AIR COMBAT COMMAND

INSTALLATION SUSTAINABILITY ASSESSMENT REPORT

Fitness Center

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Dyess Air Force Base

Texas

Sustainability assessment summary of Dyess Air Force Base to establish baseline metrics, to identify actionable opportunities and investment strategies, and year-over-year comparisons.

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EXECUTIVE SUMMARY

Due to expanding requirements and diminishing resources as well as lacking holistic/integrated design approaches, HQ ACC/A7PS has formulated a process for measuring sustainability at Air Combat Command (ACC) installations. This process will establish baseline metrics to identify actionable opportunities and investment strategies, and facilitate year-to-year comparisons. There are many individual efforts already in place at HQ ACC/A7PS and at the installation level. It is within this context that the ACC Installation Sustainability Assessment (ISA) process and report was developed. This report summarizes the current and recommended sustainability efforts at Dyess Air Force Base (AFB) and provides a basis for comparison and benchmarking.

Numbers have been calculated for the five sustainability indicators at Dyess AFB for their mission support functions. Additionally, flying mission numbers have been established for the total carbon footprint and energy intensity to show their additional effect on the installation's overall impact on sustainability. The arrow indicators, as shown in the chart below, represent how Dyess AFB compares to industry-recognized benchmarks[1]. Green indicates a metric is on target or better than target. Yellow indicates a metric is slightly off target. Red indicates a metric is off target.

MISSION SUPPORT			
Carbon Footprint:	16,367	mTons	Green
Energy Usage:	444,969	MMBTU	Green
Water Conservation:	248.3	Mg	Red
Waste Production:	2,393	tons	Green
Land Utilization:	4,011	SF/acre	Yellow

FLYING MISSION			
Carbon Footprint:	267,843	mTons	Red
Energy Usage:	3,773,404	MMBTU	Red

SF = square feet, mTons = metric tons, Mg = million gallons, and MMBTU = million British thermal units

Fiscal year (FY) 08 is the inaugural year for the ISA report; therefore, this report does not provide year-to-year comparisons but it does establish a baseline for all future measurements.

ACC has a solid history of successes with sustainability initiatives; however, progressive action must continue. This report outlines a concise, measurable, and repeatable process that can be utilized year to year. Upon this installation's yearly assessment and data analysis, recommendations and actionable items will be established and monitored. ACC HQ/A7PS's role includes identifying synergies between installations to implement new and bridge existing sustainability initiatives. The ACC HQ/A7PS ISA will deliver a positive return on investment and promote leadership in sustainable initiatives.

[1] Industry recognized benchmarks are noted where referenced within the report.

I. INTRODUCTION

A. Installation Sustainability Assessment (ISA) Definition

The Installation Sustainability Assessment (ISA) is a process by which an installation's relative level of sustainability can be measured, identifies and recommends installation-specific improvement strategies, and it is expressed in five key indicators: (1) Carbon Footprint, (2) Energy Usage, (3) Waste Conservation, (4) Waste Reduction, and (5) Land Utilization. Identified improvement strategies will allow for the bridging of diverse sustainable initiatives (i.e., energy, heat island effect, water conservation, habitat/watershed protection and restoration, new construction practices) and a more efficient implementation of these initiatives as it will account for installation-wide conditions. Additionally, overall review of completed ISAs will provide valuable trend analysis across installations. Direct comparison of installations is not the focus due to differing missions, climate variations, and unique installation attributes.

Sustainable design is a design philosophy that seeks to maximize the quality of the community and the built environment while minimizing or eliminating the negative impact to the natural environment. The word installation is defined as the grounds and buildings that belong to a given institution, and specifically refers to the Air Force installation in this document. Sustainability initiatives include conscious efforts to protect habitats, optimize land use, produce zero waste, reduce heat islands, improve air quality, reduce light pollution, use energy efficiently, and maintain the health and well-being for a community.

Initiatives to improve on a particular established indicator typically will also have an effect on other indicators. In determining and prioritizing actionable items, it is important to take into account this interaction to determine which initiatives will result in the most positive outcome and highest return on investment.

B. ISA and the DoD Strategic Sustainability Performance Plan

The *Installation Sustainability Assessment* (ISA) process, metrics, and indicators were initially developed in 2009 by HQ ACC as a means for measuring the overall "green posture" of the installation. In late 2010, the Department of Defense (DoD) published the Strategic Sustainability Performance Plan (SSPP) that identified department wide goals.

HQ ACC reevaluated the ISA process, metrics, and indicators in light of policy established in the SSPP in order to determine if there were conflicts or if changes were needed in the ISA.

The following table provides a summary of the evaluation. The ISA anticipated and aligned favorably with the broad goals and policy in the SSPP. Few modifications in the ISA data collection were needed and those have been fully incorporated into this updated ISA. The SSPP identified some goals that are completely outside the ability of the ISA to collect and report as, to the best of our knowledge, this information is not currently being collected (recall that the ISA relies on collecting data from existing sources).

Bottom Line: The ISA will remain ACC's tool for evaluating the progress of an installation towards the goals and performance expectations of the SSPP.

The following headers are provided in the table below.

- *SSPP Goals* are the goals and sub-goals taken directly from DoD's SSPP.
- *Changes to Align ISAs with SSPP Goals* shows three categories addressing how the ISA aligned with the SSPP.
    - *Few/No ISA Changes* indicates that the original data collect and the data input format of the ISA aligned very closely with the SSPP. *Modifications* that were needed have been incorporated into the ISA.
    - *ISA Additions (data available)* means that the ISA did not originally collect or have a data input format for these goals that were eventually identified in the SSPP. For the most part the data is available *for* collection. However, some of the data may not be easily accessible. Modifications to the ISA spreadsheet have been made for inputting the new data.
    - *Goals outside the ability of the ISA to collect and report* refer to goals that are not applicable to ACC *installations*. It also includes goals for which installations do not have the ability to collect the data for measuring progress against the goal.
- *Data Status and Location* addresses the location within the electronic ISA worksheet where data can be found and inputted in order to calculate progress towards meeting the SSPP goals. It also identifies what data has been collected for each goal.

COMPARISON AND ALIGNMENT OF ISA AND SSPP

SSPP Goals		Changes to Align ISAs with SSPP Goals: Few/No ISA Changes	Changes to Align ISAs with SSPP Goals: ISA Additions (Data Available)	Changes to Align ISAs with SSPP Goals: Goals Outside the Ability of the ISA to Collect and Report	Data Status and Location
Goal 1	**Use of Fossil Fuels Reduced**				
Sub-Goal 1.1	Energy intensity of facilities reduced by 30% of FY03 levels by FY15 and 37.5% by FY20	●			• Data collected in the ISA is acceptable. • Data input under the Energy Tab Spreadsheets.
Sub-Goal 1.2	18.3% of energy consumed by facilities is produced or procured from renewable sources by FY20	●			• Data collected in the ISA is acceptable. • Data input under the Energy Tab Spreadsheets. • Sustainable Measures Tab worksheet shows a separate table for facilities with the energy intensity bar chart showing the renewable component.
Sub-Goal 1.3	Use of petroleum products by vehicle fleets reduced by 30% by FY20 relative to FY05	●			• Data collected in the ISA acceptable. • Data input under the Energy Tab Spreadsheets. • Sustainable Measures tab shows reduction in transportation energy use and separates petroleum and renewable sources.
Goal 2	**Water Resources Management Improved**				
Sub-Goal 2.1	Potable water consumption intensity by facilities reduced by 26% of FY07 levels by FY20 Assessment of ISA	●			• Data collected in the ISA is acceptable. • Data input under the Water Tab Spreadsheets. • Sustainable Measures Tab shows the percent improvement from baseline in the per built SF table.
Sub-Goal 2.2	Reduce industrial and irrigation water consumption 20% by FY20 from FY10 baseline			●	• Water Tab spreadsheet updated to provide data entry points for when data becomes available. • Data not currently available for input in the ISA for this metric. No separate metering for industrial uses.
Sub-Goal 2.3	All development and redevelopment projects of 5,000 square feet or greater maintaining pre-development hydrology to the maximum extent technically feasible		●		• Water Tab spreadsheet modified to add a yes/no box with a percent compliance. • Data not originally collected for sub-goal.
Goal 3	**Greenhouse Gas Emission from Scope 1 and 2 Sources Reduced 34% by FY20, Relative to FY08**	●			• Data collected in the ISA is acceptable. • Data input under the Energy Tab Spreadsheets.
Goal 4	**Greenhouse Gas Emission from Scope 3 Sources Reduced 13.5% by FY20, Relative to FY08**				
Sub-Goal 4.1	Greenhouse gas emission from employee air travel reduced 15% FY20 relative to FY11		●		• Operations Tab spreadsheet modified to a yes/no box with a percent compliance. • Data not originally collected for sub-goal.
Sub-Goal 4.2	30% of eligible employees teleworking at least once a week, on a regular, recurring basis, by FY20		●		• Operations Tab spreadsheet modified to a yes/no box with a percent compliance. • Data not originally collected for sub-goal.
Sub-Goal 4.3	50% of non-hazardous waste diverted from disposal in landfills not owned by DoD by FY15, and thereafter through FY20	●			• Data collected in the ISA is acceptable. • Waste Management Tab has a check box for verification of the waste is going to non-DoD landfill.

COMPARISON AND ALIGNMENT OF ISA AND SSPP

SSPP Goals		Changes to Align ISAs with SSPP Goals: Few/No ISA Changes	ISA Additions (Data Available)	Goals Outside the Ability of the ISA to Collect and Report	Data Status and Location
Goal 5	**Solid Waste Minimized and Optimally Managed**				
Sub-Goal 5.1	All DoD organizations implementing policies by FY14 to reduce the use of printing paper		●		• Operations Tab spreadsheet modified to a yes/no box with a percent compliance. • Data not originally collected for sub-goal.
Sub-Goal 5.2	50% of non-hazardous solid waste diverted from the waste stream by FY15, and thereafter through FY20—not including construction and demolition debris	●			• Data collected in the ISA is acceptable. • Data input under the Waste Management Tab Spreadsheets.
Sub-Goal 5.3	60% of construction and demolition debris diverted from the waste stream by FY15, and thereafter through FY20		●		• Waste Management Tab spreadsheet modified to add a header for C&D debris. • Data not originally collected for sub-goal.
Sub-Goal 5.4	Ten landfills recovering landfill gas for use by DoD by FY20			●	• Not applicable to ACC installations.
Goal 6	**The Use and Release of Chemicals of Environmental Concern Minimized**				
Sub-Goal 6.1	On-site releases and off-site transfers of toxic chemicals reduced 15% by FY20, relative to FY07		●		• Waste Management Tab spreadsheet modified for listing reportable quantities. • Data not originally collected for sub-goal.
Sub-Goal 6.2	100% of excess or surplus electronic products disposed of in environmentally sound manner		●		• Operations Tab spreadsheet modified to a yes/no box with a percent compliance. • Data not originally collected for sub-goal.
Sub-Goal 6.3	100% of DoD personnel and contractors who apply pesticides are properly certified through FY20		●		• Operations Tab spreadsheet modified to a yes/no box with a percent compliance. • Data not originally collected for sub-goal.
Goal 7	**Sustainability Practices Become the Norm**				
Sub-Goal 7.1	95% of procurement conducted sustainably				• Operations Tab spreadsheet modified to a yes/no box with a percent compliance.
Sub-Goal 7.2	15% of existing buildings conform to the guiding principles on high performance and sustainable buildings by FY15, holding through FY20			●	• ACC/A7PS is evaluating how to implement this goal.
Goal 8	**Sustainability Built into DoD Management Systems**				
Sub-Goal 8.1	All environmental management systems effectively implemented and maintained		●		• Operations Tab spreadsheet modified to a yes/no box with a percent compliance. • Data not originally collected for sub-goal. Data is available.
Sub-Goal 8.2	Sustainability of transportation and energy choices in surrounding areas optimized by coordinating with related regional and local planning		●		• Operations Tab spreadsheet modified to a yes/no box with a percent compliance. • Data not originally collected for sub-goal. Data is available.
Sub-Goal 8.3	All DoD installations have Integrated Pest Management Plans prepared, reviewed, and updated annually by pest management professionals		●		• Operations Tab spreadsheet modified to include a year and review date. • Data not originally collected for sub-goal. Data is available.

C. Goals and Objectives

The ISA has been established to formulate a process for measuring sustainability at the installation level. ISAs take a comprehensive look at ACC installations and will address, at a minimum, current use of renewable energy, green procurement practices, infrastructure systems, existing facility operations, conservation plans, environmental compliance, biological resources, habitat protection, watershed restoration, land use, and environmental stewardship.

The ISA will be used to:

- Report the findings
- Establish a baseline for year-to-year comparisons
- Define sustainable initiatives
- Identify synergistic opportunities between diverse initiatives
- Support the Mission, improve the quality of life, and conserve resources over time
- Create an awareness of impacts and a catalyst for cultural change

D. Setting the Context

Flying Mission:

Flying Mission includes anything that directly affects or has direct participation in flight or deployment operations. The flying mission calculations currently take into account fuel usage (i.e., transportation and aviation fuels) and mission-specific building, and land use areas to calculate the installation's Flying Mission carbon footprint and energy usage. In the future, once sub-metering of all facilities is complete, additional measures for Flying Mission may be established for water consumption and waste production.

Mission Support:

Mission Support includes all other activities on the installation that do not directly affect flight and deployment operations.

E. Process

1. Data Collection Categories

The ISA categories are a way of grouping data that was collected and used to calculate a set of sustainability criteria. In summary, the ISA data collection categories are:

1. **Development—**Includes land use, building utilization, transportation, noise, and light emissions.
2. **Energy—**Includes electrical, gas, oil, and liquid propane gas consumption; power purchased from utility or generated on site; and transportation and mission fuels for government vehicles and support equipment.
3. **Water—**Includes domestic, irrigation, and storm water consumption as well as its source and its usage.
4. **Waste—**Includes solid and liquid waste production and its usage.
5. **Operations—**Includes best management practices (BMPs) such as procurement, training, maintenance, and purchasing program for energy efficient equipment.

The following defines the five data collection categories in more detail:

Development:

Expanding human requirements and economic activities are placing ever-increasing pressures on land resources, creating competition and conflicts and resulting in suboptimal use of resources. By examining all land uses in an integrated manner, it is possible to minimize conflicts, make the most efficient tradeoffs, and link social and economic development with environmental protection and enhancement, thus helping to achieve the objectives of sustainable development.

Land use refers to the activities practiced by humans on land. Land supports uses such as residential, industrial, and commercial facilities; recreational areas; natural infrastructure areas; and transportation functions. Integrating a green infrastructure with community connectivity in land use planning is essential to achieving sustainable developments as they incorporate multiple environmental benefits including:

- Reducing storm water runoff volumes and reducing peak flows by using the natural retention and absorption capabilities of vegetation and soils.

