorado Springs Transit Company ceased operations in 1972. Public transit service began that year as the City of Colorado Springs purchased the system.

Increased oil price shocks in the 1970s produced a measurable increase in carpooling in the 1980 Census, but this phenomenon soon waned. The region's air quality improved dramatically during the 1980s removing this as a motivating issue for reducing vehicle travel.

During the 1980s, the focus of growth shifted northeast to the extensive Briargate development. The City also annexed the Banning-Lewis Ranch, east of Marksheffel Road, a future growth area of more than 20,000 acres.

Figure 2-55. A 1954 aerial photograph shows eastern Colorado Springs. High aerial view of eastern Colorado Springs looking east. Pikes Peak Avenue is in the center of the picture. Photo courtesy the Pikes Peak Library District. Photographer: Stewarts Commercial Photographers.

TRANSPORTATION PATTERNS TODAY

A national 1999 survey of 68 metropolitan areas ranked the Colorado Springs area as the most congested among areas with fewer than 500,000 residents. (Texas Transportation Institute, Urban Mobility Report, 1999). Residents of the area recognize that traffic congestion is a key regional problem. Consistent with other survey results since the mid-1990s, traffic congestion ranked as the No. 1 issue in a 2001 public survey about the region's quality of life. (City of Colorado Springs, 2001 Citizen Survey, May 2001)

At a December 2002 symposium entitled, Colorado Springs 2020: Our Town Our Future, participants were asked to describe the current transportation network in Colorado Springs. From this audience (not a large, statistically representative sample) more than half rated the current transportation network as "poor," and fully 92% rated it "fair" or "poor."

Speeding in neighborhoods by cut-through traffic is becoming an increasing problem. The City of Colorado Springs has recently established a formal Neighborhood Traffic Calming Program. As reported in the [Colorado Springs] Gazette ("Neighborhoods in Gear to Slow Down Speeders," Bill Vogrin, Oct. 17, 2002), one neighborhood resident implemented her own "traffic calming program" to slow down motorists speeding through a school zone. She sits in her car in front of an elementary school every weekday afternoon and points a hair dryer out her window at passing vehicles. Many drivers mistake the hand-held dryer for a radar gun and slow down.

The region's latest-adopted long-range transportation plan, Destination 2025, describes more than $2.2 billion worth of transportation projects planned in the region between the years 2000 and 2025. The plan is "financially constrained," containing only improvements for which there is foreseeable funding. The region also has a long list of needed improvements for which funding is not available.

While traditionally, north-south roadway improvements, like the proposed improvements to I-25 and Powers Boulevard, have ranked highest among area residents' concerns, east-west mobility has increasingly become a concern. The City completed a two-year East-West Mobility Study in 2002, identifying a number of prioritized roadway improvements for implementation as funding becomes available.

Fixed-route bus is provided by the City of Colorado Springs, largely serving those who depend on transit for mobility. Today's publicly owned fleet of 56 buses represents little gain over the fleet of 51 buses operated privately more than four decades ago. In fact, since the city has grown in area and population, the number of buses operated per capita has declined by 80% since 1960. The current fixed-route service is supplemented with demand-responsive para-transit services.

Currently, public transit costs are paid by general revenues in the City budget, competing with all other City programs under spending restrictions imposed by State tax and spending limitations. Major transit improvement will require a new dedicated funding source. The City's voters rejected a 1999 proposal to form a transit district and authorize a sales tax to fund bus-system improvements.

Major progress is being made on implementing regional trails, boosted by a sales tax for parks, trails and open space that was approved by the city's voters in 1997.

TRENDS IN TRANSPORTATION PATTERNS

The City of Colorado Springs Intermodal Transportation Plan notes that automobile travel continues to increase faster than population growth and faster than roadway capacity. Accordingly, traffic congestion will continue to worsen citywide, with many areas sure to experience severe congestion.

The estimated number of vehicle-miles traveled per El Paso County resident has increased from 13.6 miles per day in 1980 to around 20 daily miles per capita today, an increase of roughly 50%. By the year 2025, this figure is expected to increase by an additional 6 miles per person, to more than 26 daily miles per capita.

Total vehicle miles of travel in the region increased from 4.2 million in 1980 to 10.5 million in 2000, en route to a projection of 19 million in 2025. (See Figure 2-54)

Even if growth in the Colorado Springs region were to slow, rapid population growth along Colorado's Front Range would continue to increase demand on the region's transportation facilities, especially on I-25. Between 1990 and 2000, Colorado's population increased by about 1 million residents, and 80% of the increase occurred in the Front Range counties served by I-25.

In the absence of a dedicated funding source for public transit, continuation of current City subsidies at today's levels will lose ground to inflation, soon requiring cuts in the City's already inadequate service levels.

Many in the aging Baby Boom generation will be reaching retirement age by 2025. As they become unable to drive due to physical infirmity, demand for public transit service may increase substantially. This is an extremely important "megatrend" that hasn't yet received much public attention in the region.

Well before the time that aging baby boomers will demand improved transit service, physicians today are warning that America's sedentary, auto-dependent lifestyle is causing epidemic levels of obesity. Researchers Killingsworth and Schmidt report 75% of all trips less than one mile in length are made by automobile and that the average adult spends 73 minutes per day driving. As individuals and as a society, our health would improve if we were willing and able to make short trips by foot or bicycle, substituting exercise time for driving time. It is important to have adequate pedestrian and bicycle facilities to meet this urgently needed behavior change.

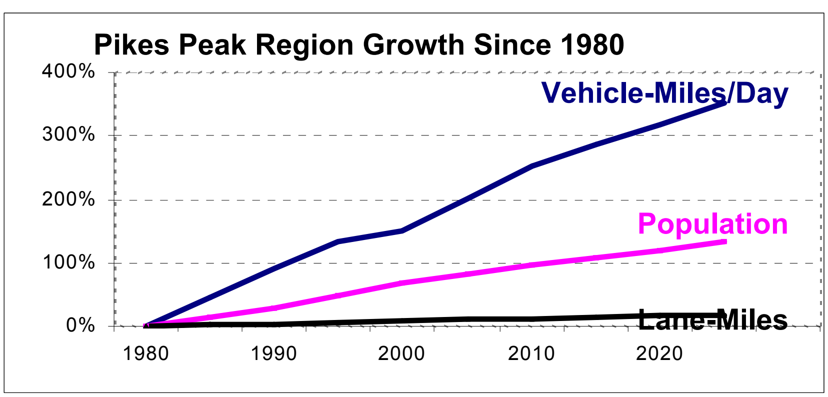


Figure 2-54. Automobile travel is increasing faster than population growth and much faster than roadway capacity. This trend is expected to continue.

THE VISION FOR TRANSPORTATION PATTERNS IN THE FUTURE IN THE PIKES PEAK REGION

The following statements from the City of Colorado Springs 2001 Comprehensive Plan express the approach to transportation that the City will take while also striving to achieve its non-transportation goals. Often, competition for funding results in tradeoffs between objectives.

Our Community envisions a Colorado Springs…

- that has a transportation system with a high degree of efficiency, mobility, accessibility, connectivity,
- and a range of real choices for traveling between destinations within the community.

Source: *City of Colorado Springs 2001 Comprehensive Plan*

Several of the main points of the Colorado Springs Comprehensive Plan relate to transportation and suggest what sustainable patterns might be:

- Develop a coordinated land-use pattern that efficiently uses land by encouraging mixed-use activity centers rather than segregated land uses.
- Create opportunities for travel modes that can reduce the rate of growth in automobile use.
- Evaluate effective tools for assessing the fiscal impact of development. (Since transportation needs far outweigh available resources, ensure that future development pays its own way.)
- Strengthen the quality of development's visual character and appearance. (This can include pleasing roadway or transit facility design.)
- Maintain a citywide context or perspective as an integral part of incremental land use decision-making. (This may help to curtail the historic practice of approving discontinuous roadway systems.)

KEY STRATEGIES FOR IMPLEMENTING EFFECTIVE TRANSPORTATION PATTERNS IN THE PIKES PEAK REGION

POLICY-LEVEL STRATEGIES: TRANSPORTATION

- ☑ Incorporate mixed-use land use concepts in future developments so that land use itself does not force new residents to commute to far-away employment centers.
- ☑ Incorporate provision for alternate transportation designs in the design of new developments (including transportation facility development).
- ☑ Develop a dedicated funding mechanism for transit so that the region can accommodate the mobility needs of the aging Baby Boom generation.
- ☑ Assess impact development fees such that new developments will pay for the off-site transportation capacity needs they generate, rather than worsening the current backlog of needed but unfunded projects.
- ☑ Identify and monitor transportation indicator variables that track progress toward established transportation goals. (The City of Colorado Springs now is tracking the number of motor vehicles registered per capita in El Paso County; traffic level-of-service on selected arterial links; number of miles of streets with bike lanes per 1,000 persons; and number of annual bus boardings).

PROJECT-LEVEL STRATEGIES: TRANSPORTATION

- ☑ Provide all transportation facilities and services within a reasonable timeframe of development to thereby improve concurrency between transportation facility supply and demand.
- ☑ Achieve advance right-of-way reservation and dedication for transportation through the land-development process.
- ☑ Coordinate with appropriate local agencies to identify future alternate mode needs and ensure that transportation project designs don't preclude future alternate mode options.
- ☑ Situate new facilities in locations that minimize habitat or neighborhood fragmentation, as well as providing adequate crossings to minimize corridors' "barrier" effects.
- ☑ Design all projects in full compliance with applicable environmental regulations, as well as ensure designs that recognize the character of the facility's natural and community character.
- ☑ Look for ways to use projects to bring new uses, such as roads and intersections, to Brownfields or other degraded lands.

Case Study

A National Issue:

DO NEW LANES INDUCE TRAVEL OR MERELY RESPOND TO EXISTING DEMAND? THAT IS A QUESTION OF CONTINUING DEBATE IN PROFESSIONAL CIRCLES.

Within the transportation field, there is a body of research suggesting that adding roadway capacity as a means of addressing traffic congestion may be partially self-defeating, because the added lanes induce more and longer trips than would have been made without them.

The important economic principle underlying the discussion is one of supply and demand. The cost of transportation service perceived by the consumer is measured primarily in travel time. Adding transportation capacity reduces travel times, at least initially, thereby reducing the time cost of the transportation service. When the price of a normal good is lowered, consumers with a fixed time budget will be able to afford a greater quantity of that transportation service. In theory, this means the consumer would have incentive to travel more.

In a presentation to the Transportation Research Board (TRB) in 2000, U.S. Environmental Protection Agency researcher Dr. Lewison Lee Lem identified the following potential behavioral changes that could result in response to increased capacity:

<u>Potential short-run effects:</u>

- Changes in departure time
- Changes in route
- Changes in travel mode
- Changes in destination
- Changes in the number of trips

<u>Potential long-run effects:</u>

- Changes in household auto ownership
- Changes in residential location
- Employee changes in work location
- Employer changes in work location
- Changes in land-development location

An important work on the subject is TRB Special Report 245: Expanding Metropolitan Highways: Implications for Air Quality and Energy Use. Two key findings from Special Report 245 are as follows:

"Early major highway capacity expansions had major impacts on land use and urban form in metropolitan areas because of the dramatic reduction in travel costs they afforded, which in turn increases access to undeveloped land. In general, currently planned expansions…in built-up metropolitan areas are not as likely to result in major structural changes in metropolitan development patterns.

"Planned major capacity expansions in relatively undeveloped areas, such as outer beltways at the urban fringe, that significantly reduce travel times and improve accessibility to developable land will influence development patterns in these corridors."

Case Study

Colorado Springs, Colorado

CITY OF COLORADO SPRINGS RIDEFINDERS PROGRAM

The City of Colorado Springs Transit Systems department manages the Ridefinders program, which includes:

Carpool Matching matches families that have children at the same school so they can share driving responsibilities for getting their children to school. These services can be provided not just on a general, regional basis but also customized to meet the collective needs of employers in the high-density corridors (e.g. the Garden of the Gods Transportation Management Association). The service is available by calling (719) 385-RIDE.

