FORT HOOD ENVIRONMENTAL SUSTAINABILITY EXECUTIVE CONFERENCE

Message from the Garrison Commander

The Army environmental strategy is focused on four "pillars": compliance, conservation, restoration, and prevention. Fort Hood has adopted and made these four pillars of environmental stewardship a fundamental part of daily operations consistent with the accomplishment of the military mission, and we have developed these into an award-winning environmental program. A strong tradition of proactive, innovative, enduring, and partnering efforts to meet pollution prevention challenges will guarantee Fort Hood's role as a leader in the environmental arena as the Army moves into the 21st century. Sustainability of our installations is the future. Recently, the FORSCOM Commander explains in a 9 July 2001 memo:

> ***"Forces Command (FORSCOM) has a proud record of environmental compliance and stewardship. However, complying with environmental regulations and focusing on management of environmental resources inside the fence line is not sufficient to protect us from training constraints or ensure the long-term sustainability of our operations. Encroachment, funding uncertainties, aging infrastructure, and deteriorating natural resources outside our gates all threaten our ability to successfully accomplish our mission."***

At the Senior Environmental Leadership Conference held in November 2000, senior leaders mandated that we develop an integrated strategy that engages all stakeholders in the long-term viability of our installations. We are proud to be an integral part of that overall FORSCOM environmental mission. Environmental sustainability planning is a fast train and we are the lead car. From Abrams tanks to Apache helicopters, from our staunchest foot soldiers to our most dedicated contractors—we are a team of environmentally conscious professionals. We provide the most up-to-date training and support to our troops and are standing ready as the most lethal war-fighting machine in the Army—Task Force Hood! The environment and superior training—we will compromise neither.

Over 41,000 military and 3,100 Department of the Army civilians are assigned to Fort Hood. The total "daytime" on-post population exceeds 70,000, to include soldiers, civilians, contractors, and family members living on-post. The installation-supported population, which includes retirees, survivors, and their family members, is approximately 166,000. People, culture, and history are the historic make-up of this dynamic installation. Bonding together to ensure we support the mission while sustaining our land, resources, and environment is paramount to Fort Hood, its workforce, leadership, and the community.

Resource limitations, mission changes, and dwindling funding pose significant challenges for us in the future. We must be able to effectively integrate all aspects of how we do business in our daily routine. We must also ensure that we are wise stewards of our resources and the environment—that is our responsibility. Fort Hood is living a legacy—leaving our legacy is a must.

Protection of this legacy that we leave for Fort Hood is paramount and has already begun. We are using energy-saving appliances and lighting, designing and constructing buildings to meet and exceed "Green" standards, recycling everything from demolition materials to antifreeze, and supporting a commodity acquisition program that includes the purchase of all recycled products. "Green buying and building" is not a revolutionary process, rather it has been evolutionary—teaching, learning, and doing. It has taken time and practice, but we are now on the fast track.

Message from the Garrison Commander

June 11-13, 2002, will be an historical event for Fort Hood. During that time, we will host our first Environmental Sustainability Executive Conference where installation, community, state regulators, representatives from The Environmental Protection Agency (EPA), and other stakeholders will team together in a consensus-building process to establish the 25-year environmental goals for Fort Hood—*this Environmental Baseline document will be used as a blueprint for establishing these 25-year goals*. As proactive participants, I challenge each of you to look at our present environmental performance and how we are interacting with the local community, state, and federal agencies. We must then look at where we want to be 25 years from now. Mission changes, funding support, congressional environmental mandates, and growing communities, will all play a role in our decision-making processes for the future. This conference will be conducted in support of the FORSCOM Installation Sustainability Program and will serve as FORSCOM's Environmental Management System, as required by Executive Order 13148, Leadership in Environmental Management, 22 April 2000.

We are positioning ourselves for future success in several arenas to include (1) enabling ourselves to adopt better practices and technologies in the future, (2) building a framework to facilitate change, (3) improving our public image and our relationship with the community, (4) building a better working relationship with the state and EPA, (5) enlisting greater support from FORSCOM, (6) increasing our base of knowledge by using other installations as resources of new technological opportunities and lessons learned, (7) creating a management/planning tool for all installation agencies, and (8) providing a mechanism to distribute budgeting and implementation guidelines to the appropriate organization as required.

We will face challenges in meeting our environmental sustainability goals. Environmental regulations and associated issues are becoming increasingly complex and have the potential to impact all aspects of day-to-day operations. However, we must meet these factors head-on—it is not going to be easy. Teamwork and tenacity combined with creative management processes will afford us the ability to overcome these challenges, thereby facilitating our advancement throughout the next 25 years. Our commitment must persevere to obtain an environmentally sustainable facility, sound and effective training, and protect the quality of life for our most valuable commodity—our troops and their families, and the entire Fort Hood community.

I'M CONFIDENT WE'LL ACHIEVE - I LOOK FORWARD TO YOUR PARTICIPATION & CONTRIBUTIONS.

WILLIAM H. PARRY, III
Colonel, U.S. Army
Garrison Commander

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Water Resources – Water is a very carefully managed resource in Texas. The state's strategic water plan provides a detailed analysis of measures required to ensure that enough water is available for all Texans. The key aspect of this plan is that water supplies remain CLEAN. With the increasing population in Fort Hood and surrounding communities, managing consumption will be very important, and avoiding water supply contamination will be absolutely critical. Water will always be essential to the mission of Fort Hood. How can Fort Hood ensure that its activities support the state's water plan and maintain the water resources upon which it depends?

Air Quality – The local community around Fort Hood currently has good air quality. However, regional air quality in the Dallas, Austin, San Antonio, and Houston metropolitan areas surrounding Fort Hood does not meet current national standards for ozone, and is unlikely to meet future standards for particulate matter (e.g., dust and combustion products). If regional air quality continues to degrade, Fort Hood may face training restrictions on obscurants or other mission constraints, as well as higher costs of managing facilities. How can Fort Hood minimize future operational restrictions and costs while improving regional air quality?

Infrastructure – Facility construction, operation, maintenance, and demolition represent a significant investment and result in numerous environmental impacts. A building's siting and design drive its requirements for maintenance, energy, and water throughout its lifespan. How can Fort Hood provide the world-class facilities that soldiers and families deserve, while also reducing operation and maintenance costs, pollution, and resource use?

Energy – Energy is an essential resource for Fort Hood's training and deployment missions, and its availability and cost affect the quality of life for soldiers and families. Inefficient energy use increases operational costs and contributes to environmental degradation from resource extraction, climate change effects, and air pollution. High energy-price volatility makes it difficult to allocate and manage the installation's financial resources effectively. Finally, there are significant questions about the reliability of the energy supply due to both marketplace and physical interruptions. How can Fort Hood improve reliability of the energy supply, reduce costs and environmental impacts, and reduce the impact of price volatility on Fort Hood's operations?

Executive Summary

Products and Materials – Fort Hood purchases $655M worth of products annually and generates about 38,676 tons of waste per year. How can Fort Hood reduce the environmental liabilities and costs associated with waste disposal, promote sustainable manufacturing, and stimulate local/national markets for environmentally preferable products?

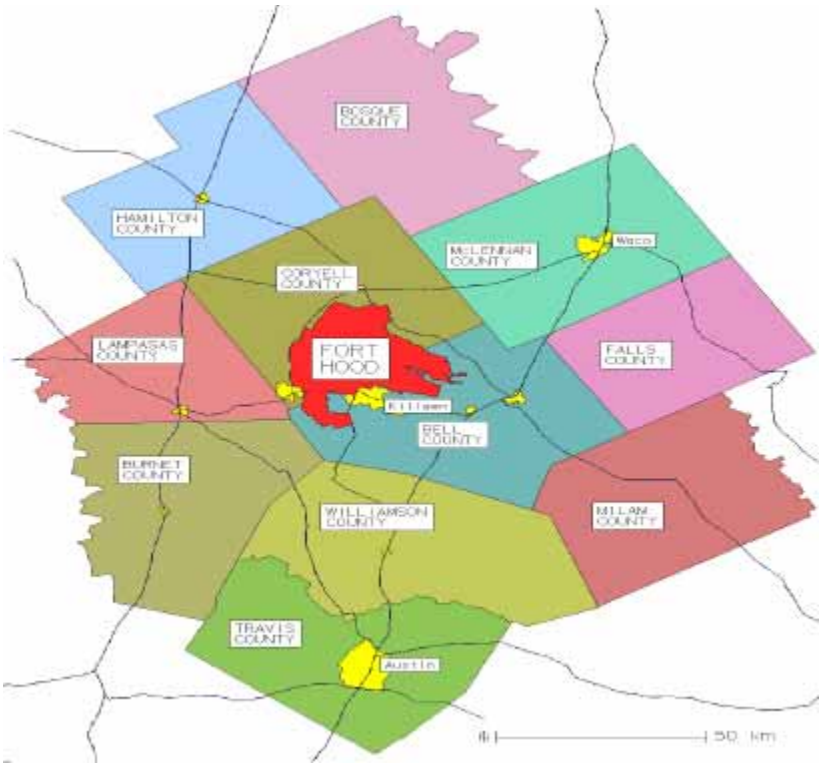
Fort Hood At A Glance

Introduction

Fort Hood is located in the heart of the central Texas hill country in Bell and Coryell counties. The post is approximately 70 miles northwest of Austin, 70 miles southwest of Waco, and 130 miles southwest of Dallas. Fort Hood is the premier installation for training and deploying heavy forces. It is home of the III Corps Phantom Command, 1st Cavalry Division, 4th Infantry Division, 13th Corps Support Command, and eight other brigade-size units. Fifty-three battalions are stationed at Fort Hood. Fort Hood also supports other assigned and tenant organizations, the U.S. Army Reserve, the National Guard, the Reserve Officer Training Corps, reservists from other military services, Operational Test Command, Medical Department Activity, and the Dental Command.

Encompassing a total of 212,500 acres, Fort Hood is the largest, most capable armored military training installation in the U.S. Army. The installation's primary mission is to train, house, and support III Corps units. Fort Hood also plays a key role in Army modernization by testing new equipment and systems. Facilities at Fort Hood are located in three separate cantonment areas: the main cantonment, West Fort Hood, and North Fort Hood. The main cantonment area is in the south central portion of the reservation just northwest of Killeen. North Fort Hood is southeast of Gatesville, and West Fort Hood is southeast of Copperas Cove. U.S. Highway 190 is the major highway access to the main cantonment and West Fort Hood. Access to North Fort Hood is by Texas Highway 36.

Currently, more than 2,500 tanks and other tracked vehicles, 193 helicopters, and 10,126 vehicles are assigned to Fort Hood. Over 100 motor pools service 15,000 vehicles and tanks. Fort Hood has nearly 5,000 buildings, including 2,700 family housing units, that total approximately 29 million square feet. More than 41,000 military personnel and 3,500 Department of the Army civilians are assigned to Fort Hood. The total daytime population exceeds 71,000 and includes soldiers, civilians, contractors, and family members living on-post. The installation-supported population, which includes retirees, survivors, and their family members, is approximately 182,600.



Main Cantonment

The main cantonment is organized along an east-west axis along the southern edge of the Fort Hood reservation. Troop housing extends from Hood Army Airfield on the east to Clear Creek Road on the west. Tactical equipment parks and maintenance shops for weapon systems and heavy equipment are located just north of troop housing areas, allowing convenient access to maneuver

training areas and live-fire ranges. The area immediately south of the troop housing area contains administrative, medical/dental, commercial service, recreational, and community facilities. Additional troop housing for support units and associated maintenance facilities are located south of this area. Darnell Army Community Hospital is in a quiet zone in the south-central portion of the cantonment near the main gate on Hood Road. Family housing areas are located south of the administrative and recreation belt, west of Clear Creek Road, south of U.S. Highway 190, and on the north and south sides of Tank Destroyer Boulevard. A large post exchange and commissary complex is located west of Clear Creek Road with easy access to U.S. Highway 190. Another commissary and post exchange complex is located off of Warrior Way Road, serving the East Cantonment Area. Supply, storage, and maintenance facilities have access to the Santa Fe Railway and are located in the southwestern portion near U.S. Highway 190.

Hood Army Airfield (HAAF) is adjacent to the northeast portion of the main cantonment on approximately 723 acres. The airfield, which is used by 193 rotary-wing aircraft, has a FAA-approved helicopter instrument approach with a 4,712-foot long runway. The airfield also includes hangars; maintenance facilities; helicopter training simulators; wash racks; and the petroleum, oil, and lubricants (POL) testing facility.

West Fort Hood

West Fort Hood is located approximately 6 miles southwest of the main cantonment area and consists of Robert Gray Army Airfield (RGAAF); the Training and Doctrine Command, Combined Arms Test Activity (TCATA); the research and testing administrative area; and the Fort Hood ammunition supply point. RGAAF consists of 2,142 acres with a 10,000-foot long, 200-foot wide runway and a parallel 75-foot wide taxiway that accommodates both Army and Air Force aircraft, including the largest jet transports. Troop housing and administrative facilities are located adjacent to the airfield along its northwest boundary. The ammunition supply point is located west of RGAAF; most ammunition is stored in underground reinforced concrete magazines, although some is stored in above-ground bunkers. Other units use some of the underground magazines for storage.

North Fort Hood

North Fort Hood is located approximately 17 miles north of the main cantonment at the northern edge of the installation. Currently, North Fort Hood is the primary site of reserve activities on the reservation and the location of annual, summertime, two-week active duty training for most reserve units. The cantonment area is organized along a northwest-to-southwest axis. Tactical equipment parks are located along the western portion of the axis, allowing access to maneuver and live-fire training areas. The troop housing area and administrative and support facilities are located along the axis to the east. An additional equipment park is located to the east along with two paved, noninstrumented airstrips: Longhorn and Shorthorn Airstrips.

Belton Reservoir

Belton Lake Outdoor Recreation Area (BLORA) is located approximately 8 miles east of the main cantonment along the southern edge of Belton Reservoir. It is the primary outdoor recreation area for the installation and has extensive facilities for water activities, recreational vehicle camping, and hiking.

Ranges

The 77 active ranges on Fort Hood comprise approximately 61,760 acres, including 21,587 acres of multipurpose maneuver/live-fire ranges. The range area, the dominant feature in the central portion of the reservation, is primarily contained by East and West Range Roads and is configured so that firing generally occurs inside these roads with projectiles directed toward the Artillery Impact Area. Numerous artillery and mortar firing points are located outside the range area in surrounding maneuver areas where artillery fire is directed toward the impact area.

Maneuver Areas

Fort Hood has 52 active training areas. The maneuver training area is primarily located to the east, southwest, and west of the live-fire training areas. The maneuver training area totals 138,940 acres; an additional 21,587 acres in the live-fire area are designated as multipurpose and are available for maneuver training. Maneuver training areas west of the live-fire training areas offer excellent training opportunities for armored and mechanized infantry forces and will support task force and battalion-level operations. Maneuver training areas east of the live-fire training areas are too small for large armored or mechanized infantry forces, but offer excellent company- and platoon-level dismounted training, along with engineer, amphibious, combat support, and combat services support training. Maneuver training areas in the southern portion of the reservation contain excellent terrain for training, but U.S. Highway 190 and the Santa Fe Railway tracks separate the site from the cantonment areas and the proximity to Robert Gray Army Airfield limits airspace access. Rugged terrain and dense vegetation characterize the maneuver training areas to the north of the live-fire training areas, so they are primarily used by small units for dismounted infantry training.

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Sustainable Training Areas

Sustainable Training Areas

Challenge

Sustaining Fort Hood's primary mission of training and readiness for the Army's III Corps is critical. How can Fort Hood accomplish its training mission while protecting the cultural and natural resources on base, protecting endangered species, and addressing concerns relating to urban sprawl, encroachment concerns, and nonmilitary training lands usage? How can Fort Hood manage training lands to sustain training and maintain a viable, holistic, biodiverse landscape capable of supporting military training and ancillary land uses?

Key Considerations

- **Training Land Conditions** – Land conditions directly affect the ability of Fort Hood's units to conduct and sustain realistic readiness training and to protect and enhance ecosystem health. Environmental concerns include erosion, vegetation management, sediment movement, runoff, water quality, endangered species, and wildlife habitat management. Sustaining the post's land at high quality conditions may require some land to be used for purposes other than the primary mission of indefinite support of readiness training.

- **Endangered Species** – Several plant and animal endangered species around and near Fort Hood require some level of management. Those such as winter residents or occasional migrants may be left alone. Currently, protection of endangered species results in some training restrictions at Fort Hood. Future expansions of designated endangered species habitats, or related additional constraints beyond those outlined in the 2000 Biological Opinion (issued by the Fish and Wildlife Service), may be detrimental to readiness training. Future installation plans should include procuring or leasing adjacent lands for increased habitats.

- **Noise** – Fort Hood is surrounded by expanding civilian communities. Close proximity of these civilian lands generates infrequent noise complaints. Resolution of such complaints requires community education on the importance of Army training and the role of Fort Hood units in the Army's Strategic Plans. Common sense training plans support readiness requirements and alleviate some civilian nuisance concerns. Noise models should be incorporated into community and regional planning to ensure "smart growth."

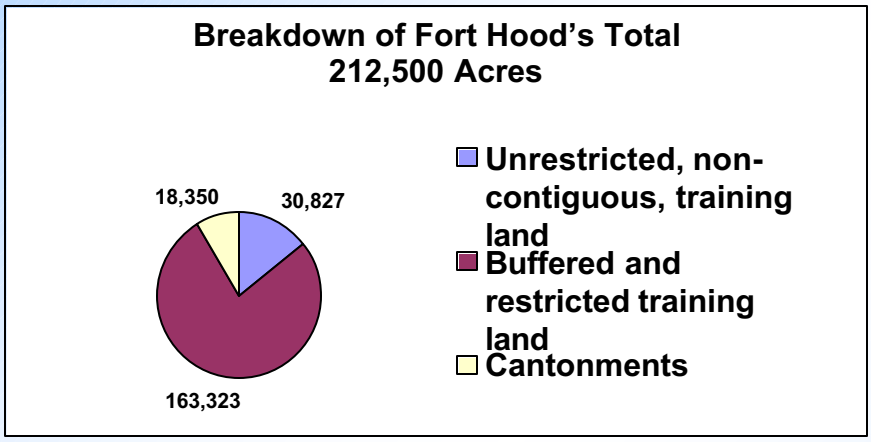
- **Encroachment** – Fort Hood should continue to work with local communities to influence local land use management to minimize (1) impacts of adjacent community growth on readiness training and training land sustainment and (2) impacts that Army activities may have on adjacent communities. The lease or purchase of adjacent lands can expand species' habitats, reduce restrictions on training, and create buffers between Army activities and the desirable growth of surrounding communities. Realistic community zoning and real estate transactions should reflect and minimize the impacts of Fort Hood's training mission.

- **Water Quality** – Fort Hood must manage, repair, and sustain training lands to minimize training impacts on surface water and groundwater quality. This includes reducing sediment movement, and removing munitions and metal contaminants from water sources.

- **Cultural Resources** – Fort Hood must manage, repair, and sustain training lands to minimize training impacts on cultural resources and to balance preservation and conservation with training requirements. The main restriction to training is digging within the boundaries of protected archaeological sites. Cultural resource staff must work closely with training staff, continually evaluating and protecting sites while supporting training requirements and priority work projects.

Importance to Fort Hood

Mission – Intense and realistic readiness training requires unencumbered access to adequate land. Training constraints imposed to protect, prevent, or minimize impacts to threatened and endangered species (TES), cultural resources, people, and water resources compromise readiness. Training land restrictions at Fort Hood are summarized below:



Quality of Life – Fort Hood's mission and large population contribute to the direct and induced growth of surrounding communities and to the local economy by providing business activity, employment, and personal income. Noise from live-fire exercises and aviation operations, dust, exhaust, smoke from maneuver training, and impacts from other military training activities are relatively minor costs associated with living or working on or near Fort Hood. However, impacts such as water or air quality concerns may become more significant, and may adversely affect soldiers, their families, and other local residents. Appropriate planning can minimize such impacts, presenting Fort Hood as a model for the regional community.

Importance to Fort Hood (Continued)

Cost – The monitoring, mitigation, and rehabilitation of lands damaged by military training (over the last 50 years) are costly. Land repair costs at Fort Hood are estimated at $200M. The current funding snapshot, shown below in Figure 1, depicts dollars dedicated to Fort Hood's military for land repair and maintenance and for future sustainment requirements.

Figure 1 – Training Area Costs

Operation Costs	FY01	FY02	FY03	FY04 to 08
Total Training Land and Sustainment Costs	$11.05M	$14.86M	$31.36M	$136.1M
Conservation Program	$0.75M	$0.83M	$4.9M	$24.4M
Integrated Training Area Management (ITAM)	$1.7M	$2M	$13M	$50M
Cultural Program	$1.4M	$4.3M	$6M	$30M
TES Program	$3.54M	$3.68M	$6.3M	$31M
Wildlife Program	$0.11M	$0.75M	$1.14M	$0.5M
Pest Management Program	$0.05M	$0.0M	$0.02M	$0.2M
Real Property Maintenance Allowance (Ranges & Training Area Structures & Trails)	$0.0M	$0.0M	UNK	UNK
Live-Fire Training Program	$3.5M	$3.3M	$6M	$45M

Environment and the Community – The development of open space around the installation brings community residents closer to Fort Hood's activities. This results in community concerns about contamination of land and waters, noise, and land sustainment. The installation's training areas are in rapidly growing Bell and Coryell counties. Between 1990 and 2000, the population in Bell County increased by 18 percent, and in Coryell County by 19 percent (Source: http://txsdc.tamu.edu/online.php).

Sustainable Training Areas

Introduction

Fort Hood is the only Army installation that supports two heavy divisions and is the only digitally-equipped Corps. Fort Hood supports the training of reserve forces and serves as a major power projection platform for the mobilization, training, equipping, and worldwide deployment of U.S. forces. Additionally, Fort Hood supports doctrine and equipment development for Army-wide fielding of units and weapons systems. As a result, intense, realistic training is absolutely critical to Fort Hood's readiness mission. The post is divided into 111 active training areas, 77 live-fire ranges, and one permanent impact area. There are 650 miles of tank trail and firebreak networks, 3 airfields, and 3 drop zones covering 194,150 acres. A total of 85,000 acres are designated as heavy maneuver training land. Training areas are used 242 days/year by active, National Guard, and Reserve units. Four division-size units train on Fort Hood, requiring 313,226 acres for doctrinal maneuver training. A significant shortfall of 100,726 acres exists. The training mission requires intense land use and causes land damage. Such routine damage must be managed and repaired to provide a continuous training resource.

Realistic management, preservation, and restoration of existing training areas are imperative to sustaining long-term unit readiness at Fort Hood. Rehabilitation and maintenance of this land are ongoing requirements and are costly. In 2001, the remediation cost of damaged Fort Hood training areas was estimated to be $200M. In FY02, $12M was requested for training area management under the Integrated Training Area Management (ITAM) program with $11.7M included for land rehabilitation; $2.085M was funded. Fort Hood requested $1.5M in FY02 of O&M environmental funds through DPW conservation programs. Conservation funding totaled $0.83M. Land rehabilitation cannot be indefinitely postponed. Seriously degraded land requires a very long time for rehabilitation.

Suitable open space land for training outside of Fort Hood cannot be acquired. Also, requests for small parcels of land on Fort Hood to support infrastructure, roads, utility easements, airfields, and expansions of the garrison cantonment have diverted training lands.

Land Use Requirements Studies (LURS) in the August 1997 and May 2000 editions of the Fort Hood Range and Training Land Program (RTLP) identified a total training area shortfall of approximately 100,726 acres. The estimate did not consider the effects of encroachment restrictions, cantonments, or buffer areas in the total training area acreage. In subsequent FORSCOM studies, Fort Hood acreage (212,500 acres) was found to be inadequate to conduct a full up brigade combat team exercise and meet all training standards. Continuous land usage exceeds the capability for the land to repair itself.

Specific encroachments on the use of Fort Hood's lands are listed in Figure 2 below. Acreage redundancy exists between numerous encroachments.

Figure 2 – Restrictions on Fort Hood Lands

	Acreage	%	Specific Restrictions
Undeveloped acres	198,126		
Restrictions			
• Core TES habitat	53,179	27%	Phase I* – 365 days/yr Phase II** – Mar to Aug annually (nesting season)
• Noncore TES habitat	21,209	11%	Phase I* – 365 days/yr
• Eagle habitat	10,000	6%	No flying below 1,000 feet over designated habitat
• Cultural sites	13,072	7%	No digging in site boundaries
• No dig	143,107	72%	TES habitats; cultural & riparian boundaries; 50m from streambeds, dams, roads, phone lines, pipelines, landfills, & installation boundaries
• Smoke restrictions	46,215	23%	Air field flight paths, cantonments, main roads, & parts of post
• Noise restrictions	1,082	1%	Noise complaints, MLRS & artillery live-fire restrictions in TA52A & TA51A
Total land with one or more restrictions	168,614	85%	
Unrestricted maneuver land (fragmented)	30,827	15%	

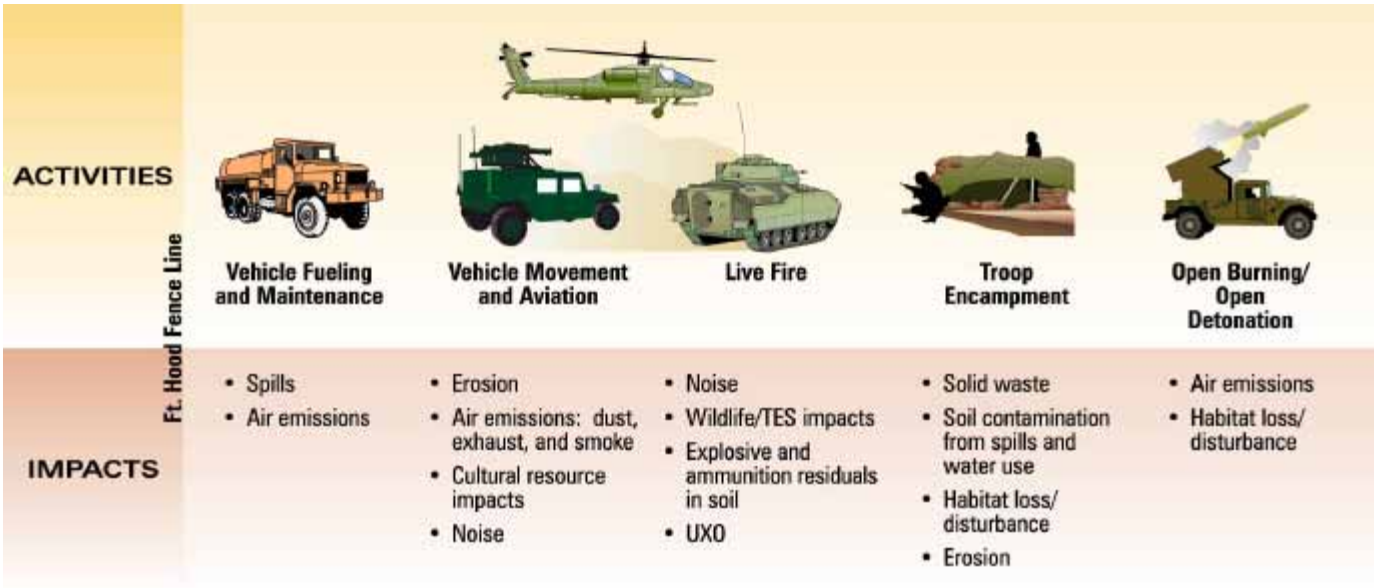
* Phase I Restrictions – No cutting of brush or trees, no open fires, no excavations. Use existing firing points, fighting positions, and emplacements only.

** Phase II Restrictions – Phase I restrictions plus the following: dismounts and vehicles must use existing roads and trails for maneuver in core habitat; no dismount or vehicle training during nest season in core habitat; no occupation or unit movements through core habitats to exceed two hours; and no use of obscurant smokes or CS agents in or within 100 meters of core habitat.

Activities and Impacts

The potential impacts associated with training activities are shown in Figure 3 below.

Figure 3 – Training Area Activities and Impacts



Wildlife Habitat and Threatened/Endangered Species

Fort Hood actively manages five endangered species, including the golden-cheeked warbler and black-capped vireo. Most management focuses on these two nesting species; the other three species are winter residents or occasional migrants that are no threat to training. A total of 74,388 acres of habitat is designated for these two nesting species (53,179 acres of core habitat and 21,209 acres noncore). Fort Hood is required to recover threatened and endangered species (TES). The U.S. Fish and Wildlife Service (USFWS) Biological Opinion for Fort Hood (26 July 2000) provides requirements and guidance on endangered species management. A cooperative agreement between Fort Hood and the Nature Conservancy allows the Nature Conservancy to conduct scientific research. Other active partnerships include the Army's Research and Development Labs, Strategic Environmental Research and Development Program (SERDP), and numerous research universities. The installation is active in developing partnerships with local communities, regulatory agencies, nonprofit organizations, and individuals to establish safe havens for endangered species on private lands.

Fort Hood works hard to balance training requirements and species recovery. A continual concern exists over habitat designations and additional training restrictions. Currently, Fort Hood maintains requisite habitat acres to recover the two nesting bird species for the region in which Fort Hood resides; additional demands would result in challenges to Fort Hood's training mission.

Sustainable Training Areas

Noise

Killeen, Copperas Cove, and other small communities border Fort Hood. Residential and commercial development continues to occur directly outside the reservation boundaries. Artillery firing, aerial bombings, and tank gunnery produce noise that often travels miles from Fort Hood. As encroachment continues and the surrounding population expands, noise complaints may increase. Noise is an inherent part of training. Creative noise management is encouraged. However, excessive restrictions could result in significant impacts to combat readiness.

Cultural Resources

Cultural resources on Fort Hood include pioneer homesteads, cemeteries, and prehistoric and Native American sites. Most potential conflicts between training and cultural resources are managed through the installation digging permit program and the Cultural Management Program. Locations of cultural sites are not published but are managed internally using the Geographic Information System (GIS). Some key archeological sites are identified in the field as "off-limits" areas to prevent maneuver damage. Capping and barricading key sites located in maneuver lanes are active protection measures until sites can be mitigated for long-term protection of the resource. Current cultural resource restrictions impact 13,072 acres, approximately 7 percent of available training lands. To reduce training impacts, cultural sites are routinely evaluated to determine site eligibility. Noneligible sites are declassified and their protection is removed. Training maps identify "controlled dig locations" to assist training managers and reduce risk of impacting protected cultural sites. Protected site reviews ensure a balance between cultural site preservation and maneuver training requirements to include dominating or key terrain. Additional information can be found on the following websites:

- ***http://www.dpw.hood.army.mil/HTML/ENV/sig_prop.htm***, and
- ***http://www.tsha.utexas.edu/handbook/online/articles/view/FF/qbf25.html***.

Regulations At A Glance

Various regulations impact or restrict our ability to use Fort Hood's lands for training activities. These include:

National Environmental Policy Act (NEPA) – This legislation directs federal agencies to evaluate planned land use activities and resolve potential environmental issues before initiating use or activity.

Endangered Species Act (ESA) – This legislation establishes a list of species that must be considered in land use decision-making. The goal is to protect struggling species and the habitats in which they can thrive.

Clean Air Act (CAA) – This act establishes regional air quality standards and can allow prescriptive restriction of activities in areas where air quality standards are not met.

Clean Water Act (CWA) – This act establishes national water quality standards that are translated into watershed specific requirements. Contamination or disruption of aquifers can result in fines and additional actions to address issues.

Resource Conservation and Recovery Act (RCRA) – This act requires the proper management of hazardous and solid wastes. Non-adherence can result in mandatory remediation and fines.

Executive Order 13112 on Invasive Species – All introduced species used to manage erosion or repair damaged areas must conform with the Executive Order's direction to maintain a viable ecosystem. As such, all seeding must be part of an annual management plan focused on mitigating maneuver damage, reducing erosion while maintaining a viable ecosystem.

Air Quality

Prescribed burning is the preferred, inexpensive method to control invasive vegetation. Prescribed burning also supports nonlive-fire training on the installation and promotes training realism. The practice is restricted due to air quality and lack of fine fuel loads necessary to carry the fire. Low volume of fine fuel loads (vegetation), driven by the post livestock grazing program and training activities, precludes an effective prescribed burn on Fort Hood. Prescribed burns are restricted during TES breeding seasons.

Dust from vehicle maneuvers is a safety and an air quality issue. Emerging technologies may mitigate and help control dust, permit line-of-sight training, and increase observation of targets.

Water Quality

Water quality is important at Fort Hood. Training activities compact soil, disturb vegetation, and produce erosion within training areas and along streams. Land restoration involves repairing damaged lands and minimizing sedimentation. Eroded and unstable stream banks contribute excessive sediment to waterways when training lands are not aggressively managed and quickly repaired. Excess sediment is deposited in streams, reducing channel capacity and increasing flooding. Decreased channel capacity causes streams to widen, resulting in additional damage to Fort Hood's training areas.

Water pollution is not a current problem. However, future regulation concerns remain. Lack of adequate land repair and maintenance causes erosion at a rate of 3 to 80 tons/acre, resulting in sediment movement, land damage, increased runoff volume, and loss of containment capacity in the erosion-control structural systems. Consequently, this poses a threat to Belton Lake and Stillhouse Reservoirs, the primary drinking water sources for Fort Hood and surrounding communities. Heavy metals and nutrients bind to soil particles and are transported into waterways through sediment-laden runoff. Significant sediment loads have been discharged into Belton Lake in the last 50 years. Current studies show the erosion-control structure system to minimize sediment movement, but the structures' capabilities to control sediment are diminishing as sediment is moved into the structures that are not being aggressively maintained. EPA and other regulatory agencies could become involved and restrict training until corrective actions are implemented.

Fort Hood analyzes munitions residues, specifically RDX, for potential contamination of land or water on and off post. Initial results indicate that there are no RDX contaminants leaving the post. Over the past five years, public and regulatory concerns about the potential effects of munitions residues and emissions on human health and wildlife have increased. Use of contaminants are managed and controlled at Fort Hood, but concerns of future restriction on readiness training and training areas could be detrimental to Fort Hood, the Army, and future support to Fort Hood by the public.

RDX/unexploded ordnance (UXO) residue management is a major concern at Fort Hood. Currently guidance is vague in execution details. Clear, simple guidance and procedures are needed to allow turn-in and removal of UXO and residue to meet environmental standards and limit impacts to live-fire areas. Resources to support weapons systems and to monitor leaching in potentially affected watersheds are needed. Sound, common sense procedures are needed to facilitate residue management and enable training. Residue management must include the requirement to monitor watersheds, destroy UXO on ranges, and

facilitate residue turn-in. This management plan must also establish and conduct periodic monitoring to identify metal and chemical contamination of soils and to provide rapid containment and disposal procedures.

Land Management

Soil erosion management and land repair are primary vehicles to sustain Fort Hood's ranges and environment. Erosion is caused by (1) vehicle damage, hard rain, and lack of vegetation recovery, often caused by overgrazing; and (2) inadequate land repair and maintenance to support the increased pace of training requirements. Over the last 50 years, the repair and maintenance of training lands have not kept pace with training demands. The results are gully networks, unserviceable trail networks, sediment loads in streams, degradation of the installation erosion-control structures, constriction of maneuver training, reduction of vegetation, and degradation of the post ecosystem. Proactive steps are required to integrate, fund, and institute erosion-control measures to limit sediment movement in the watersheds. Moreover, Real Property structures, such as dams, must be maintained to better confine sediment to the installation. Adequate Real Property Maintenance funds are required to maintain the erosion-control structure system.

Fort Hood's land condition was rated "C3" on the 2001 Installation Status Report. Land impacts on training were evaluated "C2". Land condition forecasts indicate future (5 to 10 years) land condition degraded to "C4" and impacts on training degraded to "C3" if land repairs are not completed. Annual reseeding of training lands is essential to repair maneuver damage and reduce erosion. Cattle grazing must be adequately managed to reduce long-term impacts on the training mission and natural resources that sustain the ecosystem. Adequate fine fuel loads for prescribed burns, "no grazing" zones around live fire ranges, grazing rotation, and concentrated land repair/revegetation sites must be considered in establishing stocking rates on the installation.

Land Ratings

- **C1** – Land will support all training requirements.
- **C2** – Land will support most training requirements.
- **C3** – Constraints are expected to impede training. Not all standards can be achieved.
- **C4** – Constraints are expected to stop standard training.

Trained and certified wild land fire personnel from the Natural Resources Management Branch conduct Fort Hood's prescribed burns. Fort Hood uses prescribed fire to control invasive juniper in training lands, where fuel loads permit, and to burn 'black lines' around TES habitat, in order to protect habitats and minimize training down-time. If an adequate 'black line' is in place, a fire is allowed to burn and training is not interrupted, unless there is concern over fire damage to TES habitat, personnel, or equipment. The lack of fine fuel vegetation, due to overutilization of forage by livestock and maneuver damage, is the biggest impediment to more extensive use of prescribed burning as a management tool.

Forecast

ITAM and Natural Resource Conservation Service (NRCS) forecasts indicate that the next ten years are critical to sustaining readiness training. Land repairs, land restoration, and corrective actions to training lands are required within the next ten years or land conditions will degrade to a point that causes training activities to be curtailed.

