AIR COMBAT COMMAND

INSTALLATION SUSTAINABILITY ASSESSMENT REPORT

Aerial View

Revised/Updated
Final
May 2012

Ellsworth Air Force Base
South Dakota

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

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"So we have a choice to make. We can remain one of the world's leading importers of foreign oil, or we can make the investments that would allow us to become the world's leading exporter of renewable energy. We can let climate change continue to go unchecked, or we can help stop it. We can let the jobs of tomorrow be created abroad, or we can create those jobs right here in America and lay the foundation for lasting prosperity." - President Obama, March 19, 2009

EXECUTIVE SUMMARY

Due to expanding requirements and diminishing resources, 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 Ellsworth Air Force Base (AFB) and provides a basis for comparison and benchmarking.

Numbers have been calculated for the five sustainability indicators at Ellsworth 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 installations overall impact on sustainability. The arrow indicators, as shown in the chart below, represent how Ellsworth 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. The direction of the arrow indicates whether it is above or below a specified target.

MISSION SUPPORT			
Carbon Footprint:	28,329	mTons	
Energy Usage:	707,930	MMBTU	
Water Conservation:	225	Mg	
Waste Production:	12,997	tons	
Land Utilization:	3,755	SF/acre	

FLYING MISSION			
Carbon Footprint:	162,986	mTons	
Energy Usage:	2,296,168	MMBTU	

SF = square feet; mTons = metric tons; Mg = million gallons; 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. This report demonstrates that the Base is performing well on Mission Support Carbon Footprint and Mission Support Energy Usage relative to industry benchmarks; however, it is underperforming on Waste Reduction, Water Conservation, Land Utilization, Flying Mission Carbon Footprint and Flying Mission Energy Usage.

Ellsworth AFB has already initiated a large number of sustainability initiatives. Some examples include their partial renewable energy source for electrical energy and contract with WAPA, current recycling practices, and their current reuse of Greywater for irrigation purposes. There are additional strategies that are outlined relative to each sustainability indicator in the report such as energy reduction, renewable transportation and mission fuels, and removal of all irrigation on base.

Air Combat Command 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 Installation Sustainability Assessment (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 and it is expressed in five key indicators; (1) Carbon Footprint, (2) Energy Usage, (3) Water Conservation, (4) Waste Reduction and (5) Land Utilization, and identifies and recommends installation specific improvement strategies. 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 ISA's 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 Air Force installations 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) which 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 which 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	ISA Additions (Data Available)	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	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 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. ISA's 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 effects or has direct participation in flight or deployment operations. The flying mission calculations currently take into account energy 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 is in place, 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, its source and its usage.
4. **Waste—**Includes solid and liquid waste production and its usage.
5. **Operations—**Includes best management practices 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 uses of land in an integrated manner, it is possible to minimize conflicts, to make the most efficient trade-offs and to 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 utilizing 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 by methods such as pavement demolition to mimic natural conditions and to protect water quality. Increasing the amount of pervious ground cover increases storm water infiltration rates; thereby reducing 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 about 40% 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 utilizing the natural retention and infiltration capabilities of plants and soils which 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 such things as run several errands at the same time or to interact with others.

- 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 which 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 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 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. Utilizing 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 allows 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 of 2007, any development or redevelopment project involving a Federal facility with a footprint that exceeds 5,000 square feet 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, re-using 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 50-80% 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 best management practices 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 such things 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:

- Natural Resources Plan
- Integrated Cultural Resources Management Plan
- Storm Water Pollution Prevention Plan
- Water 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
- Transportation Master Plan
- Department of Energy Report
- Transportation Fuel Reports
- Real Property Reports
- GIS 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 two Architects, two Intern Architects, and a Landscape Architect met with personnel at Ellsworth AFB on May 3-7, 2010. While at the installation, the A/E team interviewed available civil engineering flight staff, such as, but not limited to, contracting, engineering, maintenance, and real property personnel to supplement the data collected previously from HQ ACC/A7PS as well as to collect data not previously obtained. The A/E team observed and measured existing conditions such as night time light levels along the flight line and sound levels throughout the installation.

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, Energy Policy Act 2005, Energy Independence and Security Act 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 Ellsworth 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, trees and wood products, and as a result of other chemical reactions.

- Methane (CH_4)—Methane is emitted during the production and transport of coal, natural gas, and oil. Methane 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)—**Nitrous oxide is emitted during agricultural and industrial activities, as well as during combustion of fossil fuels and solid waste.
- **Fluorinated Gases—**Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6) are synthetic, powerful greenhouse gases that are emitted from a variety of industrial processes.

In the USA, our 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 about a 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 United States. (U.S. EPA)

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 United States and offers a relatively simple approach that can be adapted to installation wide systems. Where data was available, Scope I and Scope II emissions and some of Scope III emissions have been included. Scope I emissions are all direct greenhouse gasses 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 look-up 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 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 green, bio-, 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, and to provide a fair comparison to other public campuses or corporate entities.

Water Conservation:

As 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 generating 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 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 predevelopment (greenfield) calculation utilizing the USDA, NRCS (SCS) Method as outlined in Urban Hydrology for Small Watersheds Technical Release 55 (TR-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 45-85 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 we throw into our 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 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 creating excessive transportation and creating excessive hard surfaced areas.

For reporting land utilization, 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, two times the code recommended square footage per FTE is being used to provide a comparison of building area against the installation's population and to depict the utilization of the building space.

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 for 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

Ellsworth AFB is a U.S. AFB in Meade and Pennington counties located 15 miles outside of Rapid City, South Dakota. It is the headquarters for the 28th Bomb Wing of the Air Combat Command (ACC) and has a rich history that stretches back to its inception as a U.S. Army Air Base in January of 1942. The wing flies B-1B Lancers and serves as the host unit, providing all essential base operating support services for Ellsworth and combat support services for an Air Expeditionary Wing.

