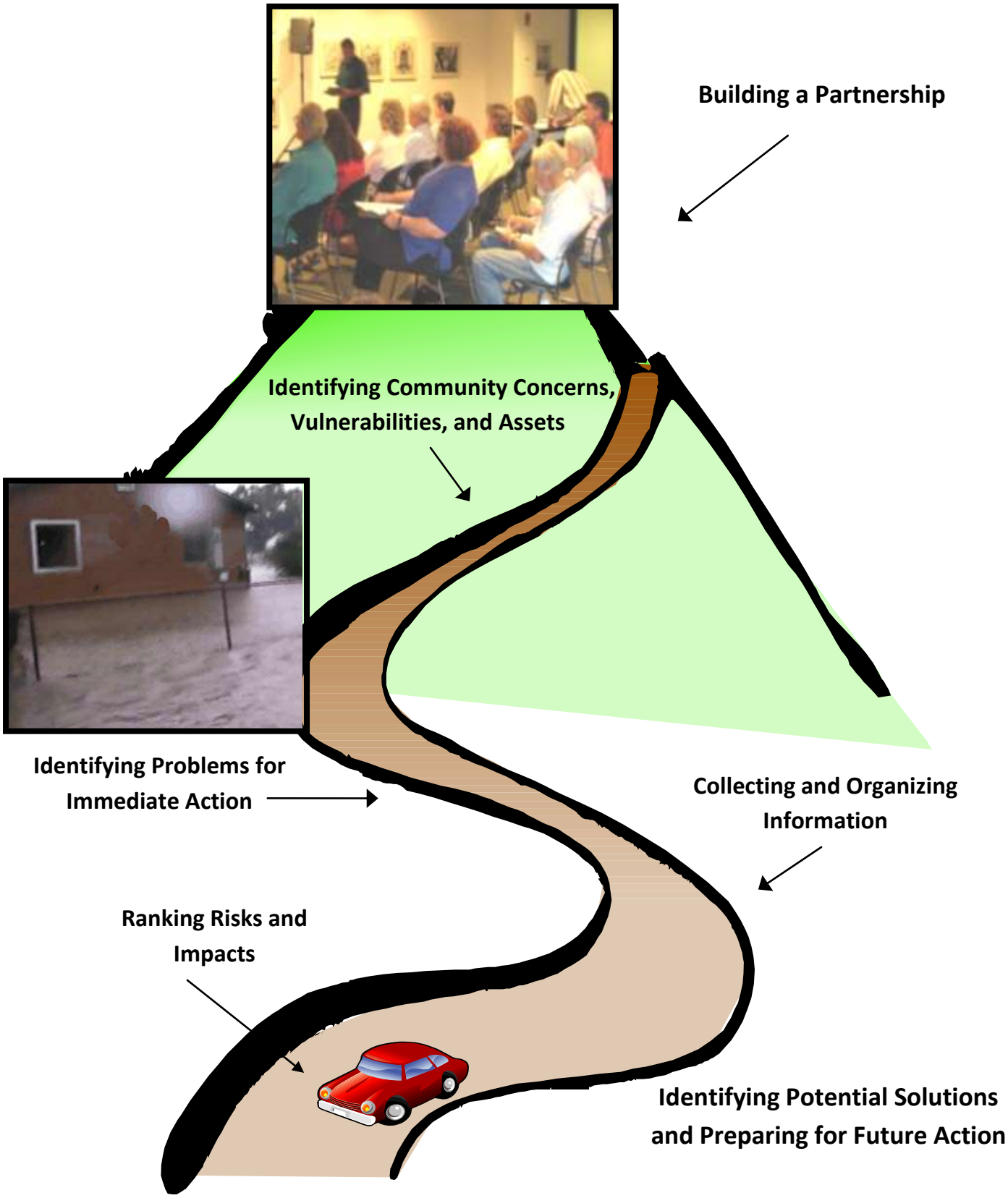
PuebloCAREs: A Community's Journey Toward Improved Human Health And Environment

CARE LEVEL I FINAL REPORT

Submitted by Citizens For Clean Air And Water In Pueblo/Southern Colorado



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April 17, 2009

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I. THE PUEBLO COMMUNITY

Pueblo County is located in south-central Colorado along the southern edge of the state's major growth corridor. Historically a transportation junction, it lies at the crossroads of two major highways 110 miles south of Denver and 40 miles south of Colorado Springs, its nearest neighbor. Pueblo is situated at the confluence of the Arkansas River and Fountain Creek, two major watersheds where the Rocky Mountain foothills meet the short grass prairie.

Pueblo County includes a medium-sized urban center surrounded agricultural land. 2007 census estimates indicate that Pueblo County has 58,819 households and a population of 154,538, with 103,805 people living within the city limits. A growing number of residents are low-to-moderate income. While the 2007 Census states that 18.3% of Pueblo County residents are below the poverty level, the City of Pueblo has a higher proportion of individuals below poverty, at 23%.

The Salt Creek, Bessemer, and Eastside neighborhoods are located immediately east, west, and south, respectively, of the city's heavy industrial plants. These communities are among the lowest income and highest minority neighborhoods in the county and closest in proximity to major sources of air pollution. Salt Creek's Latino population of 82.3%, for example, is almost five times the state's average of 17%. Pueblo City and County 44% Latino population comprises the largest group of their 56% combined minority population, which is 40% higher than the state's 35% total minorities.

Pueblo has many issues that affect the environment and public health, as it is home to a steel mill, a two-unit aging coal-fired power plant, a stockpile of chemical weapons at the Pueblo Chemical Depot, and numerous point sources of pollution. Currently, an additional 750 MW coal-fired power station is under construction and a 1 million ton/yr limestone strip mine and coal-fired Portland cement kiln are in their first year of operation. Industrial emissions of mercury and lead and their compounds from the steel mill and power plant alone comprise more than half the emissions of those pollutants in the entire state. Historical contamination is also an issue of concern in the Pueblo area. Additional concerns in the community include neglected stormwater drainage infrastructure which causes flooding in low-income neighborhoods; water pollution in Fountain Creek from upstream sewage spills, lack of recycling and waste disposal; and large traffic loads on Interstate 25, which bisects Pueblo City and County.

Some of the major concerns have been addressed by the local Pueblo City-County Health Department (PCCHD) as temporary grant-based programs for public education and applicable remediation. For instance, a grant in 2004-2006 given the PCCHD enabled homes in two low-income neighborhoods to be tested for lead with a chance of possible remediation.

II. PROJECT GOALS

The primary objective of the PuebloCAREs Project has been to engage the community in a broadly-based collaborative process to identify sources of toxic exposures in Pueblo County. Additionally, the project has aimed to increase public understanding of the nature and extent of these exposures and the risks to public health and the environment. Finally, it has focused on involving the public in a pro,cess of determining what exposures it wants to reduce and initiated collaborative thinking about how it will do so. Overall, PuebloCAREs has worked to create a sustainable process for engaging ever-increasing numbers of the public in learning about, caring about, and taking a role in decision-making aimed at reducing exposures to toxic substances in their homes, schools, neighborhoods, workplaces, and the community-at-large

Larry Howe-Kerr discusses partnership agreements

III. STRATEGIES AND METHODS

The PuebloCAREs Partnership

Over the span of two years, PuebloCAREs established partnerships with 16 Pueblo businesses, non-profits, and local government (See Table 1). Several individuals also served as consulting members of PuebloCAREs though they were not technically considered partners. Although some members were active only part of the time, each partner's opinion was solicited and taken into consideration whenever decisions were made.

Table I: PuebloCAREs Partners

Sector	Organization Name	Representative(s)
Business	Bechtel Pueblo Team	John Schlatter
	River Run Development	Michael Bradley

Local Government	Pueblo City-County Health Department	Heather Maio, Jenny Kedward, Chad Wolgram, Ken Williams
Nonprofit/ Neighborhood Groups	Bessemer Association for Neighborhood Development	Sandy Daff, Dave Balsick
	Citizens for Clean Air and Water in Pueblo/Southern Colorado (CCAP)	Margaret Barber, Reta Zane, Helen Quintana, Diane Hart
	Citizens for Clean Air in Pueblo for Education, Research, Action (CCAP-ERA)	Margaret Barber Diane Hart
	Diocese of Pueblo	Larry Howe-Kerr
	Eastside Neighborhood Association	Eva Montoya
	Neighborhood Pride	Cleo Trujillo
	Pueblo Recycles	Jo Scher
	Salt Creek Neighborhood (SPIN Project)	Nadine Triste
	Social Justice/Congregational Church	Marilyn Ghahremani
	Fountain Creek Water Sentinels	Robin Ahlenius
	Peppersauce Bottoms Neighborhood	Gloria Cornejo David Baros
	Pueblo Access for All	Kristen Kastor
	Rye Area Wildfire Education and Mitigation Association	David Barber, Lisa Elkins
	Eastwood Heights Neighborhood Association	Floyd Jaramillo

PuebloCAREs focused on including vulnerable community members in the partnership, especially the disabled, low-income neighborhoods and those beleaguered by environmental problems. The Eastwood Heights Neighborhood Association, Peppersauce Bottoms Neighborhood, Neighborhood Pride, and Pueblo Access for All represented vulnerable community members. All became CARE partners during the first few months of the project.

Citizens' for Clean Air in Pueblo (CCAP) formed the CARE Steering Committee. CCAP covered a portion of printing and mailing expenses, provided mailing lists, used contacts in the environmental community to increase number of partners, located environmental resources, and acquired meeting spaces. The organizational skills of CCAP members as well as their understanding of the political system, connection to a broad network of community activists, and ability to do mailings and host events were essential

In addition to the partnering organizations the EPA Project Officer, Michael Wenstrom, played an essential role in the partnership. Michael offered continual assistance with leadership, organization, clarification of issues, education, and linkage to EPA resources, including programs and guest speakers. He traveled to

Pueblo for Steering Committee meetings, stayed in close phone and email contact with the Project Director and other key people involved with the grant including the researcher, the PCCHD, and the *promotora*. He also networked for our benefit in the community and participated in Brownfields evaluations and selection.

The PCCHD played a vital role in all aspects of the project. One or more staff members, including the Director of Environmental Health Heather Maio. Environmental Coordinator Jenny Kedward, and other staff members with different areas of expertise attended every Steering Committee meeting, public informational session, and community meeting. The PCCHD provided meeting space, food for Steering Committee meetings, projector usage, and programs on stormwater quality, mold, and indoor air. PCCHD also assisted with radon test kit distribution, answering the Radon Hotline, research on toxic exposures, hosting public informational meetings, and publicity. PCCHD filled an organizational role and also provided supporting materials. Their participation was invaluable to the project and allowed PuebloCAREs to further expand outreach to neighborhoods across the city.

From other partners we received administrative assistance, copying services, help with the Work Day in June of 2008, publicity and meeting space, co-sponsorship of meetings, and above all, access to a wide network of community members from all walks of life and all parts of the county when we sought to know about issues affecting specific neighborhoods, and feedback on prioritizing toxic exposures for action. The knowledge of groups that specialized in issues such as recycling, water quality (especially Fountain Creek), and the needs of the disabled helped bring a broad range of perspectives to the other partners.

Barriers Encountered*:* Fortunately, the partnership was relatively free of many of the barriers that an organization like PuebloCAREs might encounter, such as unequal power, control over money, and differing priorities. Although we had provided for a trained facilitator for meetings that might prove contentious, we found that after the initial phase in which the public brought forward issues that upset them such as stormwater flooding of their homes and excessive mold in apartment buildings, relationships were largely cordial and we did not need the constant help of a facilitator. On the other hand, apathy in the community is always a barrier to accomplishing goals in Pueblo, but

Governmental agencies and Peppersauce Bottoms residents working together

working with leaders of neighborhood groups allowed us to network effectively and to involve a large number of people.

Obstacles Passed: This partnership has improved the relationships of those involved in more ways than one. Everyone has come to appreciate the local Health Department and its energetic involvement in CARE. Environmental groups (e.g., Citizens for Clean Air) have been able to work more closely with community groups than previously. Providing a series of educational programs (the "101" series) enabled everyone to reach a point where they could discuss issues from a position of some knowledge on the topic, which was not the case before. Most importantly, the communication and trust among regulatory agencies and the community were improved substantially. A specific example was the improved relationship between the City of Pueblo Stormwater Utility Department staff, PCCHD staff, and the Peppersauce Bottoms Neighborhood following initiation of action to remediate flooding of the area. In the past, these groups hesitated to work together but began to learn to trust one another

One working relationship that still needs improvement is the involvement of the business sector. Working with businesses proved difficult, but part of that problem was the selection of businesses to participate. For future projects, businesses with more vested interests in the outcomes of the project will be sought as partners. This experience has actually helped us select appropriate additions to our partnership for a Level II project application.

In addition to the involvement of the Health Department, working with small neighborhood groups was productive for gaining feedback on what were perceived to be the most urgent problems involving toxic exposures and publicizing CARE activities. Neighborhood leaders are extraordinarily busy people who could not always come to Steering Committee meetings, and the members of the neighborhood groups could not always travel across town to the location where the public educational meetings were usually held. Thus, PuebloCAREs quickly learned to take CARE to them and scheduled presentations before neighborhood groups at their regular meetings. This was more effective than expecting them to come to CARE meetings repeatedly. When PuebloCAREs began working on radon education, the informational meetings were presented in targeted neighborhoods. This approach increased attendance and furthered CARE's educational goals. Ultimately, well over a thousand people from the community-at-large attended one or more of our informational sessions.

Collecting and Disseminating Information

PuebloCAREs met at least once a month starting in January 2007. The first meeting let Pueblo residents list as many concerns they could think of for Pueblo County. For the first year, each monthly public meeting highlighted a different concern raised at this meeting. The meetings were used as educational sessions to inform residents and PuebloCAREs members about particular issues such as stormwater quality, mold and radon (See Table 2) in what we called our "101 Series."

A Steering Committee was formed to deal with policy and administrative issues and to keep CARE on track. The Steering Committee met once a month outside of the public meetings. The committee met a total of 11 times to discuss the Workplan, Roadmap and meeting agendas.

Table 2. PuebloCAREs Meetings

Meeting Date	**Topic**
November 10, 2006	Planning meeting for CARE
January 17, 2007	Gathering possible risks in Pueblo
February 7, 2007	Stormwater 101 Informational session
February 21, 2007	Develop partnership agreements
March 7, 2007	Stormwater 102 Informational Session
March 21, 2007	Mold 101 Informational Session
April 18, 2007	Brownfields 101
May 16, 2007	Risk Ranking 101
June 6, 2007	Stormwater Drainage Roundtable Pueblo Stormwater Utility, CDPHE, EPA Region 8
July 18, 2007	Mercury 101 Informational Session PCCHD, Rocky Mountain Steel Mills, EPA Region 8
August 15, 2007	Workplan update
September 19, 2007	Radon 101

October 3, 2007	Occupational Health Hazards in Pueblo
December 5, 2007	Visioning process for PuebloCAREs
January 16, 2008	Understanding Risk ranking
March 19, 2008	Radon Public Information Session
June 12, 2008	Indoor Air Quality Informational Session
June 18, 2008	Risk Ranking Work Session
June 26, 2008	Neighborhood Radon Meeting
July 9, 2008	Report on Toxic Exposures in Pueblo
August 20, 2008	Neighborhood Radon Meeting
September 17, 2008	Risk Ranking Work Session
October 9, 2008	Risk Ranking, Toxic Exposures in Pueblo
October 29, 2008	Mercury Education Project, Risk Analysis
December 17, 2008	Final prioritization of human health and environmental issues

Throughout the course of the public meetings, PuebloCAREs was able to identify several concerns for immediate action. These included stormwater drainage issues in Peppersauce Bottoms, a habitually-flooded part of town, and radon, an issue potentially impacting a large portion of the Pueblo community.

From September, 2008, through March, 2009, nine additional public meetings in neighborhoods and towns throughout the county were held to educate the public on the importance of testing their homes for radon and carrying out mitigation procedures where test results were high. We also had a booth at the Home and Garden Show in March of 2009 to pass out information on radon.

Gathering input

To better understand all of the perceived risks of the Pueblo community, PuebloCAREs developed two types of public feedback forms (see Appendix A). The first form asked residents to list their top three potential risks. This was a write-in feedback form which gave residents the ability to list anything they felt was a

threat to public health. CARE representatives went to 10 different community meetings to obtain participants. Since residents could list anything they wanted, results ranged from heart attacks to stormwater drainage issues.

PuebloCAREs used the top ten environmental issues to make the next feedback form. For this form, residents had to pick three out of the 10 listed potential risks and rank them 1, 2, or 3 (1 being the most important). The results were tabulated in a spreadsheet. To summarize the scores, each rank of 1 was given 3 points, each rank of 2 was given 2 points and the lowest rank, number 3, was given 1 point. The points for each category were calculated in two ways: the first, was to rank each using all the point values; the second, was to only rank the top issue for each risk. By comparing these two methods of ranking, CARE could determine whether issues changed the order of rank. For example, indoor air quality may be listed as the fourth most perceived risk when using the 1 to 3 ranking, but drop to issue five when looking at only the top perceived risk. Surprisingly, almost all the perceived risks stayed in the same ranking order for both methods, which strengthens the data's validity.

To further understand public concerns and experience issues first-hand, the Project Director and other committee members were given personal tours of several local neighborhoods, including Eastwood Heights, Peppersauce Bottoms, and Salt Creek. These were eye-opening experiences that highlighted issues like mold in flooded homes and illegal dumping.

Eventually, a lengthy list of local concerns was created and more research was conducted to gain a thorough understanding of local human health and environmental effects. This approach helped us to distinguish between perceived risk and actual risk. Tools used in the research process included the PM2.5 and PM10 Daily Air Quality Index; Technology Transfer Network Air Toxics Website; AirData – National Emission Inventory Database; RadNet; Toxics Release Inventory; and RCRAInfo and others.

Another invaluable tool provided by the EPA, Risk Screening Environmental Indicators (RSEI) software, was used to determine industrial emissions that posed the greatest risk of exposure in Pueblo County.

In addition to the EPA tools, other data sources used included ATSDR toxicological profiles, CDOT annual average daily traffic reports, the Colorado State University-Pueblo hazardous waste database, the 2000 U.S. Census data and published scientific journal articles. The Colorado and City/County health departments also provided statistics and surveillance data regarding community water systems, air quality, radon, West Nile Virus, coliform, and lead. An EPA Region 8 risk assessment specialist and numerous health officials at the state and local health departments were consulted.

2006 radon test results from the Colorado Department of Public Health and the Environment (CDPHE) and data from the EPA, encouraged PuebloCAREs to suggest that citizens in additional testing in targeted neighborhoods test for radon. Since September 2007, 200 free test kits from the EPA have been distributed as well as 200 CDPHE radon coupons for free kits. The results of these tests have been analyzed. More than half of the homes tested in Pueblo County have elevated levels of radon and average more than double the "action level" suggested by the EPA, indicating that radon is an issue requiring attention.

PuebloCAREs hired a recent graduate with a master's degree in environmental science as a researcher to help finalize the inventory of toxic exposures. The document produced during this process of investigation is attached to this report as Appendix C.

Prioritizing Human Health and Environmental Issues

Our researcher had academic experience with risk analysis and was able to assist us by developing a method for evaluating risk that worked for our group. She gave a presentation on the method we used at the National Care Training Workshop in Chicago in November, 2008. A complete description of the process, summarized below, may be found in Appendix B.

From the long original list, eighteen potential stressors were selected for evaluation. These can be grouped into five major categories:

1. **Air** – Diesel Exhaust from Extended Commercial Truck Idling, Dust from Construction Sites, Fly Ash, Manganese (Industrial Emissions), Mobile Source Pollutants
2. **Water** – Mercury in Local Water Bodies, Pathogens in Fountain Creek, Pharmaceuticals and Personal Care Products (PPCPs) in Local Water Bodies, Stormwater Runoff, Uranium/Radium in Drinking Water Wells
3. **Land / Waste** –Illegally Dumped Waste, Industrial Hazardous Waste
4. **Indoor** – Household Hazardous Materials/Waste, Lead (primarily from paint), Mold, Radon, Smoke from Woodstoves/Fireplaces
5. **Other (via Biological Vector)** – West Nile Virus

The development of a ranking method specifically designed for this project, required extensive communication between the researcher and the Steering Committee as well as participation by several partnering organizations. Two meetings in the fall of 2008 were dedicated to refining the ranking process. This method was used to rank the stressors based on relative risk as well as local support for action for each stressor. Each stressor was ranked using the following considerations:

- Likelihood of Exposure
- Frequency of Exceedances
- Extent of Exposure
- Severity of Likely Human Health Effects
- Impact on Sensitive Populations
- Impact on the Environment
- Level of Community Concern
- Feasibility of Effective Local Action through Education
- Feasibility of Effective Local Action through Mitigation

Results

Of the eighteen original stressors, household hazardous materials and waste, lead, mobile source pollutants, mold in homes, radon, smoke from woodstoves and fireplaces, and West Nile Virus ranked the highest. These seven top-ranked stressors and a brief description of each were presented to the PuebloCAREs Steering Committee members and the representatives of partnering organizations. All individuals were asked to select their three highest-priority stressors and rank them either 1, 2 or 3 with 1 indicating the top priority. The results were very close, due to great concern for each stressor. Consequently, four stressors were identified as the community's top priorities requiring action. The four top priorities were:

1. **Radon** – Among Steering Committee members and partnering groups, as well as community members questioned at random, radon consistently ranked as a top priority. More than 80% of Colorado's counties are rated at high risk for elevated radon and greater than 50% of the homes tested in Pueblo County exceeded EPA's recommended level of 4 picocuries per cubic liter of air. On January 2, 2009, Colorado Gov. Bill Ritter proclaimed January to be Colorado Radon Action Month, indicating the need for citizens to seriously consider this risk to human health.

2. **Household Hazardous Materials / Waste** – This stressor can be defined as any item found in the home that is potentially chemically toxic through inhalation, ingestion, or absorption. Many members of the community do not understand the importance of proper storage, use, and disposal of household hazardous materials, posing a risk to human health and both indoor and outdoor environments. Additional education and more frequent household hazardous waste collection events may be needed to reduce the risk of human exposures and environmental contamination.

3. **Lead in Homes** – According to the 2000 U.S. Census, more than 70% of all homes in Pueblo County were built prior to 1978 and may have paint containing lead. Additionally, a study investigating lead topsoil concentrations in the City of Pueblo suggests historical lead contamination may exist near old smelter sites. The lead may then be introduced into the home and serve as another source of lead contamination. As of 2004, the average elevated blood lead level rate for children in Pueblo County was 21.3 per 100,000, indicating the potential exists for local children to be exposed to lead paint and lead from other indoor sources as well.

4. **Mold in Homes** – Approximately 60 to 70 mold complaints were reported to the local health department in 2008, suggesting that community members may not fully understand how to control excess moisture and limit mold growth in the home. Since

Pueblo County has a very arid climate, educational campaigns regarding simple clean-up procedures and moisture control are viewed as likely to be effective.

Not surprisingly, the four top priorities for action are primarily indoor issues. These stressors pose possible health risks to a large portion of the community and some may impact the outdoor environment as well (e.g., Household Hazardous Materials/Waste). More importantly, these indoor stressors are mostly exempt from regulations and therefore require attention at the local community level by partnering organizations in order to reduce risks and impacts. None of the issues identified have programs to target them in Pueblo County.

Identifying the top health risks in Pueblo could not have been done without a comprehensive partnership. The dedication of volunteer and paid staff in gathering and tabulating completed public input forms was necessary to successfully learn the public's perceived risks. Without the partnership, the more than 200 forms would not have been collected and turned in. The Steering Committee was vital in determining the top risks out of the 18 actual and perceived risks identified. Each member represented a portion of the Pueblo community; therefore, his or her vote was essential in the final analysis.

A public meeting is planned to introduce the top 4 risks identified by Pueblo-CAREs and the media will be used to publicize the results. A final CARE newsletter will present the final risks recognized.

Deliverables and Changes in Behavior

In the process of identifying concerns and prioritizing risks, numerous issues were addressed. Issues that were mentioned at the onset of PuebloCAREs were targeted for education. Many public meetings were used as a vehicle to educate the community and CARE members. Issues that had particular importance were expanded upon. Each session had a guest speaker that explained the risks and possible reduction methods. Many issues were written up in one-page "factsheets" including mold, mercury and radon. The main purpose of CARE Level I was not to directly reduce risks but educate about them. Every issue raised at the genesis of the project and throughout its duration was explored in depth with experts in at least one educational meeting. Education has a critical role in reducing exposure, especially where avoidance is possible, as in the case of household mold and mercury.

PuebloCAREs offered many outputs for the Pueblo community including educational meetings and programs, factsheets, and communication efforts.

Table 3. PuebloCAREs Outputs and Outcomes

Activity Initiative	Issue(s) Addressed	Significant Outputs	Significant Outcomes
Pueblo CARE Factsheet	Communication	Information sheet developed given out at meetings and events	Communicates the CARE goals and partners.
CARE Hotline	Communication	Phone specific to CARE	Ability for residents to call to share concerns or receive meeting information
CARE website	Communication	Website dedicated to CARE information	Community members can look up CARE contacts and view newsletters and reports
CARE Newsletters	Communication	6 newsletters created	Communicate what CARE is doing in the community
Chemicals in Schools	Chemicals in Schools	Check-off sheet to use when inspecting local schools	Partnership with PCCHD to maintain list of chemicals in schools during annual inspection buildings
Radon Education	Radon	Multiple meetings about radon; 200 radon tests and 200 coupons for free test kits handed out; radon fact sheet created; evaluated combined radon results from all sources, including CDPHE and EPA (1080 total)	Educate Puebloans on testing their home for radon and how to interpret the results.
Peppersauce Bottoms Clean-up	Stormwater	1 sandbagging event in the neighborhood for 15 tons of sand to protect 23 homes; remediation of 1 house due to flooding	Education of the neighborhood about stormwater improvements.
Indoor Air Quality Presentation	Indoor Air Quality	2 presentations; PowerPoint presentation about Indoor Air Quality	Educating the community about indoor air quality risks.
School Bus Retrofit Project	Air Quality	112 school buses and 6 transit buses retrofitted	CARE was a partner in retrofitting local buses to reduce carbon emissions.

Mold Educational Session	Mold	1 meeting about mold; mold fact sheet and research compilation; mold PowerPoint presentation	Educating the community about household mold.
Risk Ranking Procedure	Risk Assessment	Format to create risk ranking criteria	Created a unbiased way to rank risks
Risk Ranking Questionnaire	Risk Ranking	2 types of questionnaires given to 330 people	Gathered input from community to review perceived risks.
Toxic Exposures in Pueblo	Risk Ranking	Fact sheet of possible toxic exposures	This list was used to create ranking criteria
Potential Exposures in Pueblo County report (Appendix C)	Risk Ranking	Comprehensive report available to the public at pueblocares.org	Provided information for risk ranking process.

IV. ACTIONS TAKEN

Pueblo CAREs enabled several side projects to reduce toxic risks in Pueblo.

Peppersauce Bottoms

Two major environmental hazards jump-started CARE's action on behalf of the Peppersauce Bottoms neighborhood. Severe flooding, responsible for the destruction of numerous homes in 2006, instigated a remediation effort through Brownfields funding (see **Brownfields** below).

The burning of creosote-laden railroad ties in Peppersauce Bottoms in July 2007. Photo courtesy of the *Pueblo Chieftain*.

Elimination of another specific environmental risk resulting from the neighborhood's proximity to a creosote-laden railway tie manufacturing and storage facility a few yards from residents' homes was achieved. In 2007 some of these ties burned, producing large plumes of smoke. Odor and nasal irritation had been an ongoing problem, since creosote fumes and creosote-filled smoke are

sources of polycyclic aromatic hydrocarbons (PAHs) which can cause skin and lung irritation. Ultimately CARE worked with several groups to encourage the large facility to move to a different location. This campaign was a big "win" for the neighborhood that improved the quality of its environment and morale.

Radon

As the Pueblo CAREs project continued over two years, topics were uncovered that had not been included in the original list of citizens' concerns. High levels of radon in Pueblo's homes were discovered during CARE's research process. With the help of the EPA in separating out Pueblo's data from radon test results furnished by the state health department, and the subsequent discovery that they were higher even than Colorado's state average, indoor radon levels became a particular concern for CARE participants.

***Promotora* Alicia Solis is interviewed by a local TV news station about radon**

CARE then undertook a program of public education on radon offering free testing to 400 homes with kits provided by the EPA and the CDPHE, and has at least begun to understand the magnitude of the problem in our area. This experience has given us a chance to think about how the extremely high reported levels of radon (over twice the EPA's recommended action level) and their threat to human health might be approached, especially in a largely low-income area where mitigation costs for homeowners would be likely to deter preventative action.

The local newspaper, The Pueblo *Chieftain,* and one of the local news stations, spotlighted PuebloCAREs' efforts on radon education. Promoting awareness of radon with free testing and educational speakers has energized the committee and stirred community awareness and participation.

Brownfields

With help from PuebloCAREs, a Brownfields project is currently underway designed to address continued destructive stormwater flooding in Peppersauce Bottoms by facilitating the transfer of property from a railroad to the city for the building of detention ponds above the threatened neighborhood.

In addition, PuebloCAREs initiated a Brownfields project focused on Minnequa Lake, another potentially polluted area, formerly owned by the steel mill. Thanks to the soil and other testing done with Brownfields funding, the City of Pueblo was able to acquire the Minnequa Lake area for a major recreational area and for stormwater drainage control. Both of these projects represent solutions to problems that have existed for many decades. Neither of them would have happened without the Brownfields funding brought to the community in conjunction with CARE. See Appendix D for more information on Brownfields projects.

School Bus Retrofit Project

CARE partnered in a project to retrofit the two local school districts' fleets of buses to reduce diesel emissions. In all, 112 school buses 6 public transit buses were retrofitted. Exposure to excessive diesel emissions was an issue of primary concern to our partnering group representing the disabled community. As a result of this project, in-cabin and external pollution were significantly reduced as well as twice-daily unhealthful exposures to diesel fumes by local school children.

IV. SUSTAINABILITY

We have every reason to think that the partnership created for CARE will continue to serve the community by protecting the environment and reducing toxics. Even before radon was identified as the top priority in need of being addressed, PuebloCAREs began a process of public education on a wide range of issues that has helped spread the word on the need for mold prevention, proper disposal of mercury-containing thermometers, the importance of maintaining clean indoor air, and radon testing and mitigation, among other things, by giving a series of educational presentations.