Sustainable Training Areas

The Fort Hood land area has increased substantially since 1942. The largest expansion occurred in 1953 when more than 49,500 acres were added. Currently, any purchase of large parcels of undeveloped land contiguous to the existing training areas is unlikely, due to urban sprawl, politics, training land utilization reporting, funding, and public relations.

The Texas Comptroller of Public Accounts projects population increases between 1990 and 2030 to be 78 percent for Bell County and 221 percent for Coryell County. As this development occurs, Fort Hood could become an island of open space in the midst of sprawling urban areas, presenting an array of potential problems. Under such growth scenarios, military installations have often become the last and best refuges for endangered species and habitats. This could significantly impact Fort Hood's training mission, and increase management costs and training limitations. Additional information can be found at http://www.window.state.tx.us/cgi-bin/poppgm.

Fort Hood may be challenged by additional training impacts through potential listings of additional TES. The listing of additional TES could impact the installation's primary mission and impose additional training restrictions for soldiers being trained for combat.

The availability of clean water will be an increasingly important concern as the population on and around Fort Hood grows in the coming years. Existing surface and groundwater resources must be protected for use by the region, and increased regulatory attention will be placed on potential pollution sources; chemical contamination from munitions will undoubtedly be considered. Environmental reporting requirements have already been expanded to include munitions expended on the installation ranges.

Unmanaged RDX contamination could impact training at Fort Hood. For example, EPA stopped Army National Guard live-fire training at the Massachusetts Military Reservation (MMR) in response to community concerns over potential munitions-related contamination of a sole source aquifer. This forced cessation of live-fire activities provides dramatic evidence of public concern over the potential effects of munitions. Potential costs to remediate UXO, munitions, hard targets, and scrap metal residues are currently unknown, but will be very high.

Current Sustainability Activities

Natural Resources Management – Fort Hood manages natural resources according to the installation's Integrated Natural Resource Management Plan (INRMP), which encompasses the management of training land, endangered species, wildlife, outdoor recreation, pests, and forests. An installation's ecosystem is complex and diverse, and must sustain training, the land, the ecosystem, and all other required mission activities. A viable, holistic, biodiverse approach to landscape management is required. Numerous factors will influence such holistic management, but Fort Hood's main considerations are the training mission, land sustainment, and environmental stewardship. If erosion management or timely repair is delayed, eventual land rehabilitation and maintenance can be very expensive.

Cultural Resources Management – Fort Hood manages cultural resources according to the installation's Integrated Cultural Resource Management Plan (ICRMP), which balances the management of training lands

with the preservation and conservation of cultural resources. "In place" preservation is the preferred method. Alternate methods of preservation are being explored, such as site burial and stabilization of erosion. A final method of preserving information, when other techniques are not sufficient, is excavation of archaeological resources from training areas. Excavations are costly and current costs are $7,000 per cubic meter of soil excavated.

Integrated Training Area Management Program – Fort Hood also participates in the Army's ITAM Program. This program supports the sustainable use of training lands through a uniform program that inventories and monitors land conditions, determines carrying capacity of the land in terms of the training requirements, and provides for land rehabilitation and maintenance measures.

Training area restoration projects include shaping and treating critical areas; checking dams and sediment-control structures; hardening of stream crossings and hilltop access trails to reduce erosion; constructing and maintaining tank trail and firebreak networks to reduce land damage, vegetation damage, sediment, and erosion, and to keep wild fires from leaving the installation; hardening of staging and high-use assembly areas to reduce land damage and sediment movement; controlling invasive juniper to maintain valid nonlive-fire training areas; and managing vegetation to reduce grazing and maneuver damage and erosion.

The ITAM Program must be robust and focused to sustain training lands. Installation and noninstallation agencies must collaborate, coordinate, and cooperate to sustain needed training resources. Teamwork, planning, funding, and work are integrated to consolidate repair work and reduce impacts to overall training. Funding lines must integrate, and the work effort must go beyond the "stovepiped" distinctions of ITAM, training, conservation, compliance, endangered species, cultural, RPMA, or other funding labels. Information must flow between the organizations, agencies, and forums, through such mechanisms as Integrated Training Land Management Meetings and Environmental Quality Control Committees, and must be routinely used to share and develop land repair plans and to coordinate activities.

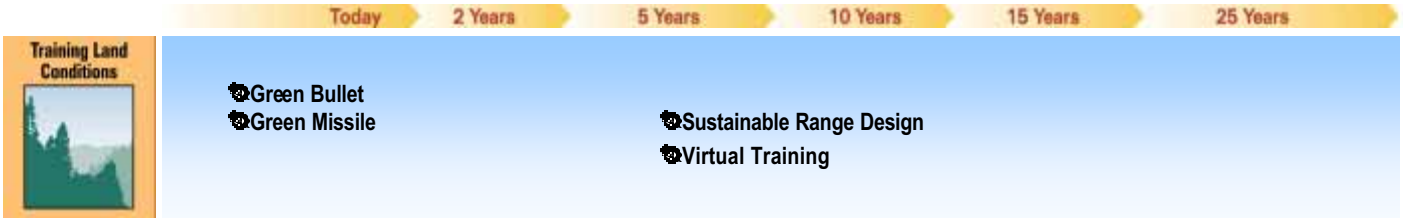
Water Resources – Water supply is a critical issue in Texas, and Fort Hood is doing its part to ensure adequate quality and quantity. The juniper research done by Thomas Thurow and Charles Taylor, presented at the Texas Water Conservation Association's 24th Water for Texas Conference in January 1995, supports Fort Hood's management of invasive juniper. By controlling invasive juniper, Fort Hood enhanced 30,000 acres to support nonlive-fire readiness training, and recovered 2 billion gallons of water per year for the installation's ecosystem. This "recovered" water will enhance natural vegetation growth, and sustain land conditions, seeding operations, and training. It also supports wildlife, endangered species, and recreation activities.

The Realm of Possibility

To become sustainable, Fort Hood is encouraged to identify and plan for innovations that will support the goals established during the Environmental Sustainability Executive Conference. To do this, participants should have exposure to 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.

Sustainable Training Areas

Training Land Conditions



- **Green Bullet** – The "Green Bullet" program is a DoD initiative to eliminate the use of hazardous materials in the process by which small caliber ammunition is manufactured as well as in the final product. This fully integrated program is spearheaded by the Small Caliber Ammunition Group within the U.S. Army's Armament Research, Development, and Engineering Center (ARDEC) and encompasses all environmental aspects of the small caliber ammunition from 5.56mm through .50 caliber. Specific thrusts include the elimination of Ozone-Depleting Chemicals (ODCs), Volatile Organic Compounds (VOCs), and heavy metals in the manufacture of primers and projectiles in the entire family of small caliber ammunition. Additional information can be found on the Green Ammo website at http://www.pica.army.mil/greenammo/.

- **Green Missile** – The Green Missile Program, an integrated pollution prevention research effort funded by the Strategic Environmental Research and Development Program (SERDP), is designed to develop alternative materials and technologies for solid rocket motor propulsion systems. The program has team members representing Army, Navy, Air Force, NASA, DOE, and EPA. The specific objectives of the program are to: (1) develop propellants that do not contain lead catalysts for both extrudable and castable propellant processes; (2) develop and demonstrate complete and clean hydrochloric acid-free combustion; and (3) develop and demonstrate the use of liquefied gases and supercritical fluids for environmentally friendly processing of energetic oxidizers and components resulting in elimination of solvents and reductions in VOC waste stream generation.

- **Virtual Training** – "Virtual training" is the next step in readiness training for the U.S. Army. While flight simulators and interactive shooting ranges have been in use for years, the next generation of virtual training systems will incorporate unprecedented realism and give soldiers the ability to experience complex and dangerous combat scenarios in a 100 percent-controlled environment.

- **Sustainable Range Design** – The Corps of Engineers is currently exploring the connection between green building design concepts and sustainable range design.

Endangered Species

- **Greenbelts** – Fort Bragg has established a 5,538-acre "Greenbelt" on the southern border of the installation. Military training continues on this land but it is otherwise left undisturbed as habitat for the endangered red cockaded woodpecker. Similar greenbelts could be established at other installations in order to protect local endangered species.

Noise

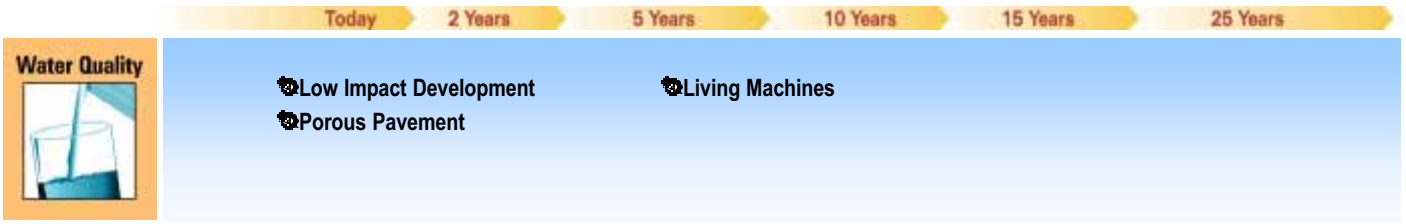
- **Weather and Training** – The rate at which wind speed and temperature change as a function of altitude can have profound effects on the behavior of high-energy sound waves as they propagate off-range and many miles into the surrounding area. Noise monitoring many miles from firing points and impact areas has shown 30-decibel variations in just a few hours for a single weapon and firing point, as weather conditions change. For a local resident, this amounts to an eight-fold increase in loudness over a very short time period. Regular sampling of meteorological conditions, and good recordkeeping can help identify adverse conditions and lead to strategies to avoid them. Disclosure of this information and the role that weather can play in noise levels at the point of reception can do a great deal to improve the trust and credibility accorded the leadership at the range.

- **Night Training** – Training between 2200 and 0700 hours has noise impacts that are especially difficult for local residents to cope with because of the lower background noise at night and the probability of being awakened. Much of the "night training" serves to teach proficiency in the dark, which is not necessarily associated with the sensitive 2200 to 0700 period. Spring, Fall, and Winter months have many hours of darkness before 2200 and in many cases the logistical problems of keeping the large weapon component of the training in the period between sunset and 2200 hours is solvable.

Encroachment

- **Private Lands Initiative** – The Private Lands Initiative (PLI) is a cooperative effort between FORSCOM, The Nature Conservancy, U.S. Fish and Wildlife Service, and private landowners around the borders of an installation. By annexing land around the fenceline and preventing that land from being developed, the PLI creates a "buffer zone" of sorts, allowing for better wildlife habitat around the edge of an installation. Increased habitat for endangered species outside the fenceline decreases training constraints inside the fenceline. The PLI has been active at Fort Bragg since 1995 and is currently reviewing 10,000 to 20,000 acres of prime habitat of the red-cockaded woodpecker.

Water Quality



- **Living Machines** – Living Machines® use bacteria, plants, snails, and fish to treat sewage and other wastewaters (http://www.livingmachines.com). The machines look like greenhouses and work by using the plants and animals to breakdown the wastes and digest organic pollutants. They are made by Living Technologies, Inc., and 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. It is possible that a similar technology could be developed to control the potential release of pollutants from ranges into groundwater and surface waters. The Army's Sustainable Range working group is charged to develop new ways to design the ranges of the future to reduce contamination by pollutants.

- **Low Impact Development** – Low impact development techniques 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 Hood and the surrounding region (http://www.tnrcc.state.tx.us/EAPP). Contaminants (e.g., oil, fuel, and sediments) that cause problems with stormwater are eliminated if the stormwater is retained on-site and allowed to seep into the soil, rather than running off into streams.

- **Porous Pavement** – Contaminants (e.g., oil, fuel, and sediments) that cause problems with stormwater are eliminated if the stormwater is retained on-site and allowed to seep into the soil, rather than running off into streams. Many new building techniques and materials, such as porous pavement, allow for such natural drainage and on-site water storage (http://www.stormwatercenter.net).

Fort Hood 25-Year Goals for Sustainable Training Areas

To be determined by Fort Hood Command and staff, as advised by members of the local and regulatory communities, at the Environmental Sustainability Executive Conference on 11-13 June 2002.

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Water Resources

Water Resources

Challenge

Water is a very carefully managed resource in Texas. The state's strategic water plan provides a detailed analysis of measures required to ensure that enough water is available for all Texans. The key aspect of this plan is that water supplies remain CLEAN. With the increasing population in Fort Hood and surrounding communities, managing consumption will be very important, and avoiding water supply contamination will be absolutely critical. Water will always be essential to the mission of Fort Hood. How can Fort Hood ensure that its activities support the state's water plan and maintain the water resources upon which it depends?

Key Considerations

- **Consumption** – Water is used for many different purposes including residential needs, industrial processes, and landscape irrigation. Care must be taken to minimize consumption so that adequate supply is available and permit limits are not exceeded.

- **Nonpoint Source Pollution** – As water moves across and through the land, it picks up and carries away 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 motorpools 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 stormwater 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.

Water Resources

Importance to Fort Hood

Mission – Clean, safe, and reliable drinking water is critical to Fort Hood's mission. Shortages caused by depletion or contamination of Belton Lake could jeopardize the ins tallation's operation and mission and the economic productivity of the surrounding communities.

Quality of Life – Clean water is necessary for the health, safety, and welfare of the soldiers and families at Fort Hood. Fishable, swimmable lakes, streams, and rivers are part of the world-class communities that Fort Hood's soldiers and families want and deserve.

Cost – Providing safe drinking water and protecting regional water resources present varied and complex challenges. The following lists illustrate some of the major programs at Fort Hood and their costs.

Average Annual Costs

- Drinking water purchase (FY01 cost): $872K/year
- Drinking water treatment/distribution system O&M: N/A
- Wastewater treatment by the county: $600K/year
- Wastewater collection system O&M: $4M/year
- Oil/water separator maintenance: $375K/year
- Ongoing environmental water monitoring and management programs: N/A
- Installation Restoration Program monitoring: N/A

Capital Investments

- Stormwater outfall upgrades: N/A
- Sewage line upgrades/repairs: $400M (one-time capital cost)
- Water distribution/storage system upgrades/repairs: N/A
- Contamination cleanup (26 out of 27 Restoration sites have been investigated and closed): No money forecasted for project
- Repair of eroded lands: $200M

Environment and the Community – Over the last five years, Fort Hood's total water consumption has averaged approximately 2.3 billion gallons per year. The average potable water consumption is 6.8 million gallons/day (MGD) and includes all domestic and industrial uses. For a supported population of over 71,000, this averages 96 gallons /capita/day, which compares favorably with the Killeen average of 120 gallons/capita/day. Because of irrigation demands, Fort Hood's peak potable water consumption occurs in the summer months and averages 10.9 MGD (153 gallons/capita/day). During the winter months, consumption drops to 5.0 MGD.

In 2000, Fort Hood received a Notice of Violation (NOV) from the state of Texas for exceeding the allowable peak water consumption of 16 MGD. The two small wastewater treatment systems that the installation operates regularly report exceeding effluent limits (mostly for suspended solids) and inadequate chlorination.

The state's 50-year strategic water plan (Water for Texas 2002, available at http://www.twdb.tx.us) predicts an increase in water demand of 67 percent between 2000 and 2050, mostly due to a projected population increase. The state plans to meet 18 percent of this increased demand through additional conservation.

Water Resources

Introduction

Fort Hood is located in the Brazos River Basin. Surface water streams that flow through the installation include Leon River, Owl Creek, Cowhouse Creek, Nolan Creek, and Reese Creek. With the exception of Reese Creek, which discharges into the Lampasas River, all the streams flow into Belton Lake. Belton Lake is located along the southeastern border of Fort Hood and is operated by the U.S. Army Corps of Engineers (USACE) for flood control, resource conservation, water storage, and recreation. Fort Hood's major drainage stream is Cowhouse Creek. Fort Hood encompasses 250 acres of lakes and ponds, 35 springs, 55 miles of rivers and permanent streams, and 161 small impoundments (manmade water bodies that provide flood control, sediment detention, wildlife and livestock water, and fish habitat).

Currently, the only significant source of water for the installation is the Belton Lake reservoir, which is fed by the Leon River and Cowhouse Creek. The main aquifer system underlying Fort Hood is the Travis Peak formation, which occurs at approximately 1,000 feet below ground surface. This aquifer was used previously as a source of water supply for the installation. However, its use has ceased due to excessive drawdown. Other shallow formations, such as the Glen Rose, Paluxy, and Edwards aquifers, constitute alternative groundwater sources. However, the mineral content of the Glen Rose groundwater is relatively high, and the Paluxy unit is potentially sensitive to pollution from Fort Hood's operations. While Belton Lake is not designated as a sole source aquifer (because it is surface water), it must be safeguarded because it is the major source of drinking water for Fort Hood and the surrounding region. Figure 4 displays the water resources and water impoundments for Fort Hood.

Regulations At A Glance

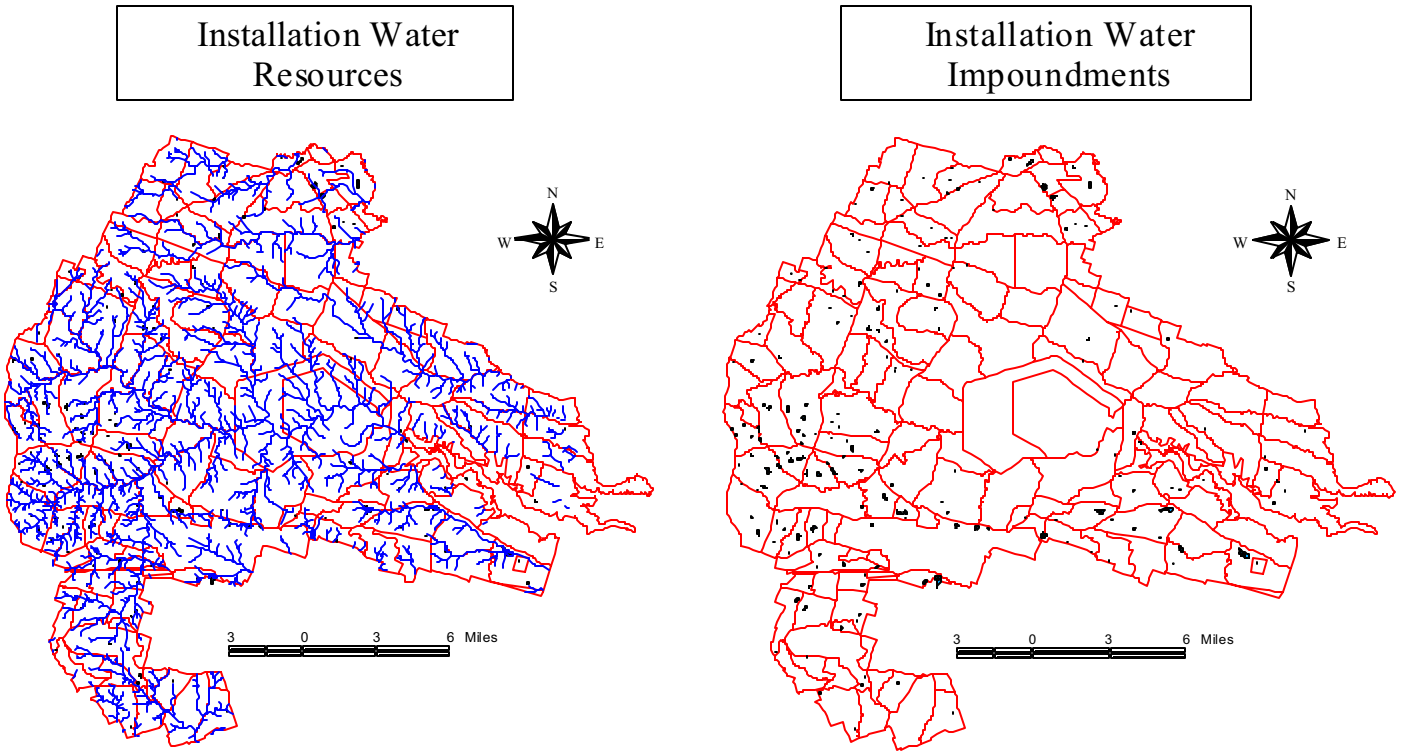
Clean Water Act (CWA) – In 1972, the U.S. Congress enacted the first comprehensive legislation to control water pollution. One of the dominant features of the CWA is a federal permitting program called the National Pollutant Discharge Elimination System (NPDES). In Texas, this system is administered by the state as the Texas Permit Discharge Elimination System (TPDES). Under TPDES, each discharger receives a permit from the state containing effluent limits that are based on the best available treatment technology or other guidelines that take into account the condition of the receiving water body. This regulation covers both end-of-pipe effluent discharges (e.g., from wastewater treatment plants) and stormwater discharged from storm sewer pipes in urban and industrial areas.

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 (TMDLs) that limit the amount of pollutants that can be discharged to the water body while still meeting state standards.

Under the new NPDES Phase II program, the entire stormwater system at Fort Hood (both industrial and residential areas) and construction sites over one acre will require permits by March 2003.

Safe Drinking Water Act (SDWA) – The 1974 SDWA was developed to protect public health. Under the SDWA, USEPA has also 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 4 – Water Resources and Water Impoundments for Fort Hood



Impaired Waters

Due to excessive levels of pathogens, Nolan Creek/South Nolan Creek and the Leon River below Proctor Lake are listed as impaired waters under CWA Section 303(d). The pathogens are associated with a confined animal feeding operation upstream of Fort Hood. Some runoff from Fort Hood enters these water bodies; however, Fort Hood does not believe it is contributing to the pathogen problem.

Major Pollution Issues

Perchlorate-contaminated soil and water are located at the former Naval Weapons Industrial Reserve Plant (NWIRP) at McGregor, TX. While no water samples collected in early 2001 showed perchlorate in Belton Lake, perchlorate has been detected in water from various creeks and in fish in the Belton Lake watershed. Congress has directed the USACE Fort Worth District to assess the impact of perchlorate associated with NWIRP and of potential contamination originating at Fort Hood. The USACE has assembled an integrated, multidisciplinary project team to address this issue as part of the Bosque and Leon River Watersheds study. The goal of this assessment is to evaluate potential human and environmental exposure to perchlorate in the Belton Lake and Lake Waco study area. Because of its high mobility, persistence in the environment, and potential adverse health effects, perchlorate may have a significant impact on local drinking water supplies.

Because Nolan Creek and South Nolan Creek feed into Belton Lake, excessive pathogen levels in these waters will need to be addressed in the near future.

Runoff from the numerous motor pools is also a concern. As the installation grows and more motor pools are constructed, the problem will only escalate.

Threatened and Endangered Species

Fort Hood is home to a number of unique biological, geological, and archeological assets. The most significant of these resources, in terms of the potential to impact military activities, are populations of two endangered migratory birds: the golden-cheeked warbler, which breeds only in the mature mixed oak-juniper forests of central Texas; and the black-capped vireo.

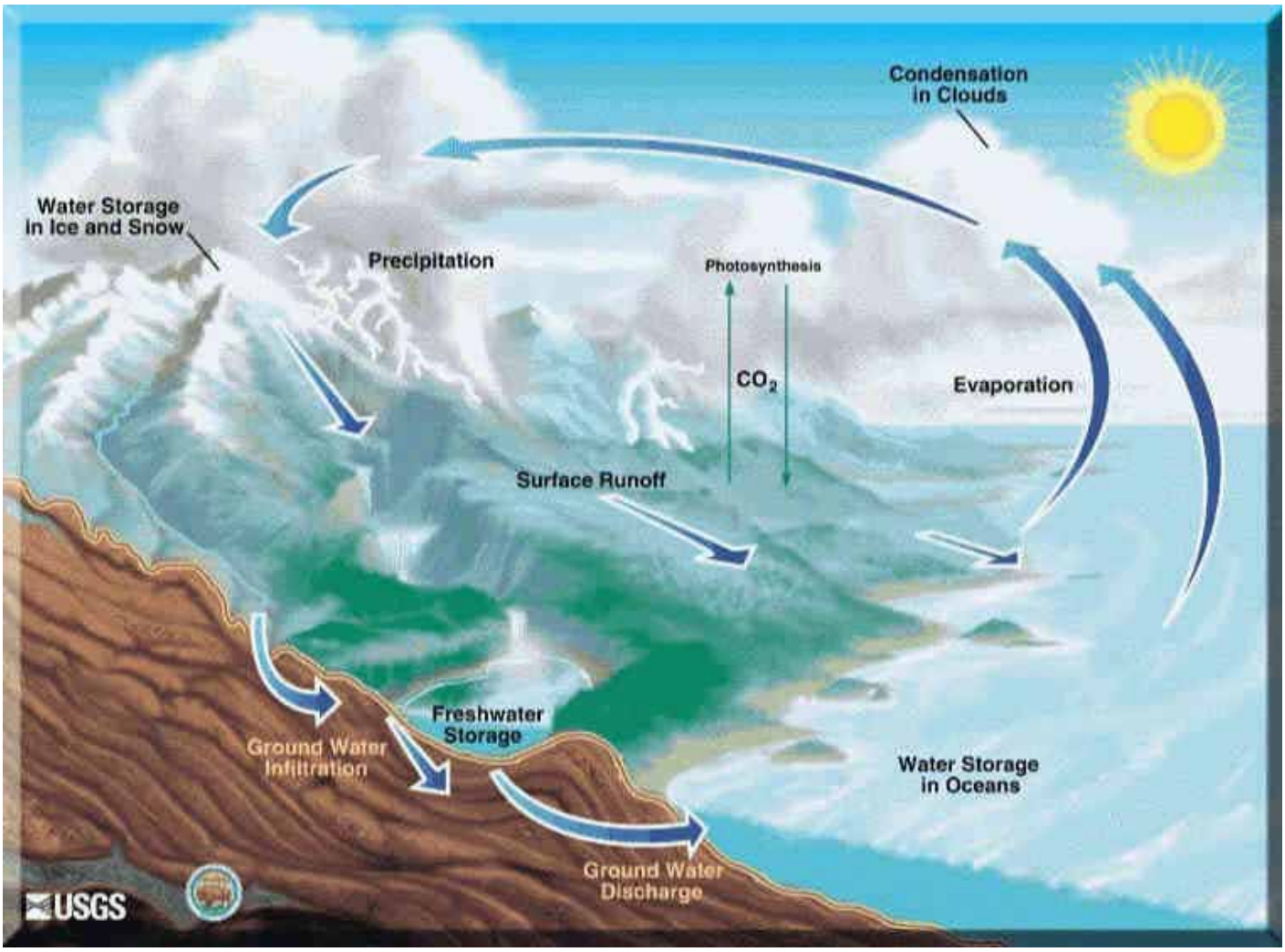
Fort Hood's karst communities, located in an underground network of moist caves and sinkholes, are perhaps the least understood but most unique natural feature of the installation. Ongoing surveys and mapping activities have identified 12 invertebrates and one vertebrate (a plethodontid salamander) found nowhere else in the world.

Activities and Impacts

Due to the interconnected nature of water resources (see Figure 5), 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 impact surface water and groundwater resources adjacent to and far away from the activity.

Activities on Fort Hood can result in three main types of water-related impacts: depleted water sources, nonpoint source pollution, and point source pollution. Figure 6 illustrates the activities and impacts associated with water consumption. Historical data on Fort Hood's water use, disposal, and costs are in Appendix B.

Figure 5 – The Water Cycle



Depleted Water Sources

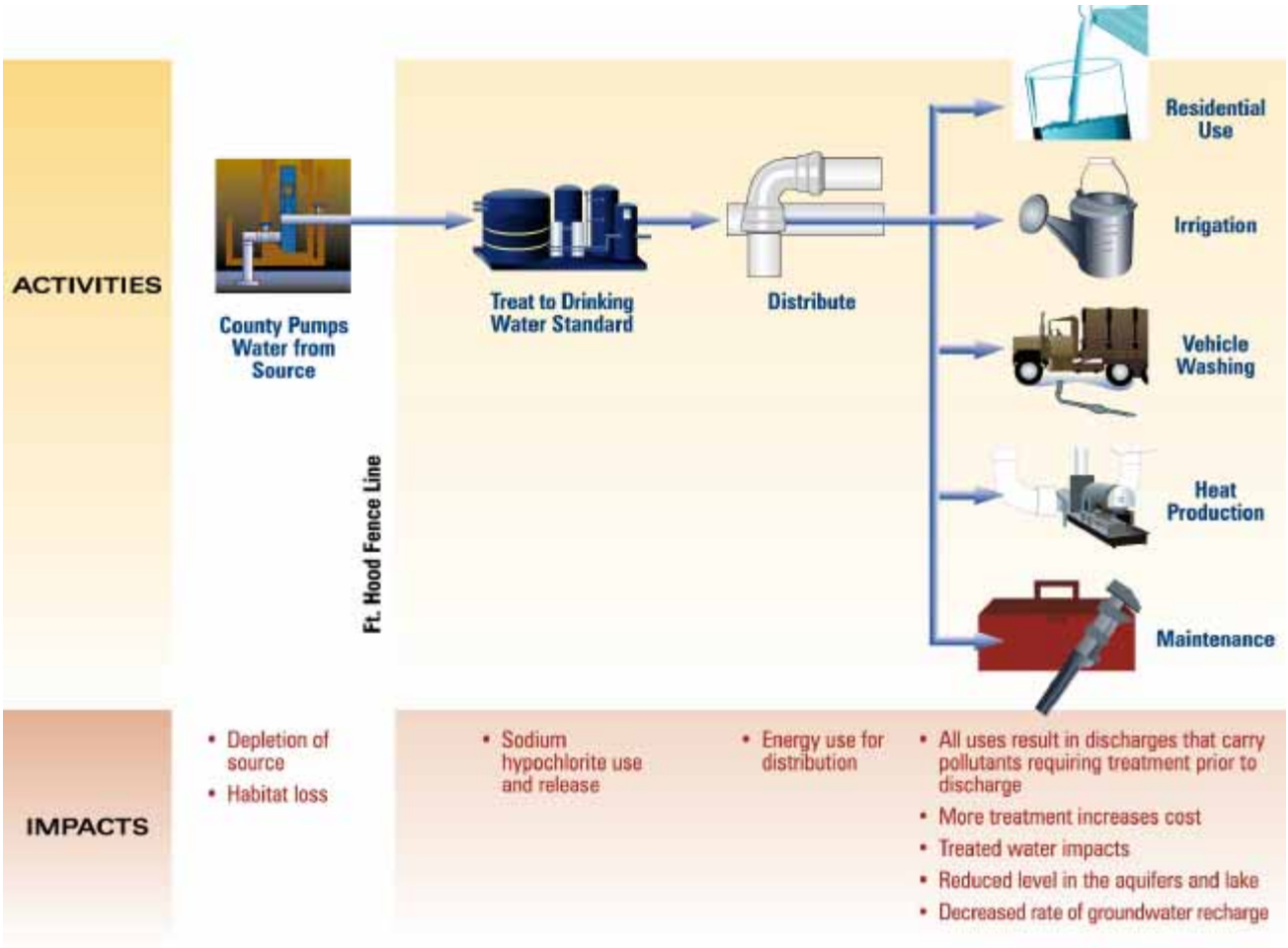
As the state's 50-year water plan shows, water is a finite and carefully allocated resource in Texas. Texas is an appropriated water state in which water use and consumption are regulated and allotted by a state agency. The Brazos River Authority, which regulates Fort Hood's water allotment, has allotted the Bell County Water Control Improvement District (BCWCID), the county water distribution facility, 42,800 acre-feet of water annually from Belton Lake. Of this total, 12,000 acre-feet is reserved for the exclusive use of Fort Hood. BCWCID guarantees Fort Hood a delivery of 16.0 million gallons per day (MGD).

Fort Hood uses large amounts of water for many different activities. Since 1997, Fort Hood's water consumption has increased by approximately 20 percent, while the cost of that water has increased 31

percent. In addition, peak water demand has increased from 12.0 MGD in 1995 to 16.1 MGD in 2001, peaking at 16.5 MGD in 1999. In 2000, Fort Hood received a NOV from TNRCC for violation of the 16.0 MGD limit. Issues identified because of the NOV included numerous required repairs and poor recordkeeping. Additional NOVs and possibly fines can be expected if Fort Hood continues to exceed its water consumption limit. Fort Hood must address this critical water supply issue, either by seeking an increase in the allowable limit and/or implementing water conservation measures.

Fort Hood does not currently have a formal water conservation program to monitor real-time demand, optimize distribution systems, educate the public, and control peak consumption. Water conservation can produce cost savings, reducing the need to purchase water and reducing the energy required to pump water throughout the installation. With sufficient planning and forethought, significant cost savings can be produced through water conservation efforts without degrading mission performance or compromising quality of life for water consumers.

Figure 6 – Water Consumption: Activities and Impacts



Drinking Water Quality

Fort Hood operates three public water distribution systems registered with the state of Texas. The installation chlorinates purchased water at five locations: main pump station, pump station 90061 (Radar Hill), pump station 93008 (south of Copperas Cove Road on Clear Creek), and the two storage tanks—the West Fort Hood tank and the main tank (57130) at North Fort Hood.

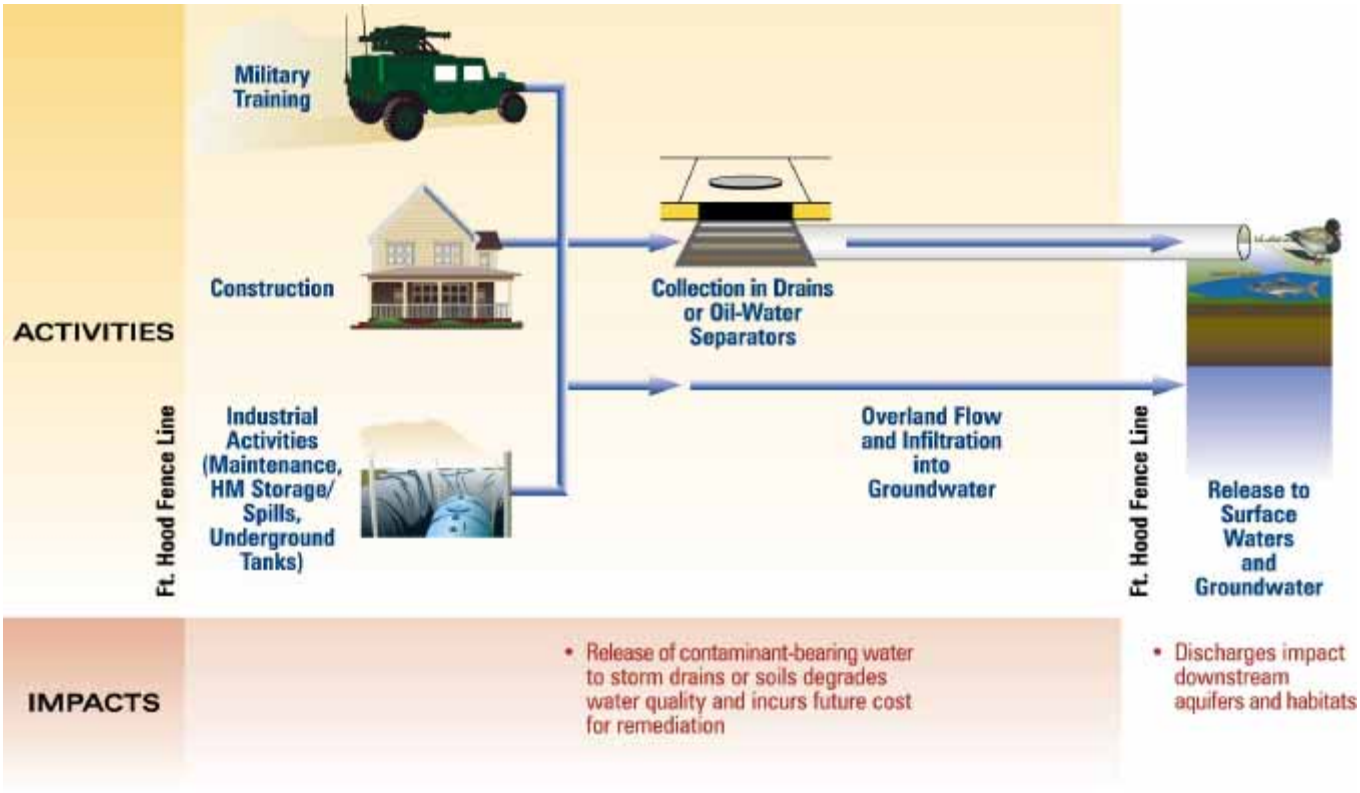
The purchased water meets all federal and state drinking water standards. However, the installation occasionally has difficulty maintaining the required chlorine residuals in some parts of the water distribution system. Sections of the system that are used infrequently or that are at remote locations require extra attention from system operators and often require significantly more flushing of storage tanks. This process is labor intensive and requires substantial amounts of potable water.

In August 2000, the U.S. Army Center for Health Promotion and Preventive Medicine (CHPPM) conducted a Water System Performance Evaluation on Fort Hood. The major findings included a shortage of trained and certified personnel to effectively operate and maintain the water systems. While the understaffed, dedicated team of civilian employees has thus far managed to provide safe drinking water to the installation, further employee reductions will create additional risks.

Nonpoint Source Pollution

Nonpoint source pollution occurs at Fort Hood when water runs over the land or through the ground, picks up pollutants, and deposits them in rivers or lakes or introduces them into groundwater. This could contaminate Belton Lake, which is the sole source of drinking water for the region. Many potential sources of nonpoint source pollution occur on Fort Hood. These include munitions and range areas, training lands, active construction sites, industrial (maintenance) areas, and leaking underground pipes and storage tanks. Each activity has the potential for different types of discharge, pollutants, and impacts (see Figure 7).

