Challenge

The Pikes Peak Region receives an average of 10 to 16 inches of rain per year, usually in intense, short bursts. This means that one of the fastest growing areas in the country receives very little water to support that growth, and pollutants that build up on surfaces such as pavement are concentrated when flowing into rivers and creeks. Water that is transported from other areas for use in the Pikes Peak Region may have existing pollutants. The challenges are to conserve more water with an ever-growing human population, protect watersheds for wildlife and training, and prevent pollution from entering the region's waterways and aquifer systems.

Key Considerations

- **Consumption** – Water is used for many different purposes including residential use, industrial processes, and landscape irrigation. Care must be taken to minimize consumption so that adequate water is available and permit limits are not exceeded.
- **Nonpoint Source Pollution** – As water moves across and through the land, it picks up natural and manmade pollutants and deposits them in lakes, rivers, wetlands, coastal waters, and underground aquifers.
  – Ordnance expended at ranges and munitions-training areas can release pollutants.
  – Erosion on active construction sites and training lands discharges sediment and nutrients into streams and lakes.
  – Runoff from industrial areas such as motor pools may contain automotive chemicals, oil, grease, and metals.
  – Contaminants from leaking underground storage tanks can enter groundwater directly and can travel to surface water and springs.
- **Point Source Pollution** – Specific industrial processes, such as sewage plants, and storm water outfalls that discharge to surface waters constitute point source pollution. These processes usually have permits that limit the allowable level of various pollutants. Failure to meet these limits can threaten water quality in bodies that receive the polluted discharge.

Importance to Fort Carson

Mission – A reliable source of water for drinking, maintaining vehicles for training, landscaping, and industrial uses is critical to Fort Carson's continued operation. In the semi-arid climate in which the Installation is situated, water shortages and maintenance of water rights are a real concern.

Quality of Life – Plentiful, clean water for drinking, hygiene, and aesthetics is essential to a high quality of life.

Cost – Fort Carson spent over $1.6 million for 1,114 million gallons of water in 2000 and $1.6 million for 1,063 million gallons of water in 2001. Because the quality of the water supply is good, only a minor amount of funds was spent on water treatment. It is estimated that approximately $3,626,000 will be spent in 2002 for protection of groundwater and surface water quality, and for water resource restoration. This figure does not include costs for operating the wastewater treatment plant.

Environment and the Community – The Fountain Creek Watershed is currently undergoing major channel changes due to an influx of water from sources outside of the watershed. Additional water causes severe erosion in some areas and deposition in other areas, which can magnify the effects of flooding, disturb riparian systems, and damage property and roadways. The causes of increased water flow include changes in land use from rangeland to urban use (concrete surfaces increase runoff), increased wastewater treatment plant discharge, and transbasin imports of water. The Pikes Peak Region is growing rapidly; eventually, all water users in the area will have to adjust to the growth to sustain the supply and quality of water.

- Fountain Creek is fed by a groundwater system; therefore, it is important to protect groundwater from contamination. An extensive groundwater monitoring system, approved by the State Department of Health, is in place at the Installation. This monitoring system provides comprehensive data on the effects of landfills on groundwater. Groundwater at Fort Carson is not used as a source of drinking water; the groundwater is naturally high in salts where shallow and high in radiation where deep.

Increased urbanization causes water quality and quantity problems. Impervious surfaces allow more

runoff to enter a stream and contribute pollutants such as gasoline, oil, and salt. In the summer,
runoff from paved surfaces can raise stream water temperatures. Due to increased water volumes in
Fountain Creek, upstream reaches are being undercut, while downstream reaches have larger deposits
of sediments.
Fort Carson manages seven water rights for wells. Only a few recreation areas and minor activities
use well water at the Piñon Canyon Maneuver Site. This is an ongoing activity that requires
monitoring and reporting. To retain well rights, beneficial use of the well water must be demonstrated. If beneficial use is not shown, the rights could be subject to abandonment.