B. History

On 2 January 1942 the U.S. War Department established Rapid City Army Air Base as a training location for B-17 Flying Fortress crews. From September 1942 -- when its military runways first opened -- until mission needs changed in July 1945, the field's instructors taught thousands of pilots, navigators, radio operators and gunners from nine heavy bombardment groups and numerous smaller units.

After World War II the base briefly trained weather reconnaissance and combat squadrons. Those missions soon ended, however, and Rapid City Army Air Field temporarily shut down from September 1946 - March 1947. When operations resumed in 1947 the base was a new United States Air Force asset. The primary unit assigned to Rapid City AFB was the new 28th Bombardment Wing (BMW) flying the B-29 Superfortress.

The base experienced one of its worst peacetime tragedies in March 1953 when an RB-36 and its entire crew of 23 crashed in Newfoundland while returning from a routine exercise in Europe. On 13 June 1953, President Dwight D. Eisenhower made a personal visit to dedicate the base in memory of Brig Gen Richard E. Ellsworth, commander of the 28th Strategic Reconnaissance Wing, who lost his life in that accident.

Headquarters Strategic Air Command (SAC) reassigned the 28 BMW from 8th Air Force back to 15th Air Force in October 1955. In 1958 all base units came under the command of the 821st Strategic Aerospace Division, headquartered at Ellsworth. In October 1960, Ellsworth entered the "Space Age," with the activation of the 850th Strategic Missile Squadron, initially assigned to the 28 BMW. For more than a year this squadron prepared for the emplacement of Titan I intercontinental ballistic missiles (ICBM), which finally arrived in 1962, shortly after the activation of the 44th Strategic Missile Wing (SMW) in January.

Titan's life span was short in western South Dakota. In July 1962, SAC had effectively rendered it obsolete by activating the 66th Strategic Missile Squadron, the first of three such units slated to operate 150 Minuteman I ICBMs under the 44 SMW. On 1 June 1971, SAC inactivated the 821st

Strategic Aerospace Division. By October of that year an upgraded Minuteman II also replaced earlier missiles.

Ellsworth soon became known as "The Showplace of SAC" as it continued to fight the Cold War by maintaining two legs of America's strategic triad: strategic bombardment and ICBMs. It carried out these vital missions for more than 15 years with relatively little change. Then, the 1980s brought many new challenges. In 1986 the base and the 28 BMW made extensive preparations to phase out the aging B-52 fleet and become the new home for the advanced B-1B Lancer. In January 1987, the wing received the first of 35 B-1B bombers.

On 1 June 1992, as part of the first major reorganization since the creation of USAF, the Air Force inactivated SAC and assigned Ellsworth's organizations (including a renamed 28th Bomb Wing (BW) to the newly activated Air Combat Command (ACC). After less than a year under the new command, the 28th's mission changed from that of strategic bombardment to one of worldwide conventional munitions delivery.

In March 1994 Ellsworth welcomed the 34th Bomb Squadron, a geographically separated unit awaiting airfield upgrades before it could return to its parent organization, the 366 BW, at Mountain Home AFB, Idaho.

Also during 1994, the Air Force selected Ellsworth as the exclusive location from which to conduct a Congressionally-mandated operational readiness assessment of the B-1B, known locally as "Dakota Challenge." After six months of hard work, under both peacetime and simulated wartime conditions, the 28 BW and Ellsworth passed the test "with flying colors"; and proved the B-1 to be a reliable and capable weapons system; the mainstay of America's heavy bomber fleet for years to come.

In March 1999, the Air Force announced a reorganization plan that makes Ellsworth AFB and the 28 BW partners in the new Expeditionary Air Force (EAF) concept. The 28 BW was named a lead wing in the EAF. Under this plan, the 77 BS will gain six additional B-1Bs, and Ellsworth AFB will gain about 100 more military personnel. The expeditionary forces will help the Air Force respond quickly to any worldwide crisis while making life more predictable for military members.

On September 19th, 2001 the 34th Bomb squadron joined the Ellsworth team and arrived from Mountain Home AFB, ID. Due to a drawdown in the number of B-1 aircraft in the Air Force inventory, the 77th BS at Ellsworth was inactivated and the "Thunderbirds" of the 34th BS were moved to Ellsworth to take their place.

The men and women of Ellsworth AFB draw from past experiences to plan for the future. As they embrace the core values of "Integrity First, Service Before Self, and Excellence in All We Do," they stand ready to provide global power for America!

C. Mission and Vision

The 28th Bomb Wing's Mission statement is, "to put bombs on target. Every Airman in this Wing, whether it's maintaining our people, equipment, pulling a trigger or aiming crosshairs, puts bombs on target."

The 28th Bomb Wing's vision is to be the "backbone" of global engagement for the 21st century.

D. Geography

According to the 2000 United States Census Bureau, the Base has a total area of 1.9 square miles, of which, 1.87125 square miles of it is land and 0.02875 square miles of it is water.

Coordinates: 44° 8' 15" N, 103° 4' 5" W (44.137471, -103.0668123)

State: South Dakota

County: Meade and Pennington

Elevation: 3,380 feet

Terrain: Pierre Hills Division of the Missouri Plateau - Series of smooth hills and ridges with rounded tops.

Soils: Area consisting of a series of thick beds of sandstone, limestone, and shale overlain by deposits of limestone, sandstone, and dolomite. Fourteen soil types present consisting of clay and loamy soils.

E. Climate

Temperature: Average July maximum and minimum temperatures are 87°F (30.5°C) and 61°F (16.1°C) respectively.

Average January maximum and minimum temperatures are 32 F (0°C) and 13°F (-10.5°C) respectively.