Figure 7 – Nonpoint Source Pollution: Activities and Impacts



Military Training – Fort Hood has 111 active training areas, including 77 live-fire ranges, 1 permanent impact area, 660 miles of tank trails, 3 airfields, 3 drop zones, and less than 85,000 acres designated as heavy maneuver training land. Firebreaks cover 194,150 acres. Fort Hood's training areas are used 242 training days per year by active, National Guard, and Reserve units. The four division-size training units require 313,226 acres of maneuver area, representing a total shortfall in maneuver space of 100,726 acres.

Because of the shortfall of maneuver space, the training mission at Fort Hood involves intensive land use. Many training activities create soil compaction, disturb vegetation, and cause erosion within training areas and along stream banks. Erosion and unstable stream banks can contribute excess amounts of sediment to waterways. As excess sediment is deposited in streams, channel capacity is diminished and flooding increases. This decrease in channel capacity also causes streams to widen, damaging property and training areas while increasing habitat loss on Fort Hood and downstream. At Fort Hood, the combination of persistent drought, continuous cattle grazing, and military training have resulted in badly eroded lands and high sedimentation rates in local streams. Current estimates to fix the erosion on Fort Hood are $200M.

In addition, heavy metals, nutrients, and other chemical contaminants can bind to soil particles and enter waterways with sediment. The amount of chemical contamination that flows into waterways from Fort

Hood's training activities is unknown. CHPPM is currently conducting studies to determine whether RDX, a high explosive, is running off from Fort Hood's ranges.

Construction and Industrial Activities – Of Fort Hood's 217,180 acres, less than 10 percent (20,870 acres) is improved grounds occupied by buildings, parking lots, and roadways. Rooftop, asphalt, and gravel areas are all considered impervious to stormwater infiltration and are a significant source of nonpoint source pollution. Oil, grease, sediment, heavy metals, nutrients, and other contaminants settle on these surfaces and are washed into waterways with every rainfall. Stormwater is collected from developed areas of the main cantonment area, West Fort Hood, and North Fort Hood. As stormwater runs off paved areas, construction sites, and training lands, it carries sediments, oil, and other pollutants into storm drains or overland to surface waters or groundwater. Some stormwaters are collected and discharged through oil/water separators (OWS) to remove oil and sediments, but some are not. Unless intercepted, all stormwater, sediment, and pollutants ultimately enter surface waters that lead to various creeks, the City of Killeen's storm sewers, adjacent private property, or Belton Lake. Fort Hood does not intentionally capture and treat stormwater in its sewage treatment plants or through the sewage collection and transport systems that go to the Bell County Water Control and Improvement District (WCID) No. 1.

What We Don't Know

The state's 50-year water supply plan, Water for Texas 2002, was created to ensure an adequate supply of water to all Texans. The plan relies on maintaining good water quality in order to have a dependable supply. The following data would assist in protecting the quality and quantity of future water supplies.

- Data on water usage for specific activities at Fort Hood such as irrigation, vehicle washing, and residential uses.
- Data to accurately assess environmental impacts of range activities, particularly impacts of munitions residue from weapons training and unexploded ordnance.
- Impacts of perchlorate contamination at the former Naval Weapons Industrial Reserve Plant at McGregor, TX (currently under study by USACE).
- Potential additional sources of contamination from the installation and surrounding areas.

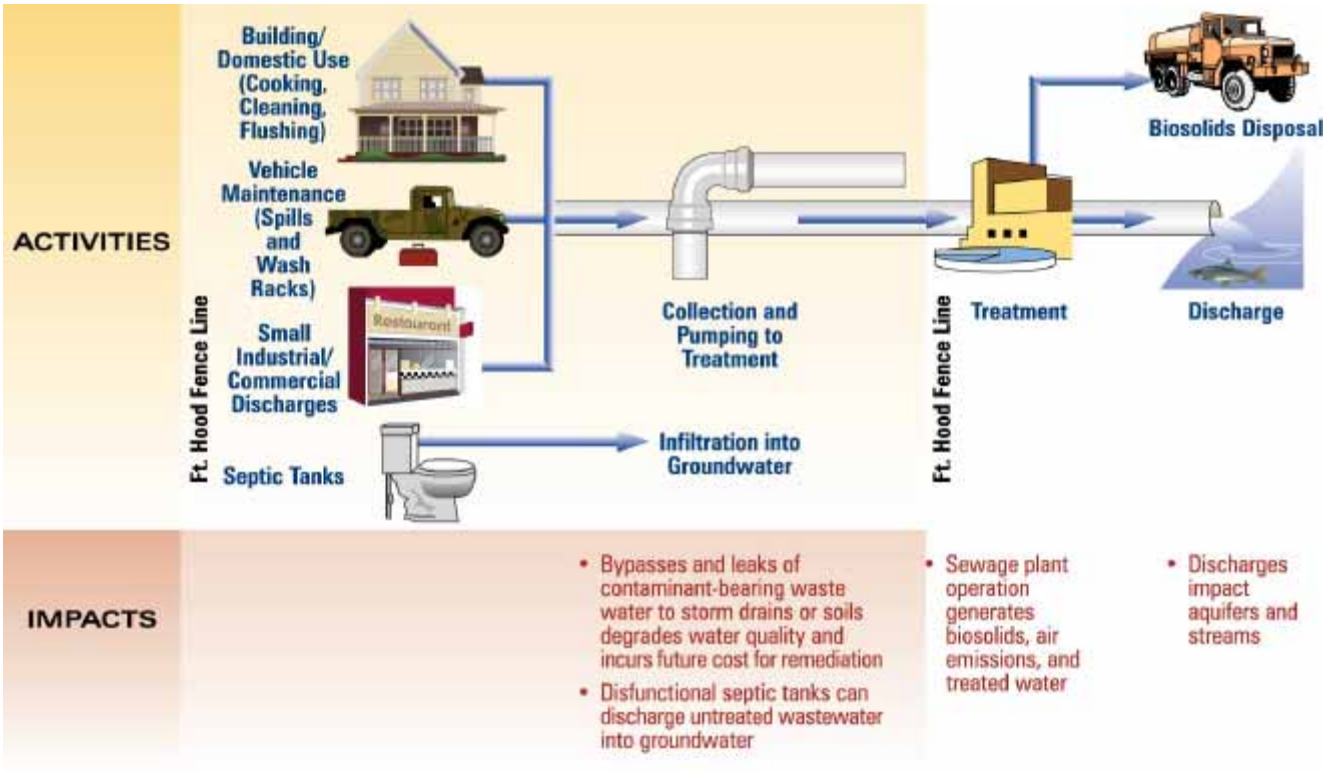
Three classes of stormwater (industrial, construction, and municipal) are defined by the type of permit associated with each discharge. Currently, Fort Hood has a permit for stormwater discharges associated with industrial activities identified in the TPDES General Permit. These activities include landfills, vehicle maintenance facilities and salvage yards, airfields, scrap recycling facilities, and hazardous waste storage areas. This permit was issued by TNRCC in August 2001 and involves a significant amount of recordkeeping, sampling, inspecting, and management to improve the quality of industrial stormwater discharges. Construction stormwater involves discharges from large construction activities that disturb five or more acres of land. The contractor and/or the USACE office supervising each project normally obtains these permits.

The recent expansion of the Texas industrial stormwater permit and pending implementation of Phase II stormwater regulations will require significantly more resources for operation of this program. Contracts are in place to provide additional support for the management of the industrial stormwater permit and for development of a Storm Water Pollution Prevention Plan (SWPPP) for the impending municipal separate storm sewer system (MS4) permit. Increased coordination between the Fort Hood Environmental Office and construction project managers and inspectors will be needed to ensure compliance with more stringent regulations governing stormwater runoff from construction sites.

Point Source Pollution

Point source pollution originates from a specific manmade object, such as a stormwater outfall or sewage treatment plant. Figure 8 shows activities and impacts associated with point source pollution.

Figure 8 – Point Source Pollution: Activities and Impacts

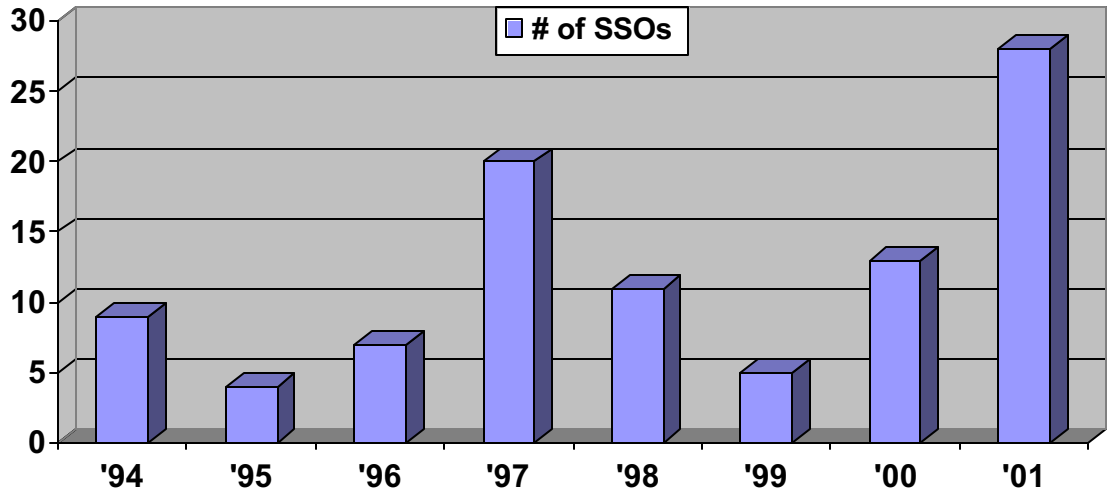


The majority of Fort Hood's wastewater is treated off-post. Fort Hood pumps an average of 1.4 billion gallons per year of untreated wastewater from the main cantonment area and West Fort Hood to the WCID No. 1 wastewater treatment plant. The wastewater collection system at Fort Hood is predominantly a gravity-flow system. The collection system consists of approximately 140 miles of sewer mains and 70 miles of laterals. Within the collection system, approximately 2,800 manholes, 40 lift stations, and 10 miles of force mains are used to connect individual facilities to the main system. Five of the lift stations have oil/water separators; nine have backup generators to supply emergency power.

Sanitary sewer overflows (SSOs) of various volumes occur from time to time in spite of concerted prevention efforts. Spills may result from blocked sewers, pipe failures, mechanical malfunctions, and other natural or manmade causes. To minimize the negative impacts of sewage spills on human health and the environment, the Fort Hood Sanitary Sewer Overflow Response Plan outlines specific actions to be performed during such events. The State of Texas and the public must be notified when significant sewage

spills endanger drinking water sources. Figure 9 shows the number of SSOs reported to the State of Texas in recent years.

Figure 9 – Number of Sanitary Sewer Overflows Reported to TNRCC



Fort Hood does treat and discharge a limited amount of domestic sewage and industrial wastewater at nine locations across the post. Sanitary sewage at North Fort Hood is collected and treated in a series of sedimentation ponds (wastewater lagoons). The treated effluent from North Fort Hood is discharged to Clear Creek and Leon River under an NPDES discharge permit. Effluent from the Belton Lake Outdoor Recreation Area (BLORA) is treated at a small package plant that discharges to a permitted outfall.

In addition to these municipal wastewaters (i.e., sewage), Fort Hood discharges industrial wastewater to permitted outfalls. Permits cover discharges from the two small wastewater treatment plants (WWTPs) discussed above, vehicle and aircraft washracks at Robert Gray Army Airfield (RGAAF), and about three dozen motorpools along North Avenue. While the volume of this discharge is unknown, water quality from the outfalls of several small lakes is monitored weekly.

Fort Hood has a history of noncompliance with its wastewater permits. Figure 10 summarizes incidents when the two treatment plants and the industrial wastewater outfalls have exceeded permit limits. The sewage plants often exceeded either the maximum or minimum required residual chlorine concentrations. Replacement of the entire treatment plant at BLORA in December 2001 and future planned improvements to the manual chlorination system at North Fort Hood should eliminate such violations at those locations. Problems at other outfalls are usually attributable to human error such as improper use or maintenance of wash racks and oil-water separators, or to heavy rainfall events, which can drive up total suspended solids (TSS), biological oxygen demand (BOD_5), and chemical oxygen demand (COD).

Figure 10 – TPDES Permit Violations, CY97 - CY01

Parameter	CY97	CY98	CY99	CY00	CY01
Flow	0	0	0	0	0
pH	0	0	3	1	5
Residual Chlorine	5	5	1	2	6
Total Suspended Solids (TSS)	5	12	6	4	8
Dissolved Oxygen	1	0	2	1	1
Chemical Oxygen Demand (COD)	0	1	1	0	3
Biological Oxygen Demand (BOD_5)	1	4	1	0	1
Oil and Grease	1	0	2	0	0
Total	**13**	**22**	**16**	**8**	**24**

Fort Hood's sanitary sewer system, including the wastewater treatment plants and the collection system, direly needs an overall upgrade. The Directorate of Public Works (DPW) has developed a 20-year plan to replace many of these degraded systems at an estimated cost of approximately $400M. Fort Hood spends over $4M per year to operate, maintain, repair, and perform limited upgrades on wastewater collection systems. This is only a small fraction of the projected $400M needed over the next 20 to 25 years to replace outdated and ineffective equipment and sewer mains. The significant increase in the number of family housing units on Fort Hood that is expected through the Residential Community Initiative will increase the demands placed on these overtaxed, antiquated systems. A utilities privatization study is currently in progress, and the transfer of utilities ownership to a private contractor is the most expeditious way to finance the needed repairs and upgrades.

Forecast

Region and State – Water for Texas 2002 lays out a plan to provide sufficient water for all Texans, including Fort Hood, through 2050. The plan projects population growth of 85 percent over the next 50 years, and an increase in water demand of 67 percent. The plan depends on water conservation to meet 18 percent of the new projected demand. The plan also assumes that existing water supplies will remain clean enough to be effectively and economically treated to drinking water standards. Costs will rise as water quality deteriorates and regulations to protect water resources become more stringent.

Fort Hood – Water consumption is expected to increase as development on Fort Hood continues and more acres require irrigation. Fort Hood will need to devote significant financial resources over the next 25 years to upgrade existing drinking water and sewer systems and ensure that Fort Hood's activities do not contaminate regional water supplies.

Current Sustainability Activities

- Fort Hood understands the importance of community involvement and will participate in several local water planning efforts, including a Town Hall Meeting with the City of Temple concerning perchlorate contamination.

- Fort Hood's three Central Vehicle Wash Facilities treat and recycle vehicle wash water in a closed-loop system that saves millions of gallons of water every year. These facilities decrease reliance on individual motorpool washracks and significantly reduce overall installation water consumption and wastewater permit violations.

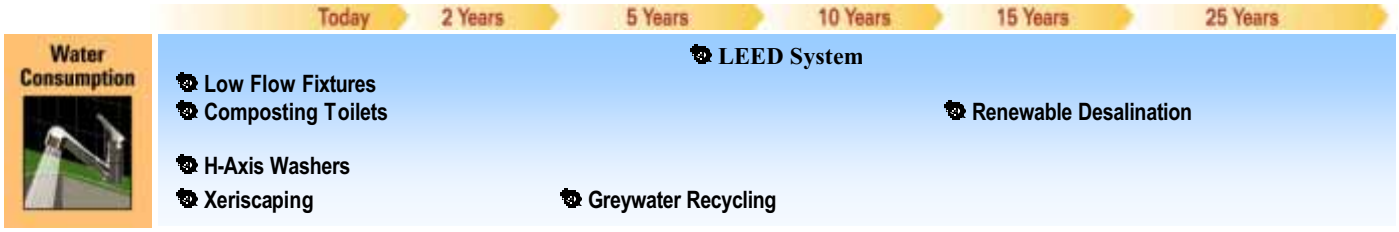
- Fort Hood minimizes the erosion impacts of training activities through seeding programs, controlled burns, and the rotation of cattle grazing. When erosion is not avoided, land rehabilitation and maintenance can be very expensive. In FY01, Fort Hood estimated that remediating all currently damaged training areas would require $200M.

- A demonstration "sustainable" building is under design and is expected to be constructed by the fourth quarter of FY02. It will be the first Army building built to the SPiRiT Platinum Certification Level, the highest rating level attainable. This project incorporates straw bale construction, xeriscaping, waterless urinals, active daylighting systems, and solar-powered lighting. It also incorporates materials salvaged and recycled from Fort Hood's demolished facilities (e.g., windows and wooden floors and beams) and crushed glass from bottles. The purpose of this demonstration is to help Fort Hood's planners, designers, and support agencies apply sustainable design principles installation-wide.

The Realm of Possibility

To become sustainable, Fort Hood is encouraged to identify and plan for innovations that will support the goals established during the Environmental Sustainability Executive Conference. To do this, participants should have exposure to 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. As noted above, Fort Hood is designing a

building in FY02 using SPiRiT standards. Understanding and applying these is a gradual process. With experience and use, more buildings can be built to sustainable standards. SPiRiT standards which will assist Fort Hood in limiting impact on water quality include:

2.C1 Water Efficient Landscaping. Limit or eliminate the use of potable water for landscape irrigation.

2.C2 Innovative Wastewater Technologies. Reduce generation of wastewater and potable water demand, while increasing local aquifer recharge.

2.C3 Water Use Reduction. Maximize water efficiency within buildings to reduce the burden on municipal water supply and wastewater systems.

- **Composting Toilets** – Composting toilets eliminate the use of water to transport human wastes, which accounts for 26 percent of residential water use, as well as sewage collection and treatment requirements. These toilets produce a humus-like product that can be used as a soil amendment. The life-cycle cost is less than that of water delivery, sewage collection, and treatment. Fort Carson, CO, has installed several composting toilets at the parks and playgrounds on post; and the National Park Services uses these types of toilets extensively in the National Parks.

- **H-Axis Washers** – Laundry facilities account for 23 percent of residential water use, and a similar proportion of residential sewage production. Horizontal-axis washers use 40 to 75 percent less water, clean clothes better with a less concentrated soap solution, and extend the life of clothes because they are not agitated. In 1996-98, U.S. manufacturers introduced these washers, which are used extensively in Europe. While initial costs are double that of conventional washers, they pay back the additional investment in three to four years through reduced energy, hot water, and soap. Fort Carson has installed horizontal-axis washers in barracks and guest quarters.

- **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.

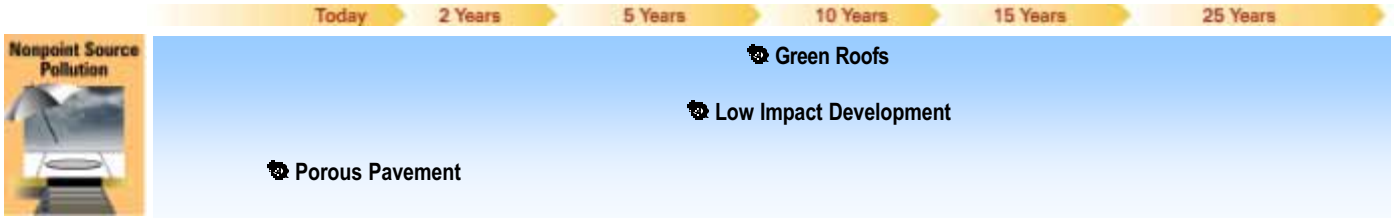
- **Renewable Desalination** – Freshwater supply is an issue of great importance to the overall sustainability of communities, especially those in water scarce regions. In some places, desalination is the only way to provide reliable (yet extremely expensive) freshwater to the population. The Greek island 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 islands 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 the while producing no emissions (http://www.wbcsd.org/casestud/gerling/index.htm).

- **Greywater Recycling –** The future of sustainable water use is in-situ water recycling and reuse. A huge 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.greywater.com/ and http://www.greenbuilder.com/sourcebook/Greywater.html).

- **Camp, Dresser and McKee** – Camp, Dresser and McKee (CDM) have pioneered a number of water management technologies that allow for reduced impact on local water resources. Aquifer Storage and Recovery (ASR) systems store stormwater and treated wastewater in underground "bubbles" where the water can later be removed. It allows for increased reserves of water in times of drought and for decreased total drain on aquifers. CDM also helps design and build stormwater overflow systems and TMDL management programs that help address point and non-point source pollution problems.

Nonpoint Source Pollution

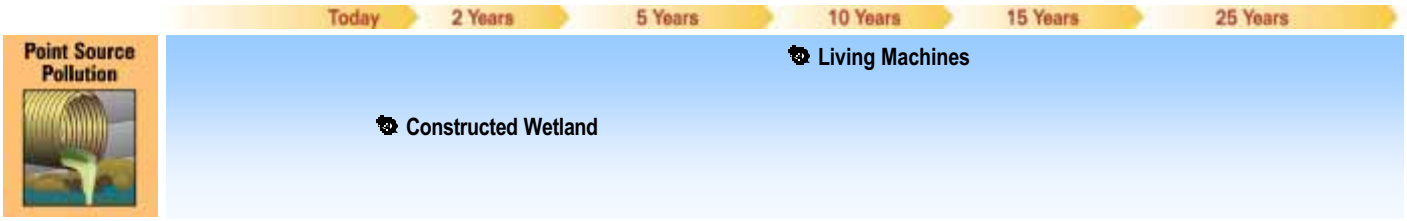


- **Low Impact Development** – Low impact development techniques can minimize impervious areas, thereby maximizing groundwater recharge (http://www.stormwatercenter.net). Proper management of stormwater protects surface and groundwater from contamination, which is critical to Fort Hood and the surrounding region (http://www.tnrcc.state.tx.us/EAPP). Contaminants (e.g., oil, fuel, and sediments) that cause problems with stormwater are eliminated if the stormwater is retained on-site and allowed to seep into the soil, rather than running 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.

- **Porous Pavement** – Porous pavement helps reduce stormwater 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 the 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 seven 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. The wetland would work similarly to the Living Machines® (described above) as the 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 Hood 25-Year Goals for Water Resources

To be determined by Fort Hood Command and staff, as advised by members of the local and regulatory communities, at the Environmental Sustainability Executive Conference on 11-13 June 2002.

Air Quality

Air Quality

Challenge

The local community around Fort Hood currently has good air quality. However, regional air quality in the Dallas, Austin, San Antonio, and Houston metropolitan areas surrounding Fort Hood does not meet current national standards for ozone, and is unlikely to meet future standards for particulate matter (e.g., dust and combustion products). If regional air quality continues to degrade, Fort Hood may face training restrictions on obscurants or other mission constraints, as well as higher costs of managing facilities. How can Fort Hood minimize future operational restrictions and costs while improving regional air quality?

Key Considerations

- **Training** – Regional air quality issues can influence training activities such as those requiring use of smokes and obscurants. Modifications in specific activities can reduce the likelihood of specific restrictions later.

- **Energy Use** – Generation and use of energy affect the regional airsheds. Efficient buildings and renewable energy sources reduce impacts to the air and can reduce long-term costs.

- **Transportation** – Participating in the development and use of a regional mass transit plan will improve regional air quality, reduce traffic congestion, and contribute to a better community/installation partnership. The use of alternative fuel vehicles and alternative fuel stations will greatly reduce vehicle emissions.

- **Product Selection and Use** – Identification and use of environmentally benign chemicals for operations and maintenance (O&M) functions and mission activities can reduce impacts and costs while improving mission readiness and worker safety/health.

Air Quality

Importance to Fort Hood

Mission – Some restrictions on the use of smoke generators already exist due to air quality concerns. Regulators could impose additional restrictions if regional air quality worsens, or when new standards on particulate matter (e.g., dust and combustion products) become effective.

Quality of Life – Clean air is essential to providing the world-class quality of life that Fort Hood's soldiers and families deserve. Poor air quality can affect soldiers and families at home and at work. High concentrations of particulate matter can aggravate asthma, reduce lung capacity, and damage lungs.

Cost – Annual and capital costs to comply with air permit requirements are summarized below.

- Air program management: $100-200K/year
- Permit fees and emissions analysis: $1.2M/year
- Ozone-depleting chemical (ODC) reduction program: $2.3M invested to date
- Software for calculating air emissions: $714K invested to date
- Dust control on tank trails and range roads: unknown
- Upgrade of paint booths to meet new standards: $9-18M estimated

Environment and the Community – Fort Hood's air currently meets all national standards. However, Fort Hood and 93 other counties are in a "covered attainment area" for volatile organic compounds (VOCs). If VOC levels increase, Fort Hood and the surrounding region will have to meet new standards, which could increase costs and/or training constraints at Fort Hood. In addition, based on current proposed standards and published information, Fort Hood's air will likely not meet new standards for fine particulate matter ($PM_{2.5}$) within one to six years, and could fail to meet new standards for eight-hour ozone levels.

Fort Hood's 941 registered air pollution emission sources and 60 "insignificant" sources emitted over 31 tons of criteria air pollutants in FY00, over 8 tons of federally listed hazardous air pollutants in FY99, and more than 6 tons of Texas-regulated air contaminants in FY99. Fort Hood received an enforcement action from Texas in July 2001 for failing to amend a permit prior to modifying the paint booth near building 40001.

The population of central Texas, which includes San Antonio, Austin, the Texas Hill Country, and Waco, is expected to grow 7 percent between 2000 and 2005. The forecast heightens existing concerns among area residents about the effects of growth on air quality. Austin and San Antonio have experienced rapid growth in their economies, populations, and traffic. State regulators at the Texas Natural Resource Conservation Commission (TNRCC) are working with local officials to keep air quality in compliance with federal standards. EPA will begin a public education campaign about the health risks of particulate matter in the next two to three years, which could heighten public concern about air quality.

Air Quality

Introduction

Clean air is essential to public health, the economy, and the environment. As both industry and population grow in central Texas, air quality becomes an increasingly important issue for all communities, including Fort Hood. Degradations in air quality could cause more stringent regulations, which could impose additional operational restrictions for Fort Hood.

Current air pollution emission sources at Fort Hood include boilers, paint booths, degreasing operations, the landfill, engine test cells, fuel storage and dispensing operations, abrasive blasting, open detonation, and smoke generators. Under Title V of the Clean Air Act (CAA), Fort Hood is required to monitor emissions from all significant sources. In addition, Fort Hood must submit an annual emissions inventory to the Texas Natural Resource Conservation Commission (TNRCC). The inventory must include all Hazardous Air Pollutants (HAPs), Texas Contaminants and Nonreactive Contaminants, and the six criteria pollutants covered by the National Ambient Air Quality Standards (NAAQS). If new air pollution emission sources are built on Fort Hood, or existing sources are modified, a new permit must be obtained. Fort Hood currently has nine air permits to cover all emission sources, in addition to the Title V permit.

Air Quality by the Numbers

Fort Hood monitors and controls annual emissions of the six NAAQS criteria pollutants. Fort Hood has steadily reduced its emissions of criteria pollutants by implementing pollution prevention projects, as shown in Figure 11. Emissions of HAPs and Texas contaminants are shown in Figure 12. The apparent decrease in HAPs is due to the state of Texas allowing Fort Hood to report on only six source categories

Regulations At A Glance

Clean Air Act (CAA) – This federal legislation establishes permitting requirements and limits for activities that release air pollutants. The state of Texas enforces these regulations at Fort Hood under the Texas Administrative Code. Three major kinds of requirements apply:

1. **National Ambient Air Quality Standards (NAAQS)** – These standards regulate the amount of six criteria pollutants in ambient air. If regional concentrations of ozone, carbon monoxide, particulate matter (e.g., dust), sulfur dioxide, nitrogen oxides, or lead rise above certain standards, operational changes may be required at Fort Hood.

2. **New Source Performance Standards (NSPS)** – Construction or modification of facilities that may emit air pollutants requires a permit. The permitting process includes a health effects review and public comment opportunities.

3. **National Emissions Standards for Hazardous Air Pollutants (NESHAPs)** – The 1990 CAA Amendments directed the U.S. Environmental Protection Agency (USEPA) to regulate emissions into the air of 189 toxic chemicals, called Hazardous Air Pollutants (HAPs), which are known or suspected carcinogens. The state of Texas also requires owners and operators of equipment to monitor, track, and control Texas contaminants in addition to those listed by USEPA. Fort Hood is currently subject to the compliance requirements of two previously promulgated NESHAPs: the Aerospace Manufacturing and Rework Facilities NESHAP and the Asbestos NESHAP. Total usage and other data must be submitted to USEPA and the Texas Department of Health on a semi-annual and annual basis. Fort Hood has designed a database to track the hazardous air pollutants associated with aircraft maintenance and repair. New NESHAPs for Engine Test Cells, Boilers and Heaters, Metal Parts, Paint Stripping Operations, Plastic Parts, and Site Remediation are due out in FY02, and will require similar recordkeeping.

See the following websites for further information:

- http://www.tnrcc.state.tx.us/admin/topdoc/sfr/057_98/statewide.html
- http://www.cleanairforce.org/

instead of the 26 originally required in 1995. Figures 13 and 14 show Fort Hood's emission data for 2000 for criteria air pollutants and HAPs.

Finally, the growth that Fort Hood has experienced has led to an increase in mobile source emissions, as shown in Figure 15. With the continued growth of Fort Hood and the surrounding community, this is a challenge that Fort Hood will face for many years.

Figure 11 – Emissions of Criteria Air Pollutants at Fort Hood

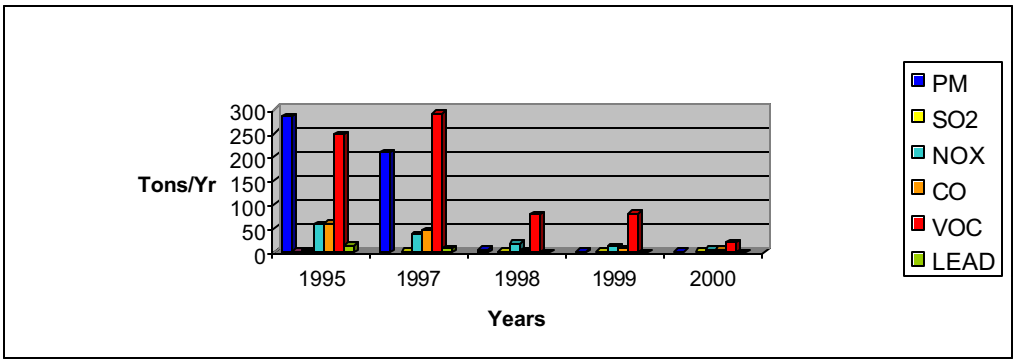


Figure 12 – Emissions of HAPs and Texas Contaminants at Fort Hood

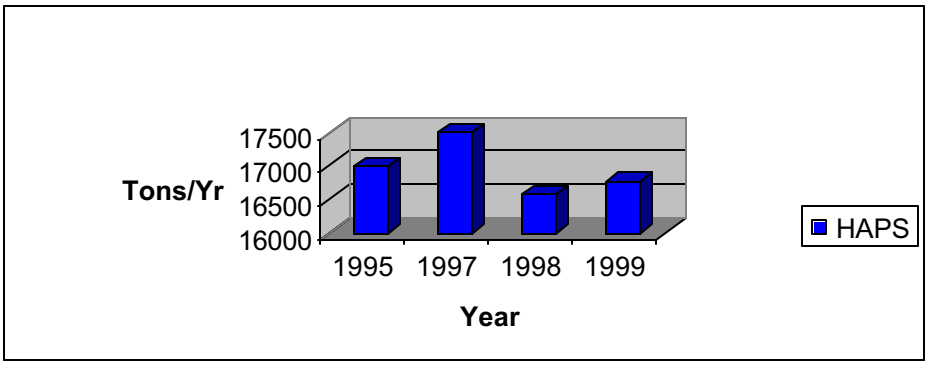


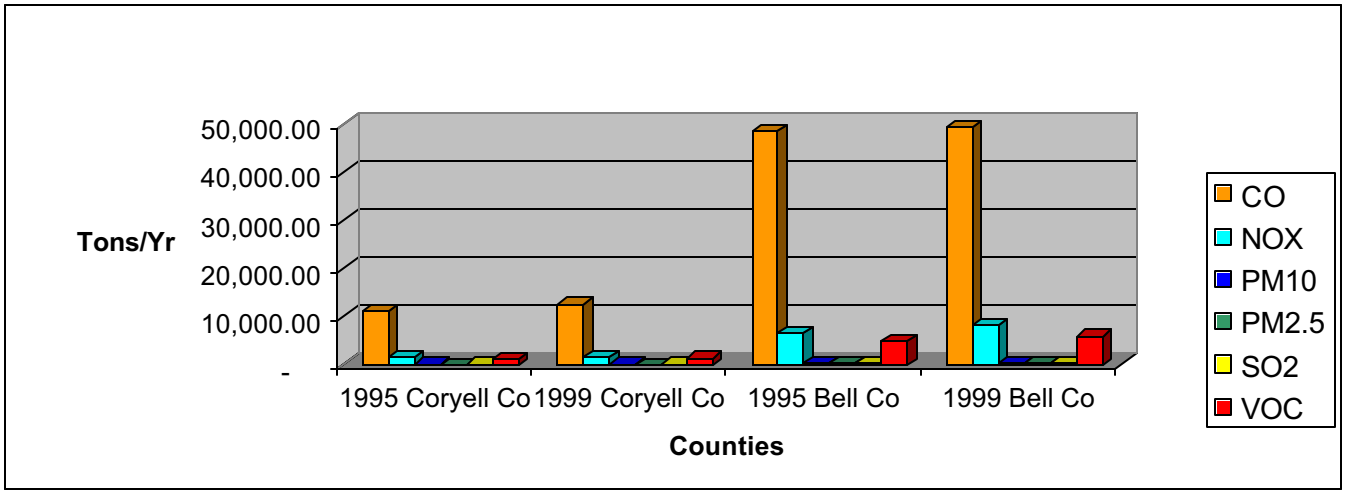
Figure 13 – 2000 Facility-Wide Criteria Pollutant Emissions

CAS NO	Pollutant	LB/Period	TON/YR	Permit Fee
PM10	PARTICULATE MATTER (less than 10 microns)	0.0000	0.0000	---
SOx	OXIDES OF SULFUR	588.6320	0.2943	$7.66
VOC	VOLATILE ORGANIC COMPOUNDS	39955.5958	19.9778	$519.42
CO	CARBON MONOXIDE	9263.4578	4.6317	$120.42
NOx	OXIDES OF NITROGEN	11521.4460	5.7607	$149.78
	Total Criteria Pollutants for Permit Fee		**30.9008**	**$803.42**

Figure 14 – 2000 Hazardous Air Pollutant Emissions > 1 ton

CAS NO	Pollutant	LB/Period	TON/YR
74828	METHANE	6655847.1800	3327.9236
74840	ETHANE	22240.7130	11.1204
104983	ISOPROPYL ALCOHOL	2505.5271	1.2528
630080	CARBON MONOXIDE	9263.4578	4.6317

Figure 15 – Mobile Source Emissions at Fort Hood



Activities and Impacts

Currently, fuel storage, painting operations, and the landfill are the largest contributors to Fort Hood's air pollutant emissions. Other activities that affect Fort Hood's air quality include military training, transportation, and hazardous material use. Each activity and the associated environmental impacts are described below.

Fuel Storage and Combustion

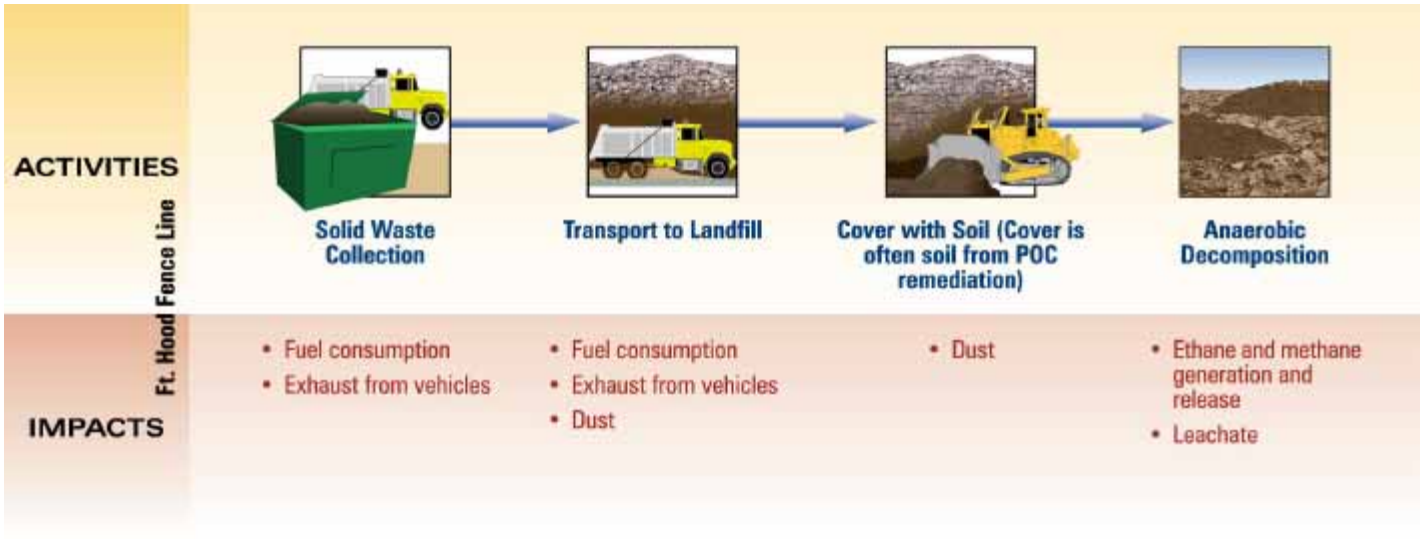
Fort Hood uses 389 boilers of various sizes (not including hot water heaters in housing) to generate hot water. Only emissions from the large comfort/industrial type boilers at the hospital and central energy plants are reported. Figure 16 summarizes the impacts associated with fuel storage and combustion.