Introduction

Water for Fort Carson is supplied by Colorado Springs Utilities. Water is used principally for industrial
purposes, personal consumption, vehicle washing and maintenance, and landscaping. Water quality and
water quantity are closely related. As the amount of water decreases, pollutants become concentrated and
the supply of useable water decreases. Most of the water used in the Pikes Peak Region comes from lakes
and reservoirs scattered throughout the mountains. The water is transported via pipeline to supply the region
with drinking water that surpasses state and federal standards. Water for the Piñon Canyon Maneuver Site
comes from the City of Trinidad. Water for the Turkey Creek Ranch Recreation Area is drawn from a well,
treated by reverse osmosis, chlorinated, and stored in two above-ground water tanks.
Colorado Springs Utilities draws the water from 25 reservoirs. Colorado Springs Utilities currently secures supplemental water from the western slope of the Rockies for use on the Front Range. In 2000, Fort Carson used a total of 1,114 million gallons of potable water and released 554.8 million gallons of treated water from its sewage treatment plant. Peak water use occurs in July and August (Figure 1.1), typically the warmest months in the area. Colorado Springs Utilities has sole control over its water distribution; thus, if water supplies decrease in the future, Fort Carson may be allowed to purchase only limited amounts of water, diminishing its ability to accomplish its mission.
Fort Carson has three natural watercourses through the cantonment, all of which drain into Fountain Creek.

The drainages are Clover Ditch, B Ditch, and Unnamed Ditch. The remainder of the Installation, including training lands, drains south into Beaver Creek and eventually into the Arkansas River. At this point, the Arkansas River is not heavily impacted by urbanization because the area is not heavily developed. Approximately one-half of the Installation drains into the Fountain Creek Watershed and the other half drains into the Arkansas River Watershed (Figures 1.2 and 1.3).

Regulations At A Glance

Clean Water Act (CWA) – In 1972, the U.S. Congress enacted the first comprehensive legislation to control water pollution. One of the dominant features of the CWA is a federal permitting program called the National Pollutant Discharge Elimination System (NPDES). The CWA requires states to identify pollution sources for water bodies that fail to meet state water quality standards and to develop Water Cleanup Plans to address those pollutants. The plans establish Total Maximum Daily Loads (TMDL's) that limit the amount of pollutants that can be discharged to the water body while still meeting state standards.

Safe Drinking Water Act (SDWA) – The 1974 SDWA was developed to protect public health. Under the SDWA, USEPA established the Source Water Protection and Wellhead Protection Programs. The Source Water Protection Program emphasizes preventing contamination of drinking water resources and includes wellhead protection and sole-source aquifer watershed control plans. By definition, a sole-source aquifer must be the sole or principal drinking water source for an area, such that contamination would create a significant public health hazard.

Figure 1.1 – Monthly Water Use for Four Years (thousands of gallons)
Figure 1.2 – Watersheds on Fort Carson Figure 1.3 – Fort Carson Stream Map

On the Installation, eight reservoirs hold approximately 1,090 acre-feet of water. Fifty-six outfalls have been identified. An outfall is a point on the land where storm water has the potential to discharge into a natural watercourse. Outfalls need to be protected from polluted water, which includes water that is heated or that has drained across paved roadways and is carrying pollutants from vehicles. Through culvert and ditch

maintenance, bank sloping projects, reseeding, construction of retention ponds, and drainage control drop

structures, Fort Carson is trying to ensure that water leaving the Installation is clean and released in appropriate volumes.

The Fountain Creek Watershed is the primary watershed for the industrial portion of the Installation and surrounding areas. This watershed is undergoing channel changes due to increases in transmountain diversions of water into the watershed and increased urban runoff, which cause increased erosion and flooding problems (Figure 1.4). Erosion and increased flooding decrease the economic value of areas near creeks. The Pikes Peak Area Council of Governments, in which Fort Carson participates, is addressing these issues through the Fountain Creek Watershed Plan Technical Advisory Committee.