  The capacity of the land can be generally categorized as either pervious or impervious. Pervious includes areas that allow rainwater to pass through them and soak into the ground instead of flowing into storm drains. Impervious includes areas that are mainly constructed surfaces covered by impenetrable materials such as asphalt, concrete, brick, and stone. These materials seal surfaces, repel water, and prevent precipitation and melt water from infiltrating soils. Impervious surface areas include rooftops, sidewalks, roads, and parking lots. The impacts of increased impervious surfaces to storm water runoff should be controlled to mimic natural conditions and to protect water quality. Increasing the amount of pervious ground cover increases storm water infiltration rates that reduces the volume of runoff entering our combined or separate sewer systems, and ultimately our lakes, rivers, and streams.

- Improving the rate at which groundwater aquifers are recharged or replenished.

  Groundwater provides approximately 40 percent of the water needed to maintain normal base flow rates in our rivers and streams. Enhanced groundwater recharge can also boost the supply of drinking water for private and public uses.

- Preventing pollutants from being transported to nearby surface waters.

  Once runoff is infiltrated into soils, plants and microbes can naturally filter and break down many common pollutants found in storm water.

- Limiting the frequency of sewer overflow events by using the natural retention and infiltration capabilities of plants and soils that will reduce runoff volumes and delay storm water discharges.

- Capturing and removing carbon dioxide (CO_2) from the atmosphere via photosynthesis and other natural processes of plants and soils that serve as sources of carbon sequestration.

- Mitigating the effects of urban heat islands and reducing energy demands by providing increased amounts of urban green space and vegetation.

Urban heat islands form as communities replace natural land cover with dense concentrations of pavement, buildings, and other surfaces that absorb and retain heat. Heat from the sun is absorbed by impervious surface areas and is radiated back into the atmosphere, increasing temperatures in the surrounding area. Additionally, buildings and streets trap and concentrate waste heat from vehicles, factories, and air conditioners. The displacement of trees and vegetation minimizes their natural cooling effects. Trees, green roofs, and other green infrastructure lower the demand for air conditioning energy, thereby decreasing emissions from power plants.

- Improving air quality by incorporating trees and vegetation in urban landscapes.

  Trees and vegetation absorb certain pollutants from the air through leaf uptake and contact removal. If widely planted throughout a community, trees and plants can even cool the air and slow the temperature-dependent reaction that forms ground-level ozone pollution.

- Providing increased access to recreational spaces and wildlife habitats including greenways, parks, urban forests, wetlands, and vegetated swales.

- Impacting overall human health by providing vegetation and green space.

  Research has linked the presence of trees, plants, and green space to provide a stronger sense of community, improved performance, and even reductions in physical and mental illnesses.

- Improving accessibility by reducing travel distances and improving transportation options by creating nodes such as rideshare and bus stops.

  Community connectivity, or clustering, refers to land use patterns in which related activities are located in proximity to one another. Clustering makes it easier to do things such as run several errands at the same time or socialize.

- Protecting greenfields and preserving habitat and natural resources by clustering buildings.

- Reducing greenhouse gas emissions contributing to the carbon footprint as a result of decreased vehicle use travelling to and from sites.

  Transportation fuel consumption and emissions contribute to climate change, smog, and particulate pollution, all of which have negative impacts on human health.

- Controlling noise levels below 65 decibels that is considered an acceptable level in suitable living environments.

  The Noise Control Act of 1972 (Public Law 92-574) directs federal agencies to comply with applicable federal, state, interstate, and local noise control regulations. Sound quality criteria disseminated by the U.S. Environmental Protection Agency (USEPA), the U.S. Department of Housing and Urban Development (HUD), and the Department of Defense (DOD) have identified noise levels to protect public health and welfare with an adequate margin of safety. Responses to noise vary depending on the type and characteristics of the noise, the expected level of noise, the distance between the noise source and the receptor, the receptor's sensitivity, and the time of day. These levels are considered acceptable guidelines for assessing noise conditions in an environmental setting.

- Reducing light pollution through fixture types, direction of light, lighting control, and improved airfield lighting.

Energy:

Energy is constantly consumed for the operations of every installation. Data is already being collected by installation personnel to capture all energy sources used at the installation, including transportation fuels and mission fuels. Energy sources may include petroleum, natural gas, electricity, coal, and renewable resources such as hydropower, solar, wind, geothermal, biomass, and ethanol. Using existing data, the amount and type of energy consumed is further analyzed to establish a baseline measure for year-to-year comparisons and to monitor the reduction of energy consumption.

Energy usage results in undesired emissions into the environment. Installations typically do not monitor all emissions. Collecting the installation energy data provides the opportunity to calculate a carbon footprint measure (Flying Mission and Mission Support) for the installation that can be monitored year to year.

Water:

The current water distribution systems at most installations and communities are designed to meet multiple supply needs:

- Potable requirements (e.g., drinking, cooking, cleaning, etc.)
- Firefighting
- Municipal, commercial, and industrial needs
- Non-potable applications (e.g., toilet flushing, landscape irrigation, heating, cooling, etc.)

In some areas of the United States, dual distribution systems have been implemented that provide a primary system for delivering high-quality drinking water and a secondary system for non-potable water applications. By using alternative sources for water supplies either to meet non-potable needs or to replenish existing water sources, higher-quality sources of drinking water can be preserved. Capacity and functionality of alternative infrastructure systems need to be considered in cases where separate systems are provided for potable and non-potable applications (e.g., water reuse and recovering gray water, rain water, or storm water).

Per the Energy Independence and Security Act (EISA) of 2007, any development or redevelopment project involving a Federal facility with a footprint that exceeds 5,000 square feet (SF) shall use site planning, design, construction, and maintenance strategies for the property to maintain or restore, to the maximum extent technically feasible, the predevelopment hydrology of the property with regard to temperature, rate, volume, and duration of flow. As mentioned under the Development category, storm water is critical to sustainable development. The combination of reducing water consumption; reusing storm, gray, and waste water as water sources; and treating runoff are sustainability goals related to water/storm water.

Waste:

Solid and liquid waste on an installation consists of paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, and hazardous wastes, each of which take their own time to degenerate. The size of the annual waste stream is determined from monthly waste-hauling reports detailing the total tons and cost of the waste that has been hauled. Waste streams include landfill, recycling, hazardous, compost, and any others that are being used on the installation.

Responsible waste management of hazardous and nonhazardous waste is essential to protecting human health and the environment. This includes conserving resources by reducing waste, preventing future waste disposal problems by enforcing regulations, and cleaning up areas where waste may have been improperly disposed.

Wastewater is any water that has been adversely affected in quality by human influence. In the most common usage, it refers to the municipal wastewater that contains a broad spectrum of contaminants resulting from the mixing of wastewaters from different sources. Grey water comprises 50 to 80 percent of the wastewater produced from such activities as dish washing, laundry, and bathing. The amount of the annual wastewater produced on an installation is calculated as a percentage of the reported total monthly gallons and cost of the municipal domestic water consumption.

Treated wastewater can be used for irrigation, fire protection, toilet flushing, artificial wetlands, processing, and cooling towers. Reusing wastewater contributes to conserving water and protecting waterways.

Operations:

Operational BMPs that have been found to be an effective and practical means in protecting or enhancing the environment include such activities as green procurement of goods and services, training, maintenance, and purchasing programs for energy-efficient equipment.

Green procurement is the purchase of environmentally preferable products and services for things such as recycled paper, green cleaning supplies, office products, and printing services. In addition to being cost effective, green procurement reduces the amount of solid and hazardous waste generated and reduces consumption of energy and natural resources.

Proper training of operations and maintenance staff on the use of building systems results in energy savings with minimal upfront investment. The environment benefits from less energy being consumed and less emissions being put into the atmosphere and the building owner benefits from the cost savings associated with less energy being used.

In commercial buildings, use of equipment is the fastest-growing consumer of electricity. Purchasing and using energy-efficient equipment and appliances saves on the total energy being used and the costs associated with their use.

2. Preliminary Research and Data Collection

HQ ACC/A7PS obtained applicable data and reports for the installation from available resources. Examples of reports used as data sources include the Integrated Natural Resources Management Plan, Integrated Cultural Resources Management Plan (ICRMP), Storm Water Pollution Prevention Plan, Integrated Water Quality Management Plan, Drinking Water Management Plan, Pollution Prevention Management Plan, Hazardous Waste Management Plan, Solid and Hazardous Waste Compliance, Economic Impact Analysis, Environmental Restoration Program Site Summaries Report, Department of Energy Report, Transportation Fuel Reports, Real Property Reports, and geographical information system database. Information gathered is from resources that already exist. Creation of new reports/data by installation personnel is not required.

3. On-Site Evaluation and Data Collection

A five-person A/E team consisting of a civil engineer, two urban and environmental planners, a landscape architect, and a surveyor met with base personnel and surveyed and documented base assets the week of 11 January 2010. While at the installation, the A/E team interviewed available environmental, engineering, and operations flight staff, such as, but not limited to, natural and cultural resources; air, water, and solid and hazardous waste managers; civil, electrical, and mechanical engineering; community planning; energy and lighting, including high-voltage alternating current (HVAC) maintenance; engineering; procurement; and real property personnel to supplement the data collected previously from HQ ACC/A7PS as well as to collect data not previously obtained.

4. Data Analysis

The data collected was entered in the pre-established spreadsheet form. Pre-established sustainability indicators were calculated that are quantifiable, repeatable, simple, and represent installation-wide sustainability conditions. The metrics establish a baseline for year-to-year comparison, and document compliance or non-compliance with Federal guidance and other applicable agency governances (e.g., Executive Orders (EOs), Energy Policy Act (EPAct) 2005, EISA 2007, MAJCOM directives, etc.).

5. Findings Summary

This report and supporting documentation is a compilation and summary of the information collected and the sustainability indicators calculated for Dyess AFB. The data was evaluated using criteria and protocol that is standard to this initiative and provides a consistent reporting structure. HQ ACC/A7PS will review these results and conclusions to identify potential projects, policy changes, incentives, and year-to-year comparisons.

The following defines the sustainability indicators and methodologies in more detail.

Carbon Footprint:

Carbon Footprint is the measure of the impact human activities have on the environment in terms of greenhouse gas emissions produced, measured in tons of CO_2.

Gases that trap heat in the atmosphere are referred to as greenhouse gases. Some greenhouse gases, such as CO_2, occur naturally and are emitted to the atmosphere through natural processes and human activities. Other greenhouse gases are created and emitted solely through human activities. Human activities typically produce the following greenhouse gases:

- **CO_2—**CO_2 is produced through the burning of fossil fuels (oil, natural gas, and coal), solid waste, and trees and wood products. CO_2 is also produced as a result of other chemical reactions.
- **Methane (CH_4)—**CH_4 is emitted during the production and transport of coal, natural gas, and oil. CH_4 emissions also result from livestock and other agricultural practices and by the decay of organic waste in municipal solid waste landfills.
- **Nitrous Oxide (N_2O)—**N_2O is emitted during agricultural and industrial activities as well as during combustion of fossil fuels and solid waste.

- **Fluorinated Gases—**Hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride are synthetic, powerful greenhouse gases that are emitted from a variety of industrial processes.

In the U.S., energy-related activities account for three-quarters of our human-generated greenhouse gas emissions, mostly in the form of CO_2 emissions from burning fossil fuels. More than half the energy-related emissions come from large stationary sources such as power plants, while approximately one-third comes from transportation. Industrial processes (such as the production of cement, steel, and aluminum), agriculture, forestry, other land use, and waste management are also important sources of greenhouse gas emissions in the U.S. (USEPA).

For reporting carbon footprint, the General Reporting Protocol v1.1 May 2008 from The Climate Registry was used. This protocol was used to calculate the carbon footprint as it is one of the most widely accepted systems in the U.S. and offers a relatively simple approach that can be adapted to installation-wide systems. Where data was available, Scopes I and II emissions and some of Scope III emissions have been included. Scope I emissions are all direct greenhouse gases from combustion sources to refrigerant leaks. Scope II includes indirect greenhouse gas emissions from offsite power generation. For this report, Scope III includes an estimate of employee commuting greenhouse gas emissions. Where possible, direct calculations of materials consumed or released to calculate the equivalent greenhouse gas emissions have been used. In some cases, the use of generalized lookup figures and/or averages to generate quantities of emissions has been allowed. It is important to track the greenhouse gas emissions relative to mission fuels and transportation fuels to allow comparisons to other public and corporate entities.

Energy Usage:

Energy usage is integral to every facet of our daily lives and is a critical component of a sustainable installation. The long-term reliance on non-renewable resources can be decreased and renewable resources can be developed in an environmentally and economically responsible manner. This potential for improved energy usage is important as carbon-based energy sources are the most significant contributor to greenhouse gas emissions.

For reporting energy use, actual usage data from the base was captured from reporting practices in the government. For the purposes of this project, the energy usage data was separated into building/site energy and transportation categories. Transportation data was further broken down into flying mission and mission support categories along with quantifying which energy sources are from bio-based (green) and/or renewable sources. These numbers are used to provide energy consumption relative to full-time equivalent (FTE) and installation building square footages along with allowing analysis of green/renewable sources and Flying Mission versus Mission Support consumption. It was important to separate mission energy consumption from standard transportation due to the large amount of fuels required for aircraft. This separation also provides a fair comparison to other public campuses or corporate entities.

Water Conservation:

As the demand for fresh, clean water for irrigation and industry increases, underground aquifers are being drained faster than they can be refilled. Pollution and changing climatic conditions are adding to the burden on fresh water supplies. Poor land development creates more impervious surfaces which generate higher levels of runoff, while more natural areas decrease the amount of runoff. There is the potential to become water self-sufficient by harvesting rainwater and reducing the use of domestic water.

For reporting water conservation, the domestic water use is captured and compared to the installation population and building square footages for comparison year to year.

Storm water conservation is based on comparing the 2-year post development calculation to a 2-year pre-development (greenfield) calculation using the U.S. Department of Agriculture, Natural Resource Conservation Service (NRCS), Soil Conservation Service Method as outlined in Urban Hydrology for Small Watersheds Technical Release 55. Any increase in runoff has the potential for contaminated or polluted waters from parking lots, streets, and the airfield to reach water systems off site, resulting in a need for improved containment and/or treatment.

Waste Reduction:

Every economic activity produces waste. The average human uses 45 to 85 tons of materials each year. Due to diminishing resources and recent legislation, bases need to reduce the amount of waste produced and increase the amount of waste recovered. Composting has the potential to significantly alter the amount of waste thrown into local landfills.

For reporting waste reduction, data is captured regarding total waste, landfill, recycling, compost, hazardous, and the costs associate with each. The data is compared to installation population, USEPA recommended guidelines, and tracked year to year.

Land Utilization:

Community sustainability requires a transition from poorly managed sprawl to land use planning practices that create and maintain efficient infrastructure, ensure a sense of community, and preserve natural systems. Many current land use practices have converged to generate haphazard, inefficient, and unsustainable sprawl. Stratified land use policies and inadequate funding for demolition of obsolete facilities isolates employment locations, shopping and services, and housing locations from each other, thereby creating excessive transportation and creating excessive hard surfaced areas.

