National Park Service
U.S. Department of the Interior

CLIMATE*Friendly* PARKS

Grand Canyon National Park Action Plan

CLIMATE*Friendly* PARKS
Empowering parks to address climate change

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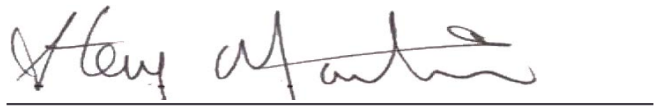
Message from the Superintendent

Grand Canyon National Park is committed to reducing its carbon footprint through strategic sustainable planning and action. We strive towards a vision of carbon neutrality by continuously reducing the amount of greenhouse gases (GHG) from consumption of energy and water, use of transportation, and generation of waste. Each year we will evaluate our emissions output through an inventory process which will measure the success of the mitigation actions highlighted in this plan. We will educate our employees, partners, and visitors about climate change through demonstrated action and increased educational efforts. Finally, the park will explore adaptive solutions to regional climate change issues along with partners, universities, and other experts. By creating a climate of action, Grand Canyon will meet the goal of reducing GHG emissions by 30% in 2020 while reaching far beyond the park boundaries to increase awareness and positively influence our global visitors.



Steve P. Martin
Superintendent, Grand Canyon National Park

GRAND CANYON NATIONAL PARK BECOMES A CLIMATE FRIENDLY PARK

As a participant in the Climate Friendly Parks program, Grand Canyon National Park belongs to a network of parks nationwide that are putting climate friendly behavior at the forefront of sustainability planning. By conducting a GHG emission inventory, setting a GHG emission reduction goal, evaluating adaptation scenario planning process, developing this Action Plan, and committing to educate park staff, visitors, and community members about climate change, Grand Canyon National Park provides a model for climate friendly behavior within the park service.

Grand Canyon National Park has contributed to improving the environment through implementation of a variety of programs and projects. Sustainable operational practices implemented include the transition to an alternative-fuel/hybrid fleet, photovoltaic panels at the primary visitor center, an extensive recycling program, employing LEED (Leadership in Energy and Environmental Design) building practices for new structures, "Green" purchasing, and an extensive mass transit shuttle system that utilizes clean alternative fuel.

This Action Plan describes measures the park will take to reduce its GHG emissions. In addition to implementing these measures, Grand Canyon National Park will:

- Utilize the Environmental Management System to measure progress with respect to reducing emissions and preserving natural and cultural resources and infrastructure.
- Identify additional actions to reduce GHG emissions and preserve natural and cultural resources and infrastructure, as necessary.
- Periodically assess and revise this Action Plan to strengthen existing actions and include additional actions.

THE CHALLENGE OF CLIMATE CHANGE

Climate change presents significant risks and challenges to the National Park Service and specifically to Grand Canyon National Park. Scientists cannot predict with certainty the general severity of climate change nor its impacts. Average global temperatures on the Earth's surface have increased about 1.1°F since the late 19th century, and the 10 warmest years of the 20th century all occurred in the last 15 years. The single leading cause of this warming is the buildup of GHGs in the atmosphere—primarily carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) —which trap heat that otherwise would be released into space.

The continued addition of CO_2 and other GHGs to the atmosphere will raise the Earth's average temperature more rapidly in the next century; a global average warming of 4-7°F by the year 2100 is considered likely.[1] Rising global temperatures will further raise sea levels and affect all aspects of the water cycle, including snow cover, mountain glaciers, spring runoff, water temperature, and aquatic life. Climate change is also expected to affect human health, crop production, animal and plant habitats, and many other features of our natural and managed environments.

[1] IPCC 2007. Climate Change 2007: The Physical Science Basis. Intergovernmental Panel on Climate Change, Geneva Switzerland. Available online at < http://ipcc-wg1.ucar.edu/wg1/wg1-report.html>

At Grand Canyon National Park, increasing temperatures and changing precipitation patterns may alter park ecosystems, changing vegetation communities, habitats available for species, and the experience of park visitors. Possible challenges associated with global climate change to Grand Canyon ecosystems are migrations of vegetation and wildlife to new habitats, habitat fragmentation, occurrence of more frequent or intense droughts, increases in insect populations due to longer frost-free seasons, increase in frequency and intensity of wildfires and floods, and changes to water flows in the Colorado River. Challenges to cultural resources and infrastructure may occur from increased flooding, rockslides, wildfires, and heavy, seasonal storms. Potential exists for increases to air pollution, as well as energy requirements for seasonal air conditioning or heating. Finally, park operations will be affected through demand increases for emergency services due to heat-related illness, wildfires, and flooding.

GOALS AND OBJECTIVES

This Action Plan identifies steps that Grand Canyon National Park can take to reduce GHG emissions and adapt to current and future impacts of climate change. The plan presents the Park's GHG emission reduction goals, and associated reduction actions and adaptation strategies to achieve the Park's goals. Strategies and action plan items were developed by working groups at Grand Canyon's Climate Friendly Parks Workshop[2] and additional post-workshop follow-up meetings. While the plan provides a framework needed to meet the park's GHG emission reduction and adaptation goals, it is not intended to provide detailed instructions on how to implement each of the proposed measures. The park's Environmental Management System and Green Team are tasked with assessing priorities and details to implement these actions.

Grand Canyon National Park intends to:

- *Reduce greenhouse gas (GHG) emissions from park operations by 30 percent below 2008-level by the year 2020.*

- *Plan and implement measures that best allow the Park's natural and cultural resources to adapt to the impacts of climate change.*

To meet these goals, the park will implement strategies proposed in this plan that relate to the Park's current and future emission inventories. Specifically, the plan recommends four strategies:

Strategy 1: Reduce GHG emissions resulting from activities within and by the park.