Figure 16 – Fuel Storage and Combustion: Activities and Impacts

Landfill Operations

The landfill produces methane and ethane. These hazardous air pollutants must be monitored and reported to the state. Figure 17 summarizes the impacts associated with landfill operations.

Figure 17 – Landfill Operations: Activities and Impacts

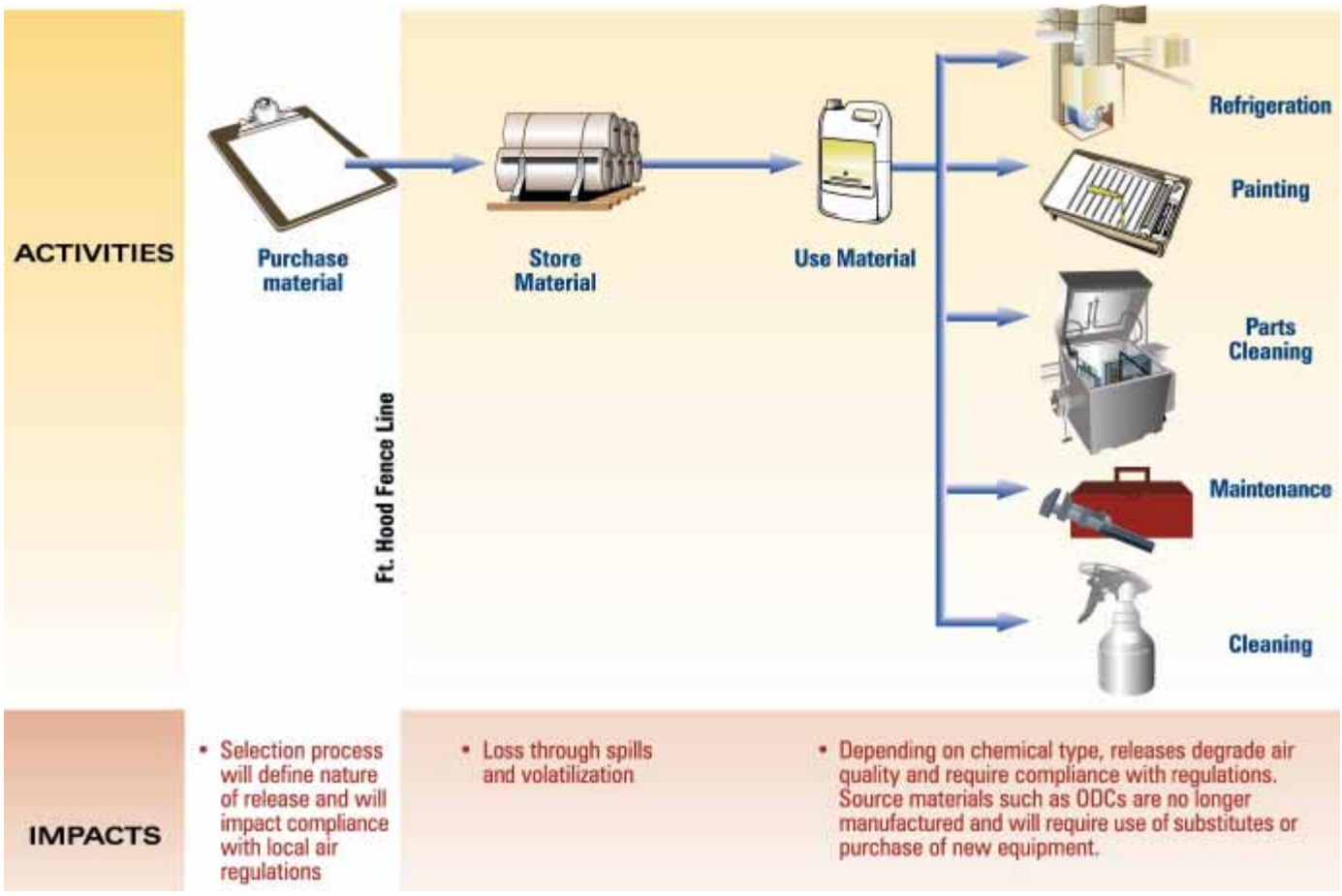


Painting, Degreasing, and other Hazardous Material Use

Figure 18 summarizes the impacts from painting, degreasing, and hazardous materials use. Fort Hood uses paints (in 10 paint booths) and solvent degreasing tanks (433 units installation-wide), resulting in annual

VOC emissions of approximately 26 tons from paint booths and 2.9 tons from degreasers. In FY00, VOC emissions were 17.78 tons from paint booths (several paint booths were not operational) and 1.70 tons from degreasers (new Clarus degreasers were installed). Hourly and annual limits are currently imposed on painting. In addition, Fort Hood must begin to track and report fugitive emissions from maintenance painting, crushing of aerosol paint cans, etc.

Figure 18 – Painting, Degreasing, and Hazardous Materials Use: Activities and Impacts



At Fort Hood, some hazardous materials (e.g., fuels) are stored centrally and used in large quantities, while others (e.g., solvents, paints, and refrigerants) are stored at many locations and used in smaller quantities. Small uses of hazardous materials, such as aerosol can painting, are difficult to characterize because each individual use is difficult to track. These impacts are best controlled with material substitution through Fort Hood's Hazardous Material Control Center (HMCC), or "pharmacy." (See the Products and Materials section.)

Volatile hazardous materials such as chemical agent resistant coating (CARC) paint and solvent degreasers can contribute to the formation of smog and ground-level ozone. This can result in serious environmental and health impacts. For example, high amounts of ground-level ozone can irritate the lungs, causing

respiratory problems. Hazardous material emissions can also contribute to more regional issues such as acid rain and to global environmental issues such as depletion of stratospheric ozone.

Some hazardous materials are so problematic to the environment that USEPA has restricted or eliminated their production and use. Ozone-depleting chemicals (ODCs), which were developed in the 1930s and 1940s for use as refrigerants, solvents, fire suppressants, etc., are targeted for elimination by 2010. This class of chemicals interacts with and destroys stratospheric ozone, which protects the earth's surface from ultraviolet radiation.

Through military construction, and environmental and energy-conservation projects, approximately 13,412 tons of ODC-associated chiller capacity has been replaced over the last six years. ODC-containing equipment on Fort Hood that still requires replacement includes chiller plants, refrigerators, air conditioners, fire suppression systems, and fire extinguishers. Currently, testing of ODC fire extinguishers is prohibited because ODCs are released during testing. The installation is removing all Class I ODC extinguishers except those in tactical vehicles, for which no approved substitute is available. Estimated retrofit/replacement cost to remove all ODC-containing equipment from the installation is $2.3M, not including the replacement requirements for the Army and Air Force Exchange Service (AAFES) and the Defense Commissary Agency (DCA).

Military Training

A Fort Hood Environmental Assessment (EA) for the use of M56 and M58 smoke generators was prepared. The EA includes procedures and training scenarios to ensure that smoke from the generators will not leave the installation boundaries. Because TNRCC considers smoke generators to be mobile sources, Fort Hood is not required to track and report these emissions.

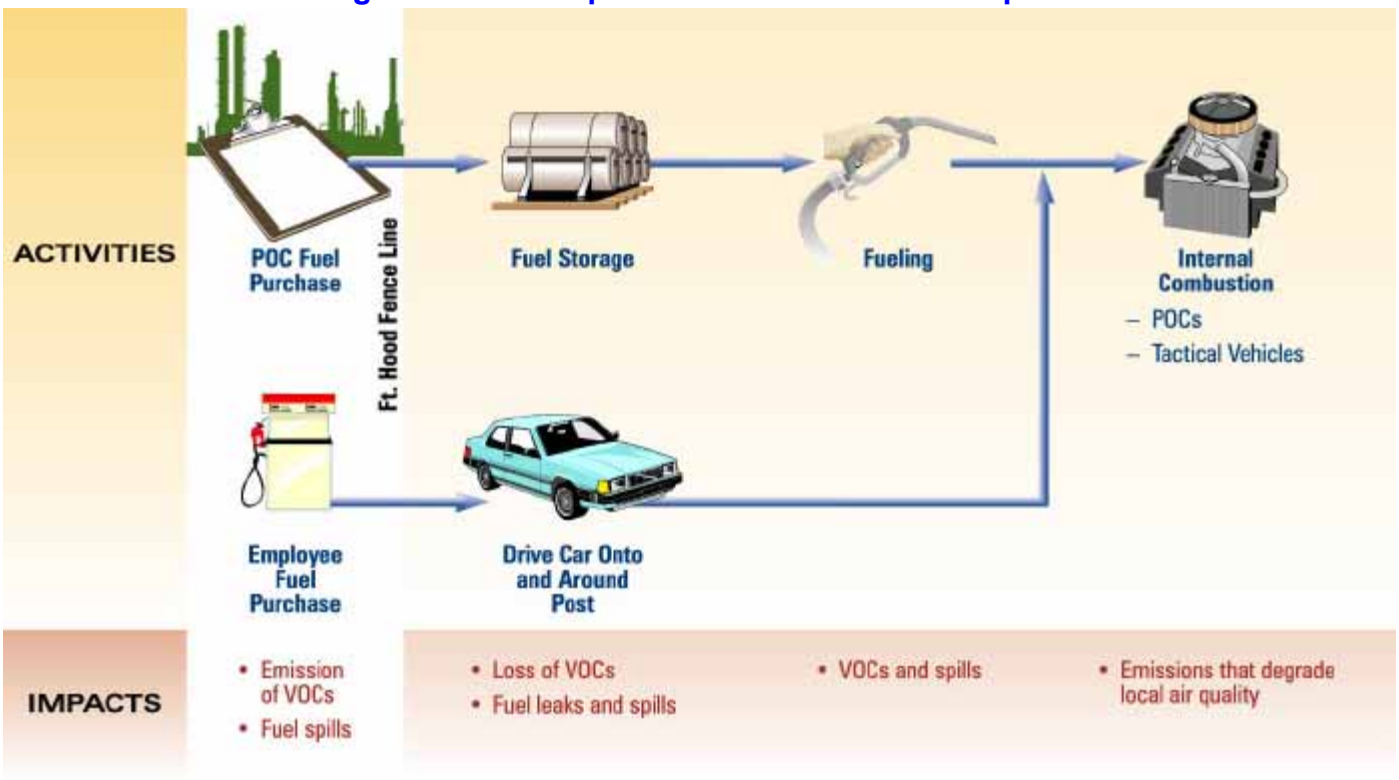
To complete emissions inventories, the amount of particulate matter and fugitive dust kicked up by vehicle wheels and tracks is being determined. Figure 19 summarizes impacts associated with military training.

Figure 19 – Military Training: Activities and Impacts

Transportation

Emissions released by cars and trucks account for close to one-third of all air pollution in the United States today. These emissions are the largest single source of air pollution in almost all areas. In Texas, emissions from mobile sources are estimated on a countywide basis. Bell County has an estimated population of 228,127 people and 194,781 registered vehicles, which travel approximately 4,981,031 miles per year. Coryell County has an estimated population of 73,916 people and 39,524 registered vehicles, which travel approximately 889,308 miles per year. Fort Hood has a daily supported population of approximately 71,000 military, dependents, civilian, and contract personnel that contribute to the air pollution associated with transportation and commuting. Figure 20 summarizes the activities and impacts of transportation on air quality at Fort Hood.

Figure 20 – Transportation: Activities and Impacts



Forecast

Regional air quality will continue to degrade, mostly due to population growth and resulting increases in traffic. This will cause decreased quality of life and numerous new regulatory requirements that will increase the costs of pollution control, recordkeeping, and reporting, and may impose additional constraints on training at Fort Hood. Therefore, Fort Hood must continue reducing its impact on regional air quality. In the long-term, Fort Hood needs regional air quality to improve so that constraints on training activities are reduced, or at least not expanded. The most important air quality issues facing Fort Hood include regional haze, HAPs in painting/coating activities, and the impacts of regional population growth.

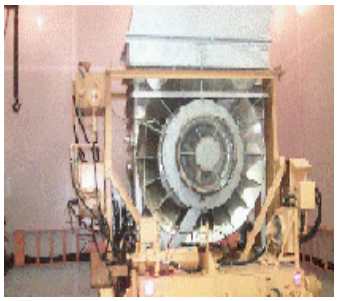
Regional Haze

EPA has proposed new regulations to control regional haze. The proposed national haze regulations were issued in conjunction with new NAAQS for fine particulate matter ($PM_{2.5}$), which is a major component of haze. State Implementation Plans for regional haze will be submitted following EPA's designation of areas as in attainment or nonattainment for the new $PM_{2.5}$ standards. Texas has been monitoring $PM_{2.5}$ officially since 18 August 2000. When three years of data have been collected, EPA will determine whether to declare any parts of the state in nonattainment. It is likely that the Fort Hood area will be in nonattainment.

Submission of State Implementation Plans will occur between 2004 and 2008. At that point, Fort Hood will need to comply with any additional emission controls in the plan. Training with smokes is currently

restricted. The new plan could place greater restrictions on smoke generation, smoke munitions training, off-road vehicle movement that creates dust, and other activities such as outdoor (forestry) burning and cantonment area activities that generate particulate matter. Mobile source emissions may become regulated. "Ground hopping" of tactical equipment engines may not continue once TNRCC promulgates its new engine test cell Permit By Rule. (Ground hopping involves testing a vehicle's engine before it is reinstalled in the vehicle.)

Helicopter Engine Test Cell



In addition, TNRCC has changed the Permit By Rule section of the air regulations. The changes will require extensive recordkeeping, one-time calculations, and stack testing or manufacturer's equipment certification. TNRCC is requesting a level of recordkeeping that will be difficult and expensive to achieve. However, the installation's air quality staff must ensure that new construction projects are reviewed for permit requirements. With so many construction projects going on, maintaining compliance is a challenge.

HAPs in Painting/Coating Activities

EPA is proposing a new rule that will limit the amount of HAPs in miscellaneous metal parts and plastics and will require records of the amounts and kinds of paints, primers, solvents, and cleansers used to paint parts and products. The rule is expected in 2002, which means the compliance date could be sometime in 2005. The requirements of this rule will affect many, if not all, of the painting operations on the installation.

Population Growth

Air quality will continue to degrade as the regional population grows. A particularly disturbing trend is the soaring vehicle use accompanying rapid population growth. Over the next 10 years, the population in Bell County is expected to grow 37 percent and to 18 percent in Coryell County. Therefore, the toughest air quality challenge may be finding ways to reduce vehicle emissions. Fort Hood will need to participate in state and regional efforts to meet this challenge.

Four Texas metropolitan areas (Houston-Galveston, Dallas-Fort Worth, Beaumont-Port Arthur, and El Paso) that are home to nearly half of the state's population, do not meet USEPA's one-hour national standard for ozone. While Austin, San Antonio, Corpus Christi, and Longview-Tyler-Marshall are considered to be near nonattainment of the one-hour standard, violations of the new federal eight-hour ozone standard are likely in all of these areas. Continued violations of the ozone standard will result in expanded monitoring efforts, more stringent emission controls, and expanded air quality planning areas that could grow to encompass Fort Hood. TNRCC is working with local officials to help keep air quality in compliance with federal standards.

Air Quality

Current Sustainability Activities

Painting

- Low-VOC/HAP, waterborne CARC paint has been demonstrated successfully at Fort Hood. Sometime in 2002, Fort Hood expects to switch to this paint at several paint booths. The new paint will greatly decrease emissions from painting operations.

- Portable Air Pollution Control Equipment (PAPCE) has been purchased for several painting operations. These units have High Efficiency Particulate Air (HEPA) filtration systems that greatly reduce emissions from small painting operations.

- The U.S. Army Engineer Research and Development Center (ERDC) selected Fort Hood as a test site for its Mobile Zone spray booth. The booth contains a new type of recirculation system that houses workers in a climate-controlled unit that moves around the equipment to be painted. This improves safety and greatly reduces the cost of treating hazardous emissions. This system could be incorporated into new construction and retrofitted to existing spray booths.

Ozone-Depleting Compounds

- The Directorate of Public Works' Maintenance Division replaced R-12 with MP39 (HCFC 401A) in twelve facilities with walk-in refrigeration equipment.

- Most, if not all, of the fire suppression systems on flightlines and in armored combat vehicles contain halon, a Class I ODC for which no substitute is available. A Department of Defense (DoD) Strategic Reserve of halon has been created to meet the needs in tactical vehicles and equipment. Currently, the Assistant Chief of Staff for Installation Management (ACSIM) is studying whether the accelerated removal of halon from facilities (before equipment failure) is cost effective. Fort Hood is participating in this study. The removed halon is stockpiled in the Strategic Reserve.

Flightline Fire Suppression System

- When Halon 1211 flightline fire extinguishers must be replaced, Fort Hood's units are required to purchase TRI-MAX KOLD CAF systems using Arctic Foam solution. This foam, which does not contain any ODCs, was specifically designed for the TRI-MAX Compressed Air Foam systems.

Fuel Combustion and Energy Production/Use

- Fort Hood's Energy Program has reduced energy use more than 25 percent since 1985.

- The Fort Hood DPW, Plans and Projects Division, has recently installed 96 percent-efficient boilers at a building on the installation. This continues their efforts to reduce NO_x emissions by 30 percent. Boilers at four major central energy plants have been replaced with new high-efficiency, low-NO_x burner-type modular boilers. These boilers replace those that TNRCC had listed as grandfathered facilities.

- Fort Hood's G3 has installed "solargizers" on vehicle and equipment batteries. These solar energy units keep batteries charged during periods of inactivity, which greatly extends battery life. Fort Hood has also installed active daylighting in some buildings and some solar-powered streetlights.

- Fort Hood is building a demonstration "green" building in FY02. The building will reduce air emissions by reducing energy use and by eliminating the use of paints, sealers, adhesives, etc. that contain hazardous air pollutants. (See the Infrastructure section for more details.)

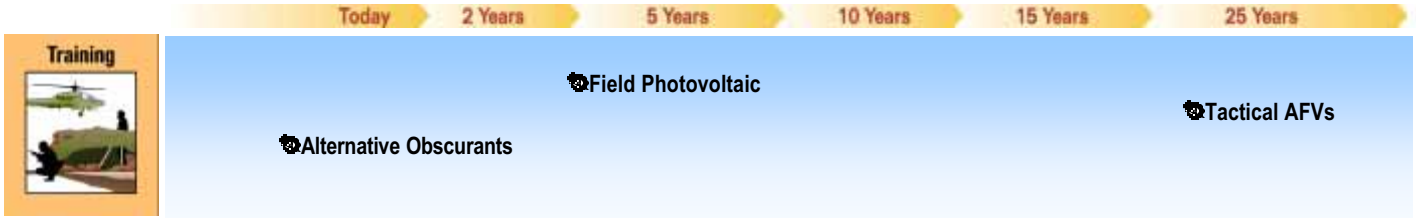
Hazardous Materials Management

- Fort Hood's Hazardous Materials Control Center (HMCC), or "pharmacy," has reduced or eliminated the use of various hazardous materials that affect air quality (see Products and Materials section).

The Realm of Possibility

To become sustainable, Fort Hood is encouraged to identify and plan for innovations that will support the goals established during the Environmental Sustainability Executive Conference. To do this, participants should have exposure to 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.

Training



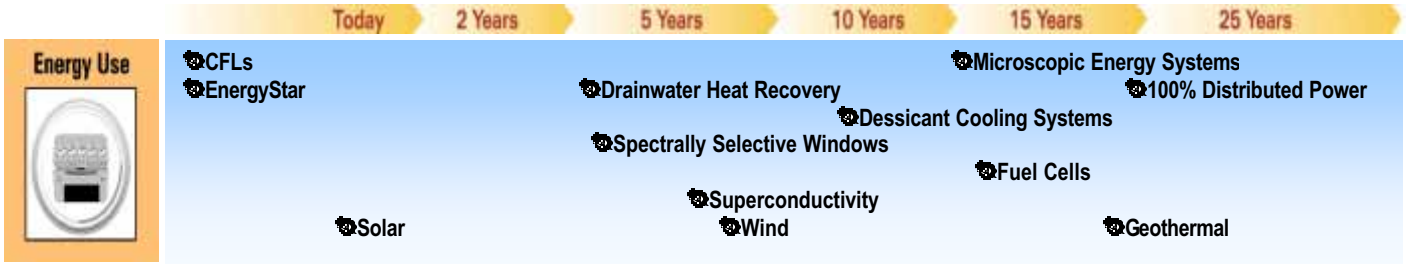
- **Field Photovoltaic** – The 504th Parachute Infantry Regiment, 82nd Airborne, has developed and tested a mobile photovoltaic system capable of providing up to 80 percent of the power required by a modern tactical operations center. Use of this system would remove the need for dirty diesel generators and improve air quality in and around installations.

- **Tactical Alternatively Fueled Vehicles** – While alternative fuels are not currently approved for use in tactical vehicles, advances in technology may someday allow our tanks and armored personnel carriers to run on biodiesel, compressed natural gas, or even fuel cells. Beyond the obvious benefit to

air quality, moving towards the use of alternative fuels may also have operational benefits. Biodiesel is one of the only truly renewable domestic fuel sources (being produced from refined vegetable oils), and vehicles using biodiesel would be, in effect, immune from variations in foreign oil supply.

- **Alternative Obscurants** – The U.S. Army Environmental Center has determined that certain types of signal smoke grenades and smoke pots may be releasing toxic substances that could endanger soldiers and the environment. The research indicated that dyes in the hexachlorethane smoke pots could be carcinogenic. As a result, a project is underway to develop and test new alternative obscurants with less toxic characteristics. If successful, these new dyes would increase soldier safety and well-being while decreasing training restrictions in place to protect surrounding communities. Click here for more information: http://www.estcp.org/projects/pollution/200122o.cfm.

Energy Use



- **Microscopic Energy Systems** – Scientists at PNNL and other research laboratories are developing a family of micro-sized energy systems that are manufactured in much the same way that computer chips are made. Microscopic heat exchangers, evaporators, condensers, gas absorbers, turbines, bioreactors, chemical reactors, chemical separators, pumps, and valves exhibit extraordinary rates of heat and mass transfer. When combined into HVAC or process equipment, this translates into very high efficiencies and minimal pollution generation. These miniature components can be combined to create small heat pumps that can be integrated into window frames, with simple, plug-in replacement units if the originals fail. Small bio-fueled fuel cells will be developed and can be located wherever heat and electricity is needed. Miniature chemical separation units will be developed for in-situ cleanup of tanks, wells, aquifers, and other polluted systems—imagine a pen-sized device that can be dropped into a drum of waste to eliminate PCBs.

- **Drainwater Heat Recovery** – It is estimated that up to 80 percent of water-heating bills come from shower/bath water. An innovative technology called drainwater heat recovery uses the latent heat in drainwater to "preheat" cold water before it is sent through a conventional water heater. Drainwater is typically 90 to 95°F when it is piped away from the shower or bath, and 100 percent of that potential energy is wasted. These systems take heated drainwater and run it through tiny spiraling pipes to preheat cold water to a higher temperature, thus reducing the total amount of energy a water heater must expend to heat fresh water. Installing a drainwater heat recovery unit can reduce overall heating bills by as much as 40 percent. U.S. EPA estimates that if 6 million hot water systems were outfitted with drainwater heat recovery systems, carbon dioxide emissions could be reduced by 20 million tons a year (http://www.oikos.com/gfx/index.html).

- **Superconductivity** – Superconductivity, the ability of a material to conduct electricity with zero resistance and almost no loss of power, is a cutting edge technology that may some day revolutionize the way we think about electricity (http://www.eren.doe.gov/superconductivity/). Today, almost 10 percent of all electricity generated is lost in transmission, radiated as heat from inefficient copper and aluminum wires. Superconductors will lead to the development of a number of new technologies:

    - Transmission wires will carry 100 times more current on a wire no bigger than those we use now.
    - Super-efficient mass transit systems (similar to the MagLev train in Japan) will transport people at enormous speeds using a fraction of the energy that current commuter trains do.
    - Electric motors using superconductor wiring will operate at a fraction of the cost, improving industrial and residential energy efficiency while saving money.
    - Electric generators will be smaller and lighter and require less fuel to generate power.

- **CFLs** – There are a number of commercially available alternatives to traditional incandescent lights. Compact fluorescent lights (CFLs) use between 50 to 70 percent less power than incandescent lights of the same intensity. EPA maintains a comprehensive list of CFLs (http://www.energystar.gov/products/cfls/).

- **EnergyStar** – EPA maintains a database of high-efficiency appliances and office equipment. By simply investing in these readily available alternatives, businesses and homes can save hundreds in energy bills every year (http://www.energystar.gov).

- **Dessicant Cooling Systems** – In the next few years, dessicant cooling systems could be saving offices and large commercial buildings thousands of dollars a month in electricity bills. Used in conjunction with traditional HVAC units, dessicant coolers remove moisture from the outside air, cooling it in the process, and allowing for much higher efficiency for the primary cooling unit. Some estimates place the potential savings in the thousands of dollars per month for large commercial buildings (http://www.nrel.gov/desiccantcool/tech.html).

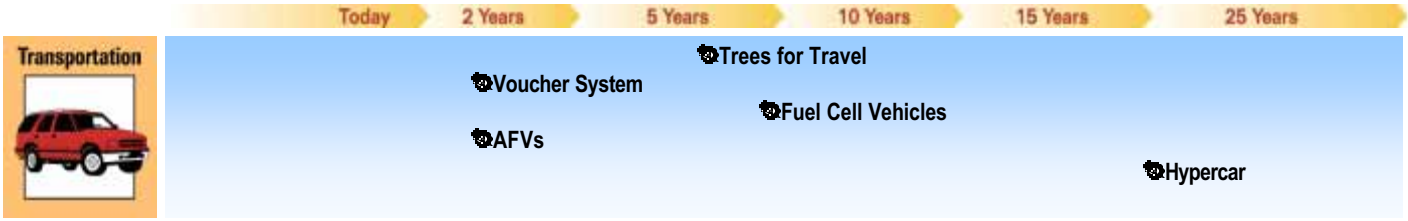
- **Spectrally Selective Windows** – The next generation of windows will be so-called "spectrally selective" and chromogenic windows. Spectrally selective windows have advanced coatings that filter certain wavelengths of radiation from the incident sunlight, lowering the overall solar heat gain significantly. Chromogenic windows are even more advanced, with coatings that actually change their reflective properties based on ambient temperature or light conditions. Some estimates place the potential energy savings at 40 to 70 percent for electrically heated spaces.

- **Solar, Wind, and Geothermal** – Many Army installations are experimenting with renewable energy sources such as geothermal, solar, and wind, which generate no air emissions. Fort Bliss is doing a feasibility study on developing a wind farm to fulfill the majority of its electrical needs. Fort Hood and Fort Irwin have installed "solargizers," active daylighting of buildings, and solar-powered streetlights to capture the sun's energy. Fort Carson heats a hangar using a solar "wall" on one side of the building. For more information on the realm of possibility and examples of efforts world-wide, see Chapter 12, *Climate: Making Sense and Making Money*, Natural Capitalism.

- **Fuel Cells** – While fuel cells are starting to become available now, most industry analysts believe that it will be 8 to 10 years before they are truly cost competitive with traditional energy systems. These systems work by combining an ionized hydrogen fuel source with air to produce water and electricity. There are NO harmful emissions associated with their operation. They produce electricity that can then be used to heat and power a residence or office space. GE and other large energy services companies have invested millions in this technology and it is only a matter of time before we begin to use fuel cells in earnest (http://www.dodfuelcell.com/).

- **100 Percent Distributed Generation** – Distributed generation works on the premise that the most efficient way to produce electricity for a customer is to produce it at the location where it is needed, thus avoiding losses due to transmission. Imagine a country with no power lines, no polluting smokestacks, and no power companies as we know them today. Imagine instead a country where every home or office has a fuel cell in the basement generating electricity while releasing only water vapor as a by-product. Or imagine an office building with a solar roof and windows that becomes a net source for power on sunny days. Impossible? Maybe so. But as technology continues to develop the day may come when every home and business can generate its own electricity for less than it costs now to buy electricity from a utility.

Transportation



- **Trees for Travel** – Trees for Travel is an organization that will plant trees to offset the pollutants caused by air and vehicle travel. Organizations can keep track of their mileage and send donations to Trees for Travel, or large land-owning organizations, such as Fort Hood, can start their own program to offset the vehicle emissions caused by transportation activities (http://www.treesftf.org).

- **Voucher System** – The new Mass Transit Voucher System requires government agencies to pay up to $65/month to cover the costs of employees who take mass transit or van pools to work.

- **Fuel Cell Vehicles** – Toyota and Honda will begin selling Fuel Cell Vehicles in 2003. Toyota Motor Corporation will begin selling fuel cell motor vehicles in mid-2003, possibly becoming the first world automaker to start selling next-generation automobiles. Japan's No. 1 automaker initially expects to sell only about a dozen fuel cell vehicles—in the Tokyo metropolitan area alone—primarily for use by government offices and leading businesses because of the limited availability of both hydrogen for fuel and maintenance for the new vehicles. A Toyota spokesman confirmed that the company is preparing to launch the vehicle "at the soonest possible time of next year," which is expected to be based on its experimental model, the FCHV-4, mounted on the sport utility vehicle, the Kluger V. Honda Motor Co. also is gearing to launch its own fuel cell model for limited commercial sales next

year. DaimlerChrysler Corporation and Ford Motor Company are also preparing to launch their fuel cell cars in 2004. Fuel cell vehicles, which are powered by hydrogen stored in an onboard, high-pressure tank, emit no harmful pollutants into the air at the point of use (BNA, Feb 2002).

- **AFVs** – GSA provides vehicles that run on alternative fuels, such as natural gas, propane, and electric hybrids. These vehicles have reduced air emissions. Honda, Nissan, and Ford also have alternative fuel vehicles on the market. Fueling stations are needed to make this a viable option.

- **Hypercar** – Rocky Mountain Institute (RMI) developed a concept design for a "hypercar" and put it in the public domain in the early 1990s. By reconfiguring three key design elements, RMI estimates that 70 to 80 percent of the fuel could be saved, which corresponds to a decrease in air emissions, while making cars safer, sportier, and more comfortable. The three design elements include: 1) making the vehicle ultra-light by using composites instead of metal, with a weight two to three times less than steel cars; 2) making the vehicle more aerodynamic, so it has much less drag; and 3) making the vehicle's propulsion system hybrid-electric, with the electricity produced on-board from fuel as needed. The fiel could be conventional gas or diesel, or a stack of fuel cells, which turn hydrogen and air into electricity. From 1993-98, the private sector committed roughly $5B to developing the hypercar. The major automakers have built prototypes and predict mass production of fuel cell powered cars by 2005; Honda and Toyota already have hybrid-electrics on the market in Europe, Japan, and the U.S.

Product Selection and Use

- **Solvent-free Degreasing** – The Army Tank and Automotive Command (TACOM) and the Army Research Laboratory are testing and evaluating new technologies for solvent-free degreasing.

- **Alternative Cleaners** – Many different cleaning chemistries are available to reduce the use of hazardous air pollutants and ozone-depleting chemicals. Common alternative chemistries range from aqueous-based to petroleum distillates. A new class of plant-derived cleaners began to emerge in the last decade. Terpenes, derived from citrus oils, are the most noted of this class. Recently, other plant-derived chemistries have been developed. These include the ethyl lactate-based cleaners derived from corn and soy (http://www.gemtek.com). Plant-derived cleaning chemistries can be used over a wide range of cleaning applications, from clean room applications to general maintenance.

Fort Hood 25-Year Goals for Air Quality

To be determined by Fort Hood Command and staff, as advised by members of the local and regulatory communities, at the Environmental Sustainability Executive Conference on 11-13 June 2002.

Infrastructure

Infrastructure

Challenge

Facility construction, operation, maintenance, and demolition represent a significant investment and result in numerous environmental impacts. A building's siting and design drive its requirements for maintenance, energy, and water throughout its lifespan. How can Fort Hood provide the world-class facilities that soldiers and families deserve, while also reducing operation and maintenance costs, pollution, and resource use?

Key Considerations

- **Design** – "Green" design and siting can greatly reduce a building's operational costs and environmental impact. The U.S. Green Building Council (USGBC) has established the Leadership in Energy and Environmental Design (LEED) Green Building Rating System to evaluate the relative long-term sustainability of buildings. The U.S. Army Corps of Engineers (USACE) has modified the LEED criteria. The SPiRiT standard (Sustainable Project Rating Tool) adds military-specific design considerations to the LEED standard. Army policy is that all future construction will meet, at a minimum, the SPiRiT Bronze Certification Level.

- **Energy Efficiency** – Energy-efficient building design and operation can conserve existing resources, lessen environmental impact, and save money. The extensive construction and renovation planned over the next seven years provide an opportunity to increase energy efficiency.

- **Water Consumption** – "Green" design can minimize water consumption, reducing direct water cost, environmental impacts, and the energy used to pump water from the treatment system to users and then back to the wastewater treatment system prior to discharge.

- **Privatized Housing** – Family housing represents 31 percent of over 29M square feet of buildings at Fort Hood. Privatization may provide an opportunity for the development of sustainable, more energy-efficient communities for soldiers and families through the Residential Communities Initiative (RCI).

- **Water Pollution** – Impervious surfaces, such as rooftops and parking lots, increase the volume and velocity of stormwater, resulting in contaminated runoff, increased soil erosion, and reduced aquifer recharge. Reducing building footprint and roadways, selecting appropriate building sites, increasing sustainable landscaping, using porous pavement, and reducing parking lot size are a few ways that building design can reduce water pollution and save money.

- **Construction & Demolition (C&D) Waste** – Building demolition results in large amounts of debris—about 11,600 tons last year. Nearly 30 percent of Fort Hood's total solid waste is C&D debris, not including concrete and other inert materials that are stockpiled for later grinding and use as riprap and road gravel. As buildings are slated for removal, modern building deconstruction and recycling techniques may reduce demolition costs, increase use of salvaged materials, and reduce environmental impacts. Efficient deconstruction techniques should be considered when new facilities are designed.

Infrastructure

Importance to Fort Hood

Mission – Adequate, affordable facilities for training soldiers and maintaining equipment are critical to accomplishing the mission.

Quality of Life – Clean air and water and comfortable facilities for living, working, and training are basic to a good quality of life for soldiers and families.

Cost – Replacement and annual maintenance of the infrastructure at Fort Hood is expensive. In addition, the cost of power and water is directly related to the efficiency of buildings and the appliances and equipment inside. A summary of costs is provided in Figure 21 below.

Figure 21 – Infrastructure Costs

Type		Requirement	FY01 Costs
Military Construction – Army (MCA)		$805M over next 7 years	$50.3M
Family Housing (RCI)		$135M over next 7 years	-
Range Revitalization		$197M over next 7 years	-
Minor Construction		$85.9M/yr	$24.9M
Maintenance and Repair		$144.7M/yr	$34.5M
Water		-	$1.5M
Total Energy		-	$36.3M
	Natural Gas	-	$10.0M
	Electricity	-	$26.3M

Environment and the Community – Facility construction and operation and maintenance (O&M) require large quantities of building materials and other supplies. The increased local purchase of such materials and supplies could enhance the regional economy around Fort Hood.

Energy used to light, heat, and cool buildings generates air pollution both on- and off-post, and can be reduced through "green" building design and construction. "Green" design includes proper site design and the use of more efficient materials, appliances, and equipment.

Proper placement of buildings and roads can prevent erosion and subsequent degradation of water quality. Impervious surfaces decrease infiltration, absorption of surface waters into the soil, and recharge of aquifers. Domestic and industrial water consumption, including water use for irrigation, can be reduced substantially at Fort Hood.

Building O&M requires the use of hazardous materials and generates solid and hazardous wastes. Demolition of excess buildings and subsequent landfill disposal creates a very large solid waste stream. Reuse and recycling programs can save regional landfill space and benefit the local building industry and community.

Infrastructure

Introduction

Fort Hood's infrastructure, which includes buildings, grounds, irrigation systems, utilities, roads, and parking areas, is large, diverse, and continually changing to meet current and future requirements. Fort Hood has over 29M square feet of building space with an estimated value at time of acquisition of $1.7B. Figure 22 lists the types of buildings on Fort Hood and the associated square footage. In support of these facilities, Fort Hood maintains 446 miles of paved roads, and 660 miles of gravel roads and tank trails. The installation also maintains 10,726,420 square yards of paved parking areas, and 1,135,072 square yards of gravel parking areas. The post currently includes 5,860 impervious acres. Maintenance activities include repair, cleaning, irrigation, and upgrades.