For reporting land use, source data was gathered on the installation that provides a baseline site area along with area breakdowns for buildable, non-buildable, and habitat areas. Combining this information with building footprints and building areas by category/use codes allows the breakdown of land use and utilization of the installation. Some of the starting basic calculations include total building area relative to the buildable land along with the total non-built or green area relative to the entire site. An attempt was made to provide a reference of built area relative to the site occupancy. Currently, the square footage per FTE being used to provide a comparison of building area against the installation's population and to depict the utilization of the building space is twice the code-recommended square footage.

6. Recommendations

The recommendations described in this report are derived from the specific information obtained at the installation and are intended for further definition and development of projects that would have a direct and viable impact for the sustainability of the installation. The recommendations are categorized within the pre-established sustainability indicators. Ultimately, this list will be used to develop a prioritized group of projects.

II. INSTALLATION INFORMATION

A. Background

Dyess AFB is a U.S. Air Force installation located in the northeast corner of Taylor County, Texas, within the city of Abilene (see figure on the following page). The host unit at Dyess AFB is the 7th Bomb Wing of the ACC. The base was named in honor of Texas native and Bataan survivor Lt. Col. William Dyess.

Roundabout Landmark

Situated in the southwestern portion of the rolling plains of north central Texas, Dyess AFB is approximately 180 miles west of the Dallas-Fort Worth metroplex. Nearby communities include the cities of Albany, 35 miles northwest; Brownwood, 78 miles southeast; San Angelo, 89 miles southwest; Sweetwater, 40 miles west; Lubbock, 165 miles northwest; and Tye, bordering the base to the north. Major transportation resources surrounding Dyess AFB include U.S. Interstate 20 (I-20), running east-west; U.S. Highways 83/84 and 277, running north-south; and Abilene Regional Airport (Dyess AFB, March 2009).

The northwestern and eastern perimeters of the base are primarily bordered by residential development, with the remainder adjacent to agricultural land. Farming and ranching is the primary land use south and west of the base with significant wind energy development occurring over a 6,000-acre site on the Callahan Divide, which is about 12 miles southwest of Abilene, Texas.

B. History

Dyess AFB's current prosperity evolved from open Texas rangeland largely through the efforts of the local citizens. Prior to the mid-1800s, the area abounded in buffalo herds and Indian scouting parties. Driving cattle to market ended with the establishment of the railroad in 1881 and the area was then farmed and ranched (Dyess ICRMP, 2006).

The construction of defensive forts began in 1849. The first line of forts ran between Fort Worth and Eagle Pass. However, these proved inadequate, so a second line of forts were constructed farther west between 1850 and 1867. Of particular note is Fort Phantom Hill, which was built in 1851 approximately 14 miles north of present-day Abilene. In part, these forts also protected the Butterfield Stage Line that operated between September 1858 and February 1861 and ran to San Francisco.

In 1942, pilot training operations began during World War II at the Tye Army Airfield. The airfield was operated as an extension of the mission of Camp Barkeley, which was located several miles to the South of Abilene, and was home to more than 60,000 military personnel. The airfield was closed in 1946. From 1947 to 1952, 1,500 acres of the former airfield was used by the Texas State National Guard as a training facility, which was then eventually sold to the City of Abilene. Following the outbreak of the Korean conflict, the citizens of Abilene raised more than $750,000 to purchase 3,500 acres. In 1952, the city offered that land, along with the original 1,500 acres, to the DoD as a home for a new military base. Construction began the following year and the first unit was activated in 1955. This unique level of civilian dedication to military support continues to grow each year (Dyess ICRMP, 2006).

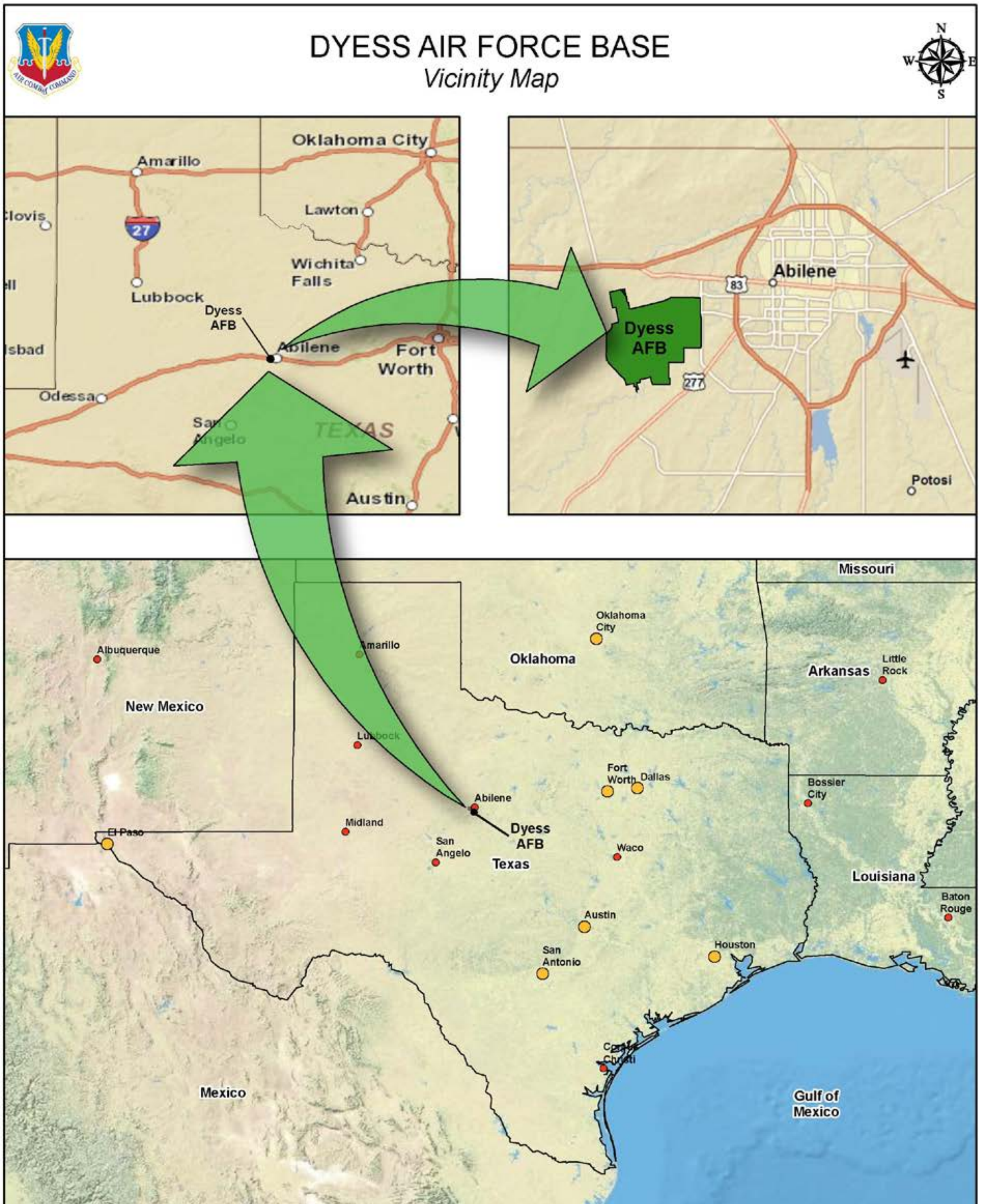

DYESS AIR FORCE BASE
Vicinity Map
Oklahoma City
Amarillo
Lawton
Wichita Falls
Lubbock
Dyess AFB
Abilene
Fort Worth
Odessa
San Angelo
TEXAS
Austin
Abilene
Dyess AFB
Potosi
Missouri
Oklahoma City
Albuquerque
Amarillo
Oklahoma
Arkansas
Little Rock
New Mexico
Lubbock
Fort Worth
Dallas
Bossier City
Abilene
Midland
Dyess AFB
El Paso
San Angelo
Texas
Waco
Louisiana
Baton Rouge
Austin
Houston
San Antonio
Mexico
Gulf of Mexico

Figure 1-1

The base is named after Lt. Col. William Edwin Dyess, a native of Albany, Texas, who was captured by the Japanese on Bataan in April 1942. Dyess escaped in April 1943 and fought with guerilla forces on Mindanao until the forces were evacuated by submarine in July 1943. During retraining in the United States, his P-38 Lightning caught fire in flight on December 22, 1943. Refusing to bail out over a populated area, he attempted to land the aircraft in a vacant lot; he died in the ensuing crash.

C. Mission

The 7th Bomb Wing's mission is to provide world-class Airmen and air power for the warfighter.

The Wing, which has two operationally ready B-1B Lancer combat squadrons, is also host to the only B-1B combat crew training squadron, all initial B-1B combat crew training, a weapons school, and a B-1 test and evaluation squadron.

The 7th Bomb Wing is a unit of the Twelfth Air Force, which is a numbered air force of the ACC. The 12th Air Force command serves as a primary conventional fighter and bomber warfighting headquarters trained and ready for worldwide employment of airpower.

1B-1B Lancer, Static Display, Dyess AFB

The primary tenant organization at Dyes AFB is the 317th Airlift Group, Air Mobility Command, which operates the C-130 aircraft in support of airlift requirements worldwide. There are numerous other associated units in both direct and indirect support of these missions. Dyess AFB maintains a close relationship with local communities and provides a substantial economic impact on the surrounding region.

D. Geography

The Base has a total area of 9.9 square miles, of which 9.8 square miles of it is land and less than 0.1 square miles of it is water.

Coordinates: 32° 25' 15" N, 99° 51' 17" W

State: Texas

County: Taylor

Elevation: 1,789 feet above mean sea level; average field elevation

Terrain: Nearly level to gently sloping

Soils: Deep noncalcareous to calcareous clay loams

E. Climate

Temperature: Average July maximum and minimum temperatures are 94.3°F (35°C) and 73°F (22°C), respectively

Average January maximum and minimum temperatures are 54°F (12°C) and 37°F (3°C), respectively

Precipitation: Average yearly rainfall is 23.5 inches (59.7 cm), average yearly snowfall being approximately 4.1 inches (10.4 cm)

Humidity: Average Annual Relative Humidity 75% (morning) and 50% (afternoon; NOAA, 2008)

Wind: Dyess Wind Power Classification is 3

WIND POWER CLASSIFICATION	WIND POWER DENSITY	WIND SPEED
3	300-400 w/m^2 @ 50m aboveground level	14.3-15.7 mph @ 50m aboveground level
Source: National Renewable Energy Laboratory, http://www.nrel.gov/gis/wind.html w/m^2 = watt per square meter, m = meter, and mph = miles per hour		

F. Demographics

As of September 2008, there were 1,914 people (including 773 active military and 1,141 dependents) residing on the base. The off-installation residing population was 8,335 people, including 5,003 dependents. The residing population density was 193 people per square mile. There were 483 military family housing units at an average density of 49 units/square mile. There are also 744 dormitory rooms with a bed total of 744 for Airmen/non-commissioned officers (Dyess AFB, 2008).

III. FINDINGS

A. Description

A set of five sustainability indicators have been established to summarize the installation's level of sustainability. The five indicators are 1) Carbon Footprint, 2) Energy Usage, 3) Water Conservation, 4) Waste Reduction, and 5) Land Utilization. These indicators have been established to consolidate the large amount of data analyzed into a few comprehensive outputs.

The findings associated with the indicators presented below are based on the population and consumption numbers presented in the following table.

POPULATION AND CONSUMPTION NUMBERS, DYESS AFB	
Base Area (acres)	6,342
Usable Building Area (SF)	4,567,214
Base Population	4,881
Military	4,105
Civilian	776
Dependent Population	6,144
2009 Energy Use[1]	
Electric Use (kWh)	68,416,000
Natural Gas (kcf)	156,750
Potable Water (Mgal)	248
2009 Mission Fuel Usage (gal)	28,164,489
Aviation Fuels	27,701,334
Diesel	30,011
Gasoline Fuel	60,560
Bio Diesel	77,066
2009 Non-Mission Fuel Usage (gal)	536,159
Diesel	106,277
Gas fuel	97,855
Bio Diesel	15,078
Ethanol/E85 Fuel	7
Municipal Solid Waste (tons)	1,804.2
Solid Waste Recycled (tons)	405
[1]Includes the base and military family housing. SF = square feet, kWh = kilowatts hour, kcf = thousand cubic feet, Mgal = million gallons, and gal = gallons	

B. Current Sustainability Indicators

Refer to the following pages for a summary of findings for the five sustainability indicators for Dyess AFB.

1. Dyess Carbon Footprint

In the context of the ISA, carbon footprint is a measure of the Carbon Dioxide (CO2) and other Greenhouse Gas (GHG) generated to produce energy that is used by the installation. Each energy source has an associated CO2/GHG value based on the source (e.g., gas, coal, solar, etc.) and the process used to convert fuels (e.g. gasoline engine, jet engine, oil furnace, etc.) to a usable form.

Total Carbon Footprint Dyess AFB is 284,210 mTons (includes Flying and Support Missions)

ACC and Dyess AFB jointly need to establish a goal for the installation's carbon footprint. Currently, based on industry benchmarks, Dyess AFB produces a smaller carbon footprint for mission support transportation and facilities and a larger one for flying mission shown on the following page.

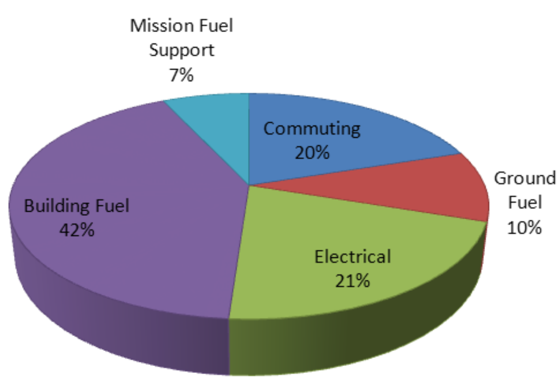
Annual Total Mission Support Carbon Footprint for Dyess AFB is 16,367 mTons

MISSION SUPPORT—Transportation[5] (No Commuting[3])

Annual Total Carbon Footprint:	3,493	mTons
Per FTE		
Baseline (2005):	(A)	mTons/FTE/year
Previous Year (2008):	(A)	mTons/FTE/year
Current Year (2009):	0.72	mTons/FTE/year
Benchmark[1]:	7.54	mTons/FTE/year
% Reduction from Baseline:	-	
% Reduction from Previous Year:	-	
Per Built SF		
Baseline (2005):	(A)	mTons/1,000 SF/year
Previous Year (2008):	(A)	mTons/1,000 SF/year
Current Year (2009):	1.05	mTons/1,000 SF/year
Benchmark[2]:	20.44	mTons/1,000 SF/year
% Reduction from Baseline:	-	
% Reduction from Previous Year:	-	

MISSION SUPPORT—Facilities[6]

Annual Total Carbon Footprint:	12,874	mTons
Per FTE		
Baseline (2003):	3.40	mTons/FTE/year
Previous Year (2008):	2.56	mTons/FTE/year
Current Year (2009):	2.64	mTons/FTE/year
Benchmark[1]:	7.54	mTons/FTE/year
% Reduction from Baseline:	22%	
% Reduction from Previous Year:	-3%	
Per Built SF		
Baseline (2003):	5.12	mTons/1,000 SF/year
Previous Year (2008):	3.75	mTons/1,000 SF/year
Current Year (2009):	3.87	mTons/1,000 SF/year
Benchmark[2]:	20.44	mTons/1,000 SF/year
% Reduction from Baseline:	25%	
% Reduction from Previous Year:	-3%	



MISSION SUPPORT CARBON FOOTPRINT[4] (INCLUDES COMMUTING[3])

[1]Per the American College and University Presidents' Climate Commitment (ACUPCC), the weighted average for college campus' carbon footprint based on 2008 reportings is 7.54 mTons/FTE.
[2]Per the American College and University Presidents' Climate Commitment (ACUPCC), the weighted average for college campus' carbon footprint based on 2008 reportings is 20.44 mTons/1,000 SF.
[3]Greenhouse gases from personal commuting (i.e., back and forth to work) is not included in the Mission Support Transportation calculation table because personal commuting is not part of the SSPP goals. However, in order to gain an understanding of the base's energy/carbon footprint from commuting it is included in the pie chart as a percentage of the Mission Support footprint.
[4]Definitions for pie chart categories can be found in IV. Glossary of Terms and Abbreviations.
[5]Mission Support—Transportation includes ground fuel and mission support fuel quantities shown in the pie chart.
[6]Mission Support—Facilities includes electrical and building fuels shown in the pie chart.
(A) = Data is incomplete.