Vanpooling is targeted at long-distance commuters (e.g., Colorado Springs to Denver, Pueblo to Colorado Springs) who want to save money and energy by riding in a vanpool.

The **Telecommuting Consulting** program helps evaluate a business' telecommuting needs and provides training at minimal costs to the business.

Case Study

National Trend:

THE ROLE OF TRANSPORTATION IN 'SMART GROWTH'

For too long, transportation has been associated with much of what's wrong about land-use patterns, whether it's highways bisecting low-income neighborhoods, new roads fueling sprawl or residential streets designed for automobile travel at the expense of other modes of transport. But in recent years, the transportation field has been quietly changing course, and communities across the United States are starting to use transportation to help manage growth, breathe new life into older neighborhoods and improve their quality of life. And numerous signs indicate that transportation will continue to play a vital role in the pursuit of smarter growth.

Adapted from "Smart Growth: The New Challenge for Transportation" by Don Chen. The complete version of this article appeared in the July 1999 issue of *Geting Smart!*: The newsletter of the Smart Growth Network.

Other relevant case studies to see in this report:

City of Austin, Texas: Sustainable Communities Initiative

Douglas County, Colorado: U.S. Highway 85 wildlife planning

Fort Carson, Colorado

Greater Wasatch Area, Utah: Envision Utah

Kansas City region, Kansas and Missouri

Key written resources:

Colorado Springs Intermodal Transportation Plan, City of Colorado Springs.

Colorado Springs Regional 2025 Long Range Public Transportation Plan, City of Colorado Springs.

Destination 2025: A Mobility Plan for the Pikes Peak Region, Pikes Peak Association of Governments.

2-E. NOISE

Noise can cause hearing loss and interfere with human activities at home and work. It can also be injurious to people's health and well-being. Although hearing loss is the most clearly measurable health hazard, noise is also linked to other physiological and psychological problems. Noise can annoy, awaken, anger or frustrate people. It can disrupt thinking and communication and affect performance capability.

The numerous effects of noise can combine to detract from the quality of people's lives and the environment. Some birds and other animals use sound to navigate and communicate, and excessive noise can interfere with these functions. Noise can sometimes affect wildlife use of an area and add to wildlife stress.

Measurable indicators of noise (what to look at in gauging what is happening with noise in the Pikes Peak region).

- Average noise levels
- Number of people living in areas where the 24-hour day-night noise level exceeds 55 dBA

Did You Hear?

Sound and noise are measured as sound pressure levels in units of decibels (dB). Human hearing can detect decibel levels ranging from 0 (the threshold of audibility) to 140 dB (threshold of pain).

Community noise is measured in terms of A-weighted decibels (dBA). A-weighting adjustments are made to mimic the fact that the human ear is less sensitive to low-frequency sound than it is to high-frequency sound.

Figure 2-57. Measuring sound levels on a roadway near downtown Colorado Springs.

CHANGES IN THE PATTERNS OF NOISE

Community noise levels in the Colorado Springs area are the sum of the effects of noise from a number of different sources that vary over time and space (Figure 2-58). For the purposes of this study, the most significant of these sources have been grouped into seven categories.

For each of these categories, the following describes the nature of the sources, existing noise levels, how noise from each source has changed over the past 50 years or so and how it might change in the future.

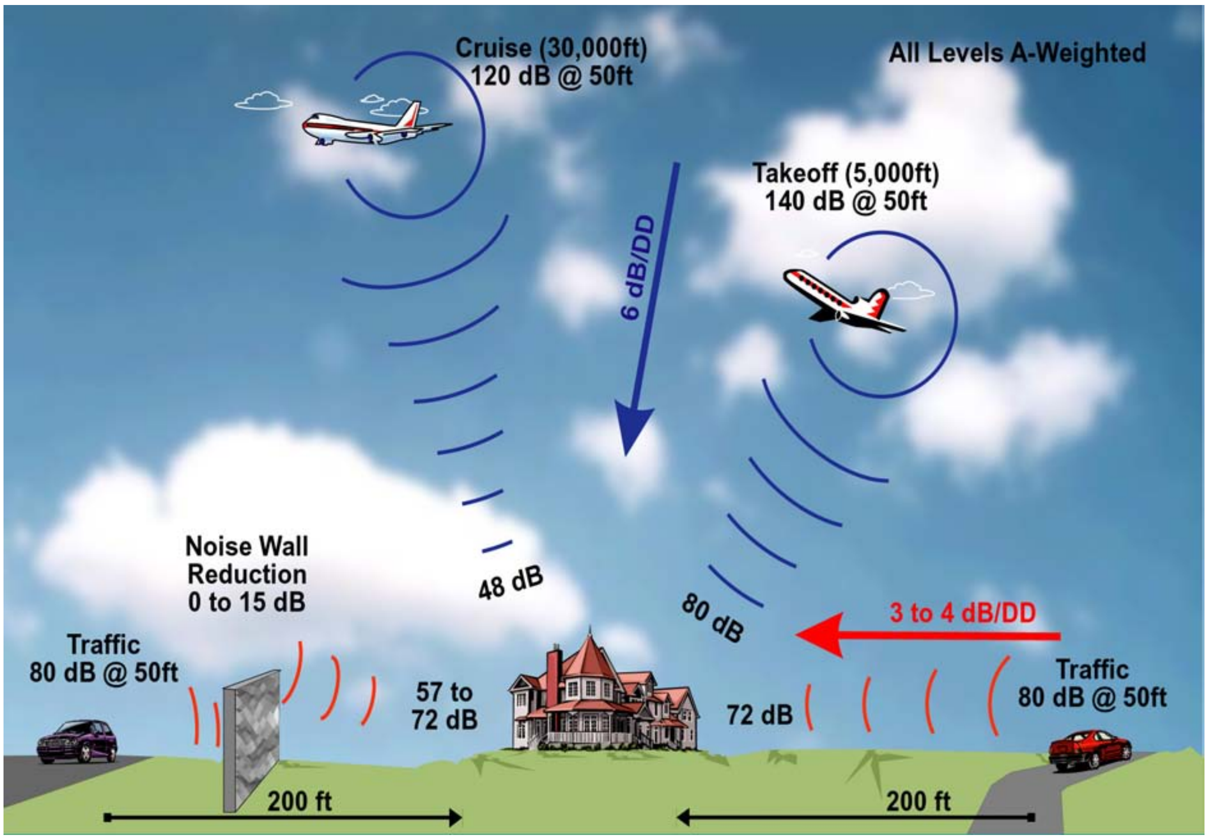


Figure 2-58. Community noise levels in the Colorado Springs area are the sum of the effects of noise from a number of different sources that vary over time and space. In the figure, changes in decibel level with a doubling of distance are denoted as dB/DD.

ROADWAYS

For many residents, roadway traffic is the most significant and constant source of noise. Between the 1950s and today, the impact of traffic noise has increased because there are more cars and trucks on the road, houses and highways are being built in closer proximity to one another and traffic speeds have increased.

The number of miles being driven is increasing significantly in this area (Figure 2-54). The result of this is a 3 dBA increase in traffic noise every time the traffic volume on a given road doubles. Heavy trucks (e.g., semi-trucks) are particularly important to consider because they are as loud as approximately 13 passenger cars. They also are important because truck traffic is growing at a faster pace than the general U.S. population.

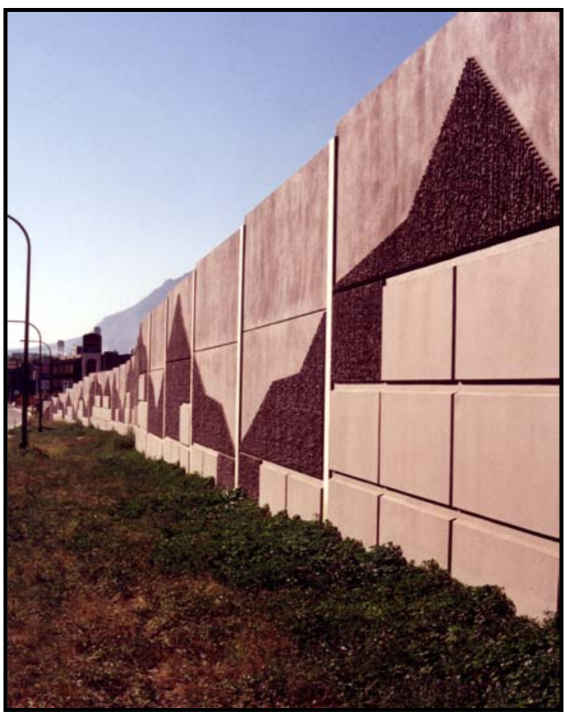


Figure 2-59. This noise wall is one of five that are found along Interstate 25 through Colorado Springs. Eight more are planned.

Houses and roads continue to be built near each other, as evidenced throughout the Colorado Springs area. The impact of this is a 3 dB increase in noise for every halving of distance between a house and a road. For example, if noise levels from a road are 55 dBA at a distance of 400 feet, they will be 58 dBA at a distance of 200 feet. Finally, noise levels increase approximately 1 to 2 dBA for every 10 mph increase in speeds.

Vehicle noise emissions were first regulated in the U.S. on the federal level in the 1980s. The EPA set a limit of 80 dBA at 50 feet for new trucks and 83 dBA at 50 feet for trucks already in service. These regulations cover only trucks and buses engaged in interstate commerce. There are no EPA noise emission regulations for automobiles.

AIRCRAFT

Noise from aircraft taking off and landing at the Colorado Springs Airport and the U.S. Air Force Academy is an issue for residents living near these facilities and under the flight paths. Traffic at the Colorado Springs Airport is growing steadily—it ranked 17th in the nation's 25 Fastest Growth Airports from 1994-2000. Enplanements jumped 53.5% during that period, compared to 25.2% nationally. It must be noted that a major impetus for this growth was Western Pacific Airlines, which established a hub at Colorado Springs in the late 1990s but went out of business before the end of the decade.

While the number of flights and the size of the aircraft at the Colorado Springs Airport are continually increasing, the noise level of individual planes has been decreasing. By 1989, the quieter "Stage III" airplanes composed nearly 40% of the domestic fleet (Air Transport Association 1991b). By the year 2004, all of the noisier Stage II aircraft must be phased out (based on the Airport Noise and Capacity Act 1990).

Despite these advancements, one reason for increased impact from aircraft over time is the number of residents living in proximity to these airports and their flight paths.

NEIGHBORHOOD ACTIVITY (LAWN MOWING, ETC.)

Noise from lawn mowing, street sweeping and other neighborhood activities has increased since 1950, mainly because many activities that used to be performed by hand are now motorized. That is, most lawnmowers are now motorized, leaf blowers are used in place of rakes, power tools are used in place of hand tools, snow blowers are used in place of shovels, etc. In the future, it's likely that noise levels from these sources will decrease substantially as more and more tools are converted to electrical power as battery technology continues to develop.

FREIGHT TRAINS

Today in Colorado Springs, coal freight train noise levels are significant only along the north-south mainline tracks, where there are 30-35 trains per day. Historically, the Colorado Springs area featured far more active railroad tracks than at present, and these operations were more widely distributed.

INDUSTRY

There is relatively little noise-producing industry, such as power plants and manufacturing facilities, in Colorado Springs. It's likely that noise from manufacturing will decrease with time. Today, much of the Colorado Springs economy is powered by relatively quiet operations such as microchip manufacturing, call centers and other non-manufacturing industries.

CONSTRUCTION (HIGHWAYS, HOUSING, ETC.)

There is not much empirical data regarding what construction noise levels were like in the Colorado Springs area circa 1950. Two things are known, however: Construction equipment has become larger, more powerful and more prevalent. This is particularly evident in home construction, where almost everything is now done using power tools. Second, individual pieces of construction equipment are quieter now. For example, portable generators and compressor are readily available in "quiet" versions.

TRAINING EXERCISES AT FORT CARSON

In 1943, the Army established Camp Kit Carson, now Fort Carson, in the southern Colorado Springs area. At this facility, the Army conducts live-fire exercises involving machine guns, tanks, and mortar and artillery shells. The Army also trains with Blackhawk helicopters at the site.