Figure 1.4 – Sources of Water Increases to the Fountain Creek Watershed (From the Pikes Peak Region)

Water use increases in the summer months; 90 percent of the increase is due to a greater need for irrigation. This amounts to approximately 200 percent more water, or over one million gallons of water per summer month for irrigation alone. Also, wash rack use due to training rotations increases in the

summer. At $1.60
per thousand gallons of water, the total cost for water dramatically increases in the summer (Figure 1.5).
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Except for localized contamination, water in the Pikes Peak Region is of good quality. For Fort Carson, the
primary issues are the potential for groundwater contamination from landfills, the potential for materials
spills, and mercury in the Turkey Creek drainage area. The landfills are monitored by a system of
groundwater monitoring wells. Hazardous material (HAZMAT) teams address spills immediately. High
mercury levels are bioaccumulated in fish and other wildlife in the Turkey Creek drainage area. However,
the source of mercury is thought to be natural, and there are no practical actions that may be taken at this
point. Fort Carson is currently investigating, remediating, and monitoring the groundwater associated with
several landfills, underground storage tanks (UST), and spill sites. There is a hydrologic connection between
surface water and groundwater in the area. The proposed budget for water protection for 2002 is $3,626,000.
Major restoration and monitoring activities and their costs are listed in Figure 1.6.

Figure 1.6 – Primary Restoration Costs Proposed for 2002

Soil vapor extraction system for sewage treatment lagoons at Butts Air Field $55,000
Long-term monitoring and excavation of impacted soils at the Equalization Basin $270,000
Long-term monitoring and soil vapor extraction at Building 1515 Service Station $40,000
Removal of free product from well near site of former UST at Building 1211 $50,000
Continuation of tank and product removal from subsurface at Building 1882 UST $225,000
Long-term monitoring and cleanup of Landfill 1 area $135,000
Long-term monitoring at industrial wastewater treatment area $30,000
Other (continued monitoring, sampling, and maintenance of other sites) $2,821,000

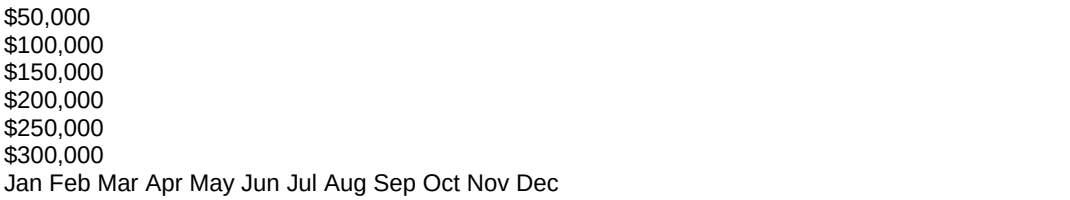

Figure 1.5 – Monthly Costs for Water Use for 2001
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The Fort Carson Restoration Advisory Board plays a major role in ongoing environmental restoration
activities at the Installation. The board consists of personnel from Fort Carson and regulatory agencies, and

citizens representing the interests of the surrounding communities. Members meet quarterly and are invited
to participate in decisions concerning restoration activities.
The primary receiving waters from the Fort Carson Sewage Treatment Plant are within the Fountain Creek
Watershed and Fountain Creek itself. Fort Carson has done much to improve ammonia levels entering
Fountain Creek by improving its sewage treatment processes. Unfortunately, due to growth and urbanization
in the Colorado Springs metropolitan areas and suburbs, Fountain Creek still suffers from erosion and
sedimentation problems as well as impacts from storm water runoff.

Background for Piñon Canyon Maneuver Site

All water from the Piñon Canyon Maneuver Site eventually flows into the Purgatory River or Timpas Creek
(Figure 1.7). The streams at the Piñon Canyon Maneuver Site are ephemeral, flowing only seasonally, with
high flows in May through August and low or no flows September through April (U.S. Geological Survey
Water Resources Report 91-4095).
The Army has a strong interest in maintaining the environmental integrity of its training lands. Fort Carson works with federal and state geological surveys and other agencies and universities in continuous study and monitoring of the health of the Piñon Canyon Maneuver Site. The major use of the Piñon Canyon area changed from livestock grazing to military maneuvers in 1985. Some detrimental effects from livestock grazing, such as trampling and destruction of riparian areas may have been mitigated with the change of land use. However, military maneuvers damage vegetation and increase soil compaction, which increases flow into streams. Any long-term increase or decrease in stream flow has deleterious effects on the watershed that contains the stream.
Fort Carson is proactive in addressing water quality and flow at the Piñon Canyon Maneuver Site, with careful training rotation schedules, erosioncontrol
dams, Maneuver Damage Control training, and continuous studies of the area. According to the U.S.
Geological Survey (USGS) (Water Resources Report 91-4095), measurements of stream flow and water

quality parameters such as cadmium, copper, iron, lead, and dissolved oxygen show no statistical difference
at the Maneuver Site since military training began. Sediment yields were smaller or unchanged in all but one
of the 21 drainage basins examined in the training area. This could be due to the change from long-term,