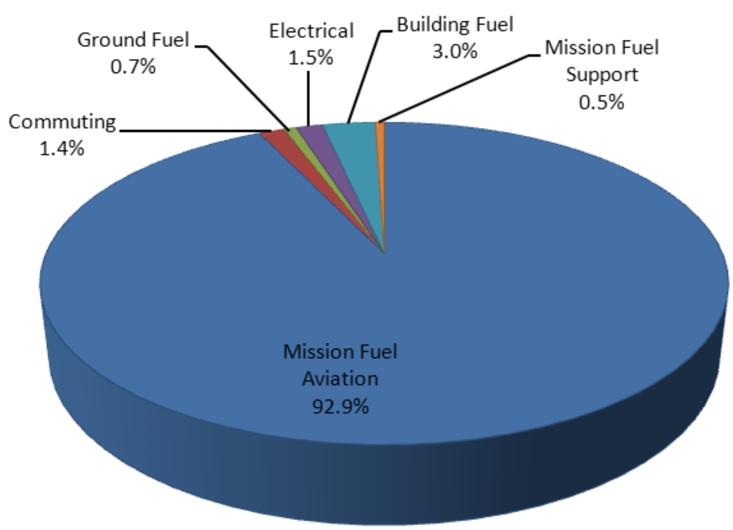
1a. Dyess Carbon Footprint—Flying Mission

Annual Total Flying Mission Carbon Footprint for Dyess AFB is 267,843 mTons

FLYING MISSION[1]

Annual Total Carbon Footprint:	267,843	mTons	
Baseline (2003):	(A)	mTons/FTE/year	**Per FTE**
Previous Year (2008):	54.09	mTons/FTE/year	
Current Year (2009):	54.87	mTons/FTE/year	
Benchmark[1]:	7.54	mTons/FTE/year	
% Reduction from Baseline:	-		
% Reduction from Previous Year:	-1%		
Baseline (2003):	(A)	mTons/1,000 SF/year	**Per Built SF**
Previous Year (2008):	79.30	mTons/1,000 SF/year	
Current Year (2009):	80.45	mTons/1,000 SF/year	
Benchmark[2]:	20.44	mTons/1,000 SF/year	
% Reduction from Baseline:	-		
% Reduction from Previous Year:	-1%		

Flying Mission, Support, and Commuting Carbon Footprint Percentages



TOTAL CARBON FOOTPRINT[4]
FLYING, SUPPORT, AND COMMUTING

- The total grassland needed to offset the total carbon footprint
  for Mission Support is 28,305 acres = 4.5 times the installation area
  for Flying Mission is 385,429 acres = 60.8 times the installation area
- The Flying Mission carbon footprint is equivalent to 74 Pentagons
  1 Pentagon = 77,015,000 cu. ft.

[1]Per the American College and University Presidents' Climate Commitment (ACUPCC), the weighted average for college campus' carbon footprint based on 2008 reportings is 7.54 mTons/FTE.
[2]Per the American College and University Presidents' Climate Commitment (ACUPCC), the weighted average for college campus' carbon footprint based on 2008 reportings is 20.44 mTons/1,000 SF.
[3]Definitions for pie chart categories can be found in IV. Glossary of Terms and Abbreviations.
(A) = Data is incomplete.

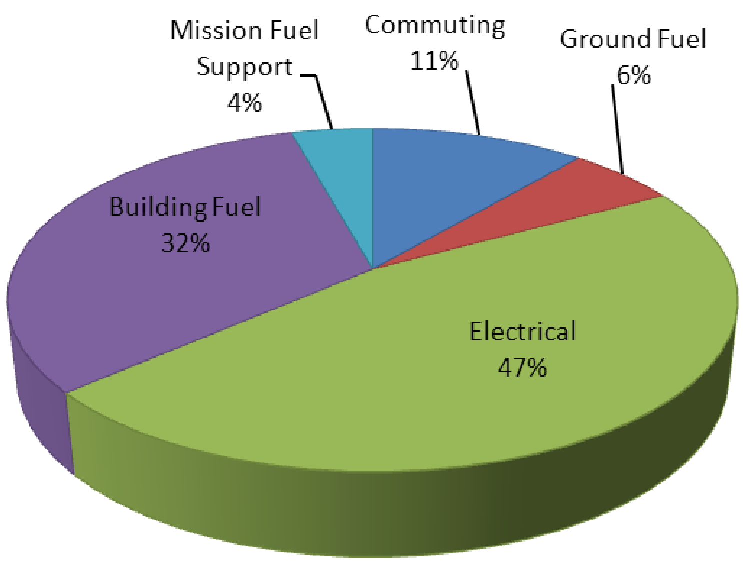
2. Dyess Energy Usage

Total Energy Usage Dyess AFB is 4,218,373 MMBTU (includes Flying and Support Missions)

ACC and Dyess AFB jointly need to establish a goal for the installation's energy intensity. Currently, based on industry benchmarks, Dyess produces a smaller energy use footprint for mission support transportation and facilities and a larger one for flying mission shown on the following page.

Annual Total Mission Support Energy Usage for Dyess AFB is 444,969 MMBTU

MISSION SUPPORT—Transportation[5] (No Commuting[3])				MISSION SUPPORT—Facilities[6]		
Annual Total Energy Usage:	50,395	MMBTU		**Annual Total Energy Usage:**	394,574	MMBTU
Baseline (2005):	(A)	MMBTU/FTE/year	Per FTE	Baseline (2003):	97.79	MMBTU/FTE/year
Previous Year (2008):	(A)	MMBTU/FTE/year		Previous Year (2008):	77.94	MMBTU/FTE/year
Current Year (2009):	10.32	MMBTU/FTE/year		Current Year (2009):	80.84	MMBTU/FTE/year
Benchmark[1]:	327.00	MMBTU/FTE/year		Benchmark[1]:	327.00	MMBTU/FTE/year
% Reduction from Baseline:	-			% Reduction from Baseline:	17%	
% Reduction from Previous Year:	-			% Reduction from Previous Year:	-4%	
Baseline (2005):	(A)	MMBTU/SF/year	Per Built SF	Baseline (2003):	0.15	MMBTU/SF/year
Previous Year (2008):	(A)	MMBTU/SF/year		Previous Year (2008):	0.11	MMBTU/SF/year
Current Year (2009):	0.02	MMBTU/SF/year		Current Year (2009):	0.12	MMBTU/SF/year
Benchmark[2]:	0.13	MMBTU/SF		Benchmark[2]:	0.13	MMBTU/SF/year
% of Energy from Renewable Source:	4.6%			% of Energy from Renewable Source:	0%	
% Reduction from Baseline:	-			% Reduction from Baseline:	20%	
% Reduction from Previous Year:	-			% Reduction from Previous Year:	-4%	



MISSION SUPPORT ENERGY USAGE[4] (INCLUDES COMMUTING[3])

[1]Per the American College and University Presidents' Climate Commitment (ACUPCC), the weighted average for college campus' carbon footprint based on 2008 reportings is 7.54 mTons/FTE.
[2]Per the American College and University Presidents' Climate Commitment (ACUPCC), the weighted average for college campus' carbon footprint based on 2008 reportings is 20.44 mTons/1,000 SF.
[3]Greenhouse gases from personal commuting (i.e., back and forth to work) is not included in the Mission Support Transportation calculation table because personal commuting is not part of the SSPP goals. However, in order to gain an understanding of the base's energy/carbon footprint from commuting it is included in the pie chart as a percentage of the Mission Support footprint.
[4]Definitions for pie chart categories can be found in IV. Glossary of Terms and Abbreviations.
[5]Mission Support—Transportation includes ground fuel and mission support fuel quantities shown in the pie chart.
[6]Mission Support—Facilities includes electrical and building fuels shown in the pie chart.
(A) = Data is incomplete.

2a. Dyess Energy Usage - Flying Mission

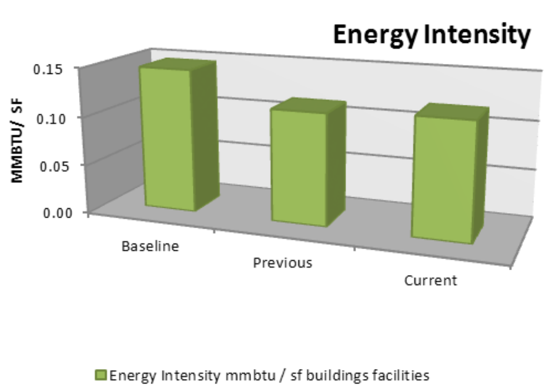
Annual Total Flying Mission Energy Usage for Dyess AFB is 3,773,404 MMBTU

FLYING MISSION

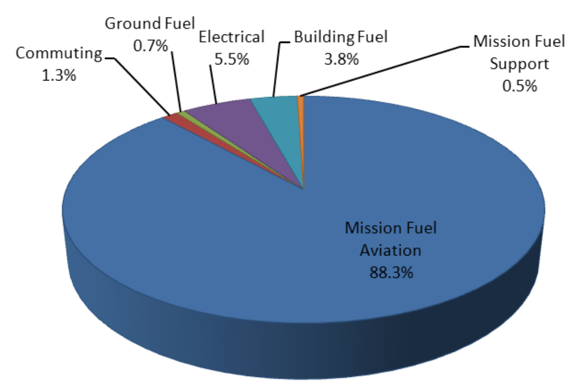
Annual Total Energy Usage:	3,773,404	MMBTU	
Baseline (2003):	(A)	MMBTU/FTE/year	Per FTE
Previous Year (2008):	761.98	MMBTU/FTE/year	
Current Year (2009):	773.08	MMBTU/FTE/year	
Benchmark[1]:	327.00	MMBTU/FTE/year	
% Reduction from Baseline:	-		
% Reduction from Previous Year:	-1%		

Baseline (2003):	(A)	MMBTU/SF/year	Per Built SF
Previous Year (2009):	1.12	MMBTU/SF/year	
Current Year (2010):	1.13	MMBTU/SF/year	
Benchmark[2]:	0.40	MMBTU/SF/year	
% Reduction from Baseline:	-		
% Reduction from Previous Year:	-1%		

Energy Intensity per Square Foot of Total Building Space



Flying Mission, Support, and Commuting Energy Usage Percentages



TOTAL ENERGY USAGE[3]
FLYING, SUPPORT, AND COMMUTING

- % of total energy from a renewable source
  for Mission Support is 2%
  for Flying Mission is 0%

[1]Per the American College and University Presidents' Climate Commitment (ACUPCC), the weighted average for college campus' carbon footprint based on 2008 reportings is 7.54 mTons/FTE.
[2]Per the American College and University Presidents' Climate Commitment (ACUPCC), the weighted average for college campus' carbon footprint based on 2008 reportings is 20.44 mTons/1,000 SF.
[3]Definitions for pie chart categories can be found in IV. Glossary of Terms and Abbreviations.
(A) = Data is incomplete.

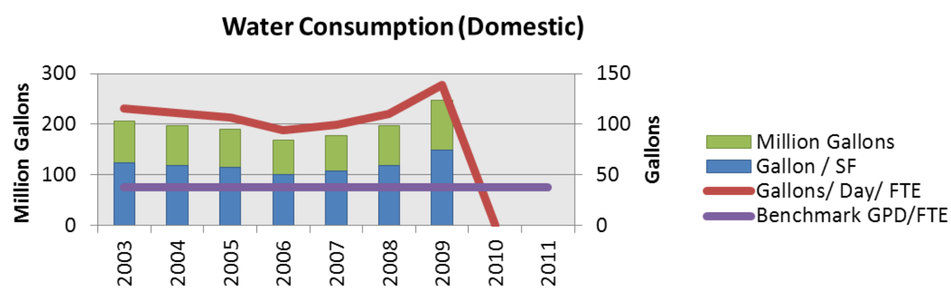
3. Dyess Water Conservation

ACC and Dyess AFB jointly need to establish a goal for the installation's water conservation. Currently, based on industry benchmarks, Dyess AFB has high water consumption per FTE.

MISSION SUPPORT

Annual Total Water Consumption:	248.30	Million Gallons	
Baseline (2007):	99.74	Gallon/FTE/day	**Per FTE**
Previous Year (2008):	110.58	Gallon/FTE/day	
Current Year (2009):	139.37	Gallon/FTE/day	
Benchmark[1]:	28-38	Gallon/FTE/day	
% Reduction from Baseline:	-28%		
% Reduction from Previous Year:	-26%		

Baseline (2007):	53.38	Gallon/SF/year	**Per Built SF**
Previous Year (2008):	59.17	Gallon/SF/year	
Current Year (2009):	74.58	Gallon/SF/year	
Benchmark[2]:	-	Gallon/SF/year	
% Reduction from Baseline:	-28%		
% Reduction from Previous Year:	-26%		



[1]Per Yudelson Associates, Benchmarking Campus Sustainability, 2010.
[2]Benchmark has yet to be established relative to an AFB. This could be established either through the initial ISA investigation or through an additional research project.

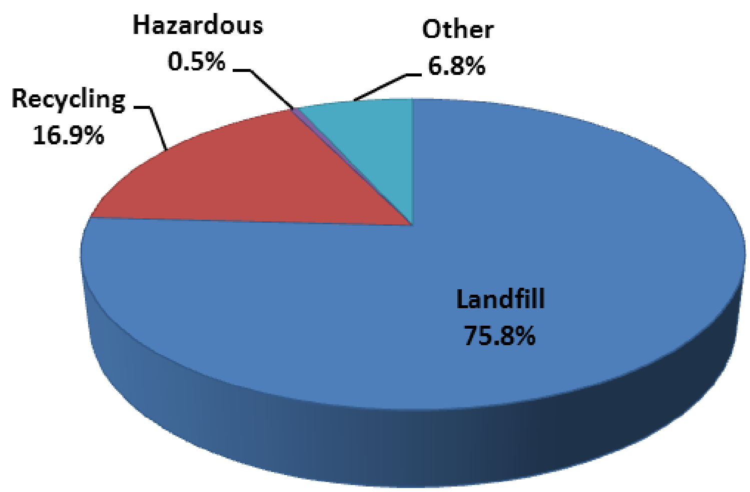
4. Dyess Waste Reduction

ACC and Dyess AFB jointly need to establish a goal for the installation's solid waste reduction. Currently, based on industry benchmarks, Dyess AFB produces a low amount of solid waste.