Figure 22 – Key Building and Structure Data
(as of 30 Sep 01)

Type	Number	Ft^2
Barracks	98	4,106,935
Barracks (AT)	42	242,482
Family Housing (5,622 Quarters)	2,704	8,899,244
801 Housing	300	292,500
Storage/Depot	447	2,033,207
Maintenance	227	3,393,504
Training	137	777,375
Community Facilities	264	2,977,012
Administrative	244	3,356,729
Medical	33	772,762
Utilities (Supporting Structures)	150	95,490
Dining Facilities	50	306,822
Carports	81	132,758
Others		1,622,835
TOTAL	4,777	29,009,655

The Directorate of Public Works (DPW) is responsible for the design, construction, operation and maintenance, demolition, and ultimate disposal of the installation's buildings. The Public Works Plans and Projects Division (PWPPD) plans and programs the installation's real property management and development through the Real Property Master Plan (RPMP). The USACE provides design and construction management and project oversight.

Family housing on Fort Hood is being privatized. All future construction and operation and maintenance (O&M) of family housing will be through the Army's Residential Communities Initiative (RCI). RCI is an Army program designed to enhance quality housing by transferring ownership, maintenance, and operation of military family housing to large housing contractors through 50-year contracts. The three-way partnership formed among Lend Lease Actus, Trammell Crow Residential, and the Army is called "Fort Hood Family Housing." The partnership's goals are to upgrade all existing housing and to eliminate the current housing deficit in five years.

Fort Hood has an active Facilities Reduction Program to eliminate excess temporary wooden buildings. Over 461 buildings with 1,623,366 square feet of space were removed between 1993 and 2000. An estimated additional 630,000 square feet of space will be demolished by 2008.

Infrastructure

To heat buildings and water on the installation, Fort Hood operates 389 boilers, varying in size from under 0.0025 MMBtu/hr to 10.2 MMBtu/hr input capacity. Three boilers can operate on either natural gas or oil; all the others use only natural gas. Fort Hood relies on commercial power for 100 percent of the electricity used on-site. TXU Energy provides electricity through three substations located on the installation.

Activities and Impacts

Numerous environmental impacts arise from the design, construction, operation, maintenance, renovation, and demolition of facilities. The design and siting of a building determines the type of construction materials and equipment to be used and the kinds of energy, water, and other impacts it will have. The planning decisions that establish the lifecycle operation and maintenance costs of the building affect 90 percent of the total cost of a typical building. The design, placement, and construction of buildings and roads determine the quantity and quality of stormwater during and after construction. The use of buildings results in energy and water consumption, air pollution, and the release of hazardous materials and various other wastes from operation, repair, replacement, and occupant activities. Construction, renovation, and demolition create debris disposal requirements. Figure 23 depicts the impacts associated with each of these activities.

Regulations At A Glance

Executive Order 13123, Greening the Government through Efficient Energy Management – According to this executive direction, compared to a 1985 baseline, Fort Hood must reduce energy use by 35 percent by 2010.

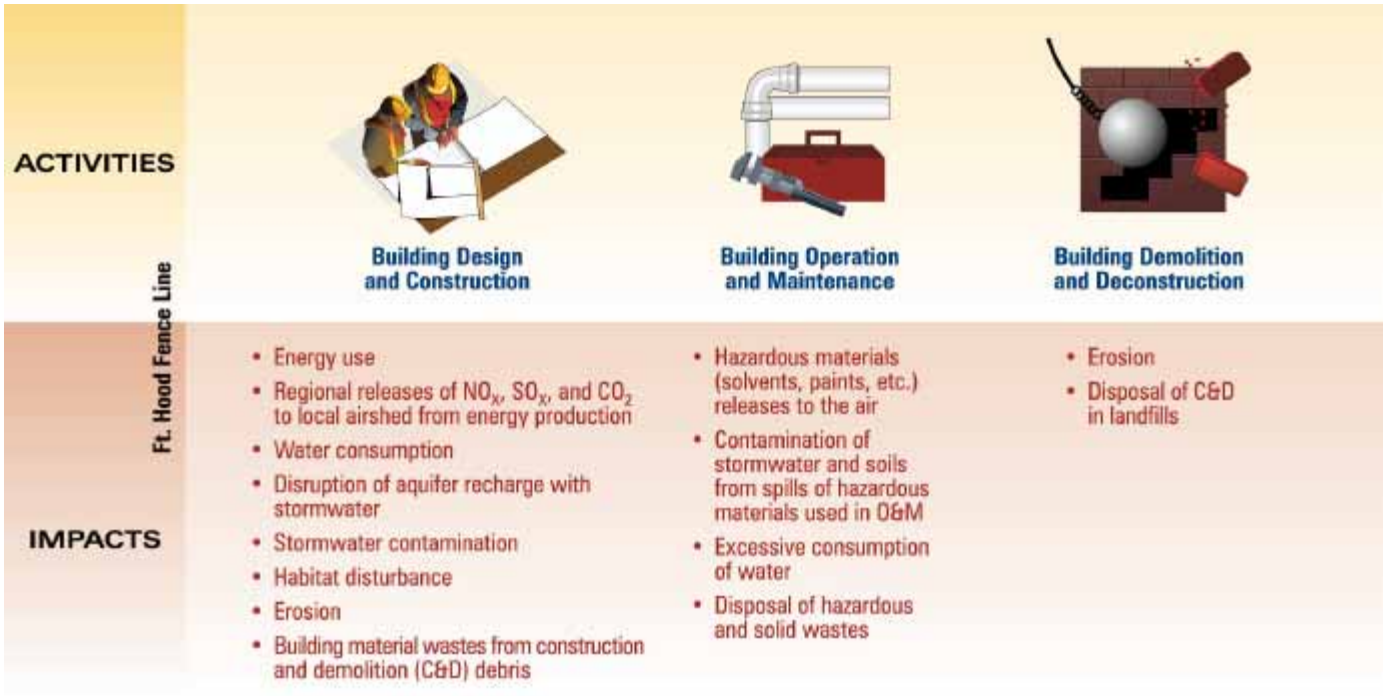
Resource Conservation and Recovery Act (RCRA) – This legislation's primary goals are to protect human health and the environment from the potential hazards of waste disposal, to conserve energy and natural resources, to reduce the amount of waste generated, and to ensure that wastes are managed in an environmentally sound manner. RCRA regulates the management of solid waste (e.g., garbage), hazardous waste, and underground storage tanks holding petroleum products or certain chemicals.

Clean Air Act (CAA) – This legislation sets limits on the amount of certain pollutants that can be in the air in the United States. The CAA requires installations to apply for permits for activities that create air impacts.

Clean Water Act (CWA) – In 1972, the U.S. Congress enacted the first comprehensive legislation to control water pollution. Under the CWA, discharges to surface water must be permitted by the U.S. Environmental Protection Agency (EPA) and monitored by the discharger.

Safe Drinking Water Act (SDWA) – This legislation was developed to protect the public water supply. Source Water Protection emphasizes preventing contamination of drinking water resources and includes wellhead protection and sole source aquifer watershed control plans.

Figure 23 – Infrastructure: Activities and Impacts



Air Quality Impacts

The production of energy to light, heat, and cool buildings results in air pollution both on- and off-post. In FY00, Fort Hood consumed 2,403,901 MMBtu of energy (electricity, natural gas, and fuel oil) at a cost of approximately $27.2M. In FY01, consumption was 2,887,783 MMBtu, a 20 percent increase, at a cost of approximately $37.8M, a 39 percent increase. Most of this energy was used to light, heat, and cool buildings.

Based on national averages, energy use at Fort Hood results in an estimated annual release of 388,050.25 tons of carbon dioxide (CO_2), 60.23 tons of nitrogen oxides (NO_x), and 175.9 tons of sulfur oxides (SO_x).

The lifetime energy use of a building is easily controlled through proper building design. Experts at Rocky Mountain Institute estimate that smart design of buildings, using currently available technologies, can produce new buildings that are 9 to 10 times more efficient and renovated buildings that are 3 to 4 times more efficient than those built in the 1970s. Such reductions could reduce the releases of CO_2, NO_x, and SO_x.

Since 1985, energy use at Fort Hood has been reduced by more than 25 percent. As the post continues to demolish buildings and implement energy conservation projects, overall energy consumption and corresponding air emissions will diminish further. Fort Hood expects an additional 3 percent reduction by

2005 through use of the Energy Savings Performance Contracting (ESPC) vehicle. After this time, the reduction will level out. Since Fort Hood is growing rapidly, proactive participation from all of Fort Hood's energy users is required to achieve the mandated 35 percent reduction by 2010.

Water Consumption

Many activities at Fort Hood require water. Fort Hood's overall water consumption has averaged approximately 2.3B gallons per year over the last five years. The average potable water consumption is 6.4 million gallons per day (MGD) for a supported population of over 71,000. This averages 90 gallons per person per day and includes all domestic and industrial uses. Fort Hood's peak potable water consumption (average 10.9 MGD or 153 gallons/capita/day) occurs in the summer months with irrigation demands. During the winter months, consumption drops to 5.0 MGD. This compares favorably with the Killeen average of 120 gallons/capita/day, published in the state 50-year strategic water plan (*Water for Texas 2002*, available at http://www.twdb.tx.us). The state plan predicts a 67 percent increase in water demand between 2000 and 2050, mostly due to projected population increase. State resource managers plan for 18 percent of this increase in demand to be offset by additional water conservation practices.

Water is not metered on-post; therefore, information on water use for specific activities is not available. Nationally, one-third of all water is consumed for domestic uses, one-third for industrial uses such as wash racks and boilers, and one-third for irrigation. At Fort Hood, irrigation accounts for the difference in water consumption between the winter and summer months. Potable water is used for all irrigation except for the golf course, which uses stormwater. The Fort Hood water consumption figures show that just over half of the peak water demand is for irrigation in the summer; it is reasonable to assume that half of the remainder is used for domestic uses and half for industrial uses.

A Water Conservation Policy was established in March 1999 to save water and reduce utility costs. The Policy promotes the use of water-conserving landscaping practices, the use of closed-loop Tactical Vehicle Wash Facilities by military units, and education of the military and civilian workforce and families on how to prevent waste of potable water.

Incorporating water conservation technologies into facility design is the easiest and cheapest way to reduce a building's water consumption. These technologies should be "transparent" to the building user, providing the same amount of comfort, convenience, and effectiveness as older technologies. New irrigation technologies that decrease water use by up to 90 percent, without decreasing effectiveness, are also available.

Water Pollution

In addition to the sewage generated by building use, buildings and building sites create "nonpoint source pollution." Nonpoint source pollution occurs when water runs over the ground, accumulates pollutants, and deposits these pollutants in rivers, lakes, coastal waters, or groundwater. On Fort Hood, sources of nonpoint source pollution include active construction sites, impervious surfaces (paved areas and

buildings), and training lands. Oil, grease, sediment, heavy metals, nutrients, and other contaminants from these areas can be washed into waterways with every rain, and eventually flow into Lake Belton, the source of drinking water for Fort Hood.

Impervious surfaces prevent rainfall from seeping slowly into the ground and groundwater, leading to inadequate recharge of underground water reserves. Impervious areas also increase the amount and velocity of rainfall runoff into natural areas. The increased runoff velocity can cause soil erosion and sedimentation of surface waters. The 214,351-acre installation contains 74,306 acres of cantonment area, which includes many buildings, parking lots, and roadways that are impervious to stormwater infiltration.

Building design and siting affect water quality throughout the lifespan of the building. While stormwater can be intercepted and treated, a good design is less expensive and more effective.

Land Impacts

Impacts to land include habitat destruction, reduced green space, erosion and soil loss, and land required for the disposal of C&D debris. Fort Hood has an active Facilities Reduction Program to eliminate excess temporary wooden buildings. In addition, many buildings are being demolished to make way for new construction. Over 461 buildings with 1,623,366 square feet of space were removed between 1996 and 2001. Approximately 11,600 tons of C&D debris were generated in FY01, representing about 30 percent of Fort Hood's total waste. Nearly 78 percent of C&D debris is contaminated with lead-based paint and must be disposed of properly, in accordance with local requirements. Of the remaining C&D waste, about 5 percent is wood that is turned into compost, and less than 1 percent is metal that is recycled. The rest is concrete and other inert material that is stockpiled for later use as riprap, road gravel, and similar products.

Other installations have programs for selling or donating excess buildings and/or building components. These opportunities have not yet been actively pursued at Fort Hood due to concerns over hazardous materials and liability issues. A potential "deconstruction" project with the Austin Habitat for Humanity Re-Store is on hold, pending legal review.

Forecast

Fort Hood – Over the next seven years, Fort Hood's infrastructure will continue to grow. The installation will invest over $805M in new construction of 2.4M square feet of barracks and other facilities and $196.5M in range revitalization. The private companies partnered with Fort Hood in the RCI will invest $135M in new family housing.

Region – Over the next 10 years, the population of Bell County will grow approximately 37 percent; Coryell County will grow 18 percent. This will result in more construction, energy use, air pollution, water use and pollution, and waste disposal in the surrounding region.

Current Sustainability Activities

Green Training Facility – Fort Hood's staff and supporting organizations have begun to consider many of the issues identified above. A "green" training facility is under design and is expected to be constructed by 4th quarter FY02. It will be the first U.S. Army facility of its kind to be built to the USACE SPiRiT Platinum Certification Level, the highest rating level attainable. This project incorporates straw bale construction, xeriscaping, waterless urinals, active daylighting systems, and solar-powered lighting. It also incorporates materials salvaged and recycled from Fort Hood's demolished facilities: wooden floors and beams, windows, and crushed glass from bottles.

The Construction Engineering Research Lab designed a "green" neighborhood for Fort Hood's family housing in 1996. The design estimated a 71 percent decrease in energy use with only a 5 percent increase in initial costs. It was never built because the Residential Communities Initiative took over family housing, but it serves as a good example of "green" building potential.

Energy Conservation – The Fort Hood Energy Management Team supervises one of the most aggressive and ambitious Energy Conservation Programs in the Army. Spending more than $35M to provide energy for almost 5,000 buildings, energy conservation is important. Using statistical methods and tools such as Life-Cycle Cost Analysis, Fort Hood continues to research opportunities for high-efficiency, renewable, and "earth-friendly" energy sources, such as solar-powered lights and active daylighting. These two technological advancements already save the installation nearly $100,000 annually. The Fort Hood Energy Conservation Program has been recognized with numerous awards from the Department of Defense (under the Federal Energy Management Program) and with a Government Technology Leadership Award for successful implementation of the Frequency Modulation Load Management System. Using this aggressive and proactive Energy Conservation Program, Fort Hood has consistently achieved energy reduction goals prescribed by the Energy Policy Act of 1975 and subsequent Executive Orders. Proactive participation from all of Fort Hood's energy users is essential to achieve the mandated 35 percent reduction by 2010. See the Energy section for further details.

Partnering – Fort Hood is working with Austin Energy on the design of the "green" training facilities described above. Austin Energy is a national trendsetter in the area of energy conservation. Starting as the City of Austin Electric Department in 1893, Austin Energy has become a leader in conservation and renewable energy resource programs and is nationally recognized for service excellence. Austin Energy's Green Building Program, which has nationally recognized expertise in "green" residential and commercial construction, provides technical seminars and individualized technical assistance; programming assistance and construction document review; marketing services for new structures; and technical analysis for energy efficiency, natural resource conservation, and healthy indoor environments.

More Partnering – Fort Hood is the first military installation recognized as a charter member of the Clean Texas 2000 Program. Developed by the Texas Natural Resource Conservation Commission, the Clean Texas 2000 Program recognizes organizations that protect air, water, or land and that establish regional partnerships and networks to help members achieve goals. The Program recognizes members for creative

approaches to environmental challenges and for setting goals that exceed compliance levels under existing regulations, thus encouraging sustainable practices. Fort Hood's current goal in this program is to increase the amount of recycling to 40 percent of solid waste. Reuse/recycling of building components may be one way to do this.

The Realm of Possibility

To become sustainable, Fort Hood is encouraged to identify and plan for innovations that will support the goals established during the Environmental Sustainability Executive Conference. To do this, participants should have exposure to 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.

Design

- **LEED System** – The U.S. Green Building Council's (USGBC) 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 that takes into account military-unique aspects of building design, called the Sustainable Project Rating Tool (SPiRiT). Projects are rated 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.

- **Pentagon Renovation** – The current renovation of the Pentagon is being done according to green design principles. The first project was a separate $10M central receiving facility. Given the security requirements for the building, it was designed as an earth-sheltered building with a park on top for Pentagon employees to enjoy. The $1.1B renovation of the Pentagon itself is harnessing market forces to determine how to "green" the historic structure. The contractor has been given a list of performance criteria for the building, some of which address environmental impacts. Some are mandatory and some are not; however, if the contractor can suggest a way to meet the criteria that will save money over the expected lifetime of the building, and the government accepts the suggestion, then the contractor shares in the anticipated savings by increasing the percentage of profit.

- **Design Charette** – Fort McPherson held a design charette in FY00 to do "green" renovations on a historic structure. Fort Bragg is currently designing a low-impact parking lot for its environmental education building. Forts Carson and Polk also have green building demonstrations in design. The Fort Polk green building, also a training facility, was designed using off-the-shelf technologies at a very reasonable cost of $100/square foot, and is expected to qualify for a "silver" SPiRiT rating.

- **Solar, Wind, and Geothermal** – Many Army installations are experimenting with renewable energy sources such as geothermal, solar, and wind, which generate no air emissions. Fort Bliss is doing a feasibility study on developing a wind farm to fulfill the majority of its electrical needs. Fort Hood and Fort Irwin have installed "solargizers," active daylighting of buildings, and solar-powered streetlights to capture the sun's energy. Fort Carson heats a hangar using a solar "wall" on one side of the building.

- **Earthship Biotecture** – Earthship Biotecture is a truly innovative development in green building. It is the first commercial attempt to design affordable, comfortable, and totally sustainable homes for widespread use on a global scale. Earthship designs incorporate passive solar heating and cooling, solar hot water and electricity, grey and black water recycling systems, and rainwater collection and filtration systems. The innovative design allows most owners to build the majority of their homes on their own, using tires, soda cans, and cement! At an Earthship community in Taos, New Mexico, two-bedroom homes sell for $140,000, a price competitive with standard homes (http://www.earthship.org).

Energy Consumption

- **CFLs** – There are a number of commercially available alternatives to traditional incandescent lights. Compact fluorescent lights (CFLs) use between 50 to 70 percent less power than incandescent lights of the same intensity. EPA maintains a comprehensive list of CFLs (http://www.energystar.gov/products/cfls/).

- **EnergyStar** – EPA maintains a database of high-efficiency appliances and office equipment. By simply investing in these readily available alternatives, businesses and homes can save hundreds in energy bills every year (http://www.energystar.gov).

- **Dessicant Cooling System** – In the next few years, dessicant cooling systems could be saving offices and large commercial buildings thousands of dollars a month in electricity bills. Used in

conjunction with traditional HVAC units, dessicant coolers remove moisture from the outside air, cooling it in the process, and allowing for much higher efficiency for the primary cooling unit. Some estimates place the potential savings in the thousands of dollars per month for large commercial buildings (http://www.nrel.gov/desiccantcool/tech.html).

- **Fuel Cells** – While fuel cells are starting to become available now, most industry analysts believe that it will be 8 to 10 years before they are truly cost competitive with traditional energy systems. These systems work by combining an ionized hydrogen fuel source with air to produce water and electricity. There are NO harmful emissions associated with their operation. They produce electricity that can then be used to heat and power a residence or office space. GE and other large energy services companies have invested millions in this technology and it is only a matter of time before we begin to use fuel cells in earnest (http://www.dodfuelcell.com/).

- **Distributed Generation** – Distributed generation works on the premise that the most efficient way to produce electricity for a customer is to produce it at the location where it is needed, thus avoiding losses due to transmission. Imagine a country with no power lines, no polluting smokestacks, and no power companies as we know them today. Imagine instead a country where every home or office has a fuel cell in the basement generating electricity while releasing only water vapor as a by-product. Or imagine an office building with a solar roof and windows that becomes a net source for power on sunny days. Impossible? Maybe so, but as technology continues to develop, the day may come when every home and business can generate its own electricity for less than it costs now to buy electricity from a utility.

Water Consumption

- **Composting Toilets** – Composting toilets eliminate the use of water to transport human wastes, which accounts for 26 percent of residential water use, as well as sewage collection and treatment requirements. These toilets produce a humus-like product that can be used as soil amendments. The life-cycle cost is less than that of water delivery, sewage collection, and treatment. Fort Carson, CO, has installed several composting toilets at the parks and playgrounds on post, and the National Park Service uses these types of toilets extensively in the National Parks.

- **H-Axis Washers** – Laundry facilities account for 23 percent of residential water use, and a similar proportion of residential sewage production. Horizontal-axis washers use 40 to 75 percent less water, clean clothes better with a less concentrated soap solution, and extend the life of clothes

because they are not agitated. In 1996-98, U.S. manufacturers introduced these washers, which are used extensively in Europe. While initial costs are double that of conventional washers, they pay back the additional investment in three to four years through reduced energy, hot water, and soap.

- **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 but require much less water.

- **Irrigation Meters** – Irrigation meters, in use in western Texas, save one- to two-thirds of water 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 (http://www.wbcsd.org/casestud/gerling/index.htm).

- **Greywater Recycling** – The future of sustainable water use is in-situ water recycling and reuse. A huge 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.greywater.com/ and http://www.greenbuilder.com/sourcebook/Greywater.html).

Privatized Housing

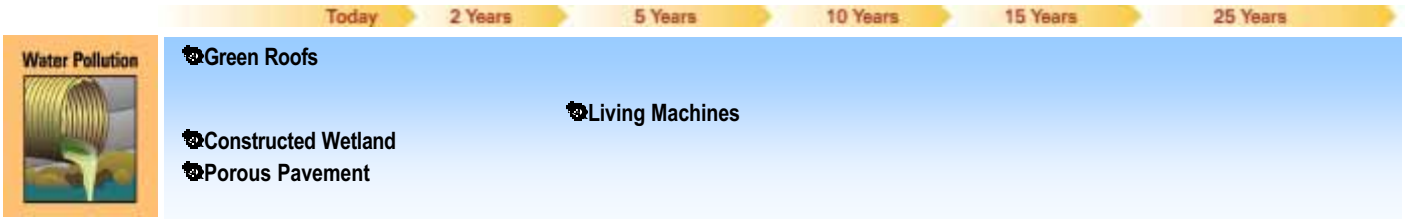
- **Green Neighborhoods** – On average, 25 percent of Army facilities are residential developments for soldiers and their families. Army Family Housing (AFH) is composed of over 110,000 units, with

an average age of 35 years for this inventory. Only 38 percent of these units rate as adequate under Army standards, and these housing units are very inefficient in resource use (e.g., water, energy and land consumption). The U.S. Army Construction Engineering Research Laboratory (CERL) developed a Green Neighborhood Planning process, using a "whole-systems" approach, which demonstrates both improved resource efficiency and reduced environmental impacts from family housing developments through integrated design methods and life-cycle costing considerations.

CERL researchers modeled entire AFH neighborhoods to simulate the energy impacts of critical factors like building orientation, envelope insulation and strategic landscaping to evaluate alternative design and development scenarios against traditional approaches. CERL combined these simulations with cost analyses to determine optimal neighborhood layout and housing design for case studies at Fort Hood and West Point. These studies demonstrated significant improvements in quality of life—community connectivity, safety and security, etc.—while dramatically reducing life-cycle energy use (73 percent less than the baseline), at no appreciable additional cost (within 5 percent of the baseline).

The findings of this study may serve in developing environmental performance criteria for privatized housing contracts. For additional information on this initiative, go to http://www.aepi.army.mil and select AWEEC Proceedings; then scroll down to session "B18 - Moving Federal Facilities Towards Sustainability."

Water Pollution



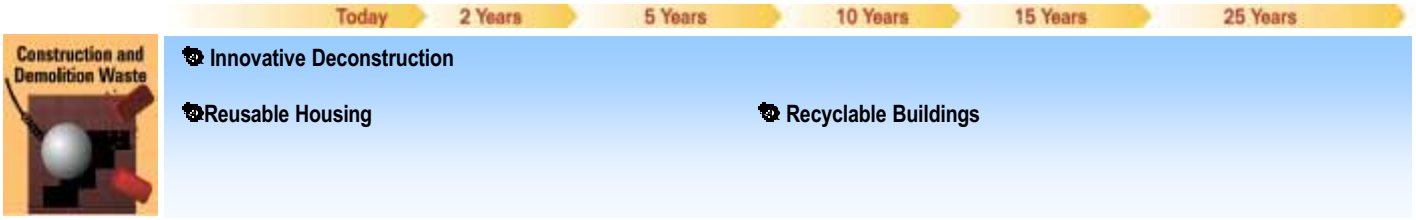
- **Green Roofs** – All across the country, thousands of apartment buildings and offices are now growing "green roofs" in place of traditional roofing material. These roofs, sometimes grass, sometimes shrubs, "soak up" water when it rains rather than letting it run off into area rivers and streams. It lowers both the volume and contaminant levels of the runoff.

- **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 the 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 seven different countries, including the United States. They offer better, more stable treatment at the same cost as traditional sewage treatment, while decreasing wastewater treatment 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. The wetland would work similarly to the Living Machines® (described above) as the wetland plants and animals purify the wastewater as it flows through the wetland.

- **Porous Pavement** – Contaminants (e.g., oil, fuel, and sediments) that cause problems with stormwater are eliminated if the stormwater is retained on-site and allowed to seep into the soil, rather than running off into streams. Many new building techniques and materials, such as porous pavement, allow for such natural drainage and on-site water storage (http://www.stormwatercenter.net).

Construction & Demolition (C&D) Waste



- **Innovative Deconstruction** – Fort Knox sells the "salvage rights" to buildings that are on the demolition schedule. The purchaser of the rights can remove windows, doors, flooring, siding, plumbing, and copper wire—but must remove at least 50 percent of the volume of the building. The installation makes about $100,000/year on the sale of the salvage rights, but saves hundreds of thousands on reduced demolition costs and disposal costs. Fort McCoy has a similar program.

  The Army has signed a Memorandum of Agreement with Habitat for Humanity to allow them to "deconstruct" buildings on the demolition schedule and sell the salvaged items to support Habitat home-building activities.

- **Reusable Housing** – Redstone Arsenal has paid a local house mover and developer to move 89 two-story brick duplexes off the installation and into the local community, where they will be sold and reused. The cost was about $9,000 per house versus the $12,000 it would have cost to demolish them, resulting in a cost savings of $267,000.

- **Recyclable Building** – The building of the future is one built completely of recycled (and recyclable) materials, with a minimum of waste generated during construction. Demolition of buildings as we know it will no longer exist; building materials will be uniformly collected and reused or reconstituted into other products. A new Public Works facility in Minnesota may come as close as we can (economically) to this ideal. By weight, almost 63 percent of the 242,000 square foot building is made from recycled material (http://www.msdg.umn.edu/msdg/case/medina/medina.html).

Infrastructure

Fort Hood 25-Year Goals for Infrastructure

To be determined by Fort Hood Command and staff, as advised by members of the local and regulatory communities, at the Environmental Sustainability Executive Conference on 11-13 June 2002.

Energy

Energy

Challenge

Energy is an essential resource for Fort Hood's training and deployment missions, and its availability and cost affect the quality of life for soldiers and families. Inefficient energy use increases operational costs and contributes to environmental degradation from resource extraction, climate change effects, and air pollution. High energy-price volatility makes it difficult to allocate and manage the installation's financial resources effectively. Finally, there are significant questions about the reliability of the energy supply due to both marketplace and physical interruptions. How can Fort Hood improve reliability of the energy supply, reduce costs and environmental impacts, and reduce the impact of price volatility on Fort Hood's operations?

Key Considerations

- **Energy Conservation** – Many opportunities for reducing energy consumption in existing facilities and operations are available. Fort Hood needs to find the financial resources to invest in these opportunities and the management time to initiate and manage retrofit projects.

- **New Construction** – Significant new construction is underway on Fort Hood. The energy consumed in new facilities will likely remain relatively constant over the 50+ years these buildings are in operation. New buildings can be designed to be substantially more efficient than most buildings constructed today, and more efficient than the inventory of buildings now on Fort Hood. Given the lifetime of new facilities, and the difficulty in radically improving energy efficiency in buildings after construction, energy efficiency of all new Fort Hood facilities needs to be a top-level priority.

- **Energy Independence** – Future energy costs will fluctuate to an even greater degree given recent deregulation of the gas and electricity markets. On-site generation of electricity from renewable sources (e.g., solar and wind) would help stabilize energy costs and improve energy supply reliability. Installation of distributed energy sources (e.g., renewables and small, distributed generators such as microturbines and fuel cells) can help ensure a reliable energy supply.

- **Green Energy** – The pressure to move to renewable energy sources is significant and growing. Fort Hood can support the development of renewable energy sources by increasing its efforts to buy energy from renewable sources. The adoption of multifueled vehicles that can use biofuels would be another important step towards energy independence and reduced environmental impact.

Energy

Importance to Fort Hood

Mission – Reliable, affordable energy is essential to Fort Hood's continued operation. Energy security is a growing concern nationwide, as shown by recent shortages in California last year and continued reliance on unstable foreign petroleum supplies. Reliable energy at a predictable price is critical to maintaining the mission at Fort Hood.

Quality of Life – Good quality of life depends on sufficient heat, hot water, and air conditioning. Efficient use of energy supports clean air objectives, which are also critical to a high standard of healthy living and training.

Cost – Annual total energy cost has increased by 50 percent over the past two years. As shown in Figure 24 below, total demand for energy is rising due to the growth of Fort Hood, despite the fact that energy efficiency (energy used per square foot of building) continues to improve.

Figure 24 – Total Energy Costs at Fort Hood

	FY99	FY00	FY01
Total Cost	**$24M**	**$26.5M**	**$36.3M**
Natural Gas	$4M	$4.5M	$10M
Electricity	$20M	$22M	$26.3M

Environment and the Community – Energy use at Fort Hood results in an estimated annual release of 388,000 tons of carbon dioxide (CO_2), 60 tons of nitrogen oxides (NO_x), and 175 tons of sulfur oxides (SO_x). Though air quality close to Fort Hood is good, regional air quality surrounding Fort Hood, from Houston to San Antonio to Dallas, already exceeds federal limits for ozone. Local and regional air quality is unlikely to meet new requirements for particulate matter (e.g., dust and combustion products) that will be required in the next several years. Due to the concerns about the larger region, Fort Hood already faces more stringent operating requirements on boilers and other air emission sources, and may face even stricter requirements when the new particulate matter standards become effective.

Reducing energy use and/or switching to more renewable energy sources will decrease the regional air quality impact associated with local energy production. Currently, Fort Hood uses photovoltaic systems to power parking lot and warning lights.

Energy

Introduction

The Fort Hood Energy Manager structures and oversees the Fort Hood Total Energy Management Program. He is assigned to the Directorate of Public Works, Environmental Office (DPW-ENV). Historically, the energy team was composed of two to three FTEs. In FY00/01, energy staffing was reduced to only the Energy Manager. In FY02, staff was increased to three FTEs. The Energy Manager and one support engineer are now in place and one additional engineer should be added later this year.

Fort Hood Energy Action Plan

Fort Hood developed this plan in October 1997. The purpose was twofold: to serve as a comprehensive "roadmap" for achieving the federally mandated energy reduction goal, and to minimize energy consumption and costs while meeting all operational mission requirements.

The plan is an integrated effort that involves every energy consumer from the Commanding General down the chain of command to every individual either residing or working on the installation. The plan focuses on five areas: energy awareness, training and education, energy strategies, incentive awards, and assessment of energy impact.

The plan reflects the understanding that three basic systems affect the efficient use of energy in a facility. The energized systems are heating, cooling, lighting, ventilation, and equipment. The nonenergized systems are the floors, ceilings, walls, roof, doors, and windows. The human systems are the operating and maintenance personnel, occupants, and visitors. Each of these systems can be modified to achieve energy savings.

Regulations At A Glance

Numerous energy policies are relevant to energy use on Fort Hood. State and federal performance standards exist for building design, equipment, and appliances. Texas Public Utility Commission regulations constrain how Fort Hood can buy electricity and natural gas. Also, environmental laws restrict energy options. For example, the Clean Air Act and its local implementation constrain Fort Hood's ability to generate electricity from fossil sources because of restrictions on air emissions.

Executive Order 13123, *Greening the Government through Efficient Energy Management* – President Clinton issued this Executive Order, which prescribes requirements for reducing energy consumption and greenhouse gas emissions and revokes earlier energy conservation goals, in June 1999. Two key requirements of the Order are that each agency shall (1) reduce energy consumption per gross square foot by 30 percent by 2005 and 35 percent by 2010, relative to 1985; and (2) reduce greenhouse gas emissions attributed to facility energy use by 30 percent by 2010, relative to 1990. Other Executive Order goals include specific energy-conservation objectives for industrial and laboratory facilities, an emphasis on renewable energy, a focus on reducing consumption of petroleum and water, and an emphasis on reducing source energy consumption (even at the expense of greater site energy consumption). The Defense Authorization Act for Fiscal Year 2002 establishes the 2005 and 2010 goals as law and requires annual progress reports. In response to Executive Order requirements, Fort Hood has established a Total Energy Management Program and published Fort Hood Regulation 420-9.

The Army Forces Command (FORSCOM) has directed all of its installations to develop and manage 10-year energy plans that are focused on compliance with Executive Order 13123 (see above). The Fort Hood Energy Manager is now developing the plan, working closely with staff from Pacific Northwest National Laboratory (PNNL). The Army proposes to regionalize its installation management function, with the reorganization taking effect on 1 October 2002. Regardless of this new organizational structure, the 10-year energy plan developed this year will be useful to Fort Hood.

Sustainable Design

In April 2000, the Deputy Assistant Secretary of the Army (Installations & Housing) established the Army's policy of incorporating Sustainable Design and Development (SDD) principles into installation planning and infrastructure projects.

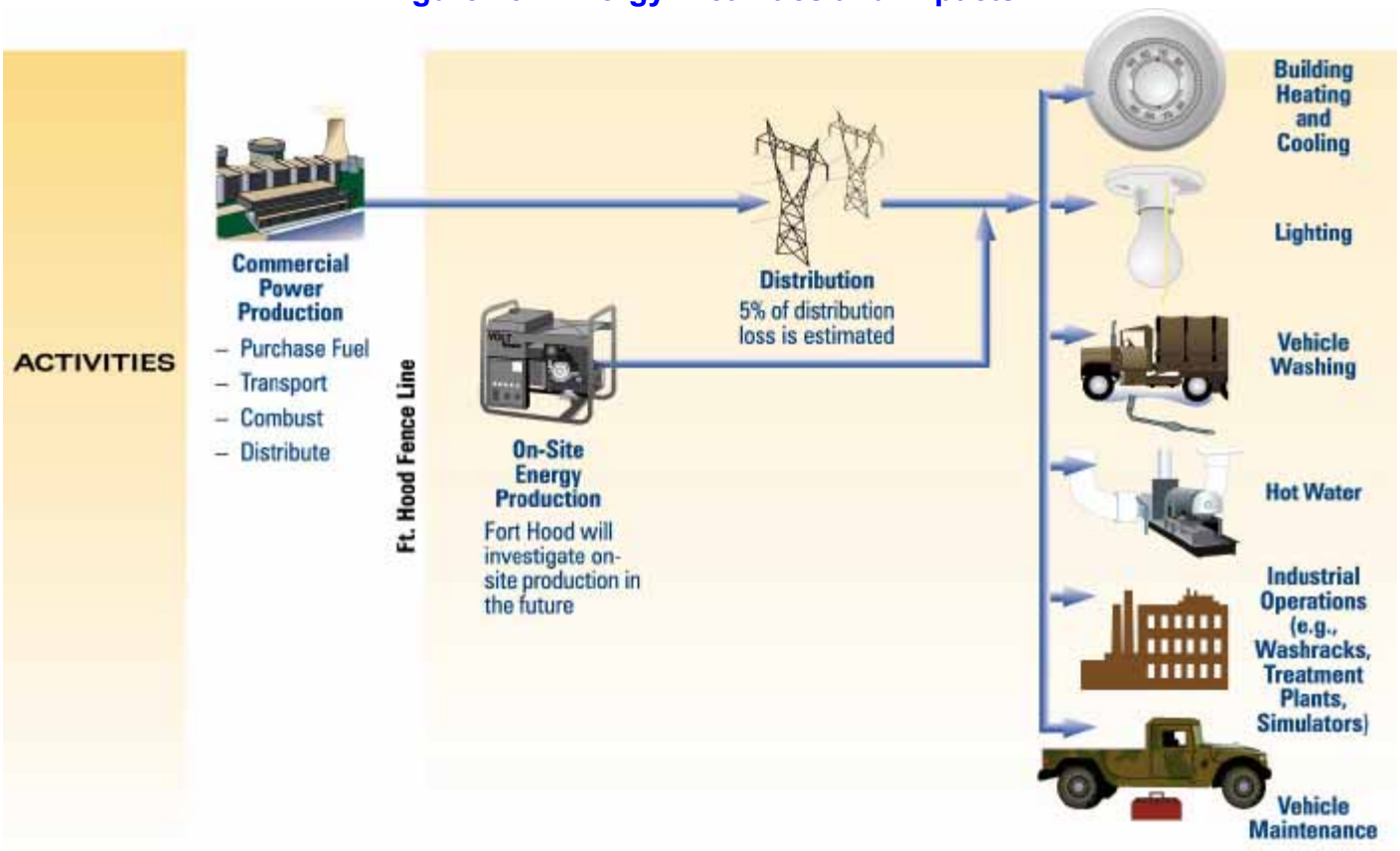
The U.S. Army Corps of Engineers (USACE), in coordination with Assistant Chief of Staff for Installation Management (ACSIM), developed the Army's Sustainable Project Rating Tool (SPiRiT), a self-assessment tool that will help installations and designers quantify the sustainability of infrastructure plans and projects. SPiRiT is an adaptation of the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) Building Rating System used by industry. SPiRiT includes additional rating factors appropriate for military projects and facilities. Projects are rated for sustainability in eight facility categories: Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, Facility Delivery Process, Current Mission, and Future Missions. Four SPiRiT levels (Bronze, Silver, Gold, and Platinum) can be achieved based on the total project points earned.