Figure 1.7 – Map of Piñon Canyon Maneuver Site Waterways

widespread plant material removal (from grazing) to short-term, localized plant removal caused by military
activities. The rotating schedule for training allows for some plant recovery between training sessions.
Overall, on the Maneuver Site, range conditions have improved since the primary use changed from grazing
to military use (USGS Water-Resources Investigations Report Number 91-4095). There is reduced erosion
and reduced sediment transport due to maneuver erosion-control structures such as hardened crossings and
erosion-control dams. Improved range conditions and less sediment transport and erosion protect water
quality by promoting more stable channels that reflect the natural geomorphology of the stream.

Activities and Impacts

Due to the interconnected nature of water resources, human activities can affect water supply and quality in a
number of ways. Pollutants can travel in rainwater over the surface of the ground to waterways or they can
filter into groundwater. Pollutants that leach into the ground can travel many miles in unexpected directions
in underground streams and contaminate connected surface water systems. Therefore, pollutants from land

use activities and discharges that occur within watersheds or aquifer recharge areas can affect surface water
and groundwater resources adjacent to and far away from the activity.
Activities on Fort Carson can result in three main types of water-related impacts: depleted water sources,
nonpoint source pollution, and point source pollution. Figure 1.8 illustrates the activities and impacts
associated with water consumption in Fountain Creek Watershed.
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Figure 1.8 – Major Areas of Water Use, Flow, and Impacts

The Human Perspective

Small, individual water reductions can add up to huge conservation measures. For example, El Paso County
has 141,516 households; if each household conserves only one gallon of water per day, over 51 million
gallons of water may be conserved in El Paso County alone. At Fort Carson, conserving one gallon per
household per day, which could be accomplished through water-conserving faucets and low-flush toilets,
would conserve up to 2.6 million gallons of water per year and save the Installation $416,000 per year—with
no impacts to consumers. Applying xeriscaping techniques, which use native species that do not require
irrigation, can also conserve significant amounts of water.

Beyond the Pikes Peak Region

The eastern Front Range of the Rocky Mountains in Colorado is being developed at an incredible rate,
leading to increasing water demand. If population on the western slope continues to increase, the amount of
water the eastern Front Range can take from the west is likely to decrease. Furthermore, robbing lakes and
streams of their water is not a good practice from a riparian and stream system perspective.
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Forecast

The State Demographer estimates that Colorado will gain 1.7 million new residents by 2020
(http://www.colorado.edu/Law/NRLC/WaterandGrowthFAQ.PDF). Due to increases in development in the
area, some dams have been built to provide reservoirs for drinking water. However, some dams that were
proposed were not approved, primarily because of concerns over extensive damage to ecosystems.

Reallocation of water rights from high-use sectors, such as agriculture, may soon be used to gain more water
for Colorado's growing population.
The Supreme Court and nine interstate compacts (which can only be modified by Congress) govern
Colorado's water use. These compacts list the rights of each concerned state over shared rivers. As long as
there are no modifications to the compacts, Colorado's water rights will remain secure.

Current Sustainability Activities

Fort Carson is progressive in its award-winning water conservation and protection measures. A strong water
program requires command support and a proactive champion. The Directorate of Environmental
Compliance and Management (DECAM) works closely with the Directorate of Public Works to develop
progressive programs that serve the community and the environment as well as the Installation. Figure 1.9
illustrates water use over an 11-year time period.

Central Vehicle Wash Facility – The Central Vehicle Wash Facility is a one-stop location for washing of
all military vehicles, especially after training rotations. By centralizing the location, Fort Carson recycles its
wastewater and reduces consumption. This system saves 150 to 200 million gallons of water per year and
has saved over 4 billion gallons of water since start-up in 1990.

Irrigation by Treated Wastewater – Since 1971, treated wastewater has been pumped from the
Installation's sewage treatment plant to irrigate Fort Carson's golf course (180 acres of grass). This practice
conserves over 100 million gallons of potable water per year.