MISSION SUPPORT

Annual Total Waste Production:	2,393	Tons	
Current Year (2009):	2.69	LBS/FTE/day	Per FTE
Benchmark[1]:	4.62	LBS/FTE/day	

Current Year (2009):	1.44	LBS/SF/day	Per Built SF
Benchmark[2]:	-	LBS/SF/day	
% Non-Hazardous Waste Diverted from Landfill	18%		



- Total % of composted waste material
  Currently is 0%

[1]Per the USEPA Municipal Solid Waste in The United States: 2007 Facts and Figures, the annual municipal solid waste (MSW) generation rate in 1960 was just 2.68 pounds (lbs.) per person per day; it grew to 3.66 lbs. per person per day in 1980, reached 4.50 lbs. per person per day in 1990, and increased to 4.65 lbs. per person per day in 2000. Since 2000, MSW generation has remained fairly steady. The generation rate was 4.62 lbs. per person per day in 2007.
[2]Benchmark has yet to be established relative to an AFB. This could be established either through the initial ISA investigation or through an additional research project.

5. Dyess Land Utilization

ACC and Dyess AFB jointly need to establish a goal for the installation's land utilization. Currently, based on industry benchmarks, Dyess AFB building density is significant under the benchmark of 60,000 SF/acre while the amount of square footage per FTE is significantly higher than the benchmark. Additional studies and comparisons among ACC installations need to be completed to provide a weighted opinion on land utilization.

MISSION SUPPORT

Total Building Density[1]:

Current Year (2009):	4,011	SF/Acre
Benchmark[2]:	60,000	SF/Acre
Previous Year (2008):	4,011	SF/Acre
% Change from Previous Year[4]:	0%	

Total Building Utilization[5]:

Current Year (2009):	682	SF/FTE
Benchmark[3]:	160	SF/FTE
Previous Year (2008):	682	SF/FTE
% Change from Previous Year:	0%	

MISSION SUPPORT

Total % Green Space[6]:

Current Year (2009):	93%	
Benchmark[4]:	-	
Previous Year (2008):	93%	

Total % Building/Impervious[7]:

Current Year (2009):	9%	
Benchmark[4]:	-	
Previous Year (2008):	9%	

Total % Building/Footprint[8]:

Current Year (2009):	72%	
Benchmark[4]:	-	
Previous Year (2008):	72%	

- 15,800 average daily traffic at the gates = 3.24 trips per FTE
- 2.79 people per acre of Mission Support developable area

[1]Building density = ACSES real property records, building square footage/property acreage.
[2]Per the U.S. Green Building Council (USGBC) LEED-NC guidelines, development density must be equal to or greater than 60,000 SF/acre.
[3]Per building code guidelines, the average gross square foot per FTE figured at 2 times code standard is 160.
[4]Benchmark has yet to be established relative to an AFB. This could be established either through the initial ISA investigation or through an additional research project.
[5]Building Utilization = ACSES real property records, building square footage/population
[6]% Green Space = Non-Built Green area/Total Installation area.
[7]% Building-to-Impervious = ACSES real property records and Geobase, usable building square footage/impervious area.
[8]% Building-to-Footprint = ACSES real property records and Geobase, usable building square footage/building footprint area.

C. Year-to-year Sustainability Indicators

This is the initial report for Dyess AFB; therefore, year-to-year comparisons do not exist at this time. For reports in future years, comparisons will be provided for the established sustainability indicators:

1. **Carbon Footprint**
2. **Energy Usage**
3. **Water Conservation**
4. **Waste Reduction**
5. **Land Utilization**

D. Current Sustainability Initiatives

Over the years, Dyess AFB has undertaken a number of substantial initiatives that can be characterized as sustainable. To help understand future actions to be taken by the base, past actions need to be documented. The following are past actions that have been identified and undertaken by the base:

- Completed in 2003, Dyess AFB uses wastewater effluent from the city of Abilene's wastewater treatment plant to irrigate the base golf course and other landscaped areas of the base. Effluent water is delivered to the base via an old Chevron pipeline that was turned over to the city of Abilene. The water is stored in a storage pond at the northeast end of the golf course and distributed by pumping for use on the base through a raw water piping system. The base is currently using an average of 90 million gallons per year of effluent water, and more capacity is available. By paying $0.52 per thousand gallons (kGal) for effluent water, compared to $2.78/kGal for potable water, the base saves approximately $203,000 per year. Effluent water is not used for irrigation in the family housing area due to the perception of issues with human contact, although the water is safe. It is also not completely distributed throughout the base due to funding shortage for distribution line construction (Denslow, 2010).

- Dyess AFB implements a "no heat and no cool" program for non-essential buildings from 15 March to 15 May and 15 October to 1 December. This program does not include family housing (Denslow, 2010; Crosby 2010).

- The base constructed a small central ice plant (Building 6130) as a cooling system for multiple buildings. The system includes uses water cooled chillers and an ice storage system that is capable of storing 4,600 ton-hours. A pond is used for additional heat rejection in support of the cooling towers. The plant provides cooling for 13 dorms and the B-1 simulator building. The plant generates ice at night during low power costs that is used for cold water cooling during the day in the buildings served (Denslow, 2010). Effluent water from the city is used as makeup water in the ice plant. There are opportunities to connect additional facilities into the system.

- Energy efficiencies in lighting have been achieved through the replacement of fluorescent T-12 lighting with T-8 lighting across the base. Replacement of hangar lighting in buildings 5020 and 2314 with dimmable metal halide lighting that is integrated with daylight sensors to adjust lighting levels throughout the day has also achieved significant cost savings (Denslow, 2010).

- Approximately 70 percent of exterior lighting is controlled by photo cell, remainder on timers.

- Infrastructure System Replacements to Reduce Inefficiencies

1. Substantial efforts have been made towards metering and advance metering of facilities throughout the base. In addition, automated building management systems have been installed at number of buildings. Dyess has installed metering for most of the base's reimbursement facilities/commands including the hospital, sections of family housing, and commercial stores.

2. The base has made a significant effort to replace its aging water distribution network composed of cast iron, concrete, and asbestos piping that is in poor condition. The system was installed in the early to mid-1950s during the Phase I replacement of distribution system piping which involved 35,000 linear feet of water line. This phase has been completed. Phase II, which has yet to be started, will include 51,000 linear feet of distribution line. The planned looping of water distribution line during this phase will help with the drop of chlorine residuals in the water and the need for system flushing.

3. All sewer main pipes were pipe bursted or slip-lined during 2002 and 2003 in an attempt to eliminate infiltration and inflow (I&I) problems; sewer service laterals were not renovated. Since then, there have been continued I&I issues with the sanitary sewer system. An updated I&I study has been completed. It is suspected that the continued I&I issues may be a result of H_2S damaging seals at manholes (Danko, 2010).

4. There is an ongoing effort to replace natural gas mains and regulators. The replacement program is approximately 75 percent complete, with the fourth and final replacement phase to be completed in 2010. Previous gas leak detection efforts found significant leaks in the natural gas distribution system (Denslow, 2010).

- Hazardous Waste Reduction Measures

1. The base uses a centrifuge for recovery of oil and fuel from absorbents. Use of the centrifuge allows for reuse of absorbents three to four times, with the absorbents then being sold for revenue to a company that uses it for waste-to-energy fuel. The recovered oil and fuel is collected and sold at $0.35/gal as off-spec fuel and is typically used as fuel at asphalt batch plants. The base has been operating the centrifuge for about eight to 10 years (Burling, 2010).

2. Digital X-ray machines have been replacing standard X-ray machines on base to eliminate silver waste from standard machines. Not all machines have been replaced because not all Technical Orders will allow replacement (Burling, 2010).

3. Ultra-sonic cleaners are being upgraded to units that have filters, which reduces solvent waste by not having to clean out the entire tank (Burling, 2010).

4. Empty 55-gallon drums are refurbished by an outside company instead of being landfilled. This is a no-cost program for the base and the base even receives credit on the purchase of new chemicals for the refurbished drums (Burling, 2010).

5. The runway de-rubberizing program was changed two years ago from using a caustic chemical with a pH of 13.5 to clean the rubber from the runways to using a high-pressure washer. The process change results in no associated hazardous waste. Another change was the frequency of de-rubberizing; it went from a quarterly basis, whether it needed it or not, to an as-needed basis (Burling, 2010).

- A reduced mowing program was introduced in the 1990s to reduce base maintenance costs. One of the effects of the new program led to the growth of dense stands of mesquite trees that are not considered native to the region. As part of a regional effort among federal, state, and private landowners to control or minimize the negative impact of mesquite and juniper on underground water resources and rangeland, the base is actively removing areas of mesquite. The plan is to promote bunch/prairie grass habitat which will reduce fire hazards and promote groundwater infiltration (Walton 2010). Dyess AFB's restoration program aimed at reducing mesquite densities impacting grasslands has been developed following BMPs recommended by the NRCS and the Texas Cooperative Extension Service.

- A restoration and conservation effort for the riparian corridors along the Little Elm Creek diversion system was initiated in 2004 through a demonstration project developed by the U.S. Army Research and Development Center. This project has resulted in the establishment of vegetative buffer strips of native riparian over-story and mid-story species along the Little Elm Creek system. This project provides numerous long-term positive benefits to wildlife as well as improving storm water quality and ground water recharge (Walton 2010).

E. Guidance Compliance Summary and Matrix

Refer to Appendix C to review required compliance with current Federal guidance.

IV. RECOMMENDATIONS

The Dyess AFB team has already implemented many forward-thinking programs to reduce energy and potable water use and enhance the environment on base. Dyess is a showcase for some progressive practices such as ice storage and effluent reuse. The first recommendation is to "keep doing what you're doing" because the team has already achieved substantial progress and has more great ideas programmed in the funding pipeline. However, even more will be expected in the future. To name just a few of the demanding goals[2] ahead for members of the Federal government, by 2030, all new buildings will need to reduce their fossil fuel-generated energy consumption by 100 percent; by 2015, installation energy intensity (British thermal units [BTUs]/SF) must be 30 percent lower; and greenhouse gas emissions must drop by 28 percent and potable water usage must drop by 26 percent by 2020. This is not the first round of tough energy and water reduction goals faced by the Air Force and by the Dyess team, and over the last 20 years, much of the "low-hanging fruit" has been successfully picked. Our recommendations fit into the following categories:

- Encouraging implementation and/or extension of existing successful programs.
- Ideas for enhancing sustainability on base for "free" by making the most of natural solutions that mimic ecosystem services and capitalize on existing natural assets such as the sun.
- Some "high-hanging fruit" ideas for long-term, significant improvement, possibly requiring programming and investment. Small, incremental gains alone will not, in many cases, be enough to meet the extremely ambitious requirements mandated for the Federal Government.

Ultimately, the recommendation listed below should be used to develop a prioritized group of projects.

A. Carbon Footprint

Dyess AFB is presently receiving all of their purchased electricity from local utility company Electric Reliability Council of Texas. The mix of fuels providing that power is as follows: natural gas 65 percent, coal 34 percent, and nuclear and wind 1 percent.

A.1 Issue/Condition—The facility peak load across three substations has been measured at 13,526 kilowatt (kW) (with diversity included). An 11 milliwatt (mW) diesel-fired generator is operated by the base to avoid peak demand charges whenever the utility increases the rate 40 percent higher than normal. The diesel generator also ensures that the base can maintain its mission during any failure of the local power grid. While this generator reduces electricity costs and provides emergency power, each time it is used, additional Scope 1 greenhouse gases are emitted.

Recommendation—A modification to the generator burner could enable the use of 100 percent bio-diesel to eliminate this device from the carbon footprint of the installation. The base already has a bio-diesel storage system in place and some B20 biodiesel fleet vehicles.

Recommendation—Convert/acquire more bio-diesel fleet vehicles, with a preference for B100 over B20. If both the backup generator and fleet vehicles use B100 bio-diesel, bulk-purchasing of bio-diesel will allow it to be more cost effective.

[2]See Appendix C for a crosswalk of federal requirements.

A.2 Issue/Condition—A few solar panels are in use to power the base-wide Giant Voice PA system, but these do not feed back to the grid. Solar systems have not been investigated as a significant energy source due to the likelihood for hail damage in severe storms.

Recommendation—Since hail damage is a fear of base operators, continue selective use of small grid arrays of photovoltaic (PV) panels rather than large array systems. These would be less costly to repair on a panel-by-panel basis in the event that a significant hail storm creates damage. EISA §523 also calls for 30 percent of hot water demand to be solar thermal if it proves cost effective during the life cycle. If used, thermal panels using evacuated tube technology should be considered for this purpose since damaged tubes can be easily replaced without water leaks from the panels.

A.3 Issue/Condition—Efforts to decrease dependence on outside energy producers have included plans to install a 5 mW municipal solid waste incinerator facility next to the diesel generator that would generate 3 mW of power through gasification and 2 mW through heat recover to turn turbines to power the electrical grid. This effort focused on reducing utility cost and seeking independence from the electrical grid.

One of the base's ongoing efforts is to seek private development of a waste-to-energy plant within the boundaries of Dyess for the base to purchase energy. As a private development, the base would not specify the feedstock for energy.

Recommendation—These are more forward-thinking projects that can provide dividends for energy cost reductions. EOs 13423 and 13514 mandate renewable energy goals for the Federal government as a whole, and MSW incineration is considered "renewable" for purposes of compliance. EPAct 2005 §203 dictates that the facility receives double credit towards the renewable energy mandate for generating that energy on a Federal facility. In considering this project, the base must also account for its impact on other environmental and sustainability considerations such as potentially negative impacts on air quality and positive impacts on solid waste management.

A.4 Issue/Condition—The average commuting distance for Dyess AFB personnel is estimated at four miles, and traffic congestion is relatively minor. As a result, alternative modes and methods of transportation to/from the base, including ride-sharing, have never been fully embraced. One alternative is cycling. At an average of 15 mph (a reasonable speed for an inexperienced cyclist), a bicyclist can do a four-mile commute in 16 minutes, making cycling a practical alternative to driving. In addition, once on the base, the relatively small size of Dyess' administrative and industrial area makes it easy to traverse on a bike for small errands. A second alternative is ride-sharing. Ride-sharing of vehicle trips to/from base reduce the number of single-occupancy vehicles on the road, reduce the average vehicle miles traveled (VMT) on base, and reduce the use of single occupancy vehicles.