Precipitation: Average yearly precipitation is 16.5 inches (41.91 cm) of that an average yearly snowfall being around 41.9 inches (106.43 cm).

Humidity: Humid continental climate

Humidity Range between 37% rh and 77% rh.

Wind: Wind Power Classification between 5 and 6 @ 50 m
(from US DOE National Renewable Energy Laboratory)

WIND POWER CLASSIFICATION	WIND POWER DENSITY	WIND SPEED
5	500-600 w/m^2 @ 50m	16.8-17.9 mph
6	600-800 w/m^2 @ 50m	17.9-19.7 mph
w/m^2 = watt per square meter; m = meter; mph = miles per hour		

F. Demographics

As of the census of 2000, there were 4,165 people, 1,056 households, and 991 families residing on the Base. The population density was 2,217.8 people per square mile. There were 1,076 housing units at an average density of 573 per square mile.

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, ELLSWORTH AFB

Base Area (acres)	50,704
Usable Building Area (SF)	4,265,075
Base Population	
Military (2009)	3,246
Civilian (2009)	974
Dependent Population (2007)	1,800
2010 Energy Use[1]	
Electric Use (kWh)	67,760,000
Natural Gas (cf)	343,897,000
Potable Water (Mgal)	225
2009 Mission Fuel Usage (gal)	
Aviation Fuels	17,036,466
Diesel	109,265
Gasoline Fuel	57,040
Bio Diesel	62,323
2009 Non-Mission Fuel Usage (gal)	
Diesel	523,147
Gas fuel	156,046
Bio Diesel	6,767
Ethanol	111
Waste	
Total Waste (tons)[2]	12,996
Waste Recycled (tons)[2]	940

[1]Includes military family housing.
[2]Includes landfill, recycling, compost, hazardous, and other.
SF = square feet, kWh = kilowatts hour, cf = 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 Ellsworth AFB.

1. Ellsworth 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 Ellsworth AFB is 191,315 mTons (includes Flying and Support Missions)

ACC and Ellsworth AFB jointly need to establish a goal for the installation's carbon footprint. Currently, based on industry benchmarks, Ellsworth 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 Ellsworth AFB is 28,329 mTons

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

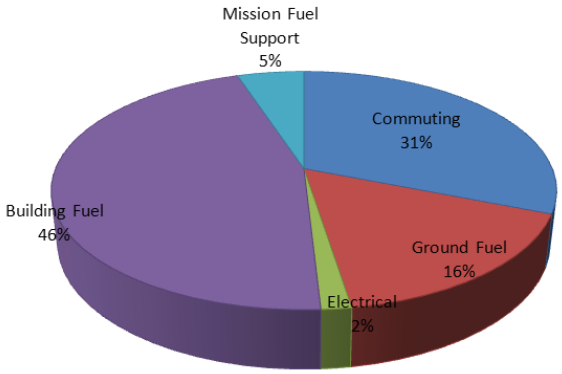
Annual Total Carbon Footprint:	8,853	mTons
Baseline (2005):	(A)	mTons/FTE/year
Previous Year: (2008)	(A)	mTons/FTE/year
Current Year (2009):	2.10	mTons/FTE/year
Benchmark[1]:	7.54	mTons/FTE/year
% Reduction from Baseline:	-	
% Reduction from Previous Year:	-	

Baseline (2005):	(A)	mTons/1,000 SF/year
Previous Year (2008):	(A)	mTons/1,000 SF/year
Current Year (2009):	2.08	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:	19,476	mTons
Baseline (2003):	4.85	mTons/FTE/year
Previous Year (2008):	5.93	mTons/FTE/year
Current Year (2009):	4.62	mTons/FTE/year
Benchmark[1]:	7.54	mTons/FTE/year
% Reduction from Baseline:	5%	
% Reduction from Previous Year:	22%	

Baseline (2003):	4.68	mTons/1,000 SF/year
Previous Year (2008):	5.65	mTons/1,000 SF/year
Current Year (2009):	4.57	mTons/1,000 SF/year
Benchmark[2]:	20.44	mTons/1,000 SF/year
% Reduction from Baseline:	2%	
% Reduction from Previous Year:	19%	



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. Ellsworth Carbon Footprint—Flying Mission

Annual Total Flying Mission Carbon Footprint for Ellsworth AFB is 45,514 mTons

FLYING MISSION[1]

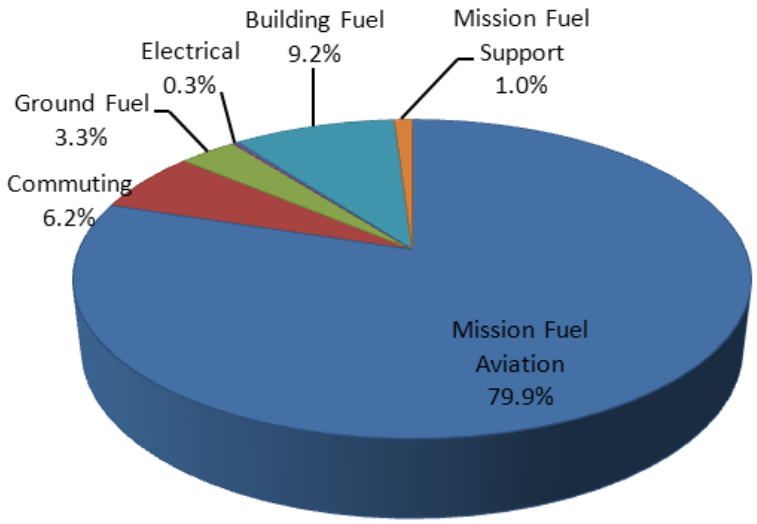
Annual Total Carbon Footprint:	162,986	mTons
Baseline (2003):	(A)	mTons/FTE/year
Previous Year (2009):	41.08	mTons/FTE/year
Current Year (2010):	38.62	mTons/FTE/year
Benchmark[1]:	7.54	mTons/FTE/year
% Reduction from Baseline:	-	
% Reduction from Previous Year:	6%	