The Health Department has spurred this along by writing articles that have been published in the local newspaper. PuebloCAREs has helped build the capacity in the community for a future comprehensive education program. An expanded partnership is being developed for action in a large radon

project that would be made possible through CARE Level II funding. A new sister organization to CCAP, with 501(c)(3) applied for, Citizens for Clean Air in Pueblo for Education, Research, Action (CCAP-ERA) has been formed to focus exclusively on grant-funded projects that accomplish goals identified in the CARE process. Since October of 2008 it has been awarded three grants, including $108,000 in Supplemental Environmental Project (SEP) funding for an 18-month project for mercury education and thermostat exchange in 350 low-income households, and two grants totaling $30,000 to pilot radon demonstration projects this summer and keep the Radon Hotline going until October of 2009. This should provide a bridge to the comprehensive assault on indoor radon in this area we hope to pursue through CARE

In addition, as a spinoff of the bus retrofit project, which was undertaken as a research project at the University of Colorado, and because of the educational community-based work done through CARE Level I, CCAP-ERA has also been invited by a team of researchers from three universities to be the community contact as a sub-grantee for an NIH project for which they are applying to do research on children's exposure to particulates in Pueblo.

Also as a direct result of partnership with PuebloCAREs, the Pueblo City/County Health Department has been awarded SEP funding through the CDPHE to reduce mercury waste in Pueblo County. The project will implement amalgam separators for dentists and expand the fluorescent bulb recycling program.

VI. REFLECTIONS AND FINAL THOUGHTS

Successes

PuebloCAREs achieved the overall objectives of engaging the community in identifying toxic exposures, increasing its understanding of the exposures and risks, determining which exposures should be reduced, and deciding how to reduce them. In some instances, additional objectives were created and achieved because CARE was flexible and responded to the immediate needs of the community, as in the case of the Peppersauce Bottoms neighborhood. PuebloCAREs realized that flooding and resulting mold issues were urgent and necessary to address during the project and became the top priority for action at the time.

Some of the anticipated project outputs varied from what was originally projected. The PuebloCAREs web site was not as useful as first hoped, partly because CARE has worked largely within in a low-income community, where Internet is not the primary mode of communication for the people we want most to reach. Although it has been practical to post contact information

and the report on toxic exposures on the web site, fliers distributed throughout neighborhoods and through churches, schools, and neighborhood association newsletters proved to be far more effective. Monthly CARE newsletters had been planned throughout the project. Even though they were functional when CARE was publicizing educational meetings, they were not as useful during the second year, when a large part of the work was developing and applying the risk ranking procedures. Ultimately, we met all our objectives, even though the publicity materials produced were of a different kind from what we expected. Instead of relying on the website and newsletters, we found that in addition to using fliers, Public Service Announcements on radio, and newspaper articles (produced by our partner, the Pueblo City-County Health Department) in the local paper were more effective in reaching the community-at-large.

We did find that we excelled in utilizing various channels for disseminating information. The media was used to announce informational sessions and to educate the public about radon. Since radon was gaining momentum as an urgent concern in Pueblo County and Radon Awareness Month provided outside impetus, the local newspaper and news stations were very willing to highlight radon as a story. Two local newspapers ran a total of five articles about radon and CARE, and a national industry journal will publish an article on how we have begun to attack the problem.

In addition to media outlets, EPA resources were essential for effective communication with Pueblo residents. PuebloCAREs used EPA online resources frequently and distributed materials provided by the EPA on a wide range of topics. For almost every presentation, the EPA website was used to gather data or confirm sources. Our Project Officer, Michael Wenstrom, was also very helpful in providing knowledge of historical information and national programs and bringing in staff experts to answer our questions. The programs that were used include Tools for Schools, Indoor Air Quality material, National Radon Action Month materials, and the Brownfields program. Copies of EPA publications were used at informational sessions. The most popular brochures were for radon, mold and lead.

To exchange information on a regional level, PuebloCAREs met with other CARE entities. In Fall 2007, the Project Director networked with Charlie Chase, the director of the HAND project in Region 8 to learn about his experiences with Groundwork Denver. He was also given a tour of several neighborhoods in Pueblo, including Peppersauce Bottoms, where he visited with residents fighting mold problems after flooding. He shared his knowledge of challenges and successes working in the Denver area. He also helped PuebloCAREs develop its Roadmap for the future.

In addition to this experience, after being granted an extension to complete the project, the Project Director and other PuebloCAREs members attended three CARE training workshops (Seattle, WA – 2006, Atlanta, GA – 2007, Chicago, IL – 2008). At the workshops, project leaders were able to effectively discuss concerns with other CARE participants and learn from other projects. At the 2006 workshop Nadine Triste shared her experience working at the grassroots community level on one panel, and in two 2008 workshops, the project director and our researcher presented information detailing the activities, challenges, and successes of the PuebloCAREs projects on risk-ranking and use of Brownfields funding, with the hope that new CARE Level I grantees might be able learn from them.

Although it had many triumphs, PuebloCAREs' greatest achievement is the coming together of so many different entities to compile a comprehensive environmental risk assessment on a level that the general public could understand. A risk assessment might have been done by one entity, such as a consultant, but because it was organized by a community partnership, it achieved broader public recognition and is much more powerful. Furthermore, by working together, local, state and federal government agencies, residents, and neighborhood leaders gained respect for one another and consequently learned to communicate more effectively. The Project Officer observed that PuebloCAREs created an attitude of receptivity to environmental concerns in and among the community. Hopefully, this new attitude, along with the improved communication and trust, will benefit collaborations in the future. A major public presentation on the project's findings and report on its actions will be given on May 13 at an event sponsored by the Colorado Department of Public Health and Environment. Ongoing dissemination of our findings and information on pollution sources at events such as Earth Day (April 18) and the community-wide Cinco de Mayo celebration (May 3) is scheduled.

None of the objectives could have been met without the vitality of PuebloCAREs. Each partner brought a different energy and perspective to the table. Without the cooperation of CARE partners, the issues raised and educational efforts would have not been as significant. Progress could not have been achieved without the partnership and the invaluable assistance of the CARE Project Officer in linking public, private, and governmental entities to identify risks and solve numerous problems that arose during the process.

Challenges

PuebloCAREs encountered several major challenges along the way. Apathy in the Pueblo community has always been hard to overcome. When a community has been bruised over and over by government rejection and environmental injustices, enthusiasm is hard to cultivate. Although it did not overcome all of the indifference in the community, CARE connected people

who had not worked together before, and we feel we have made a good start on several important issues.

In addition to general lack of public interest that took great energy to overcome, another challenge presented itself near the beginning of the project. PuebloCAREs realized early on that projects need to be specially tailored to each community and neighborhood. Without these adaptations, the projects would not have been successful. For example, education geared to the educated, middle-class homeowner may not be effective with low-income, mainly non-English speaking citizens. PuebloCAREs encountered and addressed this challenge in the Salt Creek Neighborhood, which has 41% Spanish-speaking individuals. A *promotora* who grew up in Salt Creek was hired and trained to engage the community and, in doing so, was able to communicate important information about pollutants to its members. She even provided Spanish subtitles to an educational radon movie which expanded the ability for outreach to Latino neighborhoods.

Lessons Learned

Partners

PuebloCAREs had many active partners but lacked significant affiliation with one major sector: the business community. The opinions from the business community would have enriched the objective of gathering perceived risks in the area. PuebloCAREs had two businesses represented, as well as the owner of a small business on the Steering Committee. She helped in gathering public input in the prioritizing phase and in publicizing meetings. More small businesses would have been desirable, rather than the large business (Bechtel) CARE initially included. Bechtel signed on as a partner after it had come to Pueblo to work on a large project, but the project was delayed and the staff member working with CARE was reassigned away from Pueblo. The other businessman, a housing developer, proved to show little real interest in what CARE was doing. This experience helped CARE determine what businesses and business associations would be more productive to include as actively contributing partners essential for a CARE Level II project.

It would have been desirable for PuebloCAREs to have also gained other neighborhoods as partners from the start, for as expected, the neighborhood groups were invaluable members of the partnership, especially for hosting informational meetings and gathering feedback. A few groups in town were initially invited but were never formally represented in the partnership, although PuebloCAREs did include them in the process by giving multiple presentations

to their members and soliciting their views. These groups ultimately were more effective than some of the original groups in the partnership in allowing us to do outreach to people throughout Pueblo.

Working with the University

In creating an inventory of toxic exposures, faculty participation from the University beyond the involvement of the Project Director, who is a professor there, was problematic in certain respects, although through no fault of their own. Because of the restrictive semester schedule and sabbatical leaves, supervision of students working on the inventory piece of the project was not feasible. Ultimately, CARE contracted a researcher, a recent graduate with a master's degree in environmental science, to assist us with this work. She was more qualified than undergraduate students would have been to do the quality of work necessary, and her academic experience (including publication) on risk analysis proved invaluable. If CARE were to redesign this project, a researcher would be sought at the outset to assist with the inventory phase of the work to help assure its comprehensiveness and quality. We benefited greatly from her assistance with the toxic exposures inventory and the process of risk ranking, which are presented in Appendices B and C.

Working with the Roadmap/Logic Model

In terms of overall strategy, the project was designed with the Roadmap provided by CARE in mind, though the model adapted to circumstances as the project progressed. We followed the CARE Roadmap and found it helped successfully address the challenges of the process in an organized fashion.

Increasing the Capacity of CCAP, the Partnership, and Neighborhoods

The CARE project increased the capacity of CCAP's organization to work with other community groups and to leverage funding, which include an Indoor Air Grant from the Colorado Department of Public Health and Environment, a Supplemental Environmental Project grant to address radon, and a grant to extend work on a mercury education/reduction project that grew out of the mercury education project begun with $10,000 in funding from the EPA. Mercury and radon are both sources of toxic exposures in this area identified as worthy of concern through the CARE process. Work with neighborhood groups and other partners will continue and expand for these projects.

As for increasing the capacity of the partnership, CCAP already had been involved with individuals who were members of other groups and with other groups. CCAP had been the organizing force behind an EPA Collaborative Problem-Solving (CPS) grant which included five partners, four of which joined the CARE Level I partnership. Consequently, CCAP was able to continue building on the relationships established between the groups during the CPS grant. In addition, eleven new groups became part of the CARE Level I partnership, and nine of these had continuous active representation on the Steering Committee. Also as a consequence of the large volume of community work spurred on by CARE and related projects, the formation of CCAP-ERA (see p. 20 under "Sustainability" above) will help sustain focus exclusively on doing the kind of work begun under CARE.

Without doubt, the capacity of the community to achieve environmental benefits for the population-at-large has increased in a significant way through work with CARE. Major problems have been identified, are in the process of being addressed, or have been solved through the combined efforts of CARE partners.

Sandbag barrier against flooding built during CARE work day in June, 2008, in Peppersauce Bottoms

The formerly isolated community of Peppersauce Bottoms, for example, has benefited from having various partners in CARE to address problems such as flooding and an industrial neighbor manufacturing creosote-laden ties. CARE partners brought together community resources to build sandbag barriers for flooding as a short-term remedy for the summer of 2008 and helped repair damage to one home flooded in 2007, including taking preventative action against mold. CARE's partnering organizations will continue to keep the long-term flood-prevention project on track through the Brownfields project. Community resources will stay focused on the goal until Peppersauce Bottoms no longer has to worry about being ravaged by summertime flooding.

Through the connections of CARE, CCAP also utilized many programs that had not been previously employed. For example, the Brownfields Program was coordinated by CARE along with public entities such as the City of Pueblo Planning Department. It was the first federal Brownfields money to be used in Pueblo. CARE also cooperated with the CDPHE and EPA on the school bus retrofit project. By having a track record of genuine concern for the community's welfare and of taking action to include all voices and views, CCAP and CCAP-ERA provide a foundation for future work together over the

longer term. Furthermore, relationships created among neighborhood organizations and with the local government will be sustained through established contacts and future networking.

New Community Leadership

Our project produced new community leaders. People who had never thought of organizing their neighborhoods did so with our encouragement and attended CARE meetings representing them. This is especially true of Peppersauce Bottoms. From the Salt Creek neighborhood, a talented recent college graduate with a degree in chemistry and Spanish emerged in answer to a classified ad. We funded additional training for her and employed her to do outreach as a *promotora,* specifically in the mostly otherwise difficult-to-reach Salt Creek neighborhood and surrounding area. She will be heavily involved in the grant-funded projects we have for the next year doing education on indoor air and mercury throughout Spanish-speaking, low-income areas and working with middle and high school students to promote safe practices and thermostat exchanges. Many others, including a retired science teacher, our researcher and risk analyst, leaders of neighborhood groups, and the Project Manager as well, profited from the opportunity to develop leadership skills through involvement in CARE.

Advice to other communities doing similar work

Although we realize we yet have much to learn, we are excited by the progress we have made in a town where sometimes progress on environmental issues has seemed daunting, if not impossible. Some members of the partnership had been working for many years on these. Their knowledge of the community and how to work on environmental issues was invaluable, but the boost provided by the CARE funding and assistance and CARE's requirement that we jointly pursue an organized process of identifying and ranking risks and agreeing on actions worth taking made a huge difference in the ability of each individual and group to be effective. It's definitely worth every bit of work it takes to "get things moving" and stick with the model provided by CARE.

Above all, we encourage other CARE community groups to:

- **Stay flexible**, adapt to changing conditions;
- **Expect things to change**, because they will, and often for the better;

- **Persist**; everything you do has an effect, and it all adds up;

- **Seize opportunities** for creating community benefits whenever you find them;

- **Draw on EPA's resources** provided through your Project Officer; you may be surprised at the wealth of assistance available to you;

Remember the Roadmap! Be mindful of where you are and where you are going.

Final thoughts

At the very beginning of the formation of PuebloCAREs, it was determined that one of the principal environmental challenges in Pueblo County was that only a small number of people were aware of the existence of air pollution or the dangers of toxic exposures in the workplace or elsewhere. In just two years, however, PuebloCAREs was able to increase the community's awareness of possible exposures and risks through education and outreach and develop plans to address those issues. Through work with CARE Level I, we have developed an infrastructure with a growing partnership, groups that have coalesced around CARE projects; found a *promotora* to do outreach in Spanish-speaking and low-income areas; increased public credibility for all groups involved; established a widened network of community contacts; found channels of access to expertise in data-gathering; grown through productive relationships with the City/County and state health departments and the EPA; and developed processes for involving community members and their leadership in working for positive change.

In October of 2006 the task we were facing seemed daunting, but by methodically working through each stage of the Roadmap model and bringing in the expertise made available by CARE, including consultants, researchers, and personnel from Region 8 of the EPA, the Colorado Department of Public Health and Environment, and the Pueblo City-County Health Department, the CARE partners discovered not only new resources but new sources of strength in the community that all combined, led to successful completion of the project and will make it possible to sustain and take to the next level.

Thoughts on improving the CARE program

We would be happy to stay in touch with headquarters and to discuss any aspect of the work we have done to date, or be interviewed for a case study. The Project Director Margaret Barber and Jenny Kedward from the Pueblo City/County Health Department would be able to provide information. Margaret may be reached by email at margaret.barber@colostate-pueblo.edu, margbarb@yahoo.com, or by phone at (719) 489-2078; Jenny can be contacted at jenny.kedward@co.pueblo.co.us or at (719) 583-4924.

And, since you encourage sustainability as a goal, we believe that in addition to the ways we have found to promote continued progress, CARE would be well-served to develop a mechanism for CARE alumni to communicate with each other, such as by a listserv or even better, a restricted-access blog. After meeting people at the training workshop who were dealing with similar challenges and accomplishing so much, we would welcome a chance to stay in touch with them.

APPENDIX A: SAMPLE PUBLIC FEEDBACK FORMS

Public Feedback Form #1

PUEBLO CAREs

COMMUNITY ACTION FOR A RENEWED ENVIRONMENT

Pueblo CAREs is gathering information on potential heath risks in Pueblo. Please let us know what risks are important to you in your neighborhood.

Name (optional): _____ Phone (optional): _____

Address (optional): _____ Zip: _____

Organization: _____

Top 3 Potential Health Risks

1) _____

2) _____

3) _____

Do you know of another group we could speak to? Please list them below.

_____

_____

☐ Yes! I would like to receive Pueblo CAREs Newsletter

Public Feedback Form #2

Pueblo CAREs

Community action for a renewed environment

Pueblo CAREs is gathering information on potential heath risks in Pueblo.

Directions.
Rank your top 3 health risk most important to you. 1=most important

Zip (required): _____

Name (optional): _____

Phone (optional): _____

Address (optional): _____

☐ Yes! I would like to receive Pueblo CAREs Newsletter

⬇ Pick 3 and rank them

	Radon gas
	Lead paint
	Mercury emissions
	Hazardous air pollutants (industrial emission, fly ash)
	Mold
	Stormwater run-off
	Household hazardous waste (paint, chemicals, electronics, medication)
	Workplace exposure to toxic chemicals
	Carbon monoxide exposure from wood stoves
	Air particulates (dust, diesel fumes, car emissions)
	Other: _____(bacteria in Fountain Creek, uranium, West Nile Virus, pharmaceuticals in drinking water, illegally dumped waste, industrial hazardous waste)

APPENDIX B: PuebloCAREs RANKING METHOD

Pueblo CAREs Ranking Method

Developed by Audrey Cowan

Evaluation: Risk Analysis and Prioritization of Stressors

Identification of Stressors and Data Collection

The 18 potential stressors selected for evaluation can basically be grouped into five major categories according to exposure media:

1. **Air** – Diesel Exhaust from Extended Commercial Truck Idling, Dust from Construction Sites, Fly Ash, Manganese (Industrial Emissions), Mobile Source Pollutants
2. **Water** – Mercury in Local Water Bodies, Pathogens in Fountain Creek, Pharmaceuticals and Personal Care Products (PPCPs) in Local Water Bodies, Stormwater Runoff, Uranium/Radium in Drinking Water Wells
3. **Land / Waste** –Illegally Dumped Waste, Industrial Hazardous Waste
4. **Indoor** – Household Hazardous Materials/Waste, Lead (primarily from paint), Mold, Radon, Smoke form Woodstoves/Fireplaces
5. **Other (Biological Vector)** – West Nile Virus

General stressor information as well as local data (when available) were collected from various sources including the U.S. Environmental Protection Agency, the Colorado Department of Public Health and Environment, the Pueblo City – County Health Department, the Colorado Department of Transportation, the 2000 U.S. Census, and published scientific literature. The information collected was then used to rank the stressors.

Ranking Stressors in Pueblo County

Risk is essentially a combination of the probability and magnitude of: 1) **exposure** to the stressor and 2) **effects** resulting from interaction with the stressor. In order to evaluate the risks posed by the potential stressors and rank them it was necessary to identify several considerations, or factors, that influence exposure and effects. The three considerations identified as important in influencing **exposure** are listed below.

1. **Likelihood of Exposure** – In order for exposure to occur, the stressor must be present. For the exposure to be a concern, the stressor must be present in amounts that are known to cause effects. The likelihood of exposure is increased if the exposure is

determined to be continuous. Certain circumstances like seasonal weather changes can result in intermittent exposure where interaction with the stressor is less likely than when continuous exposure occurs.

2. **Frequency of Exceedances** – If regulations or standards are in place, the chance for exposure is assumed to be reduced. However, if exceedances occur or if regulations or standards are entirely absent, the likelihood of exposure may be increased.

3. **Extent of Exposure** – The number of people potentially exposed to the stressor must be considered. Exposure becomes a greater concern when the number of people potentially exposed is high. For the purposes of this project, greater than 30,000 people (or 20% of the total population) constitute a high potential exposure.

Three considerations important in influencing **effects** were also identified. These considerations are listed below.

1. **Severity of Likely Human Health Effects** – Though minor health effects are important, moderate to severe effects are a greater concern. The possible health effects from the stressors in this project include:
    - Minor respiratory symptoms (coughing, sneezing)
    - Asthma and decreased lung function
    - Physical injury
    - Bacterial or viral infection
    - Cardiovascular problems
    - Damage (disease) to vital organs
    - Nervous system impairment
    - Increased risk of cancer
    - Mortality (death)

    Clearly, stressors that cause minor respiratory symptoms are not as severe and do not require as much attention as those that cause increased risk of cancer or death.

2. **Impact on Sensitive Populations** – Certain types of individuals may be more susceptible based on their age or health status. Health effects will be more apparent and possibly more severe for these individuals. The sensitive populations identified in this project include:
    - Children
    - Elderly
    - Asthmatics, smokers, or those with other lung conditions

    Occupational hazards were also noted but were not addressed in this project since the focus was more on risks near or inside the home.

3. **Impact on the Environment** – In addition to human health effects, environmental effects were considered as well. Interaction between the stressors and the environment could lead to decreased air or water quality, the contamination of land, or impacts to aquatic or terrestrial life. While human health effects alone are a serious outcome, environmental impacts in addition to human health effects could be a cause for greater concern.

An exposure and effects chart was created to integrate some of the considerations listed above (Table 1). This chart includes the stressors and their possible human health effects. The overall chart is grouped according to extent of exposure. Sensitive populations are identified and routes of exposure, which include inhalation, ingestion, skin contact, and inoculation via mosquito, are listed for each stressor. A chart was also created to show the possible environmental impacts from each stressor (Table 2).

In addition to assessing the risk from each potential stressor, other community -oriented considerations were evaluated as well. The community considerations collectively indicate the level of local support for action that is present within the community as well as the groups partnering to take action. The following are the community considerations important to this project.

1. **Level of Community Concern** – This can also be viewed as the local perceived risk. It is important to identify the stressors that the community views as having the greatest risk. Members of the community will likely be more receptive to local action, particularly education efforts, if they are concerned about the stressor. The receptiveness of the community will in turn influence the effectiveness of local action.

2. **Feasibility of Effective Local Action through Education** – Pueblo CAREs and other local groups partnering to take action will need support via sufficient resources and expertise to effectively educate the public about the stressor.

3. **Feasibility of Effective Local Action through Mitigation** – Similar to the previous consideration, Pueblo CAREs and other local groups partnering to take action will need support via sufficient resources and expertise to effectively help mitigate the risk and limit exposure.

Table 1 - Possible exposures and human health effects of potential stressors in Pueblo County, CO. Extent of exposure, routes of exposure, and sensitive populations are identified. Note that the effects listed for PPCPs are provided in the absence of actual data and should be considered as mere suggestions. Human health effects from PPCPs are currently unknown.

● Children particularly susceptible
◈ Elderly particularly susceptible
▲ Asthmatics, smokers, or those with other lung conditions particularly susceptible
+ All individuals susceptible
◘ Primarily an occupational hazard

			HUMAN HEALTH EFFECTS								
EXTENT OF EXPOSURE	**ROUTES OF EXPOSURE**	**STRESSORS**	Minor Respiratory Symptoms (Coughing, Sneezing)	Asthma and Decreased Lung Function	Physical Injury	Bacterial/Viral Infection	Cardiovascular Problems	Damage (Disease) to Vital Organs	Nervous System Impairment	Increased Risk of Cancer	Mortality (Death)
Less than 1,000 people potentially exposed	**Inhalation**	Diesel Exhaust from Extended Commercial Truck Idling	+ ▲ ●	+ ▲ ●			+ ▲ ●			+ ▲ ●	
	Inhalation, Skin Contact	Fly Ash	+ ◘ ▲	+ ◘ ▲							
	Inhalation, Skin Contact	Illegally Dumped Waste	+ ●		+ ●						
	Ingestion	Pathogens in Fountain Creek				● + ◈		● ◈			● ◈
	Ingestion, Skin Contact	Stormwater Runoff				● + ◈		● ◈			● ◈
	Ingestion	Uranium/Radium in Drinking Water Wells						+		+	
1,000 - 30,000 people potentially exposed	**Inhalation**	Dust from Construction Sites	+ ◘ ▲	+ ◘ ▲							
	Inhalation, Skin Contact	Industrial Hazardous Waste			+ ◘			+ ◘	+ ◘	+ ◘	+ ◘
	Inhalation, Ingestion	Lead in Homes							●		
	Inhalation	Manganese (industrial emissions)	+ ▲	+ ▲					◘		
	Ingestion	Mercury in Local Water Bodies						+	●		
	Inhalation	Mobile Source Pollutants	+ ▲ ●	+ ▲ ●			+ ▲ ●			+ ▲ ●	
	Inhalation	Smoke from Woodstoves/Fireplaces	● ◈ ▲	● ◈ ▲			● ◈ ▲				
Greater than 30,000 people potentially exposed	**Inhalation, Ingestion, Skin Contact**	Household Hazardous Materials / Waste			+			+			+
	Inhalation	Mold	● ◈ ▲	● ◈ ▲							
	Ingestion	Pharmaceuticals and Personal Care Products (PPCPs) in Local Water Bodies						+	+	+	
	Inhalation	Radon		+ ▲						+ ▲	+ ▲
	Inoculation via Mosquito	West Nile Virus				+			◈		◈

Table 2 – Possible environmental impacts of potential stressors in Pueblo County, CO.

	POSSIBLE ENVIRONMENTAL IMPACTS				
STRESSORS	**Decreased Air Quality**	**Decreased Water Quality**	**Impacts to Aquatic Life**	**Contamination of Land**	**Impacts to Terrestrial Life**
Diesel Exhaust from Extended Commercial Truck Idling	X				
Dust from Construction Sites	X	X	X		
Fly Ash	X	X	X	X	X
Household Hazardous Materials / Waste		X	X	X	X
Illegally Dumped Waste		X	X	X	X
Industrial Hazardous Waste	X	X	X	X	X
Lead in Homes				X	X
Manganese (industrial emissions)	X	X	X		
Mercury in Local Water Bodies		X	X		
Mobile Source Pollutants	X				
Mold in Homes					
Pathogens in Fountain Creek					
Pharmaceuticals and Personal Care Products (PPCPs)		X	X		
Radon					
Smoke from Wood Stoves/Fireplaces	X				
Stormwater Runoff		X	X		
Uranium / Radium in Drinking Water Wells					
West Nile Virus					X

After all of the important considerations had been identified the ranking scheme was developed. It was decided that when evaluating the exposure and effects considerations for each stressor, each consideration would receive a rank of 1, 2, or 3 where as a general rule, a 1 indicates low risk, a 2 indicates moderate risk, and a 3 indicates high risk,. In evaluating the community considerations a similar ranking scheme was employed where each consideration would receive a rank of 1, 2, or 3, where generally a 1 indicates low support for action, a 2 indicates moderate support, and a 3 indicates high support. Specific ranking criteria for each consideration were developed to aid in assigning ranks. These criteria are provided in Tables 3, 4, and 5.

It is important to mention that a conservative approach was used in designing the exposure criteria as it was decided that it is better to consider the “worst-case scenario” when determining possible risk. For example, if factors influencing exposure were entirely unknown (stressor presence, etc.) a rank of 3 was assigned to Likelihood of Exposure. Furthermore, if regulations or standards for a stressor were absent a rank of 3 was assigned to Frequency of Exceedances under the assumption that the stressor may frequently exceed unhealthy levels when controlling mechanisms are not in place.

Table 3 – Ranking criteria for exposure considerations. As an example, rank assignments and the rationale for each assignment for the potential stressor, Radon, are included.

Exposure Considerations	***Rank***	***Criteria***	***Example: Radon (rank and rationale)***
Likelihood of Exposure	1	Stressor is not present or present only in small quantities insufficient to cause effects, or if situation severely limits exposure	**Rank of 3** - Greater than 50% of the homes tested in Pueblo County had elevated levels. Exposure in the home is considered to be continuous.
	2	Stressor may be present in quantities sufficient to cause effects but exposure is intermittent due to circumstances such as seasonal weather changes, etc.	
	3	Stressor is present in sufficient quantities to cause effects and exposure is continuous, or if exposure is entirely unknown.	
Frequency of Exceedances	1	No known exceedances of regulations / standards.	**Rank of 3** – Regulations / standards are absent. EPA recommends that the levels do not exceed 4.0pCi/L but mitigation is not enforced.
	2	Regulations / standards are in place but exceedances have occurred or are likely	
	3	Regulations / standards are entirely absent	
Extent of Exposure	1	Less than 1,000 people potentially exposed	**Rank of 3** – Due to local geology, any home with cracks or openings in the foundation could risk radon accumulation.
	2	Between 1,000 and 30,000 people potentially exposed	
	3	Greater than 30,000 people potentially exposed	

Table 4 - Ranking criteria for effects considerations. As an example, rank assignments and the rationale for each assignment for the potential stressor, Radon, are included.

Effects Considerations	***Rank***	***Criteria***	***Example: Radon (rank and rationale)***
Severity of Likely Human Health Effects	1	Minor health effects are likely	**Rank of 3** - Long-term exposures to high levels of radon and radon decay products can lead to lung tissue damage and an increased risk of lung cancer
	2	Moderate health effects are likely	
	3	Severe health effects are likely	
Impact on Sensitive Populations	1	Sensitive populations (children, elderly, asthmatics, etc) are most likely not affected	**Rank of 2** – Smokers, as well as asthmatics and those with other lung conditions, may be more susceptible to effects.
	2	One or two types of sensitive populations are affected	
	3	Three or more types of sensitive populations are affected	
Impact on the Environment	1	Environmental impacts (decreased air quality, decreased water quality, contamination of land, impacts to aquatic/terrestrial life) are not likely	**Rank of 1** – Radon is primarily an indoor, human health issue. Environmental impacts are not expected.
	3	Environmental impacts are likely	

Table 5 - Ranking criteria for community considerations. As an example, rank assignments and the rationale for each assignment for the potential stressor, Radon, are included.