Recommendation—Create a base-wide ride-share program. Provide preferred parking (the closest spots to the building besides handicap parking) for car/vanpools. Preferred parking spots not only encourage ride sharing but also contribute to Leadership in Energy and Environmental Design (LEED) certification of buildings by possibly earning one LEED point.[3]

Recommendation—Purchase unit-owned bikes (with helmets and a lock) for use on and around the base. These bikes can be used for free by unit personnel for short distance errands within the

[3]To earn LEED Credit 4.4 "Alternative Transportation: Parking Capacity" under Option 1, a building project must fulfill two requirements: 1) size parking capacity not to exceed minimum requirements and 2) provide preferred parking for carpools and vanpools for 5 percent of the total provided parking spaces.

administrative, unaccompanied housing, and flightline areas of the base without the inconvenience of moving a car and finding a parking spot for a short trip. Installation of bike racks at main facilities on base would complement the purchase of unit-owned bikes.

Recommendation—Accommodate bike travel on main thoroughfares on base by programming key roads with a wide shoulder or bike lane. Bikeways targeting commuters would connect the gates and housing with the industrial/administrative areas and the hospital.

B. Energy Usage

Base personnel have demonstrated a "no holds barred" approach to managing energy use, resulting in many progressive programs and practices. Additional projects should be considered to build upon past success, continue existing programs, and consider new options for energy savings.

B.1 Issue/Condition—Dyess' operations staff is actively involved in energy-minimizing programs as a means to address the base carbon footprint and energy costs. Continue existing programs and expand them where practical. Examples of existing programs to continue/expand are highlighted below as recommendations.

Recommendation—Major air handlers have economizers in place to use free-cooling when air temperatures are below 55°F and cooling is required. The buildings with energy management systems (EMSs) are also using CO_2 monitors to perform demand-controlled ventilation when spaces are lightly staffed. Continue this practice on new construction and major renovation for energy savings. It also contributes to LEED credits for indoor environmental quality and energy savings.[4]

Recommendation—One of the most significant energy saving procedures in place is the "no heat and no cool" mandate for non-critical facilities (approximately 50 percent of all buildings) from 15 March to 15 May and 15 October to 1 December.

Recommendation—Lighting systems are continuously being modified to use more energy-efficient lamps and equipped with photocells and timers to minimize actual use. The runway lights are also provided with manual switching to turn the lights off during training sessions. The photocells and timers for these lights are apparently not being used at this time, since the lights are usually on all night long. New high-pressure sodium lights are planned for the flightline, some light emitting diode street lighting is being tried, and some new metal halides have been installed. The base should continue to replace lighting systems with more energy-efficient lamps and should review the set points for lighting controllers to reduce the hours that the lights are on. The base may consider a study of the night time uses of lit parking areas to determine if all parking areas require the lighting that is currently used.

Recommendation—Approximately 50 buildings are scheduled to have occupancy sensors installed in assembly areas, conference rooms, and restrooms to control lights. Continue and enhance this program.

Recommendation—Additional energy savings from electrical sources will be accrued by an existing program to replace pumps in 14 sewage lift stations with more energy-efficient models.

B.2 Issue/Condition—Reducing the installation's energy intensity (on a BTU/SF basis) and increasing use of non-fossil fuel-generated energy is a complex problem that will only be solved by looking at the base energy situation in a holistic way. The base's infrastructure and facilities systems need to be

[4]LEED Indoor Environmental Quality credit 1–Outdoor Air Delivery Monitoring, Energy, and Atmosphere Credit 1–Optimize Energy Performance.

evaluated and a resulting energy master plan and program needs to be developed, which is informed by a tremendous amount of facility, equipment, and energy usage data. An integrated energy master plan can discover base-wide energy savings on the order of 50 percent or better and identify geographically appropriate sources of renewable energy. The function of the master plan is to identify the projects that not only provide the best potential for meeting the goal of 30 percent energy savings by 2015 (EISA §431), but also show economic benefit through a life cycle cost analysis. An energy master plan goes beyond quick payback periods and individual building projects to illuminate the "high-hanging fruit" that can provide an order of magnitude improvement in energy savings across the entire installation.

Recommendation—Develop an energy master plan to discover the best alternatives to achieve EO, EISA, and EPAct mandates. An energy master plan will identify a base-wide strategy that not only decreases Dyess' carbon footprint, but does it in a manner that saves energy use and cost. Alternatives that would be studied and vetted by an energy master plan team would include:

A. Using combined heat and power plants (co-gen), burning biomass if possible and natural gas if not. The current mix of fuel used for heating on base is approximately 80 percent natural gas, 17.5 percent coal, and 2.5 percent nuclear and wind.[5] Any modification to the type of heating used should favor non-electrical power sources to reduce the Source 2 greenhouse gas (GHG) emissions caused by the local energy provider's use of coal to generate electricity.[6]

B. Constructing district heating and cooling plants.

   - District heating enables the use of co-generation plants to heat and power multiple buildings independent of local utilities. In lieu of steam distribution, a high-temperature hot water system that distributes hot water under pressure could be used to minimize construction and maintenance costs of the distribution network.

   - District cooling plants provide the most energy-efficient means to produce air conditioning and also allow more use of thermal energy storage (such as ice storage) to perform electrical peak savings. Developing chilled water overnight results in approximately seven percent savings simply due to the generation occurring during cooler hours of the day.

C. Changing over facilities using electric heat to using heat pumps or district heating. A master plan would likely recommend, at a minimum, converting electric-only systems to heat pumps in places that are both heated and air conditioned, which would also allow retrofitting to district heating in the future.

D. Replacing existing heating boilers (and hot water heaters) to 94 percent or higher condensing-type boilers in the event that district heating cannot be used.

E. Using ground source geothermal heat pump systems for future heating and cooling projects if the projects are at remote locations and cannot feasibly be placed on a district system.

F. Using variable refrigerant flow systems that can use internal space heat gains to minimize heating required for the exterior envelope of buildings as an alternative to water source heat pump systems.

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[5]Heating systems on the base consist mostly of gas fired boilers (50 percent) and resistance electric and/or electric heat pumps (50 percent), so more natural gas is used than electric energy.

[6]Dyess AFB is presently receiving all of their purchased electricity from local utility company ERCOT. The mix of fuels providing that power is natural gas 65 percent, coal 34 percent, and nuclear and wind 1 percent.

G. Recommending locations for installation of additional advanced meters for electricity and gas to enable individual users to monitor their energy use. Real-time energy use displayed in each facility can result in significant savings since users take charge of their own habits.

H. Installing a comprehensive facility-based EMS that allows trained operations staff to monitor and modify energy use continuously.[7]

B.3 Issue/Condition—Air conditioning systems are mostly air cooled, serving individual buildings. The installation has recorded as much as 1,000 lbs. of refrigerant lost annually from these units. Not only is the low efficiency of these units creating a greater carbon footprint than if water-cooled equipment were in use, but also the loss of refrigerant is increasing greenhouse gas emissions.

Recommendation—Water-cooled systems for larger facilities will save considerable electrical energy and decrease the amount of refrigerant lost from air conditioning equipment. A large central chiller facility providing chilled water to districts of the base can provide even more significant savings in energy and greenhouse gas emissions. The large distribution system acts as a thermal reservoir (the "flywheel" effect) that a diverse group of buildings use, and a central plant is more efficient in aggregate and easier to maintain than many smaller air conditioning units.

B.4 Issue/Condition—A small central plant (Building 6130) for multiple buildings uses water-cooled chillers and an ice storage system that is capable of storing 4,600 ton hours of cooling capacity. A pond is used for additional heat rejection in support of the cooling towers. Another ice storage facility has been considered.

Recommendation—Ice storage and a central plant should be considered for other locations on the base, with the potential for creating a district cooling system for as many clustered buildings as possible. The more buildings attached to a chilled water loop, the more benefits from the thermal storage system, and the lower the electrical usage of the base during peak loads as well as all season long.

B.5 Issue/Condition—Domestic hot water heating is provided almost exclusively by gas-fired equipment. Some of this equipment may be operating at efficiencies as low as 50 percent, depending on condition and age. Most equipment was initially rated for 80 percent efficiency when new.

Recommendation—If solar is not used due to concerns about hail damage and a distributed heating system is not available, a program to replace old standard hot water heaters with newer condensing type gas-fired heaters rated for 94 percent or better efficiencies should be considered. Hot water heat pumps are also a potential efficiency improvement.

B.6 Issue/Condition—The local electric utility is charging the base on a 15-minute interval time-of-day rate. The three substations are providing power factor kW and kilowatt-hour (kWh) data at 15-minute intervals to enable operators to coordinate energy demand with varying rates.

- Advanced metering and a control management system are installed in buildings larger than 35,000 SF); however, there is no consolidated EMS in place.
- Some sub-metering is in place: at the hospital, a section of family housing (as a whole), and at the stores to allow for reimbursements. A mix of building control systems involving Siemens Apogee, Johnson Invensys, and various LON-based systems are in use at the larger buildings.

[7]An energy master plan would also include LCCA to determine if the cost of additional operating staff would be off-set by energy savings and reduced HVAC calls.

- The standard thermostat setpoints directed for all spaces is 68° Fahrenheit (F) heating and 78°F cooling; however, these setpoints are not always able to be controlled by operations since many of the systems are not part of a base-wide EMS.

It is imperative that base Energy Managers have the ability to assess the instantaneous level of power that is being consumed, as well as the major users of that power, at any given time to coordinate the operations of the physical plant in the most advantageous manner to minimize energy use and energy costs.

Recommendation—Install advanced metering and control systems that are building automation and control networks (BACnet) compatible (i.e. open protocol). Retrofit existing non-compatible systems to be BACnet compatible. Develop a base-wide process for operating and maintaining HVAC systems and lighting systems using proactive control logic.

Recommendation—Additional buildings that should be monitored are the ones that are suspected of being the most energy intensive. An audit of facilities is suggested to determine the best candidates for additional metering, which could be a part of an energy master planning effort.

B.7 Issue/Condition—Dyess AFB uses the ACC Sustainable Development and High Performance Green Building Design (SD&HPGBD) Scorecard as its green building self-assessment metric. The scorecard assembles and consolidates EOs, Public Laws, and Federal Agency rulemaking on SD&HPGBD requirements with the LEED Rating System. Using the scorecard is a way to achieve the desired LEED rating and meet critical statutory minimum requirements.

When applied in context, the scorecard rating system can illuminate opportunities for sustainable design, often with low- or no-cost choices. Some choices carry an upfront cost but provide long-term operational cost savings, and are value-added building features. Starting with programming, the base can direct the design and construction of the building to achieve certain LEED and other federal requirements that base level engineers deem to add the most value and advance the base towards their specific sustainability goals. Without direction otherwise, contractors often choose to satisfy requirements based on upfront cost alone.

Recommendation—Use the ACC scorecard requirements to guide and inform building projects towards lower life-cycle costs and enhanced sustainability.

Recommendation—Train the programming staff and design/engineering staff in the LEED Rating System and scorecard application.[8] A scorecard checklist must be completed for military construction projects, and can also be completed for Sustainment, Restoration, and Modernization building projects to inform their design. The checklist outlines a strategy that will inform all other stages of building design, so it is critical that base-level programmers understand LEED and the application of the scorecard; how it supports broader energy, water, and sustainability goals; and how to choose appropriate points for building projects.

Recommendation—Enhanced commissioning is a scorecard credit which carries an upfront cost to implement, but provides value to the installation in reducing long-term energy and maintenance costs.[9] As building energy systems become more advanced to meet higher levels of energy efficiency, commissioning becomes even more critical to assure those energy systems function as intended. We

[8]AFIT's Civil Engineer School offers a one-week course in LEED, for example.
[9]"The Cost-Effectiveness of Commercial Building Commissioning," by Lawrence Berkeley National Laboratory (LBNL), Dec 15, 2004.

recommend enhanced commissioning because of the rapid payback period and long-term operational cost savings.

Recommendation—Choose roofing material and color to earn scorecard credits. For low slope roofs (≤2:12), the roof surface must have a Solar Reflectivity Index (SRI) of 79 or greater, and for steep slope roofs (>2:12) an SRI of 29 or greater is required.

Recommendation—When siting a building and developing early schematic design, maximize the shape and orientation of the building with respect to the sun for passive solar heating, cooling, and daylighting. This will maximize the energy performance the building achieves "for free" as a result of the sun and will help earn points in several categories.

Recommendation—Site buildings such that occupants can walk or bike to adjacent services and amenities instead of driving, ideally embodying the LEED concept of "Community Connectivity"[10] Include safe pedestrian and bike ways in base development plans.

Recommendation—Set aside 5 percent of parking for car/vanpools and 5 percent for low-emitting vehicles in preferred locations near building entrances. This embodies the LEED concept[11] and encourages alternative transportation.

Recommendation—Maximize water use reduction in all new buildings. By choosing plumbing fixtures that use less water than the fixture requirements passed in the EPAct of 1992, projects can earn scorecard points[12] and will also assist the base in achieving the potable water reduction goal of 26 percent reduction by 2020 compared to a 2007 baseline.[13]

C. Water Conservation

The Dyess AFB team has already implemented significant water conservation measures at the base. The Dyess team has retrofitted many existing water fixtures in base facilities with low-flow and automatic (low use) fixtures. The majority of potable water irrigation on the base has been replaced by reuse of effluent water from the city of Abilene, a project that required coordination between the city and Chevron for turnover of an old pipeline to deliver water to the base from the city's wastewater treatment plant. In the case of water conservation, much of the "low-hanging fruit"–the projects that are easily executed because they have a justifiable life cycle cost or even a return on investment–has been completed.

C.1 Issue/Condition—Potable water reduction strategies (effluent water for most irrigation, low-flow, and sensored fixtures) have been executed prior to FY07, which is the EO 13514 benchmark for a 26 percent reduction of potable water use. Current strategies for achieving the new reduction requirements are not likely to present a significant return on investment.

Recommendation—Continue and expand upon the implementation of low-flow water fixtures and automated faucets in base facilities to the maximum extent feasible. Although the program has been fairly exhausted on the base, it is important to continue to promote the installation of low-flow water

[10]Sustainable Site Credit 2.
[11]Sustainable Site Credits 4.3 and 4.4.
[12]Water Efficiency Credits 3.1 and 3.2 and Innovation and Design Credit 1 are all achievable by achieving gradually higher water efficiency. Under LEED NC v2.2 a maximum of three points can be earned by reducing water use by 40%. Under LEED NC v3, a maximum of five points can be earned with 45% water use reduction.
[13]Executive Order 13514 §2(d)(i).

fixtures. The program can be further expanded by implementing the use of effluent water for toilet flushing and other non-potable water uses in new construction on the base, as acceptable to local plumbing code.

Recommendation—Educate personnel and dependents at the base on the importance of reducing water use and the effects that excessive water use has on the environment. In particular, education on proper irrigation techniques for personnel using potable water irrigation in the family housing area can have a significant impact on reducing potable water use. Educate personnel and dependents on the source of the goals, the extent of the goals, and emphasize command support (Commander-in-Chief and HQ ACC) established for water use reduction so they are aware of the challenge and can have buy-in to the goals.

Recommendation—Expand the use of effluent water for irrigation to all irrigation on the base. Consider drip irrigation systems for family housing if necessary to get past the stigma of effluent reuse. The base needs to determine/estimate the amount of potable water still used for irrigation, by area, to execute life-cycle cost analysis of projects to replace the potable water system with effluent water systems. Industrial areas still irrigated with potable water should also consider xeriscaping techniques.