Figure 1.9 – Water Use: 1989 Through 2000

Composting Toilets – Designed for high-use recreational facilities, composting toilets have been installed at
Iron Horse Park, Fort Carson's main recreational facility, and at the Installation's golf course. This type of
toilet uses only 1,825 gallons of water per year instead of the 200,000 gallons used in a

traditional toilet. In addition, the 220,000 gallons of wastewater produced by a traditional toilet must be sent for treatment.

Beneficial Landscaping – Some beneficial landscaping measures are currently in place at the Installation. All turf irrigation is operated on a watering schedule for maximum efficiency, moisture probes are used in some areas, and xeriscaping is encouraged and used in some areas. Fort Carson has been designated a "Tree City USA" for 10 consecutive years, due to its use of trees for erosion control, wildlife habitat, and energy conservation. Fort Carson plants more than 150 trees per year.

Leak Detection Surveys – A water leak detection survey at the vehicle wash racks has prevented the potential for leakage of 70 million gallons of water per year.

Ultraviolet Disinfection of Wastewater – Fort Carson was able to greatly reduce its use of gaseous chlorine and gaseous sulfur dioxide by switching to ultraviolet technologies in the disinfection process. This switch has ensured that wastewater is cleaner when released.

Barracks and Family Housing Improvements – Many water flow devices in the barracks and family housing areas have been retrofitted with low flow devices such as one-gallon-per-flush urinals and low flow toilets, faucet aerators, and showerheads.

Fountain Creek Watershed Community Participation – Fort Carson actively participates in the Fountain Creek Watershed committee, which works with watershed stakeholders to address erosion and flooding in the Fountain Creek watershed.

Horizontal Axis Washers – DECAM purchased four horizontal axis washers as a pilot study in 1998. The washers have saved money and water as predicted, but are more expensive than traditional washing machines. However, these machines provide significant savings in reduced maintenance costs.

The Realm of Possibility

To become sustainable, Fort Carson is encouraged to identify and plan for innovations that will support the goals established during the Installation Sustainability Workshop. To do this, participants should review the concepts and technologies that are within the realm of possibility now and in the future. This section provides a glimpse of what can be accomplished with existing technology and what can be expected from developing sustainability approaches.

Water Consumption

- **LEED System** – The U.S. Green Building Council's release in 2000 of the Leadership in Energy and Environmental Design (LEED) rating system provides a national standard for evaluating and comparing green building performance. The Army has developed its own version of the LEED standards called the Sustainable Project Rating Tool (SPiRiT), which includes additional rating factors appropriate to military projects and facilities. Projects are rated for sustainability in eight categories: sustainable sites, ***water efficiency***, energy and atmosphere, materials and resources, indoor environmental quality, facility delivery process, current mission, and future missions. More information on the SPiRiT standards can be found at http://www.cecer.army.mil/sustdesign/SPiRiT.cfm. SPiRiT standards that will assist Fort Carson in limiting impact on water quality include:
  - C1 – Water-Efficient Landscaping. Limit or eliminate the use of potable water for landscape irrigation.
  - C2 – Innovative Wastewater Technologies. Reduce generation of wastewater and potable water demand, while increasing local aquifer recharge.
  - C3 – Water Use Reduction. Maximize water efficiency within buildings to reduce the burden on municipal water supply and wastewater systems.
- **Xeriscaping** – Xeriscaping, a landscape design method that creates elegant and water-efficient landscapes that require little or no irrigation, uses native plants that are as attractive as traditional ones (http://www.ciwmb.ca.gov/organics/xeriscaping/default.htm).
- **Irrigation Meters** – Irrigation meters, in use in western Texas, save one to two-thirds of water formerly used for irrigation. A $1 block of gypsum, buried at the root zone, is connected through two wires to a clip-on meter that reads soil moisture. Drip irrigation, which delivers a small amount of water directly to the root zone of plants as needed, also drastically reduces water use.
- **Renewable Desalination** – Freshwater supply is an issue of great importance to the overall sustainability of communities, especially those in water-scarce regions. In some places, desalination

is the only way to provide reliable (yet extremely expensive) freshwater to the population. The Greek
island of Milos is rapidly reaching the point where freshwater supply will not be adequate for
habitation anymore. A pilot project is underway that will tap the island's geothermal energy to
desalinate seawater. If successful, the desalination plant will become a net ***producer*** of electricity
and will lower the cost of freshwater on the island 200 times, all while producing no emissions
(http://www.wbcsd.org/casestud/gerling/index.htm).