Per FTE

Baseline (2003):	(A)	mTons/1,000 SF/year
Previous Year (2008):	39.15	mTons/1,000 SF/year
Current Year (2009):	38.21	mTons/1,000 SF/year
Benchmark[2]:	20.44	mTons/1,000 SF/year
% Reduction from Baseline:	-	
% Reduction from Previous Year:	2%	

Per Built SF

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 57,707 acres = 10.6 times the installation area
  for Flying Mission is 275,022 acres = 50.8 times the installation area
- The Flying Mission carbon footprint is equivalent to 53 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. Ellsworth Energy Usage

Total Energy Usage Ellsworth AFB is 3,004,098 MMBTU (includes Flying and Support Missions)

ACC and Ellsworth AFB jointly need to establish a goal for the installation's energy intensity. Currently, based on industry benchmarks, Ellsworth AFB has relatively average energy usage for mission support transportation and facilities. Flying Mission energy intensity shown on the following page is will above average though with aviation fuel as the biggest contributor with commuting being the second largest contributor.

Annual Total Mission Support Energy Usage for Ellsworth AFB is 707,930 MMBTU

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

Annual Total Energy Usage:	123,207	MMBTU
Baseline (2005):	(A)	MMBTU/FTE/year
Previous Year (2008):	(A)	MMBTU/FTE/year
Current Year (2009):	29.20	MMBTU/FTE/year
Benchmark[1]:	327.00	MMBTU/FTE/year
% Reduction from Baseline:	-	
% Reduction from Previous Year:	-	

MISSION SUPPORT—Facilities[6]

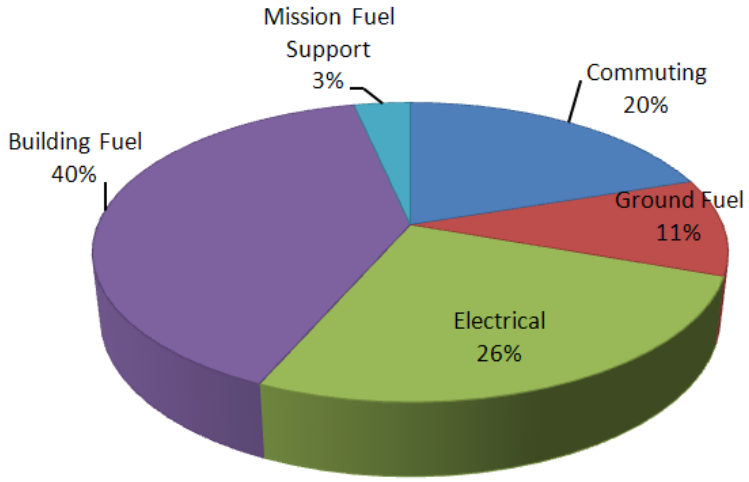
Annual Total Energy Usage:	584,723	MMBTU
Baseline (2003):	154.92	MMBTU/FTE/year
Previous Year (2008):	167.10	MMBTU/FTE/year
Current Year (2009):	138.56	MMBTU/FTE/year
Benchmark[1]:	327.00	MMBTU/FTE/year
% Reduction from Baseline:	11%	
% Reduction from Previous Year:	17%	

Per FTE

Baseline (2005):	(A)	MMBTU/SF/year
Previous Year (2008):	(A)	MMBTU/SF/year
Current Year (2009):	0.03	MMBTU/SF/year
Benchmark[2]:	0.13	MMBTU/SF/year
% of Energy from Renewable Source:	1.4%	
% Reduction from Baseline:	-	
% Reduction from Previous Year:	-	

Baseline (2003):	0.15	MMBTU/SF/year
Previous Year (2008):	0.16	MMBTU/SF/year
Current Year (2009):	0.14	MMBTU/SF/year
Benchmark[2]:	0.13	MMBTU/SF/year
% of Energy from Renewable Source:	35%	
% Reduction from Baseline:	8%	
% Reduction from Previous Year:	14%	

Per Built SF



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. Ellsworth Energy Usage - Flying Mission

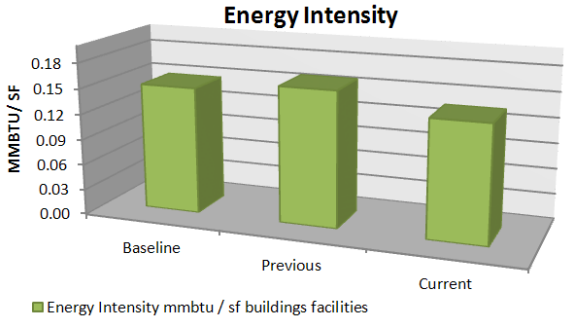
Annual Total Flying Mission Energy Usage for Ellsworth AFB is 2,296,168 MMBTU

FLYING MISSION

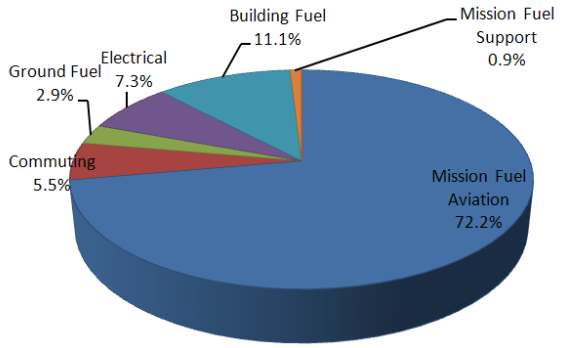
Annual Total Energy Usage:	2,296,168	MMBTU	
Baseline (2003):	(A)	MMBTU/FTE/year	**Per FTE**
Previous Year (2008):	578.69	MMBTU/FTE/year	
Current Year (2009):	544.12	MMBTU/FTE/year	
Benchmark[1]:	327.00	MMBTU/FTE/year	
% Reduction from Baseline:	-		
% Reduction from Previous Year:	6%		

Baseline (2003):	(A)	MMBTU/SF/year	**Per Built SF**
Previous Year (2009):	0.55	MMBTU/SF/year	
Current Year (2010):	0.54	MMBTU/SF/year	
Benchmark[2]:	0.40	MMBTU/SF/year	
% Reduction from Baseline:	-		
% Reduction from Previous Year:	2%		

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 30%
  for Flying Mission is 7%

[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.