Recommendation—Because a significant portion of the on-base family housing was under construction during FY07, the facility energy manager should pursue evaluation of the reduction goal based on adjusted 2007 baseline that considers a "per housing unit" rate of consumption. The total consumption of potable water by the family housing area in FY07 is recorded as 20.545 MGAL and records show that there were only 270 housing units in FY07 for a per housing unit rate of 0.077 MGAL per unit. The base housing construction project completed a total of 674 housing units, which would provide an adjusted total for family housing of 51.286 MGAL per year. The addition to the recorded FY07 base consumption of 157.111 MGAL would provide an adjusted total of 208.397 MGAL for the adjusted 2007 baseline.

C.2 Issue/Condition—Potable water use on base is not sufficiently metered to be able to identify and target high use activities and areas. Currently, only 12 water sub-meters are used on the base at facilities for which sub-invoicing must be performed. Potable water is used for irrigation in the family housing area and along the flightline, for washing of planes, and for filling fire suppression tanks that are not maintained in potable water conditions. Because these uses are not sub-metered, insufficient data exists for comparing life-cycle costs of new systems to use effluent water to current potable water use costs.

Recommendation—Install additional water sub-meters at locations upstream of industrial area irrigation and washing facilities using potable water. In the family housing area, where sub-meters on each irrigation system would not be practical, conduct a survey of irrigation timers to determine an estimated use of potable water irrigation in the family housing area.

Recommendation—Test the quality of the effluent water with the goal of revising the current Technical Orders (TO) for plane washing and filling of fire suppression tanks. Testing to show the effluent water does not have corrosive characteristics or other contaminants may be necessary before TOs will be revised for plane washing.

Recommendation—Change all potable water irrigation along the flightline and in the family housing areas to effluent irrigation. If after educating the residents of family housing on the safety of the using effluent water for irrigation, there are still safety concerns, the irrigation systems can be installed as drip irrigation systems, which have minimal potential for direct contact with the effluent water.

Recommendation—Air conditioning condensate from air-handling units could be used for water-cooled air conditioning systems. Combining multiple unit drains into storage tanks and pumping the water to cooling towers for make-up water can provide a significant amount of water. This especially applies to hospital units due to the high percentage of outside air used in these facilities.

C.3 Issue/Condition—Low chlorine levels in potable water coming onto the base require dosing to keep levels within regulated limits. Reduction of water use on the base has increased the detention time of the treated water in the distribution system, which further lowers chlorine levels to the point of requiring regular flushing of the system to waste the stagnated potable water.

Recommendation—Model the existing water distribution system. Model should consider existing water use and future water use meeting the 26 percent reduction requirement with current chlorine levels. The water model should determine looping and size reductions to minimize stagnation of water in the water distribution system so that as the existing water main is replaced, the system performance can be maximized. The model should also quantify the amount of water disposed through the automated flushers to support life-cycle cost analysis for future projects.

C.4 Issue/Condition—Due to a previous event in which a fuel line leak discharged to storm drainage and eventually into the surface waters in the channel running off of the base, current practice at the base is to divert all storm water runoff from the airfield to the sanitary sewer system to guarantee zero discharge of jet fuel to the storm water channel. Diverted water flows through the lift station(s) along the flightline, which require a currently unquantifiable use and cost of power to pump storm water runoff that is normally not significantly polluted. The diverted storm water is discharged to the sanitary sewer system, where the city of Abilene has an additional use and cost of power to provide treatment for the storm water that could be discharged to existing storm water channels.

Recommendation—Perform a study of the need for the current practice of discharging storm water runoff to the sanitary sewer system. Study of the practice should quantify the volume of runoff discharged through the sanitary sewer system, the cost to pump the runoff through the on-base lift station, and the costs to the city of Abilene wastewater system to convey and treat the storm water runoff. The study should identify practices for automated detection of fuel line leaks or excessive pollutants in the storm water runoff and automated detention or diversion of storm water runoff. The study should further examine and plan for structural practices to provide treatment of storm water runoff with normal levels of pollutants for pavement runoff, such as sediments and small amounts of hydrocarbons and heavy metals. Structural practices could include hydrodynamic filtration devices or constructed wetlands in the channels downstream of the airfield. The restored riparian corridor in the main channel on base should be considered as providing treatment to 'normal' storm water discharge. Modification of existing channels to provide a necessary volume could be considered for retention of excessively polluted runoff so that it can be treated. All costs, including costs to the city of Abilene, of the current practice to pump and treat all storm water runoff from the airfield should be considered in performing a life-cycle cost analysis for improvements necessary to provide treatment of normal runoff and a system to retain/divert excessively polluted storm water.

C.5 Issue/Condition—The base sanitary sewer system experiences a significant amount, estimated at 10.2 Mgal per year, of storm water and ground water I&I. Inflow of storm water is approaching ACC standards for "excessive" inflow and infiltration of ground water already does exceed the standards for "excessive" infiltration. I&I can present a serious environmental concern when they cause a sanitary sewer system to surcharge and discharge to surface waters. In addition, both the base and the city of Abilene have additional use and cost of power to provide transport/treatment for I&I.

Recommendation—Implement the recommendations of the Sanitary Sewer I&I Evaluation and Rehabilitation Plan previously prepared by URS in June 2009 to reduce the I&I in the sanitary sewer system and therein the potential of citation for overflow.

Recommendation—Continue upgrades to on-base lift stations presented in the Wastewater and Storm Water System Evaluation prepared in 2006 for updates to on-base lift stations. New pumps and new station controllers, if properly designed, will improve the pumping efficiency of the lift stations. Stations not yet upgraded should be re-evaluated to determine if a reduction in station capacity is feasible by removing storm water runoff from the air field. Life-cycle cost savings for reducing station capacity should be considered for evaluation of the storm water runoff retention system.

D. Waste Reduction

D.1 Issue/Condition—The Dyess AFB recycling program started in 1992 when the base received funding to build a recycling center and purchase equipment to sort and manage materials. At its peak, the program included on-base sorting of materials and a 9-month storage capacity to time commodity markets. The expiration of the combined MSW and recycling service contract coincided with the release of new Air Force policy mandating that qualified recycling programs (QRP) be financially self-supporting. At that time, a new refuse contract was negotiated using a prescriptive, less stringent ACC-wide contract template. The new MSW and recycling contract is performance based for refuse, and only requires the minimum recycling necessary to meet EO mandates. Since the initiation of the new contract, on-base sorting of materials has shut down and the diversion rate has fallen from 74 percent to 5 percent. Unfortunately, due to relatively inexpensive tipping fees for MSW (~$20/ton), and a lack of local markets for recycled goods, it is cheaper to landfill materials than to recycle them.

Recommendation—Should funding become available to revive the once award-winning recycling program, base personnel need the ability to write a unique statement of work which addresses the recycling market in west Texas next time the refuse contract is competed. Past experience holds that having a contractor sort materials was more cost effective and assured better quality in the materials going to market than having government personnel sort and collect materials all over the base. Under current policy, the wing commander would have to fund the program internally, and it cannot compete for funds against other mission-related requirements.

D.2 Issue/Condition—Construction teams executing new construction or major renovation projects must divert at least 50 percent of construction and demolition debris away from the landfill via recycling or reuse, regardless of contracting vehicle (USACE, SABER, AFCEE, etc.).[14] Some but not all contractors are complying with this requirement and/or providing reporting of diversion.

Recommendation—Require all projects teams, regardless of funding source or execution agency, to divert 60 percent of construction and demolition debris away from the landfill. This will meet the requirement found and the newly published DoD Strategic Sustainability Performance Plan, 2010, and will earn LEED Materials and Resources credit 2.1 "Construction Waste Management-Divert 50 percent

[14]Required by Guiding Principles for Federal Leadership in High Performance and Sustainable Building Memorandum of Understanding and EO 13514.

from Disposal." ACC command level guidance will also identify 60 percent diversion as a requirement. Another possibility is to write performance-based contracts that encourage teams to achieve 75 percent or higher levels of waste diversion in support of LEED MR Credit 2.2.

E. Land Utilization

E.1 Issue/Condition—There is approximately 160 acres of vehicle parking area on the base. Anecdotal evidence suggests there are a number of parking areas that are underutilized. Parking areas are a source of power usage for lighting, storm water runoff, and heat and they contribute to maintenance costs.

Recommendation—Undertake a parking area analysis to determine the need for the current amount of parking area within an overall goal to reduce the parking area that will, in turn, reduce resource demand.

E.2 Issue/Condition—By 2030, all new buildings will need to reduce their fossil fuel-generated energy consumption by 100 percent, with intermediate goals in the intervening years (i.e., 50 percent by 2010). The Air Force is also required to reduce its energy intensity (BTUs/SF) by 30 percent by 2015, and to reduce greenhouse gas emissions by 28 percent by 2020. Enacting such dramatic improvement in energy efficiency without dramatic construction cost increases will require taking maximum advantage of "free" energy savings. Passive solar design of buildings can reduce a building's energy demand by as much as 30 percent, at essentially no cost. Dyess cannot afford to develop new buildings without maximizing solar orientation for energy savings.

Recommendation—Maximize solar orientation through land development planning. All future area development plans (ADP) in areas without an established road system must be laid out and new buildings oriented, such that solar heat gains/losses are optimized. This is generally with the long axis of buildings east-west and solar exposures to the north and south. The layout of new streets in an ADP often dictates the future orientation of buildings toward the street and as such, aligning the street grid according to the sun is critical. Aligning streets and buildings on an east-west axis will serve the dual purpose of also optimizing those buildings to host rooftops solar panels, should such an opportunity arise. To assure compliance, any ADP or building not designed to optimize passive solar gains should require permission/review from a higher level of authority.

E.3 Issue/Condition—Dyess AFB uses the ACC SD&HPGBD Scorecard as its green building self-assessment metric. Use of the scorecard can illuminate opportunities for sustainable development, often with low- or no-cost choices. One opportunity is called "Community Connectivity," which rewards development within a half-mile radius[15] of at least 10 community amenities (restaurants, library, shopping, churches, etc.) and high-density housing, such as dormitories or apartments. There must also be pedestrian access between the amenities, housing, and the building to earn scorecard credit. Dyess AFB can apply this metric to future developments and ADPs to see if a plan encourages mixed-use development and connectivity and will enhance the walkability and bikeability of Dyess. Developing towards improved connectivity will have many "free" benefits such as reduced VMT on base, reduced associated greenhouse gas emissions, improved fitness for those who chose to walk/bike.

Recommendation—Develop, track, and improve over time a community connectivity metric for the installation. Measure the diversity of services/uses within an area with a half-mile radius around future

[15]A half-mile radius was chosen because it is the distance a typical person is willing to walk instead of drive. It equates to roughly a five-minute walk.

development and use the metric to highlight and encourage mixed-use development. This practice will help achieve "free" but meaningful scorecard points.

E.4 Issue/Condition—Dyess AFB has a laudable Natural Resource Management program that contributes to the health of the base for both humans and the natural ecosystem. Continue and enhance efforts within that program to reduce the heat island effect on the base, provide energy savings, and restore habitat and maintain water quality. Restore ecosystem services to enhance both human and natural habitat.

Recommendation—Plant trees in the administrative, unaccompanied housing and industrial area of Dyess AFB. A suggested goal is to become a Tree City USA through the Arbor Day Foundation. Tree planting should be part of the Complete Streets program for the administrative and community center of the installation. Plant trees strategically to shade buildings, thereby reducing heat load and energy costs; reduce the heat island effect of dark pavements and hardscapes; shade walk/bike ways connecting key services and buildings; and enhance habitat by choosing native/indigenous tree species

Recommendation—Continue ongoing efforts to replace mesquite with bunch/prairie lands because of the substantial benefits of groundwater infiltration and reduced storm water runoff. A suggested sustainability metric could be to track the percent of base land covered by mesquite and the percent restored to healthy prairie and create a restoration goal. Continue to restore riparian habitat along watercourses to support populations of the Texas Horn Lizard (state threatened species). To encourage human interaction with nature, plan a restoration area that can also provide recreation outlets for base personnel, such as combining a riparian corridor with a bikeway/trail.

V. GLOSSARY OF TERMS AND ABBREVIATIONS

Term	Definition
Alternative work schedule	Work schedules that do not follow the traditional format of an 8-hour day Monday through Friday; alternatively compress the 40 hour work week into fewer days or allow staff to work remotely.
Aviation fuel	All special grades of gasoline for use in aviation reciprocating engines, as given in the American Society for Testing and Materials (ASTM) specification D 910. Includes all refinery products within the gasoline range that are to be marketed straight or in blends as aviation gasoline without further processing (any refinery operation except mechanical blending). Also included are finished components in the gasoline range, which will be used for blending or compounding into aviation gasoline.
Baseline	A standard reference case or condition used as a basis for comparison. Establishing a clearly defined baseline is important and defining a repeatable baseline is essential if the work is to be compared to results of other work.
Baseline year	The year in which the baseline was established.
Benchmark	A standardized problem or test case that serves as a basis for evaluation or comparison. The terms benchmark and baseline are often used interchangeably. Consistent and repeatable benchmarking requires clearly defined performance metrics and protocols for developing the reference case to serve as the baseline.
Buildable area	Land use classification areas including administration, aircraft operations and maintenance, community commercial, community service, manufacturing and production, and medical/dental.
Building Fuel	Includes gas, oil, and liquid propane gas used for buildings.
CO_2 equivalent	A metric measure used to compare the emissions from various greenhouse gases based upon their global warming potential (GWP). CO_2 equivalents are commonly expressed as “million metric tons of CO_2 equivalents (MMTCDE).” The CO_2 equivalent for a gas is derived by multiplying the tons of the gas by the associated GWP. (MMTCDE = (million metric tons of a gas) * (GWP of the gas))
CO_2 equivalent (CO_2e)	A measure for describing how much global warming a given type and amount of greenhouse gas may cause, using the functionally equivalent amount or concentration of CO_2 as the reference. For a given mixture and amount of greenhouse gas, the amount of CO_2 that would have the same GWP, when measured over a specified timescale (generally, 100 years).
Carbon equivalent	A metric measure used to compare the emissions of different greenhouse gases based upon their GWP. Greenhouse gas emissions in the U.S. are most commonly expressed as “million metric tons of carbon equivalents” (MMTCE). GWPs are used to convert greenhouse gases to CO_2e–they can be converted to carbon equivalents by multiplying by 12/44 (the ratio of the molecular weight of carbon to CO_2). The formula for carbon equivalents is: MMTCE = (million metric tons of a gas) * (GWP of the gas) * (12/44)
Carbon footprint	The total set of GHG emissions caused directly and indirectly by an individual, organization, event or product.
Climate Registry	A nonprofit collaboration between North American states, provinces, territories, and Native Sovereign Nations to record and track the greenhouse gas emissions of businesses, municipalities and other organizations. Data submitted to the Climate Registry is inputted into the Climate Registry Information System (CRIS), which was developed on EPA’s CRAVe-EATS platform.
Commuting	Calculated based on average commuting distance of base FTE using a mix of passenger car and light trucks used for commuting. A typical fuel MPG is calculated for each and summed to calculate the total gallons of fuel used for commuting.
Current year	The FY in progress.