LEED System
Low Flow Fixtures Renewable Desalination
Xeriscaping Greywater Recycling
Water Conservation Easements
Gypsum Block Metering
Nonpotable Irrigation

- **Greywater Recycling** – The future of sustainable water use is *in situ* water recycling and reuse. A
large portion of the water we use becomes “greywater” when it is washed down our sinks and
showers. This water, with minimal treatment by natural and cost-effective means, can be reused
many times over for irrigation, flushing of toilets, and even dishwashing. The home or office of the
future could provide up to 70 percent of its daily water needs through simple recycling of bath and
laundry water. Treatment systems will be low-tech and cost effective, many times using natural
bacteria and plants to clean water
(http://www.greenbuilder.com/sourcebook/Greywater.html) and
http://www.greywater.com/).
- **Camp, Dresser and McKee** – Camp, Dresser and McKee (CDM) have pioneered a number of water
management technologies that reduce the impact on local water resources. Aquifer storage and
recovery (ASR) systems store storm water and treated wastewater in underground “bubbles” where
the water can later be removed. It increases water reserves in times of drought and decreases total
drain on natural aquifers. CDM also helps design and build stormwater overflow systems and TMDL
management programs that help address point and nonpoint source pollution problems.
- **Water Conservation Easements** – In cooperation with the Nature Conservancy, Fort Huachuca has

purchased several water conservation easements. The easements were purchased to restrict water use
and preserve ecosystems in the area. The easements decrease the use of water near the installation so
that the water is available in the future, while providing a service to the community and the
environment.

- **Nonpotable Water Irrigation** – Potable water irrigation can be replaced with water from Fountain
Creek at one-half the cost of treated water. Fort Carson already has the pipe connectivity needed to
irrigate with water from the river.

Nonpoint Source Pollution

- **Low-Impact Development** – Low-impact development practices can minimize impervious areas,
thereby maximizing groundwater recharge (http://www.stormwatercenter.net). Proper management
of stormwater protects surface and groundwater from contamination, which is critical to Fort Carson
and the surrounding region. Contaminants (e.g., oil, fuel, and sediments) are eliminated if the
stormwater is retained on site and allowed to seep into the soil, rather than run off into streams.
- **Green Roofs** – All across the country, thousands of apartment buildings and offices are now growing
"green roofs" in place of traditional roofing material. These roofs, made of any number of plant
species, soak up water when it rains rather than letting it run off into area rivers and streams. It
lowers both the overall volume and contamination levels of the runoff.

Green Roofs
Low-Impact Development
Porous Pavement

- **Porous Pavement** – Porous pavement helps reduce storm water volume and contamination by letting
rainwater percolate through the pavement rather than collect and be funneled into local watersheds.

Point Source Pollution

- **Living Machines** – Living Machines® use bacteria, plants, snails, and fish to treat sewage and other
wastewaters. The machines look like greenhouses and work by using plants and animals to break
down the wastes and digest organic pollutants. Made by Living Technologies, Inc., they have been

permitted at 23 locations in 7 different countries, including the United States. They offer better, more
stable treatment at the same cost as traditional sewage treatment while decreasing wastewater
treatment needs and biosolids disposal.

- **Constructed Wetland** – Fort Knox, KY, is conducting a feasibility study on construction of a
wetland that would link the sewage treatment plant outfall to the drinking water intake. A wetland
works similarly to the Living Machines® described above; wetland plants and animals purify the
wastewater as it flows through the wetland. Constructed wetlands have the potential for containing
and treating nonpoint source pollution from ranges and other natural areas.

Fort Carson 25-Year Goals for Water

To be determined by Fort Carson Command and staff, as advised by members of the local and regulatory
communities, at the Installation Sustainability Workshop on 4-6 September 2002.

Living Machines
Constructed Wetland