Fifty years ago, this area was remote and the impact to residents minimal, with the possible exception of local ranchers. Today, however, subdivisions have been constructed adjacent to Fort Carson, and residents often complain about the noise and vibration. Sudden noises from military training activities often can startle nearby residents, increasing their annoyance.

TRENDS IN NOISE IN THE PIKES PEAK REGION

In general, community noise levels have been increasing in the Colorado Springs area, and will likely continue to increase. This will be primarily due to growth in roadway traffic. There may also be an increase in train and aircraft noise, but these impacts are more localized. Roadway noise permeates all areas of Colorado Springs. Construction and industrial noise will be subject to the trends of the economy, but likely won't increase significantly. The impact of roadway noise will increase as there are more vehicle miles being driven, and more people coming to live in the area and, presumably, many of them living closer to major roadways.

Noise levels in the future will increase 3 dBA every time vehicle miles traveled doubles, which it's predicted to do. The number of people living with noise levels of 60 dBA or greater, typical of levels along the interstate, will increase as more residences are built along major roads. The impact of these increases depends on people's perception toward noise. A noise increase of 3 dBA or less usually is not offensive to most people, but an increase of 4 to 6 dBA will be noticeable and may be annoying to some, and increases of more than 7 to 10 dBA might be considered annoying to many and very irritating to some. Increases in all these ranges are possible in different areas (see Figure 2-60).

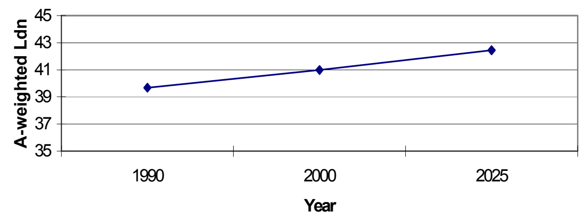


Figure 2-60. Average noise levels based on increasing population density in Colorado Springs.

NOISE IN THE FUTURE

It is unlikely that Colorado Springs will become the audible equivalent of New York City anytime soon. Even if it did, most people seem to have an ability to adapt, as evidenced by the millions of people living with noise levels in the 80-dBA range in major cities across the world. Compare this to the City of Colorado Springs noise ordinance, under which levels greater than 55-decibels can result in a citation.

Generally, noise levels in the Pikes Peak region will increase in the future. This will occur in established areas as the result of infill and high-density redevelopment. In rural fringe areas, noise will increase as the prairie gives way to housing subdivisions and new retail and employment centers.

One of the main objectives in the Colorado Springs Comprehensive Plan that relates to noise is:

- Create opportunities for travel modes that can reduce the rate of growth in automobile use.

KEY STRATEGIES FOR DEALING WITH NOISE IN THE PIKES PEAK REGION

POLICY-LEVEL STRATEGIES: NOISE

- ☑ The most effective noise mitigation strategy for roadways and aircraft is good planning: set back development at least 500 feet from major roadways—like I-25—and discourage development near airports.
- ☑ Support research into tire and pavement design to reduce tire/pavement noise.
- ☑ Encourage research into rechargeable-battery technology that can result in electrification of vehicles, as well as lawn mowers and other power tools used in neighborhoods.
- ☑ Minimize future development near freight rail corridors to reduce the impact of freight (and future passenger) train noise.
- ☑ Use zoning to keep noise-producing industry and residences away from one another.

PROJECT-LEVEL STRATEGIES: NOISE

- ☑ Separate development from major roadways (principal arterials and above) by at least 500 feet.
- ☑ Install earthen berms where possible, and use features within a development such as garages and commercial buildings as shields from roadways.
- ☑ When possible, delay major noise-producing actions, such as blasting or live-fire exercises at Fort Carson, until atmospheric conditions aren't conducive to the spread of sound toward residences. Also, advise nearby residents of the time and duration of such activities to reduce the startle factor.

Case Study

Phoenix, Arizona:

SOUND WALLS AND ART

One of the most ambitious efforts to improve the character of roads is a public-arts program that has been operating in Phoenix since 1987. Under the guidance of the Phoenix Arts Commission, the city planning department, and the street-transportation department, artists have been hired to design new sound walls and improve existing ones, retaining walls, bridges, and overpasses. For example, Marilyn Zwak, of Cochise, Arizona, and two assistants applied 150 tons of adobe to the Thomas Road overpass on Phoenix's Squaw Peak Parkway, shaping the twenty-four-foot-high support columns into evocative profiles inspired by Hohokam Indian zoological forms. On the retaining walls of the overpass Zwak installed thirty-four relief panels based on human, animal, and abstract images found on Hohokam artifacts. Then she invited neighborhood residents to imprint into the adobe their own designs or objects, ranging from tools to clothing remnants to the key to one of the houses that was demolished to make way for the freeway. Completed in 1990, the overpass has since been voted Phoenix's most popular work of public art.

One lesson of the Phoenix experience, says James Matteson, the city's director of street transportation, is that artists and designers should be invited to work with highway engineers while a road is being designed, rather than being asked to relieve existing highway structures of their starkness. He points out that Zwak was asked to collaborate with the engineering team for the Thomas Road overpass from the very beginning—a principal reason the project achieved such wide appreciation and yet cost less than the plain overpass the engineers would have produced.

From "Noisy Highways" by Philip Langdon. Reprinted from *The Atlantic Monthly*, August 1997

Sample of Phoenix art work at bridge retaining wall.

Source: *Our Shared Environment: Thomas Road Overpass* by Marilyn Zwac, 1990. Imagesby Marilyn Szabo and courtesy of the Phoenix Arts Commission.

Case Study

City and County of Denver, Colorado
NOISE CONTROL PROGRAM

Denver has had a community noise program since 1973, when the Noise Ordinance (Revised Municipal Code RMC, Chapter 36) was passed by City Council and signed by the mayor. When complaints of excessive noise are received by the Denver Department of Environmental Health, an inspector is assigned to investigate the complaint. If the complaint is legitimate, the source of the noise (individual/company/organization) receives a verbal or written warning of the violation requiring a noise reduction to legal levels. If the source doesn't comply with the warning, a court summons is issued. If guilty, a fine of up to $999 per incident can be levied by the court.

A noise survey was conducted in Denver in 1995 to establish the baseline ambient noise levels in various neighborhoods within the City and County of Denver. To provide the data necessary for this baseline study, 178 short-term noise monitoring sites and 17 long-term sites were used. It is anticipated that the survey will be updated periodically to determine if the noise environment within Denver is deteriorating because of continued growth and increased vehicular traffic.

Other relevant case studies to see in this report:

- City of Austin, Texas: Sustainable Communities Initiative
- Fort Carson, Colorado
- Greater Wasatch Area, Utah: Envision Utah
- Kansas City region, Kansas and Missouri

Key written resources:

"Noise Analysis and Abatement Guidelines," Colorado Department of Transportation, 2002.

"Highway Traffic Noise," U.S. Department of Transportation, Federal Highway Administration, ***www.nonoise.org/library/highway/traffic/traffic.htm.***

"Highway Traffic Noise Analysis and Abatement Policy and Guidance," U.S. Department of Transportation, Federal Highway Administration, Office of Environment And Planning, Noise and Air Quality Branch, ***www.nonoise.org/library/highway/policy.htm.***

"Highway Traffic Noise in the United States: Problem and Response," U.S. Department of Transportation, Federal Highway Administration, ***www.nonoise.org/library/highway/probresp.htm***.

"Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety", EPA.

2-F. VISUAL RESOURCES

Some aspects of the landscape are very important to us and to our quality of life, although hard to define. Visual resources are an example. Most everyone agrees that attractive surroundings contribute greatly to sustaining quality of life. The things we see around us in our daily lives can inspire, exhilarate, or calm us. These visual elements—as small as a tree or a flower and as big as a mountain—are the reference points that tell us not only where we are, but also what we are as a community.

Measurable indicators of visual resources (what to look at for gauging what is happening to visual resources in the Pikes Peak region).

- Status of places listed on the Colorado Springs Urban Growth Area Inventory of Significant Natural Features
- Ratio of open lands to built areas
- Number of buildings on the National Register of Historic Places
- Number of historic neighborhoods
- Number of places with public art

A key component of visual quality in the Pikes Peak region is the almost always-present view to Pikes Peak, so important a feature it gives our region its name (Figure 2-61). Times of the year and times of the day change how we perceive the view.

Figure 2-61. Pikes Peak, the region's predominant visual feature.

At a more human scale than views of Pikes Peak, views to the city's historic and architecturally significant features are also important visual resources. These include buildings, open spaces, significant and prominent physical features, and parks.

Also important are views to significant human-created landscapes, including prominent districts such as downtown and its buildings, and the significant vegetation and streetscaping found along many transportation corridors. Often these corridors include planted street medians, street trees, and textured pavement features.

"Smart, talented people, not companies, are the center of the knowledge economy. They are moving where they want to live, and jobs are coming to them. As a result, places that offer a high quality of life, high environmental quality, natural beauty, outdoor recreation, thriving cultural centers and active downtown areas are ones that thrive—because they appeal to talented people."
—Richard M. Rosan, president Urban Institute

"The Key Role of Universities in Our Nation's Economic Growth and Urban Revitalization"

The Colorado Springs Urban Growth Area Inventory of Significant Natural Features carefully documents and evaluates the location, significance and overall importance of well-defined natural features that are directly connected to travel corridors in the Colorado Springs area, including I-25.

Colorado Springs' urban forest—the trees that people have planted throughout the city—makes an important contribution to the quality of life in the region by providing air pollution removal, stormwater runoff prevention, water quality improvement, carbon storage and sequestration, and energy savings provided by shade and evapo-transpiration.

Highway corridors with well-placed landscape features contribute to the region's "sense of place" and the process of finding one's way through the region. A good example of this is found in the design and careful placement of public art within the Colorado Springs Airport property along Drennan Road.

Figure 2-62. Prairie grassland converted to residential subdivision in 1967 now is part of the urban forest of Colorado Springs.

VISUAL RESOURCES IN THE HISTORIC PAST

Since before people settled in the region, the Front Range mountain backdrop—and especially Pikes Peak—has been noted as a dominant visual feature. Other significant natural features that have contributed to the region's scenic quality include Monument Creek, Shooks Run, Pulpit Rock, Garden of the Gods, Cheyenne Canyon and Cheyenne Mountain. Mining and quarrying has degraded the natural appearance of parts of the mountain backdrop.

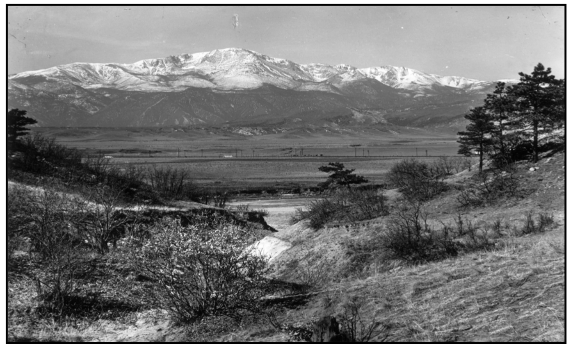


Figure 2-63. An historic view of Pikes Peak.

VISUAL RESOURCES TODAY

Culturally significant buildings of the Pikes Peak region include the historic El Paso County Courthouse (now housing the Colorado Springs Pioneers Museum), the Colorado Springs Fine Arts Center, many downtown Colorado Springs churches, including Saint Mary's Cathedral, the Denver & Rio Grande Western Railroad station (now Giuseppe's Restaurant).

The region also has significant open, undeveloped agricultural spaces such as the landscapes mentioned in the Inventory of Significant Visual Resources. These include the foothills between the flatter prairie ecosystems of Colorado Springs and the montane biomes of the Front Range.

Development on hillsides—because of its potential to be seen from a great distance—can have a significant impact on scenic quality. For this reason the City of Colorado Springs has a hillside overlay zone that stipulates how development can occur so that it is less visually intrusive.

