NASA/SP–2009-572

August 2009

Environmental Sustainability Report 2009

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National Aeronautics and
Space Administration

Ames Research Center
Moffett Field, California 94035-1000

Acknowledgments

The authors would like to thank the many people from throughout NASA Ames and particularly Dr. S. Pete Worden, Center Director, Deborah Feng, Director of Center Operations, and John Adams and Charlotte Barton, of the Logistics and Documentation Services Division, and Gary Martin, Director of the New Ventures and Communications Directorate, Jeff Smith, Deputy Chief, Entrepreneurial Initiatives Division, and Julie Fletcher, Lockheed-Martin, for their support in the production of the report. We also want to thank the many members of the Ames Working Group on Executive Order 13423, Strengthening Federal Environmental, Energy, and Transportation Management, the NASA Ames Research Park Development Office, and the Ames Environmental Management Division and its support services contractor ISSi for providing information and reviewing drafts of the report.

All photographs were provided by NASA or by Free Web Images.

This report was printed on 100% post-consumer waste color copy paper.

This report is available at http://environment.arc.nasa.gov

Available from:

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Hanover, MD 21076-1320
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(703) 487-4650

Letter from the Center Director

"NASA Ames Leadership in Sustainability"

A Culture of Sustainability

Sustainability is an increasingly important principle of doing business in the government, as well as in industry, non-governmental organizations, and academia with whom we interact. Sustainable practices are designed to protect the resources and relationships that will enable NASA to thrive as it carries out its mission across space and time. Sustainable practices include ethics, corporate governance, workplace diversity and inclusion, community involvement (e.g., education, outreach, volunteerism), health and safety, and environmental quality. In this report we focus on Ames environmental sustainability not only as a necessary step to assuring resources are available to sustain future endeavors, but also as a means to demonstrate integrity, assure transparency, provide for inclusion, consider impacts on the larger environment, and protect health and safety of workers and the public.

Dr. Pete Worden
Center Director
NASA Ames Research Center

Letter from the Environmental Management Division Chief

I am pleased to present the first annual Ames Environmental Sustainability Report. This report was produced by the Environmental Management Division of the Operations Directorate. The division collaborated with Engineering and Real Property Management Division, the Logistics Division, and with the Ames New Ventures and Communications Directorate (including the "GreenSpace" Initiative Group).

We encourage you to continue to learn more about the Center's progress toward making Ames one of, if not the greenest Center at NASA. We also encourage you to visit the several websites referenced in the report to learn about the NASA Ames research and development activities that address needs for sustaining missions in the harsh environment of space and the more familiar environment of Earth. Many of these efforts have had or may result in spinoffs that contribute to a more sustainable future for all of us.

Dr. Ann Clarke
Chief, Environmental Management Division
NASA Ames Research Center

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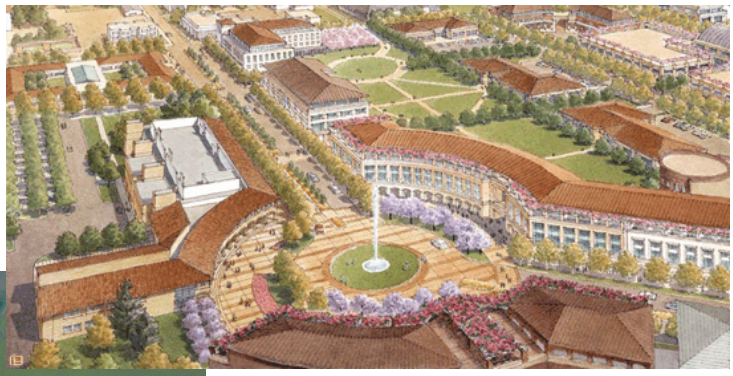
About NASA Ames

NASA Ames Research Center at Moffett Field, California, was founded December 20, 1939 as an aircraft research laboratory by the National Advisory Committee for Aeronautics (NACA). With the passage of the Space Act in 1958, the National Aeronautics and Space Administration (NASA) was created, replacing the NACA.

NASA Ames is one of ten NASA field installations and is uniquely situated at the core of the research cluster of high-tech companies, universities, and laboratories in Silicon Valley that define the region's character. Ames' wind tunnels, office buildings, dirigible and blimp hangars, and airfield are a significant presence in the community. With more than $3.0 billion in capital equipment, 2,300 research personnel and a $600 million annual budget, Ames' economic impact is significant.

Ames is making history by forging ahead with its small, inexpensive satellite missions. This dynamic center is at the forefront in astrobiology, supercomputing, robotic lunar exploration, the search for habitable planets, intelligent/adaptive systems, advanced thermal protection, and airborne astronomy. Ames also develops strategic private sector partnerships to further space exploration, create innovative technologies, and foster interdisciplinary scientific discoveries in Earth and space sciences. To find out more about the exciting work being done at the NASA Ames Research Center visit *http://www.arc.nasa.gov/*

In addition, Ames is redeveloping the former Naval Air Station at Moffett Field into the NASA Research Park (NRP). The NRP will be an integrated, dynamic research and education community cultivating diverse partnerships with academia, industry, non-profit organizations, and other Federal and state agencies in support of NASA's mission. The Center received the General Services Administration Sustainable Design Award in 2003. To find out more about the NRP visit *http://researchpark.arc.nasa.gov/*



Top: Artist rendition of the future NASA Research Park.
Left: A current aerial image of NASA Ames.