Term	Definition
Design guideline	A set of rules and strategies to help building designers meet certain performance criteria such as energy efficiency or sustainability.
Electrical	Electricity usage entered is for the KWH used by the base annually. Note that the relationship between energy intensity and carbon footprint varies based on the mix of coal, natural gas, diesel, fuel oil, nuclear, wind, solar, and hydro electric energy production within the eGRID region.
Energy	The capacity for doing work as measured by the capability of doing work (potential energy) or the conversion of this capability to motion (kinetic energy). Energy has several forms, some of which are easily convertible and can be changed to another form useful for work. Most of the world's convertible energy comes from fossil fuels that are burned to produce heat that is then used as a transfer medium to mechanical or other means in order to accomplish tasks. In the United States, electrical energy is often measured in kWh, while heat energy is often measured in BTUs.
Energy efficiency	Using less energy to provide the same level of energy service. Also referred to as efficient energy use and is achieved primarily by means of a more efficient technology or process rather than by changes in individual behavior.
Energy intensity	Ratio between the consumption of energy to a given quantity of output; usually refers to the amount of primary or final energy consumed per unit of gross domestic product.
Energy recovery	Includes any technique or method of minimizing the input of energy to an overall system by the exchange of energy from one sub-system of the overall system with another. The energy can be in any form in either subsystem, but most energy recovery systems exchange thermal energy in either sensible or latent form.
Energy Star	An international standard for energy efficient consumer products. Devices carrying the Energy Star logo, such as computer products and peripherals, kitchen appliances, buildings and other products, save 20%-30% on average.
Fiscal Year (FY)	The period used for calculating the annual ("yearly") sustainability indicators. The U.S. government's FY begins on October 1 of the previous calendar year and ends on September 30 of the year with which it is numbered. For example, FY for 2008 is written as "FY08" or as "FY07–08."
Fleet	Two or more vehicles.
Flying Mission	Includes anything that directly effects or has direct participation in flight or deployment operations.
Footprint	The outline of the total area of a lot or site that is surrounded by the exterior walls of a building or portion of a building, exclusive of courtyards. In the absence of surrounding exterior walls, the building footprint shall be the area under the horizontal projection of the roof.
Full-time Equivalent (FTE)	In the U.S. Federal government, FTE is defined by the Government Accountability Office (GAO) as the number of total hours worked divided by the maximum number of compensable hours in a work year as defined by law. For example, if the work year is defined as 2,080 hours, then one worker occupying a paid full time job all year would consume one FTE. Two employees working for 1,040 hours each would consume one FTE between the two of them.
General aviation	That portion of civil aviation, which encompasses all facets of aviation except air carriers. It includes any air taxis, commuter air carriers, and air travel clubs, which do not hold Certificates of Public Convenience and Necessity.
Geographical Information System	An information system that integrates, stores, edits, analyzes, manages, shares, and displays geographic information that is linked to a specific location.
Grassland	Terrestrial ecosystem (biome) found in regions where moderate annual average precipitation (25 to 76 centimeters or 10 to 30 inches) is enough to support the growth of grass and small plants but not enough to support large stands of trees.

Term	Definition
Green space	A land use planning and conservation term used to describe protected areas of undeveloped landscape. Also known as open space.
Greenhouse effect	The effect produced as greenhouse gases allow incoming solar radiation to pass through the Earth's atmosphere, but prevent part of the outgoing infrared radiation from the Earth's surface and lower atmosphere from escaping into outer space. This process occurs naturally and has kept the Earth's temperature about 59˚F warmer than it would otherwise be. Current life on Earth could not be sustained without the natural greenhouse effect.
Ground Fuel	Ground Fuel is considered the total of all government vehicle fuel used outside flightline fuel use.
Incentive program	A formal scheme used to promote or encourage specific actions or behavior by a specific group of people during a defined period of time.
Indicator	A parameter, or a value derived from a set of parameters, that points to, provides information about, or describes the state of a phenomenon. It has significance beyond that directly associated with the parameter value. Indicators are one of many tools for simplifying, quantifying, and communicating vast amounts of information in ways that are more easily understood. They are also useful for alerting us to what areas that need more attention, as well as areas that see improvement.
Industrial sector	Construction, manufacturing, agricultural and mining establishments.
Installation	A facility directly owned and operated by or one of its branches that shelters military equipment and personnel and facilitates training and operations.
Land classification	The analysis of land according to its use. Land classifications include agricultural, industrial, recreational, and residential.
Land use	The human modification of natural environment or wilderness into built environment such as fields, pastures, and settlements.
Land use planning	The term used for a branch of public policy which encompasses various disciplines which seek to order and regulate the use of land in an efficient and ethical way.
Leadership in Energy and Environmental Design (LEED)	Green Building Rating System, developed by the USGBC, provides a suite of standards for environmentally sustainable construction.
Lumen	A measure of the perceived power of light.
Meter	Metering devices used on utility mains for electricity, water and gas.
Metric	Any measurable quantity. A performance metric is a metric of some performance characteristic; however, not all metrics are performance metrics. For example, area is a metric, but it is not a performance metric.
Metric ton	Common international measurement for the quantity of greenhouse gas emissions. A metric ton is equal to 2205 lbs. or 1.1 short tons. See short ton.
Military	Any property or aspect of a military.
Mission Fuel	This includes aviation fuel only. That is, the fuel needed for the aircraft to fly.
Mission Support	Includes all other activities on the installation that do not directly affect flight and deployment operations.
Mission Support Fuel	This fuel is used for vehicles working on the flightline. It does not include fuel used for aircraft.
Offset	An agent, element, or thing that balances, counteracts, or compensates for something else.
Performance goal	A specific statement of a desired level of achievement. Performance goals must be measurable and definite such that progress can be evaluated. Performance metrics should be carefully chosen to measure progress toward performance goals.

Term	Definition
Performance indicator	A high-level performance metric that is used to simplify complex information and point to the general state or trends of a phenomenon. Performance indicators are used to communicate general trends and are often used on a program planning level to show progress toward goals. See the definition of indicator for more discussion.
Performance metric	A measurable quantity that indicates some aspect of performance. Performance metrics should measure and communicate progress toward achieving performance goals. There are different levels of performance metrics.
Performance objective	A general statement of a desired achievement.
Population density	A measurement of population per unit area or unit volume.
Potential energy	Energy stored within a physical system that has the potential to be converted into other forms of energy, such as kinetic energy, and to do work in the process. The standard unit of measure for potential energy is the joule, the same as for work or energy in general.
Power generation	The process of creating electricity from other forms of energy. Also known as electricity generation.
Previous year	12-month period prior to the current year.
Procedure	A standard method or set of methods for determining one or more performance metrics.
Procurement	The acquisition of goods and/or services at the best possible total cost of ownership, in the right quality and quantity, at the right time, in the right place and from the right source for the direct benefit or use of corporations, individuals, or even governments, generally via a contract. Simple procurement may involve nothing more than repeat purchasing. Complex procurement could involve finding long term partners or even 'co-destiny' suppliers that might fundamentally commit one organization to another.
Renewable energy	Energy obtained from sources that are essentially inexhaustible, unlike, for example, the fossil fuels, of which there is a finite supply. Renewable sources of energy include wood, waste, geothermal, wind, PV, and solar thermal energy. See hydropower, PV.
Residential sector	An area or portion consisting only of housing units.
Transportation sector	Consists of private and public passenger and freight transportation, as well as government transportation, including military operations.
Abbreviations/Acronyms	
Acre	A unit of area equal to 43,560 SF
AFB	Air Force Base
BACnet	building automation and control networks
BMP	Best Management Practice
BTU	British thermal unit: The quantity of heat required to raise the temperature of 1 pound of water 1°F at or near 39.2°F.
CFS	cubic feet per second
CH_4	Methane
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent based on the GWP
DoD	Department of Defense
EISA	Energy Independence and Security Act
EMS	energy management system
EO	Executive Order
EPAct	Energy Policy Act
F	Fahrenheit
FTE	full-time equivalent

Term	Definition
FY	fiscal year
GHG	greenhouse gas
GWP	global warming potential
kGal	thousand gallon
kW	Kilowatt
kWh	kilowatt hour
HVAC	high-voltage alternating current
I&I	infiltration and inflow
lb.	Pound
ICRMP	Integrated Cultural Resources Management Plan
LEED	Leadership in Energy and Environmental Design
m	Meter
MMBTU	One Million British thermal units: A BTU is the quantity of heat required to raise the temperature of 1 pound of water 1°F at or near 39.2°F.
mph	miles per hour
MSW	Municipal Solid Waste
mTons	metric tones
mW	Milliwatt
N_2O	nitrous oxide
NRCS	Natural Resource Conservation Service
PV	Photovoltaic
SD&HPGBD	Sustainable Development and High Performance Green Building Design
SF	square feet
SSPP	Strategic Sustainability Performance Plan
USEPA	U.S. Environmental Protection Agency
USGBC	U.S. Green Building Council
VMT	vehicle miles traveled
w/m2	watt per square meter

VI. APPENDICES (NOT INCLUDED)

A. Data Collection Forms and Supporting Documentation

1. Development

2. Energy

3. Water

4. Waste

5. Operations

A.1 Development: The following pages include the development data collection forms, data sources and supporting documentation that supports the information reported in the Installation Sustainability Assessment for Dyess AFB.

A.2 Energy: The following pages include the energy data collection forms, data sources and supporting documentation that supports the information reported in the Installation Sustainability Assessment for Dyess AFB.

A.3 Water: The following pages include the water data collection forms, data sources and supporting documentation that supports the information reported in the Installation Sustainability Assessment for Dyess AFB.

A.4 Waste: The following pages include the waste data collection forms, data sources and supporting documentation that supports the information reported in the Installation Sustainability Assessment for Dyess AFB.

A.5 Operations: The following pages include the operations data collection forms, data sources and supporting documentation that supports the information reported in the Installation Sustainability Assessment for Dyess AFB.

B. Data Sources

The following are data sources received from HQ ACC/A7PS and Dyess AFB:

1. Reports
    a. I&I Evaluation and Rehabilitation Plan for Dyess AFB, 2009
    b. Oil and Water Report, 2008
    c. Grease Trap Interceptor Report, 2008
    d. Architecture and Landscape Guidelines, Dyess AFB, 2003
    e. Integrated Natural Resources Management Plan, 2006
    f. Dyess AFB, eGP, as of December 2009
    g. Dyess AFB Traffic Engineering Study, 1996
    h. Integrated Waste Management Plan, 2005
    i. Economic Resource Impact Statement, Dyess AFB, 2008
    j. Integrated Pollution Prevention Plan, 2005
    k. Integrated Water Quality Management Plan, 2005
    l. Installation Environmental Restoration Program (ERP) Site Summary, 2006
    m. Integrated Cultural Resources Management Plan, 2006
2. Dyess AFB, Texas, Miscellaneous Data Provided by Dyess
    a. Automatic Flushing Points, Water, as of 2010
    b. Building Management systems, as of 2010
    c. Solvent Use, for 2009
    d. Air Emission, for 2009
    e. 7115 Report, as of January 2010
    f. Hazardous Waste Generation/Cost, for 2009
    g. Building Metering Information, as of January 2010
    h. MS4 permit
    i. Storm Water Multi-Sector Permit
    j. Solid Waste Recycling Amounts/Cost, for 2009
    k. Streetlight Base Inventory, 2007
    l. Solid Waste Management Units land Use Restricts, as of 2010
    m. Hazardous Waste Recycling, for 2009
    n. Buildings Retrofitted with Water Saving Device, as of 2010
    o. Area Development Plans
    p. Buildings/Areas Pending NHRP Eligibility, as of 2010
3. Dyess AFB, Texas, Data Provided by HQ/ACC/A7PS
    a. Mission Fuel Data Use for 2009
    b. Non-Mission Fuel Data Use for 2009
    c. Fleet Data Numbers for 2009
    d. Potable water, Electric, and Natural Gas for the Main Base and Military Family Housing (2003, and 2006-2009)
4. Geobase Data
    a. Data provided by both HQ ACC/A7PS and Dyess AFB
5. Meeting Minutes

C. Expanding Requirements

There are expanding requirements for military facilities constantly being developed and issued. The expanding requirements include new EOs, Statutes, Directives, Rulemaking, and Guidance.

1. EO 13514
2. EO 13423
3. EPAct 2005
4. EISA of 2007
5. Higher Level DoD and HAF directives
6. MAJCOM directives
7. Key Air Force Environmental Goals
8. Other Federal Agency rulemaking and guidance
9. See Separate Attachment Appendix C for a Crosswalk of Regulations

D. References

Burling, 2010 personnel communication with Gary Burling, Dyess AFB; during the 11-15 January 2010 site visit as well as follow up discussions, with Anne Ambrose, HQ ACC/A7PS; Mike Ellerbrock, Woolpert; and David Helter.

Crosby 2010, personnel communication with Robert Crosby, Dyess AFB; during the 11-15 January 2010 site visit, with Anne Ambrose, HQ ACC/A7PS; Mike Ellerbrock, Woolpert; and David Helter.

Danko, 2010, personnel communication with Brian Danko, Dyess AFB; during the 11-15 January 2010 site visit as well as follow up discussions, with Anne Ambrose, HQ ACC/A7PS; Mike Ellerbrock, Woolpert; and David Helter.

Denslow, 2010, personnel communication with Tom Denslow, Dyess AFB; during the 11-15 January 2010 site visit as well as follow up discussions, with Anne Ambrose, HQ ACC/A7PS; Mike Ellerbrock, Woolpert; and David Helter, Woolpert.

Dyess AFB (eGP), 2009, Dyess AFB Electronic General Plan.

Dyess AFB, 2006, Integrated Cultural Resources Management Plan

Dyess AFB, 2008, Economic Resource Impact Statement for Dyess AFB

Ford, 2010, personnel communication with John Ford, Dyess AFB; during the 11-15 January 2010 site visit, with Anne Ambrose, HQ ACC/A7PS; Mike Ellerbrock, Woolpert; and David Helter.

National Renewable Energy Laboratory, http://www.nrel.gov/gis/wind.html

NOAA, 2008, http://lwf.ncdc.noaa.gov/oa/climate/online/ccd/avgrh.html

Walton 2010, personnel communication with Kim Walton, Dyess AFB; during the 11-15 January 2010 site visit as well as follow up discussions, with Anne Ambrose, HQ ACC/A7PS; Mike Ellerbrock, Woolpert; and David Helter.

Other publications and websites used as resources:

1. http://epa.gov/
2. http://www.eere.energy.gov/
3. http://www.un.org/esa/dsd/susdevtopics/sdt_land.html
4. http://www.nps.gov/sustain/spop/jtree.htm
5. http://www.eia.doe.gov
6. ISAUK Research Report 07-01, A Definition of Carbon Footprint, June 2007.
7. http://acupcc.aashe.org/ghg-scope-statistics.php
8. http://www1.eere.energy.gov/femp/program/printable_versions/waterefficiency.html