Figure 2-64. A view of Pikes Peak today.

Older trees in the urban forest have matured, creating a shady oasis. While the city's urban forest and extensive park-like landscapes of bluegrass are very attractive to residents, they come at a considerable cost of water and other resources.

There is some recognition today of the importance of views to grasslands, as well as the more dramatic mountains. The El Paso County Comprehensive Plan (October 1993) identifies various scenic views suggested for preservation, including not only local views of bluffs and westward views of the Front Range, but also views eastward toward the prairie. Specifically, this includes views between J.D. Johnson Road and Log Road (north-south roads) for the six miles south of Judge Orr Road.

A new stage of landscape design is evolving in the region that makes better use of indigenous plants and materials, rather than trying to recreate the look of more humid landscapes.

AGGREGATE MINING

El Paso County Land Development Code (Chapter IV, Section 35.13) identifies development requirements for mineral and natural resource extraction operations. Selected requirements related to visual impacts include:

1. The use will not have an adverse long-term visual impact either from adjacent and adjoining properties or from major transportation corridors.

2. The site can be reclaimed to a use and character compatible with surrounding uses and zoning.

3. Reclamation of adverse visual and other environmental impacts will take place within a reasonable and specified time frame.

Report guidelines for visual-impact analysis of mineral and natural resource extraction operations require that the following aspects be addressed:

- Graphic depiction of all off-site properties which will be visually impacted during each of the proposed phases and upon completion of the operation.
- Depiction of the approximate number of existing and anticipated future residences, businesses and institutions that will be visually impacted.
- Identification of major transportation corridors from which any part of the proposed operation will be visible.
- Temporal aspects of the visual impact.
- Night lighting and glare.
- Textual and graphic description of measures proposed to mitigate visual impacts.

Figure 2-65. Quarry operations in the foothills of the Pikes Peak region have created visual scars that will take decades to heal.

Figure 2-66. St. Mary's Cathedral, one of the region's culturally important buildings, stands astride Bijou Street, a key gateway entrance into downtown Colorado Springs.

Figure 2-67. The First Congregational Church, also in downtown Colorado Springs, on St. Vrain Street at Tejon, was built in 1889.

TRENDS IN VISUAL QUALITY

The region's visual quality is threatened by the sheer volume of development and by the patterns of that development. As Colorado Springs has expanded, fewer people find themselves living adjacent to undeveloped land and the scenic and recreational resources it offers.

The mountain backdrop, however, is so visually dominant that it will always play a crucial role in defining the region's visual quality, even if houses and other developments on its ridges detract from views to it and its mining scars cannot be completely erased.

Sound attenuation walls along roads can limit transportation corridor users' views to scenic resources, such as the mountain backdrop. As more and more people spend time in stop-and-go traffic, it will be important to improve the visual quality of highway corridors in which they will find themselves.

The loss of historic buildings to new development is degrading the sense of place. Often new development has generic architecture not related to the Pikes Peak region and extensive plantings of bluegrass and other exotic plant species. Through these actions we miss the opportunity to further develop an indigenous sense of place.

Highway improvements—including significant expanses of rights of way, prominent structures and interchanges—negatively compete with the development of more visually pleasing resources. The development of low density, visually sprawling housing areas can be visually disruptive. This development also can unnecessarily encourage the absorption of significant natural features, including open areas into the less visually appealing built environment.

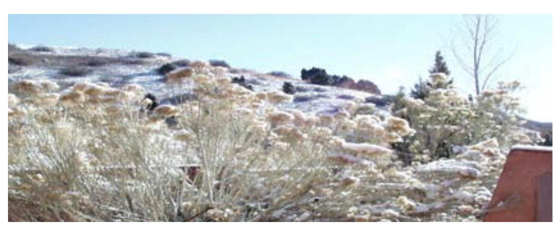


Figure 2-68. Indigenous plants, which blend with the surrounding landscape in the region, are being used more in new developments.

VISUAL CHARACTER IN THE FUTURE

Characteristics of sustainable future (from the Colorado Springs Comprehensive Plan) that relate to visual character:

- Strengthen the quality of development's visual character and appearance.

Also from the Comprehensive Plan:

Our Community envisions a Colorado Springs

- that respects its heritage and natural setting
- that projects a highly attractive image and protects its unique character and scenic beauty
- that provides an incomparable system of open spaces, natural areas, and greenways

The nighttime sky over Colorado Springs and the Colorado Front Range today is much brighter than in the past, due to continued rapid population growth and the associated increased use of artificial lighting. This is an issue of concern not only to amateur astronomers, but to biologists as well. Artificial light makes vulnerable certain nocturnal animals who depend on darkness for safety from predators. Also, unnecessary use of lighting wastes energy and ultimately causes pollution in the energy production cycle.

In 2001, the Colorado General Assembly passed "Dark Skies" legislation geared toward minimizing unnecessary use of artificial lighting. Additionally, the law (CRS 24-82-901) has specific provisions for CDOT to ensure that highway lighting in installed in a manner so as to shield the fixtures from direct view and minimize upward lighting.

Figure 2-67. The Garden of the Gods is El Paso County's second most-famous geological landmark.

STRATEGIES FOR A SUSTAINABLE FUTURE

POLICY-LEVEL STRATEGY: VISUAL RESOURCES

- ☑ Protect significant viewsheds and view corridors.
- ☑ Minimize the use of artificial lighting to preserve "dark skies."

PROJECT LEVEL STRATEGIES: VISUAL RESOURCES

- ☑ Provide and maintain visual access to important community features.
- ☑ Provide significant xeriscape corridor planting in public view.
- ☑ Provide well-designed and detailed bridges and other structures.
- ☑ Buffer transportation corridor improvements from culturally and historically significant areas.
- ☑ Reveal views to streams and other natural areas, through the sides of bridges.
- ☑ Plant medians, when possible, with native and locally adapted plants.
- ☑ Add public art to appropriate corridor and community locations.
- ☑ Provide entryway features in road corridors approaching cultural districts.
- ☑ Keep highway improvements from blocking public vistas.
- ☑ Trees should be planted in ways and places that don't restrict all-important mountain views.
- ☑ By adding significant numbers of trees, transportation arterials can become boulevards and expressways can become parkways. Such transportation corridors increase in value to the community as the trees mature.
- ☑ Use appropriate lighting design that shields roadway light fixtures from direct view and minimizes upward lighting.

Case Study

City of Boulder, Colorado

PROTECTING VIEWS TO THE FLATIRONS

In the mid-1990s, the U.S Bureau of Standards proposed a major redevelopment of their existing site on Broadway in the City of Boulder. There was considerable concern that new buildings would block views of the mesa and the Flatirons behind the property—this was one of the most popular views in the city. City staff worked with federal designers and eventually agreed to restrict the height of new buildings so that existing views could be maintained. The new facility maintains the desired views and blends in with the existing landscape.

In another case, a stretch of Highway 93 between Boulder and Golden, which contains one of the few areas west of the highway that hasn't been developed, was proposed for development. The development would have removed one of the last remaining unrestricted views of the Flatirons. This area also has a significant tallgrass prairie community. This view was considered to be such a high priority that the City of Boulder intervened and purchased a large part of this area to be managed as open space, effectively forcing the developer to change plans. The view remains unobstructed today.

Photo courtesy City of Boulder Open Space and Mountain Parks, ***www.ci.boulder.co.us/openspace.***

Case Study

Colorado Springs, Colorado

BIG JOHNSON OPEN SPACE MASTER PLAN

In the fall of 2000, the City of Colorado Springs acquired an open space parcel of 646 acres adjacent to the Big Johnson Reservoir, south of the Colorado Springs Municipal Airport and Powers Boulevard. This open space area is an important prairie remnant and viewshed and is the City's first open-space acquisition of a grassland area.

The site is a valuable ecological resource attracting over 200 species of birds, including the red-tailed hawk, mountain plover, burrowing owls, and migratory shore birds. Also present are mammals including pronghorn and black-tailed prairie dogs. The site also is noted for its outstanding views of Pikes Peak and the surrounding mountains of Colorado's Front Range.

This project reflects effective collaboration and planning by its governmental and non-profit sponsors. Funding for the $8.1 million acquisition came from the City of Colorado Springs' Trails, Open Space and Parks (TOPS) Program, supplemented with a grant from Great Outdoors Colorado (GOCO). Valuable additional support was provided by the Trust for Public Land and the Palmer Foundation.

The site is bounded to the north and the east by Powers Boulevard, a four-lane expressway. The Big Johnson Reservoir holds non-potable water and isn't used for recreational water sports. It is owned by the Fountain Mutual Irrigation Company.

Due to its proximity to the airport, noise and aviation safety issues somewhat limit the land's development potential for other uses. Plant communities on the property are somewhat degraded due to past livestock grazing.

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After acquiring the land, the City prepared a Master Plan for the area, with input from a large range and number of stakeholders

While it is desirable to make the site accessible for bird watching and wildlife viewing, it's important to ensure that this human intrusion doesn't degrade the usefulness of the site as habitat for grassland flora and fauna. For example, while the Master Plan includes a loop trail, it's likely that trail users won't be allowed to bring dogs or other pets onto the property.

The Big Johnson Open Space Master Plan includes the following specific goals:

Ecological Goals

- Manage the property to enhance regional conservation efforts.
- Promote the conservation and restoration of natural communities.

Community Goals

- Maintain the open space as a buffer to the greater Colorado Springs area.
- Promote educational programs and recreational activities where appropriate.

Reference: City of Colorado Springs. *Big Johnson Open Space Master Plan, A Resource Management Guide,* November 2002.

Case Study

U.S. Air Force Academy, Colorado

UNITED STATES AIR FORCE ACADEMY DESIGN CHARETTE

Approximately six miles of Interstate 25 in northern El Paso County, Colorado, are located on U.S. Air Force Academy (USAFA) property, via an easement. This segment, extending roughly from North Academy Boulevard to North Gate Boulevard, includes the planned future connection of Interstate 25 with Powers Boulevard. A design for this interchange had been selected in 1997 through the Powers Boulevard Environmental Assessment, but a second chance to examine the issue arose in 2002.

The USAFA and I-25 planners have always worked together; the two facilities were constructed at about the same time. In 2002, at the request of the USAFA, the Federal Highway Administration and the Colorado Department of Transportation agreed to take a new look at the planned I-25/Powers connection. A weeklong design charette meeting was held in February 2002 to address the issue in a comprehensive manner. A public meeting about the interchange was held just before the charette to solicit public comment on issues that ought to be considered. The charette began with a discussion airing of USAFA mission needs, including airspace patterns, base security, and special event considerations, as well as I-25 environmental issues and regional and local traffic demands.

The charette also included a discussion of the academy's original design philosophy. It was noted that the widened highway median extending north and south of the North Gate interchange was deliberately planned as a subtle, visual "arrival experience" for motorists traveling the long rural highway between Denver and Colorado Springs

The charette team then drafted several different interchange concepts and evaluated these based on criteria developed in the initial discussion. These ideas were later taken to the public for input, and ultimately a proposed concept was identified.

The result of the entire process was a new interchange concept was selected to replace the one earlier approved by FHWA. All ramps in the new design are at or below the I-25 grade, to minimize urban intrusion into the natural landscape and to minimize viewshed impacts.

Subsequently, this cooperative interagency planning process was nominated for an award from the American Planning Association. At press time, the results of the awards judging are not yet known.

In the foreground, I-25 passes over North Gate Road. The Cadet Chapel and other key campus buildings loom behind like a citadel on a hill.

Other relevant case studies to see in this report:

- City of Austin, Texas: Sustainable Communities Initiative
- Greater Wasatch Area, Utah: Envision Utah
- Kansas City region, Kansas and Missouri

Key written resources:

"American Forests Unveils CITYgreen 5.0; Nonprofit Provides New Emphasis on the Environmental and Economical Benefits of Urban Tree Cover," ***www.americanforests.org/news/display.php?id=44***.

"Calculating the Value of Boulder's Urban Forest," ***www.ci.boulder.co.us/publicworks/depts/utilities/conservation/exec_summary.htm***.