Top: U.S.S. Macon on mast in front of Hangar 1 about 1932.
Bottom: NASA Ames Driector S. Pete Worden welcomes the return of a new airship to Moffett Field, Nov. 21, 2008.

Introduction

NASA Ames Research Center's first environmental sustainability report highlights fiscal year (FY) 2008.

In an effort to manage its environmental resources, NASA follows Executive Order (EO) 13423 of January 24, 2007. The EO sets broad goals to strengthen environmental, energy, and transportation management across Federal agencies. It consolidated previously issued EO's and requires Federal agencies to implement environmental management systems (EMS) at all appropriate organizational levels. It then requires the use of EMS as the primary management approach for addressing environmental aspects of internal agency operations and activities, including energy and transportation functions. EMS compliance is equivalent to ISO 14001 compliance.

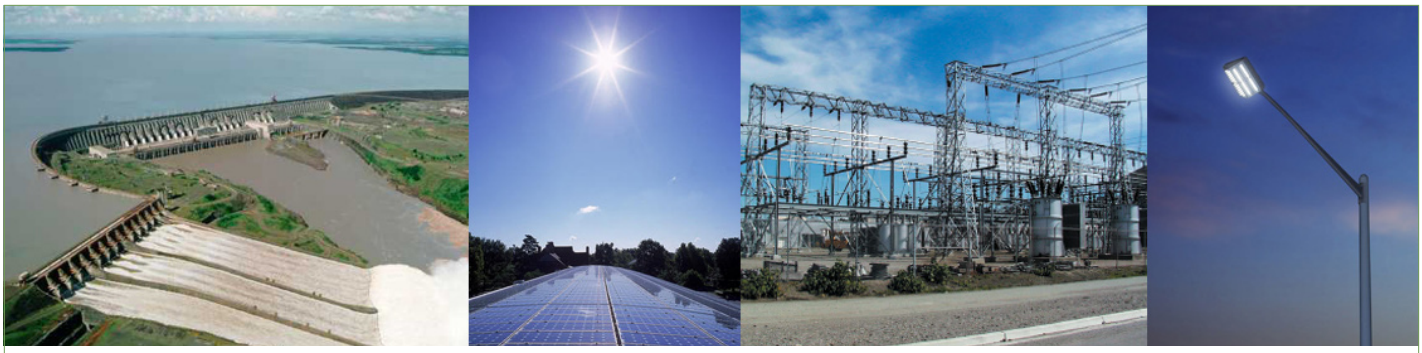
> EO 13423 Definition:
> ***"Sustainable"*** *- creating and maintaining conditions under which humans and nature can exist in productive harmony that permits fulfilling the social, economic, and other requirements of present and future generations of Americans.*

The NASA Ames Environmental Management Division is spearheading an internal Executive Order 13423 Working Group focused on strengthening the Center's environmental management system, including outreach through websites, a variety of forums, and topical fact sheets. It participates in the U.S. Environmental Protection Agency's National Environmental Performance Track Program, the Federal Network on Sustainability, Sustainable Silicon Valley, and other organizations that share information and collaborate in finding common solutions to such challenges as clean transportation, energy and water conservation, chemical management, and green purchasing. NASA Ames recently received the USEPA's Federal Electronics Challenge Bronze Award and is involved in research on biofuels for application in operations at NASA Ames.

Sustainability for NASA Ames is consistent with the Space Act of 1958, NASA policy on Environmental Quality and Control (14 CFR subpart 1216.1) and NASA's strategic goals. NASA Ames' strategic goal is to carry out NASA's mission *"To pioneer the future in space exploration, scientific discovery, and aeronautics research"* in a safe and environmentally sound manner (NASA Strategic Plan 2006). It includes continuing research and development efforts, taking into account its Federal stewardship responsibility to sustain its missions across generations and throughout space. It also includes preserving knowledge that NASA has gained about the Earth's environment and space, and transmitting this knowledge to society. It is working on sustaining NASA's infrastructure including historic aspects such as Shenandoah Plaza National Historic District and national assets such as the Columbia Supercomputer. Ames has a number of activities that are designed to engage our employees in green efforts, including the Annual Earth Day Expo, Sustainability Awards, GREEN seminars, and guest speakers.

> ***The National Environmental Policy Act of 1969***
> The purposes of this Act are: To declare a national policy which will encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the Nation; and to establish a Council on Environmental Quality.

Energy



EO 13423 requirement • Reduce energy intensity by 3 percent annually through 2015 or by 30 percent by 2015. Baseline Agency's energy use in FY03.

Effective energy management is crucial to Ames' sustainability. Ames uses both electricity and natural gas for its power. Energy reliability hinges on supply, quality and price.

Ames purchases electricity from Western Area Power Authority (WAPA), the majority of which is supplied by large scale hydroelectric dams. WAPA power is delivered to Ames over Pacific Gas & Electric (PG&E) power lines.

Ames' major energy users are the wind tunnels, arc jet, and supercomputing facilities. Base power demand is 10 to 20 megawatts. Peak demand can be up to 150 megawatts when running the wind tunnels and arc jet.