Community Considerations	***Rank***	***Criteria***	***Example: Radon (rank and rationale)***
Level of Community Concern	1	0 to 4.9% of people surveyed consider the stressor their top priority	**Rank of 3 -** 10.6% of people surveyed considers radon a top priority.
	2	5.0 to 9.9% of people surveyed consider the stressor their top priority	
	3	10.0% or more of people surveyed consider the stressor their top priority	
Feasibility of Effective Local Action (Education)	1	Not Very Feasible - Local groups partnering to take action would NOT have the resources and expertise to find partners to make a campaign for the stressor and educate the public (legislative action may be required).	**Rank of 3** – Pueblo CAREs is able to partner with Douglas Kladder (a radon specialist) and arrange public education meetings.
	2	Somewhat Feasible - Local groups have the resources or the expertise (but not both) to find partners to make a campaign for the stressor and educate the public.	
	3	Feasible - Local groups have the resources and expertise to find partners to make a campaign for the stressor and educate the public.	
Feasibility of Effective Local Action (Mitigation)	1	Not Very Feasible - Local groups partnering to take action would NOT have the resources and expertise to find partners to make a campaign for the stressor and effectively mitigate the risk, thereby reducing the exposure (legislative action may be required).	**Rank of 3** – Pueblo CAREs is able to assist with radon mitigation in select areas of Pueblo County (Salt Creek). The development of Do-It-Yourself programs is also possible.
	2	Somewhat Feasible - Local groups have the resources or the expertise (but not both) to find partners to make a campaign for the stressor and effectively mitigate the risk, thereby reducing the exposure.	
	3	Feasible - Local groups have the resources and expertise to find partners to make a campaign for the stressor and effectively mitigate the risk, thereby reducing the exposure.	

Using the ranking scheme criteria, ranks were assigned to all considerations for each of the 18 stressors. The ranks were then summed to produce several subtotals and a total score. As stated previously, risk is the combination of exposure and effects and therefore the exposure and effects subtotal indicates the risk of interaction with the stressor and the subsequent effects. The community considerations subtotal indicates the local support for action. When the exposure and effects subtotal and the community considerations subtotal are summed, a total score is created that represents a combination of not only risk but also local support for action (Figure 1). The total scores are compared relative to each other and the stressors having the highest scores should be addressed by Pueblo CAREs not only because they pose a risk but also because support for action from the community and partnering groups exists. The total score, in essence, drives the prioritization process. The ranks, subtotals, and total scores for each of the 18 stressors are provided in the ranking charts (Tables 6 and 7).

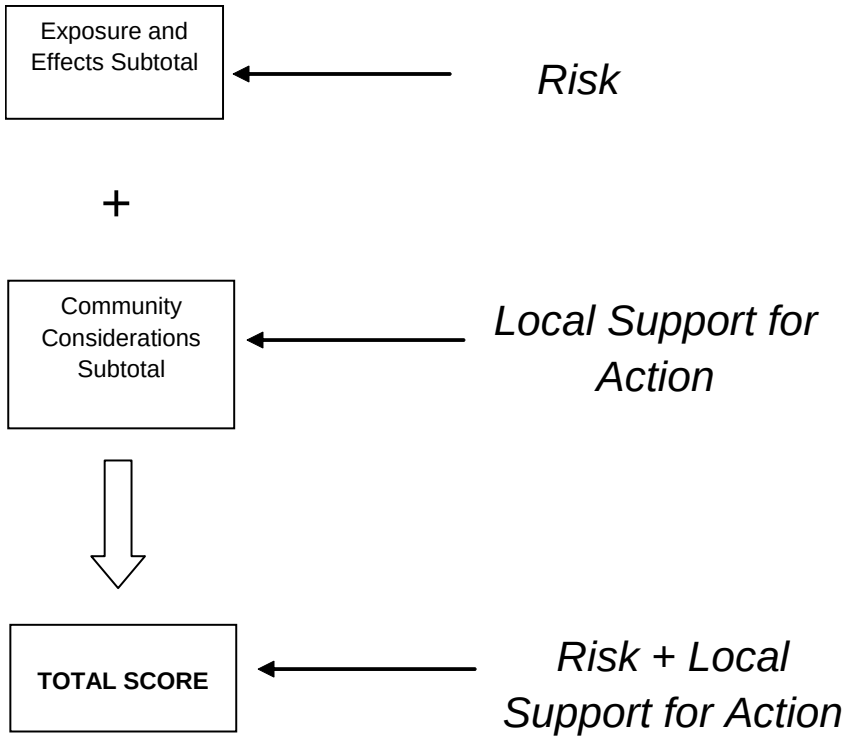

Figure 1 - The summation of the exposure and effects subtotal (risk) and the community considerations subtotal (local support for action) result in a total score that represents the risk as well as the local support for action for the stressor. This total score can be used in prioritization of the stressors.

Table 6 – The ranking chart showing the ranks, subtotals, and total scores for nine of the 18 stressors, listed alphabetically beginning with Diesel Exhaust from Extended Commercial Truck Idling.

	STRESSORS								
CONSIDERATIONS	Diesel Exhaust from Extended Commercial Truck Idling	Dust from Construction Sites	Fly Ash	Household Hazardous Materials / Waste	Illegally Dumped Waste	Industrial Hazardous Waste	Lead in Homes	Manganese (industrial emissions)	Mercury in Local Water Bodies
EXPOSURE AND EFFECTS									
Likelihood of Exposure	2	2	1	3	2	1	3	2	1
Frequency of Exceedances	3	2	1	3	2	2	2	2	1
Extent of Exposure	1	2	1	3	1	2	2	2	2
Exposure Subtotal	**6**	**6**	**3**	**9**	**5**	**5**	**7**	**6**	**4**
Severity of Likely Human Health Effects	1	1	1	2	2	3	3	1	3
Impact on Sensitive Populations	2	2	2	1	2	1	2	2	2
Impact on the Environment	3	3	3	3	3	3	3	3	3
Effects Subtotal	**6**	**6**	**6**	**6**	**7**	**7**	**8**	**6**	**8**
Exposure and Effects Subtotal	**12**	**12**	**9**	**15**	**12**	**12**	**15**	**12**	**12**
COMMUNITY CONSIDERATIONS									
Level of Community Concern	3	3	3	3	1	1	1	3	1
Feasibility of Effective Local Action (Education)	2	1	1	3	1	1	3	1	3
Feasibility of Effective Local Action (Mitigation)	1	1	1	3	1	1	1	1	1
Community Considerations Subtotal	**6**	**5**	**5**	**9**	**3**	**3**	**5**	**5**	**5**
TOTAL SCORE	**18**	**17**	**14**	**24**	**15**	**15**	**20**	**17**	**17**

Table 7 - The ranking chart showing the ranks, subtotals, and total scores for the remaining nine stressors, listed alphabetically beginning with Mobile Source Pollutants.

	STRESSORS								
CONSIDERATIONS	Mobile Source Pollutants	Mold in Homes	Pathogens in Fountain Creek	PPCPs in Local Water Bodies	Radon	Smoke from Wood Stoves and Fireplaces	Stormwater Runoff	Uranium/Radium in Drinking Water Wells	West Nile Virus
EXPOSURE AND EFFECTS									
Likelihood of Exposure	2	1	1	3	3	2	2	2	2
Frequency of Exceedances	3	3	2	3	3	2	2	3	2
Extent of Exposure	2	3	1	3	3	2	1	1	3
Exposure Subtotal	**7**	**7**	**4**	**9**	**9**	**6**	**5**	**6**	**7**
Severity of Likely Human Health Effects	2	1	2	2	3	2	2	3	2
Impact on Sensitive Populations	2	3	2	1	2	3	2	1	2
Impact on the Environment	3	1	1	3	1	3	3	1	3
Effects Subtotal	**7**	**5**	**5**	**6**	**6**	**8**	**7**	**5**	**7**
Exposure and Effects Subtotal	**14**	**12**	**9**	**15**	**15**	**14**	**12**	**11**	**14**
COMMUNITY CONSIDERATIONS									
Level of Community Concern	3	3	1	1	3	1	2	1	2
Feasibility of Effective Local Action (Education)	1	3	3	1	3	3	2	2	3
Feasibility of Effective Local Action (Mitigation)	1	2	1	1	3	2	1	1	2
Community Considerations Subtotal	**5**	**8**	**5**	**3**	**9**	**6**	**5**	**4**	**7**
TOTAL SCORE	**19**	**20**	**14**	**18**	**24**	**20**	**17**	**15**	**21**

The stressors with the highest scores by a large margin are Radon and Household Hazardous Materials/Waste, each having a total score of 24. West Nile Virus was the next highest stressor with a total score of 21, followed closely by Lead in Homes, Smoke from Woodstoves/Fireplaces and Mold (all 20).

When reviewing these results it is important to look for major discrepancies between the total score and the exposure and effects subtotal for each stressor. For instance, Household Hazardous Waste and Radon have relatively high total scores and exposure and effects subtotals, signifying that both the overall risk and the local support for these issues are high. Conversely, Pharmaceuticals and Personal Care Products (PPCPs) have a high exposure and effects subtotal but a low total score. This indicates that the overall risk for this issue is high but the total score is low because local support is lacking. It may be decided that despite the higher risk, no action can be taken since education and mitigation were ranked as not feasible.

Describing Uncertainty

Unfortunately, current data and other information is often lacking for one or more of the exposure and effects considerations for each stressor. Therefore, it is necessary to describe the uncertainty that exists for each rank that was assigned. Describing the uncertainty serves to communicate the overall confidence in each rank and identifies data gaps that need to be addressed.

For the exposure and effects considerations, the uncertainty was classified for each rank as low, medium, or high (Tables 8 and 9) based on the amount and recentness of available information. Low uncertainty indicates that the assigned rank is believed to be accurate because data or other information is available. Medium uncertainty indicates that there is a slight chance that the assigned rank may vary because some data is lacking. High uncertainty indicates that there is a considerable chance that the assigned rank may vary because a large amount of data is lacking or is completely unavailable.

The community considerations were addressed in a slightly different manner. The uncertainties for these ranks were not described as low, medium, or high but are understood to have some inherent uncertainties. The Level of Community Concern ranks for each stressor were determined by questioning members of the community about their top priorities. Due to time constraints and financial limitations only a small portion of the community was polled and consequently it is questionable whether the results of the questionnaire are representative of all Pueblo County residents. The ranks for Feasibility of Effective Local Action (Education and Mitigation) were not dependent on data but on the opinions of the Pueblo CAREs Steering Committee members, who were confident in the rank assignments.

Table 8 – The ranking chart for nine of the 18 stressors, listed alphabetically beginning with Diesel Exhaust from Extended Commercial Truck Idling. The uncertainty classifications (low, medium or high) for the exposure and effects considerations ranks are listed in parentheses.

	STRESSORS								
CONSIDERATIONS	Diesel Exhaust from Extended Commercial Truck Idling	Dust from Construction Sites	Fly Ash	Household Hazardous Materials / Waste	Illegally Dumped Waste	Industrial Hazardous Waste	Lead in Homes	Manganese (industrial emissions)	Mercury in Local Water Bodies
EXPOSURE AND EFFECTS									
Likelihood of Exposure	2 (High)	2 (Med)	1 (Med)	3 (High)	2 (Med)	1 (Med)	3 (Med)	2 (High)	1 (HIgh)
Frequency of Exceedances	3 (High)	2 (Med)	1 (Med)	3 (High)	2 (Low)	2 (Low)	2 (HIgh)	2 (High)	1 (High)
Extent of Exposure	1 (Low)	2 (Med)	1 (Med)	3 (High)	1 (Low)	2 (Low)	2 (Med)	2 (Med)	2 (Med)
Exposure Subtotal	**6**	**6**	**3**	**9**	**5**	**5**	**7**	**6**	**4**
Severity of Likely Human Health Effects	1 (Med)	1 (Med)	1 (Low)	2 (High)	2 (High)	3 (High)	3 (Low)	1 (Low)	3 (Low)
Impact on Sensitive Populations	2 (Med)	2 (Med)	2 (Med)	1 (Med)	2 (Low)	1 (Med)	2 (Low)	2 (High)	2 (Low)
Impact on the Environment	3 (Med)	3 (High)	3 (High)	3 (Med)	3 (Low)	3 (Low)	3 (Med)	3 (Med)	3 (Low)
Effects Subtotal	**6**	**6**	**6**	**6**	**7**	**7**	**8**	**6**	**8**
Exposure and Effects Subtotal	**12**	**12**	**9**	**15**	**12**	**12**	**15**	**12**	**12**
COMMUNITY CONSIDERATIONS									
Level of Community Concern	3	3	3	3	1	1	1	3	1
Feasibility of Effective Local Action (Education)	2	1	1	3	1	1	3	1	3
Feasibility of Effective Local Action (Mitigation)	1	1	1	3	1	1	1	1	1
Community Considerations Subtotal	**6**	**5**	**5**	**9**	**3**	**3**	**5**	**5**	**5**
TOTAL SCORE	**18**	**17**	**14**	**24**	**15**	**15**	**20**	**17**	**17**

Table 9 - The ranking chart for the remaining nine stressors, listed alphabetically beginning with Mobile Source Pollutants. The uncertainty classifications (low, medium, or high) for the exposure and effects considerations ranks are listed in parentheses.

	STRESSORS								
CONSIDERATIONS	Mobile Source Pollutants	Mold in Homes	Pathogens in Fountain Creek	PPCPs	Radon	Smoke from Wood Stoves and Fireplaces	Stormwater Runoff	Uranium in Drinking Water Wells	West Nile Virus
EXPOSURE AND EFFECTS									
Likelihood of Exposure	2 (Med)	1 (Med)	1 (Low)	3 (High)	3 (Low)	2 (High)	2 (High)	2 (High)	2 (High)
Frequency of Exceedances	3 (HIgh)	3 (High)	2 (Low)	3 (HIgh)	3 (Low)	2 (HIgh)	2 (Low)	3 (High)	2 (Low)
Extent of Exposure	2 (Med)	3 (High)	1 (Med)	3 (Low)	3 (Low)	2 (High)	1 (Med)	1 (Low)	3 (High)
Exposure Subtotal	**7**	**7**	**4**	**9**	**9**	**6**	**5**	**6**	**7**
Severity of Likely Human Health Effects	2 (Low)	1 (Low)	2 (Low)	2 (High)	3 (Low)	2 (Med)	2 (High)	3 (Med)	2 (Low)
Impact on Sensitive Populations	2 (Med)	3 (Low)	2 (Low)	1 (High)	2 (Med)	3 (Low)	2 (Med)	1 (Low)	2 (Low)
Impact on the Environment	3 (Low)	1 (Low)	1 (Low)	3 (High)	1 (Low)	3 (Low)	3 (Low)	1 (Med)	3 (Med)
Effects Subtotal	**7**	**5**	**5**	**6**	**6**	**8**	**7**	**5**	**7**
Exposure and Effects Subtotal	**14**	**12**	**9**	**15**	**15**	**14**	**12**	**11**	**14**
COMMUNITY CONSIDERATIONS									
Level of Community Concern	3	3	1	1	3	1	2	1	2
Feasibility of Local Action (Education)	1	3	3	1	3	3	2	2	3
Feasibility of Local Action (Mitigation)	1	2	1	1	3	2	1	1	2
Community Considerations Subtotal	**5**	**8**	**5**	**3**	**9**	**6**	**5**	**4**	**7**
TOTAL SCORE	**19**	**20**	**14**	**18**	**24**	**20**	**17**	**15**	**21**

Acknowledging uncertainty can be useful when prioritizing stressors. For instance, Radon and Household Hazardous Materials/Waste (HHMW) both received the highest total scores however the level of uncertainty in the ranks for each stressor were very different. With the exception of Impact on Sensitive Populations, the uncertainty in the ranks for all exposure and effects considerations was low, indicating high confidence in the total score of 24 for Radon (Table 9). Conversely, high uncertainty was assigned to four out of six HHMW exposure and effects ranks (Table 8). The excessive amount of high uncertainty suggests low confidence in the total score, with particularly low confidence regarding exposure. In other words the actual total score for HHMW may be higher or lower than the predicted score of 24 but there is no way of knowing until more data becomes available. Since it is fairly certain that the total score for Radon is 24 while the total score for HHMW could be variable and may actually be lower than the predicted score, it is recommended that Radon be given top priority and more resources allocated to the education and mitigation of this stressor than HHMW.

Conclusion

The ranking method used in this project incorporates a scientific approach in identifying risk and prioritizing stressors. Considerations that influence exposure, effects, and local support for action are evaluated using specific criteria and the uncertainty within the results is described. In the end, the highest scoring stressors indicate issues that may require additional attention and allocation of resources. Comparison of subtotals, uncertainties, and even individual ranks can further help to prioritize the highest-scoring items.

APPENDIX C: "Potential Exposures Affecting Human Health and the Environment in Pueblo County, Colorado"

Potential Exposures Affecting Human Health and the Environment in Pueblo County, Colorado

Prepared for

Pueblo CAREs (Community Action for a Renewed Environment)

By

Audrey Cowan

January 2009

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INTRODUCTION

According to the Pueblo CAREs (Community Action for a Renewed Environment) Steering Committee, the Pueblo County community in the state of Colorado is concerned about numerous types of exposures to stressors in the air, on land, in local water bodies, inside the home, and pathogens transmitted via biological vectors. This report serves to provide background information regarding sources, health effects and existing regulations for each stressor in order to assist in the determination of the exposure potentials for those living in Pueblo County.

POTENTIAL AIR EXPOSURES IN PUEBLO COUNTY

AMBIENT AIR QUALITY

There are a variety of different air pollutants. The criteria pollutants are six common air pollutants which include particulate matter, ground-level ozone, carbon monoxide, sulfur oxides, nitrogen oxides and lead.

Sources of air pollution in the South Central region of Colorado (includes Pueblo County) include:

- Area sources – fugitive dust and open burning
- Mobile sources – motor vehicle emissions
- Point sources – facilities including power plants, concrete batch plants, sand and gravel mining operations, and processing operations

The Colorado Department of Public Health and Environment (CDPHE) identified mobile and area sources as the two major contributors to air pollution in the South Central region. Point sources were noted as being a minor contributor to criteria pollutants (Figure 1).

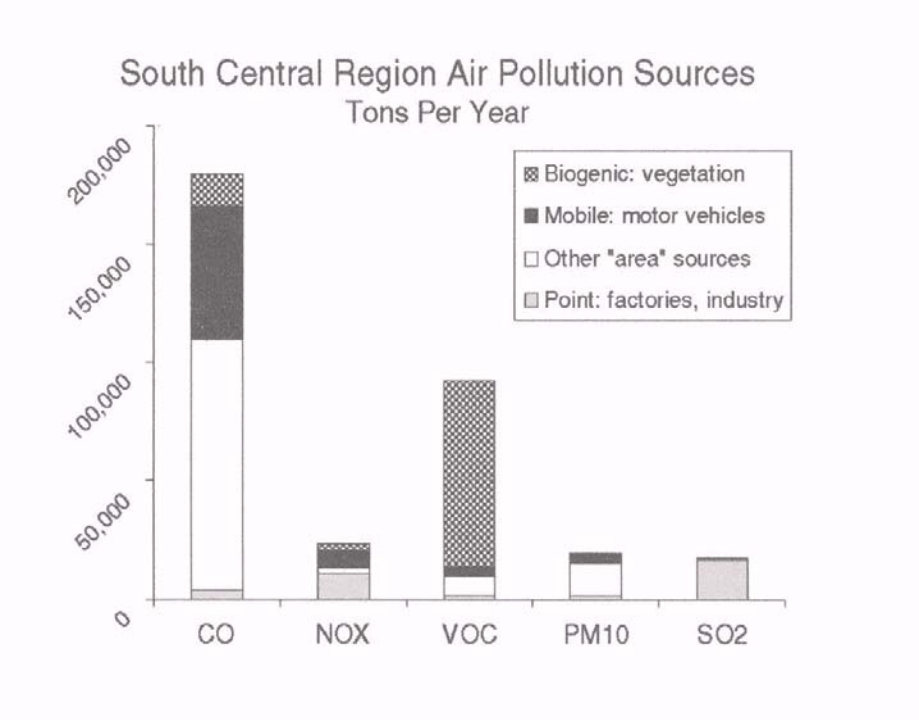

Figure 1 - Contribution of sources to levels of carbon monoxide (CO), nitrogen oxides (NOX), volatile organic compounds (VOC), particles less than 10 microns (PM10), and sulfur dioxide (SO2) for the 2006-2007 year in South Central Colorado (CDPHE 2007a).

PARTICULATE MATTER

Particulate matter is the main criteria pollutant that is monitored in Pueblo. Particulate matter (also called particle pollution) is the term for a mixture of solid particles and liquid droplets found in the air. Particulate matter (PM) can be divided into two categories:

- PM2.5 – particles 2.5 micrometers in diameter and smaller. They are fine particles like those found in smoke and haze and can be directly emitted from sources such as forest fires, or they can form when gases emitted from power plants, industries and automobiles react in the air.
- PM10 – particles larger than 2.5 micrometers and smaller than 10 micrometers in diameter. They are the inhalable coarse particles like those found near dusty roadways and industries.

Health Effects

PM2.5 and PM10 can be breathed deep into the lungs and cause various health problems such as increased respiratory symptoms, including irritation of the airways, coughing, or difficulty breathing, which can lead to:

- Decreased lung function
- Aggravated asthma
- Chronic bronchitis
- Heart problems

Regulations

The National Ambient Air Quality Standards (NAAQS) for particulate matter are as follows (CDPHE 2007a):

- PM2.5:
  - The annual mean standard must not exceed 15 micrograms per cubic meter of air ($\mu g/m^3$) averaged over three years
  - The 24-hour standard is 35 $\mu g/m^3$ applied to the 3-year average of the 98th percentile value
- PM10:
  - The annual mean standard is 50 $\mu g/m^3$
  - The 24 hour standard 150 $\mu g/m^3$ cannot be exceeded more than once per year over three years

Potential Exposure in Pueblo County

Currently Pueblo is in compliance with the federal standards (CDPHE 2007a) as the PM2.5 and PM10 levels at the sampling site (located at 211 D Street) are well below the standards for the 24-hour and annual averages (Table 1). Additionally, PM2.5 and PM10 have not yet exceeded the national standards. The 2000-2007 annual averages for PM2.5 are shown in Figure 2 and the 1998-2007 annual averages for PM10 are shown in Figure 3. These trends are fairly similar to that of PM2.5 and PM10 in other areas in Colorado, including the city of Denver. The PM2.5 levels at several sample sites in Denver have remained below the national standard since 2000. The PM10 levels at one site in Denver exceeded the national standard in 1992 but have since decreased.

Table 1 - Air quality standards and measured levels of PM2.5 and PM10 in Pueblo, Colorado for 2006-2007 (CDPHE 2007a).

	Federal Standards for Air Quality	Levels as Reported by CDPHE Air Quality Control Commission (2006-2007)
PM2.5 – 24 hr average	35 µg/ m^3	15.4 µg/ m^3
PM2.5 – annual average	15 µg/ m^3	7.5 µg/ m^3
PM10 – 24 hr average	150 µg/ m^3	58 µg/ m^3
PM10 – annual average	50 µg/ m^3	23.2 µg/ m^3

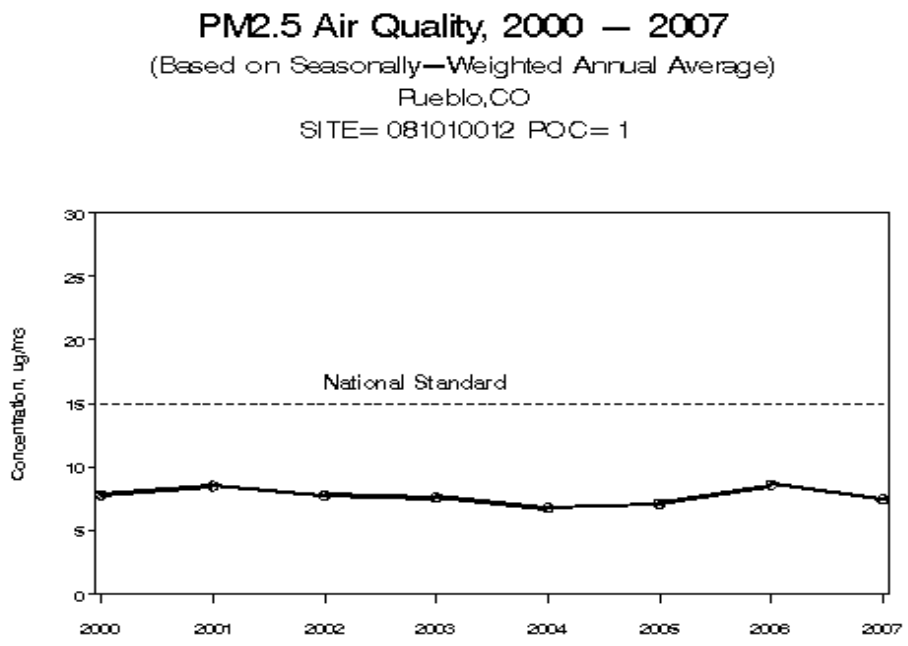

Figure 2 - Annual averages of PM2.5 from 2000-2007 for Pueblo, Colorado (EPA 2008a).

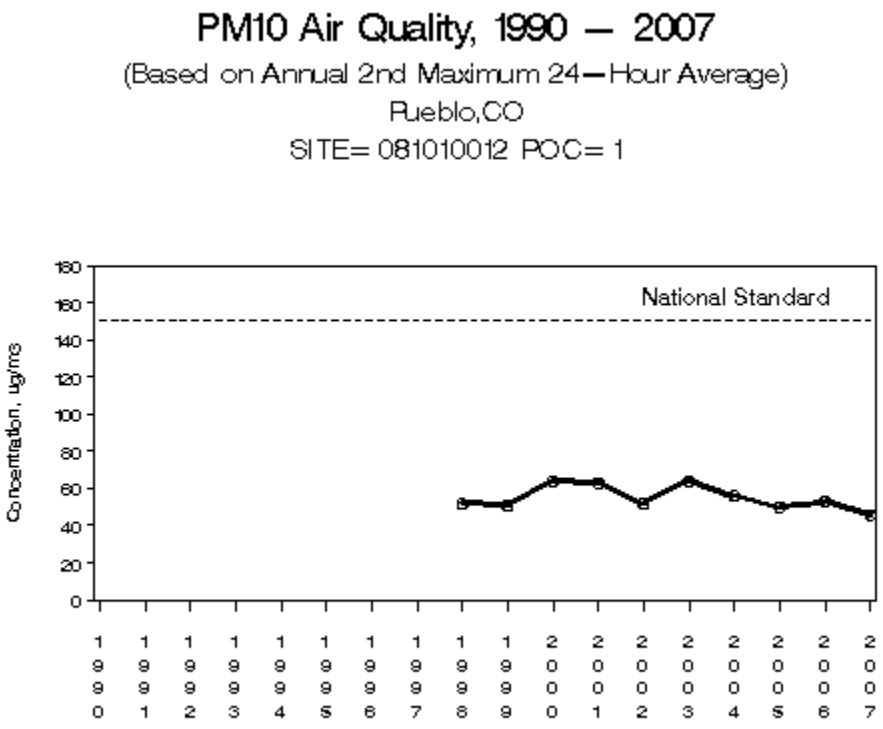

Figure 3 - Annual averages of PM10 from 1990-2007 for Pueblo, Colorado (EPA 2008a). Measurements were not reported prior to 1998.

Since the levels of PM2.5 and PM10 are low, the ambient particulate matter is considered to be at a healthy level. The Air Quality Index (AQI) for PM2.5 and PM10 at the same sampling site (211 D. Street) in Pueblo from 1996-2007 rated the levels overall as good with a few days in which the levels were rated as moderate (EPA 2008b). This indicates the air quality levels in the sampling site area are generally healthy. To put this rating in perspective, the AQI levels include: good, moderate, unhealthy for sensitive groups, unhealthy, very unhealthy, and hazardous. The AQI for 2007 is provided in Figure 4. Though the PM2.5 and PM10 levels are low and the AQI is good at the sampling site, this data is not necessarily representative of the air quality of the entire county. Certain areas within the county may have higher levels which may lead to increased exposure potential but they are unknown at this time.

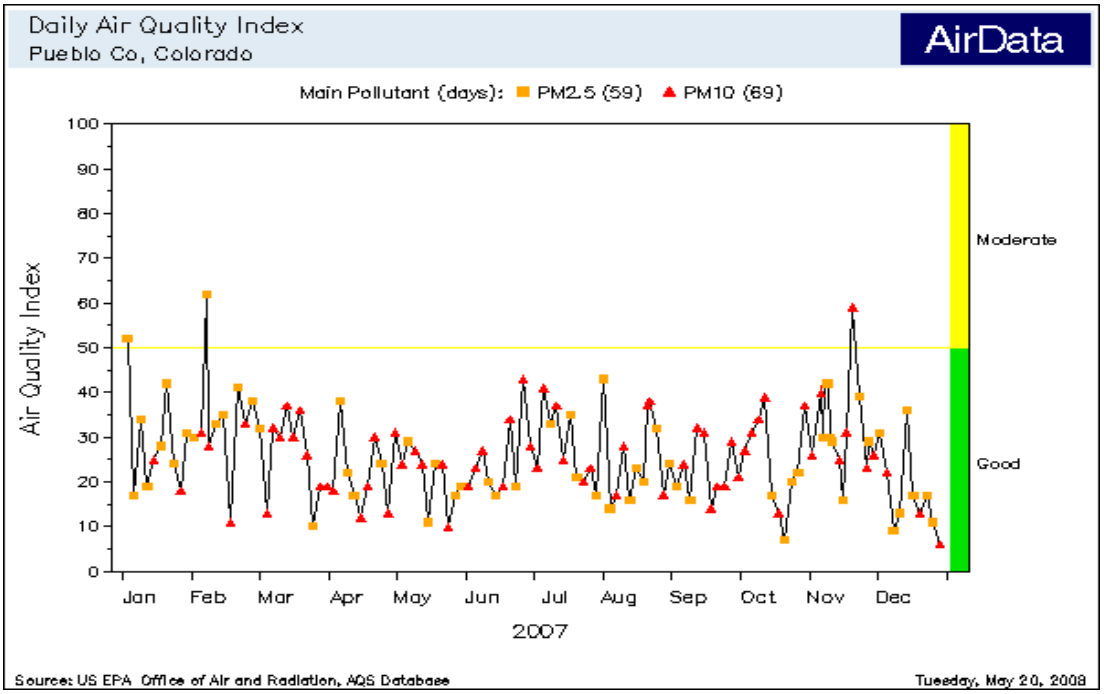

Figure 4 - Daily air quality index for PM2.5 and PM10 in Pueblo, Colorado in 2007 (EPA 2008b).