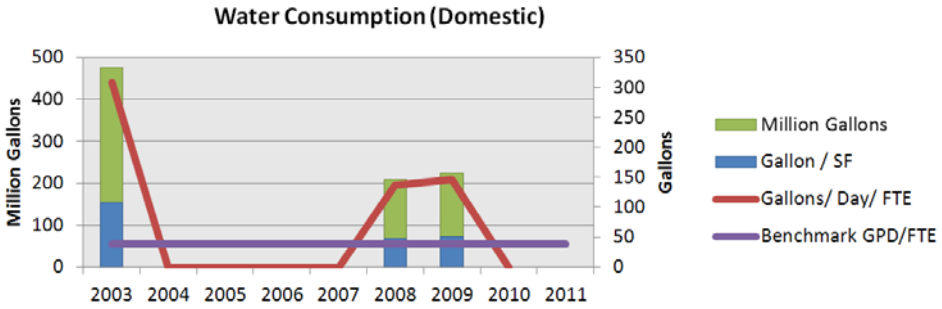
3. Ellsworth Water Conservation

ACC and Ellsworth AFB jointly need to establish a goal for the installation's water conservation. Currently, based on industry benchmarks, Ellsworth AFB has relatively high water consumption. The base does have sustainable measures in place such as a greywater and storm water irrigation system for the golf course, demolition of old buildings, fixing leaks throughout the base, and it soon will be getting rid of all irrigation except for establishment of new plants.

MISSION SUPPORT

Annual Total Water Consumption:	225.00	Million Gallons	
Baseline (2007):	(A)	Gallon/FTE/day	Per FTE
Previous Year (2008):	136.34	Gallon/FTE/day	
Current Year (2009):	146.08	Gallon/FTE/day	
Benchmark[1]:	28-38	Gallon/FTE/day	
% Reduction from Baseline:	-		
% Reduction from Previous Year:	-7%		

Baseline (2007):	(A)	Gallon/SF/year	Per Built SF
Previous Year (2008):	47.43	Gallon/SF/year	
Current Year (2009):	50.82	Gallon/SF/year	
Benchmark[2]:	-	Gallon/SF/year	
% Reduction from Baseline:	-		
% Reduction from Previous Year:	-7%		



[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.
(A) = Data is incomplete.

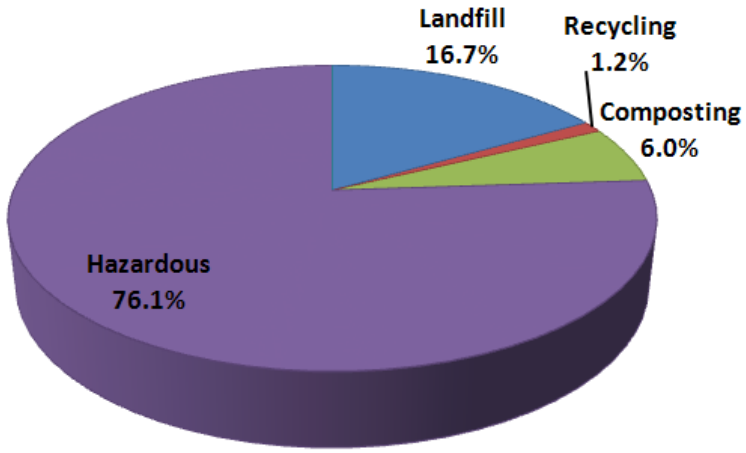
4. Ellsworth Waste Reduction

ACC and Ellsworth AFB jointly need to establish a goal for the installation's waste reduction. Currently, based on industry benchmarks, Ellsworth AFB produces large amount of waste. The average American only recycles 30% of their waste. If one ton or 100% post-consumer paper is recycled, it saves the equivalent of 24 trees (40' in height, 6'-8" diameter), 7,000 gallons of water, 4,100 kilowatt hours of electricity, and 60 pounds of air pollution.

MISSION SUPPORT

Annual Total Waste Production:	12,997	Tons	
Current Year (2009):	16.88	LBS/FTE/day	Per FTE
Benchmark[1]:	4.62	LBS/FTE/day	

Current Year (2009):			Per Built SF
Benchmark[2]:	6.09	LBS/SF/day	
% Non-Hazardous Waste Diverted from Landfill	30%	LBS/SF/day	



- Total % of composted waste material
  Currently is 6%

[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. Ellsworth Land Utilization

ACC and Ellsworth AFB jointly need to establish a goal for the installation's land utilization. Currently, based on industry benchmarks, Ellsworth AFB's building density is under the benchmark by approximately a factor of 16 (i.e. building density is extremely low). The building utilization for Ellsworth AFB is over the benchmark by approximately a factor of six. 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):	3,755	SF/Acre
Benchmark[2]:	60,000	SF/Acre
Previous Year (2008):	3,898	SF/Acre
% Change from Previous Year:	-4%	

Total Building Utilization[5]:

Current Year (2009):	1,011	SF/FTE
Benchmark[3]:	160	SF/FTE
Previous Year (2008):	1,049	SF/FTE
% Change from Previous Year:	-4%	

MISSION SUPPORT

Total % Green Space[6]:

Current Year (2009):	82%	
Benchmark[4]:	-	
Previous Year (2008):	82%	

Total % Building/Impervious[7]:

Current Year (2009):	8%	
Benchmark[4]:	-	
Previous Year (2009):	8%	

Total % Building/Footprint[8]:

Current Year (2009):	60%	
Benchmark[4]:	-	
Previous Year (2008):	62%	

- 4,799 average daily traffic at the gates = 1.14 trips per FTE
- 3.64 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 Ellsworth 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

The ISA process at Ellsworth AFB and the data compiled and analyzed establish baseline sustainability metrics for the installation. The A/E team learned from the data gathering process and interviews that the following sustainable initiatives are currently in place at Ellsworth AFB.