WAPA allots Ames 5.3 percent of the daily generating capacity of WAPA hydroelectric dams. This allotment varies day to day as well as seasonally. The price for electricity also varies based on the volume of water available to WAPA. When WAPA has abundant water, Ames' cost per kilowatt hour falls. When the volume decreases as in a drought, NASA's costs may increase.

When Ames exceeds WAPA's electricity allotment, WAPA purchases power for Ames through the California Independent Systems Operators (CAISO), part of the open market for electricity. Electricity through the open market is generally more expensive than WAPA power. In 2008, Ames spent $7.4 million to purchase 167,070 megawatt hours of electricity.

Ames uses natural gas to power boilers for heating water and air, and running air conditioning and ventilation systems. Natural gas is provided to NASA Ames by PG&E via the Defense Energy Support Center. In 2008, NASA Ames spent $3 million to purchase 343,361 thousand cubic feet of natural gas.

The Ames Facilities Engineering Branch has a number of energy-related projects, including prototype LED streetlights and solar-powered parking lot lighting. Additionally, they have rooftop solar panels, a windmill that powers the storm management system, and energy-efficient motion sensor lightswitches in some of the buildings.

Prototype LED Streetlights - In cooperation with Relume Technologies, Ames is currently installing ten prototype LED streetlights around our administration building. These streetlights have a life of 10,000 hours and will use 90 percent less power than the existing streetlights.

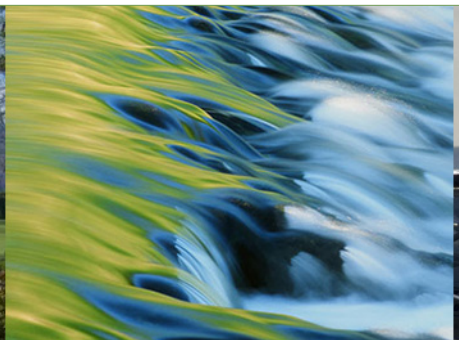
Solar-Powered Parking Lot Lights - Ames installed five SolarOne LED photovoltaic parking lot lights at the Automation Sciences Research building.

Rooftop Solar Panels - Two of Ames' buildings have rooftop photovoltaic solar panels. These panels provide more than 10 kW of power.

Solar-Powered Display Sign - Ames is working on acquiring and installing a solar-powered photovoltaic display sign that will be placed at the Main Entrance. The sign will be used to inform employees and visitors about green projects, events, information, and opportunities at Ames.

Golf Course Parking Lot and Pathway Lighting - Plans are underway to install LED lighting in the parking lot and along the pathways of the Ames Exchange Golf Course.

Water


EO 13423 requirement • Reduce the intensity of water consumption by 2 percent annually through 2015. Baseline is the Agency's water consumption in FY07. *(Good environmental practices carried out by the different agencies have already reduced water consumption by 19.6 percent between 2000 and 2005.)*

Ames' goals are to reduce water use intensity in its processes and to use reclaimed water instead of potable water where feasible.

Ames receives water from the San Francisco Public Utilities Commission whose sources are the Hetch Hetchy Reservoir in the Sierra Nevada Mountains and a local watershed in Alameda County.

Large water uses at Ames include irrigation, cooling towers, interior building use, vehicle and aircraft washing, and food service. Approximately 33 percent of the potable water is used for irrigation. In 2008 Ames spent $1,446,926 to purchase 311.4 million gallons of water.

Only 10 to 20 percent of water used at Ames is from reclaimed water sources. The rest is from potable water sources. The golf course is the only current user of reclaimed water, which is generated at the Sunnyvale Wastewater Treatment Plant.

Wastewater from groundwater treatment, cooling tower sump clean-outs, interior buildings, vehicle and aircraft washing, and food service activities is either sent to the Palo Alto Regional Water Quality Control Plant, to the Sunnyvale Wastewater Treatment Plant, treated at the Industrial Wastewater Pretreatment Plant then discharged to Palo Alto, or discharged directly to Stevens Creek. In 2008, Ames spent $408,606 in fees to dispose of 139.3 million gallons of wastewater.

Ames' contaminated groundwater is cleaned by granular activated carbon filtration and released to Stevens Creek at a rate of 20 gallons per minute. The groundwater is treated to remove chlorinated solvents, such as trichloroethylene. A recent project has been proposed to use this in place of potable water for industrial cooling. Ames is undertaking several initiatives to protect water quality and reduce potable water consumption.

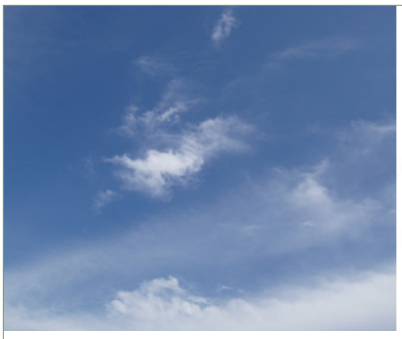
Ames Environmental Management and Facilities Engineering Divisions implemented native plant landscaping. They also maintain an active compost pile.