While particulate matter is assumed to not be a concern at the urban level (4 – 50km), meaning the entire city of Pueblo, Gilliland *et al*. (2005) notes that there are various spatial scales of variability for ambient pollutants and that for certain types of pollution, exposure must also be considered at the neighborhood scales (50m to 4km). Therefore, localized exposures of air pollutants originating from construction sites (an area source) and mobile sources will be considered in addition to fugitive and stack air emissions from industrial sites.

DUST FROM CONSTRUCTION SITES

Construction dust is a contributor to particulate matter pollution and can have a substantial temporary impact to air quality (EPA 1995a). Construction is different from other forms of emissions in that it is temporary and that the daily emissions can vary substantially, depending on the activity levels, specific operations and prevailing meteorological conditions.

Sources of Construction Dust

Dust emissions occur when:

- Native soil is disturbed by processes such as:
    - Land clearing
    - Drilling and blasting
    - Ground excavation
    - Earth moving
- Soil is stockpiled

- As project vehicles travel on unpaved roads
- When mud/dirt is carried out onto paved roadways

Regulations

The Pueblo Municipal Code of Ordinances requires that the air quality at the site cannot exceed 20% opacity. Furthermore, the Pueblo City County Health Department (PCCHD) requires that land developers planning construction activities equal to or greater than 1,000 square feet but less than one acre must agree to follow the guidelines in the Standard Emission Control Plan for Minor Land Disturbance and Construction Activities. If land developers are planning activities that involve from one acre to less than 25 acres, they must submit an application with a dust control plan and are then issued an emission permit.

Some of the emissions control and prevention methods that land developers may employ include:

- Watering site prior to and during activities
- Using chemical stabilizers
- Using wind breaks, fencing or other barriers
- Mulching
- Adding vegetation and seeding
- Locating topsoil and spoil piles in proper areas
- Stopping / minimizing dust generating activities during high, gusty and variable wind conditions
- Limiting vehicle access and reducing vehicle speed
- Constructing a stabilized construction site entrance
- Washing vehicles/wheels prior to entering streets

Potential Exposure in Pueblo County

The CDPHE Air Quality Control Commission noted that construction activities in the South Central region typically occur on areas less than one acre (CDPHE 2007a). As of January 2008, there are 36 active construction permits in Pueblo County for areas larger than one acre (Scott Cowan, Heather Maio, PCCHD, personal comm. 21 July 2008). Complaints to PCCHD, and thus possible violations, regarding fugitive dust are estimated to occur 10 to 20 times per year with more occurrences in the spring (Heather Maio, PCCHD, personal comm., 12 June 2008). This is most likely due to the fact that Pueblo experiences average wind speed ranges at approximately 11 miles per hour in the spring compared to seven miles per hour in the fall and early winter (CDPHE 2007a). It is important to note that an environmental assessment of construction activities noted that dust settles out very quickly and higher levels in the air rarely exceed a distance of 50m from the site (AMEC Earth and Environmental 2006). Therefore, individuals living or working in close proximity to construction sites in Pueblo County may be temporarily exposed to construction dust primarily in the spring, especially if control measures

are not followed. Those individuals with existing respiratory conditions may be more susceptible.

MOBILE SOURCE POLLUTANTS

Mobile sources pollute the air through combustion and fuel evaporation. The mobile sources that are typically found on highways include:

- Light-duty vehicles – passenger cars
- Light-duty trucks –pickup trucks, minivans, passenger vans, and sport-utility vehicles (SUVs) having 6,000 to 8, 500 pounds Gross Vehicle Weight
- Medium-duty passenger vehicles –including large SUVs and passenger vans between 8,500 and 10,000 pounds Gross Vehicle Weight
- Heavy-duty vehicles –large pick-ups, buses, delivery trucks, RVs, and semi trucks having 8,501 pounds Gross Vehicle Weight and higher that are equipped with heavy-duty engines
- Motorcycles

These mobile sources contribute to four air pollutants:

- Carbon monoxide
- Hydrocarbons
- Nitrogen oxides
- Particulate matter

Based on 1999 national emissions data, light-duty vehicles contribute the most to carbon monoxide and hydrocarbon levels whereas diesel vehicles contribute the most to nitrogen oxides and particulate matter.

Health Effects

Delfino (2002) reported in a review of the literature regarding asthma and air toxics that numerous studies have shown increased risk in respiratory symptoms from higher traffic density, especially truck traffic density, near the home. High traffic density is not a clearly definable term however one study identified respiratory effects in children living in homes near freeways that carried between 80,000 and 150,000 vehicles per day with a truck traffic density of 9,482 trucks per day (van Vliet *et al*. 1997). The distance the children lived from the freeway ranged from 100 meters (m) to 1000m with more symptoms reported for children living within 100m. Additionally, ambient air concentrations of black smoke (similar to particulate matter) and nitrogen dioxide (NO2) were greatest near the freeway and these concentrations were much more pronounced when the measurement sites were downwind from the freeways.

Potential Exposure in Pueblo County

On I-25 through Pueblo the greatest annual average daily traffic (AADT) in 2007 was 72,300 vehicles per day (Table 2, Figure 5) (CDOT 2007). This number was taken by the Colorado Department of Transportation (CDOT) continuous traffic recorder located near the 13th Street Exit (#99B). The average annual average daily truck traffic at this location in 2007 was 3,690 trucks per day which is approximately 5.10% of the total AADT (Table 2). CDOT estimates that within 20 years the AADT will reach approximately 95,436 vehicles per day and the AADT for trucks will reach 4,870. On Highway 50 the AADT in 2007 was much less than I-25 with the greatest AADT at approximately 46,800 vehicles per day at the intersection with Elizabeth Street near I-25(Table 2, Figure 5). The AADT for trucks at this location was approximately 1,970 or 4.2 % of total AADT. It is estimated that within 20 years the AADT will increase to over 71,000 vehicles per day and the truck AADT will be nearly 3,000 trucks per day at this location (Table 2). These AADT values are not the highest in Colorado. For example, the greatest AADT in Denver in 2007 on I-25 was estimated to be approximately 258,000 vehicles per day and the truck AADT was over 26,000. This was near Fox Street and 38th Avenue (CDOT 2007).

Though the AADT values for Pueblo County are lower than the study mentioned previously, the potential for exposure to mobile source pollution exists and may increase in the future as the AADT increases. Individuals that live downwind of I-25, especially those living within 100m, may have a higher potential for exposure. In particular, children and those individuals with existing respiratory conditions may more susceptible to effects from mobile source pollution.

Table 2 - Traffic statistics for the sites having the greatest traffic density on I-25 and Highway 50 in Pueblo, Colorado in 2007 (CDOT 2007). The 20 year factor is a traffic forecasting statistic that when multiplied by the current AADT yields an estimate for 20 years. The 20 year factor was used to generate the AADT estimates.

Site Description	Annual Average Daily Traffic (AADT)	Percent Trucks	Trucks AADT	20 Year Factor	AADT Estimate for 20 Years	Trucks AADT Estimate for 20 Years
ON I-25 N/O 13TH ST, PUEBLO	72,300	5.10%	3,687	1.32	95,436	4,870
ON SH 50 E/O ELIZABETH ST, PUEBLO	46,800	4.2%	1,970	1.52	71,136	2,994

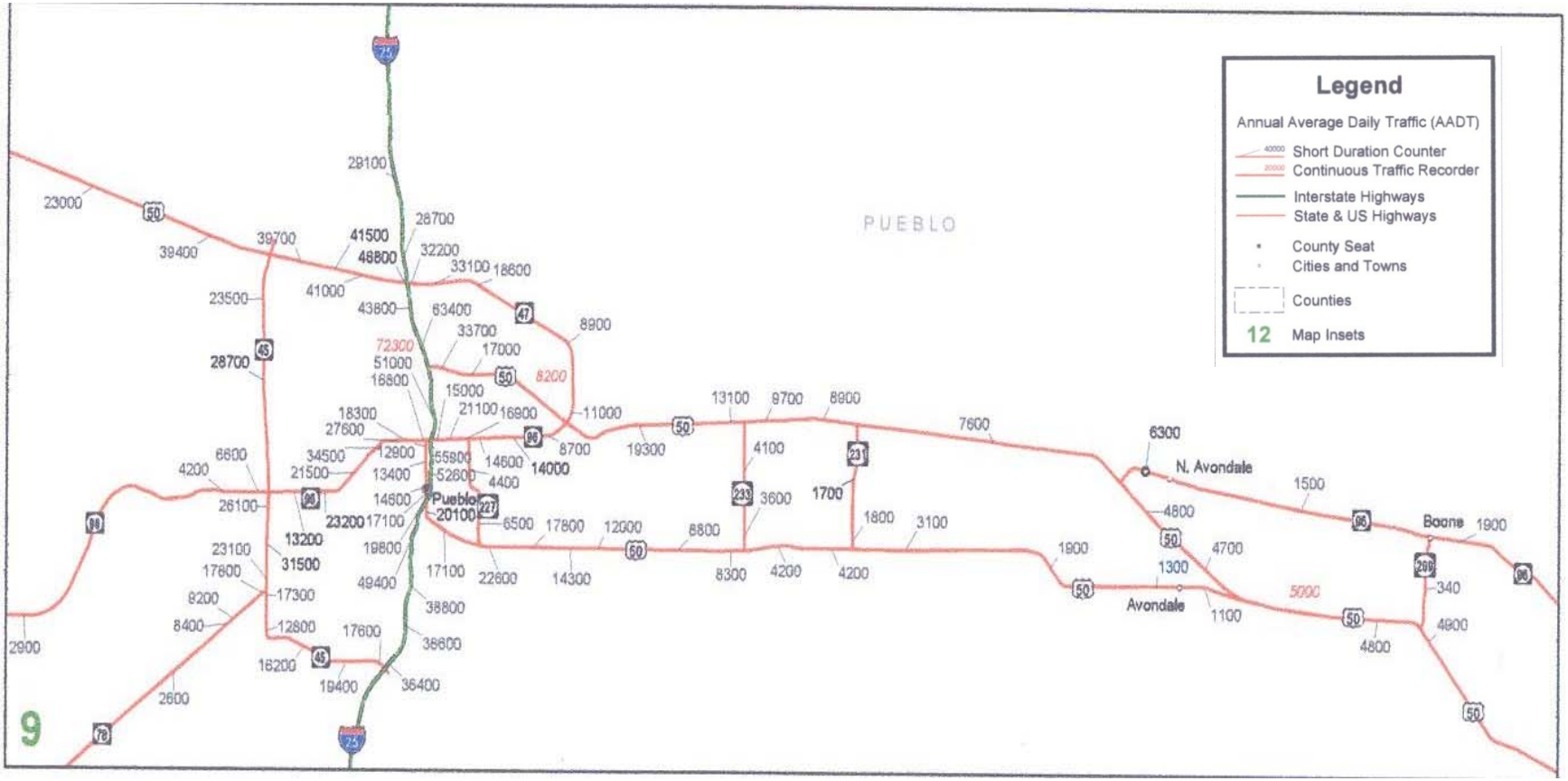

Figure 5 - Colorado Highway system traffic volume map for the Pueblo area in 2007. Map courtesy of the Colorado Department of Transportation (CDOT 2007).

DIESEL EXHAUST FROM EXTENDED COMMERCIAL TRUCK IDLING

In addition to mobile source pollution on highways, idling is another possible source of air pollution. Idling is common among trucking and busing industries in which heavy-duty diesel vehicles are used. Extended, or long duration idling can be generally defined as the operation of a truck or bus propulsion engine when not engaged in gear for an extended time period (EPA 2004), typically for five minutes or longer. Extended idling typically occurs during the loading or unloading process and does not include routine stoppages due to traffic movement or congestion.

According to the Environmental Protection Agency (EPA), vehicles are most inefficient while idling due to incomplete fuel combustion and pollutants are released in higher levels than when the vehicle is in operation (EPA 2006a). Furthermore, diesel exhaust emissions while idling are considered more harmful because the pollutants cannot be dispersed by the wake created by a moving vehicle (Ning 2005). Diesel emissions are said to produce more harmful emissions than gasoline engines (EPA 2006b). The two main pollutants present in diesel exhaust of an idling vehicle include nitrogen oxide and particulate matter (ICF International 2007). Several other pollutants may be associated with diesel exhaust such as benzene, formaldehyde, elemental (black) carbon, and particulate bound polycyclic aromatic hydrocarbons (Trenbath 2008).

The emissions of trucks while idling are variable due to factors such as the engine manufacturer, age of the vehicle, rpm at an idle state, and ambient temperature which influences the use of air conditioning or heat (EPA 2004). Despite this variability, the EPA (2004) estimates that nitrogen oxides are emitted from extended idling trucks at an average rate of 135 grams per hour (g/hr). For trucks produced prior to the 2007 model year, the particulate matter (PM)emission rate for extended idling trucks is approximately 3.68 g/hr. The PM emission rate is expected to decrease significantly for trucks produced after the 2007 model year due to the institution of new regulations.

Health Effects

As mentioned previously, particulate matter as well as other pollutants associated with diesel exhaust can aggravate asthma and other respiratory problems, and may decrease lung and heart functions. Much of the exposure to diesel exhaust will be short-term and therefore likely effects may include upper respiratory inflammation and exacerbated asthma and other allergenic responses (EPA 2002a) although long-term exposure to diesel exhaust can pose a lung cancer hazard. Those individuals near the vehicles are more likely to be affected as one study noted that all pollutants decayed to background concentrations within a distance of 3 meters (m) along the centerline from the emission source and within a distance of 1m from both sides of the centerline and to a height of 1 m (Ning 2005). It is important to note that this study was conducted in an isolated environment with calm weather conditions.

Regulations

Diesel Fuel Regulations

The EPA is now working to implement new standards for diesel fuel. As of June 2006, clean ultra-low sulfur (at or below 15 parts per million (ppm)) diesel fuel is required for use in highway diesel engines (EPA 2008e). When the new fuel is combined with certain pollution control equipment like PM filters, the PM emissions are expected to decrease by 90% (EPA 2008e). Overall, new trucks and buses produced in 2007 or later should be up to 95% cleaner than earlier models if used with pollution control technology. By 2030, the engine fleet is expected to be fully turned over, reducing PM emissions by 250,000 tons per year and nitrogen oxide emissions by four million tons per year. Until this time, however, diesel engines already in use will continue to emit large amounts of nitrogen oxides, particulate matter and other air pollutants.

In addition to the fuel regulations, the Clean School Bus USA campaign plans to retrofit or replace the US diesel school buses by 2010. This will not only help emissions outside the bus but inside as well which is important since tailpipe exhaust is a significant source of in-cabin self-pollution for many school buses (Trenbath 2008). Locally, it is planned for Pueblo County's District 60 and 70 school buses to be retrofit with tailpipe and crankcase control devices, which have been effective in reducing in-cabin pollution concentrations (Trenbath 2008).

Idling Regulations

Pueblo County does not currently have extended idling laws for trucks or buses. The only areas that have idling laws in Colorado are the City of Aspen and the City/County of Denver (ATRI 2008). The allowed idling times are five minutes and 10 minutes within a one hour period, respectively (Table 3). This is not even as strict as the idling law in Washington D.C. where motor coaches shall not idle for more than three minutes (EPA 2006a).

For those areas that do not have idling laws, the EPA developed a model for a state idling law that recommends owners prevent vehicle idling for greater than 30 minutes at loading/unloading locations(USEPA 2006b). The use of mobile idle reduction technologies and stationary electrified parking spaces are also encouraged.

Table 3 - Idling laws in effect for cities and counties in Colorado (ATRI 2008).

City/County	Maximum Idling Time	Penalties	Exemptions
City of Aspen	5 minutes within any hour	Fines: $1000 max and/or one year imprisonment	• Safety reasons • To achieve an engine temperature of 120°F and air pressure of 100lbs/square inch
City & County of Denver	10 minutes in any 1-hour period	Fines: not>$999 and/or one year imprisonment	• Temperature less than 20°F for previous 24 hour period, less than 10° F at any time • Emergency vehicles, traffic conditions, being serviced or auxiliary equipment

Potential Exposure in Pueblo County

The potential for exposure to diesel exhaust from idling trucks and buses is high in Pueblo County however, the extent of exposure is extremely uncertain. Variability of exposure is due to numerous factors such as the type and year of vehicle, which were previously mentioned. Weather conditions will also influence exposure. Individuals, especially children or those with existing respiratory conditions that are near idling vehicles may be more susceptible. It is recommended that the levels of particulate matter and nitrogen oxides as well as the idling time periods are monitored at locations where extended idling is suspected in order to accurately understand the exposure potential.

INDUSTRIAL EMISSIONS

Sources

There are numerous facilities in Pueblo County that release emissions via various media including fugitive air (nonpoint air emissions), stack air (point air emissions), and direct water releases (discharges to receiving water bodies). As of 2005, the facilities in Pueblo County reporting releases and their respective industries include:

- Air Products and Chemicals Inc. – industrial organic chemicals
- CF&I Steel, L.P. DBA Rocky Mountain Steel Mills CF – steel works, blast furnaces (including coke ovens) and rolling mills

- Davis Wire Pueblo Corp. – steel wiredrawing and steel nails and spikes
- Eldorado Stone LLC Pueblo Facility – concrete products except for block and brick
- Flexible Foam Products Inc. – plastics, foam products
- Goodrich Carbon Operations – aircraft parts and auxiliary equipment
- Harso Heckett Multiservice Plant 67 – minerals and earths, ground or otherwise treated
- Interstate Chemical Co Inc. – chemicals and allied products
- Pueblo East – chemicals and allied products
- Safety-Kleen Systems – business services
- Trane Co. – air conditioning and warm air heating equipment
- Xcel Energy Comanche Station – electric services

In order to determine which industrial emissions posed the greatest risk of exposure in Pueblo, the EPA Risk Screening Environmental Indicators (RSEI) software was used. This software uses risk concepts to screen large amounts of Toxics Release Inventory (TRI) data, which is publicly available information on toxic chemical releases reported annually by certain industries and federal facilities. Risk-related results were generated by RSEI by considering the chemical release, its toxicity, environmental fate and transport, exposure assumptions and the number of people exposed. Each risk score is a unitless value only useful when compared with other values.

When all forms of industrial emissions were considered including fugitive air, stack air and direct water releases, manganese and manganese compounds contributed the most to risk in Pueblo County in 2005 (Figure 6). Manganese and manganese compounds from Rocky Mountain Steel Mills accounted for approximately 75% of the total risk with 47% from fugitive air releases and 28% from stack air releases.

MANGANESE

Sources of Manganese

While manganese is naturally ubiquitous in the environment and is found in low levels in water, air, soil and food, it is also released from steel mills as it is used in steel production to improve hardness, stiffness and strength. It is also used in carbon steel, stainless steel, and high-temperature steel, along with cast iron and super alloys (EPA 2000).

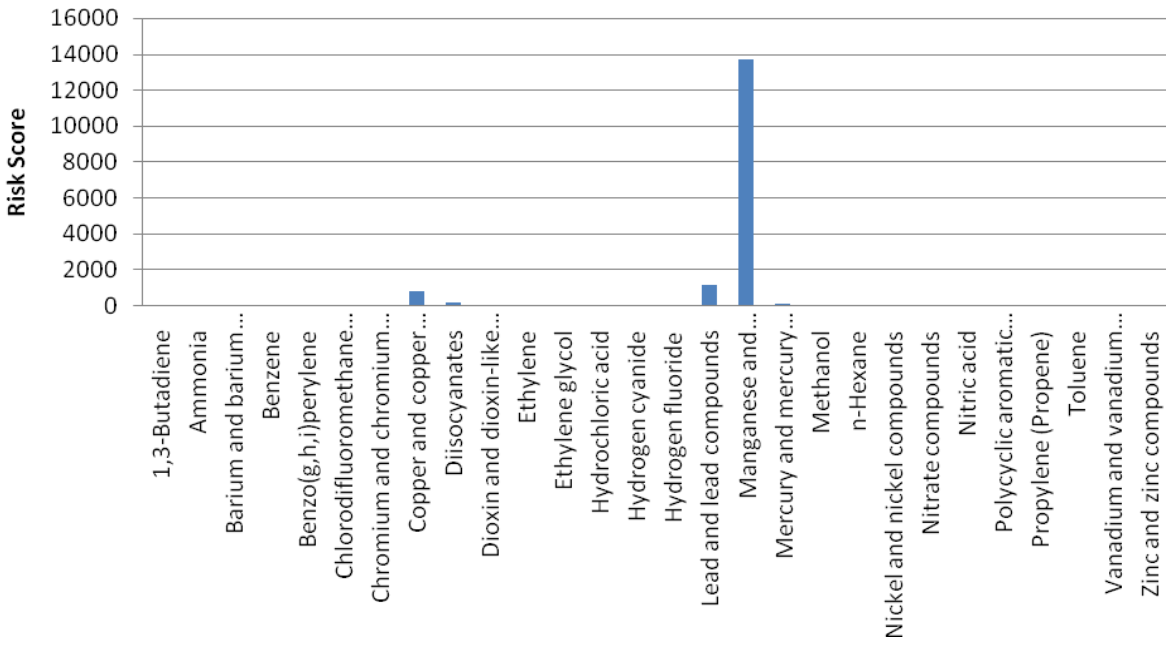

Figure 6 - Risk-related results for industrial emissions in Pueblo County in 2005.

Health effects

Low levels of manganese in the diet are nutritionally essential in humans. Long-term exposure to high levels of manganese, mainly through inhalation and ingestion of contaminated soil, can affect the nervous system causing:

- Slowed visual reaction time
- Poor hand steadiness
- Impaired eye-hand coordination

A syndrome called manganism may result from long-term exposure to higher levels. Manganism is characterized by:

- Feelings of weakness and lethargy
- Tremors
- Mask-like face
- Psychological disturbances.

The severe nervous system effects have mostly been observed in workers with long-term exposure to manganese fumes and dusts in industrial settings, in which the levels of manganese were much greater than that of outdoor air (CDPHE 2003). Respiratory effects can also result from long-term exposure through inhalation. It is important to note that the EPA has classified manganese as a Group D, not classifiable as to carcinogenicity in humans. No studies are

available regarding carcinogenic effects in humans or animals from inhalation exposure to manganese.

Regulations

Air pollution is most effectively regulated by category of industry as opposed to regulating each chemical that is released. EPA achieves this type of regulation by requiring industries to follow pollution prevention management practices where a performance level is determined for each type of industry based on a technology or other practices that have proven to result in lower emissions. An operating permit is required for all stationary sources that emit or have the potential to emit (CDPHE 2008a):

- more than 100 tons of any regulated air pollutant per year
- more than 10 tons per year of a hazardous air pollutant, or
- more than 25 tons per year of a combination of hazardous air pollutants

These permits specify the air pollution control obligations of the sources and contain monitoring, record keeping, and reporting requirements so that compliance can be monitored by the source (CDPHE 2008a). Owners of the source must certify that the source is in compliance each year, and the permits must be renewed every five years wherein performance tests are conducted to demonstrate compliance with emissions limitations. According to Nancy Chick (CDPHE, personal comm. 22 October 2008), sources only have to report emissions for specific pollutants, like manganese, if they are above certain thresholds.

Rocky Mountain Steel Mills, the main contributor of manganese emissions in Pueblo County, is a major stationary source because it has the potential to emit greater than 250 tons per year of PM10, nitrogen oxides, sulfur dioxide, volatile organic carbons, and carbon monoxide. There are no direct standards for manganese, however, manganese and other HAP emissions are indirectly controlled through limiting the level of particulate matter allowed to be emitted from the stacks of the mills (0.0052 grains per dry standard cubic foot is maximum level). Particulate matter, sulfur dioxide, nitrogen oxides, volatile organic compounds, carbon monoxide, and lead are controlled with emission capture and control systems (CDPHE permit). The emissions of these chemicals cannot exceed limitations specified in the permit. The only pollutants continuously monitored are opacity, carbon monoxide, nitrogen oxides, and sulfur dioxide. Manganese was only monitored during an initial source compliance test as well as during pre-construction and post-construction ambient air quality monitoring.

Potential Exposure in Pueblo County

In 1999, the EPA National Air Toxics Assessment program estimated the ambient concentrations of hazardous pollutants across the nation. The concentration of manganese compounds in the air

in Pueblo County was estimated to be higher than other counties in Colorado and was within the 90th percentile of highest concentrations in the United States (Figure 7).

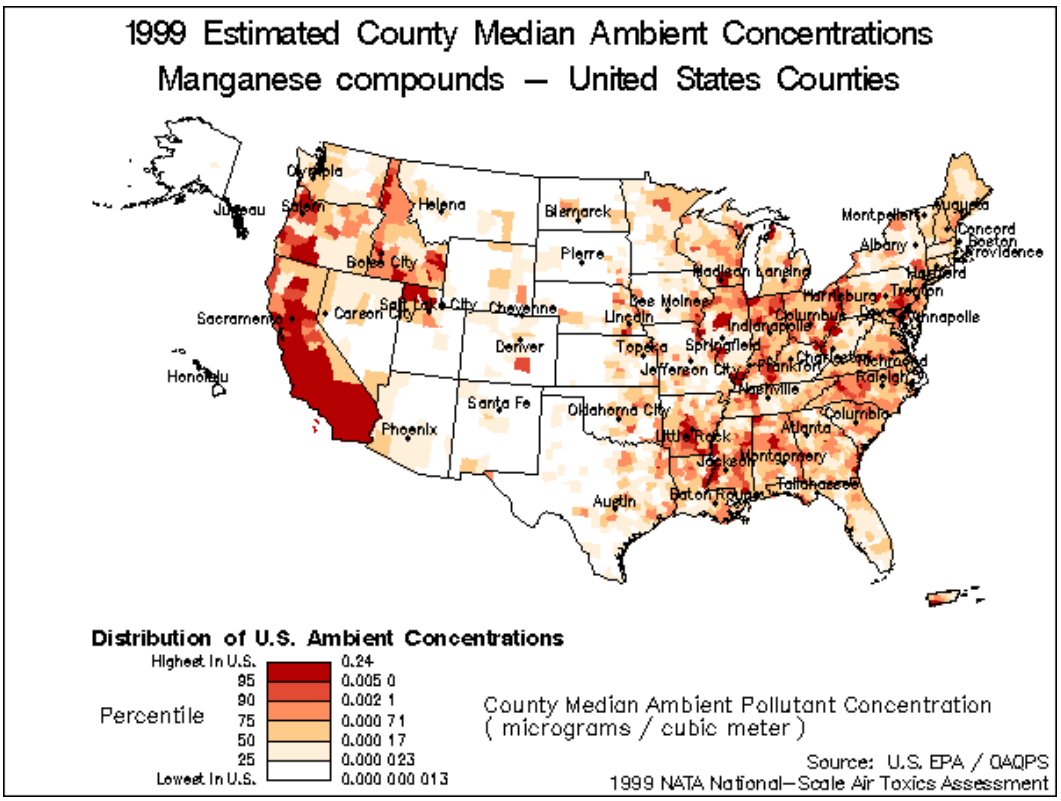

Figure 7 - Estimated median ambient concentrations of manganese compounds by county in the United States in 1999 (EPA 2008d).

Further confirming this estimation, CDPHE (2003) reported that in 2002 ambient metal concentrations at monitoring sites near the Rocky Mountain Steel Mill were near non-detect levels except for lead and manganese. Ambient concentrations of manganese in Pueblo County were higher than typical national urban levels. Furthermore, the concentrations exceeded those in other areas of Colorado, most likely due to the close proximity of the samples sites to the source. The samples were taken from two separate sites: Fulton Heights (1411 Santa Rosa) and Jeannie's Dance Studio (1141 South Santa Fe Avenue) from May to December, and September to December, respectively. The average concentrations were 0.0783 $\mu g/m^3$ at Fulton Heights and 0.0595 $\mu g/m^3$ at the dance studio (CDPHE 2003). To put these values in perspective, both are slightly above the Reference Concentration (RfC) of 0.00005 mg/m^3 (0.05 $\mu g/m^3$). At exposures greater than the RfC , the potential for adverse health effects increases. However, this value is lower than the Lowest Observed Adverse Effect Level (LOAEL) for manganese (0.05mg/m^3 or 50 $\mu g/m^3$) (Figure 8).

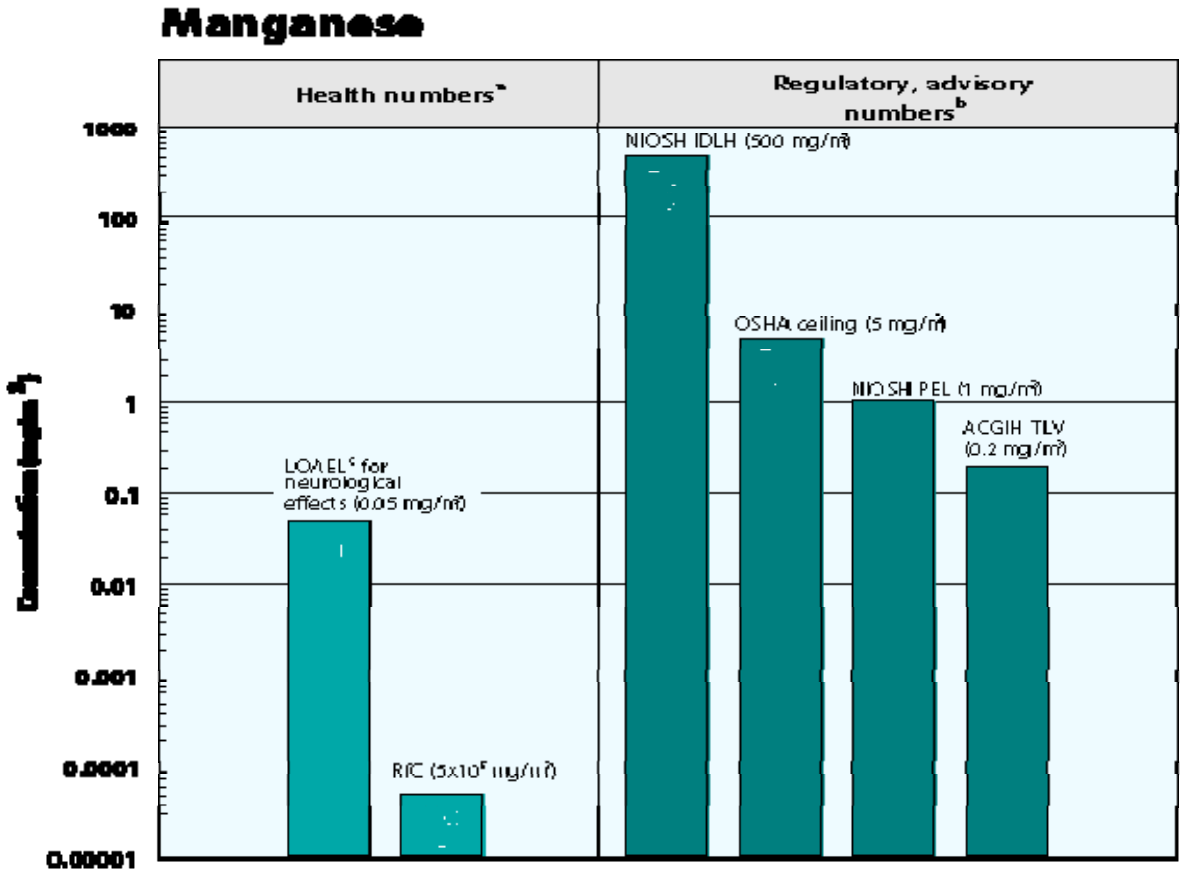

Figure 8 -Health and regulatory / advisory numbers for Manganese (EPA 2000) including Lowest-observed-adverse-effect level (LOAEL), Reference Concentration (RfC), NIOSH's immediately dangerous to life or health concentration (NIOSH IDLH), OSHA's short-term exposure limit (OSHA ceiling), National Institute of Occupational Safety and Health's recommended exposure limit (NIOSH REL), and American Conference of Governmental and Industrial Hygienists' threshold limit value (ACGIH TLV), the concentration of a substance to which most workers can be exposed without adverse effect.