The initial Army goal is for all Major Command (MACOM) and installation projects to achieve a minimum SPiRiT Bronze sustainability rating. Most projects can reach a Bronze rating without increased costs while improving installation sustainability and balancing available resources with customer requirements. It should be noted that 28 percent of all possible points are energy related—more than for any other category.

Activities and Impacts

Energy use at Fort Hood's facilities is divided among family housing, barracks, training facilities, troop buildings, and medical facilities. The installation also has industrial energy loads including a wastewater treatment plant, a battle simulation center, and a drinking water treatment plant. Figure 25 illustrates the types of activities that require energy and their subsequent impacts.

Figure 25 – Energy: Activities and Impacts



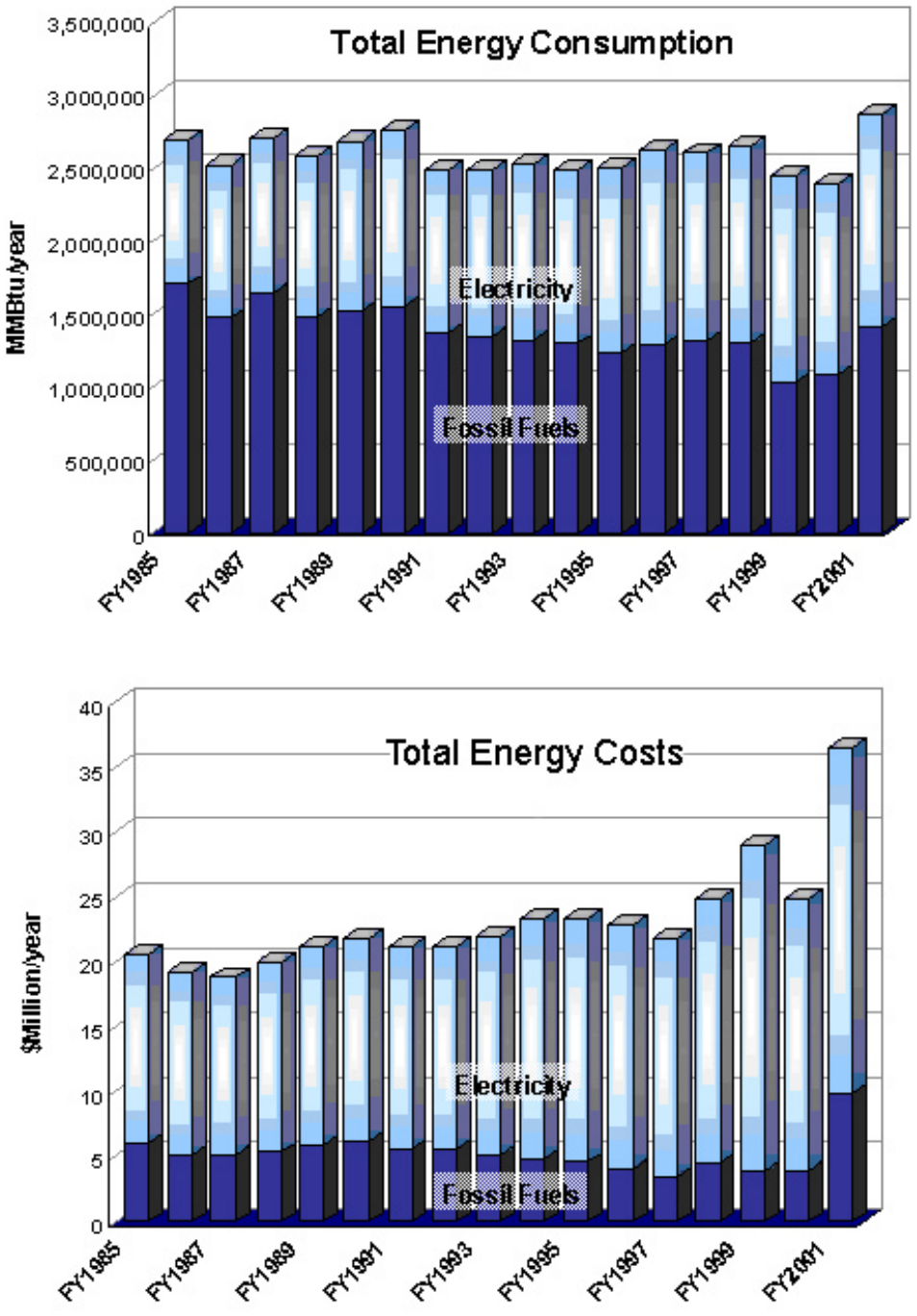
Historical Consumption and Impacts

In FY01, Fort Hood used 2.9 million MMBtus of facility energy (electricity and natural gas), and the total energy bill was $37M, an all-time high by a significant margin. The high consumption was due in large part to lack of funding for the Energy Control system. Since being revitalized in 1991, this system has saved the installation millions of dollars in total utility costs. The increase in energy consumption was also due to new construction and abnormal weather. The Pacific Northwest National Laboratory (PNNL) estimated that FY01 consumption was 5 percent higher than expected in a "normal" weather year, excluding the effect of the nonfunctioning energy control system.

The higher total cost was due to higher consumption, substantial increases in natural gas prices, and moderate increases in electricity prices in the volatile energy markets of FY01. Overall, electricity consumption increased by 1 percent, while electricity cost increased by 27 percent. Natural gas consumption increased by 30 percent, while the cost increased by 155 percent.

Total energy consumption is expected to diminish in FY02 unless severe weather conditions continue. Gas prices have already returned to historic levels. Deregulation

Figure 26 – Total Energy Consumption and Costs

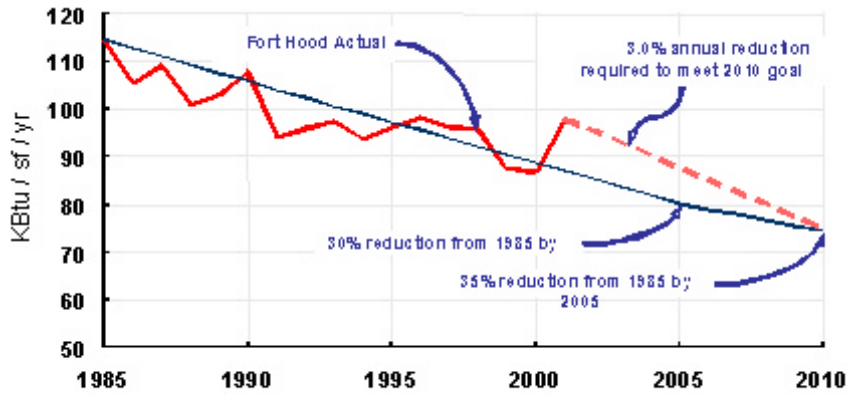


of retail electricity markets has resulted in a modest electricity rate reduction for Fort Hood in CY02.

Prior to 1993, fossil fuel totals included a limited amount of fuel oil and liquified petroleum gas (LPG). Since that time, however, natural gas is the only fossil fuel consumed in facilities on-post.

While annual energy consumption has been relatively stable, the number of facilities has steadily increased, with total building area increasing from approximately 23 million square feet in 1985 to approximately 29 million in FY01. As shown in Figure 27, energy use per square foot per year—the metric employed in the Executive Order—has been on a continuous downward trend since the 1985 baseline. This reduction trend is chiefly due to energy-saving retrofit projects; energy-efficient new construction; and demolition of old, inefficient facilities.

Figure 27 – Fort Hood Energy Use Glide Path



Energy use intensity decreased from 115 KBtu/sf in 1985 to approximately 87 KBtu/sf in 2000, a 24 percent reduction. Prior to FY01, this trend was somewhat better than the linear trend projected for compliance with the Executive Order. Much of the year-to-year variability can be explained by the changing emphasis on energy conservation by different post commanders; some can be explained by weather.

The significant upward spike in FY01 was chiefly due to the nonfunctioning energy control system and unusually severe weather. This put Fort Hood substantially above projections and requires a 3.0 percent annual reduction in KBtu/sf per year if the FY10 energy goal is to be achieved. However, had the weather been "normal" in FY01, Fort Hood would be near the projected trend and would need only a 2 percent reduction in annual energy consumption to meet the FY10 goal.

Energy use at Fort Hood results in an estimated annual release of 388,000 tons of carbon dioxide (CO_2), 60 tons of nitrogen oxides (NO_x), and 175 tons of sulfur oxides (SO_x). Though local air quality is good, the larger region (the Houston-San Antonio-Dallas corridor) exceeds federal limits for ozone. Local and regional air quality is unlikely to meet new requirements for particulate matter (e.g., combustion products, dust, etc.) that will be implemented in the next several years. Due to concerns about the larger region, Fort Hood already faces stringent requirements on the operation of boilers and other emission sources, and may face additional requirements when new particulate matter standards become effective.

Energy

Reducing energy use and/or switching to more renewable energy sources will decrease regional air pollution due to energy production. Currently, the only use of renewable energy on-site is active daylighting in a number of office buildings and some photovoltaic exterior lighting.

Efficiency Potential

Analyses at PNNL indicate that energy use intensity (KBtu/sf) can be significantly reduced at Fort Hood. The most effective mechanism is to retrofit existing buildings and facilities. Retrofit projects can be funded using multiple government funding sources including military construction (MILCON), O&M funds (OMA), the DoD Energy Conservation Investment Program (ECIP), the Federal Energy Management Program (FEMP), or FORSCOM's Expanded Utility Modernization Program (EUMP). Projects can also be funded by the private sector through Energy Savings Performance Contracts (ESPCs) and Utility Energy Services Contracts (UESCs), or via programs offered through agencies such as the Bonneville Power Administration. Recent PNNL analyses suggest that Fort Hood energy use could be reduced by as much as 14 KBtu/sf through ESPC financing. Lighting, insulation (roof and foundation), and upgrades to space heating and hot water boilers were the most important measures identified.

Other opportunities for saving energy on-post are described below. Estimated savings were derived by PNNL using the Federal Energy Decision System, a sophisticated building energy-use analysis tool.

Equipment Replacement

All aging and failing equipment should be replaced with the most life-cycle cost effective technologies. Purchasing systems need to be established so that this is a default decision; complying with EPA's Energy Star® recommendations is one way to facilitate this process. Projected energy use reductions from this activity are estimated to be 5 KBtu/sf. Fort Hood will identify and evaluate appropriate technologies from a number of sources, including utility and government information programs, recommendations from ESPC contractors, and staff submissions to the Energy Suggestion Program.

Housing Privatization

Housing is being privatized (see later section in this chapter) and, consequently, the entire inventory is being modernized through either new construction or major rehabilitation. The estimated savings potential due to housing renovation is 3 KBtu/sf.

Barracks Modernization

Current construction projects will improve control systems for lighting and for heating, venting, and air conditioning (HVAC) in barracks. Future barracks modernization/renovation projects will be reviewed to ensure that the best available, cost-effective technology is installed to reduce the energy consumption of those buildings. New technologies will include, but not be limited to, LED exit signs, occupant motion sensors, and high-intensity lighting. The projected energy use reduction from this activity is estimated to be 1 KBtu/sf.

Other Construction and Demolition

Demolition and construction of buildings other than Army family housing and barracks are estimated to save approximately 1 KBtu/sf.

Utility Modernization

Rehabilitation of central plants (boilers and chillers) and thermal distribution systems is also projected to save 1 KBtu/sf.

Energy Supply Systems

Fort Hood purchases its electricity in bulk and maintains its own distribution system. TXU Energy supplies electric power to Fort Hood through three substations. The substations are located in Main Fort Hood, North Fort Hood, and Clear Creek (West Fort Hood). TXU Energy-owned transformers supply 13.8 kilovolt (kV), three-phase power to Fort Hood's looped distribution system. Electricity bills are calculated based on meters at each substation.

The looped distribution system provides flexibility and redundancy. The North Fort Hood and West Fort Hood substations can backfeed the main portion of the post and vice versa. The capacities of the North and West Fort Hood systems, however, are not sufficient to supply all the power required on-post. Therefore, only select, critical circuits can be provided with backup power from these substations.

The distribution system consists of approximately 240 miles of overhead primary and 100 miles of overhead secondary power lines. There are approximately 14,400 utility poles, which include power poles and light poles. Another 50 miles of underground primary and 35 miles of underground secondary lnes complete the system.

At the present time, only limited metering of electricity—primarily for reimbursable customers—occurs within Fort Hood's boundaries. That situation is changing. All new buildings will have electricity meters installed, and the utility and housing privatization initiatives will provide for substantially increased metering across the post.

Lone Star Gas (LSG) Company supplies natural gas to Fort Hood through three natural gas pressure reducing stations. The stations are located at 31st and 761st Battalion (main cantonment), 24th and Avenue 'G' (North Fort Hood), and U.S. Hwy 190 and Clear Creek Road by the railroad tracks (West Fort Hood). Natural gas is metered and billed at each of these sites.

Two of the three natural gas distribution systems are interconnected. The distribution systems for the main cantonment area and West Fort Hood are interconnected and can backfeed each other. The North Fort Hood distribution system is independent of the other two.

The natural gas system includes approximately 200 miles of looped distribution main and 30 miles of service laterals. Of the 230 miles, approximately 180 miles of the main distribution system and the majority of

service laterals use polyethylene piping. Within the distribution system, approximately 15 regulator stations maintain an operating line pressure of approximately 36 psi.

Natural gas is metered for a majority of the housing and schools on Fort Hood. The housing privatization initiative will direct that all houses on Fort Hood be metered for natural gas. There are no plans to extend gas metering to most buildings in the cantonment area.

All four of Fort Hood's utility systems (electricity and natural gas distribution, water supply, and wastewater collection and treatment) are in the process of privatization. If the systems are privatized, which is the most likely outcome, Fort Hood will have less direct control over how these systems are operated and maintained. However, privatization is intended to provide the financial and technical resources to upgrade these systems and maintain them at industry standards.

The Regional Energy Situation

Texas is a major supplier of natural gas to the nation. Deregulation of retail electricity sales spawned a boom in the construction of natural gas-fired power plants that supplemented existing coal and nuclear power generation. Electricity and natural gas supplies in Texas are expected to be readily available for at least the next decade. Because Texas natural gas trades in a nationwide market, natural gas prices will be subject to national supply and demand forces and associated price volatility. Electricity prices are expected to be more stable, although they will also be affected by natural gas price volatility. The reasons for this are unique to Texas.

The Electricity Reliability Council of Texas (ERCOT) is an independent, not-for-profit organization that is responsible for the reliable transmission of electricity in Texas. ERCOT lies entirely within the state and serves 85 percent of the customers in Texas. ERCOT is electrically isolated from the rest of the U.S. electric grid, and power cannot be readily imported from or exported to other states. Within Texas, power exchanges between east-and-west and north-and-south regions are limited due to historic utility service area boundaries. Fort Hood is located in the southeastern part of the state, which has direct access to natural gas from wells in the state and the Gulf of Mexico. This area is also home to the majority of new gas-fired power plants. Accordingly, Fort Hood should benefit from abundant, reliable, and comparatively low-cost electricity for most of the next decade.

Since 1 January 2002, retail electricity consumers in Texas have been allowed to choose among competitive suppliers. Texas benefited from observing retail choice experiments in other states and by having almost total control over Texas electric utilities through ERCOT. Consequently, Texas utilities and regulators are confident that retail choice will be a success. Like every other state that has deregulated, Texas has mandated a ceiling on electricity rates for several years. This factor, coupled with increased intrastate competition, resulted in price reductions of approximately 15 percent for Fort Hood in CY02, compared to the previous year.

Texas is one of the leading states in the country in green power development. The law that deregulated the retail electricity markets requires that 2,000 megawatts (MW) of new renewable-source generating capacity be installed by 2009 (the Renewable Portfolio Standard). By making a commitment to the development of

renewable power as an integral part of the electric system, Texas has guaranteed that green power will be readily available to customers throughout the state for years to come. West Texas is a wind-rich region and most of the required new renewable power is coming from wind farms located there, although some power is available from certified (qualifies as a renewable resource) small hydro and landfill gas generation facilities. Power flowing from West Texas to Fort Hood faces transmission restrictions. Nevertheless, Fort Hood can procure green power under retail choice from TXU Energy.

Despite the favorable electricity supply climate for Texas, retail utility regulations are not favorable to large electricity customers, including Fort Hood. Therefore, Fort Hood is exploring the option of becoming a wholesale customer through a filing with the Public Utility Commission of Texas (PUCT). The advantages of being a wholesale customer include:

- continued choice of electricity supplier if Texas rescinds retail choice,
- a wider variety of wholesale supply options,
- a more secure electricity supply, and
- potentially lower-cost electricity.

Fort Hood's formal wholesale petition has been before the PUCT for over a year; it appears the Commission is close to a decision.

Current Sustainability Activities

Utility Partnering Concept (UPC) – As directed by the Defense Reform Initiative (DRI) issued by the Secretary of Defense, military installations must streamline operations and divest themselves of noncore functions. Utility management has been identified as a noncore function; therefore, DoD is in the process of privatizing its four major utility systems, including electricity and natural gas distribution, water supply and distribution, and wastewater collection and treatment.

Because operation and maintenance of utility systems is critical for mission success and for meeting energy and environmental requirements, Fort Hood is piloting a Utility Partnering Concept (UPC). The UPC approach is to issue a comprehensive solicitation for privatization of the four utility systems, procurement of electricity and natural gas, and integration of these disparate functions. The goal is to establish a tightly knit team that can work well together and with the Fort Hood DPW to improve the utility's physical infrastructure and to provide excellent utility services at reasonable cost. The UPC solicitation has been issued and is expected to be awarded in early FY03.

The UPC approach has some novel features. For example, the gas and electricity prices submitted in the proposals will be compared with prices negotiated on a regional basis (outside the UPC) by the Defense Energy Support Center (DESC) and the lowest cost alternative will be selected.

The integration contractor will be responsible for providing technical and administrative support to the utility management of Fort Hood's utility systems, continuous evaluation of Fort Hood's utility operations, and specific recommendations for means by which Fort Hood can improve its utility operations. The challenge is

to help establish and implement a management approach that provides utility services that meet commercial standards for quality and reliability at the lowest life-cycle cost to the installation. Specific duties include:

- coordinating the formal Fort Hood utility planning process among the members of the Utility Partnership;
- coordinating the development of a formal Fort Hood Utility Annual Report;
- ensuring that plans for new construction and rehabilitation of facilities at Fort Hood are the most life-cycle cost effective with respect to the consumption of utility commodities and services;
- providing an independent review of all ESPC contractor proposals;
- reviewing Fort Hood's plans for and progress toward compliance with the requirements of Executive Order 13123;
- monitoring the Fort Hood utility account throughout each fiscal year, with the goal of providing guidance to the DPW on how/when available resources should be expended; and
- analyzing utility-related activities on the installation, and making recommendations for how these activities can be modified to improve energy efficiency.

Energy Savings Performance Contract (ESPC) – Fort Hood has entered into an energy savings performance contract with Johnson Controls, Inc. (JCI). The ESPC contractor is considered part of the UPC; however this contract was awarded early so that the savings could be realized as quickly as possible.

Under ESPC, the contractor will audit facilities, develop retrofit proposals, and (if/when tasks are awarded) implement the retrofits. The contractor may also, depending on the specific task order negotiations, manage the operation and maintenance (O&M) of the retrofitted equipment. The projects will be funded by the contractor, who will be repaid through energy and O&M savings that result from the retrofits. Energy use in ESPC-retrofit facilities will be baselined before the retrofits and actual savings will be documented. If there are no savings, there will be no contractor repayment.

JCI is currently negotiating its initial work order with Fort Hood, covering a limited suite of buildings as a test case. Two major retrofits are being proposed:

1. An energy management and control system (EMCS), which is expected to save about 11,200 MBtu/year with an annual cost avoidance of $125,000 and a payback of approximately 9 years; and
2. A lighting retrofit, which is expected to save about 6,400 MBtu/year with an annual cost avoidance of $110,000 and a payback of approximately 13 years.

Housing Privatization – Fort Hood, like most Army installations, has been directed to privatize its Army Family Housing (AFH) through the Residential Communities Initiative (RCI). The RCI goal is to upgrade the quality of life for the soldier and his or her family by leveraging private funding to improve family housing. Under RCI, some existing housing will be razed, significant new housing will be constructed, and major rehabilitation projects will be undertaken for most existing housing. Fort Hood will encourage energy-efficient design for new construction and rehabilitation. Once the housing is privatized, the RCI contractor will begin paying all utility bills. This will provide an incentive for design of efficient housing

units. While discussions are still underway, AFH residents will likely take over utility payments within 5 to 10 years, providing an incentive to use utility resources efficiently.

The RCI contractor assumed ownership of the housing assets on 1 October 2001 and is now working with Fort Hood to develop a Community Development and Management Plan (CDMP). The goal is to have all 5,912 housing units at "green" status by 2010, and to keep them in that condition for the following 40 years of the contract. In the first five years of the contract, implementing these goals will mean rehabilitating 4,614 existing units and building 974 new units. The RCI contractor will also add neighborhood amenities such as landscaping and recreational facilities.

Renewable Energy Resources – In several facilities, Fort Hood has installed active daylighting systems that use a tracking mirror system on the roof to reflect sunlight into the building. These systems virtually eliminate the need for electric lighting during daytime hours on sunny and on bright, cloudy days. The system actively tracks the sun from minutes after sunrise until minutes before sunset, providing an average of 10 hours of light on clear or bright days. In the future, each unit is expected to provide light equivalent to 600-800 fluorescent light bulbs.

Fort Hood has installed photovoltaic-powered lights for several parking lots. Solar panels generate electricity, which is stored in batteries. The model selected for Fort Hood has two solar panels; two gel-cell, 12-volt batteries; a charge/load controller; and a 36-watt DC compact fluorescent lamp. The system is designed to operate for 16 hours a day and on batteries for five days without sunshine. The cost savings for this project is over $60,000 a year.

Energy Awareness Seminars – Reducing energy use goes beyond replacing equipment and constructing new, efficient facilities. Ongoing energy awareness seminars are necessary to ensure that occupants become wise stewards of energy resources. The energy awareness program defined in Fort Hood's Energy Action Plan focuses on a "conserve with common sense" theme. The program reinforces opinions of energy users that "energy efficiency reduces pollution, dependence on oil imports, and cost." The energy awareness program also communicates the message of the Army's Energy Program: energy reduction does not mean doing without energy; it does mean achieving the same mission using less energy.

The Realm of Possibility

To become sustainable, Fort Hood is encouraged to identify and plan for innovations that will support the goals established during the Environmental Sustainability Executive Conference. To do this, participants should have exposure to 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.

Energy

Energy Conservation

- **Continuous Commissioning** – This is a process of improving building performance through independent hourly metering, monitoring, analysis, and system fine tuning as part of the energy conservation program. This approach has yielded an additional 15 to 45 percent savings beyond traditional conservation measures. The process involves comparisons of design intent and actual building operation. For additional information, visit http://www-esl.tamu.edu/cc/.

- **Microscopic Energy Systems** – Scientists at PNNL and other research laboratories are developing a family of micro-sized energy systems that are manufactured in much the same way that computer chips are made. Microscopic heat exchangers, evaporators, condensers, gas absorbers, turbines, bioreactors, chemical reactors, chemical separators, pumps, and valves exhibit extraordinary rates of heat and mass transfer. When combined into HVAC or process equipment, this translates into very high efficiencies and minimal pollution generation. These miniature components can be combined to create small heat pumps that can be integrated into window frames, with simple plug-in of replacement units should the originals fail. Small bio-fueled fuel cells will be developed that can be located wherever heat and electricity are needed. Miniature chemical separation units will be developed for in-situ cleanup of tanks, wells, aquifers, and other polluted systems—imagine a pen-sized device that can be dropped into a drum of waste to eliminate PCBs.

- **Drainwater Heat Recovery** – It is estimated that up to 80 percent of water-heating bills come from shower/bath water. An innovative technology called drainwater heat recovery uses the latent heat in drainwater to "preheat" cold water before it is sent through a conventional water heater. Drainwater is typically 90 to 95°F when it is piped away from the shower or bath, and 100 percent of that potential energy is wasted. These systems take heated drainwater and run it through tiny spiraling pipes to preheat cold water to a higher temperature, thus reducing the total amount of energy a water heater must expend to heat fresh water. Installing a drainwater heat recovery unit can reduce overall heating bills by as much as 40 percent. U.S. EPA estimates that if 6 million hot water systems were outfitted with drainwater heat recovery systems, carbon dioxide emissions could be reduced by 20 million tons a year (http://www.oikos.com/gfx/index.html).

- **Superconductivity** – Superconductivity, the ability of a material to conduct electricity with zero resistance and almost no loss of power, is a cutting edge technology that may some day revolutionize the way we think about electricity (http://www.eren.doe.gov/superconductivity/). Today, almost 10 percent of all electricity generated is lost in transmission, radiated as heat from inefficient copper and aluminum wires. Superconductors will lead to the development of a number of new technologies:

- Transmission wires will carry 100 times more current on a wire no bigger than those we use now.
- Super-efficient mass transit systems (similar to the MagLev train in Japan) will transport people at enormous speeds using a fraction of the energy that current commuter trains do.
- Electric motors using superconductor wiring will operate at a fraction of the cost, improving industrial and residential energy efficiency while saving money.
- Electric generators will be smaller and lighter and require less fuel to generate power.

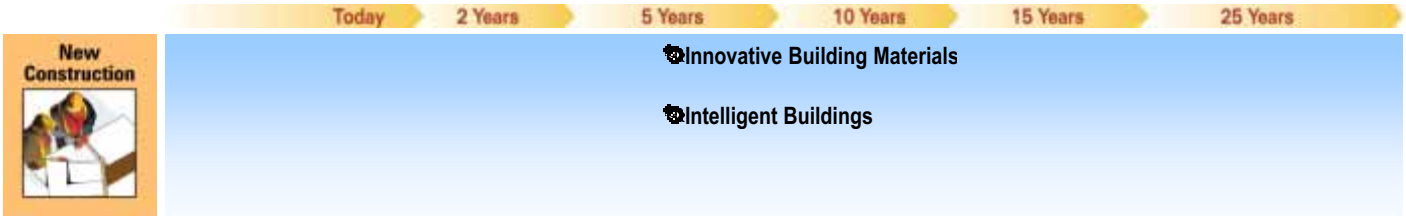
- **CFLs** – There are a number of commercially available alternatives to traditional incandescent lights. Compact fluorescent lights (CFLs) use between 50 to 70 percent less power than incandescent lights of the same intensity. EPA maintains a comprehensive list of CFLs (http://www.energystar.gov/products/cfls/).

- **EnergyStar** – EPA maintains a database of high-efficiency appliances and office equipment. By simply investing in these readily available alternatives, businesses and homes can save hundreds in energy bills every year (http://www.energystar.gov).

- **Dessicant Cooling Systems** – In the next few years, dessicant cooling systems could be saving offices and large commercial buildings thousands of dollars a month in electricity bills. Used in conjunction with traditional HVAC units, dessicant coolers remove moisture from the outside air, cooling it in the process, and allowing for much higher efficiency for the primary cooling unit. Some estimates place the potential savings in the thousands of dollars per month for large commercial buildings (http://www.nrel.gov/desiccantcool/tech.html).

- **Spectrally Selective Windows** – The next generation of windows will be so-called "spectrally selective" and chromogenic windows. Spectrally selective windows have advanced coatings that filter certain wavelengths of radiation from the incident sunlight, lowering the overall solar heat gain significantly. Chromogenic windows are even more advanced, with coatings that actually change their reflective properties based on ambient temperature or light conditions. Some estimates place the potential energy savings at 40 to 70 percent for electrically heated spaces.

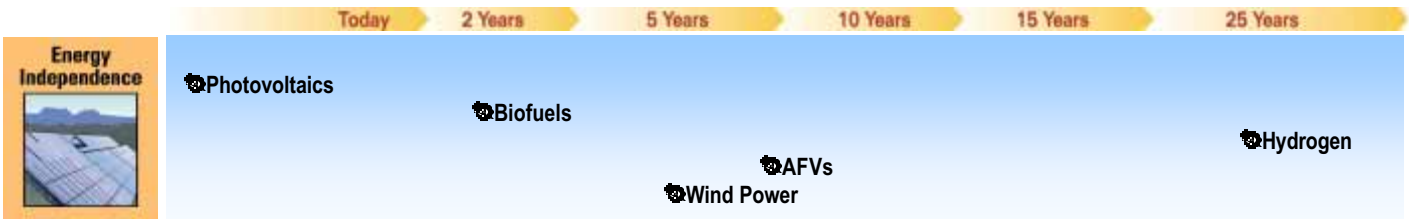
New Construction



- **Innovative Building Materials** – The building industry and its product-supplying manufacturing industry have aggressive research activities that are providing us with a host of environmentally friendly and sustainable products. These include soy-based adhesives and foam insulators, shellfish-derived coatings, gas-filled wall panels, ceramic insulators, and others. For additional information, go to http://www.nahbrc.org and click on "Green Buildings."

- **Intelligent Buildings** – The intelligent building is the future of architecture. It looks like any other building from the outside, but employs sophisticated control systems to make building systems (heating, cooling, ventilation, lights, windows, and appliances) more convenient and efficient. Commercial office buildings are being designed wherein lighting, temperature, and humidity in the space occupied by each worker are regulated according to his/her preferences, and windows automatically darken to provide appropriate ambient lighting for the task at hand. This technology is appropriate for homes, as well. Even today, in Bill Gates' private home, occupants wear an electronic pin that keeps track of them, so the house can adjust lighting, temperature, music, and/or television shows as they move about. Investors are pumping vast amounts of money into intelligent building research. Intelligent buildings make good financial sense: for instance, by turning off unnecessary lights and not heating unoccupied rooms, these buildings can reduce utility bills by 20 to 30 percent.

Energy Independence



- **Photovoltaics** – Photovoltaics (PV) have the potential to provide a significant amount of the nation's electricity supply. *The theoretical potential of PV on rooftops alone could satisfy up to one-third of world electricity demand.* However, they are expensive to manufacture, have not yet realized their efficiency potential, and take up lots of room. This situation is starting to change. Overall system efficiency is improving. New products that integrate photovoltaic cells into building materials are now coming on the market. Skylights, awnings, wall panels, and roof shingles now incorporate PV, generating electricity while serving a second structural function. This integration approach (1) obviates the need for additional land use, (2) reduces total system costs, and (3) makes available thermal energy dissipated by the PV panels for space heating and/or water preheating.

- **Biofuels** – Biofuels are alcohols, ethers, and other chemicals made from renewable resources (e.g., fast growing trees, grasses, and algae) and waste products (e.g., agricultural and forestry residues, and municipal and industrial wastes). It is estimated that domestically produced biomass resources could eventually provide at least half of the U.S. light duty vehicle (LDV) fuel requirement. Biodiesel fuels are available today. In the not-too-distant future, biomass will be consumed in fuel cells in vehicles and stationary equipment to produce heat and electricity very efficiently, with virtually no pollution and no net increase in carbon emissions. Eventually, highly-efficiency biomass power plants will allow any facility to generate its electricity on-site.

- **Hydrogen** – Hydrogen is not a viable energy source since there is little free hydrogen available. Instead, it is viewed by many as the ultimate energy storage and transmission medium. It will be

extracted from hydrocarbons, biofuels, and even water, and shipped/piped to another location where it will be directly burned, or indirectly consumed in a fuel cell, producing nothing other than energy and water vapor. Recently, Iceland, which has rich geothermal and hydro resources that can be employed to extract hydrogen from seawater, has set a goal of becoming the first hydrogen economy. Iceland New Energy, a consortium that includes Daimler Chrysler AG, Norsk Hydro AS of Norway, Royal Dutch Shell Group, and a Reykjavik-based venture capital fund, has launched projects aimed at promoting the hydrogen economy in Iceland. Three buses powered by hydrogen fuel cells will be introduced into Reykjavik's city transport fleet by the end of 2002. A second project will begin replacing conventional chemical batteries with fuel cells in stationary power structures that are not currently on the regular electric grid.

- **AFVs** – Alternatively fueled vehicles (AFVs) are available on a limited basis now, but it will be a few more years before they truly begin to capture market share in the public and private sectors. Honda is working on a zero emission vehicle that uses fuel cells for power. The state of California will now give up to $9,000 in rebates to people who buy super-low emission vehicles (SuLEVs). Fleets, especially buses, are prime candidates for alternative fuels, such as compressed natural gas, with lower per mile costs associated with the fueling of larger fleets (http://www.afdc.doe.gov/afvehicles.html).

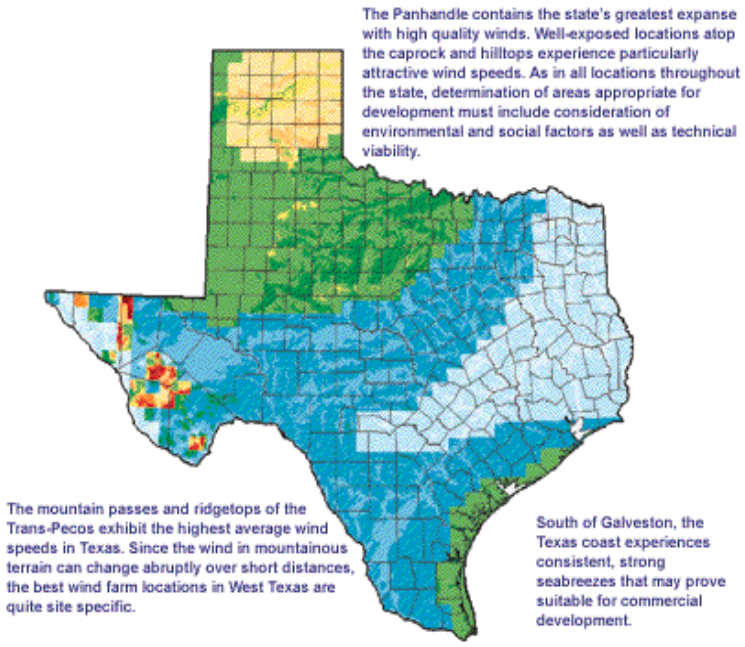
- **Wind Power** – Wind has been the fastest growing source of electricity generation in the world through the 1990s. However, the majority of this growth has been in Europe, where conventional energy costs are higher than those in the United States. With large, untapped, wind energy resources throughout the country and declining wind energy costs, the United States is now moving forward into the 21st century with an aggressive initiative to accelerate the progress of wind technology and further reduce its costs, to create new jobs, and to improve environmental quality. Wind Powering America, an initiative led by the Department of Energy to increase the use of wind power, will expedite the movement of wind technology into the mainstream of the U.S. electric sector. For more information on how to establish a wind farm at your installation, go to http://www.nrel.gov/wind.

Green Energy

- **Texas Wind Power** – Texas is one of the leading states in the country in green power development. In fact, Texas utility law stipulates that 2,000 megawatts (MW) of new renewable generating capacity be installed by 2009 (there are currently about 750 MW on-line). The majority of these green power production projects will be wind powered. There are four large wind projects currently on-line including the Delaware Mountain Wind Farm, the West Texas Wind Power Project in Culberson County, the Big Spring Wind Power Project, and the Southwest Mesa Wind Project in McCamey, TX. The figure to the

right shows the potential for wind development in Texas. Areas of red and orange are considered commercially viable areas for wind power development using today's technology.

The largest and most successful retailer of green power in Texas is the Green Mountain Energy Company (https://www.greenmountain.com/index.jsp). It offers a 100 percent renewable energy blend from wind, solar, and hydro sources to customers throughout Texas. Customers in the TXU service area (Fort Hood included) can buy green power from Green Mountain at rates competitive with current prices. The Public Utility Commission of Texas (PUCT) maintains up-to-date data on current pricing offered by Retail Electricity Providers (REPs) throughout the state. Click on the following link to access this information: http://www.puc.state.tx.us/electric/projects/22834/repoffers.cfm).



Customers in the Killeen area can also purchase power from First Choice Power, which is in the process of setting up the *Energy Ranch* program to provide 100 percent clean wind energy to the grid. Pricing for this program is not yet available (http://www.firstchoicepower.com/choice/provider.asp).

Reliant Energy Services (http://www.reliant.com) can also provide power to customers in the Fort Hood area, and they too are offering a green pricing program. More details will follow after the first of the year.

For more information about renewable energy in Texas, please visit http://www.infinitepower.org. Also, visit http://www.infinitepower.org/pdf/FactSheet-20.pdf for more information about the deregulation of the Texas electricity market and its effect on the green power market.

Fort Hood 25-Year Goals for Energy

To be determined by Fort Hood Command and staff, as advised by members of the local and regulatory communities, at the Environmental Sustainability Executive Conference on 11-13 June 2002.

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Products and Materials

Products and Materials

Challenge

Fort Hood purchases $655M worth of products annually and generates about 38,676 tons of waste per year. How can Fort Hood reduce the environmental liabilities and costs associated with waste disposal, promote sustainable manufacturing, and stimulate local/national markets for environmentally preferable products?