Colorado Office of Archaeology and Historic Preservation, ***www.coloradohistory-oahp.org***

"*Colorado Springs Utilities Xeriscape Demonstration Garden,"* ***www.csu.org/xeri/.***

"Digging Into Xeriscape Gardening," **www.ci.boulder.co.us/publicworks/depts/utilities/drought/xeri.htm**.

National Register of Historic Places, ***www.cr.nps.gov/nr/about.htm***.

"Scenic America: Smart Growth and Scenic Stewardship," ***www.scenic.org/growth.htm***.

APPENDIX 1 – DESCRIPTION OF TRANSPORTATION CORRIDORS

This appendix provides additional detail about the major transportation corridors that were discussed in Section 1 of this report.

INTERSTATE 25

An Environmental Assessment is underway to examine the proposed widening of the region's only existing freeway (currently four lanes) to an ultimate cross-section of eight lanes through central Colorado Springs, including one lane in each direction reserved for use only by carpools and buses during peak periods. The freeway would be six lanes north of Briargate Parkway and south of the Martin Luther King US24 Bypass.

I-25 was opened through Colorado Springs in 1960, and thus has been a part of the region's landscape pattern for nearly 45 years. The freeway runs through central Colorado Springs, where the City began in 1871 and most of the region's oldest buildings can be found.

North and south of central Colorado Springs, I-25 has strongly influenced development. The vast majority of today's community was built since 1960, and access to I-25 interchanges therefore was taken into account in many of these land use decisions.

For adjacent neighborhoods, increased noise levels along I-25 are of concern. There are five noise walls along the corridor today, a sixth is planned, and eight more barriers are proposed to mitigate future capacity improvements. The corridor is a noisy place and is getting ever noisier.

The alignment of I-25 largely follows existing linear features (railroad tracks and Monument and Fountain Creeks) that already created barriers to east-west movement by people before the highway was built.

I-25 is located very close to Monument and Fountain Creeks, and was built at a time when water quality impacts of stormwater runoff were not as much of a concern as they are today. The proximity of the road to the receiving waters limits the amount of space available for water detention facilities to hold and mitigate the resulting discharge.

POWERS BOULEVARD

The 18-mile central section of Powers, extending from Woodmen Road and Mesa Ridge Parkway, is proposed to undergo capacity improvements and is currently the subject of an Environmental Assessment. The Destination 2025 Plan reflects this segment being upgraded from the existing expressway to a freeway.

Powers also is being extended northward for 7 miles to I-25, and there are plans to extend it southward another 10.5 miles to a future terminus at I-25 near the Pikes Peak International Raceway.

Plans for Powers Boulevard have been on the books since 1963, and was originally conceived as a possible bypass alternative for I-25. Due to rapid growth in eastern Colorado Springs, however, Powers is needed to serve its own local traffic demand, and is not primarily a bypass route.

The road itself is named after the Powers family that operated dairy and ranching operations in eastern Colorado Springs. But the wide-open spaces, cattle and pronghorn that until recently defined the corridor are rapidly giving way to residential subdivisions and extensive retail development. Powers also is a main north-south route for accessing the Colorado Springs Municipal Airport.

Powers Boulevard is already a limited-access expressway, and is modeled as a freeway in the region's long-range transportation plan. Many of its at-grade intersections will need to be converted to grade-separated interchanges, which will consume a lot of land adjacent to the existing intersections. This land is already developed or rapidly developing with minimal setbacks, so any proposed corridor improvements (not yet specified in the Powers Boulevard Environmental Assessment) are likely to have impacts to adjacent businesses.

WOODMEN ROAD

An Environmental Assessment is underway for the proposed widening of Woodmen Road, one of the region's busiest east-west routes. The PPACG Destination 2025 Plan reflects widening of the roadway from two lanes in each direction in urban areas and one lane in each direction in rural areas.

The most congested portion of Woodmen is the four-lane section between I-25 and Academy Boulevard. East of the intense retail land use at Academy Boulevard, Woodmen is also four lanes, passing by residential areas and less intense retail centers. East of Powers, Woodmen is just a two-lane road, but carries heavy volumes of traffic to residential areas in Falcon and Peyton. Traffic will intensify with the future development of the 20,000-acre Banning-Lewis Ranch.

Woodmen Road crosses Cottonwood Creek, Sand Creek, and a number of other south-flowing creeks that are part of the Fountain Creek Watershed. Improvements in the Woodmen corridor will impact prairie grasslands.

SOUTH METRO ACCESSIBILITY STUDY

A proposal to widen two-lane Drennan Road for four miles from Powers Boulevard to South Academy Boulevard has evolved into a joint City-County study seeking to find east-west mobility solutions for the southern edge of Colorado Springs. The study also may consider connectivity to State Highway 115, an additional 3.5 miles west of South Academy.

East of Powers, Drennan is the access road into the Colorado Springs Municipal Airport. The existing Drennan does not provide a high-speed connection between the Airport and I-25.

Social and environmental factors in this corridor include low-income residential areas on the north side of Drennan, prairie wildlife issues, the need for a crossing of Fountain Creek, I-25 interchange issues, and residential impacts near Fort Carson.

Table A-1
Four Major Transportation Projects - By the Numbers

Corridor	Length (miles)	Facility Type	Lanes	Existing Weekday Traffic	Future Weekday Traffic	Traffic Increase
Interstate 25[a]	26[a]	Freeway	4	108,500[b]	171,000[c]	58%
Powers Blvd.	18[d]	Expressway	4/6	52,000[e]	128,000[f]	140%
Woodmen Road	10.5[g]	Principal Arterial	2/4	35,000[h]	61,000[i]	74%
Drennan Road	4[j]	Minor Arterial	2	14,000[k]	38,000[l]	171%

Notes:
a. from South Academy Boulevard (Exit 135) to Monument (Exit 161)
b. denotes highest year 2000 volume in corridor, found north of Bijou Street (Exit 141)
c. denotes highest year 2025 volume in corridor, assuming capacity improvements made
d. segment from Woodmen Road to Mesa Ridge Parkway
e. denotes highest year 2000 volume in corridor, found north of Palmer Park Blvd.
f. denotes highest year 2025 volume in corridor, assuming Powers upgraded to freeway
g. segment from Interstate 25 to U.S. Highway 24
h. year 2000 volume west of Academy Boulevard, from PPACG Regional 2001 Traffic Volume Map
i. year 2025 volume west of Academy Boulevard, assuming Woodmen Road capacity improvements
j. segment from Powers Boulevard to Academy Boulevard; proposed improvements may vary
k. year 2000 volume west of Hancock Expressway, from PPACG Regional 2001 Traffic Volume Map
l. projected volume for four-lane freeway segment, from Colorado Springs East-West Mobility Study

APPENDIX 2 – ECOLOGICAL COMMUNITY DESCRIPTIONS

This appendix provides additional detail about the land cover types that were discussed in Section 2-A ("Landscape Patterns") of this report. Additional information about sensitive species found in the Pikes Peak Region follows, in Table A-2.

El Paso County consists of a complex array of ecosystems that mirror a diverse landscape and wide range in elevations. Although much of the County has been converted to other land uses, remnants of many of the original natural ecosystems are still evident. The biodiversity of these systems can be used as a barometer of ecosystem health and a measure of the changes that have occurred since the area was settled by European-influenced culture. Five ecosystems or land cover types were selected as markers to characterize the cumulative effects to natural resources in El Paso County. These include shortgrass prairie, forests, riparian and wetland areas, agricultural development, and urban areas.

Other important ecosystems occur in El Paso County, but tracking changes to many of these through aerial photograph interpretation may not be practicable. For example, shrub-dominated vegetation occurs in much of the County at a slightly lower elevation position or on more xerophytic sites, and in close proximity to ponderosa pine. And in fact, an "Oak – mountain mahogany" zone has been noted for the higher plateaus of the County, between the forested area and grasslands (Monument Creek Watershed Landscape Assessment 2002), but is not described here as a separate entity because of its disjunct, patchy nature.

SHORTGRASS PRAIRIE

Originally the shortgrass prairie ecosystem covered a nearly contiguous area, extending from eastern Kansas west to the Rocky Mountains and from Texas into Canada (Oosting 1956, Kuchler 1967). This prairie is typified by a blue grama (*Bouteloua gracilis*) and buffalograss (*Buchloe dactyloides*) association. But the dynamics of this ecosystem were characterized by a productive grazer component of bison (*Bison bison*), pronghorn (*Antilocapra americana*) and small mammal (e.g., black-tailed prairie dog: *Cynomys ludovicianus*). These herbivores in turn supported numerous predator species, including wolf (*Canis lupus*), coyote (*Canis latrans*), swift fox (*Vulpes velox*), various raptors, as well as with bullsnake (*Pituophis melanoleucus*) and prairie rattlesnake (*Crotalus viridis viridis*).

Generally, western wheatgrass (*Pascopyrum[Agropyron] smithii*), needle-and-thread (*Hesperostipa [Stipa] comata*), and junegrass (*Koeleria macrantha*) occur as associates of blue grama and buffalo grass (Soil Conservation Service [SCS] 1981). In eastern Colorado though, fringed sage (*Artemisia frigida*) and threadleaf sedge (*Carex filifolia*) often occur commonly with junegrass to characterize shortgrass prairie (Barbour and Billings 1988).

Much of this ecosystem was converted either to farmland or livestock production in the late 1800s and early 1900s (*Monument Creek Watershed Landscape Assessment, 2002*). Because short grass plant species are low in stature and adapted to gazing by bison, livestock use has in many cases preserved some elements of this ecosystem. If overgrazed, however, weedy perennial species often predominate, and include prickly pear (*Opuntia polyacantha*), snakeweed (*Gutierrezia sarothrae*), and yucca (*Yucca glauca*). At present, remnants of short grass prairie occur as scattered tracts in El Paso County, primarily east of I-25.

Because this ecosystem currently exists as disjunct patches, and in a variety of altered states, it contains numerous extirpated and rare species. These include bison, wolf, burrowing owl (*Athene cuniculatus*), swift fox, mountain plover (*Chadrius montanus*), and long-billed curlew (*Numenius americanus*).

FORESTS

Forests become prominent at approximately 6500 feet elevation in El Paso County, first as open ponderosa pine (*Pinus ponderosa*) parkland or woodland on the eastern edge of the foothills, along what Weber and Whitman (2001) term the mountain front. An outlier of ponderosa pine forest occurs in the Black Forest area northeast of Colorado Springs, with Douglas-fir (*Psuedotsuga menziesii*) occupying north-exposed ravines and canyons. Pinon – juniper (*Pinus edulis – Sabina [Juniperus] monosperma*) woodlands occur along the foothills along the mountain front throughout the County (e.g., Garden of the Gods Park, Fort Carson) and as a lower elevational fringe to ponderosa pine. In much of the uplands and hills surrounding Colorado Springs, and as the characterizing element of the Black Forest area, ponderosa pine commonly interfaces with oakbrush or Gambel oak (*Quercus gambelii*), as well as grassland elements, such as blue grama, little bluestem, and junegrass that form much of the ground cover. Other prominent species are Oregon grape (*Mahonia repens*), antelope bitterbrush (*Purshia tridentata*), mountain-mahogany (*Cercocarpus montanus*), currant (*Ribes aureum*), and yucca (City of Colorado Springs 1997). With continued increases in elevation, the montane elements of Douglas-fir and ponderosa pine are replaced at approximately 9500 feet elevation by forests of Englemann spruce (*Picea engelmannii*) and subalpine fir (*Abies bifolia [=lasiocarpa]*), as well as lodgepole pine (*Pinus contorta*) and aspen (*Populus tremuloides*) as subclimax or disturbance elements within this forest habitat.

Characteristic animal species of montane woodlands and forests include mule deer (*Odocoileus hemionus*), mountain lion (*Felis concolor*), bobcat (*Lynx rufus*), coyote, red fox (*Vulpes fulva*), black bear (*Ursus americana*), porcupine (*Erethizon dorsatum*), striped skunk (*Mephitis mephitis*), Abert squirrel (*Sciurus aberti*), bushy-tailed woodrat (*Neotoma cinerea*), and many other birds and small mammals.