Manganese levels were also measured weekly at the Rocky Mountain Steel Mills site by the Mill's contractor, Air Resource Specialists (Gordon Pierce, CDPHE, personal comm., 8 September 2008). From September 2006 to May 2008, the measured manganese levels have been extremely variable and therefore a trend is not apparent (Table 4). CDPHE (2003) mentions that the levels measured at the steel mill are much higher than the levels measured at the residential sites because the Rocky Mountain Steel Mills sampling site is much closer to the plant and lacks vegetative and paved ground cover. The potential for exposure exists especially for those living near the steel mill but there is a great amount of uncertainty regarding the possibility of effects. Lifetime exposure above the RfC does not imply that an adverse health effect will necessarily occur. The risk of exposure to individuals in other areas of Pueblo County is somewhat uncertain. Additional air monitoring in residential areas throughout Pueblo County

is recommended to more accurately understand the current exposure potential for all areas of the county.

Table 4- Ambient manganese concentrations at the Rocky Mountain Steel Mill from September 2006 to May 2008. Samples were collected weekly by Air Resource Specialists. The data was provided by Nancy Chick, Environmental Protection Specialist, Air Pollution Control Division, CDPHE.

Sampling Month and Year	Number of Samples	Average Concentration ($\mu g/m^3$)	Minimum Concentration ($\mu g/m^3$)	Maximum Concentration ($\mu g/m^3$)
September 2006	5	0.2927	0.1000	0.5283
October 2006	5	0.2162	0.0709	0.4432
November 2006	4	0.3434	0.1355	0.5745
December 2006	6	0.2322	0.0623	0.3660
January 2007	5	0.5351	0.1862	1.0069
February 2007	4	0.4631	0.1594	0.7771
March 2007	6	0.3268	0.1731	0.4944
April 2007	4	0.1427	0.0827	0.2705
May 2007	5	0.1699	0.1126	0.2591
June 2007	5	0.3219	0.1430	0.4448
July 2007	5	0.2939	0.0980	0.5556
August 2007	5	0.3356	0.2087	0.6126
September 2007	5	0.2675	0.0859	0.4247
October 2007	5	0.2923	0.0916	0.4792
November 2007	5	0.5380	0.2890	1.0097
December 2007	5	0.2887	0.0592	0.6623
January 2008	6	0.3106	0.1315	0.5068
February 2008	4	0.5218	0.3975	0.6733
March 2008	6	0.5393	0.3529	0.7408
April 2008	5	0.5425	0.2836	0.9666
May 2008	5	0.4890	0.2290	1.0592

FLY ASH

Sources of Fly Ash

Fly ash is a coal combustion product that is produced at power generation facilities but is no longer considered an industrial emission. Historically it was released into the atmosphere through the smoke stack but it is now mandated that it is captured prior to release. Following capture the fly ash is stored on site at the facility landfill however a portion of the ash can be reused in various applications including as an additive to concrete, road base, embankments and flowable fill.

Health Effects

Fly ash can contain trace concentrations of heavy metals. These concentrations depend on the source and makeup of the coal being burned. The concentrations of naturally occurring elements found in many fly ashes are similar to those found in naturally occurring soil (EPA 2005a) and are thus not believed to have significant effects on environmental and human health. Mercury, a possible contaminant, is very stable in coal fly ash and leaches less than 1% of initial concentrations (EPA 2005a). The EPA does not classify coal ash as hazardous waste. Furthermore, the United States Geological Survey (USGS) (1997) adds that radioactive elements in fly ash are not a concern since the radioactivity of typical fly ash is not significantly different from that of more conventional concrete additives. Also, there is little potential for fly ash to accumulate in soil and increase in concentration through the food chain.

Though fly ash does not present significant risk to human health or the environment, the EPA (2005a) acknowledges that there are occupational issues associated with the handling of fly ash in which the ash could be ingested, inhaled or brought into contact with the skin. These issues include:

- Handling dry coal ash prior to or during its inclusion in a concrete mix
- Exposure (primarily inhalation) during demolition of concrete structures
- Exposure (primarily inhalation) during storage and processing of ash

The process of fly ash handling and on-site disposal must follow several control measures to minimize fugitive particulate emissions (CDPHE 2005b) which can impact the public as well as the environment. These control measures include:

- Haul roads should be graveled or have a hard bottom ash surface
- Haul roads should be watered
- Vehicle speed shall not exceed 10 miles per hour
- Haul trucks shall be enclosed with fixed solid tops
- Water shall be applied to the clay liner during construction for compaction
- The disposal area shall be watered after each layer of fly ash is deposited and spread and as further necessary
- Topsoil revegetation shall take place as soon after stockpiling as practical

Also to minimize occupational exposure, it is recommended that workers:

- Clean work areas by wet sweeping or vacuuming
- Wear basic personal protection such as goggles
- Use standard dust filters on vehicles and silos
- Use mechanical ventilation or extraction where dust could escape into the work environment

- Use closed pumping for bulk deliveries

Disposal at Facility Site Landfill in Pueblo County

Regulations

Colorado is a state that exempts certain on-site coal combustion waste landfills from state solid waste permitting requirements. Therefore, Colorado law authorizes each local government to plan for and regulate the use of land within its respective jurisdiction. Special Use Permits are typically required for large-scale industrial projects such as power plants (DOE 2006).

The Xcel Energy Comanche Power Plant produces fly ash via combustion of its primary energy source, sub bituminous coal (DOE 2006). Fly ash is unloaded from the storage silos and trucked to the Mobile Ash Conditioning System (MACS). The fly ash is deposited in the main hopper of the MACS where it is thoroughly mixed with controlled portions of water (Joyce 2004). The conditioned ash is stockpiled for use or placed in compacted lifts in the landfill, which is approximately 250 acres. According to the CDPHE Operating Permit (CDPHE 2005a), the amount of fly ash disposed of cannot exceed the limitation of 141,600 tons/year.

Use in Construction Applications in Pueblo County

EPA (2005) notes that using fly ash in construction projects is beneficial since one ton of fly ash used as a replacement for cement conserves enough landfill space to hold about 1200 pounds of waste. In Pueblo, bottom ash is hauled to the landfill from the Public Service of Colorado bottom ash basin and rock is hauled in from off-site. The conditioned ash (which was mixed with water), bottom ash and sometimes rock are blended and screened to create road base. Finally, the road base is loaded and hauled off-site as product (Joyce 2004).

To minimize exposure to the environment when using construction materials containing fly ash, the EPA advises that Highway engineers should conduct an evaluation of local groundwater conditions (possibly using groundwater models), consult with the state regulatory agency about test procedures, and mitigate leaching by assuring daily compaction and grading to promote surface water runoff, and daily proof rolling of the finished sub grade to impede infiltration.

Provided that the proper procedures are followed for fly ash handling and disposal as well as in the applications of fly ash, the exposure to humans and the environment in Pueblo County is expected to be minimal.

POTENTIAL WATER EXPOSURES IN PUEBLO COUNTY

MERCURY IN LOCAL WATER BODIES

Mercury is often a contaminant of concern. It is a naturally occurring element that is found in air, water, and soil, and exists in several forms: elemental or metallic mercury, inorganic mercury compounds, and organic mercury compounds. It is also found in rocks including coal.

Anthropogenic Sources

Approximately 80% of the mercury released from human activities is released to the air, primarily from fossil fuel combustion from coal-burning power plants, mining, smelting, and solid waste incineration (ATSDR 1999a). The largest human-caused source of mercury emissions to the air in the United States is coal-burning power plants, which contribute to about 40% of all human-related emissions. Other potential emission sources include copper and zinc smelting operations, metal production, fires at waste disposal sites and diffuse emissions from various anthropogenic sources (ATSDR 1999a). Mercury in the air eventually settles into water or onto land where it can be washed into water. Once deposited, certain microorganisms can change it into methyl mercury, a highly toxic form that builds up in fish, shellfish and animals that eat fish.

Health Effects

Humans are primarily exposed to mercury when they eat fish from contaminated bodies of water. The EPA notes that most people's fish consumption does not cause a health concern, however, high levels of methyl mercury in the bloodstream of unborn babies and young children may harm the developing nervous system, impairing the child's ability to think and learn. Furthermore, mercury exposure at high levels can potentially harm the brain, heart, kidneys, lungs, and immune system of people of all ages. High levels of mercury are more likely to occur in individuals with chronic exposure to contaminated fish, as in the case of those relying on subsistence fishing.

Regulations

The air pollution regulations are similar to that of manganese in that pollution prevention management practices are used and operating permits are required for major stationary sources. Emissions controls such as the removal of mercury switches from automotive scrap are required at iron and steel industries such as Rocky Mountain Steel Mills during scrap selection and inspection (EPA 7 February 2008). Furthermore certain industries such as the Xcel Energy Comanche Plant have mercury requirements listed in their operating permit (Nancy Chick, CDPHE, personal comm. 22 October 2008).

The Colorado soil cleanup standard for mercury is 17.66ppm (Diawara *et al*. 2006). The Colorado Department of Public Health and Environment has an action level of 0.5 milligrams

(mg) mercury per kilogram (kg) of fish. When this level in fish is reached, restrictions are issued on fish consumption.

Potential Exposure in Pueblo County

While ingestion of aquatic organisms is the primary route of human exposure, local ambient air concentrations were evaluated as well. Following analysis using the RSEI software, it was determined that Pueblo County ranks higher than any other county in Colorado for mercury releases via stack air. Approximately 422lbs of mercury and mercury compounds were released into the air in Pueblo County in 2005 (Figure 9) from Rocky Mountain Steel Mills and Xcel Energy, and from 2000 to 2005 the release amounts of mercury via stack air were fairly consistent. This amount and type of release in addition to other factors such as toxicity, environmental fate and transport, and nearby population caused Pueblo County to have the highest relative risk of all Colorado counties releasing mercury via stack air in 2005 (Figure 10). It is important to note that, as mentioned previously, out of all industrial emissions in Pueblo County, manganese emissions contribute more to risk than mercury.

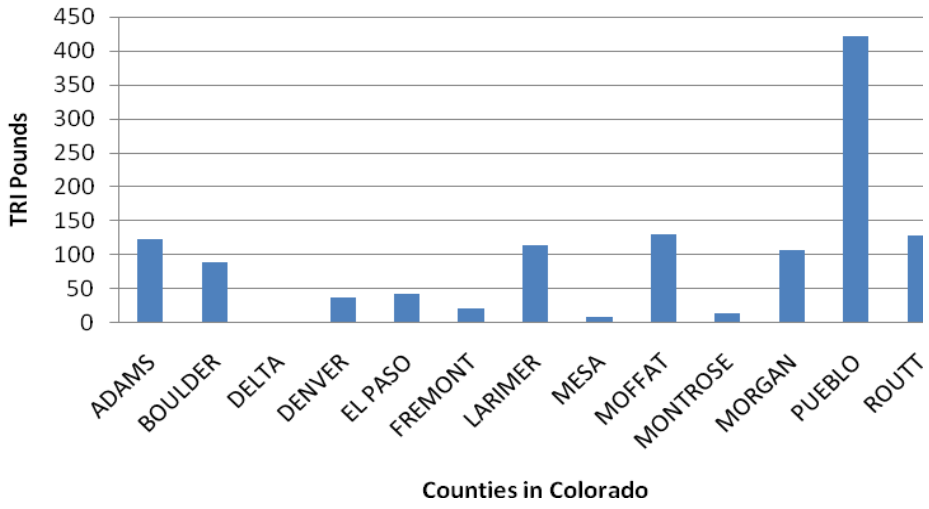

Figure 9 - Amount of mercury and mercury compounds released via stack air for each county in Colorado in 2005. Total pounds based on Toxics Release Inventory (TRI) data.

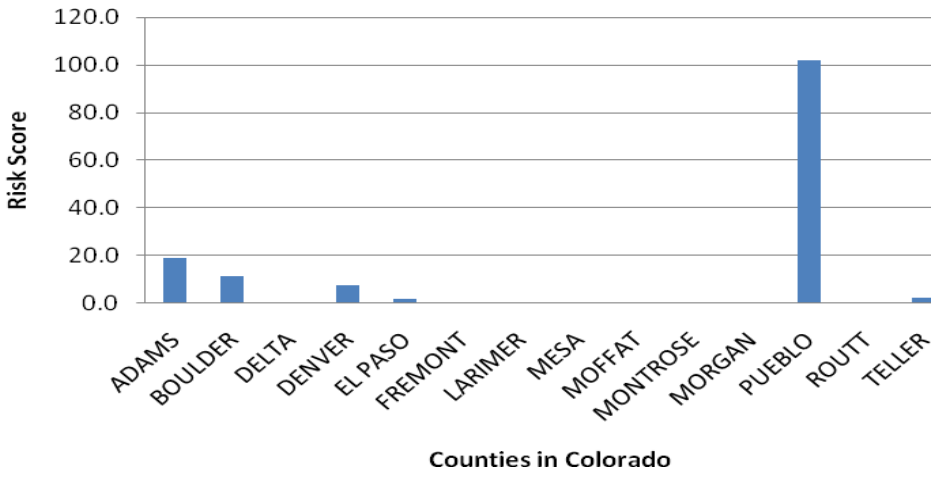

Figure 10 - Risk-related results for stack air releases of mercury and mercury compounds for each county in Colorado in 2005.

Little information is available regarding ambient mercury concentrations in the air in Pueblo County. The EPA National Air Toxics Assessment program estimated ambient mercury concentrations for the entire United States in 1999. Pueblo County was predicted to have greater ambient concentrations than most of Colorado and was within the 75th percentile of highest concentrations in the nation (Figure 11). It should be noted however, that the EPA assigned a lower confidence to these results.

Though ambient air concentrations may be relatively higher in Pueblo County, it is important to consider topsoil deposition and transport to local water bodies since human exposure to mercury primarily occurs via ingestion of aquatic organisms. Diawara *et al.* (2006) reported that mercury topsoil concentrations in the city of Pueblo varied from 0.01ppm to 2.45ppm (Figure 12) with the mean concentration equaling 0.12ppm. These concentrations were within baseline ranges and were also well below the Colorado soil cleanup standard of 17.66ppm. It is important to note that the results were only for the City of Pueblo and that the entire Pueblo County was not considered. Elevated levels of mercury in the topsoil may exist in other locations of Pueblo County and may eventually be transported into local water bodies where, as stated previously, it can be converted into the most readily bioavailable form, methyl mercury.

In 2005, CDPHE tested fish in the Pueblo Reservoir for mercury. The levels were substantially below the action level of 0.5mg/kg (Machado 2005). As of 2006, no fish consumption advisories have been issued for Pueblo County. The nearest advisory issued was for Brush Hollow Reservoir however this is not within Pueblo County. The small amount of mercury detected in the soils and fish in Pueblo may be due to the fact that metallic mercury released in vapor form to the atmosphere can be transported long distances before it is converted to other forms of mercury where it is finally deposited on land and water surfaces (ATSDR 1999a). Consequently mercury released into the air in Pueblo County may not be deposited locally.

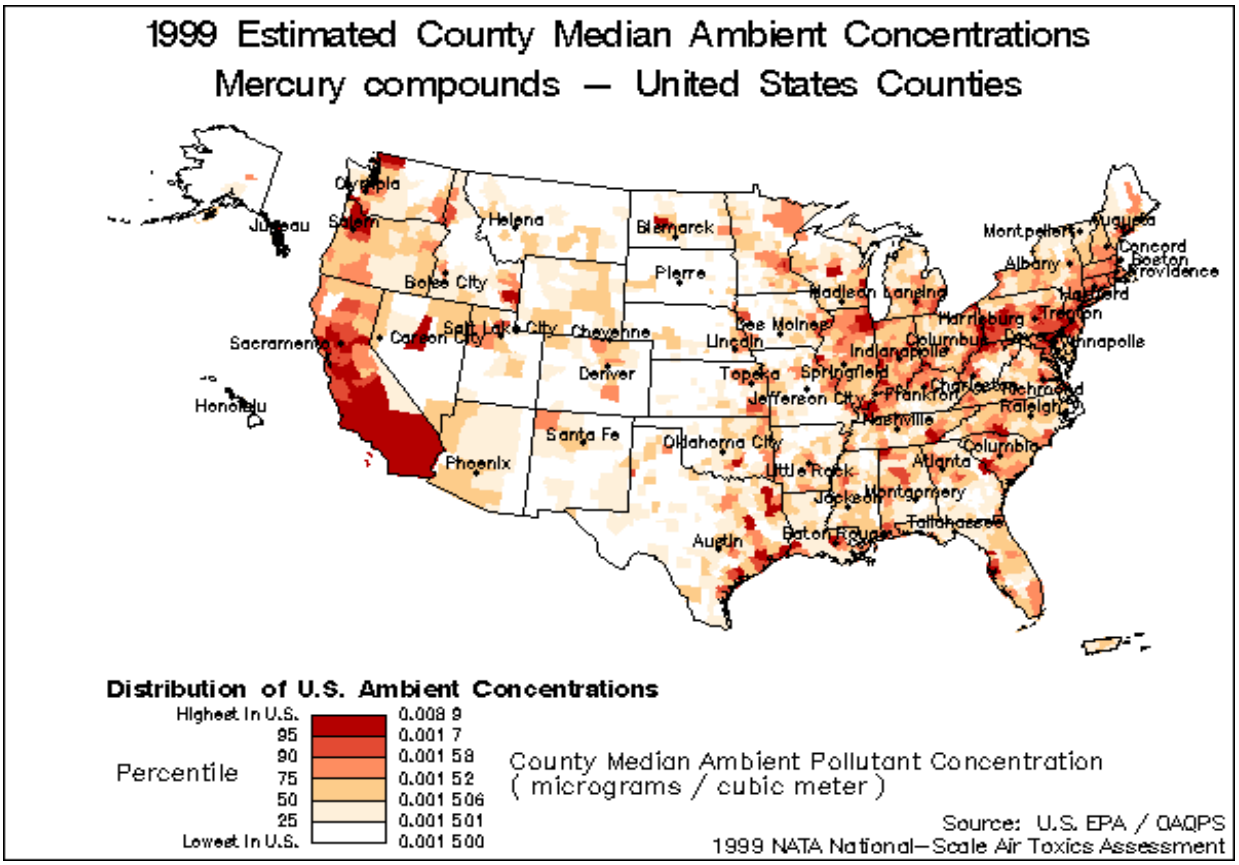

Figure 11 - Estimated median ambient concentrations of mercury compounds by county in the United States in 1999 (EPA 2008d).

Overall, the potential for exposure of individuals in Pueblo County to mercury exists, mostly for those who rely on subsistence fishing; however the extent of exposure is unknown. Some uncertainty remains regarding contamination of fish in water bodies other than the Pueblo Reservoir as well as soil and sediment concentrations in all of Pueblo County. Also, the number of families relying on subsistence fishing is unknown. Additional monitoring, especially of mercury levels in fish and shellfish in local water bodies, is necessary to determine the extent of exposure.

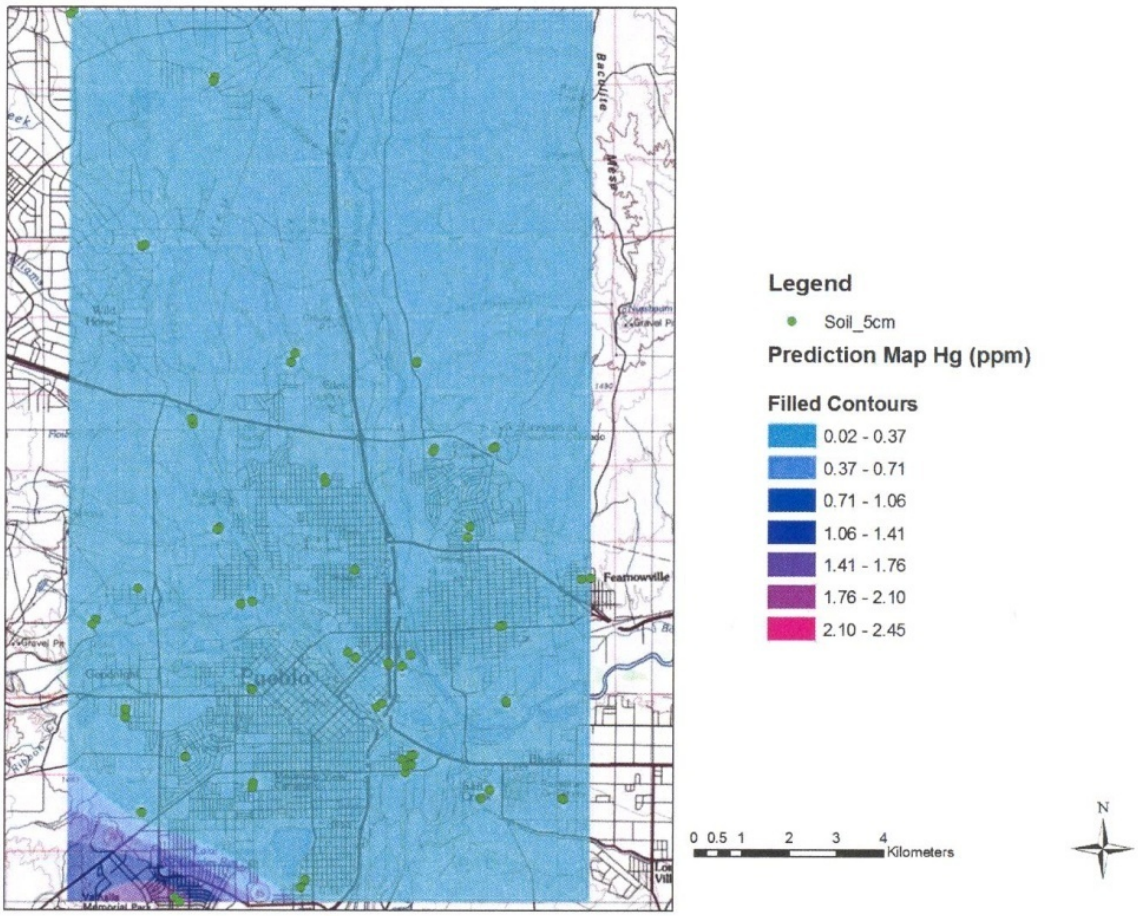

Figure 12 - Exploratory spatial prediction map of mercury concentrations in the topsoil in Pueblo, Colorado (Diawara et al. 2006).

PATHOGENS IN FOUNTAIN CREEK

Sources

E. coli, or *Escherichia coli*, is a type of bacteria normally found in the intestinal tract and waste of humans and other warm-blooded animals, including birds. During rain, snow melts, or other types of precipitation, *E. coli* may be washed into creeks, rivers, streams, lakes, or ground water (EPA 2006a). Additionally, accidental releases of partially or untreated sewage can result in *E. coli* contamination. *E. coli* serves as an indicator organism and thus if *E. coli* is present in a creek, other disease causing organisms may be present as well.

Health Effects

Humans are typically exposed to *E. coli* and other disease causing organisms through drinking improperly treated water or swallowing water while swimming or engaging in other aquatic recreational activities. Although most strains are harmless and live in the intestines of healthy humans and animals, the strain O157:H7 produces a powerful toxin and can cause severe illness (EPA 2006c). Some of the symptoms include severe bloody diarrhea and abdominal cramps. Recovery time is approximately five to 10 days. However, some people, especially children under five and the elderly, can have complications from the infection which causes hemolytic uremic syndrome, in which the red blood cells are destroyed and kidney failure occurs. Between 3 and 5% of the cases of hemolytic uremic syndrome are fatal.

Regulations

The EPA requires public water systems to monitor for coliform bacteria. The EPA established state acute standard for recreational contact is 235 colony forming units (CFU) per 100 milliliters (mL) of water. The geometric mean standard is 126 CFU / 100mL of water.

Potential Exposure in Pueblo County

According to Scott Cowan of PCCHD (personal comm., 17 June 2008), there have been no reported cases of individuals becoming ill due to exposure to the water in Fountain Creek. Nevertheless, several releases of partially or untreated sewage from Colorado Springs Utilities into Fountain Creek have occurred in recent years. Total illegal discharges have been recorded from 1998 to 2006 (Scott Cowan, PCCHD, pers. comm., 17 June 2008). In 1999, there were 20 discharge events and over 72 million gallons were released with the maximum amount released in one event totaling more than 60 million gallons (Table 5). This event occurred May 1, 1999 and was caused by a storm. Since 1999 the frequency and amounts of illegal releases appear to be decreasing (Table 5).

Since June 2005 PCCHD has collected weekly and biweekly samples from Fountain Creek to monitor *E. coli* levels. The samples were collected from four sites which are near Pinon Bridge, CO 47 Bridge, Highway 50 Bypass and 8th Street. The trend suggests that in the summer months, the *E. coli* levels increase and exceed the acute standard for recreational contact which is 235 CFU/100mL (Figure 13).

The potential exists for exposure of individuals using the water bodies in Pueblo County to *E.coli* and other disease causing organisms in Fountain Creek, particularly during the summer months. The more sensitive groups, including children under the age of five and the elderly, are at a greater risk of more severe health effects.

Table 5 - Illegal discharges reported by Colorado Springs Utilities between 1998 and 2006. *Discharges for the total year were not reported for 1998 and 2005. Only discharges from June 23, 1998 to December 1998 and discharges from January 2005 to June 22, 2005 were reported (Scott Cowan, PCCHD, personal comm., 17 June 2008).

Year	Number of Discharges	Maximum Amount Released at One Time (gallons)	Total Released (gallons)
*1998	6	120,000	187,100
1999	20	60,230,000	72,052,156
2000	16	30,000	74,864
2001	15	300,000	632,266
2002	11	95,929	129,041
2003	9	1,200	4,054
2004	12	138,000	161,124
*2005	11	218,750	378,901
2006	6	44,400	57,170

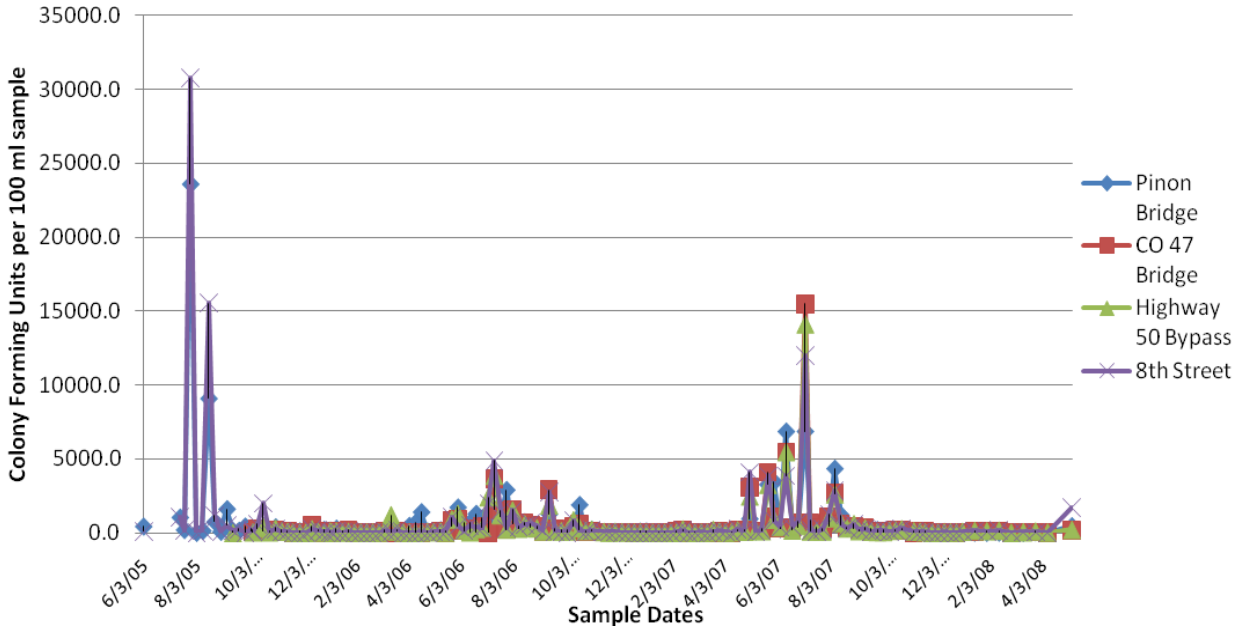

Figure 13 - *E. coli* levels, represented by colony forming units (CFU) per 100 mL of water, in Fountain Creek in Pueblo County from June 2005 to May 2008.

URANIUM / RADIUM IN DRINKING WATER WELLS

Sources

Uranium is a naturally occurring radioactive metal that occurs in low concentrations in nature. It is present in certain types of soils and rocks like granite, sedimentary rocks like shale, metamorphic rocks derived from these rocks, and phosphate deposits, minerals, and ores (ATSDR 1999b). Uranium has several different isotopes. Naturally occurring uranium contains approximately 99.27% U-238, 0.72% U-235, and 0.006% U-234 (ATSDR 1999). As the uranium decays other radionuclides are produced, including radium, which can also emit radiation. U-234 is the most radioactive but it is important to note that uranium is the only radionuclide for which the chemical toxicity has been identified to be comparable to or greater than the radiotoxicity (ATSDR 1999b).