Key Considerations

- **Clean Products** – The use of materials that are non-toxic, made of renewable resources, produced in an environmentally friendly manner, and easily reused or recycled is critical to sustainability.

- **Product Leasing** – Fort Hood purchases many products such as carpeting, furniture, and appliances. Little or no consideration is given to what will happen to the product when it no longer meets its intended use. Companies now offer leasing of products where the supplier will take away and reuse/recycle the product when the user is finished with it.

- **Local Manufacture** – The purchase of locally manufactured products stimulates the regional economy, reduces transportation costs and environmental impacts, and helps to sustain the community. In addition, the use of local manufacturers may increase the feasibility of creative product use approaches, such as product leasing or manufacturer buy-back in which the manufacturer buys back all of, or components of, the original product.

- **Use Reduction** – Sustainability depends on our ability to use the smallest quantities of products and materials needed to meet minimum requirements—in other words, not wasting resources. This includes reducing amounts used, spilled, and leaked to the environment.

- **Reuse and Recycling** – Material reuse and recycling reduces the costs and environmental impacts associated with processing virgin materials, transporting new products, and use/disposal of waste materials.

- **Waste** – Both garbage and hazardous waste are expensive to manage and dispose of (Fort Hood spent well over $3.7M last year). Changes in purchasing and use of materials and products can reduce waste generation.

Products and Materials

Importance to Fort Hood

Mission – The management of products and materials and wastes requires many person-years of labor, and represents a significant portion of the operating budget of Fort Hood. Additionally, the proper management of hazardous materials and wastes requires soldier time that could otherwise be spent on mission-related tasks.

Quality of Life – The use of hazardous materials can impact the health and safety of Fort Hood's soldiers, families, and workers. The release of hazardous materials and waste and the disposal of household garbage can contaminate air and the sole source water supply.

Costs –

- New products and materials: ~$655M/yr ($235M – Contracts (includes some costs for services); $409M – Supplies/Equipment; $11M – Bulk Petroleum, Oil, and Lubricants (POL)
- Garbage collection: $3.3M/yr
- Hazardous waste disposal costs: $291K/yr
- HazMart operating cost: $250K/yr
- Treatment, Storage, and Disposal Facility (TSDF) permitting and Resource Conservation and Recovery Act (RCRA) compliance program cost: $600K/yr
- Fort Hood diverted 13,059 tons of materials (recycle, compost, re-use) from the landfill for a cost avoidance of $391K

Environment and the Community – Fort Hood purchases approximately $655M worth of materials and products each year. Many major manufacturing sectors are present in a 300-mile radius around Fort Hood, with a workforce to support industries that could be beneficial to Fort Hood. Fort Hood has the potential to stimulate growth with local manufacturers and producers. This could support community sustainability while improving the quality of life for the community and its resident soldiers.

Transforming the procurement and use program at Fort Hood to incorporate sustainability concepts will require that everyone—end-users, purchasing officials, waste handlers, and partner manufacturers in the local and regional community—take a hard look at the way Fort Hood buys and uses materials. A new purchase and use system that extracts the maximum amount of value from each material, while causing the minimum amount of undesirable impacts, must be designed if Fort Hood wants to continue to serve the country in its current capacity and into the future.

Products and Materials

Introduction

It is critical to understand that the impacts of the purchase and use of products and materials go well beyond their mere purchase and use. When a material is purchased, regardless of whether the material is hazardous or not, a whole chain of events is triggered. Each of those activities in the chain of events has economic, environmental, societal, and personal impacts. For example, the extraction and processing of raw materials, the use of energy in manufacturing, the transport of finished products, and the ultimate use and disposal of these products all have significant impacts. These impacts affect the sustainability of Fort Hood. In other words, can Fort Hood continue to operate in the same manner into the unforeseeable future? How can Fort Hood change wasteful and damaging material use patterns to ensure a high quality of life now and in the future?

Fort Hood purchased approximately $655M worth of materials in FY01. (Note: This figure includes some costs for services. This figure does not include costs for some major items such as tanks and weapons.) The amount of hauling required to bring these products to Fort Hood is not tracked, so the costs and environmental impacts are not quantified.

The use of products and materials creates over 38,676 tons of solid waste annually. In addition, Fort Hood generated about 9,529 tons of hazardous waste in 2001 that resulted in disposal fees of $120K.

The decision of what to buy drives the future costs of using, managing, and disposing of a product. Costs and environmental impacts associated with waste disposal include air and water contamination, and undesirable land use. In addition, manufacturing, transportation, storage, and use of products and materials also cause negative environmental impacts both on- and off-post.

The federal government is committed to encouraging markets for recycled products (see "Requirements At A Glance" below). To that end, all federal installations are required to purchase environmentally preferable products (EPPs) such as recycled paper, re-refined oil, and retread tires. EPPs are those products that contain or require less hazardous materials to produce or use, have fewer environmental impacts compared to similar products, and/or contain recycled materials. (A list of products containing recycled materials can be found at http://www.epa.gov/cpg/products.htm.) The General Service Administration Environmental Products and Services Guide also provides a list of EPPs and can be found by visiting http://www.gsa.gov (click on "Support for Communities and the Environment" and then "Environmental Programs"). To maximize the

Useful Information

The following information would be useful in determining where Fort Hood could begin to establish sustainable purchasing and use practices:

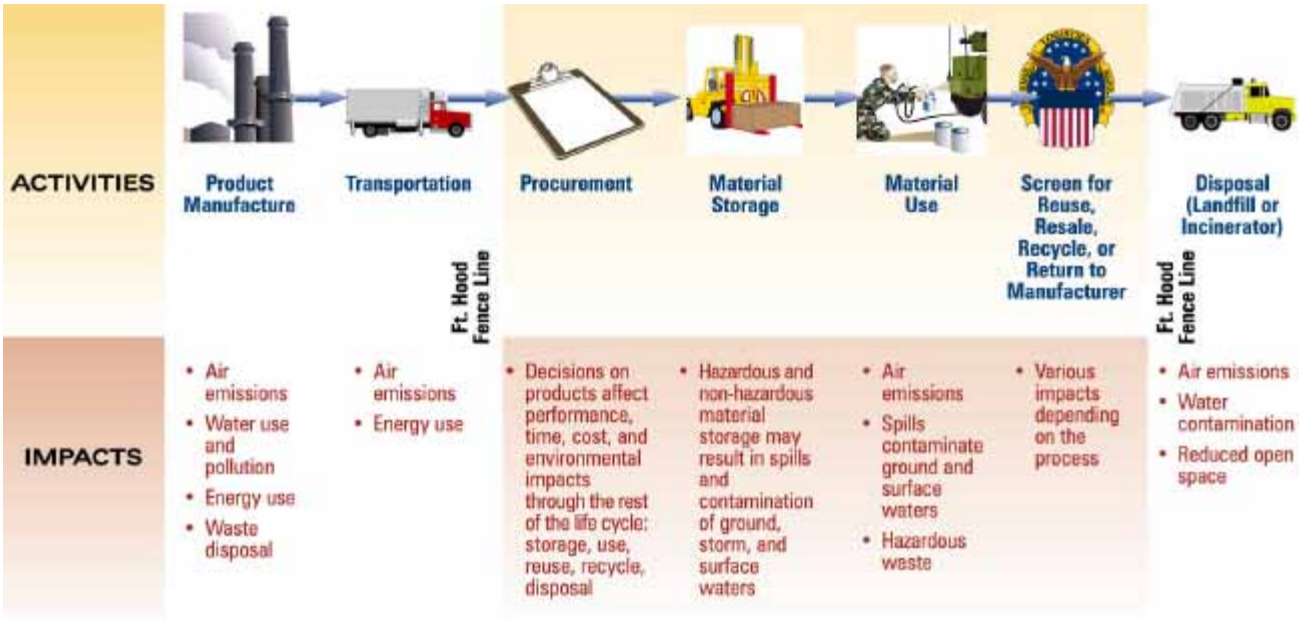
- **Sources of materials and products** – Where are the products used at Fort Hood manufactured? Are local suppliers available?
- **Quantities** – How many commonly discarded materials/products are used each year?
- **Composition** – What products contain hazardous components? What products contain recycled materials?
- **Releases** – Which products result in the release of chemicals to the environment or generation of hazardous waste?
- **Markets** – Various organizations manage the sale and recycling of materials and wastes. The nature of markets and the value of materials are not easily quantified or tracked.
- **Treatment and disposal** – What is the long-term availability of capacity to dispose of garbage and hazardous waste? What are the projected costs for treatment and disposal in the short-, mid-, and long-term?

purchase of environmentally preferable products, however, a facility must have a purchasing program whose goals relate in part to minimizing environmental impacts and whose procedures allow for the easy, efficient procurement of those products. In other words, a products and materials procurement program must be designed with sustainability in mind; it will not happen automatically.

Activities and Impacts

Figure 28 shows the life cycle of products and materials, and the environmental impacts associated with each stage in the life cycle. The buying decisions of Fort Hood's users and contract officials can vastly limit environmental impacts and life-cycle costs. At present, Fort Hood's understanding of the environmental and cost impacts associated with product and material use is fragmented. Waste generation volumes, as required under various laws, are known, but little is known about the production, distribution, or content of the products that create these wastes. Further, the long-term environmental impacts associated with the use of hazardous and non-hazardous products and materials are largely unknown.

Figure 28 – Product Life Cycle: Activities and Impacts



Facts and data associated with the purchase, use, reuse, and disposal of materials are described in the following sections.

Purchase

Fort Hood has aggregate statistics on its purchase of materials, products, and services for FY01. The Directorate of Contracting (DOC) awarded $235M worth of service and product contracts. Of these, an estimated $33M was spent on materials and products. In addition, the budget for this past year indicates that $409M was spent on Supplies and Equipment and $11M was spent on bulk Petroleum, Oil, and Lubricants (POL). There are no data on locally manufactured products that Fort Hood has purchased. Data

obtained and presented in this chapter do not include the amounts of materials purchased by contracts issued through other organizations such as the Corps of Engineers (e.g., construction).

Centralized tracking of hazardous materials began when Fort Hood achieved its Initial Operational Capability (IOC) of the Hazardous Substance Management System (HSMS) in November 1998. Along with the implementation of HSMS, Fort Hood established three HazMarts and nine POL centralized storage and issue facilities to support the hazardous materials requirements for all users on the installation. The DPW HazMart is the focal point for hazardous materials normally purchased on the local economy. Fort Hood's users are no longer allowed to purchase these materials with their Purchase Credit Cards outside of the HazMart channels. The 289th Quartermaster Company assigned to the 13th Corps Support Command is the focal point for hazardous materials (HM) used on a daily basis in the military units and maintenance facilities that support the military population. In addition, DynCorp, Fort Hood's installation aviation maintenance contractor, operates a HazMart. DynCorp provides HM support to its aviation and ground support personnel located throughout Fort Hood. POL centralized storage and issue facilities are established within each of the Forward Support Battalions (FSBs) and Main Support Battalions (MSBs) operating within the 1st Cavalry Division and 4th Infantry Division. These facilities allow for streamlined management of POL distribution and use among the many organizations assigned to the divisions.

Requirements At A Glance

The following environmental regulations and requirements impact the purchase and disposition of materials and wastes at Fort Hood:

Resource Conservation and Recovery Act (RCRA) – This federal legislation's primary goals are to protect human health and the environment from the potential hazards of waste disposal, to conserve energy and natural resources, to reduce the amount of waste generated, and to ensure that wastes are managed in an environmentally sound manner. RCRA regulates the management of solid waste (e.g., garbage), hazardous waste, and underground storage tanks holding petroleum products or certain chemicals.

Executive Order (EO) 13101 – *Greening the Government Through Waste Prevention, Recycling, and Federal Acquisition* (1998) – This Executive Order requires federal agencies to minimize negative environmental impacts caused by the whole life cycle of products, rather than focusing only on better waste management through recycling and reuse programs.

Emergency Planning and Community Right-to-Know Act – This act requires reporting the storage and release of EPA-identified chemicals above threshold quantities.

Clean Air Act (CAA) – This federal legislation aims to protect air quality by limiting emissions from stationary and mobile sources. States implement many provisions of the CAA. For example, a state air pollution agency holds a hearing on a permit application by a power or chemical plant or fines a company for violating air pollution limits. In addition, states are responsible for preparing State Implementation Plans that contain strategies for meeting ambient air quality standards.

Fort Hood has a limited ability to track items that contain recycled materials. Recycled antifreeze and re-refined oil are tracked annually. In FY01, 15,740 gallons of recycled antifreeze and 76,615 gallons of re-refined oil were purchased. Fort Hood is developing an Affirmative Procurement Plan (APP) and has provided some information and training on affirmative procurement concepts. The enormous difficulty associated with tracking individual purchases, through numerous procurement outlets that are under the responsibility of various agencies, has made the full implementation of the APP challenging. In addition, many purchases are made through Federal agencies that continue to offer products that do not meet APP guidelines.

Use

Fort Hood is aggressively tracking and reducing its use of hazardous materials. The HazMart, established in 1998, serves as the installation's central hazardous material issuing facility. This facility provides centralized hazardous material ordering, issuing, and storing; distribution to authorized users in quantities limited to immediate needs; tracking of hazardous material; and collection and reissue of unused serviceable hazardous material on a free-issue basis. The Directorate of Public Works (DPW) operates this facility. DPW collects information to ensure that environmental reporting requirements are met and develops authorized user lists. The facility currently serves 90 percent of the installation's units/activities. Approximately 10 percent of the units/activities do not utilize the HazMart for various reasons that include: non-compatible funding sources, product availability, and convenience.

Fort Hood adopted the FORSCOM Hazardous Material Management Plan (HMMP). The HMMP incorporates eight business practice initiatives:

- A centralized hazardous materials management team,
- Authorized user/use lists for hazardous materials,
- Hazardous material tracking system (HSMS),
- Ordering/dispensing by Unit of Use vs. Unit of Issue,
- Establishing re-use procedures for hazardous materials left over,
- Establishing inventory levels of hazardous materials at user/operator levels,
- Centralized storage and issue of hazardous materials (HazMart), and
- Implementing a hazardous material training and awareness program.

Simply put, the purpose of the HMMP is to examine the uses of the hazardous materials, buy only those that are absolutely necessary, buy only the amount that is needed, and limit the use of hazardous materials to specific purposes.

Incorporating these business practices into everyday operations at Fort Hood promotes a safer and manageable hazardous material program. HSMS is an automated tool that assists in incorporating these initiatives into daily operations on Fort Hood.

Reuse

The Department of Defense (DoD) is one of the original "recyclers" in the nation. Through the Defense Reutilization and Marketing Office (DRMO), almost every product and material that is no longer needed on a military installation is screened for reuse within DoD, if possible, followed by resale to the general public. Through this system, the vast amount of material that Fort Hood no longer needs—office furniture, tires, tents, even scrap metal—is kept out of the solid waste stream and reused by someone else. The success of the DRMO limits the environmental impact and cost of waste disposal to a great extent. Fort Hood has had recent success in negotiating agreements with the DRMO to achieve services at a much better rate than had been provided by DRMO in years past. Fort Hood had numerous contracts with local vendors for various recycling services. Fort Hood personnel persuaded DRMO to include these local

vendors in the DRMO umbrella contract. The result is business with local vendors at a better cost, and with reduced costs for contract management.

Disposal

When materials are no longer needed and DRMO cannot resell or reuse them, they become solid waste. The term "solid waste" includes household garbage, also known as municipal solid waste (MSW); construction and demolition (C&D); special waste, which includes POL soils, grit trap waste, and wastes that contain lead-based paints; and hazardous waste. Figure 29 shows the quantities of waste generated and the amount diverted from disposal through recycling. The remaining waste was landfilled. Recycling, treatment, and energy recovery opportunities also allow for the diversion of some hazardous waste from disposal. Landfills result in various environmental impacts including use of open lands, habitat destruction, release of chemicals to the air and water, odor, impact to local species, and various health impacts associated with all of these.

Municipal Solid Waste (MSW) – Solid waste generated from activities at Fort Hood is landfilled on-post. The current active landfill (TNRCC Permit #1866) has been receiving waste since October 1990 and services the installation only. Initial solid waste handling alternatives include two degenerators for classified documents, wood grinding, inert waste areas, composting, and a recycling program.

DPW contracts for the entire SWM requirement for all of Fort Hood, to include refuse, recycle and compost collection from housing and cantonment areas, grease trap collection, compost center operation, landfill cell construction, liquid waste solidification, and landfill operation.

Approximately 34 percent of SW on Fort Hood is being diverted (see Figure 29). Items may be resold, recycled, composted, reused, or diverted. Community recycling drop-off points are located at the main shopping areas. Troop units have recycle containers beside barracks and within motor pools and may also turn-in recyclables for credit in the Recycle Buy Back Program that gives them monetary credits that are deposited into unit funds. Housing areas have a similar program to earn monetary credits for community events, playgrounds, etc. Inert materials, such as concrete, asphalt, dirt, and rock, are placed in an area for future use as foundation material. Fort Hood has a "no bag it" policy within the housing areas for grass clippings, and composts tree limbs, shrubs, and other vegetative waste. Fort Hood also collects manure from the stables, Christmas trees, and other non-treated wood from construction projects or shipping operations for reuse as wood chips or compost. There currently is no food waste composting program.

Figure 29 – Waste Generation and Management Data (FY01)

Type	Amount (tons)	Diverted (tons)	Diverted (%)
MSW	26,629		
C&D	2,517		
Special Waste	9,531		
Recycle		5,800	
Compost		3,529	
Reused		3,730	
TOTAL	**38,677**	**13,059**	**33.76**

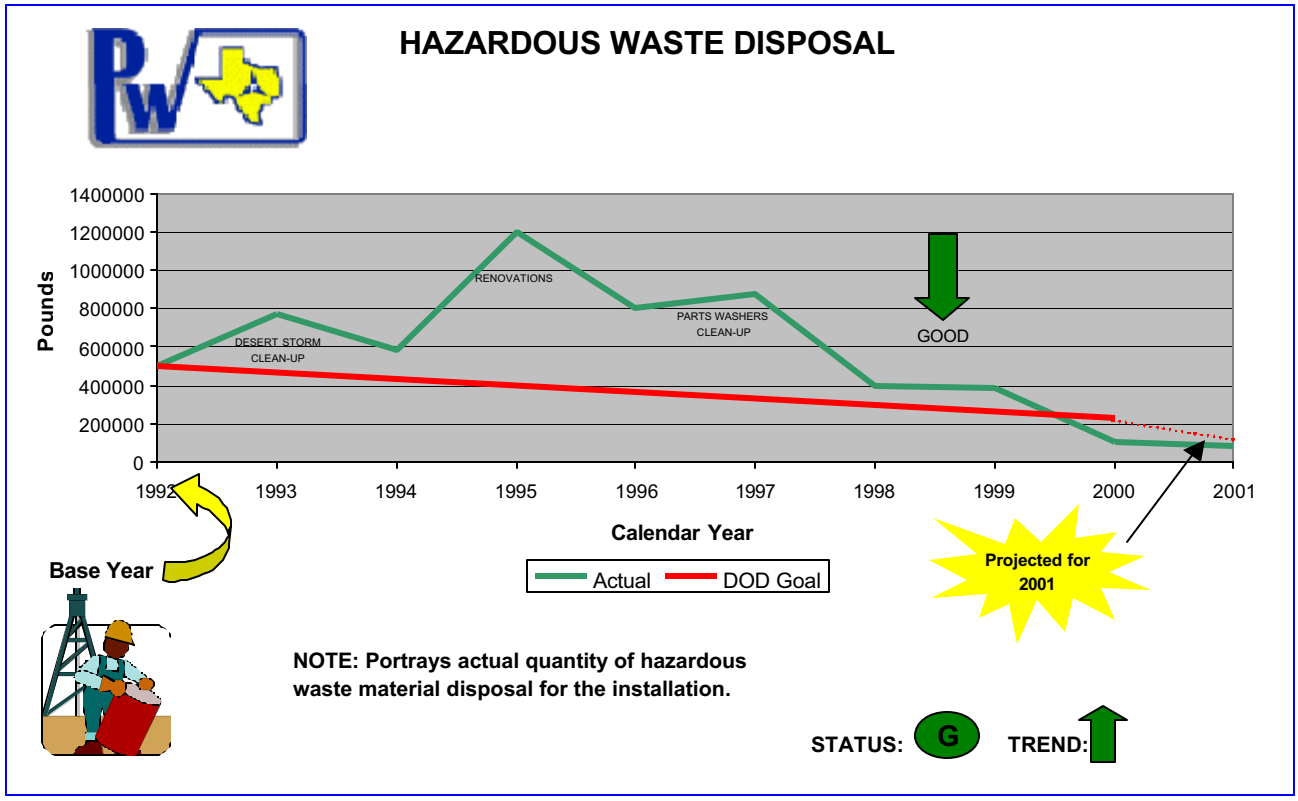
Twenty-five percent of municipal solid waste is recycled. These items are usually marketable and can be sold to recyclers for reprocessing into new products. Less marketable items such as plastics, mixed paper, and glass are not as easily recycled, due to contamination and segregation problems. These items are often left in the solid waste stream and hauled to the landfill. A community recycling drop-off point is located near the main shopping area. Currently, the market for most recyclable materials has dipped, and recyclers have been warned to prepare for a lean 2002. The downturn in the economy has reduced the demand for manufactured goods, thereby reducing the demand for raw materials, including recyclables.

Construction and Demolition (C&D) Debris – Fort Hood's demolition contracts require recycling of C&D debris. Of the debris generated during construction and demolition, Fort Hood estimates, based on the contract requirements with demolition companies, 14 percent of wood is recycled, 15 percent of concrete is recycled into concrete aggregate or crushed stone, and nearly 7 percent of all metal is recycled. The remaining materials are sent to a landfill.

Land Clearing and Inert Debris (LCID) Waste – In general, Fort Hood does not manage LCID wastes separately from its MSW. Currently, all yard waste is collected along with other MSW because Fort Hood does not have a composting program. After windstorms, there are periodic collections of branches, which are chipped and used for mulch.

Hazardous Waste Generation – The use of various products results in the generation of used products and the release of chemicals to the environment (air and water). Fort Hood operates more than 125 used product reclamation points (UPRPs) for collection of motor pool wastes and generates 35 active waste streams that include non-recurring waste streams. Fort Hood ensures that waste is correctly containerized, issued, and tracked through its DPW Classification Unit. Figure 30 shows hazardous waste generation rates normalized for activity from 1992-2000.

Figure 30 – Hazardous Waste Generation Rates



Fort Hood has a permitted hazardous waste Treatment, Storage, and Disposal Facility (TSDF) on-site. The TSDF is owned by Fort Hood but operated by DRMO. Decisions made regarding the TSDF are made in cooperation with DRMO.

Environmental impacts—air emissions and water quality—resulting from those activities associated with products and materials are discussed in the following sections.

Air Emissions

Purchasing and disposal methods for materials have a tremendous impact on air quality. Transporting products to post and hauling waste off-post causes vehicle air emissions. In addition, the storage and use of hazardous materials result in the release of pollutants to the air. Release of these materials to the air can result in local air pollution, regional air pollution, or even degrade stratospheric ozone. While air emissions are addressed in greater detail in the Air Quality section of this baseline document, it is important to link air emissions to the sources—material purchase and use.

Water Quality

Water is contaminated in a variety of ways by products and materials. Water is combined with solvents and soaps to wash vehicles, facilities, and equipment such as paint guns. Water runs over the surface of the

ground and picks up metals, organics, oil, fuel, dirt, and whatever else is in its path. Hazardous materials spilled into drains or streams contaminate surface and groundwater. Water is also contaminated by the chemical stew called "leachate" that is released when solid waste landfills leak—and most eventually do. Products that are bought and the manner in which they are disposed of have serious impacts on water quality. The Water Resources section of this baseline document goes into more detail about the water-related issues facing Fort Hood.

Current Sustainability Activities

Fort Hood has been aggressive in moving beyond simple waste management, especially for hazardous materials and waste. Fort Hood has taken advantage of many opportunities that arise from Fort Hood's material/product purchase and use. Further, Fort Hood has been aggressive in identifying and implementing source reduction and recycling initiatives that have reduced waste generation, and in some cases, material consumption. Several on-going activities are identified below:

Purchase of Environmentally Preferable Products

Fort Hood has taken some initial steps toward encouraging the purchase/use of environmentally preferable products, including products with recycled content. The general environmental specification that is included in all of Fort Hood's contracts refers to the provisions of the Affirmative Procurement program. In addition, the Contracting Command (CCMD) has included provisions of the Affirmative Procurement program in its International Merchant Purchase Authorization Card (IMPAC) training class. Contracting Command heads and their staff have been provided with Affirmative Procurement information in briefings and brochures. In addition, the DPW HazMart stocks re-refined oil and recycled antifreeze in accordance with Section 6002 of RCRA.

DPW HazMart

As discussed previously, the HazMart supports Fort Hood's efforts to reduce its reliance on hazardous materials and products that result in the generation of hazardous waste.

DPW Classification Unit

Fort Hood's Directorate of Public Works Classification Unit, which went into operation in 1991, is unique in the U.S. Army—it takes the total burden for waste management off the units and performs these functions at one place. It is a TNRCC–registered automotive waste recycling storage facility; it accepts, classifies, repackages, labels, stores, and processes for reuse, recycle, or disposal all used products (except for used oil and fuel) and hazardous waste generated by Fort Hood's units, tenants, and contractors. At this centralized operation, materials considered wastes by one unit turn into feedstocks or products for another unit. The Classification Unit has had a significant amount of success in diverting materials from disposal, with significant cost savings.

Source Reduction Activities

Fort Hood has initiated pollution prevention projects that have resulted in reduced reliance on hazardous materials, waste generation, operational costs, and/or environmental releases. Pollution prevention activities include the following:

Re-refined Oil – A contractor picks up used oil and leaves a supply of re-refined oil at a 20 percent discount (closed-loop recycling).

Recycled Antifreeze – Fort Hood issued a Command Policy Letter in 1997 that mandated 100 percent use of recycled antifreeze products for all tactical vehicles operating on-post. As a result, Fort Hood now purchases commercially recycled antifreeze through the Standard Army Retail Supply System. Customers collect and deliver used antifreeze to the Classification Unit, where it is picked up by a local recycler, who in turn recycles the antifreeze and sells it back to Fort Hood.

Automotive Battery Consignment Program – A contractor picks up failed batteries for recycling.

Automotive Battery Management Plan – A change in replacement policy resulted in a fifty-eight percent reduction in new batteries purchased since 1997.

Can Shredder – Fort Hood has an efficient, user-friendly way to clean and dispose of empty POL containers. In 1998, the installation had an automated can shredder, wash, and bale system specifically designed for Fort Hood. This system uses the latest technology to process empty metal and plastic containers.

Now, customers can deliver empty metal and plastic containers to the Classification Unit, where personnel place containers in a hopper that shreds the containers into 1½" x 8" strips of metal or plastic. The strips are then cleaned automatically on the conveyer and deposited into the baler for compaction. The baler produces materials suitable for sale in the secondary materials market. Attached to the unit is a 55-gallon drum washer. Empty drums are cleaned and reissued to customers or turned in to DRMO for sale. The machine is fully automated and includes a safety overload system.

Fluorescent Lamp Recycling – The Fort Hood fluorescent lamp recycling program has contributed to waste minimization goals by recycling 67,082 pounds of metal and glass and 53,893 pounds of ballasts, and diverting 14 pounds of mercury from the landfill since 1996.

ECOLAB Cleaning System – In 1999, Fort Hood procured the ECOLAB cleaning chemical system, which replaces common cleaning supplies with a dispensing station of diluted chemicals that are ready-for-use. With this system, the chemicals are purchased as a concentrate and automatically dispensed into ready-to-use jugs and bottles.

Motor Pool Used Product Reclamation Point – To improve material management, Fort Hood provided each motor pool with a Used Product Reclamation Point. The Used Product Reclamation Point is a uniform concrete slab with a monolithic concrete ramp for access to the 3-foot working area. For

convenience, the platform height is level with the doors on the metal storage building. Each reclamation point has:

- 500 gallon pods where used oil, antifreeze, and off-spec fuels are collected
- Drums for used oil and fuel filters, used poly pads, used sweepable absorbants, and used grease
- Drums that hold contaminated soil that is sent to the bio-remediation yard for processing

Used/empty containers are also stored at this location, and then sent to the classification yard for reuse or disposal.

Vapor Recovery on Fuel Tanks – Fort Hood's Pollution Prevention Program goes beyond the call of duty. This is evidenced by the installation of a vapor recovery system on fuel tanks in 1998—even though it was not required by the regulatory agencies.

Soil Bioremediation – Fort Hood has chosen to bioremediate soil, eliminating the need to hire a contractor to haul away or burn the soil. Bioremediation allows the soil to be reused. This process has been used on Fort Hood since 1997. Microbes, which have known abilities to degrade petroleum contaminants, are seeded into the soil mixture, enhancing degradation rates. After the soils are remediated to less than 1500 ppm TPH, they are used as intermediate cover at the Fort Hood Municipal Waste landfill. Using the remediated soil as intermediate cover conserves space at the landfill and reduces the requirement for excavating non-contaminated soil for use as intermediate cover.

Solar-Powered Lights and Daylighting – In 1998, Fort Hood installed solar-powered lights for several parking lots. Solar panels absorb the sun's rays and convert them to electricity that is stored in batteries. Fort Hood installed an Active Daylighting System in several facilities. This system consists of a sun-tracking mirror device, which attaches to skylights, providing a free energy light source and superior daylighting for buildings instead of operating costly electric lighting during sunny and bright cloudy days. The system actively tracks the sun from minutes after sunrise until minutes before sunset, thereby providing an average of ten hours of light per day.

Golf Course Maintenance (DCA) – Mowing less frequently and leaving grass clippings have reduced the use of fuel and fertilizers.

Digital Photography Equipment (Training Support Center) – Use of this equipment replaces wet film processing and eliminates hazardous material use.

Paint Gun Conversion (DOL) – High volume, low pressure painting reduces the amount of waste caused from over spraying, which results in reduced quantities of hazardous material used, as well as reduced quantities of paint ingredients released to the air.

Lighting/Equipment Upgrade (DPW) – Fort Hood replaced fixtures containing mercury, such as light tubes and thermostats, with those containing less hazardous material.

Aqueous Parts Washer (DOL) – Where authorized, aqueous parts washers clean vehicle parts without the use of chemical solvents.

Green Design and Renovation

The U.S. Green Building Council's (USGBC) 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 that takes into account military-unique aspects of building design, called the Sustainable Project Rating Tool (SPiRiT). Projects are rated in eight categories: sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality, facility delivery process, current mission, and future missions. The SPiRiT standards incorporate sustainability concepts; for example, more points are awarded for purchasing construction materials from local manufacturers. More information on the SPiRiT standards can be found at http://www.cecer.army.mil/sustdesign/SPiRiT.cfm.

Fort Hood's staff and supporting organizations have begun to consider many of the issues identified above. A "green" training facility is under design and will be constructed by 4^{h} quarter FY02. It will be the first of its kind, and the first in the U.S. Army to be built to the Corps of Engineers SPiRiT Platinum Certification Level, the highest rating level attainable. This project incorporates straw bale construction and xeriscaping, waterless urinals, active daylighting systems, and solar-powered lighting. It also incorporates materials salvaged and recycled from Fort Hood's demolished facilities: wooden floors and beams, windows, and crushed glass from bottles.

Recycling Activities

The Recycle Center processes the following classes of materials: paper (writing paper, newspaper, computer printouts, and cardboard), cans (aluminum and steel), plastics (milk jugs, soda bottles, detergent bottles), concertina wire, pallets, heavy-grade plastics, toner cartridges, CDs, off-spec fuel, and used motor oil (see Figure 31). The Recycle Team also established a satellite operation at the DPW Environmental Classification Unit this year, the mission of which is to collect and process all empty POL and antifreeze containers generated on Fort Hood, ranging from the 1-quart to 40-gallon size. This material is jet washed at more than 220°F, shredded, and baled for sale through the Recycle/Classification Yard.

Figure 31 – Materials Processed at the Recycle Center

2001 Commodity	Tons*	Sales*
Cardboard	**3945**	**$238K**
Computer Paper	**4.09**	**$5.4K**
White Paper	**234**	**$39K**
Mixed Paper	**593**	**$20K**
Newspaper	**287**	**$27K**
Maps	**32**	**$.5K**
Office Pack	**123**	**$17K**
Aluminum	**53**	**$20K**
Steel Cans	**53**	**$.8K**
Plastic	**160**	**$13K**
Pallets	**113**	**$2.7K**
Toner Cartridges	**1.8**	**$.5K**
Concertina Wire	**91**	**$.01K**
POL	**97k/gal**	**$13K**

Processing – The Fort Hood Recycle Program has outgrown its original 12,500-square-foot processing facility and expanded by adding an additional 11,000 square feet for a total of 23,500 square feet. Expansion accommodated the modern balers (which include new auto-tie cardboard and paper balers

capable of processing up to 10 tons per hour), sorting lines, perforators (for plastic bottles), magnetic sorters (for aluminum/steel cans), paper shredders (one of which is a high output unit), and a glass crusher to allow for a high degree of efficiency. These efficiencies are achieved by material handling equipment such as forklifts, loading ramps, new pallet and scrap irons storage yard, and a team with a "can-do" attitude. Sales and production dictate storage requirements. The Recycle Center's indoor storage capacity is approximately 400 material bales, equating to approximately 350 tons of material ready for shipment. In order to remain a successful recycling program, management views the recycling program as a business venture. In such a venture, raw materials are collected, processed, quality assured, and marketed.

Collection – Fort Hood has conducted a detailed assessment of all activities to determine the "production potential" of recyclable materials. This assessment is updated continually with the cooperation of military units, civilian activities, and solid waste contractors. Accordingly, Fort Hood's personnel place the appropriate number and type of collection containers to capture these materials (e.g., containers are inside buildings for the collection of office-style paper products and aluminum cans). The Recycling Buy Back Program (RBBP) provided Fort Hood's military units with over 8,000 40-gallon recycle containers at no cost, which in turn saved Fort Hood approximately $560K.

Office Recycle Containers Area

Over 600 Recycle Containers Placed Throughout the Cantonment Area

For industrial facilities, the Solid Waste Management Contractor placed more than 600 large "dumpster"-sized recyclable collection containers at approximately 400 locations for collection of paper/cardboard, mixed plastics, aluminum/steel, and glass. Fort Hood Recycle also provided 370 3.5-cubic-yard containers for units to collect scrap metal for turn-in at the DRMO at no cost to units.

Fort Hood expanded its recycle collection by receiving materials from a community recycling center (City of Killeen) and is working with the city of Copperas Cove to accept their recyclables collected at community drop-off points, which average 2,500 pounds monthly. Fort Hood collects undeliverable third-class mail from four community post office facilities (two in Killeen, one in Harker Heights, and one on Fort Hood), each averaging 3,500 pounds per week. In supporting partnership with the community, seven moving and storage companies are delivering cardboard directly to the Fort Hood Recycle Center, saving them solid waste charges they would normally be charged by their city waste transfer points. The Recycle

Center's goal is to collect/receive 100 percent of all cardboard generated on Fort Hood, to include cardboard generated during Permanent-Change-of-Station move-ins.

Fall and Spring Clean Up Weeks – These events are sponsored by the Recycle Program and conducted annually in April and October. In addition to raising public awareness of the importance of recycling, during FY00 cleanup weeks, Recycle Center personnel collected, received, sorted and processed 5,250 pallets that equal 22,599 pounds of wooden pallets, 7.0 tons of concertina wire, 510 pounds of aluminum cans, 300 pounds of plastic, and 3,600 pounds of cardboard. In addition, personnel turned in 10,200 pounds of scrap metal and 1,400 pounds of used automobile tires to the DRMO for direct sales.

Sales – Fort Hood Recycle receives anywhere from 100 to 532 percent of The Chicago Yellow Sheet prices, which indicates top-dollar return for processed commodities. Fort Hood's baled recyclable materials meet and exceed the industry standard.

Fort Hood's participation in the local Corporate Recycle Council helps develop additional products and markets for the recyclable materials. Fort Hood also practices "after-the-sale" coordination with vendors to identify potential for increased quality of Fort Hood's products.

The costs associated with the operation of the Fort Hood landfill are approximately $30/ton. Therefore, recycling has a much greater overall financial impact than just the income generated through sales. A 40-percent diversion rate would equate to annual savings of approximately $420,000. Figure 32 shows the annual figures for recycling, diversion, and landfilling.

Figure 32 – Annual Figures for Recycling, Diversion, and Landfilling

Year	Recycled (tons)	Diverted (tons)	Landfilled (tons)	Measure of Merit (MoM)
FY92	1,160	1,160	141,677	
FY97	4,025	10,145	61,300	
FY98	4,355	15,626	51,000	
FY99	4,200	10,690	24,379	31%
FY00	4,900	9,791	30,154	30%
FY01	5,370	10,383	25,855	28%

Resource Recovery Recycling Program (RRRP)

DRMO receives and processes scrap metals and other scrap materials generated on the installation (see Figure 33). DRMO plays an active role in supporting the Recycle Program at Fort Hood with funds received for their efforts. The adjacent chart shows the magnitude and scope of the scrap operations. To ensure that Fort Hood

receives all the credit and funds generated from the RRRP, DRMO has incorporated a Recycle employee (additional duty) who processes scrap turn-in documents and assures the profits are deposited into the Fort Hood Recycle fund account.