These forests have changed in composition with the advent of settlement by European culture. Many of the ponderosa pine and Douglas-fir have been logged for timber starting in approximately 1860 (Monument Creek Watershed Landscape Assessment, 2002). Re-growth since logging, along with fire suppression and livestock grazing have generally increased the forest densities, and decreased the heterogeneity or forest diversity both in structure and numbers of species.

RIPARIAN AND WETLAND ECOSYSTEMS

Riparian communities occur along most of the stream systems in the project area. Willow-dominated shrub habitat defines most stream systems throughout El Paso County (Colorado Division of Wildlife 1998). Dominant species are sandbar willow (*Salix exigua*), crack willow (*S. fragilis*), peachleaf willow (*S. amygdaloides*), and in some areas lead plant (*Amorpha fruticosa*) (City of Colorado Springs 1997). Other species that occur primarily as subordinates to willows include red osier dogwood (*Swida sericea*), wild plum (*Prunus americana*), chokecherry (*Padus [Prunus]* virginiana), Baltic rush (*Juncus balticus*), cocklebur (*Xanthium strumarium*), and snowberry (*Symphoricarpos occidentalis*).

Occasionally plains cottonwoods (*Populus deltoides*) are scattered along drainages that contain a floodplain or valley floor, and form a more mature community. Boxelder (*Acer negundo*) may also occur as part of this community, along with bluegrass (*Poa* spp.), bluejoint (*Calamagrostis canadensis*), snowberry, orchardgrass (*Dactylis glomerata*), and meadow foxtail (*Alopecurus pratensis*).

Characteristic animal species of riparian areas include mule deer, white-tailed deer (*Odocoilus virginianus*), beaver (*Castor canadensis*), red fox, striped skunk, deer mouse (*Peromyscus maniculatus*), and other small mammals. These areas also provide habitat to a great diversity of songbirds, waterfowl, shore-birds and wading birds (e.g., great blue heron: *Ardea herodius*), as well as reptiles, such as plains garter snake (*Thamnophis radix*). Raptor species including red-tailed hawk (*Buteo jamaicensis*) and great-horned owl (*Bubo virginianus*) often nest in riparian areas where habitat is suitable and prey species are more plentiful.

Preble's meadow jumping mouse (*Zapus hudsonius preblei*) is endemic to riparian habitats along the Front Range of Colorado, and is listed federally as threatened. Such species can be used as a measure of riparian ecosystem health. Over-development, overuse, and stream channelization, for example, often reduce the habitat diversity making it unsuitable for many of the original species that depend on these scarce waterways.

Riparian areas in much of the County have been affected over the last 150 years by heavy livestock use. Because of the high productivity of forage in riparian areas, and availability of water, livestock often congregate in these areas, resulting in decreased vegetation cover and diversity as well as decreased water quality (sedimentation-siltation) (Monument Creek Watershed Landscape Assessment 2002).

Wetlands occur as part of the riparian stream courses, but also as seeps and ponds, which are a prominent feature in an otherwise dry prairie and woodland landscape. Riparian systems and seeps were often dammed as part of livestock grazing operations, and stock ponds remain a prominent feature in the County, especially east of I-25. These areas have in some cases increased the habitat diversity of riparian systems to include additional areas of marsh and open water. Wetlands of seeps and springs occur frequently north and east of Colorado Springs in conjunction with the Dawson Formation of alluvium (von Ahlefeldt 1998). Ground water that flows laterally through this alluvium from the Black Forest area surfaces when it encounters a clay lens, forming seeps and ponds. This area gives rise to a number of streams that eventually flow into Fountain Creek and Monument Creek

Seeps and wetland swales are characterized by narrowleaf cattail (*Typha latifolia*), Baltic rush, Nebraska sedge (*Carex nebraskensis*), tufted hairgrass (*Deschampsia cespitosa*), wild iris (*Iris missouriensis*), bulrush (*Bolboschoenus maritimus* ssp. *paludosus* [*Scirpus paludosus*]), and three-square (*Schoenoplectus pungens* [*Scirpus americanus*]). Near-surface moisture is often marked by thick, dark green stands of Baltic rush and sedges. These areas are an important feature to the ecosystem, and support a diverse array of wildlife species.

AGRICULTURE

Areas of prairie were first used in the region's development for livestock production, which remains as an important livelihood in the County. Both dryland and irrigated crops have been developed in El Paso County since the 1860s (SCS 1981). Settlers in the Fountain Creek valley first irrigated small fields of potatoes and corn. Irrigation was also initiated in the early 1900s in the Black Squirrel Creek basin to grow native hay. Today, dryland crops primarily consist of small grain (e.g., winter wheat), millet, and sorghum, while irrigated crops include alfalfa, corn and pinto beans. Many areas of croplands have lately been converted to pastures and rangeland, and beef production is an important part of most farm operations (SCS 1981).

A second swing in land development has occurred over the last 15 – 20 years, as Colorado Springs and other communities in the County have experienced rapid growth. This growth has converted land use in many communities from agricultural to urban development.

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Table A-2. Sensitive Species That Potentially Occur in El Paso County, Colorado

SCIENTIFIC NAME	COMMON NAME	STATUS CODE*	HABITAT	RCEA COVER TYPE	DRENNAN	I-25	POWERS	WOOD-MEN	POTENTIAL TO BE IMPACTED	TYPE OF IMPACT
AMPHIBIANS										
Rana pipiens	Northern leopard frog	FSS, BLM	Ponds, ditches, wet meadows	OT, RI	1.2%	6.6%	2.7%	2.9%	Moderate; suitable habitat present within project area buffers and species is known to be present in Colorado Springs area.	Habitat loss, indirect effects due to water quality issues.
BIRDS										
Buteo regalis	Ferruginous hawk	FSS, BLM, SC	Open grasslands	SG, AG	43.1 %	38.8 %	60.3%	4.9 %	Low; project area is within known range of this species and suitable habitat is present. However, this species probably uses the area lightly.	Direct habitat loss, indirect habitat loss due to increased development and disturbance
Charadrius montanus	Mountain plover	FSS, SC	Short-grass prairie with very short grass (grazed; prairie dog	SG	42.0 %	36.9 %	58.3 %	43.5 %	Low, suitable habitat – heavily grazed or	Direct habitat loss, indirect habitat loss due to increased

SCIENTIFIC NAME	COMMON NAME	STATUS CODE*	HABITAT	RCEA COVER TYPE	DRENNAN	I-25	POWERS	WOOD-MEN	POTENTIAL TO BE IMPACTED	TYPE OF IMPACT
			towns), flat slopes						burned, with low amounts of human disturbance - probably rare in project area.	development and disturbance.
Falco peregrinus aratum	American peregrine falcon	FSS	Nests on cliffs, forages in adjacent habitats	All					Depends if there are birds currently breeding in the region. Peregrines hunt widely around their nest sites.	Indirect habitat loss due to increased development and disturbance.
Grus Americana	Whooping crane	FE, SE	Mudflats, wet meadows, agricultural areas	RI, AG	2.0 %	6.7 %	4.6 %	3.2 %	Very low; rare migrant only.	Direct habitat loss, indirect habitat loss due to increased development and disturbance
Haliaeetus leucoccephalus	Bald eagle	FT, ST	Reservoirs, rivers, prairie dog towns	OT, RI, SG, AG	44.3 %	45.4 %	63.0 %	43.9 %	Low; likely present only at active prairie dog towns with adjacent perches, and only in winter.	Direct habitat loss, indirect habitat loss due to increased development and disturbance.

SCIENTIFIC NAME	COMMON NAME	STATUS CODE*	HABITAT	RCEA COVER TYPE	DRENNAN	I-25	POWERS	WOOD-MEN	POTENTIAL TO BE IMPACTED	TYPE OF IMPACT
Numenius americanus	Long-billed curlew	FSS, SC	Shortgrass prairie	SG, AG	43.1 %	38.8 %	60.3 %	4.9 %	Low; suitable habitat present in project area but this species is most likely present in the area only during migration.	Direct habitat loss, indirect habitat loss due to increased development and disturbance.
Strix occidentalis lucida	Mexican spotted owl	FT, ST	Canyons with old growth coniferous forest	none	–	–	–	–	None; no suitable habitat in project area.	–
FISH										
Etheostoma cragini	Arkansas darter	ST	Clear waters 3,000-6500', with sandy bottoms, moderate current, and abundant rooted vegetation	OT	0.3 %	1.8 %	0.1 %	*0.1 %*	Moderate; moderately suitable habitat exists in project area, confirmed present downstream of C. Springs.	Indirect effects due to water quality issues.

SCIENTIFIC NAME	COMMON NAME	STATUS CODE*	HABITAT	RCEA COVER TYPE	DRENNAN	I-25	POWERS	WOOD-MEN	POTENTIAL TO BE IMPACTED	TYPE OF IMPACT
MAMMALS										
Conepatus mesoleucus	Common hog-nosed skunk	FSS	Canyons in PJ and oakbrush habitats and possibly grasslands.	FR	0.0 %	0.4 %	0.0 %	0.2 %	Very low; very small amounts of suitable habitat present in project area and last confirmed record of this species El Paso County dates from 1920s.	Direct habitat loss, indirect habitat loss due to increased development and disturbance.
Cynomys gunnissoni	Gunnison's prairie dog	FSS	Open grasslands	SG, AG	43.1 %	38.8 %	60.3 %	4.9 %	Moderate; suitable habitat is present, confirmed population at Northgate Interchange on the Air Force Academy However, this is the easternmost record of this species.	Direct habitat loss, indirect habitat loss due to increased development and disturbance.

SCIENTIFIC NAME	COMMON NAME	STATUS CODE*	HABITAT	RCEA COVER TYPE	DRENNAN	I-25	POWERS	WOOD-MEN	POTENTIAL TO BE IMPACTED	TYPE OF IMPACT
Cynomys ludovicianus	black-tailed prairie dog	FSS, SC	Short grasslands	SG, AG	43.1 %	38.8 %	60.3 %	4.9 %	Moderate; this species is known to exist in the project area.	Direct habitat loss, indirect habitat loss due to increased development and disturbance.
Mustela nigripes	Black-footed ferret	FE, SE	Prairie dog towns	SG	42.0 %	36.9 %	58.3 %	43.5 %	Very Low; there are no current records of this species on the Front Range. Existing prairie dog towns in the area are too small to support this species.	-
Plecotus townsedii pallescens	Townsend's big-eared bat	FSS	Forested, riparian, and urban areas.	RI, FR, UR	55.7 %	54.2 %	34.6 %	44.9 %	Low; suitable habitat is widespread but there are no records of this species in the project area.	Direct habitat loss, indirect habitat loss due to increased development and disturbance

SCIENTIFIC NAME	COMMON NAME	STATUS CODE*	HABITAT	RCEA COVER TYPE	DRENNAN	I-25	POWERS	WOOD-MEN	POTENTIAL TO BE IMPACTED	TYPE OF IMPACT
Vulpes velox	Swift fox	FSS, SC	Open grasslands	SG, AG	43.1 %	38.8 %	60.3 %	4.9 %	Low; suitable habitat is present within the project area, but the existing level of development in the project area probably excludes this species.	Direct habitat loss, indirect habitat loss due to increased development and disturbance.
Zapus hudsonius preblei	Preble's meadow jumping mouse	FT, ST	Riparian areas and adjacent uplands	RI	0.9 %	4.8 %	2.6 %	2.8 %	High; species is known to be present within the project area buffers.	Direct habitat loss, indirect habitat loss due to increased development/ disturbance.
PLANTS										
Ambrosia linearis	Plains ragweed	FSS	Sandy soils in seasonal moist prairie habitats, elevations of 4,300-6,700'	SG	42.0 %	36.9 %	58.3 %	43.5 %	Moderate; habitat is likely present in the project area.	Direct habitat loss, indirect habitat loss due to increased development and disturbance.
Aquilegia chrysantha var. rydbergii	Golden columbine	FSS, BLM	Rocky outcrops along mountain streams, 5,500-6,000' elevation	RI	0.9 %	4.8 %	2.6 %	2.8 %	None; no suitable habitat in project area.	–