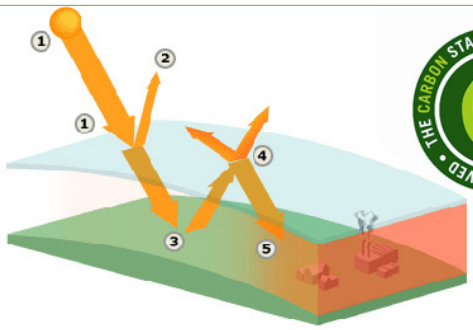
Native Demonstration Gardens - Ames has planted native demonstration gardens in front of our cafeteria and supercomputer buildings. These projects help NASA Ames meet the EO 13423 and EO 13112 requirements to reduce pesticide, herbicide, fertilizer, water, and fuel use, and to minimize the risk of introducing invasive species. The demonstration garden in front of the cafeteria met the USEPA National Performance Track 2006–2009 goals. The gardens save as much as 6000 gallons of water per week in the summer.

Moffett Field Golf Course - The Moffett Field Golf Course uses 30 to 60 million gallons of potable water per year for irrigation. This represents 10 to 20 percent of Ames' potable water use. Ames worked with the City of Sunnyvale to replumb a part of the irrigation hardware so the Golf Course can use reclaimed water. The Golf Course project is estimated to cost $460,000 and yield a 5.1 year payback.

Clean Water Holding Capacity - Ames is considering increasing its clean water holding capacity for treated wastewater at the Industrial Wastewater Pretreatment Plant. This would allow the plant to send back more water to the Unitary and Arc Jet cooling towers and reduce Ames' annual potable water purchase by 20 million gallons, saving more than $93,000 per year.

Air





EO 13423 requirement • Reduce greenhouse gas (GHG) emissions by decreasing energy intensity by 3 percent annually or 30 percent by 2015. *(Good environmental practices carried out by the different agencies have already reduced its GHG emissions by 22.1 percent between 1990 and 2005.)*

Besides the above requirement, the EO also requires that at least 50 percent of current renewable energy purchases come from new renewable sources under Energy Policy Act (EPAct) 2005. This requirement will intensify use of carbon-neutral energy sources and lower GHG emissions.

As an active research center, Ames requires clean air in its operations and under various regulations is allowed to generate air pollution from these operations. Table 1 lists the major pollution sources and control systems.

The Toxics Release Inventory (TRI) tracks pollutants in an annual report to the Environmental Protection Agency (EPA). TRI has thresholds for air, waste, and water releases. Ames is required to report releases and emissions for certain chemicals above certain thresholds. These chemicals include:

- HCFC-22 – refrigerant in HVAC system
- Xylene – in jet fuel and in solvent cleaning
- Toluene – in jet fuel and in solvent cleaning
- Ethylbenzene – in jet fuel

While carbon dioxide (CO_2) is not currently a regulated pollutant, the gas is emitted into the atmosphere as a result of Ames' energy usage.

Ames has one of the most comprehensive air-quality monitoring programs in the Federal government. The data is used to make informed decisions on how to demolish or retrofit older buildings, and design and operate new buildings to assure a healthy work environment.

To assure air quality, Ames has undertaken several initiatives — some of which are highlighted here.

CO_2 emissions reduction agreement - Ames has signed onto a CO_2 emissions reduction agreement with the Sustainable Silicon Valley (SSV). SSV set a regional goal to reduce CO_2 20 percent by 2010, using a 1990 baseline level. Moving beyond SSV's partnership agreement, Ames has set a goal of 30 percent reduction of CO_2 by 2010. Ames Earth Science Division is also actively involved in analyzing changes in the atmosphere of the Earth and developing data applications for other agencies such as the EPA, National Weather Service, and the U.S. Forest Service to benefit the larger user community.

Fleet Management - The Ames Transportation Branch manages the Motor Pool, which is a fleet of flex-fuel vehicles from the General Services Administration. This fleet includes vehicles that can use either ethanol or gasoline. In addition, they have compressed natural gas (CNG) vehicles and Global Electric Motorcars (GEM), and green products are used to maintain them.

Table 1: Major Air Pollution Sources And Controls At Ames.

Air Pollution Source	Pollution Control System
Vehicular traffic	Federal and state emission controls
Aircraft operations	Aircraft emission controls
Boilers (natural gas combustion)	Bay Area Air District emission controls
Paint and resin spray booths	Filter/water wash spray, low volatile organic compound coatings
Solvent cleaning and operations	Tightly closed tanks and containers, high boiling point (low volatility) solvents
Fuel dispensing stations	Vapor recovery systems
Thermal Protection Laboratory Arc Jets	2-stage scrubber— vacuum-holding sphere and tower
Wind tunnel testing of powered models	Bay Area Air District emission controls, air credits

Material

EO 13423 requirement • Take part in an integrated Federal purchasing effort of environmentally-sound goods and services, bio-based products, and environmentally preferable products. Maintain the requirement that agencies purchase office paper containing 30 percent postconsumer fiber.

Consistent with Federal policy, Ames strives to procure recycled content, bio-based, energy-efficient, environmentally preferable products (EPP) to meet the EPA Comprehensive Procurement Guidelines (CPG) and the U.S. Department of Agricultures bio-based product requirements wherever feasible. Buying EPPs has many benefits, including supporting a market for recycled and energy efficient products, protecting employee health, and protecting the environment.