1. The base receives its electric power from a *WAPA agreement and Basin Power*, which combined has hydro-electric power plants that makes up 86% of the electrical power the base uses. The current Federal guideline requires a renewable energy source for a minimum of 3% by FY07, 5% by FY10, 7.5% by FY13, and 25% by FY25 of total electric use.
2. The new Civil Engineering Facility at Ellsworth AFB is designed to meet LEED® certification requirements totaling approximately 55,000 square feet. There is a Department of Defense requirement that all new buildings be designed and constructed to a minimum LEED® SILVER design standard.
3. Alternative work schedules are being implemented on the base. The current alternative work schedule allows for flex-scheduling and for shop workers to work (4) 10 hour days during the week.
4. The replacement of lamps in buildings with energy efficient light bulbs is currently in process. Also the implementation of LED lighting is being incorporated throughout the base.
5. All exterior lights for roads and parking lots have photocells, Energy Monitoring Control Systems, or Standard Timers. An initiative to install more energy efficient lighting fixtures is in place.
6. Individual sub-metering program is already implemented for electric, gas, and water consumption at all most buildings on the installation. There are currently 63 existing buildings that have been updated with sub metering and these can be monitored at all times via the Air Force Advanced Meter Monitoring System (AFAMMS) online tool. All new construction will require sub meters for electricity, gas, and water.
7. A recycling program is in place in an effort to reduce waste and diverts roughly 42% of the non-hazardous solid waste the base creates. This is in slightly below Air Combat Commands goal to divert 50% of the municipal solid waste and with the Air Force Instruction 32-7080 and Presidential Executive Order 13423.

8. A Greywater system is in place that pumps treated water into a lake on the golf course for irrigation of the golf course.

9. Procurement initiatives using paper with 30% - 50% recycled fiber content are being implemented. The base Supply Store also has a wide variety of green and sustainable products for purchase on base. All of these products are clearly marked as either recycled or made with recycled content and range from cleaning products to printer toner cartridges.

10. Operations and Maintenance Manuals are current for all new and remodeled equipment. There are continuous training programs in place for building systems and employee development.

E. Guidance Compliance Summary and Matrix

Refer to Appendix C to review Ellsworth AFB compliance with current Federal guidance.

IV. RECOMMENDATIONS

The recommendations described below are derived from the specific information obtained at Ellsworth AFB. They are intended for further definition and development of projects that would have a direct and viable impact on the sustainability of the installation. Ultimately this list will be used to develop a prioritized group of projects. Some of the other currently established expanding requirements that are in various stages of implementation will have an impact on sustainability; however, these efforts are independent from the goal of this report.

A. Carbon Footprint

- Ellsworth AFB obtains all of its electrical energy from *Basin Power and WAPA Power*, which combined produces 86% of its power from a hydroelectric source; therefore, the carbon footprint of its mission support is reasonably good relative to carbon footprint benchmarks set for this report. The mission support carbon foot print per FTE is a small amount below the benchmark, but it is significantly below the benchmark per 1,000 square feet of built building. The flying mission is considerably higher per FTE and per 1,000 built square feet though because of the extremely large amounts of jet fuel that is being used for the training operations on base. Based on the information we have at this time, the area of most impact on the carbon footprint are the mission aviation fuels, commuting, and the building fuel being consumed during operations.
  - Develop strategies to decrease the commuting carbon footprint by encouraging carpooling, public transportation, or high efficiency/non-carbon based fuel vehicles.
    - If the number of vehicles entering/leaving the installation decreased by 10%; there would be a 21.4% net decrease of the total carbon footprint for the Mission and a 5.0% net decrease of the total carbon footprint for the Mission Support.
  - Continue to improve on energy efficiency by using carbon-based fuels such as natural gas to reduce total carbon fuel consumed. This can be accomplished by assessing existing building systems via the retro-commissioning process and by improving existing systems.
    - Typically energy efficiency is 80%. If Ellsworth's energy efficiency increased to 95%; there would be a 1.7% net decrease of the total carbon footprint for the Mission and a 5.9% net decrease of the total carbon footprint for the Mission Support.
  - Incorporate bio fuels or non-carbon based fuels like electricity (hydroelectric) or hydrogen for ground transportation and aviation fuels.
    - If the diesel fleet improved by 20% bio diesel (B20 blend) fuel, there would be a 4.0% net decrease of the total carbon footprint for the Mission Support.
    - If 20% bio aviation fuel was implemented, there would be a 15.1% net decrease of the total carbon footprint for the Flying Mission.
  - Allow non-essential personnel to telecommute one or more days per week.
    - If telecommuting was implemented one day a week, the participating individual's contribution to the commuting portion of the carbon footprint by decrease by 20% per week.

B. Energy Usage

- Based on the information available, Ellsworth AFB energy usage is at or below the benchmark standards for both MMBTU/FTE and MMBTU/built SF in regards to mission support. The flying mission at Ellsworth AFB however more than doubles the benchmark standards for MMBTU/FTE

and MMBTU/built SF. This is mainly due to mission aviation fuel and not related to energy usage by the buildings themselves.