Health Effects

Uranium and other radionuclides like radium can enter surface and groundwater through dissolving of uranium bearing minerals into the water or the release from activities like using phosphate fertilizers, mining, and combustion from coal and other fuels. When uranium is ingested while drinking water, it is deposited primarily in the bone and kidneys. Therefore, exposure to high levels of uranium can cause kidney disease and an increased risk of cancer.

Regulations

According to the 2000 Radionuclides Rule, the EPA's maximum contaminant level for uranium in public water systems is 30 micrograms per liter of water (µg/L) which corresponds to 27 picocuries per liter of water (pCi/L), or the activity of the radionuclide (EPA 2001). The EPA also established a maximum contaminant level of 5pCi/L for combined radium-226 and radium-228 in drinking water systems (ATSDR 1990a). These regulations only apply to community water systems, which are water systems with at least 15 service connections or that serve 25 or more persons year-round. The EPA is further considering a future proposal to regulate radionuclide levels in drinking water served by non-transient non-community water systems which are water systems that serve at least 25 of the same people more than six months per year, such as schools, churches, nursing homes, and factories that supply their own water.

Potential Exposure in Pueblo County

There is limited information regarding uranium levels in private wells in Pueblo County as they are not regulated. According to Jackie Whelan, the CDPHE Drinking Water Rule Manager, CDPHE records show that currently no community water system in Pueblo County exceeds the uranium maximum contaminant level for drinking water (personal comm. 28 May 2008). The Agency for Toxic Substances and Disease Registry (1999), reported results from a study conducted in 1984 in which the average uranium concentration in drinking water in Colorado

was 1.8 pCi/L. This exceedance of 1.0 pCi/L was higher than many states in the nation (Figure 14), but not the highest value. California, Nevada, Arizona, Wyoming, New Mexico, Texas and Oklahoma exceeded this value.

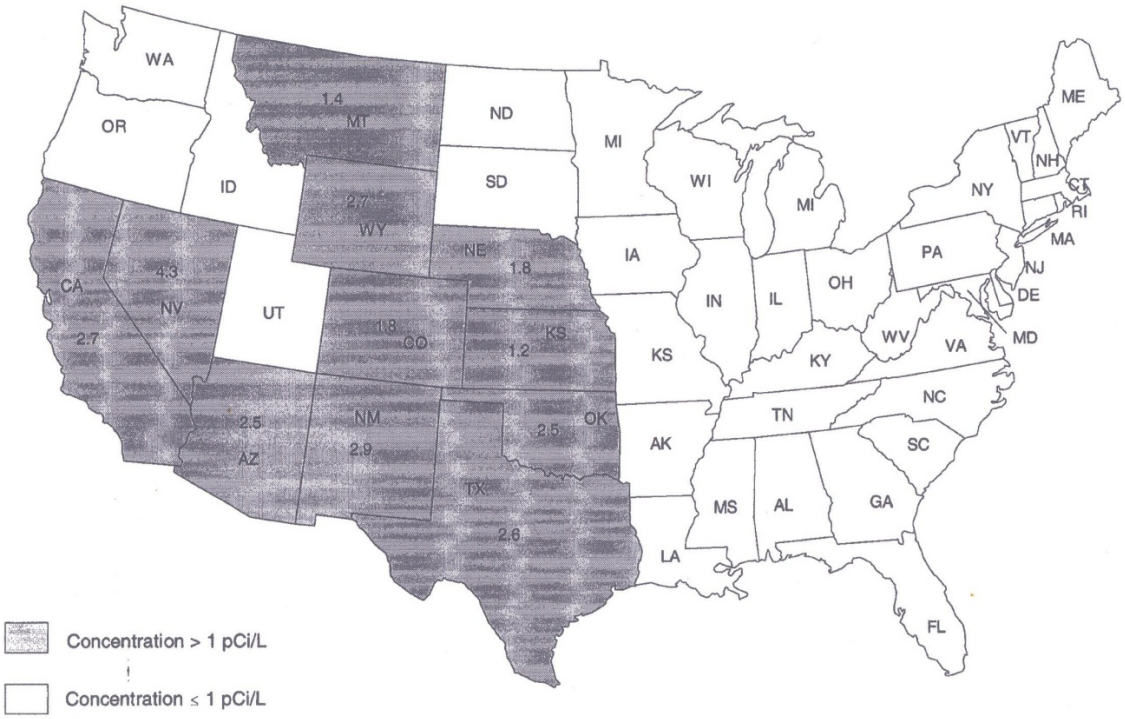

Figure 14 - Average uranium concentrations in drinking water for states where concentrations exceed 1.0 pCi/L (ATSDR 1999b).

Elevated radium levels, however, have been detected in several water systems in Colorado. About 40 drinking water systems in Colorado have had radionuclide violations (CDPHE 2008c) (Figure 15) with nearly half of the violations occurring in Otero County. Most of the water systems affected are in small, rural communities. Only one active water system in Pueblo County has had radionuclide violations in the past 10 years. Mountain Shadows Mobile Estates, located near Beulah, CO, has exceeded the maximum contaminant level for combined radium several times with concentrations ranging from 7 to 9 pCi/L (EPA 2008n). This water system serves approximately 100 people. Elevated radium levels were also detected in a town well in Rye; however, this well is not currently operational (Heather Maio, PCCHD, personal comm., 12 June 2008).

There is the potential for private wells in Pueblo County to have elevated uranium levels but the extent of exposure is unknown due to lack of data regarding concentrations in private wells. Individuals with impaired renal function may be more susceptible to health effects from long term exposure to elevated levels of uranium (HDR Engineering Inc. *et al*. 2006).

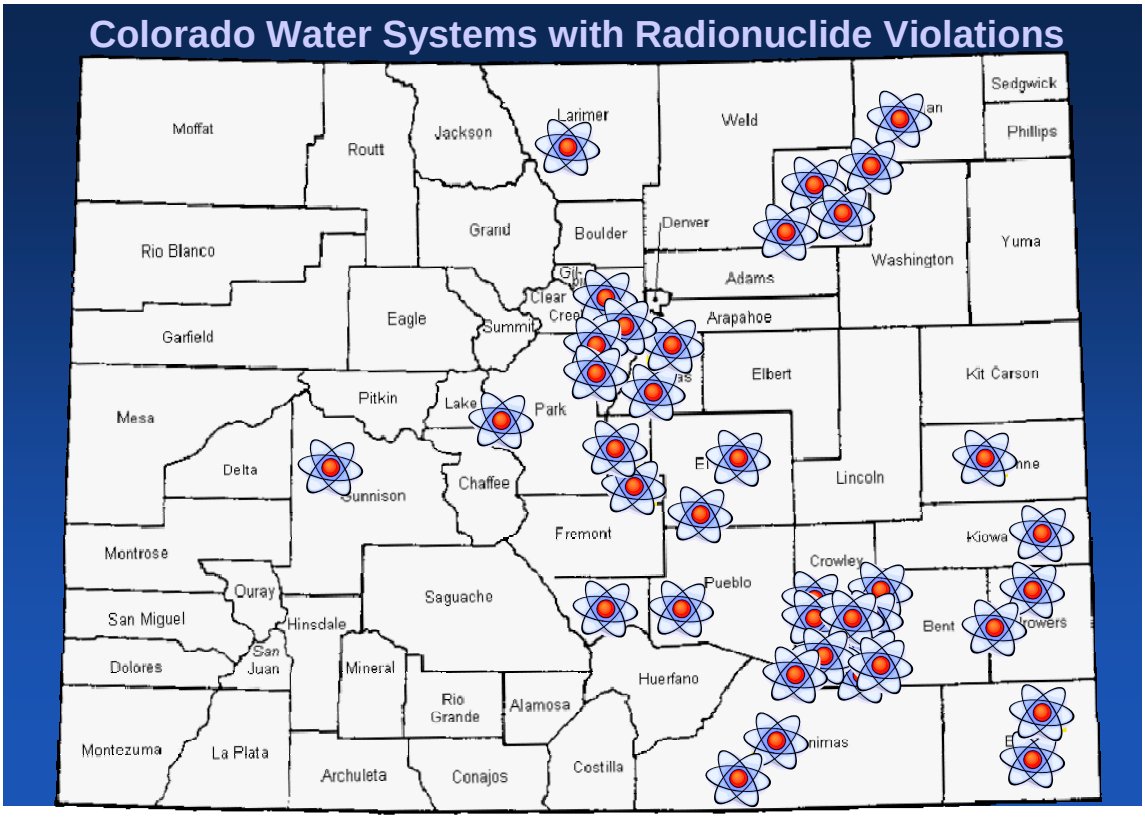

Figure 15 - Active Colorado water systems with radionuclide violations in the past 10 years (Erickson 2008).

PHARMACEUTICALS AND PERSONAL CARE PRODUCTS IN LOCAL WATER BODIES

According to the EPA (2008h), pharmaceuticals and personal care products (PPCPs) are products used by individuals for personal health or cosmetic reasons or used by agribusiness to enhance growth or health of livestock. Examples of PPCPs include (EPA 2008h):

- Prescription and over-the-counter drugs
- Veterinary drugs
- Fragrances
- Cosmetics
- Sun-screen products
- Diagnostic agents
- Nutraceuticals such as vitamins

PPCPs can enter the water systems and environment from several different sources including:

- Drug excretion – Drugs taken by individuals are not entirely absorbed by the body, and are excreted and passed into wastewater and surface water
- Disposal of drugs and other PPCPs to sewers and trash
- Agribusiness and veterinary drug use, especially antibiotics and steroids- released to the environment with animal wastes through overflow or leakage from storage structures or land applications (Kolpin *et al*. 2002)
- Bathing - fragrances, cosmetics and other PPCPs are rinsed into wastewater and surface water
- Residues from pharmaceutical manufacturing companies and hospitals

Potentially large amounts of PPCPs may enter the water systems but currently municipal sewage systems are not equipped to remove these pollutants from the water (EPA 2008h). Over 100 PPCPs have been detected at very low levels (parts per billion) in environmental samples and drinking water (Grumbles 2008, USEPA 2008), indicating that these compounds can survive wastewater treatment and biodegradation (Kolpin *et al*. 2002).

Health and Environmental Effects

As PPCPs in water is a relatively new concern, much uncertainty remains regarding effects on public health and aquatic life. Little research has been conducted to determine effects to humans with long-term exposure to extremely low levels of PPCPs. Additional concerns such as fetal exposure as well as the potential interactive effects of PPCPs still need to be investigated. Kolpin *et al*. (2002) notes that the potential exists for PPCPs to be synergistic, in which one PPCP enhances the toxic effect of another PPCP. Fish and other aquatic life are continually exposed to PPCPs in the water and may be more likely to be affected than humans.

Regulations

Though much of the PPCPs are entering water systems through natural biological functions which are not controllable, proper disposal of drugs is a necessary method to prevent additional PPCPs from entering the water systems. Government agencies are beginning to recognize the concern regarding PPCPs, specifically pharmaceuticals, and take action. In February 2007, the White House Office of National Drug Control Policy issued the first consumer guidance for proper disposal of prescription drugs (ONDCP 2007). The guidelines instruct individuals to flush prescription drugs down the toilet only if mentioned on the label or in the accompanying drug information. The following drugs are approved by the FDA to be flushed down the toilet:

- Actiq (fentanyl citrate)
- Daytrana Transdermal Patch (methylphenidate)
- Duragesic Transdermal System (fentanyl)
- OxyContin Tablets (oxycodone)
- Avinza Capsules (morphine sulfate)

- Baraclude Tablets (entecavir)
- Reyataz Capsules (atazanavir sulfate)
- Tequin Tablets (gatifloxacin)
- Zerit for Oral Solution (stavudine)
- Meperidine HCl Tablets
- Percocet (Oxycodone and Acetaminophen)
- Xyrem (Sodium Oxybate)
- Fentora (fentanyl buccal tablet)

All other drugs should be mixed with undesirable substances like coffee grounds or kitty litter, and placed in an impermeable, non-descript container like a sealable bag, prior to disposal in the trash. The EPA (Grumbles 2008) is also developing take-back programs in which individuals bring unused pharmaceuticals to a central location for proper disposal.

In addition to the disposal efforts, the EPA released the third draft Contaminant Candidate List (CCL 3) for public review in February 2008. The purpose of the CCL 3 is to identify contaminants known or anticipated to occur in public water systems that may require regulations under the Safe Drinking Water Act (EPA 21 February 2008). The EPA considered 287 chemicals identified as PPCPs but only Nitroglycerin, used for the treatment of angina, was included in the draft CCL 3. Nitroglycerin was selected based on its high toxicity and occurrence in higher levels in the water. The other contaminants were rejected since they occurred at levels extremely below those known to cause adverse health effects (EPA 21 February 2008, Grumbles 2008). Since there is much uncertainty regarding human health effects from low-level exposure, the EPA is requesting additional data on concentrations of PPCPs in finished water.

Potential Exposure in Pueblo County

Between 1999 and 2000, Kolpin *et al*. (2002) analyzed water samples from streams in 30 states for pharmaceuticals, hormones and other wastewater contaminants. The samples were taken downstream of intense urbanization and livestock production areas where streams were considered to be most susceptible to contamination. Approximately 80% of the streams sampled had at least one PPCP contaminant. The chemical groups most frequently detected were steroids, nonprescription drugs, and insect repellant while the groups having the highest concentrations were detergent metabolites, steroids, and plasticizers (Kolpin *et al*. 2002). The most frequently detected contaminants, which were present in more than half of the sampled streams, included:

- Coprostanol (fecal steroid)
- Cholesterol (plant and animal steroid)
- N-N-diethyltoluamide (insect repellent)
- Caffeine (stimulant)

- Triclosan (antimicrobial disinfectant)
- Tri (2-chloroethyl) phosphate (fire retardant)
- 4-nonylphenol (nonionic detergent metabolite)

The South Platte River was the only site analyzed in Colorado. The sample was taken from the river above Clear Creek near Commerce, Colorado. Several contaminants, including antibiotics, pharmaceuticals, organic compounds, and steroids, were detectable at very low levels in the South Platte River sample (Table 6). None of the contaminants exceeded aquatic life criteria levels (LC50, or concentration that causes death in 50% of test organisms). The Maximum Contaminant Level (MCL), the highest level of a contaminant that is allowed in drinking water, was not known for any of the contaminants. Most of the contaminants analyzed in the study do not have any guidelines or criteria determined yet. As mentioned previously, little is known about human health and environmental effects resulting from long-term exposure to extremely low levels of PPCPs.

More recently, Colorado Springs Utilities in Colorado Springs, CO submitted water samples to be analyzed for 24 different PPCPs. Thirteen of the 24 PPCPs were detected in concentrations of parts per thousand and include: Atrazine, Caffeine, Carbamazepine, DEET, Diazepam, Estriol, Fluoxetine, Meprobamate, Methadone, Oxybenzone, Sulfamethoxazole, Testosterone, and Trimethoprim (Newsome 2008). Of these, atrazine is the only compound for which there is currently an MCL. The amount of atrazine detected in Colorado Springs water was 1,000 times below the MCL (Colorado Springs Utilities 2008). Colorado Springs Utilities insists that the trace amounts detected do not necessarily indicate a problem since research has not yet linked trace amounts of PPCPs to adverse human health effects.

Unfortunately, the Kolpin *et al*. 2002 study and the Colorado Springs Utilities study are currently the only studies targeting PPCPs in Colorado (Bob Benson, EPA, personal comm. 18 July 2008). Therefore, the level of exposure to PPCPs in Pueblo County is unknown at this time. Since Pueblo County has areas with high urbanization and livestock production, the possibility exists for PPCPs to be present in the local water systems. The probability of exposure as well as human health and environmental effects of PPCPs will continue to remain unknown until additional studies are conducted.

Table 6 - Pharmaceuticals and other wastewater contaminants detected in the South Platte River near Commerce, CO in 1999-2000 (Barnes *et al*. 2002). Contaminants whose concentrations were estimated or less than the detectable limit are not included. LC50 is the concentration of a compound that causes lethality in at least 50% of the test population. Test organisms noted when available.

Contaminant Group	Contaminant Name	Contaminant Description	Concentration Detected (µg/L)	Aquatic Life Criteria - LC50 (µg/L)
Antibiotic compounds	Erythromycin-H_20	Erythromycin metabolite	1.7	665,000
	Sulfamethoxazole	antibiotic	1.1	Not available
	Trimethroprim	antibiotic	0.71	3,000 (rainbow trout)
Human Pharmaceutical Compounds	Cotinine	Nicotine metabolite	0.9	Not available
	Diltiazem	Antihypertensive (prescription drug)	0.049	Not available
	1,7-Dimethylxanthine	Caffeine metabolite	0.053	Not available
	Gemifibrozil	antihyperlipidemic	0.79	Not available
Organic Wastewater Compounds	Caffeine	stimulant	0.37	40,000 (fathead minnow)
	Ethanol, 2-butoxyphosphate	plasticizer	5.4	104,000 (fathead minnow)
	Triclosan	Antimicrobial disinfectant	2.3	180 (fathead minnow)
	Tri (2chloroethylphophate)	Fire retardant	0.54	66,000
Steroid and Hormone Compounds	Cholesterol	Plant/animal steroid	12.8	Not available
	Coprostanol	Fecal steroid	9.8	Not available

STORMWATER RUNOFF

Stormwater runoff is the most common cause of water pollution and is defined as the water that originates during precipitation events (rainfall and snowmelt) or from overwatering. As the runoff moves over or though the ground it can potentially transport pollutants to the receiving water bodies. There are several sources of stormwater pollution, including:

- Industrial facilities – Spills during loading, unloading or storage of materials as well as vehicle maintenance or fueling can release toxic chemicals and petroleum hydrocarbons (CDPHE 2007a). Uncontained process water can also release chemicals and other pollutants.

- Construction sites – Activities like grading exposes the underlying soil, allowing sediment to be washed away. In fact, sediment runoff rates from construction sites are typically 1,000 to 2,000 times greater than those from forest lands (CDPHE 2007a). Also, spills and vehicle maintenance can release fuel, oil and grease, and nutrients (like phosphorous and nitrogen) and other chemicals can be released from use of fertilizers, pesticides, and herbicides.

- Agricultural areas – Activities such as animal feeding operations can have excess manure which causes a release of excess nutrients and pathogens to the water (EPA 2005b). Overgrazing of animals and overplowing can increase erosion and sedimentation. The application of fertilizer, pesticides, and herbicides release nutrients and various chemicals and metals into the water. Excessive irrigation can help to transport these pollutants. In dry climates, evaporation of irrigation water can concentrate salts in the soils which are then washed away by stormwater (EPA 2005b).

- Urban areas – Runoff from urbanized areas is one of the leading sources of water pollution in estuaries and lakes (EPA 2003) as it can be contaminated with a variety of pollutants from numerous activities. Applying fertilizers, pesticides and herbicides to residential lawns and gardens can release chemicals and nutrients. Leaky sanitary sewer lines, septic systems and pet waste can release harmful pathogens (EPA 1999). Roads, driveways and parking lots may release road salts, oil and grease from car engines and spills, or heavy metals from car exhaust, worn tires, engine parts, brake linings, paint and rust. Increased amounts of stormwater runoff due to increased impervious surfaces can cause instability and stream bank erosion. The erosion can release sediment to the water. Finally, streets and rooftops often release water that is a higher temperature than that of the natural water.

Environmental and Human Health Effects

Aquatic systems are most susceptible to stormwater runoff. Excess sediment can kill aquatic plants by limiting sunlight, clog the gills of fish, and smother fish larvae (EPA 2005b). Other

pollutants can attach to the soil particles, increasing the amount of pollutants introduced to the water bodies. A surplus of nutrients like nitrogen and phosphorous can also be harmful. These nutrients can cause algal blooms which can eventually lead to oxygen depletion when the algae decomposes, killing aquatic organisms (EPA 1999). When introduced into a natural water body, stormwater having a higher temperature can contain less oxygen while also increasing the demand for oxygen (EPA 1999). This scenario may result in death of aquatic organisms. Heavy metals and chemicals like fuel and pesticides can be toxic to aquatic organisms and harmful to humans as well. Pathogens, such as *E. coli* and other disease-causing organisms, can also be harmful to humans.

Regulations and Prevention

Construction projects larger than one acre and industrial facilities with materials or activities exposed to stormwater must obtain a water quality permit and follow the guidelines mentioned in the permit. If the discharger does not obtain a permit they are in violation of the Clean Water Act and the Colorado Water Quality Control Act which is punishable by a fine ranging from $10,000 to $25,000 per day. As part of the permit process, dischargers are required to create and implement a Stormwater Management Plan which identifies possible pollutant sources and determines Best Management Practices (BMPs) that will reduce impacts to water quality (CDPHE 2007b). Some of the BMPs that may be used include silt fences, temporary detention ponds, hay bales, vehicle tracking controls, good housekeeping, inspection and maintenance schedules, and training (CDPHE 2007b). Approximately 10 sites in Pueblo are inspected by PCCHD annually. The inspection rate was decreased from 20 to 10 in 2008 due to decreased funding by the state (Scott Cowan, PCCHD, personal com m. 1 October 2008). If violations are noted, CDPHE determines whether follow-up inspections are necessary.

Pueblo County, the City of Pueblo, and Pueblo West Metro District are under Municipal Separate Storm Sewer System (MS4) general permits in which MS4s are conveyances like roads with drainage systems, municipal streets, catch basins, gutters, ditches, man-made channels and storm drains. Under these permits, EPA requires that select municipalities within the state follow certain measures including educating the public on stormwater impacts, complying with state and local public notice requirements when implementing the stormwater management programs, and developing and implementing a program to detect and eliminate discharges to the MS4 (CDPHE 2007b). Permitees must also develop, implement and enforce a pollutant control program that reduces pollutants in stormwater runoff to the MS4 from construction activities as well as from the new development. An operation and maintenance program is also required to prevent or reduce pollutant runoff from municipal operations (CDPHE 2007b).

The Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 enforces the management of roads, highways, and bridges to mitigate water pollution due to highway runoff. Some management measures include developing an erosion control plan, incorporating pollution

prevention into operation and maintenance procedures, and developing runoff pollution controls for existing road systems to reduce pollutant concentrations and volumes (EPA 1995b).

EPA mentions that stormwater pollution is caused by so many different activities that traditional regulatory controls will only go so far. Therefore, education and outreach, especially for urban and agricultural areas, are key components to any successful stormwater program. Local health departments encourage homeowners in urban areas to use fertilizers, herbicides and pesticides responsibly and sparingly, sweep driveways, sidewalks and roads instead of using the hose, and dispose of pet waste (EPA 2003). Farmers and ranchers are encouraged to apply best management practices that control volume and flow rates of runoff water, improve water efficiency, and limit discharges by storing and managing facility wastewater and runoff with waste management systems (EPA 2005b). They are also encouraged to adjust grazing intensity, keep livestock out of sensitive areas, and promote revegetation of grazing areas.

Potential Exposure in Pueblo County

Scott Cowan (PCCHD, personal comm. 1 October 2008) noted that the majority of violations are plan violation issues with the Stormwater Management Plan in which the discharger does not adequately describe or list BMPs. He also mentioned that nearly every site inspected has at least one violation such as failure to install adequate BMPs or failure to maintain structural BMPs. Therefore, aquatic systems and humans using water bodies for recreation may be exposed to polluted stormwater runoff from regulated areas.

Urban and agricultural areas, which are not fully regulated, may also contribute to polluted stormwater runoff in Pueblo County. Both low intensity and high intensity residential areas are present (Figure 16), suggesting stormwater runoff is possible since these areas are comprised of impervious surfaces. Furthermore, numerous sources of pollution are possible in residential areas. Irrigated areas are also present in Pueblo County (Figure16), primarily near the Arkansas River, and may contribute to polluted stormwater runoff. Approximately 35,000 acres of land (2% of the total land) in Pueblo County is irrigated area (Bauder *et al*. 2004). Though the amount of urban and agricultural areas are much lower when compared to northern counties near Denver, aquatic systems and humans recreating in local water bodies in Pueblo County may risk exposure to polluted stormwater runoff.

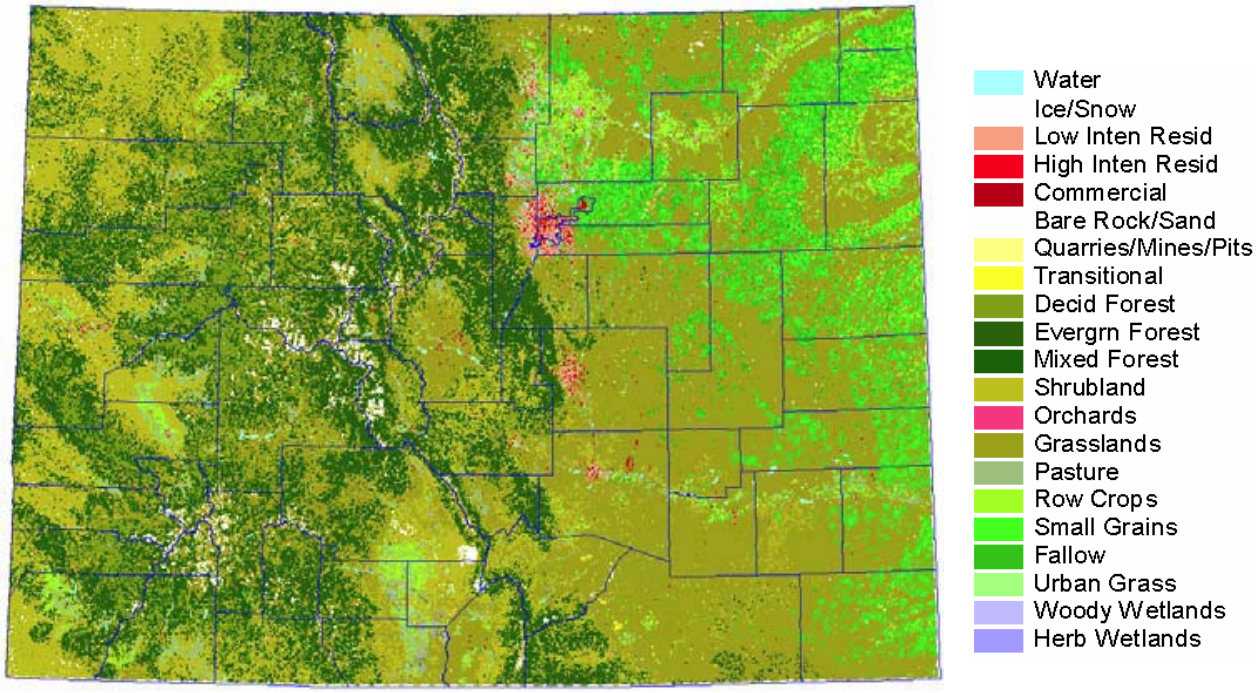

Figure 16 - Land classifications in Colorado (Bauder et al. 2004).

POTENTIAL LAND / WASTE EXPOSURES IN PUEBLO COUNTY

INDUSTRIAL HAZARDOUS WASTE

Hazardous waste is a waste that may be dangerous or potentially harmful to human health or the environment. The waste can be liquids, solids, contained gases, or sludges, and is usually on one of the four hazardous waste lists (EPA 1997):

- F-list – includes wastes from common manufacturing and industrial processes such as solvents used for cleaning or degreasing operations.
- K-list – includes wastes from specific industries like pesticide manufacturing and petroleum refining which may include sludges and wastewaters from treatment and production processes.
- P-list and U-list – include unused commercial chemical products that become hazardous when discarded, such as certain pesticides and pharmaceutical products.

If a waste is not on the above lists it may also be considered hazardous if it demonstrates at least one of the following characteristics (EPA 1997):

- Ignitability – can create fires under certain conditions, is spontaneously combustible, or has a flash point less than 60° C (140° F). Waste oils and used solvents are included in this category.
- Corrosivity – acids or bases, having a pH less than or equal to 2 or greater than or equal to 12.5, that are capable of corroding metal containers. An example is battery acid.
- Reactivity – wastes, such as explosives, that are unstable under normal conditions, causing explosion, toxic fumes, gases or vapors when heated, compressed or mixed with water.
- Toxicity – harmful or fatal when ingested or absorbed, such as mercury. Pollution of ground water is possible if it is land disposed.

Sources of Industrial Hazardous Waste

Industrial hazardous waste is produced by three different types of generators:

- Large Quantity Generators – generate more than 2200lbs of waste per calendar month. These generators include pharmaceutical companies and chemical manufacturers.
- Small Quantity Generators – generate between 220lbs and 2200 lbs per month and include industries such as laboratories, printers and dry cleaners.
- Conditionally Exempt Small Quantity Generators – generate less than 220lbs per month, such as dental offices. These generators are subject to minimal requirements.

Hazardous waste is managed in several different ways (EPA 1997). Source reduction and waste prevention by means such as taking proper precautions to avoid spills, leaks and mixing with

non-hazardous waste, is encouraged. Some wastes, like dirty cleaning solvents, can be recycled instead of disposed. If disposal is necessary, the types of land disposal include:

- Landfills – hazardous waste is placed in landfills or surface impoundments after it has been properly treated using treatment technologies such as neutralization, oxidation or precipitation.
- Underground injection wells – hazardous waste is deposited into steel and concrete encased shafts. A large proportion of wastes, especially liquids, are disposed of in wells.
- Waste piles – solid, non-flowing hazardous waste is accumulated in non-containerized piles. It is often a method for temporary storage.
- Land treatment – hazardous waste is applied onto or incorporated into the soil surface where natural microbes break down or immobilize the hazardous constituents

Waste combustion is another method of disposal in which waste is burned in an incinerator, or disposed of in boilers or industrial furnaces. This method is subject to strict emission control regulations.