With increasing quality and decreasing cost of EPPs, the opportunities to buy green continue to expand. Ames tracks purchasing of many environmentally preferable items on EPA's CPG list, including:

- Building insulation (recycled content)
- Carpeting (recycled content)
- Sanitary tissue (recycled content)
- Concrete (fly ash content)
- Floor tiles (recycled content)
- Latex paints (low volatile organic compound)
- Motor vehicle tires (retreated)
- Paper products (recycled content)
- Re-refined oil (recycled)
- Toner cartridges (remanufactured and refilled)

Ames is required to guarantee annually that 95 percent of electronic products purchased meet Electronic Product Environmental Assessment Tool standards where applicable, enable Energy Star® features on 100 percent of computers and monitors, and reuse, donate, sell, or recycle 100 percent of electronic products using environmentally sound management practices.

Knowledge Sharing - The Environmental Management Division works with the Acquisition Division and the Chief Information Officer to share information with the Ames community about environmentally preferable products and Electronic Product Environmental Assessment Tool (EPEAT) computers.

Green Janitorial Products - The Logistics and Documentation Services Division implemented contract requirements for green janitorial products and initiated pilot programs to test bio-based products. An example of this is the janitorial contract that now requires supply and use of Green Seal certified bathroom paper and towels.

The Motor Pool - pilot tested Smartwasher, a microbe-based parts washer that uses a soy-based penetrating lubricant product to replace conventional petroleum based penetrating lubricant. It also tested a bio-based (soy) lubricating fluid that protects parts after they have been cleaned. These have both proven suitable and are in use at the motor pool and other locations.

Biodegradable Takeaway Containers - The Ames Exchange now features green, biodegradable takeaway cups, containers, and cutlery in the Cafeteria and organic menu items at the Golf Course Grill.

NASA Ames cafeteria "Mega Bites".

Waste

EO 13423 requirement • Reduce use of chemicals and toxic materials and purchase lower risk chemicals and toxic materials from top priority list.

Ames has programs that recycle paper, batteries, printer cartridges, bottles, cans, cardboard, building material, electronic waste, metal waste, and computers.

Waste generated at Ames mirrors the overall commercial sector for California. The goal is waste divertion – to divert waste from landfill to reuse.

Solid Waste: Landscape waste, scrap metal, demolition debris, asphalt, paper and cardboard represent the major materials that Ames diverts for recycling. While Ames has many different types of material for recycling, many recyclable materials are still going into the trash. The challenge is to divert more recyclable materials from the waste stream into the recycling stream.

Ames has achieved a 67 percent recycling diversion rate due to the hard work and coordination of many of the staff at Ames as well as the Center's proximity to California recycling markets.

Hazardous Waste: NASA is subject to the Resources Conservation and Recovery Act (RCRA), a cradle-to-grave requirement, and other Federal, State, and local hazardous material and waste requirements. Oil-related waste, contaminated soils, polychlorinated biphenyl (PCB) oil from transformers, demolition debris with non-RCRA waste and asbestos were the most common waste streams in 2008. Ames disposes 200 tons of hazardous waste per year, mostly soil by weight.

The following are a few examples of pollution prevention programs at Ames.

Food compost - The Exchange is working with the Environmental Management Facilities Engineering and Logistics Division to establish food composting.

Bioremediation - Ames scientist, Dr. Kenneth Cullings, and his team have been conducting research to identify candidate microorganisms and substrates to degrade waste products. Using genes isolated from naturally occurring forest soil fungi, they are creating bio-engineered "packages" that will clean up human byproducts such as petroleum-based solvents and fuels from past activities at Ames. Traditional pump and treat systems will remove some contamination but over time become less efficient relative to their operational cost. Bioremediation offers a lower cost solution for removing contamination.

The Ames Chemical Exchange (ACE) - accepts donations of Ames's hazardous materials that have been purchased but not opened, and then makes them available to other members of the NASA Ames community for free. ACE saves the Center money by avoiding unnecessary purchases, avoiding disposal costs, and returning unused materials to suppliers (such as gas cylinders).

Ames Electronics Recycling Events - Ames participates in the Federal Electronics Challenge, which encourages Federal agencies to recycle electronics such as computers. At the most recent event, organizers collected 20,000 lbs. of computers, cell phones and other electronic wastes for recycling. The Environmental Management Division, in coordination with Logistics and computer manufacturers, recycle styrofoam packaging.

Mercury Thermometer Exchange Program - The Environmental Management Division exchanges mercury thermometers for citrus oil thermometers. Mercury thermometers are disposed of as hazardous waste. This program has resulted in a reduction of 5.4 lbs of mercury at Ames.

Transportation



EO 13423 requirements • Increase purchase of alternative fuel, hybrid, and plug-in hybrid electric vehicles when commercially available. Reduce petroluem consumption in fleet vehicles by 2 percent annually through 2015 from 2005 baseline. Increase alternative fuel consumption at least 10 percent annually. Baseline is previous years consumption.

Green Transportation is a revolution in the way people get around and is critical to mitigating the effects of climate change. Transporting people and goods encompasses ~30 percent of the total energy used in the United States.

Ames has promoted alternative commute programs such as ride sharing, telecommuting, offering subsidized employee public transportation passes, and participating in Bike-to-Work-Day.