- Complete sub-metering of all existing buildings in order to capture and analyze the data to facilitate focused direction on future projects that will impact energy usage, carbon footprint, water conservation, etc.
- Currently the base obtains its power from *Basin Power and WAPA Power Agreement* which produces 86% renewable energy from its hydro-electric power plants. The base has the ability to increase its current energy efficiency by introducing internal sources of renewable energy such as solar energy from photovoltaic panels and wind energy from wind turbines. The seemingly continuous winds across the base allows for almost continuous energy generation from wind turbines that could be placed on the edges of the base where they would not have an effect on the flying mission of the base.
  - The wind power classification for the installation is between 5 and 6 according to the American Wind Energy Association (AWEA) which would allow the use of wind turbines that could maximize the 17 to 19 mph consistent winds that the base possesses.
  - Ellsworth could produce around 4.0 – 5.0 kWh/m^2/Day per the direct normal solar radiation map created by the National Renewable Energy Laboratory for the U.S. Department of Energy.
- Continue to reduce small appliance duplication, replace low efficiency motors, and change light fixture types at buildings. These efforts should be analyzed on a building by building basis to establish the return on investment.
  - Fluorescent lighting upgrades can reduce power consumption by as much as 40 percent. Older T12 lighting systems with magnetic ballasts produce only about 55 lumens per watt of energy consumed. This can be replaced with a T8 or T5 lighting system with electronic ballasts that provide approximately 90 lumens per watt. The base is currently undertaking this task per stimulus funds.
  - Electric motors replaced with energy efficient motors can increase motor efficiency by up to 20 percent.
- Provide rooms with occupancy sensors on all lights to reduce energy use across the base.

C. Water Conservation

- At Ellsworth AFB, all water is obtained from the Rapid City Water Division. The initial source of the water is a combination of treated surface water, three infiltration galleries, and nine groundwater wells. As of now, water consumed on base per FTE per day (146 gal/FTE) is 1.5 times higher than the benchmark set by the United States Geological Survey of the average Americans water usage (80-100 gal/FTE). Currently the base has minimal irrigation on base and utilizes native plants that require little to no irrigation except for when they are established.
  - Continue to implement the required 2% reduction per year of water consumption based on the Executive Order.
    - Implement the next generation of low flush toilets and urinals and introduce automatic faucets on hand wash sinks.
  - Track leaks in piping across the base in order to reduce the amount of water escaping the system.

- The base does not receive enough precipitation per year to have major issues with storm water drainage. As of now the base handles all storm water events through BMP's that allow the water to percolate down through the surface to help recharge the aquifer.
    - The use of a rainwater collection system for irrigation, car washing, or other functions would be a sustainable idea that could be implemented by the base.

D. Waste Reduction

- The waste production per FTE at Ellsworth AFB is almost 4 times the U.S. daily average benchmark. The installation does recycle and compost a large percentage of the solid waste that is produced. Because of this, Ellsworth AFB's waste minimization and recycling efforts are very good relative to being "green". Beyond reducing waste production and recycling, energy creation from solid waste and an increase in composting efforts are other potential suggestions for improving on the installations overall sustainability.
    - An increase in composting efforts on the base would help to reduce the amount of waste being sent to the landfill.
        - Per the Environmental Protection Agency, Yard trimmings and food residuals together constitute 24% of the U.S. municipal solid waste stream. If 24% of Ellsworth AFB's current average yearly landfill solid waste could be diverted and composted, this would help to eliminate 2,771 metric tons of CO_2e from being released into the atmosphere each year.

E. Land Utilization

- The Ellsworth AFB installation is mixed-use including residential, commercial, industrial spaces, and aircraft operations. There are certain height restrictions for air bases, numerous anti-terrorism force protection requirements, and the availability of space and political process tends to spread development out rather than concentrate it. This base has an abundance of space and the calculations for building density and building utilization are skewed because of the large overall area of the base being compared to the building footprints of the structures within. As of now the base is doing a good job of infilling where needed in order the keep the base as dense as possible while still following the restrictions and requirements for a U.S. AFB.
    - Remove or schedule for reuse all unused or undesirable buildings to bring the square feet per FTE closer to the benchmark average.
        - Currently the base removes unnecessary buildings whenever possible. Presently, there are few buildings on base that are underutilized.
        - For example, if the overall building square footage is decreased by an additional 25%, it would result in a reduction of energy usage to 0.094 MMBtu/SF and a reduction in building utilization to 561 SF/FTE.
    - Future development of the installation should consider improving the overall density of the site, and providing proximity to supporting services.
        - Reducing unnecessary vehicle travel would decrease energy used.
        - Incorporating a system of trails and sidewalks that connects the base functions to each other as well as connecting the existing housing areas to the commercial and industrial areas of the base.
        - Combining uses and functions of buildings to maximize efficiency of building SF. This can be done with new construction as well as existing by promoting more vertical buildings with 3-4 stories instead of 1-2 story buildings that have a bigger footprint. Building

vertically will also help to increase the building density and allow for outdoor spaces (i.e. courtyards) to be created by these structures. Try not to however create large interior spaces that require a vast amount of energy to keep climate controlled.

- Conduct a study to determine existing internal traffic counts and internal commuting to examine the impact of the proximity of services and energy usage and carbon footprint.
- Conduct a study to determine the benefits of allowing prairie grass to grow out instead of maintaining it by mowing.

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.
Design guideline	A set of rules and strategies to help building designers meet certain performance criteria such as energy efficiency or sustainability.

Term	Definition
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.
Green space	A land use planning and conservation term used to describe protected areas of undeveloped landscape. Also known as open space.

Term	Definition
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.
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.