Regulations

The EPA Office of Solid Waste regulates hazardous waste under the Resource Conservation and Recovery Act (RCRA). RCRA regulates all hazardous waste by tracking each facility handling waste, requiring proper documentation of all hazardous waste from generation to final disposal, and issuing permits to facilities wishing to treat, store, and dispose of hazardous waste (EPA 1997). Once the permits are issued, the facilities must follow guidelines which include:

- Analyzing and identifying wastes prior to treatment, storage, and disposal
- Preventing the entry of unauthorized personnel into the facility
- Inspecting the facility periodically for problems
- Training employees in safe use of equipment and emergency response procedures
- Preparing a contingency plan for emergencies and establishing other emergency response procedures.
- Complying with the manifest system, various reporting and recordkeeping requirements, and facility-specific standards
- Banning liquids from landfills
- Banning underground injection of hazardous waste within 1/4-mile of a drinking water well
- Following strict structural and design conditions, such as double liners, leachate collection systems, and ground-water monitoring
- Limiting facility sites in unstable hydrogeologic areas

In 1984, Colorado was authorized by EPA to implement its own hazardous waste program (CDPHE 2008b). The Hazardous Materials and Waste Management Division of the Colorado

Department of Public Health and Environment, along with local agencies, regulate hazardous waste generation, storage, transportation, treatment, and disposal (CDPHE 2008b). The Division ensures compliance with state regulations and permits and oversees remediation of contamination at federal facilities located in the state.

Federal facilities are inspected annually and all other facilities are inspected once every two years to ensure compliance with the regulations. The EPA estimates that approximately 50 to 70% of all treatment, storage, and disposal facilities (TSDFs) have some degree of environmental contamination requiring detailed investigation and possibly cleanup. If a facility has environmental contamination, it must be cleaned up under the Corrective Action program in which two indicators are used to determine if the contamination is being mitigated. These indicators are:

1. "Human Health Exposures Under Control" - no unacceptable human exposures to contamination of concern that can be reasonably expected under current land use and ground water use conditions.

2. "Migration of Contaminated Ground Water Under Control" - the migration of the contaminated ground water has stabilized and monitoring will be conducted to confirm that the contaminated ground water remains within the original area of contaminated ground water.

Cleanup is complete when proper controls, either engineering or institutional, are implemented. Engineering controls manage physical elements such as access to the land or the flow of water by using fences, pumps, or cement caps over contaminated areas (EPA 2008f). Institutional controls are administrative and/or legal controls that limit land or resource use. Governmental institutional controls may include zoning ordinances or groundwater permitting programs while proprietary institutional controls may involve deed restrictions, covenants, or easements.

Potential Exposure in Pueblo County

Currently in Pueblo County there are four large quantity generators: Ashland Chemical, the Pueblo Chemical Depot, Safety-Kleen, and Rocky Mountain Steel Mills (USEPA 2008f). All of these facilities, with the exception of Ashland Chemical, are known as TSD sites (those that treat, store, or dispose of hazardous waste). According to the Herron Enterprises USA, Inc. waste management mapping project (2004), there are approximately 171 small quantity generators. As of 2004, there were approximately 296 underground storage tank sites in Pueblo County, which all contain petroleum products (Colorado State University - Pueblo 2004) and there have been at least 181 leaking underground storage tank incident reports (Herron Enterprises USA, Inc. 2004). Herron Enterprises USA, Inc.(2004) listed five historical landfill sites: Pueblo Memorial Airport Solid Waste Disposal Site, Rockwool Industries, Southside Solid Waste Disposal Site, Tabor Fly Ash Disposal Site, and a site located in Pueblo at 3800 E. 4th. The Southside Solid Waste Disposal Site was the only public landfill available, having

approximately 5.1 million tons of waste, until it was closed in May 2008. It will remain closed until the state health department determines that new pit's liner, drainage, and monitoring systems are able to prevent leaching of wastewater into the groundwater.

Colorado is not listed on the EPA 2008 Corrective Action Baseline list which mentions the 1,968 highest priority sites in the United States (EPA 2008g). Three facilities in Pueblo County are reported as having recent RCRA Corrective Action activity. These facilities are Rocky Mountain Steel Mills, the Pueblo Chemical Depot, and Safety-Kleen. As of March 2004, cleanup is complete for Rocky Mountain Steel Mills (EPA 2008g). Both indicators, human health exposures and migration of contaminated groundwater, are under control as government institutional controls and non-groundwater engineering controls were implemented (EPA 2008g). At the Safety-Kleen site, there is currently insufficient information to determine whether human health exposures and groundwater migration are under control.

Cleanup is complete for the Pueblo Chemical Depot. Groundwater engineering controls are in place and therefore migration of contaminated groundwater is under control. However, human health exposures are not under control but an explanation for the lack of control was not available. Some human exposures near the Chemical Depot have been evaluated. Due to concerns related to historical groundwater contamination in areas near the Depot, CDPHE (2002) investigated cancer incidence rates in the towns of Avondale, North Avondale, and Boone from 1982 to 2000. It was determined that the incidence of cancer was consistent with the expected number of diagnoses based on cancer rates in a seven county comparison. The area was categorized as having no apparent health hazard.

Though several facilities have had violations, the contamination is addressed due to strict regulations. There may be incidental exposure potential for those living near a facility when a violation occurs but the severity is questionable. Overall, a low exposure potential is most likely for communities near hazardous waste facilities.

HOUSEHOLD HAZARDOUS MATERIALS / WASTE AND ILLEGAL DUMPING

Many household products can also be considered hazardous when used, stored or discarded improperly. In Colorado alone, approximately 33,000,000 pounds of household hazardous waste are discarded every year (CDPHE 2008b). These items include (CDPHE 2008b, EPA 1997):

- Paint and decorating supplies
- Solvents and cleaning products such as oven cleaner
- Herbicides and pesticides
- Fertilizers and other lawn care products
- Automotive products like motor oil
- Batteries

These items may be improperly disposed of or even illegally dumped in unpermitted areas such as unsecured properties. In addition to the items listed above, items that are commonly illegally dumped may include (EPA 1998):

- Construction and demolition waste (drywall, roofing shingles, lumber, bricks, concrete, siding)
- Abandoned automobiles and auto parts
- Appliances
- Furniture
- Yard waste
- Household trash
- Medical waste

Health Effects

Household hazardous materials/waste may be corrosive, explosive, flammable, toxic, radioactive, or a skin or eye irritant. Any of these can possibly result in severe injury or even death. Additionally, the numerous items that are illegally dumped may also be hazardous as these sites are oftentimes easily accessible to people and possibly children (EPA 1998). Items having protruding nails or sharp edges may lead to injury and inhaling dust can result in respiratory issues. Harmful fluids or other compounds pose a chemical hazard upon contact or can contaminate drinking water sources such as wells and surface water. In addition to human health effects, the waste may also be harmful to the environment by blocking waterways like creeks, culverts or drainage basins. The EPA (1998) also notes that if not addressed, illegal dumps can attract more waste, including hazardous waste, which can lead to decreased property value.

Regulations

Individuals generating waste from their homes (as well as hotels, motels, and campgrounds) are exempt from hazardous waste regulations (EPA 1997). CDPHE encourages saving the majority of household hazardous waste for annual or semi-annual collections organized by the local health department. Collection of household hazardous waste in Pueblo occurs in May of even numbered years while recyclable waste only is collected in odd numbered years.

Disposing of any type of waste anywhere within the City of Pueblo besides a designated waste disposal facility is considered to be unlawful and a municipal offense. Conviction of this violation may be punishable by a fine (not exceeding $300.00) or imprisonment (not exceeding 90 days). The probability, however, of witnessing an illegal dumping event is low. Furthermore, it has become increasingly difficult to identify individuals that have illegally dumped waste (Ken Williams, personal comm. 9 July 2008).

Potential Exposure in Pueblo County

Several members of the community participate in PCCHD household hazardous waste collection. In May 2008, more than 900 people turned in hazardous or recyclable waste and a total of 12,970 pounds of hazardous chemicals were collected (Jenny Kedward, PCCHD, personal comm.. 25 July 2008). While this event is successful, many individuals do not participate in the waste collections and may be unaware of the dangers of improper hazardous materials storage and disposal. Therefore, the potential for exposure to household hazardous waste to individuals inside the home as well as trash haulers and landfill operators exists if the waste is handled or disposed of improperly. The potential also exists for the waste to enter the local water supply leading to health and environmental risks.

Despite the regulations, illegal dumping occurs in Pueblo County. In fact, in 2004 a study by Colorado State University – Pueblo (2004) identified 39 illegal dump sites in the City of Pueblo and the immediately surrounding area (Figure 17). Ken Williams of the Pueblo City-County Health Department (personal comm. 9 July 2008) cautioned that this number may have decreased as certain areas of Pueblo have been developed since that time and the sites may no longer be available. The number of illegal dumpings may increase, however, while the Southside Solid Waste Disposal Site is closed. In recent years, a large portion of illegal dumping in Pueblo has consisted of yard waste and roofing shingles (Jenny Kedward, Heather Maio, PCCHD, personal comm. 9 July 2008), though the contents may vary.

In 2007 Code Enforcement received 1,697 calls for illegal dumping and litter (Jenny Kedward, PCCHD, personal comm. 23 July 2008). Since illegal dumping appears to be prevalent in Pueblo, the potential for exposure exists. Furthermore, the illegal dumping sites are distributed throughout the entire city of Pueblo and surrounding areas suggesting the entire community as well as the environment is at risk of exposure. The extent of exposure, however, is circumstantial and variable as it is dependent upon the content of the dump sites.

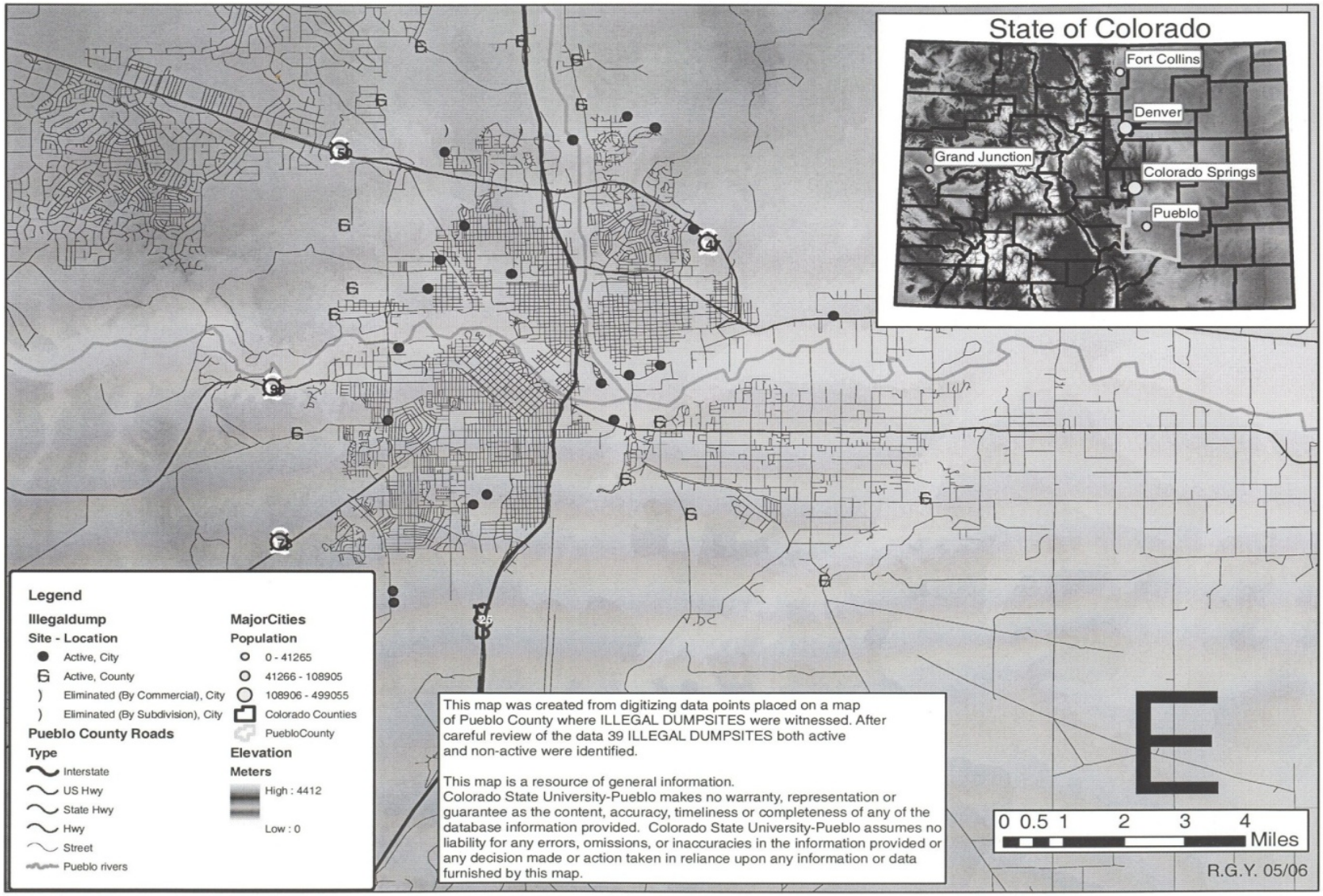

Figure 17 - Illegal dumpsites in Pueblo County, Colorado as of 2004. (Colorado State University - Pueblo 2004)

POTENTIAL INDOOR EXPOSURES IN PUEBLO COUNTY

RADON

Radon is a colorless, odorless, radioactive gas that is produced by the natural decay of uranium that is found in almost all soils (EPA 1993). It moves through the ground in soils, rock, and water to the air above and can enter homes and other structures through cracks and openings in the foundation. The radon accumulates, increasing the indoor radon levels to much higher concentrations compared to that outdoors. In fact, while outdoor concentrations range from 0.003 to 2.6 picocuries of radon per liter of air (pCi/L) (ATSDR 1990b) with an average of 0.4 pCi/L (EPA 2008a), indoor radon levels can be as high as 2,000 pCi/L (EPA 2008i).. Nearly one out of every 15 homes in the U.S. is estimated to have elevated radon levels (EPA 2008i). The amount of radon in any given home is extremely variable due to factors including house design, local geology and soil conditions, and the weather (EPA 2008i).

Health Effects

As radon decays in air, the decay products attach to aerosols and dust, which can be inhaled into the lungs. Though most of the radon and decay products are breathed out again, some may remain in the lungs where they continue to decay. The radiation released during this process can damage the lung tissue (ATSDR 1990b). Long-term exposures to high concentrations of radon and radon decay products can lead to thickening of lung tissues and eventually an increased risk of lung cancer (ATSDR 1990). Radon is second only to smoking as the leading cause of lung cancer in the United States and approximately 20,000 lung cancer deaths (10 to 14% of total lung cancer deaths) each year in the United States are due to indoor exposure to radon (EPA 2008i). Radon is the number one cause of lung cancer among non-smokers (EPA 2008k). Smoking can increase the chance of getting lung cancer from radon.

Recommended Levels

The EPA recommends fixing the home if the radon level is 4.0pCi/L or higher (EPA 2008k). Home repairs may include sealing foundation cracks and openings, and installing a soil suction radon reduction system which is a vent pipe system and fan that pulls radon from beneath the house and vents it to the outside.

Potential Exposure in Pueblo County

The EPA (1993) noted that because of the widespread occurrence of uranium-bearing rock formations and alluvium, and soils derived from them, virtually all areas of Colorado have the potential for some indoor elevated radon levels (Figure 18). Furthermore, Pueblo County is in an area of Colorado where the average indoor radon levels are predicted to exceed 4.0pCi/L (EPA 1993). This prediction is based on five factors: indoor radon data, geology, aerial radioactivity, soil parameters, and house foundation type.

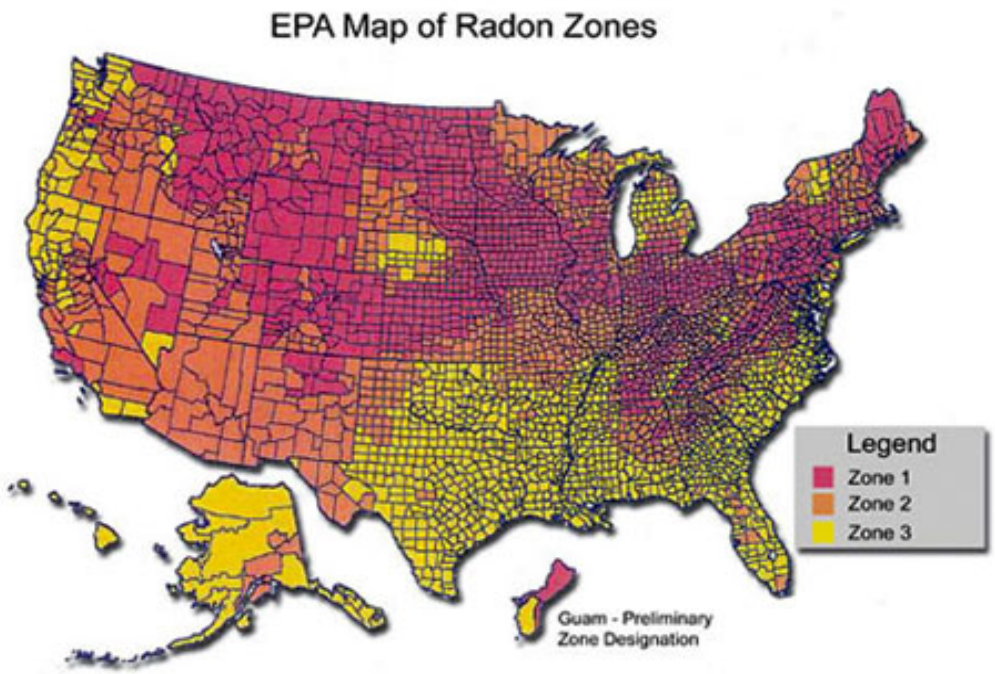

Figure 18 - Elevated indoor radon level potentials for counties within the United States (EPA 2008j). Zone 1 counties have the highest potential for elevated indoor radon levels. Zone 2 counties have a moderate potential and Zone 3 counties have a low potential.

Approximately 48% of the homes in Colorado have indoor radon levels greater than 4.0pCi/L (Chrys Kelley, CDPHE, personal comm., 16 July 2008). In 2007, CDPHE found that the average indoor radon concentrations for homes in western Pueblo County ranged from 0.15 to 25pCi/L (Figure 19) and the percentage of homes in each zip code exceeding 4.0pCi/L ranged from zero to 100% in various parts of western Pueblo County (Figure 20). Apparently, the homes within the eastern portion of Pueblo County were not sampled.

The radon levels in Pueblo County in 2006 and 2007 (2008 tests are currently being conducted) ranged from nearly zero to above 100pCi/L (Table 7 and 8) and varied greatly both within and between zip codes. The 81004 and 81007 zip codes had overall higher averages and percentage of homes with levels exceeding 4.0pCi/L (Table 7 and 8). For instance, in 2007 the average indoor radon levels for the 81004 and 81007 zip codes were 19.1 and 12.4pCi/L, respectively (Table 8). Approximately 69% of the homes tested in both 81004 and 81007 were equal to or greater than 4pCi/L (Table 8). Overall 58% of homes tested in 2006 and 56% of homes tested in 2007 had radon levels greater than or equal to 4.0pCi/L, indicating the potential for exposure to elevated levels of radon exists for most of Pueblo County. Individuals residing in the 81004 and 81007 zip codes may potentially have a higher risk of exposure however; the exposure will also depend on the structural integrity of the home.

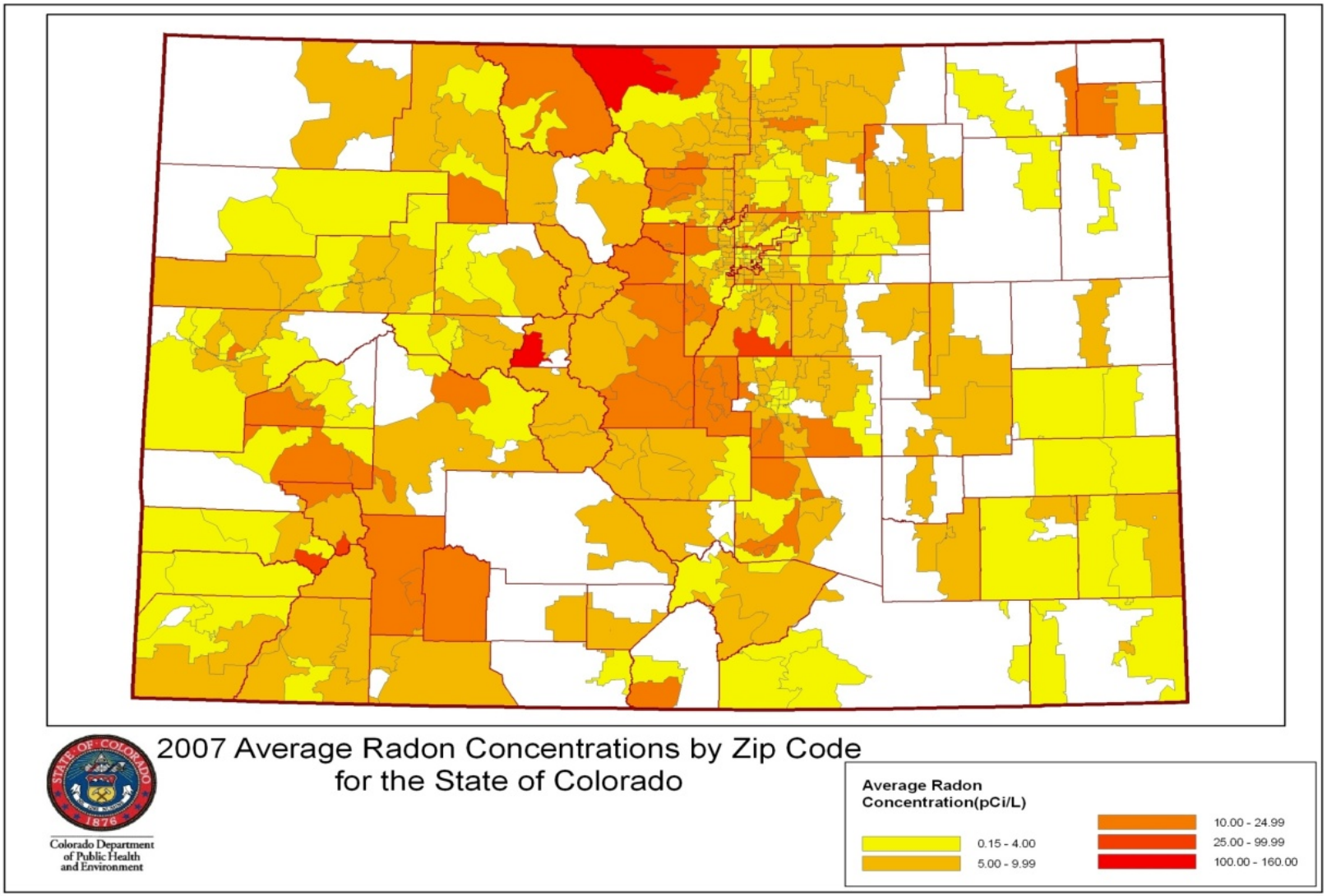

Figure 19 - Average radon concentrations by zip code in Colorado in 2007. Map courtesy of Chrys Kelley, CDPHE.

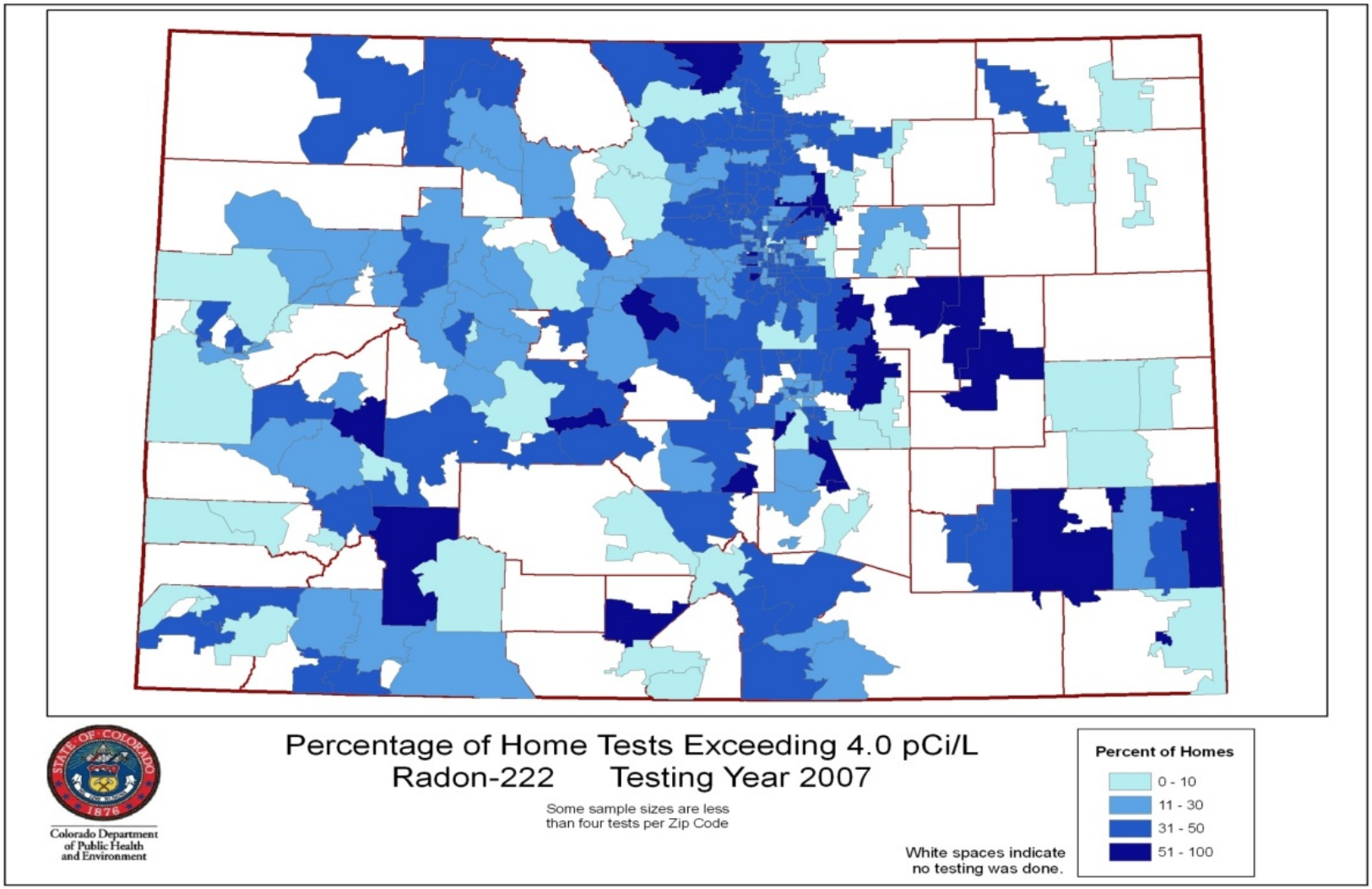

Figure 20 - Percentage of homes exceeding 4.0pCi/L in Colorado in 2007. Map courtesy of Chrys Kelley, CDPHE.

Table 7 -2006 radon concentrations within homes in Pueblo County zip codes. Only the zip codes in which tests were conducted are shown.

Zip Code	Number of Tests	Average (pCi/L)	Minimum (pCi/L)	Maximum (pCi/L)	% ≥ 4.0 pCi/L
81001	18	3.6	0.3	12.3	28%
81003	53	5.2	0.8	20.4	42%
81004	20	21.3	1	135.3	55%
81005	34	10.6	0.7	98.4	53%
81006	4	2.3	1	5.2	25%
81007	127	9.9	0.3	51.6	71%
81008	7	6.2	1.2	10.5	71%

Table 8 -2007 radon concentrations within homes in Pueblo County zip codes. Only the zip codes in which tests were conducted are shown. *Only one home was tested and therefore the reported value is listed but does not represent an average for the zip code and the other fields cannot be calculated.

Zip Code	Number of Tests	Average (pCi/L)	Minimum (pCi/L)	Maximum (pCi/L)	% ≥ 4.0 pCi/L
81001	29	13.4	0.3	93.9	59%
81002	1	2.4*			
81003	61	3.3	0.1	7.9	30%
81004	13	19.1	2.8	77	69%
81005	56	3.8	0.3	17.1	36%
81006	20	5.6	1	45.1	35%
81007	199	12.4	0.2	76.6	69%
81008	29	9.3	1	95	76%
81012	1	9.6*			

MOLD

Molds are microscopic organisms that are found both indoors and outdoors year round. Inside the home, mold is most likely to grow and become a problem when water damage, high humidity, or dampness occurs. There are many different sources of moisture indoors that may encourage mold growth. Some of the sources include (PCCHD 2008):

- Flooding
- Sewer back-ups
- Leaky roofs
- Humidifiers
- Mud or ice dams
- Damp basements or crawl spaces
- Persistent plumbing leaks
- House plants
- Steam from cooking
- Shower or bath steam and leaks
- Wet clothes on indoor drying lines
- Clothes dryers vented indoors
- Combustion appliances not exhausted to the outdoors

Also, air conditioners can enhance mold growth by cooling the air too quickly; preventing the removal of excess moisture from the air and evaporative coolers can increase the indoor humidity levels. If the moisture from any of the above sources persists for more than 24 to 48 hours (EPA 2002b) mold can grow. The growths can appear discolored, ranging from white to orange or from green to brown and black and may cause leaching from plaster (PCCHD 2008). Often the growths have an earthy or musty odor.

Health Effects

The mold release spores which can be inhaled or can come into contact with the skin, leading to allergic reactions, infections, asthma episodes as well as other respiratory problems (PCCHD 2008). Infants and small children, elderly, immune-compromised patients, and individuals with existing respiratory conditions, such as asthma, are more likely to experience health effects (PCCHD 2008).

Regulations and Prevention

Currently, regulations or standards for airborne concentrations of mold or mold spores do not exist (EPA 2002b). Certain circumstances that can cause mold growth, however, can often be regulated. For instance, if an active water leak is present, the Pueblo City County Health

Department has the authority to cite the 1997 Housing Code under section 1001.2 for dampness of habitable rooms and enforce the repair of the leak (Scott Cowan, PCCHD, personal comm. 15 September 2008).

EPA strongly encourages moisture control as it can prevent mold from becoming a problem. Leaky pipes should be fixed and water flow towards the house should be prevented through landscaping, waterproofing, or the addition of gutters. Crawlspaces, bathrooms and kitchens should be well ventilated using exhaust fans whenever possible, and previously soaked carpets and upholstery should be removed or replaced.