Ames Motor Pool - uses green products to maintain its fleet, recycles antifreeze, and uses recapped tires on the vehicles. GEM vehicles are battery-electric and operate on a 72-volt battery system that plugs into a standard 110-volt outlet. Other vehicles are bi-fuel vehicles burning one fuel at a time. Their engine is a standard gasoline internal combustion engine. This means that they can run on either gasoline from a gasoline tank or CNG from a separate cylinder. The driver can select what fuel to burn by flipping a switch on the dashboard.

Green Aviation - Ames has been working on Green Aviation projects that strive to reduce the impact of aviation on the environment. These projects are aimed at improving aircraft fuel efficiency, developing the next generation of efficient air traffic control, and developing new technologies and systems engineering processes to advance the future of carbon-neutral air transportation across the globe.

The Future - Air Traffic Management Concepts Evaluation Tool (FACET), developed at Ames, was selected as NASA's 2006 Software of the Year. FACET is a flexible software tool that provides powerful simulation capabilities and can rapidly generate thousands of aircraft trajectories to enable efficient planning of traffic flows at the national level.

FACET has transitioned from the NASA laboratory to national operational use. Technologies derived from FACET have been incorporated into the FAA's traffic management system, which is used by more than 500 air traffic managers at 100 sites nationwide. NASA has licensed the FACET software to Flight Explorer®, Washington, a leading vendor of flight operations management tools that are used by nearly 5,000 dispatchers at more than 600 customer sites including 80 percent of major United States airlines. FACET is a component of a growing suite of air traffic management tools developed at Ames.

SkyTran - Ames has formed a partnership with Unimodal Systems, LLC, who intends to develop SkyTran, a solar-powered high-speed personal rapid transit system to transport people throughout the Ames Campus.

An artist concept of SkyTran.

Land Use

Black-tailed jack rabbits, western burrowing owl, golden eagle, and grey foxes at Ames.

In addition to its efforts highlighted in previous sections, Ames has responsibilities for the stewardship of the natural resources occuring at Ames or that may be affected by activities at Ames.

The fresh and saltwater marshes, wetlands, and grasslands at Ames are home to several threatened or endangered species, including the Western burrowing owl, grey fox, salt marsh harvest mouse, salt marsh common yellowthroat, clapper rail, snowy plover, loggerhead shrike, white-tailed kit, Northern harrier, golden eagle, horned lark, American peregrine falcon, and the Western pond turtle.

Mitigation measures have been taken to reduce human impact and protect these species. For example, currently 81 acres are a protected burrowing owl habitat. The number of owls varies from year to year, but generally 15 to 25 pairs are present during the breeding season, which is between February and the end of September. The number of salt marsh harvest mice at Ames is unclear since the U.S. Fish and Wildlife Services (USFWS) grants few permits to survey these animals. The USFWS is concerned that their delicate habitat would be damaged by surveying and a management plan is being implemented. Instead, pickleweed sites are cordoned off during activities that could impact the species. A survey of western pond turtles has been completed.

Wildlife Habitat Protection - Ames is a member of the Partners-in-Flight, an international partnership sponsored by the Federal government to conserve migratory birds in the Western Hemisphere. Ames is responsible for one of the few remaining populations of burrowing owls in the San Francisco Bay area and is implementing a Management Plan consistent with the Migratory Bird Treaty Act and in support of Partners-in-Flight goals.

Urban Wildlife - Ames also hosts common species such as skunks, gophers, tree squirrels, pigeons, and rats, for example. Ames implements an Integrated Pest Management Program collaborating with the U.S. Fish and Wildlife Service, California Department of Fish and Game, and local entities. Ames is working to eliminate food sources such as from open dumpsters, artificial feeding, and landfills to avoid these species from becoming wildlife pests.

South San Francisco Bay Salt Pond Restoration Project - Ames is acquiring the Northern Channel from Cargill for storm water management and spill control. Ames will grant an easement to the U.S. Fish and Wildlife Service to manage a portion of a levee as part of the 500-mile bay trail, and thereby contribute to the public access goals of the interagency Salt Pond Restoration Project. The Navy, in coordination with NASA, has cleaned up contamination in the Northern Channel and restored vegetation. NASA and the Navy have worked together to conserve the Western pond turtle.

Shoreline Study - Ames slopes from grassy uplands to marsh. The northern portion is in places 12 feet below mean sea level due to agricultural pumping up until the mid-1900s. The campus is protected from flooding by levees and is a cooperating Agency with the U.S. Army Corps of Engineers in its shoreline feasibility study to determine whether and how to upgrade the levees. This joint effort is crucial to the long-term sustainability of Ames if predictions by the California Bay Conservation and Development Commissions of increasing sea levels prove true.

Native Plants – Ames participates in the Federally led Plant Conservation Alliance. In furtherance of Federal goals to restore native plants and mitigate invasive species, Ames has converted more than 3 acres to California drought resistant native plants.

Facilities

EO 13423 requirement • New construction and major renovation of agency buildings comply with the Guiding Principles, and 15 percent of the existing Federal capital asset building inventory of the agency as of the end of fiscal year 2015 incorporates the sustainable practices of the Guiding Principles.

The investment made in a building throughout its life cycle is significant when you consider the capital and architectural costs, and operating costs such as maintenance, replacement, energy, water, and disposal. Green buildings as well as green building materials for building renovations offer cost savings from a life cycle cost perspective.

Currently there are 127 buildings on the Ames campus, with total interior space of more than 3 million square feet. As Ames or its partners and resident agencies renovate or implement "renovation by replacement", opportunities to incorporate green building design elements will save the Center operating costs.