Term	Definition
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	
Acre	A unit of area equal to 43,560 square feet.
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.
CFC	chlorofluorocarbon
CH_3OH	methanol
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent based on the GWP
cu ft or ft^3	cubic foot: A unit of volume of a cube with sides of one foot in length.
DADT	Daily Average Daily Traffic
dB	decibel: A logarithmic unit of measurement that expresses the magnitude of a physical quantity (usually power or intensity) relative to a specified or implied reference level.
eCO_2	CO_2 Equivalents
FC	fluorocarbon
FTE	full-time equivalent
FY	fiscal year
GWP	global warming potential
HCFC	hydrochlorofluorocarbon
HFC	hydrofluorocarbon
J	Joule
kW	kilowatt

Term	Definition
kWh	kilowatt hour
Lb.	pound
LEV	low emission vehicle
LNG	liquefied natural gas
LPG	liquefied petroleum gas
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.
N_2O	nitrous oxide
NGL	natural gas liquid
NMVOC	non-methane volatile organic compound
NO	nitrogen oxide
NO_x	nitrogen oxides
O_3	ozone
ODS	ozone depleting substance
PFC	perfluorocarbon
PM	particulate matter
ppb	parts per billion
ppm	parts per million
PV	photovoltaic
RCx	retro-commissioning
SF	square feet
SF6	sulfur hexafluoride
SNG	synthetic natural gas
SO_2	sulfur dioxide
SO_x	sulfur oxides
SRI	solar reflectance index
TSS	total suspended solids
VMT	vehicle miles traveled
VOC	volatile organic compounds
Acronyms	
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BMP	Best Management Practice
DADT	Daily Average Daily Traffic
DOE	U.S. Department of Energy
GIS	Geographical Information System
LEED	Leadership in Energy and Environmental Design
MSW	Municipal Solid Waste
SSPP	Strategic Sustainability Performance Plan
EPA or USEPA	U.S. Environmental Protection Agency

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 Ellsworth 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 Ellsworth 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 Ellsworth 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 Ellsworth 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 Ellsworth AFB.

B. Data Sources

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

1. Ellsworth AFB, South Dakota, Final Integrated Natural Resources Management Plan, December 2005
2. Ellsworth AFB, South Dakota, Integrated Cultural Resource Management Plan, July 2005
3. Ellsworth AFB, South Dakota, Storm Water Pollution Prevention Plan, 2009 Update
4. Ellsworth AFB, South Dakota, Economic Impact Analysis, Fiscal Year 2007
5. Ellsworth AFB, South Dakota, Economic Impact Analysis, Fiscal Year 2008
6. Ellsworth AFB, South Dakota, Environmental Restoration Program Site Summaries, December 2005
7. Ellsworth AFB, South Dakota, Entry Control Facility Transportation Engineering Assessment, May 2009
8. The Office of the Air Force Civil Engineer, United States Air Force Infrastructure Energy Strategic Plan, 2008
9. United States Air Force, U.S. Air Force Energy, Environment, Safety and Occupational Health: Managing for Operational Sustainability, 2007 Inaugural Report
10. Ellsworth AFB, South Dakota, Defense Utility Energy Reporting System (DUERS), Fiscal Year 2009
11. Ellsworth AFB, South Dakota, Defense Utility Energy Reporting System (DUERS), Fiscal Year 2008
12. Ellsworth AFB, South Dakota, Defense Utility Energy Reporting System (DUERS), Fiscal Year 2003
13. Ellsworth AFB, South Dakota, Real Properties Report, October 1, 2009
14. Ellsworth AFB, South Dakota, GIS Maps
    a. Impervious Surfaces Map, 15 April 2010
    b. Land Use Map, 15 April 2010
    c. Golf Course Map, 16 April 2010
    d. Fauna and Flora Map, 15 April 2010
    e. Noise Zone Contours Map, 10 June 2010
    f. Building/Noise Zone Contour Relationship Map, 10 June 2010
    g. Runway Apron Lighting Levels Exhibit, 10 June 2010
    h. Electrical Data, 19 April 2010
    i. Natural Gas Data, 19 April 2010
    j. Fuel System Data, 20 April 2010
    k. Water Map, 20 April 2010
    l. Storm Water Map, 20 April 2010
15. Ellsworth AFB, South Dakota, Final 20 Year Drinking Water Master Plan, 28 September, 2005
16. Ellsworth AFB, South Dakota, Pollution Prevention Management Action Plan, November 2006
17. Ellsworth AFB, South Dakota, Hazardous Waste Management Plan, May 2005
18. Green Building Certification Institute (GBCI), LEED Certified and Registered Project List, 13 March 2010
19. Ellsworth AFB, South Dakota, Base Engineering Administrative Facility, LEED v2.2 New Construction Checklist, 18 February 2010
20. Ellsworth AFB, South Dakota, Drinking Water Quality Consumer Confidence Report (CCR) for 2008 Reporting Period
21. Ellsworth AFB, South Dakota, Draft Force Structure Change Environmental Assessment, April 2002
22. Ellsworth AFB, South Dakota, Draft Facility Response Plan, December 2005
23. Ellsworth AFB, South Dakota, Draft Oil/Water Separator Management Plan, June 2008

C. Expanding Requirements

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

1. Executive Order 13423
2. Energy Policy Act 2005
3. Energy Independence and Security Act of 2007
4. Higher Level DoD and HAF directives
5. MAJCOM directives
6. Key Air Force Environmental Goals
7. Other Federal Agency rulemaking and guidance

D. References

The following are publications and websites used as resources:

1. http://epa.gov/
2. http://www.eere.energy.gov/
3. 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
9. http://oaspub.epa.gov/enviro/pcs_det_reports.pcs_tst?npdesid=NE0121789&npvalue=5&rvalue=13&npvalue=7