Figure 33 – Metals Recycling

Commodity	Tons*	Sales*
Aluminum	82	$62K
Brass	153	$174.5K
Crushed Cans	38.2	$5.1K
Steel Heavy	180	$8.4K
Steel Light	1216	$30.7K
Mixed Metal	364	$3.245K

Closing the Loop

The Recycle Advisory Council provides command emphasis toward the purchase of products with recycled content. Since 1992, Fort Hood has used GSA contracts for the purchase of recycled paper products. The Directorate of Contracting requires on-post contractors to participate in the program.

Incentive Programs

The Recycle Team developed a recycling incentive program including quarterly awards for troop units and family housing, called the Recycling Buy Back Program (RBBP). Quarterly awards are disbursed based on the tonnage of materials diverted by units and village residents. This program has been introduced to FORSCOM and used as a model for other installations such as Forts Carson, Riley, Drum, and Stewart. Statistics for the RBBP follow:

- Fort Hood has more than 350 troop units (41,000 soldiers) participating in the RBBP. These units have turned in over 11,581,480 pounds of recyclable material in FYs 99/00/01, resulting in more than $95,000 being awarded to their MWR Accounts.

- All 13 housing villages (5,528 sets of quarters with estimated 22,000 residents) are currently participating in the RBBP. They have, to date (FYs 99,00,01), turned in more than 1,038,110 pounds of recyclable materials, earning in excess of $16,769.44 for community life issues.

- In 1999, Fort Hood's two commissaries signed a Memorandum of Understanding to enroll in the RBBP. Currently, the Commissaries have provided 1,590 pounds of cardboard. Fort Hood Recycle has returned $25,795.94 in funds to the Defense Commissary Agency. This is a "Win - Win" situation for Fort Hood and the Commissaries.

Currently, Fort Hood is diverting approximately 34 percent of its waste streams. The Recycle Center is self-sufficient in that the cost of operation is fully funded by the sale of scrap and recyclable material.

Fort Hood Recycle Center

Used Oil, Antifreeze, and Fuel Recycling

In addition to the solid waste recycling programs previously discussed, Fort Hood has implemented several recycling/reuse programs for used oil, antifreeze, and fuel. The used oil-recycling program is administered as part of the DLA closed-loop oil-recycling program. The DPW Environmental Division administers the antifreeze program. The antifreeze is sent off-site through a contract administered by DRMO. Recycled antifreeze is purchased for reuse from a local vendor and sold through the DPW HazMart. Recycled antifreeze is mandated on Fort Hood. The fuel program consists of an on-site filtration facility that uses state-of-the-art filters to remove particulate matter and water from the fuel. The fuel is then sampled and rendered safe for ground vehicle use. The reclaimed fuel is free-issued back to participating units or organizations.

Recycling Programs for Other Materials

Fort Hood is in the process of implementing material recycling/reuse for specialty chemicals. For example, Darnell Army Community Hospital (DACH) is initiating a silver recovery program to recover silver from photographic processing fluid.

In addition to these specific programs, Fort Hood has used recycling as an alternative to disposal for several wastes. These recycling activities include:

- Fluorescent Tube Recycling – Fort Hood currently recycles fluorescent lamps through an off-site contractor. Fort Hood collects fluorescent lamps at the DPW Classification Unit. The lamps are brought to the DPW Classification Unit where they are packaged and sent to the recycler.

- Medical Solvent/Preservatives Recycling – DACH currently recycles medical solvents such as ethyl alcohol and xylene, and the preservative formalin for reuse in the laboratory.
- Paint Solvent Recycling – All paint booths recycle paint thinner used to clean paint spray guns.
- Plastic Bead Media Stripper – DOL uses plastic beads to strip paint off equipment. Beads are reused over and over again until their diameter becomes too small to be effective. Used beads are then collected and recycled into plastic garden furniture and plant pots.
- Bunker Fuel Project – Fort Hood removed heating oil fuel from decommissioned underground storage tanks and collected, tested, and re-distributed it on the installation for use.
- Field Laundry Recycling – AMCOM/OLR fitted its field laundry units to recycle final rinse water.
- Oil Filter Crusher – Fort Hood crushed and turned over 60,000 pounds of oil filters to an off-site vendor for recycling. Oil filters are turned in to the DPW Classification Unit for crushing.
- Fuel/Oil Blending – Fort Hood is testing a fuel/oil blending project in cooperation with Tank and Automotive Command (TACOM) and a research branch, the NAC (National Automotive Center). This project is being incorporated in Model Motor Pools (another initiative that seeks to drastically reduce or eliminate maintenance facility waste streams). The used motor oil stays on-site, is blended with fuel, and is reused in the same vehicle.
- Air Filter Cleaning – Fort Hood is seeking methods to perform air filter recycling. Currently, other FORSCOM installations are testing air filter cleaning equipment. Once the technology is approved, Fort Hood will adopt the practice.
- Battery Management Project – Fort Hood sent 3,689 pounds of small batteries (nickel-cadmium, nickel metal hydride, alkaline, and magnesium dioxide) to be recycled.
- Tactical/Combat Vehicle Battery Direct Exchange (Lead-Acid Batteries) – Fort Hood turns in thousands of pounds of lead-acid batteries used in tactical vehicles annually for disassembly and recycling. Batteries are checked for rechargeability before being turned over for direct exchange with a new battery.
- Aqueous Parts Washer Solution Recycler – DOL filters contaminants from aqueous parts washer solution and returns solution for reuse.
- Paint Recycling – Fort Hood works with a vendor in San Antonio who accepts leftover paint in the original paint cans and then reblends the paint into one of the five colors used on the installation. This is essentially a manufacturer take-back program that results in a significant reduction of paint waste. In addition, the vendor takes on the responsibility for either reusing or recycling the paint cans.

Summary of Specialized Locations for Management of Materials and Disposal of Wastes

- **Used Product Reclamation Points (UPRP)** – for collection of common motor pool wastes, such as used oil, antifreeze, solvents, off-specification fuels, and absorbents. Fort Hood has 125 of these reclamation points. Individual units are responsible for the management of these reclamation points; contract recyclers take materials away for recycling on a regular basis.
- **HazMarts** – centralized system for hazardous materials management; includes system for ordering, storing, and issuing hazardous materials to a restricted number of users. Fort Hood has three of these; DPW operates the HazMarts.
- **Petroleum, Oil, and Lubricant (POL) Centers** – for storage and distribution of POL; there are nine POL centers.
- **Classification Unit** – single, central area for accepting, classifying, repackaging, labeling, storing, and processing materials for reuse, recycle, or disposal. It is operated by DPW.
- **Recycle Center** – a 23,500-square-foot collection and processing facility for paper, cans, plastics, concertina wire, pallets, toner cartridges, CDs, off-spec fuel, and used motor oil. DPW operates the Recycle Center with labor from soldiers, on a rotating-duty basis.
- **Solid Waste Landfill** – for disposal of municipal solid waste generated from on-site sources only.
- **Permitted Treatment, Storage, and Disposal Facility** – operated by DRMO for hazardous waste management.
- **DRMO Facility** - for receipt and processing of large pieces of scrap metals and other scrap materials generated on Fort Hood.

Forecast

Environmental compliance requirements and costs have increased over time and are expected to continue to do so. Materials and product activity has, and will continue to have, a direct impact on waste generation.

The cost for solid and hazardous waste disposal has increased over time and will continue to rise as regulations become more stringent and the type and quantity of materials requiring regulated disposal increase. Fort Hood is currently evaluating proposals for its next solid waste contract. At present, landfill availability seems secure. As the population grows, however, landfilling will become a less viable option over the next 20 years.

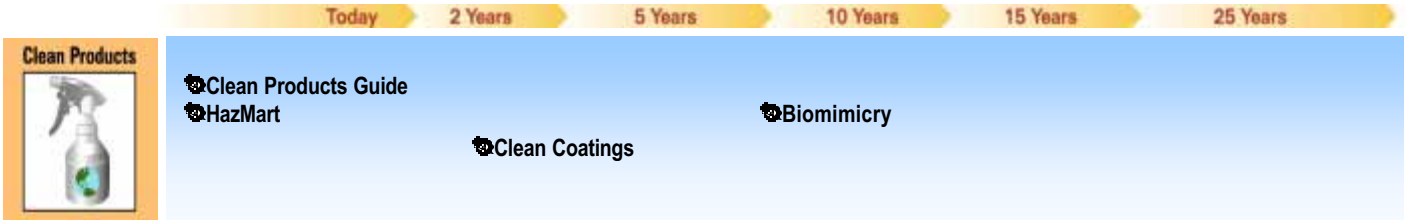
To date, Fort Hood's emphasis on pollution prevention has been on controlling hazardous materials/wastes, assisting units with compliance issues, and implementing specific pollution prevention opportunities at motor pools and other sites. Fort Hood has had tremendous success in these areas. Expanding these efforts to include all materials and products that are currently thrown away would have the following potential benefits to Fort Hood and the surrounding community:

- Decrease total life-cycle management costs of the products and materials that Fort Hood buys. Paying to buy something—and then paying again to throw it away—is often more costly than entering into manufacturer take-back and/or leasing arrangements.
- Decrease current costs of waste management and disposal.
- Increase revenues from sale of used commodities.
- Decrease legal liabilities and potential for regulatory enforcement actions.
- Decrease potential to contaminate the environment, which will decrease future costs associated with cleanup and/or fines.
- Preserve local landfill capacity to meet state goals and control future costs.
- Create a market for recycled products. The intent of EO 13101 is to use the enormous buying power of the federal government to make the recycling of products cost-effective. By buying environmentally preferable products, Fort Hood's $655M of annual purchases will support the market for recycled-content products. This will also support Fort Hood by creating markets for some of the wastes that it currently landfills.
- Reduced toxic releases and wastes through material substitutions and more efficient use will provide additional cost reductions for hazardous waste management and disposal, as well as reduce air pollution and water contamination.

The Realm of Possibilities

To become sustainable, Fort Hood is encouraged, through this process, to identify and plan for innovations that will support the goals established during the Environmental Sustainability Executive Conference. To do this, participants should have exposure to 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.

Clean Products



- **Clean Products Guide** – GSA maintains an extensive "Environmental Products and Services Guide" which lists all available "green" products. The guide can be found on the following website: http://www.gsa.gov/attachments/GSA_PUBLICATIONS/pub/EPSG2001.pdf.

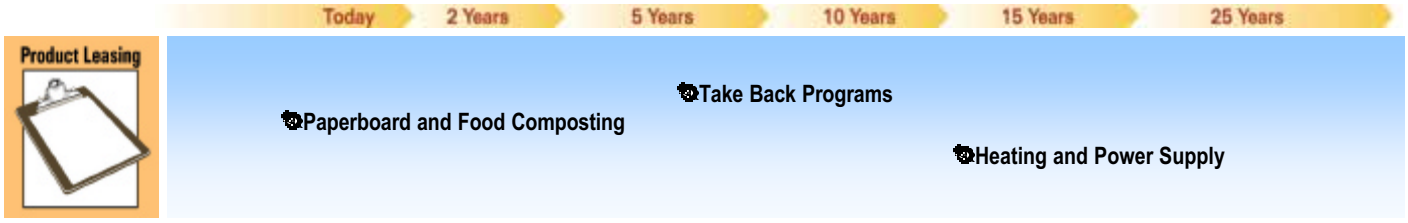
- **HazMart** – Hazardous material pharmacies help control the use of environmentally harmful materials by tracking the purchase and disposal of products in one central location. In this system, a worker who needs a certain chemical must "check-out" that substance from the central location and

then return the unused portion to the pharmacy. This not only ensures that harmful chemicals are not improperly disposed of, but it can save money by making sure all purchases are "right-sized."

- **Clean Coatings** – Researchers have developed alternative paint technologies to assist in the reduction in energy consumption used in heating and cooling facilities. Thermal Diode Ceramic Coatings create a barrier between the external environment and the surface it is applied to for thermal control of buildings or other structures and components. The coating acts like a heat conductor in one direction and an insulator in the other, thus keeping heat where it is needed and removing it from where it is not (Thermal Diode Publication by 27th Century Technologies, Inc.).

- **Biomimicry** – Biomimicry is a simple idea that may someday catch on in a big way. Simply put, biomimicry is the belief that the future of material design and use can be found in the design of the natural world around us. Everywhere, in fact, we can see evidence that nature has long ago mastered the problems that we still grapple with today. The silk from a spider's web is **3 times** stronger than Kevlar, the material we use for bulletproof vests. Slug mucous can withstand pressure up to 1500 times its weight without losing any of its fluid or lubricating properties. Termite mounds are marvels of design ingenuity, using passive cooling systems and venting to maintain constant interior temperatures regardless of exterior temperatures. Visit here for more information: http://www.natick.army.mil/warrior/97/nov/silk.htm.

Product Leasing



- **Take Back Programs** – One of the new business models taking hold in Europe and Asia is "manufacturer take back" programs. In such a program, the original manufacturer retains ownership and disposal responsibility for their products. BMW automobiles are being built to be completely recyclable into new BMWs, as are Nike shoes. The American manufacturer pioneering this concept is Interface, Inc. Interface's "Evergreen Lease" on commercial carpet provides a service in which worn carpet tiles are checked and replaced each month. The worn tiles are taken back and recycled 100 percent into new carpet. This business model is actually not new—think back to when the telephone company owned your old black phone, which never broke or had to be replaced. For more information on efforts world-wide, see Chapter 3, *Waste Not*, and Chapter 4, *Making the World*, Natural Capitalism.

- **Paperboard and Food Composting –** Shredded paperboard can be used as a bulking agent for food composting. A food composting program, which may include pre-consumer (i.e., kitchen waste) and/or post-consumer (e.g., food service waste from lunchrooms), typically needs a bulking

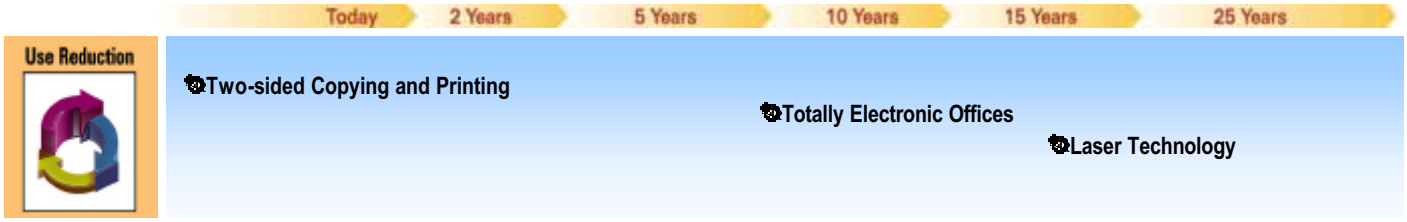
agent to absorb the excess water from food waste. A useable product, compost, can be generated from such a venture.

- **Heating and Power Supply** – Today almost every home and business owns a hot water heater and HVAC unit. When these units fall out of service or need to be replaced, they are almost always thrown away in a local landfill. There is an alternative: Trane is starting to offer full service leases to commercial clients at competitive monthly rates. In these arrangements, the customer needs to only provide the location for installation, and Trane takes care of the rest. When the customer desires a new unit, their old unit is returned to the manufacturer and a new one is provided. In the future, home heating and electricity may be bundled in a fuel cell, further simplifying the process (http://www.trane.com/commercial/financing/leasing.asp).

Local Manufacture

- **Locally Manufactured Products** – The use of locally manufactured products reduces harmful air emissions by reducing the distance those products must be transported to their final destination. In addition, the purchase of these products stimulates local economies, providing better, more vibrant communities around the installation.

Use Reduction



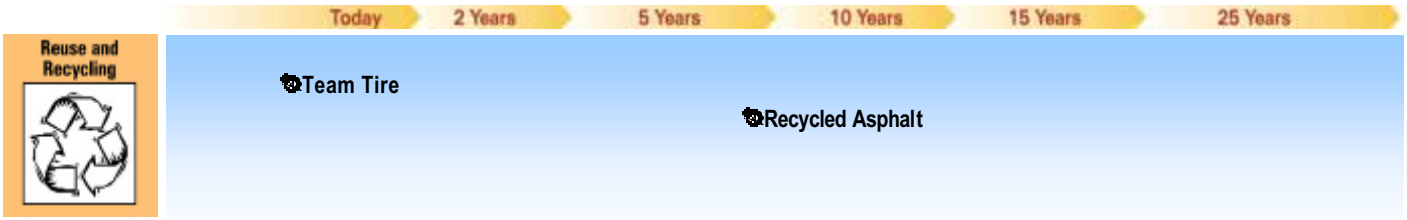
- **Laser Technology** – Laser technology is being researched for appropriate applications in military maintenance of weapon systems (http://www.jgpp.com/projects/projects_index.html). Laser technology can also be used in facility maintenance. Methodologies and techniques for using lasers on building materials have been standardized by lasers for the architectural preservation of historical landmarks (http://www.lynton.co.uk/conservation/framesetversion/frameset.htm). Laser technology eliminates the use of chemical paint strippers and reduces the generation of hazardous waste created from abrasive blasting. This technology also has been used in other industries (e.g., automotive, mold release) for cleaning applications, thus reducing or eliminating the use of chemical cleaning compounds. Furthermore, with portable laser units, production time can be

reduced due to the elimination of disassembly and assembly of weapon system or facility components for maintenance.

- **Two-sided Copying and Printing** – Printing and copying on both sides of a sheet of paper is a fast and easy way to immediately reduce the use of paper by 50 percent. Printers can be used with little or no modification and overall printing speed is preserved.

- **Totally Electronic Office** – In the next 10 years, offices will use less and less paper as workers become more dependent upon email, web pages, and other electronic means of doing business. This will reduce the overall flow of material into an office, and there will be fewer pens, staplers, tape, and plastic binders as well.

Reuse and Recycling



- **Team Tire** – Several DoD and Army agencies and installations participate in TACOM's "Team Tire" Program, in which vendors come into the motor pools and provide re-treaded tires in exchange for used tires. The used tires are retread by the vendor for reuse elsewhere. In addition, the cost for purchasing retread tires is significantly less than new tires (up to $200 less for certain tires).

- **Recycled Asphalt** – DoD and the Environmental Protection Agency (EPA) did a joint parking lot re-paving project for the Pentagon. The $1M project used 25 percent recycled asphalt.

Waste

- **Landfill Fluff** – Fort Campbell and the Construction Engineering Research Lab are testing a new waste-reduction technology in partnership with its inventor, Bouldin-Lawson Inc. Unsorted household garbage is fed into a grinder, hydrolyzed, and then flash-heated to kill germs. The resulting dry "fluff," which looks like cellulose insulation and contains many nutrients, has passed all the toxicity tests and appears to pose no environmental hazard. The process reduces waste volume and weight by 90 percent. The entire process costs $30/ton—comparable to landfill

disposal fees in most areas of the country. The testing at Fort Campbell will determine whether the "fluff" is useful as a soil amendment, and whether it can be extruded into building materials (plastic lumber). If beneficial reuse for the "fluff" can be found, this technology has the potential to eliminate the need for landfilling of household garbage.

- **Innovative Deconstruction** – Fort Knox sells the "salvage rights" to buildings that are on the demolition schedule. The purchaser of the rights can remove windows, doors, flooring, siding, plumbing, and copper wire, but must remove at least 50 percent of the volume of the building. The installation makes about $100K/year on sale of the salvage rights, but saves hundreds of thousands of dollars on reduced demolition and disposal costs. Fort McCoy has a similar program.

  Redstone Arsenal has paid a local house mover and developer to move 89 two-story brick duplexes off the installation and into the local community, where they will be sold and reused. The cost was about $9,000/house versus the $12,000 it would have cost to demolish them, totaling a cost savings of $267,000.

  The Army has signed a Memorandum of Agreement with Habitat for Humanity to allow them to "deconstruct" buildings on the demolition schedule and sell the salvaged items to support Habitat home-building activities. A pilot project is being developed at Fort Hood with the Austin, Texas Habitat affiliate.

  Researchers at the Georgia Institute of Technology are studying how to construct buildings so that they can be easily "deconstructed" and the building materials reused.

- **Zero Footprint Camp** – The U.S. Army Materiel Command (AMC) recognizes that traditional waste management methods used for base camp operations are resource-intensive and create a substantial burden on the camps. These traditional methods also depend on contracted civilian waste management services, posing potential risk to the physical security of the area from terrorist activities. In response to these concerns, AMC developed the Zero Footprint Camp (ZFC) initiative to reduce the logistics footprint, operations and support costs and environmental impacts of base camp operations. This initiative minimizes waste by applying "whole-systems" approaches to resource management, finding cost-effective and technically feasible ways to re-process and/or reutilize trash, grey water, black water, and food garbage within the camp. While the current ZFC initiative focuses primarily on solid waste and wastewater management (http://www.haifire.com/download/zfc.pdf), it will be expanded to cover other aspects of installation operations.

- **Thermal Spray Vitrification** – An alternative method for removing lead-based paint is thermal spray vitrification. In this method, a specially formulated glass media is flame sprayed onto the painted surface. Any lead in the paint is absorbed by the glass media and after a post-removal heat treatment, the removed paint and used glass media is reduced to benign waste. This technology allows for the safe removal of lead-based paint and a reduction in the disposal of hazardous waste (http://estcp.hgl.com/projects/compliance/199607v.cfm).

Fort Hood 25-Year Goals for Products and Materials

To be determined by Fort Hood Command and staff, as advised by members of local and regulatory community, at the Environmental Sustainability Executive Conference on 11-13 June 02.

Appendix A
Acronyms and Abbreviations

AAFES	Army and Air Force Exchange Service
ACSIM	Assistant Chief of Staff for Installation Management
AFH	Army Family Housing
ARDEC	Armament Research, Development, and Engineering Center
B	billions (of dollars)
BCWCID	Bell County Water Control and Improvement District
BLORA	Belton Lake Outdoor Recreation Area
BOD_5	biochemical oxygen demand
C&D	construction and demolition
CAA	Clean Air Act
CARC	chemical agent resistant coating (paint)
CDMP	Community Development and Management Plan
CHPPM	U.S. Army Center for Health Promotion and Preventive Medicine
CO_2	carbon dioxide
COD	chemical oxygen demand
CS	tear gas
DCA	Defense Commissary Agency
DESC	Defense Energy Support Center
DoD	Department of Defense
DPW	Directorate of Public Works
DPW-ENV	Directorate of Public Works, Environmental Office
DRI	Defense Reform Initiative
EA	Environmental Assessment
ECIP	Energy Conservation Investment Program (DoD)
EMCS	Energy Management and Control System
ERCOT	Electricity Reliability Council of Texas
ERDC	U.S. Army Engineer Research and Development Center
ESPC	Energy Saving Performance Contract
EUMP	Expanded Utility Modernization Program (FORSCOM)
FEMP	Federal Energy Management Program
FORSCOM	Army Forces Command
GIS	Geographic Information System
GSA	U.S. General Services Administration
HAP	Hazardous Air Pollutant
HEPA	High Efficiency Particulate Air (filter)
HMCC	Hazardous Material Control Center
HVAC	heating, venting, and air conditioning
ICRMP	Integrated Cultural Resource Management Plan
INRMP	Integrated Natural Resource Management Plan
ISR	Installation Status Report
ITAM	Integrated Training Area Management [Program]
JCI	Johnson Controls, Inc.
KBtu/sf	thousand British thermal units per square foot
LEED	Leadership in Energy and Environmental Design Building Rating System

Appendix A
Acronyms and Abbreviations

LPG	liquified petroleum gas
LURS	Land Use Requirements Study
M	millions (of dollars)
MACOM	Major Command
MCA	Military Construction, Army
MEMS	Micro Electro Mechanical Systems
MGD	millions of gallons per day
MILCON	military construction
MLRS	Multiple-Launch Rocket System
MMBtu	million British thermal units
MMR	Massachusetts Military Reservation
NAAQS	National Ambient Air Quality Standards
NESHAPs	National Emissions Standards for Hazardous Air Pollutants
NOV	Notice of Violation
NO_x	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resource Conservation Service
NSPS	New Source Performance Standards
NWIRP	Naval Weapons Industrial Reserve Plant
O&M	operation and maintenance
ODCs	ozone-depleting chemicals
OWS	oil/water separators
PAPCE	Portable Air Pollution Control Equipment
PM	particulate matter
$PM_{2.5}$	fine particulate matter, particles less than 2.5 microns in diameter
PNNL	Pacific Northwest National Laboratory
POL	petroleum, oil, and lubricants
PUCT	Public Utility Commission of Texas
PV	photovoltaic, cells or technology
PWPPD	Public Works Plans and Projects Division
RCI	Residential Communities Initiative
RCRA	Resource Conservation and Recovery Act
RDX	an explosive used in munitions
RGAAF	Robert Gray Army Airfield
RMI	Rocky Mountain Institute
RPMA	Real Property Maintenance Activity
RPMP	Real Property Master Plan
RTLP	Range Training and Land Program
SDD	Sustainable Design and Development
SERDP	Strategic Environmental Research and Development Program
SO_x	sulfur oxides
SPiRiT	Sustainable Project Rating Tool (military adaptation of USGBC's LEED)
SSOs	sanitary sewer overflows
SWPPP	Storm Water Pollution Prevention Plan

Appendix A
Acronyms and Abbreviations

TACOM	U.S. Army Tank and Automotive Command
TCATA	Training and Doctrine Command, Combined Arms Test Activity
TES	threatened and endangered species
TMDLs	Total Maximum Daily Loads
TNRCC	Texas Natural Resource Conservation Commission
TPDES	Texas Permit Discharge Elimination System
TSS	total suspended solids
UESCs	Utility Energy Services Contracts
UPC	Utility Partnering Concept
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGBC	U.S. Green Building Council
UXO	unexploded ordnance
VOCs	volatile organic compounds
WCID	Water Control and Improvement District (Bell County)
WWTP	wastewater treatment plant

Appendix A
Acronyms and Abbreviations

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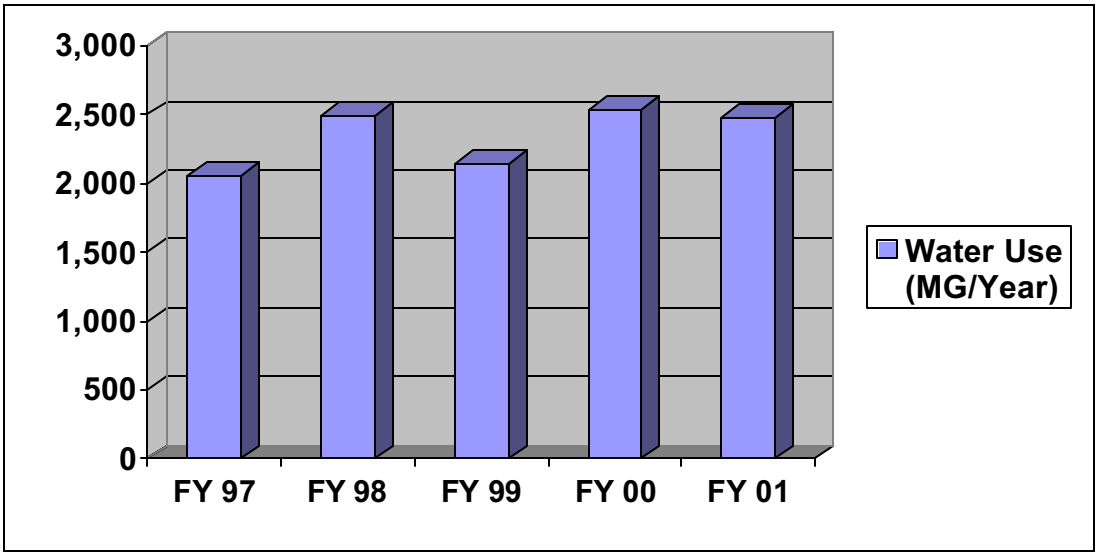
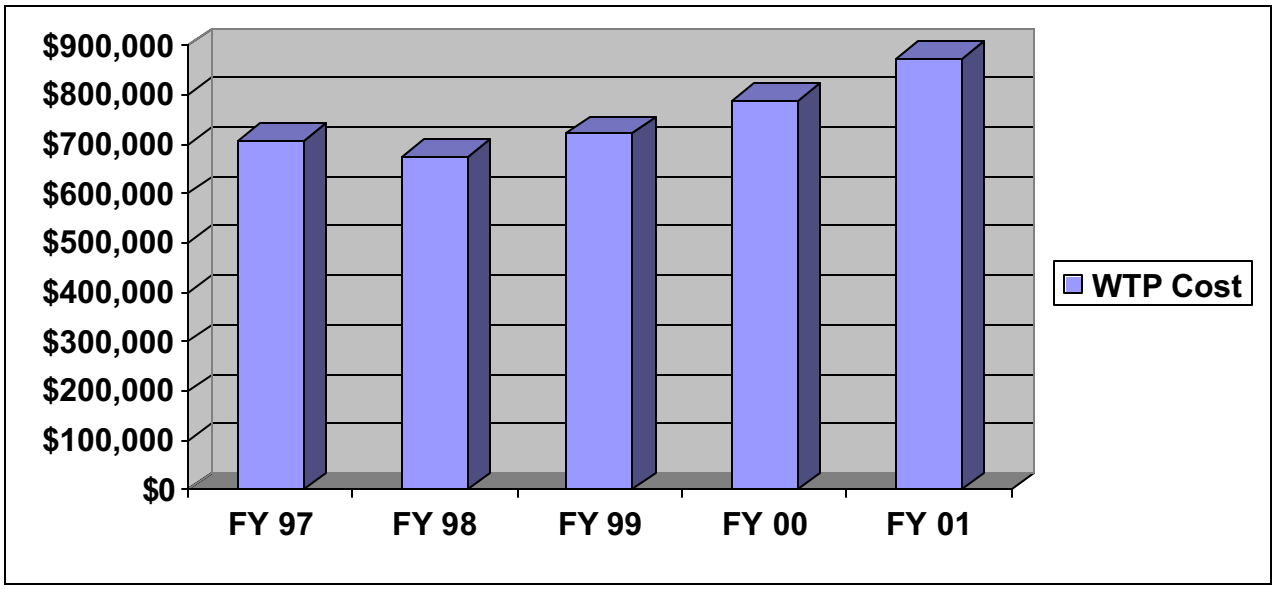
Appendix B
Water Use, Disposal, and Costs

Water Consumption
FY 97 – FY 01

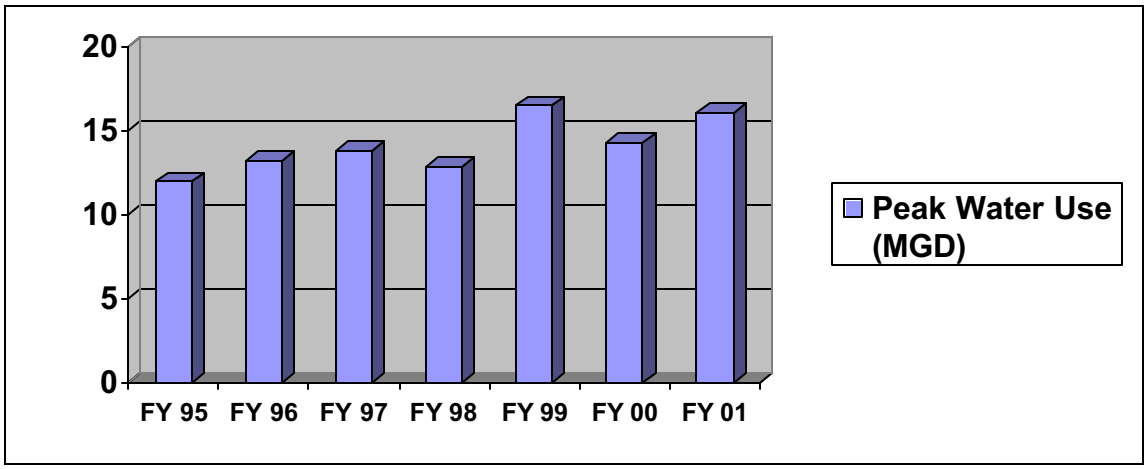


Water Costs
FY 97 – FY 01

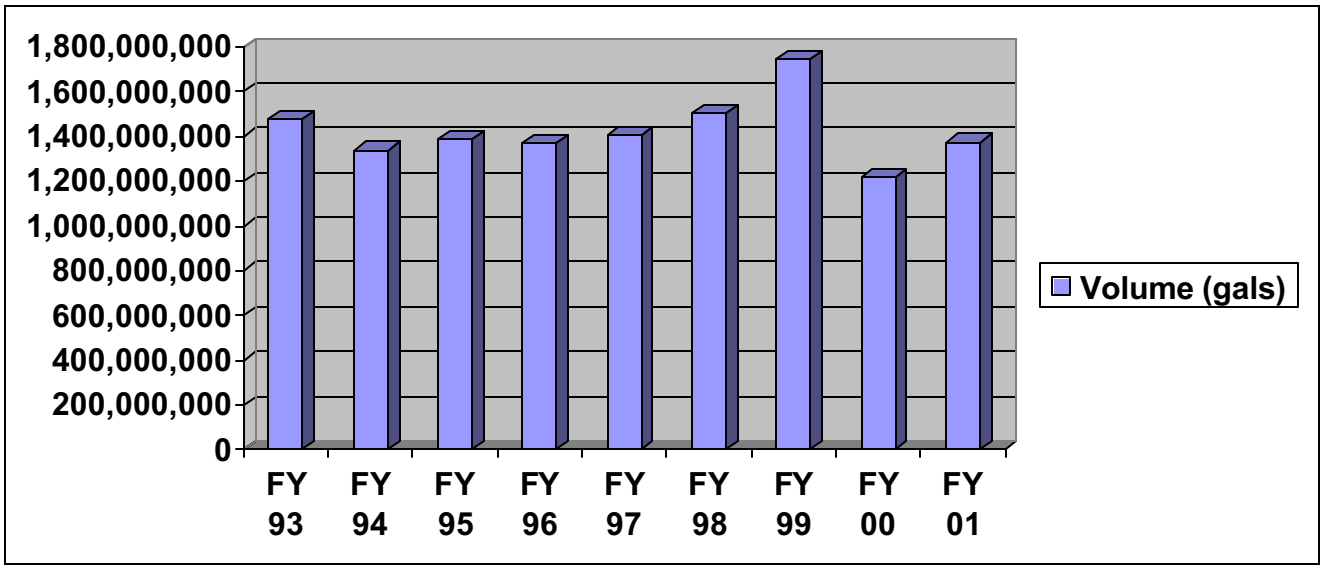


Appendix B
Water Use, Disposal, and Costs

Peak Water Usage Average
FY 95 – FY 01

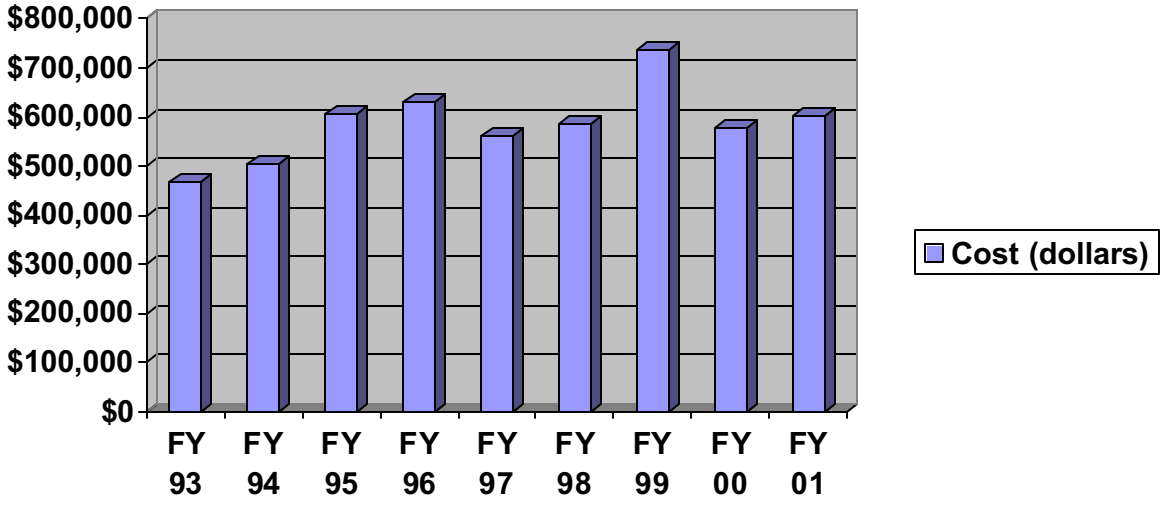


Wastewater Pumped Off-Post for Treatment
FY 93 – FY 01 (Volume)



Appendix B
Water Use, Disposal, and Costs

Wastewater Pumped Off-Post for Treatment
FY 93 – FY 01 (Cost)



TPDES Permit Violations CY 97 – CY 01

Parameter	CY 01	CY 00	CY 99	CY 98	CY 97
Flow	0	0	0	0	0
pH	5	1	3	0	0
Residual Chlorine	6	2	1	5	5
TSS	8	4	6	12	5
Dissolved Oxygen	1	1	2	0	1
COD	3	0	1	1	0
BOD_5	1	0	1	4	1
Oil and Grease	0	0	2	0	1
Total	**24**	**8**	**16**	**22**	**13**

Appendix B
Water Use, Disposal, and Costs

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