About 70 percent of facilities in the NASA Research Park and Eastside/Airfield are beyond their expected life cycle. In the Ames Campus, this proportion is 44 percent. NASA requires all new buildings and renovations to meet the Leadership in Energy and Environmental Design Silver standard.

NASA Policy Directive 8820.2C, Design and Construction of Facilities, commits NASA to the following:

"Industry-best practices of sustainable design, maintainable design, building commissioning, and safety and security shall be incorporated, to the maximum extent possible, into the planning and execution of facility projects. The use of these practices ensures that facility projects are delivered with the most economical life-cycle cost, least environmental impact, and maximum benefits in occupant's health, safety, security and productivity."

There are currently no new buildings under construction at Ames, so the Engineering and Real Property Management and the Environmental Management Division have been focused on selecting green building materials and equipment for building renovations. Some of the green building projects are: "cool roof" buildings, which use white reflective coating to keep the building temperatures cool; installing solar panels; and some buildings have carpets made from recycled bottles.

In the near future Ames is planning several green building construction projects.

New Green Building - Ames is currently designing a revolutionary new green building that will incorporate the latest green technologies and space technologies to create and demonstrate a one-of-a-kind office building.

Artist illustration of the new NASA Ames green building.

Sustainable Community for Education and Research - Another project is a dynamic new partnership with the University of California, Santa Cruz (UCSC) and Foothill-De Anza Community College District to establish a sustainable community for education and research at

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the NASA Research Park. UCSC and Foothill-De Anza have formed University Associates - Silicon Valley LLC, which signed a land lease with Ames in December 2008 for 75 acres of land in the NASA Research Park. Work on the site could begin as early as 2013, with initial occupancy as early as 2015.

Google Green Facility - Ames has leased land to its neighbor Google to construct Google's 1 million square foot new green facility consistent with NASA sustainable design policies.

Google Parnterships - The preservation or sustaining of knowledge that Ames has gained about the Earth's environment and space is another sustainability issue that Ames is addressing. Ames has partnered with Google on several projects: Google Earth, Google Moon, and Google Mars. The projects preserve and provide images, maps, and other information collected from NASA Earth and space missions over the past 40 years to the public.

Lunar Image Recovery Project - Ames is leasing an abandoned fast-food restaurant in the Shenandoah Plaza National Historic District as a place to convert analog data from 48,000 lbs of original 2 inch tapes from the five Lunar Orbiter Missions into digital form and made available for public use.

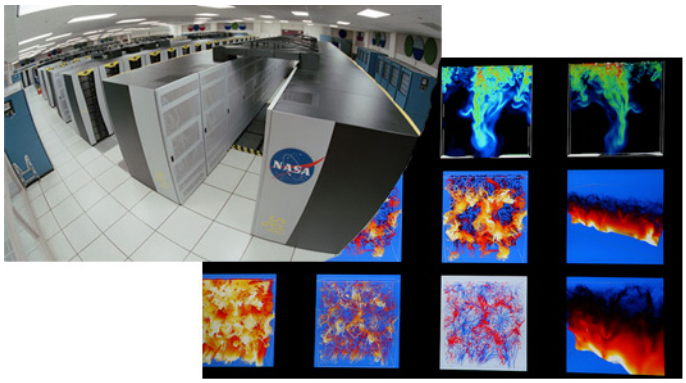
Hangar Reuse - Ames is reusing vacant hangars in partnership with other entities such as Airship Ventures and H211 LLC that have agreed to fly airborne instruments, the data from which are used in Earth Science applications.

Nationally Significant Facilities - In coordination with NASA Headquarters, Ames has stewardship responsibilities for sustaining nationally significant facilities. These facilities carry out research and development work contributing to general sustainability efforts. Ames is working to "green" these facilities since they have substantial energy, water, and other resource requirements.

NASA Advanced Supercomputing Facility

The NASA Advanced Supercomputing Facility (NAS) was dedicated in March 1987. It was established to act as a pathfinder in advanced, large-scale computing system capabilities through the use of the latest hardware and software technology and to house NASA Ames' supercomputers. In 2004, the NAS Division co-developed, with industry partners SGI and Intel, what was initially the fastest supercomputer in the world. Named Columbia, the supercomputer is a 10,240-processor SGI Altix supercluster. Columbia remains NASA's fastest supercomputer, and it is used by scientists and engineers at almost every NASA center.

Columbia was intentionally designed using sustainability principles by creating platforms which allow continuous upgrading of systems. The new uninterruptible power supply system will use quiet and clean technology. In 2008, the NAS team cut the need for one 450-ton chiller decreasing the need for 11 megawatts of power. It also increased the computing power eight-fold making it the third fastest computer in the world. Visit the NAS website at http://www.nas.nasa.gov/



Above: The Columbia supercomputer. Below: hyperwall displaying Columbia computational data.

Arc Jet Laboratory

The Ames Arc Jet Laboratory began in the 1950's, with the founding of a permanent facility in 1961. The Arc Jet is key for customers involved in the three major areas of Thermal Protection System (TPS) development: selection, validation and qualification. The arc jet data are critical for validating TPS thermal models, heat shield designs and repairs, and ultimately, for flight qualification.