If mold growth occurs, professional services are not required if the moldy area is less than about 10 square feet, which is the approximately the same as a 3 foot by 3 foot patch (EPA 2002b). During the cleanup process the individual should first remove the source of moisture, while wearing gloves and a facemask. All moldy items especially paper, rags, wallboard, ceiling tiles, carpeting, and wood products, which can all trap molds, should be decontaminated and thrown away (PCCHD 2008). The moldy area should then be cleaned using hot water and a non-ammonia soap or detergent, or a commercial cleaner. A solution of 10% bleach should also be used to disinfect the area. The area then needs to dry for two to three days.

Potential Exposure in Pueblo County

PCCHD received about 60 to 70 complaints regarding mold during the 2007 – 2008 year (Scott Cowan, PCCHD, personal comm. 15 September 2008). The majority of these complaints did not pose a threat to human health. Exposure to indoor mold is possible for individuals living in a home with sources of moisture that are not addressed. Children, elderly, and asthmatics are particularly susceptible to the mold.

LEAD

Some sources of lead in homes include (EPA 2008l):

- Old painted toys and furniture
- Food and liquids stored in lead crystal or lead-glazed pottery
- Hobbies using lead such as pottery and stained-glass making, or refinishing furniture
- Folk remedies that contain lead (“azarcon” and “greta” used to treat upset stomachs)
- Soil around a home that has been contaminated by lead from other sources

A very common source of lead inside the home is paint. Homes built before 1978 may have lead-based paint. The EPA estimates that 87% of privately owned units built before 1940, 69% of units built between 1940 and 1960, and 24% of units built between 1960 and 1979 contain some lead-based paint.

It is important to note that lead-based paint that is in good condition is usually not a hazard. If the paint is peeling, chipping, chalking or cracking or if the paint is dry scraped, dry sanded or heated during renovation efforts, lead-based paint can pose a hazard.

Health Effects

Humans can come into contact with lead through two main routes of exposure: inhalation and ingestion.

- Inhalation: Lead can attach to dust particles which can then be breathed into the lungs
- Ingestion:
    - Hands or other objects covered with lead dust are placed in the mouth
    - Paint chips or soil containing lead is eaten (a common exposure route for children)

Lead is more dangerous to children. Some effects to children include (EPA 2008l):

- Damage to the brain and nervous system
- Behavior and learning problems
- Slowed growth
- Hearing problems
- Headaches

Effects to adults include:

- Reproductive problems
- High blood pressure and hypertension
- Nerve disorders
- Memory and concentration problems
- Muscle and joint pain

Regulations

Under the residential lead hazard standards, lead is considered a hazard when equal to or exceeding: 40 micrograms of lead in dust per square foot on floors; 250 micrograms of lead in dust per square foot on interior window sills, 400 parts per million (ppm) of lead in bare soil in children's play areas or 1200 ppm average for bare soil in the rest of the yard.

There are several regulations in place for target housing, which is defined as housing built prior to 1978 (except housing for elderly or those that are disabled), including any 0-bedroom dwellings, in which a child under the age of six visits at least two different days within any week (EPA 22 April 2008). The HUD Lead Safe Housing Rule requires that all target housing that is federally owned or receiving federal assistance must notify, evaluate, and reduce lead based

paint hazards. Also, the Lead Disclosure Rule requires homeowners to disclose all known lead based paint hazards when selling or leasing a residential property built before 1978.

On April 22, 2010 a new EPA rule will be implemented that requires all renovators and dust-sampling technicians to be certified by EPA before renovating six square feet or more of painted interior surfaces or more than 20 square feet of painted exterior surfaces in any target housing or child-occupied facilities (EPA 22 April 2008). Until the new rule is implemented, renovators must follow the Pre-Renovation Lead Information Rule where they are required to distribute a lead hazard information pamphlet to the owners and administrators of child-occupied facilities and target housing prior to renovations. The pamphlet provides information on lead-based paint hazards, a guide for selecting a contractor, and necessary precautions to employ during and after the renovation process.

Potential Exposure in Pueblo County

EPA and the Centers for Disease Control and Prevention (CDC) have determined that childhood blood lead concentrations at or above 10 micrograms of lead per deciliter of blood (µg /dL) present risks to children's health. Between January 1996 and June 2001, there were 18 cases of elevated blood lead levels in Pueblo County in various locations (Heather Maio, PCCHD, personal comm. 12 June 2008) (Figure 21).

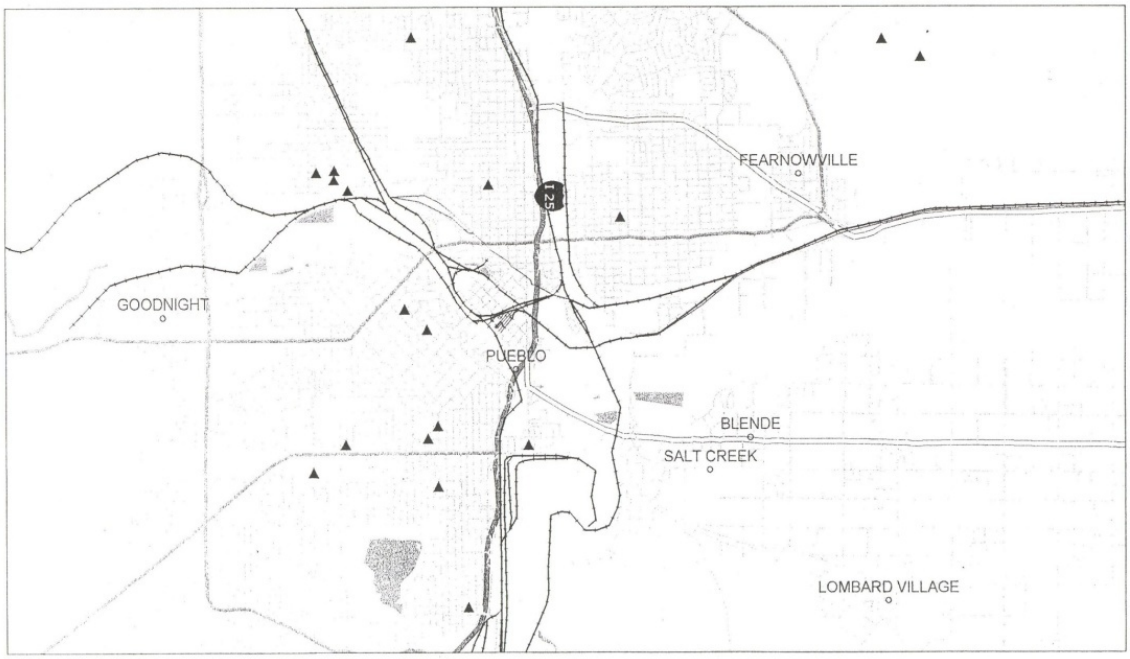

Figure 21 – Cases of elevated blood lead levels of 10 µg lead/dL blood or greater in Pueblo, Colorado between January 1996 and June 2001. Lead cases are identified by triangles. Map courtesy of Heather Maio, PCCHD.

For the year 2003-2004 the Colorado Department of Public Health and Environment reported that out of 425 children tested (ages 0 to 72 months), six children had blood lead levels greater

than or equal to 10 µg/dL in Pueblo County (CDPHE 2005b). The average elevated rate for children (0 to 72 months) in Pueblo County during this time period was 21.3 per 100,000. This rate was higher than 23 of the 39 counties sampled. It is important to note that the exact source of the lead in these cases is unknown but is thought to be from either paint, soil, cooking pots or an adult occupation in which the adult brings the lead into the household, possibly attached to clothing.

Exposure to Lead in Paint in Pueblo County

To determine who may be at risk of exposure to lead-based paint, it is necessary to understand the age composition of homes. A large portion of the homes in the city of Pueblo were built prior to 1978. As of the year 2000, 74.7% of all homes in Pueblo were built prior to 1979 (Figure 22).

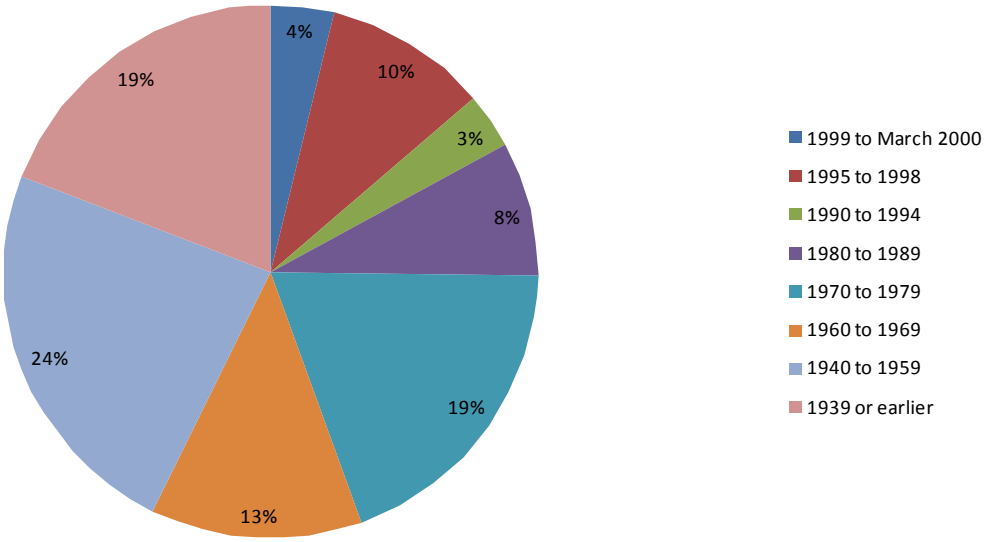

Figure 22 - Age breakdown of all homes in Pueblo, Colorado in 2000. (Data from U.S. Census Bureau 2000a)

Several zip codes within Pueblo may have a slightly greater potential for lead exposure. For instance, in the zip code 81004, 92.7% of the homes were built before 1979 with 42% built prior to 1939 (Figure 23). Higher risk areas such as these may warrant further investigation as exposure to lead in paint is possible in old homes having paint in poor condition or undergoing renovations.

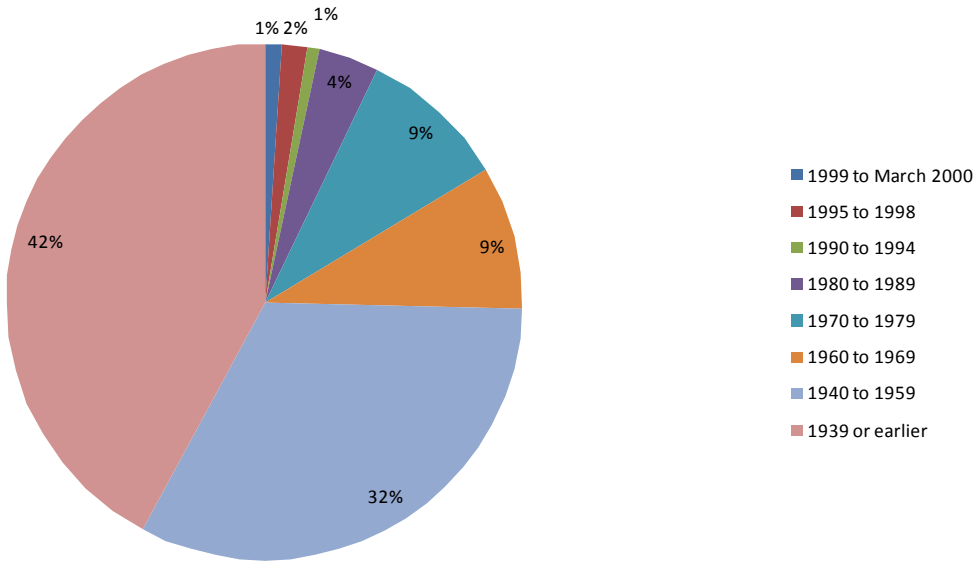

Figure 23 - Age breakdown of all homes in the 81004 zip code of Pueblo, Colorado in 2000. (U.S. Census Bureau 2000a).

Exposure to Lead in Soil in Pueblo County

In a study conducted a few years ago, it was determined the topsoil in the city of Pueblo contains more lead than national soil averages (Diawara *et al*. 2006). The lead levels ranged from 18ppm to 316ppm with the average lead content for the entire city being 87.7ppm which is five times the average for the United States (16ppm). In nature, lead is found in small quantities in the soil, ranging from 13 to 16ppm. Diawara *et al*. (2006) noted that the high lead zones, having 112-318ppm, were concentrated around the Rocky Mountain Steel Mills and historic smelter sites (Figure 24), suggesting atmospheric deposition of lead released years ago from the steel mills may be responsible for the soil contamination. Industrial processes, primarily metals processing, are recognized as the major source of lead emissions to the air with the highest air concentrations of lead usually found near lead smelters (EPA 2008l).

Though the average soil lead level in the city of Pueblo is greater than EPA ecological soil screening levels of 16ppm for avian wildlife and 59ppm for mammals, the highest reported level does not exceed the soil cleanup standard of 400ppm for residential areas.

In a study conducted by CDPHE in 1995 the average level of lead in the City of Pueblo soils was 250ppm with a maximum level of 860ppm. Three out of 21 samples taken from soil on residential properties exceeded the EPA soil cleanup standard of 400ppm however the average was well below this standard. Conversely an average of 550ppm and a maximum of 1800ppm were reported in the Blende area of Pueblo County (Heather Maio, PCCHD, personal comm. 12 June 2008). Seven out of 13 samples exceeded the EPA soil cleanup standard, suggesting that

other areas in Pueblo County may have higher lead levels than within the city. Subsequently, the blood lead levels of children between the ages of one and five in Blende were sampled but the average level was only 3.7µg/dL and the maximum level was 5.0 µg/dL. These results suggest that though higher lead levels were present in the soil, the children were not frequently coming into contact with the lead.

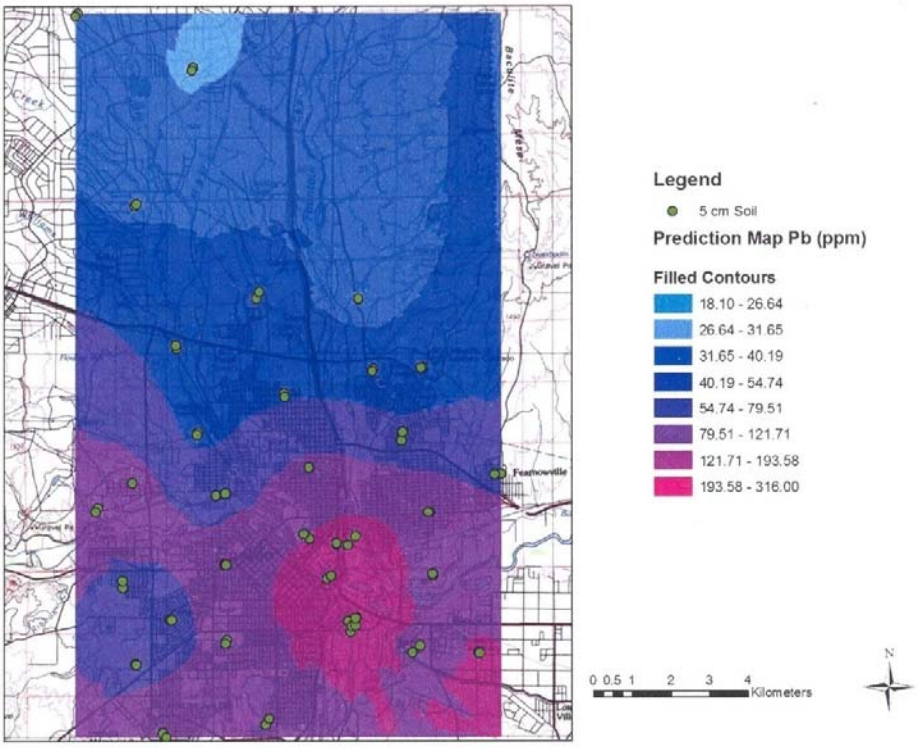

Figure 24 - Exploratory spatial prediction map of lead concentrations in the topsoil in Pueblo, Colorado (Diawara et al. 2006).

The potential for exposure to lead in soil exists, primarily in the Blende area of Pueblo County as well as in areas near the Rocky Mountain Steel Mill and historic smelter sites. Children are more at risk than any other age group and caution should be taken to prevent ingestion of soil in these areas. The lead in soil may also be introduced to the home unintentionally, creating an additional opportunity for indoor lead exposure.

SMOKE FROM WOOD STOVES AND FIREPLACES

Wood stoves and fireplaces are found in many homes and can be the primary source of indoor heat, the source of occasional heat, or used for more aesthetic purposes. Older wood stoves and fireplaces, however, can be the source of indoor air pollution. Smoke is produced when wood does not burn completely (EPA 2007). Furthermore, smoke and indoor air pollution can result if

the wood stove or fireplace is improperly installed or operated. Lack of maintenance or cleaning can cause smoke leakage into the home or the buildup of creosote, which can fuel a chimney fire (EPA 2008m). Burning items such as household garbage and plastics, plywood, particle board, or wood that is wet or has been coated, painted, or pressure-treated can cause indoor air pollution as well. Though much of the smoke exits the home through the chimney, approximately 70% of the smoke can actually reenter the home as well as neighborhood dwellings (EPA 2007).

Wood smoke that is released is not only a nuisance but can contain carbon monoxide, nitrogen oxides, volatile organic compounds, and particulate matter (EPA 2008m). The particulate matter is primarily composed of wood tars, gases, soot, and ashes (EPA 2008m). Other toxic chemicals can be released as well when garbage or treated wood is burned. These substances can be harmful to humans.

Health Effects

Inhaling wood smoke can cause minor symptoms such as headaches, irritated sinuses, burning eyes, and a runny nose (EPA 2008m). Smoke inhalation can also cause an inflammation of the respiratory system, resulting in coughing, labored breathing, decreased lung function, and aggravated asthma and bronchitis (EPA 2007). Irregular heartbeat, nonfatal heart attacks, and premature death can occur in people with heart or lung disease (EPA 2007). Some of the substances found in wood smoke are carcinogens but their effects on human health through exposure to wood smoke have not been extensively studied (EPA 2007). Healthy adults are usually not at risk of health effects from smoke (EPA 2008m). Children, elderly, and those with heart or lung diseases are the most likely to be affected by wood smoke (EPA 2007).

Standards, Regulations, and Prevention

Since 1988, all new wood stoves and fireplace inserts sold in the United States must meet new standards of performance. These EPA certified stoves use one third less wood than older stoves and release 60 to 80% less smoke up the chimney (EPA 2008m). In addition to the new wood stoves, EPA also recommends using pellet stoves, gas stoves, fireplace inserts, or decorative fireplace gas logs instead of old wood stoves or fireplaces. In some cities, the EPA has helped organize Wood Stove Changeout Campaigns during which people receive financial incentives to replace older wood stoves with either non-wood burning equipment, pellet stoves, or EPA certified wood stoves (EPA 2006d). Thus far, the only changeout campaign occurring in Colorado was in Delta County between 2005 and 2006 (EPA 2006d).

Many of the homes built prior to 1988, however, may still contain the old wood stoves or fireplaces if they were not replaced. In many large cities, the most common and least restrictive action is to limit wood stove and fireplace use, often in the winter, when air quality is most threatened. During the wintertime, wood smoke does not rise and disperse but remains close to

the ground and can reenter the house or other homes and buildings nearby (WDOE 2004). Pueblo County does not currently have any restrictions regarding wood stove and fireplace use. In Colorado, mandatory residential burning restrictions are only in place in the seven-county Denver metro area which includes Denver, Boulder, Broomfield, Douglas, Jefferson, and areas west of Kiowa Creek in Adams and Arapahoe counties (CDPHE 2008f).

Every year from October 31 through March 31, the Colorado Air Quality Control Commission Regulation No. 4 requires that in the counties listed above, uncertified wood stoves or conventional fireplaces are not used on high pollution days (red advisory days), which are days that conditions are right for increased levels of air pollution (CDPHE 2008f). Repeat violations may result in fines ranging from $100 to $15,000 per day. Exemptions to these restrictions apply only to those people using Colorado Phase III (Phase II EPA) certified stoves, approved pellet stoves or masonry heaters, or wood stoves or fireplaces as their primary source of heat. People that live above 7,000 feet are also exempt from restrictions (CDPHE 2008f).

Regardless of whether a city has residential burning restrictions, the EPA strongly encourages safe, efficient burning practices like burning small, hot fires using only clean, dry, seasoned hardwood in a wood stove or fireplace (EPA 2008m). To father reduce wood smoke, the stove or fireplace should be cleaned and inspected annually.

Potential Exposure in Pueblo County

According to the EPA (2008m), approximately 10 million wood stoves are currently in use in the United States, and 70 to 80% of them are older, inefficient, conventional stoves that pollute. The exact number of homes in Pueblo County that use uncertified wood stoves and fireplaces is unknown. According to the 2000 U.S. Census, over 80% of the homes in Pueblo County were built prior to 1989. Therefore, a portion of these homes may have wood stoves or fireplaces not certified by the EPA. As of the year 2000, approximately 530 homes, or one per cent of total homes, in Pueblo County use wood as the primary type of fuel to heat the home (US Census Bureau 2000b). Nearly half of these homes are located in Colorado City, Rye, and Beulah Valley. Children, elderly, and those individuals with pre-existing lung and heart conditions residing in homes that use uncertified wood stoves and fireplaces may be particularly susceptible to exposure to wood smoke. Exposure and effects are possibly more likely for susceptible individuals living in homes that use wood stoves and fireplaces as their primary heat source since the exposure will be more frequent and long-term.

POTENTIAL VIRAL EXPOSURES VIA BIOLOGICAL VECTORS IN PUEBLO COUNTY

WEST NILE VIRUS

West Nile Virus originated in Asia, Eastern Europe, Africa, and the Middle East but is a relatively new disease in the United States. Since the first human infections in New York in 1999, West Nile Virus has quickly spread and as of 2006 has been reported in all of the contiguous United States (CDPHE 2008d), reaching Colorado in 2002. This virus is transmitted by certain mosquito species. In Colorado, the main species of mosquito that can transmit the virus is *Culex tarsalis*. West Nile Virus is sustained in a bird-mosquito-bird cycle in which the mosquito contracts the virus by feeding on an infected bird, usually a crow, magpie, raven or jay. The mosquito, through feeding, either infects another host bird and the virus is maintained, or it can infect "dead-end hosts" like humans and other animals such as horses. In these dead-end hosts, the virus cannot be transmitted to another mosquito. The risk of contracting the virus from a mosquito is greatest during August and early September at dawn and dusk when the mosquitoes prefer to feed.

Health Effects

Many people infected with West Nile Virus do not become ill. Individuals who do become ill usually experience viral fever syndrome within five to 15 days after being bitten. Symptoms include fever, headache, and malaise and last for approximately two to seven days. In rare instances, encephalitis, which is an inflammation of the brain, or aseptic meningitis, can occur. Some of the symptoms of these severe diseases include:

- High fever
- Headache
- Stiff neck
- Disorientation
- Tremors
- Coma

Permanent brain damage and even death can occur, primarily in individuals 50 years or older (CDPHE 2008d).

Prevention

PCCHD helps to control the mosquito population through surveillance. In the summer, they set 12-hour mosquito traps every Monday night in 15 different zones in Pueblo County. When the number of trapped mosquitoes reaches 200 or if individuals issue a complaint, PCCHD will spray the zone (Heather Maio, PCCHD, personal comm., 31 July 2008). Additionally, the health

department treats standing bodies of water with larvicide and places mosquito eating fish (*Gambusia* species) in permanent water bodies.

To limit the risk of contracting West Nile virus from mosquitoes, people are also encouraged to:

- Limit outside activity around dawn and dusk
- Wear protective clothing such as lightweight long pants and long sleeve shirts when outside
- Apply insect repellant to exposed skin when outside (repellants with DEET are most effective)
- Repair or replace screens that have tears or holes in them
- Drain standing water that lasts for more than a few days (water may be in old tires, flowerpot saucers, tree holes, roof gutters, etc.)

Potential Exposure in Pueblo County

In 2003, Colorado had 2,947 cases of human West Nile Virus and 63 deaths (Table 9) (CDC 2007; CDPHE 2008e) and Pueblo County alone reported a total of 183 cases and 6 deaths that year (Table 10). The number of infection cases in Colorado was the highest of all of the United States in 2003 (Figure 25).

Table 9 - Cases of human West Nile Virus in Colorado from 2003-2007. The type of clinical diagnosis (fever, meningitis, encephalitis) is included (CDPHE 2008d).

Year	Fever Diagnosis	Meningitis Diagnosis	Encephalitis Diagnosis	Total Cases	Total Deaths
2003	2325	388	234	2947	63
2004	250	22	19	291	4
2005	85	13	8	106	2
2006	280	34	31	345	7
2007	477	44	55	576	7

Table 10 - Cases of human West Nile Virus in Pueblo County, Colorado from 2003-2008. The type of clinical diagnosis (fever, meningitis, encephalitis) is included (CDPHE 2008e).

Year	Fever Diagnosis	Meningitis Diagnosis	Encephalitis Diagnosis	Total Cases	Total Deaths
2003	136	35	12	183	6
2004	4	0	0	4	0
2005	3	1	1	5	0
2006	7	0	0	7	0
2007	16	2	2	20	1
2008	2	0	0	2	0

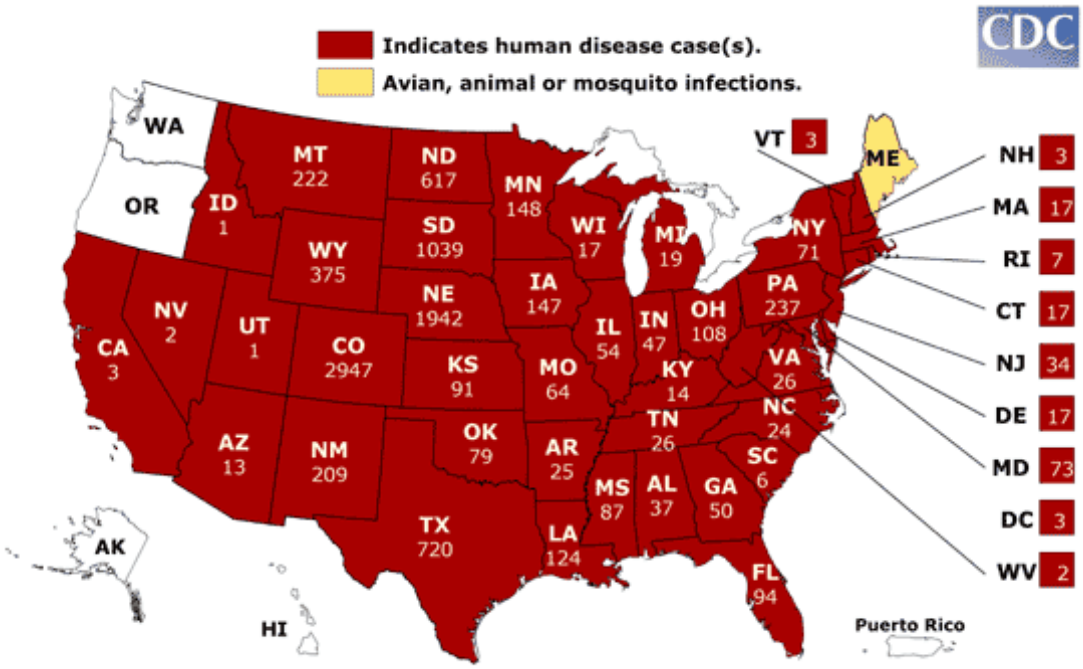

Figure 25 - Cases of West Nile Virus in the United States in 2003 (CDC 2007).

Cases of human West Niles Virus have been reported in Pueblo County each year since 2003 but Adams, Boulder, Larimer, Mesa and Weld counties have higher counts than Pueblo County nearly every year. These high counts might be present in farming communities due to larger

amounts and frequency of standing water like irrigation ditches. Additionally, larger amounts of people engaging in recreational or other outdoor activities (farming, ranching) may increase the potential for exposure. Overall, approximately 80% of the cases each year in Colorado are diagnosed with only a fever and do not develop the more severe symptoms and complications. The average age of individuals showing symptoms of West Nile Virus in Colorado is approximately 46 years.

Since 2003, the number of annual cases has decreased considerably in Pueblo County as well as in the entire state of Colorado. The decrease in cases may be due to increased awareness and effective prevention methods employed by individuals and local health departments. The amount of yearly precipitation may also be partly responsible for the drastic decrease beginning in 2004. The 2003 year was a particularly dry year and in dry years there are less pools of water available, possibly increasing the chance of interaction and thus, viral transmission, between birds and mosquitoes (Heather Maio, PCCHD, personal comm. 12 June 2008). It is important to note that the occurrence of human West Nile Virus cases is difficult to predict since additional variables such as temperature, humidity, and vegetation may also influence mosquito and disease presence and abundance (NASA 2008). While there were only two cases of human West Nile Virus this year in Pueblo County, mosquitoes tested positive for WNV in August and September. Also, the number of trapped mosquitoes exceeded 200 and complaints were issued (Chad Wolgram, PCCHD, personal comm. 12 December 2008), suggesting that the potential for exposure existed.

The potential for individuals to be exposed to West Nile Virus in Pueblo County is high, primarily from late July to early September. Individuals around 50 years of age or older may be especially susceptible and may develop more severe complications. The extent of exposure from year to year is extremely variable however, due to numerous factors that influence mosquito and disease presence and abundance.

CONCLUSION

Due to time constraints, a few of the community's concerns were not able to be addressed. These concerns include: tobacco smoke, tuberculosis, and illegal drug use. Nevertheless, this report provides information regarding 18 potential exposures in Pueblo County. The Pueblo CAREs Steering Committee, along with the community, can now determine which potential exposures can be decreased through awareness and possibly preventive or control measures. Some temporary exposures which may require further consideration include: dust and particulate matter from construction sites, household hazardous materials/ waste, illegal dumping, and pathogens in Fountain Creek. Long-term exposures that may require additional consideration include radon and lead levels inside the home. There is much uncertainty regarding exposure and effects for nearly all concerns in Pueblo County, especially for industrial emissions, PPCPs, and uranium / radium in drinking water wells. Increased monitoring is highly recommended in order to determine an accurate description of risk from these potential exposures in Pueblo County.

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APPENDIX D: BROWNFIELDS PRESENTATION

(see attached PowerPoint)