SCIENTIFIC NAME	COMMON NAME	STATUS CODE*	HABITAT	RCEA COVER TYPE	DRENNAN	I-25	POWERS	WOOD-MEN	POTENTIAL TO BE IMPACTED	TYPE OF IMPACT
Botrychium echo	Reflected moonwort	FSS	9,500 – 1,100' elevation	none	–	–	–	–	None; project area is to low in elevation.	–
Botrychium lineare	Narrowleaf grapefern	FSS	7,900 – 9,500' elevation	none	–	–	–	–	None; project area is to low in elevation.	–
Eriogonum brandegeei	brandegee wild buckwheat	FSS, BLM	Sage, Pinyon-Juniper, sparsely vegetated areas, shale/limestone soils, 5,700-7,600' elevation	SH	0.9 %	5.3 %	5.0 %	11.1 %	Very low; preferred habitat does not occur in project area.	Indirect habitat loss due to increased development and disturbance as a result of the project.
Malaxis monophyllos ssp. Brachypoda	White adders-mouth	FSS	Shaded side streams, mossy wet areas, 7,200-8,000' elevation	None	–	–	–	–	None; project area is to low in elevation.	–
Nuttallia chrysantha	golden blazing star	BLM	Barren slopes of limestone/shale	None	–	–	–	–	None; habitat does not occur in project area.	–
Ptilagrostis mongholica ssp. Porteri	Porter feathergrass	FSS	Hummocks in fens and willow carrs, 9,200 – 12,000' elevation	None	–	–	–	–	None; project area is to low in elevation.	–

SCIENTIFIC NAME	COMMON NAME	STATUS CODE*	HABITAT	RCEA COVER TYPE	DRENNAN	I-25	POWERS	WOOD-MEN	POTENTIAL TO BE IMPACTED	TYPE OF IMPACT
Spiranthes diluvialis	Ute Ladies' tresses	FT	Sub-irrigated alluvial area of open meadow floodplains, 4,500-6,800' elevation	RI	0.9%	4.8%	2.6%	2.8%	Very low; suitable habitat may occur in the project area but there are no records of this species in El Paso County	Direct habitat loss, Direct habitat loss, indirect habitat loss due to increased development and disturbance.
Viola pedatifida	Prairie violet	S2	Prairies, open woodlands, and forest openings; rocky sites. 5,800-8,800' elevation	SG	42.0 %	36.9 %	58.3 %	43.5 %	Moderate; suitable habitat likely to occur in foothills adjacent to project area and in the Black Forest area.	Indirect habitat loss due to increased development and disturbance as a result of the project.
Viola selkirkii	Selkirk violet	FSS	Cold mountain forests, moist thickets, 8,500 – 9,100' elevation	None	–	–	–	–	None; project area is too low in elevation.	–
REPTILES										
Sistrurus catenatus	Massasauga rattlesnake	FSS, BLM	Dry plains, grasslands, often in grazed areas	SG	42.0 %	36.9 %	58.3 %	43.5 %	Very low; no known records for El Paso County.	Direct habitat loss, indirect loss, indirect habitat loss due to increased development and disturbance.

SCIENTIFIC NAME	COMMON NAME	STATUS CODE*	HABITAT	RCEA COVER TYPE	DRENNAN	I-25	POWERS	WOOD-MEN	POTENTIAL TO BE IMPACTED	TYPE OF IMPACT
*Explanation of Status Codes: FSS=Forest Service Sensitive BLM=Bureau of Land Management Sensitive, SC=State Species of Special Concern, FE=Federal Endangered, FT=Federal Threatened, ST=State Threatened										

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GLOSSARY

This glossary includes terms used in this report, plus terms likely to be encountered in some of the general sources referred to in this document.

Most of the definitions given here are taken from the following sources.

- *EPA: U.S. Environmental Protection Agency Watershed Academy Web www.epa.gov/watertrain/cwa/*
- *MARC: Mid-America Regional Council, Kansas City*
- *SAF: Society of American Foresters' Dictionary of Forestry, and with input from subject-matter experts by the Office of Personnel Management Professional (Draft Job Family Standard for Professional Work in the Natural Sciences Group, Appendix G—Natural Sciences Glossary)*
- *TRB: National Cooperative Highway Research Program NCHRP Synthesis 305 Interaction Between Roadways and Wildlife Ecology A Synthesis of Highway Practice, Gary L. Evink*

Definitions from other sources are noted.

abiotic. Non-living, or derived from non-living processes. This term usually applies to environmental processes or elements such as temperature, humidity and pH. (SAF)

adaptive management. The process of implementing policy decisions incrementally so that scientists can make changes if they do not achieve the desired results. It is a process similar to a scientific experiment that tests predictions and assumptions in management plans. Experience and new scientific findings are used as the basis to improve resource-management practices and future planning. (SAF)

ambient monitoring. Monitoring program with fixed station networks and intensive surveys and producing chemical, physical and biological analyses. Ambient monitoring deals with conditions in the aquatic environment—streams, lakes, bays, estuaries and oceans. By contrast, effluent (discharge) monitoring involves sampling and analysis of wastewater. (EPA)

assessment. The act of evaluating and interpreting data and information for a defined purpose. (SAF)

BLM. Bureau of Land Management.

best management practices. Any program, process, citing criteria, operating method, measure or device that controls, prevents, removes or reduces pollution. (California Environmental Protection Agency)

biodiversity. Variability among living organisms from all sources; terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part. This includes diversity within species, between species and of ecosystems, as well as of the processes linking ecosystems and species. (TRB)

biological control. Controlling pest organisms using other organisms. (SAF)

biome. A large, regional ecological unit usually defined by some dominant vegetative pattern such as coniferous forest or prairie biomes and produced by global climate patterns. There are eight major terrestrial biomes, two freshwater biomes and a complex of marine biomes in the United States. (SAF)

biota. The living organisms in a given area. (SAF)

biotic. Living or derived from living organisms. (SAF)

brownfields. Abandoned, idled or under-used industrial and commercial facilities where expansion or redevelopment is complicated by real or perceived environmental contamination. (MARC)

buffer zone. An area in a reserve surrounding the central core zone in which nondestructive human activities such as ecotourism, traditional (low intensity) agriculture or extraction of renewable natural products are permitted. The buffer zone may also include areas that surround a central core with the intent of minimizing or filtering intrusive factors (e.g., noise, cowbird parasitism or pollution). (SAF)

carrying capacity. The maximum number of individuals of a given species that a habitat can maintain. (SAF)

CDOT. Colorado Department of Transportation.

CDOW. Colorado Department of Wildlife.

CDPHE. Colorado Department of Public Health and Environment.

charette. An intensive workshop at which representatives of various planning-related interests participate to develop a plan for a given area.

climax. The final community state (sere) in the process of succession for a given area. Upon reaching this state, the area will be stable and self-replacing until acted upon by an outside process such as a fire or climate change. (SAF)

community (biotic). Assemblage of interacting species living in a given location at a given time. (TRB)

community identity (human). Physical, natural or cultural assets that represent distinctive qualities unique to an individual community. A community's identity is enhanced by embracing and respecting the history and character of those existing features that nurture a sense of attachment and uniqueness within the area. (MARC)

connectivity. Quality or condition of structural landscape features being connected, enabling access between places via a continuous route of passage. (TRB)

conservation agreement. A formal signed agreement between a Federal agency, bureau or service and/or the National Marine Fisheries Service (NMFS) or other parties that implements specific actions, activities or programs designed to eliminate or reduce threats or otherwise improve the status of a species. These agreements can be developed at the State, regional, or national level. They generally include multiple agencies at both the State and Federal level, as well as tribes. (SAF)

***conservation biology**.* An integrative approach to protect and manage biodiversity that uses appropriate principles and experiences from several biological and social sciences fields including genetics, evolution, ecology, animal behavior, wildlife management, anthropology, philosophy and economics. (SAF)

***corridor**.* A defined tract of land connecting two or more areas of similar management or habitat type that is reserved from substantial disturbance; and through which a species can travel to reach habitat suitable for reproduction and other life-sustaining needs. (SAF)

***critical habitat**.* The ecosystems and/or habitats upon which endangered and threatened species depend in order to thrive and survive. (SAF)

***cumulative effects**.* Accumulated effects or impacts of a number of projects or actions. (TRB)

***dBA**.* A-weighted decibels; a measurement of the sound levels most perceptible to the human ear.

***density**.* The average number of persons, households or dwellings per acre of land. Developments at higher densities may be beneficial to a community if quality design features are utilized. Higher density development may make transit service more effective and maximize public infrastructure costs. (MARC)

***EPA**.* United States Environmental Protection Agency.

***easement**.* A legal agreement between parties with a vested interest. A conservation easement is a legal agreement a property owner makes to restrict the type and amount of development that may take place on the property for the purpose of protecting wildlife or their habitats. (SAF)

***ecological corridor**.* Landscape structures of various size, shape and vegetation that maintain, establish or reestablish natural landscape connectivity throughout the ecological network. (TRB)

***ecological network**.* A system of ecological corridors, habitat core areas and buffer zones surrounding corridors and core areas providing a network of habitat needed for the successful protection of biological diversity at the landscape level. (TRB)

***ecosystem**.* A community of living plants and animals interacting with each other and with their physical environments. (SAF)

***ecosystem ecology**.* The study of ecosystems and the biotic and abiotic factors that affect them. (SAF)

***ecosystem function**.* The flow of minerals, nutrients, water, energy and species within an ecosystem. (SAF)

***ecosystem management**.* An approach to maintaining or restoring the composition, structure, and function of natural and modified ecosystems for long-term sustainability. Scientists base this approach on a vision of desired future conditions. (SAF)

***ecosystem**.* A dynamic complex of plant, animal and microorganism communities and their non-living environment interacting as a functional unit. (TRB)

***endangered species**.* A species that is in imminent danger of extinction throughout all or a significant portion of its range. (SAF)

enhancement*.* Improving the quality of habitat. (TRB)

environment (natural and built)*.* A complex of physical, chemical and biotic factors (e.g., climate, soil and living things) that act upon an organism or an ecological community and ultimately determine its form and survival. (TRB)

environmental assessment*.* Concise public document that serves to (1) briefly provide sufficient evidence and analysis for determining whether to prepare an environmental impact statement or a finding of no significant impact; (2) aid an agency's compliance with the National Environmental Policy Act when no environmental impact statement is necessary; and (3) facilitate preparation of a statement when one is necessary. It shall include brief discussions of the need for the proposal, of alternatives as required by section 102(2)(E), of the environmental impacts of the proposed action and alternatives and a listing of the agencies and persons consulted. (TRB)

environmental impact statement (EIS)*.* A detailed statement of a Federal project's environmental consequences, including:

- *adverse environmental effects that cannot be avoided*
- *alternatives to the proposed action*
- *the relationship between local short-term uses and long-term productivity*
- *any irreversible or irretrievable commitment of resources. (SAF)*

ephemeral streams*.* Ephemeral waterbodies are streams, ponds, wetlands, etc. that contain water only a fraction of the time. Vernal pools and desert washes are examples. Sometime such waters are called "intermittent." As a general rule, a waterbody is not excluded from the definition of "waters of the U.S.," simply because it is intermittent. (EPA)

eutrophication*.* A process in which the addition of nutrients (primarily nitrogen and phosphorus) to waterbodies stimulates algal growth. This is a natural process, but it can be greatly accelerated by human activities. (National Oceanic and Atmospheric Administration)

exotic species*.* Species that occur in a given place as a result of direct or indirect deliberate or accidental introduction by humans. (SAF)

fauna*.* The animal species in a given area. (SAF)

federally listed species. Species that are formally listed by a Federal agency and/or the National Marine Fisheries Service (NMFS) as endangered or threatened under the Endangered Species Act. (SAF)

filter effect*.* Road barrier impact has a different effect on different species and may even vary between sexes or age categories. Thus, the road may act as a filter, inhibiting the movement of certain species or individuals. (TRB)

flora*.* Plant or bacterial life. (TRB)

fluvial*.* Of or pertaining to a river or growing or living in streams or ponds. (SAF)

fluvial morphology*.* The description and interpretation of relief features affecting the course, physical attributes, conditions and management capability of rivers and streams. (SAF)

forb*.* An herb other than grass. (SAF)

fragmentation*.* The splitting of natural habitats with the occurrence of specific plant and animal species into smaller and more isolated units. (TRB)

geographic information systems (GIS)*.* Diversity of remotely sensed information documenting the geographic character of an area. (TRB)

green infrastructure*.* A strategically planned and managed network of parks, greenways, conservation easements and working lands with conservation value that supports native species, maintains natural ecological processes, sustains air and water resources and contributes to the health and quality of life for communities and people. (MARC)

habitat*. (1)* The place, natural or otherwise (including climate, food, cover and water), where plant and/or animal populations naturally or normally live and grow. (SAF)