An arc jet is a device in which gases are heated and expanded to very high temperatures by a continuous electrical arc between two sets of electrodes at supersonic/hypersonic speeds. The gases pass through a nozzle aimed at a test sample in vacuum, and flow over it, producing a reasonable approximation of the surface temperature, pressure, and the gas enthalpy found in a high velocity, supersonic flow of the kind experienced by a vehicle on atmospheric entry. A breakthrough

patented design in 1964 by Stein, Sheppard and Watson of Ames produced a high-enthalpy constricted-arc heater, which enabled TPS studies required for development of the Mercury and Apollo missions. Ames is currently developing a Frisbee-shaped heat shield to be attached to the base of the cone-shaped crew module of its next, new spaceship, the Crew Exploration Vehicle.

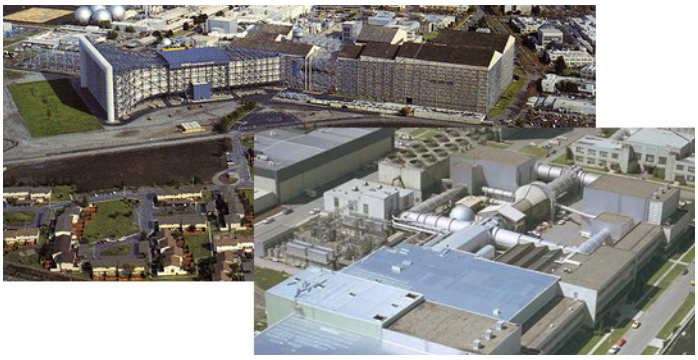
Teflon calibration test in the NASA Ames' Arc Jet Interaction Heating Facility.

The Arc Jet laboratory management is examining opportunities to improve its environmental impact by utilizing excess steam to power other needs at NASA Ames, reducing potable water use by recycling water, and reducing air emissions by upgrading its boiler system. Find out more about the Arc Jet at http://www.nasa.gov/centers/ames/research/technology-onepagers/arcjetcomplex.html

Wind Tunnels

The original Ames 40- by 80-Foot Wind Tunnel was constructed in 1944 as an experimental facility for researching and testing aircraft, later tests included first-generation jet engines, advanced rotor techniques, and peripheral space use testing. It has the largest wind tunnel test sections in the world, consisting of the 40- by 80-Foot test section and the 80- by 120-Foot test section.

The Unitary Plan Wind Tunnel is the most heavily used NASA wind tunnel. Every major commercial transport and almost every fighter aircraft built in the United States over the last fifty years has been tested in this tunnel. In addition, models of the Space Shuttle and of the Mercury, Gemini, and Apollo capsules were tested at this facility. More than 1,000 test programs have been conducted in these tunnels, totaling over 60,000 hours of operation.



Above: National Full-Scale Aerodynamics Complex. Below: Unitary Plan Wind Tunnel.

The Unitary Plan wind tunnel was designed from the start using sustainability principles by centralizing and scheduling its power supply. Visit the wind tunnel website at http://www.windtunnels.arc.nasa.gov/

Airfield

Moffett Federal Airfield (MFA), formerly part of the Naval Air Station (NAS) Moffett Field, is currently operated by NASA Ames. NASA has continued the tenant program begun by the Navy, hosting several other organizations at MFA including the Naval Reserve, the California Air National Guard, and most recently, Airship Ventures flying a commercial Zeppelin NT airship.

Moffett Federal Airfield with Hangar 1 on the left.

NAS became a major center for the development and testing of new aviation and flight-related technology in the 1940s. After the attack on Pearl Harbor, the military decided it needed aircraft to patrol the Pacific for submarines and mines, and the Navy responded by restarting the blimp project. As many as 20 blimps at a time were on duty at the base during the war years, and Moffett Field had an excellent record of ship and mine detection. During the 1950s and 1960s, NAS served as a major naval air transport base. In the 1970s, NAS returned to its original mission of long-range reconnaissance and anti-submarine patrols with the arrival of the Navy's newest anti-submarine aircraft:

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the P-3 "Orion." By 1973, aircraft based at Moffett Field were responsible for patrolling approximately 93 million square miles of the Pacific Ocean, an area stretching from the coast of Alaska to Hawaii. On July 1, 1994, the military base was closed and Ames assumed control of the airfield.

MFA has two fully instrumented parallel runways, four aircraft maintenance hangars, and 472,300 square yards of aircraft parking apron. Hangar 1, one of the best-known landmarks in the Bay Area, was constructed for the U.S.S. Macon. The Macon was intended to provide long-range reconnaissance for the Pacific Fleet, but it flew only eight missions before it crashed off the coast of Monterey in 1935.

The Hangar 1 interior covers eight acres and can accommodate 10 football fields. In 1997, NASA Ames discovered an unusual toxin called a polychlorinated biphenyl (PCB), specifically Aroclor 1268, in the Center's storm drain settling basin. Subsequent sampling programs determined that the coating on the exterior metal siding was the source of the contaminate. As a result of the high levels of PCBs, Hangar 1 was closed for human use as required by the Toxic Substance Control Act (TSCA). The Navy is reviewing alternatives for remediating the contamination. To find out more about Hangar 1 visit *http://www.nasa.gov/centers/ames/home/2008/hangar_index.html*

NASA Ames' Hangar 1.