(2) Species-specific concept of the area in which a plant or animal species find all necessary resources to live and reproduce. (TRB)

habitat capability*.* The capability of an area, given the conditions of topography, vegetation, water and climate to support a number of adult individuals of a species, subspecies or group of species. (SAF)

habitat fragmentation*.* A complex process that can be defined as a reduction in the amount of natural habitat within a landscape and apportionment of the remaining habitat into smaller, more isolated patches. (Noss and Csuti 1997)

hazardous substances*.* Any material that can have an adverse impact at the biological level. (TRB)

heterogeneity*.* Quality or state of being dissimilar or diverse. (TRB)

hierarchy theory*.* Hierarchy theory considers a system to be composed of a number of subsystems and contributing itself to a higher-level system. This implies that the mechanisms underlying ecological phenomena expressed at a given level should be sought at the next lower level in the hierarchy. For instance, levels in natural hierarchy are, e.g., cells, organs, individuals, populations, communities, and ecosystems. (TRB)

I-25*.* Interstate 25.

impact, effect, consequence*.* Impact is the immediate response of an organ, organism, species or property to an external factor. This response may have an effect on the species or condition that may give consequences to the population or species community on a longer time scale. For instance, the impact of traffic noise on birds may reduce the capability of identifying and distinguishing other birds' voices. This may effect their social interactions and breeding success, with the possible consequence of local extinction. (TRB*)*

indicator*.* Quantitative variable, usually with target value representing an objective, which symbolizes environmental or other impacts of transport infrastructure plans (including ordinal scales, e.g., low, medium, high). (TRB)

indicator species*.* A species that scientists used as a measure of the condition of a particular habitat, community or ecosystem. (SAF)

(2) Species indicative of (a) some environmental or historical influence or (b) a community or habitat type. (TRB)

indigenous. Existing, growing or produced naturally in a region or area.

infill development. The reuse of urban land or vacant lots in developed neighborhoods and urban areas. Infill development is most successful when it is accomplished at a scale and with design features that are compatible with the existing and surrounding neighborhoods. (MARC)

infrastructure. System of communications and services within an area or country. (TRB)

invasive species. A species of plant or animal that is not native to (i.e., did not evolve in) an area (e.g., exotic species). (SAF)

inventory. A set of studies to determine the presence, extent or relative condition of wildlife and plant resources. (SAF)

landscape. Total spatial and visual entity of human living space integrating the geological, biological and humanmade (anthropogenic) environment. (TRB)

landscape diversity. Formal expression of the numerous relations existing in a given period between the individual or a society and a topographically defined territory, the appearance of which is the result of the action, over time, of natural and human factors and a combination of both. (TRB)

landscape pattern. The spatial distribution of landscape elements (patches, corridors, or matrices).

land-use planning. Activity aiming at predetermining the future acting of society by deciding on the temporal and spatial usage of land and water. (TRB)

life history. The description of a species' entire life cycle including rearing, feeding, migratory and breeding behaviors. (SAF)

linkages. Features that promote the interconnectedness of neighborhoods, commercial and office areas, open space resources and public places, and provide convenient access between these different uses. (MARC)

management indicator species. A species that theoretically indicates the general condition or "health" of an ecosystem. (SAF)

minimization. Efforts to reduce impacts by alternative actions. (TRB)

mitigation. Action designed and taken to reduce the severity of or eliminate an adverse impact. (TRB)

mixed-use development. Projects that integrate different land uses such as retail stores, restaurants, residences, civic buildings, offices and parks within a defined area. (MARC)

monitoring. Conducting studies to determine the presence, extent or relative condition of wildlife and plant resources following an initial inventory or studies and success of land management activities. (SAF)

multi-modal. Pertaining to more than one mode of transportation. (TRB)

NRCS. Natural Resources Conservation Service.

network. Interconnected system of corridors. (TRB)

nongovernmental organizations (NGOs). Organizations not directly associated with Federal, State, or local government (e.g., tribes, Alaskan native organizations, conservation, special interest and advocacy groups). (SAF)

nonpoint source (NPS) pollution. Pollution that, unlike pollution from industrial and sewage-treatment plants, comes from many diffuse sources. NPS pollution is caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and manmade pollutants, finally depositing them into lakes, rivers, wetlands, coastal waters, and even our *underground sources of drinking water. These pollutants include the following:*

- *Excess fertilizers, herbicides and insecticides from agricultural lands and residential areas*
- *Oil, grease and toxic chemicals from urban runoff and energy production*
- *Sediment from improperly managed construction sites, crop and forest lands and eroding stream banks*
- *Salt from irrigation practices and acid drainage from abandoned mines*
- *Bacteria and nutrients from livestock, pet wastes and faulty septic systems*
- *Atmospheric deposition and hydromodification are also sources of nonpoint source pollution. (EPA)*

open space conservation. Protection of undeveloped areas located within or beyond city boundaries for the purposes of providing recreational, environmental or civic benefits. (MARC)

overlay zoning. A zoning district applied over one or more other districts that contains additional provisions for special features or conditions, such as historic buildings, wetland or steep slope protection, or a mix of land uses. (MARC)

PMJM. Preble's meadow jumping mouse (*zapus hudsonius preblei*).

patchiness. Irregular in appearance, makeup, size or quality. (TRB)

point source of pollution. Discrete conveyances, such as pipes or manmade ditches that discharge pollutants into waters of the United States. This includes not only discharges from municipal sewage plants and industrial facilities but also collected storm drainage from larger urban areas, certain animal feedlots and fish farms, some types of ships, tank trucks, offshore oil platforms, and collected runoff from many construction sites. (EPA)

population. Functional group of individuals that interbreed within a given, often arbitrarily chosen, area. (TRB)

private lands. Lands owned by conservation organizations, corporations, private citizens or other non-governmental entities that are eligible for funding and assistance from the Federal agencies for wildlife conservation projects. (SAF)

public spaces. Places that create community identity, foster social interaction and add community vitality. They may include major sites in central locations such as urban riverfronts, downtown plazas and parks, shopping streets and historic districts. Public spaces may be libraries, post offices or other civic building areas. Smaller, less central sites include neighborhood streets and parks, playgrounds, gardens, neighborhood squares and older suburban commercial centers. (MARC)

redevelopment. Reinvestment in older elements of a region—a historic structure, long-time residential community, Brownfield, shopping center or main street—offers an opportunity to revitalize communities while preserving social and environmental values. (MARC)

region. An area of that embraces several landscapes or ecosystems that share some qualitative criteria in, e.g., topography, fauna, vegetation, climate or urbanization. (TRB)

restoration ecology. The practice of using ecological principles and experience to return a degraded habitat or ecosystem to its former or original state. (SAF)

restoration. Process of returning something to an earlier condition or position. Ecological restoration involves a series of measures and activities undertaken to return a degraded ecosystem to a former healthier state. (TRB)

riparian. Of, or pertaining to, the zone of wetland vegetation growing along a flowing or intermittent drainage or standing body of water. (SAF)

riparian habitat. Habitat situated by a riverbank or other body of water. (TRB)

scale. Spatial and temporal dimensions of objects, patterns, and processes. Scale is an inherent property of nature but also intimately associated with observation, analysis and processing. Scale has two basic properties: grain and extent. Changing the scale in an analysis means changing the resolution and may invoke a new pattern as other hierarchical levels of organization are entered. (TRB)

Urban designers typically emphasize the importance of human scale in successful environments. Considerations of human scale include building height and bulk regulations to ensure that new development and redevelopment efforts are pedestrian-oriented and compatible with the existing built environment. (MARC)

sediment and erosion control. Practices and processes that effectively protect the soil surface from the erosive force of rain, stormwater runoff and, in some cases, wind. Higher rates of erosion and sediment loss typically accompany urban development. A variety of planning, design and engineering practices are used to minimize the negative impacts of erosion on urban streams. (MARC)

sense of place. A feeling of attachment and belonging to a particular place or environment having a special character and familiarity. (MARC)

spatial. Related to space. (TRB)

street hierarchy. The system by which roads are classified according to their purpose and the travel demand they serve.

***sustainability**.* The capacity of forests, ranging from stands to eco-regions, to maintain their health, productivity, diversity and overall integrity in the long run, within the context of human activity and use. (SAF)

***temporal**.* Dealing with time. (TRB)

***threatened species**.* A plant or animal species likely to become endangered throughout all or a significant portion of its range. (SAF)

***total maximum daily load (TMDL)**.* A calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources. (EPA)

***traditional neighborhood development**.* Planned neighborhoods that offer alternatives to conventional, use-segregated developments by providing greater variety in type, design and layout of residential and nonresidential uses. This mixed-use development pattern seeks to connect people to places by combining a variety of housing types with limited office, retail and civic uses into a pedestrian-friendly setting. (MARC)

traffic calming. Street design measures that slow down traffic, restrict the areas in which cars are allowed and otherwise manage the flow of traffic to make other forms of transportation such as walking and bicycling more attractive and feasible options. (MARC)

***transition zone**.* Areas of habitat where species of defined or distinct adjacent communities mix and thereby are not classified as either adjacent community. (TRB)

***transit-supportive development**.* A development pattern that reinforces the use of public transportation through efficient, pedestrian-oriented land-use design and higher densities. The development, within walking distance of the transit station, center or stop, offers a variety of housing and commercial activities. (MARC)

***USDA**.* United Stated Department of Agriculture.

***USGS**.* United States Geologic Survey.

***walkability**.* An area that is considered safe, comfortable, interesting and accessible. It offers amenities such as wide sidewalks, attractive storefronts that face the sidewalk, shade, shelter and a sense of spatial enclosure provided through landscaping and streetscape elements. These areas are inviting to pedestrians for shopping, recreation and relaxation. (MARC)

***water quality criteria**.* Levels of individual pollutants or water quality characteristics, or descriptions of conditions of a waterbody that, if met, will generally protect the designated use of the water. (EPA)

***water quality standards**.* Includes three major components: designated uses, water quality criteria and antidegradation provisions. (EPA)

***watershed**.* Watersheds are nature's boundaries. They are the land areas that drain to surface water bodies such as lakes and streams. Watershed management seeks to prevent flooding and water pollution, to conserve or restore natural systems and to protect human health through integrated land and water management practices. (MARC)

wetlands*.* Lands where saturation with water is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface. Wetlands vary widely because of regional and local differences in soils, topography, climate, hydrology, water chemistry, vegetation and other factors, including human disturbance. Indeed, wetlands are found from the tundra to the tropics and on every continent except Antarctica. For regulatory purposes under the Clean Water Act, the term wetlands means “those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas.” (EPA)

wildlife corridor*.* Vegetated feature that links to other wildlife areas and may act as an interconnecting route for the movement of animals between different areas needed during their lifecycle or to facilitate dispersal of animals and plants by providing access to new or replacement sites. It may also increase the overall extent of habitat for animals with large range requirements and, in urban and agricultural areas, may constitute the main remaining wildlife habitats. (TRB)

wildlife*.* Wild animals, plants and bacteria as a collective body. (TRB)

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