Strategy 2: Develop and implement a plan to adapt to current and future impacts of climate change.

Strategy 3: Increase climate change education and outreach.

Strategy 4: Monitor progress and identify areas for improvement.

[2] Original notes from these workshops, including detailed action items not presented in the final plan, have been archived by Grand Canyon National Park and are available upon request.

GREENHOUSE GAS EMISSION INVENTORY AT GRAND CANYON NATIONAL PARK

Naturally occurring GHGs include CO_2, CH_4, N_2O, and water vapor. Human activities (e.g., fuel combustion and waste generation) lead to increased concentrations of these gases (except water vapor) in the atmosphere.

Greenhouse Gas Emissions

GHG emissions result from the combustion of fossil fuels for transportation and energy (e.g., boilers, electricity generation), the decomposition of waste and other organic matter, and the volatilization or release of gases from various other sources Grand Canyon National Park GHG emissions come from day-to-day park operations such as providing shuttle buses, waste water treatment, trash management, and moving water from the inner canyon via pipeline to the South Rim. Concessions operations also contribute to GHG emissions in their daily operations by providing services to guests such as lodging, dining, mule operations, guest shuttles, and retail operations.

In 2008, GHG emissions within Grand Canyon National Park totaled 55,471 metric tons of carbon dioxide equivalent ($MTCO_2E$). This includes emissions from park and concessioner operations and visitor activities, including vehicle use within the park. For perspective, a typical single family home in the U.S. produces approximately 11 $MTCO_2E$ per year.[3] Thus, the combined emissions from park and concessioner operations, and visitor activities within the park are roughly equivalent to the emissions from the electricity use of 7,694 households each year.

The largest emission sector for Grand Canyon National Park is energy, totaling 30,955 $MTCO_2E$ (Fig 1 and Table 1). Purchased electricity comprises 63% of emissions from energy, and 35% of the park's overall emissions. Much of the purchased electricity in the park is used by concessioners. Emissions from park operations, which exclude emissions from visitor and concessioner activities, totaled 15,985 $MTCO_2E$ (Figure 2 and Table 2). Similar to total park emissions, park operations emissions were mainly comprised of emissions from energy sources, totaling 1,208 $MTCO_2E$ (70%).

[3] U.S. EPA, Greenhouse Gases Equivalencies Calculators – Calculations and References, Retrieved , Website: http://www.epa.gov/RDEE/energy-resources/calculator.html

FIGURE 1

Grand Canyon National Park 2008 Total Greenhouse Gas Emissions by Sector

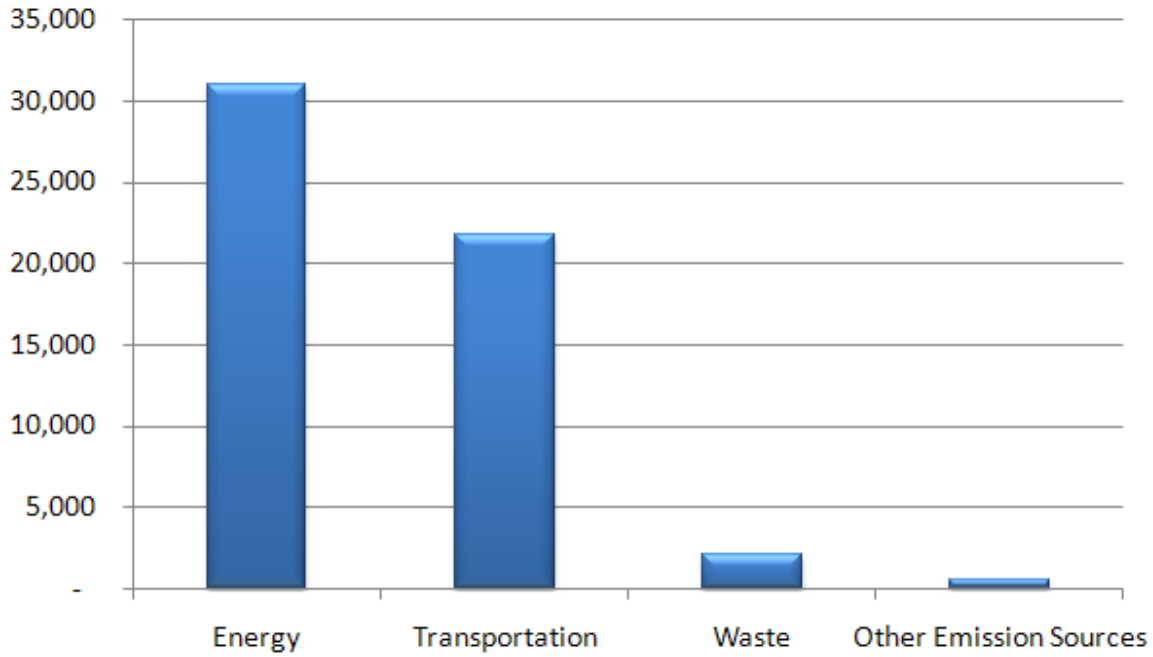


TABLE 1

Grand Canyon National Park 2008 Total Greenhouse Gas Emissions by Sector and Source

	Emissions (MTCO2E)	% of Total
Energy	30,955	55.8%
Stationary Combustion	11,520	20.8%
Purchased Electricity	19,435	35.0%
Transportation	21,811	39.3%
Mobile Combustion	21,811	39.3%
Waste	2,149	3.9%
Solid Waste Disposal	1,887	3.4%
Wastewater Treatment	262	0.5%
Other Emission Sources	556	1.0%
Refrigeration	554	1.0%
Fertilizer	2	0.0%
Total Emissions	55,471	

Note: Totals may not sum due to rounding

FIGURE 2

Grand Canyon National Park 2008 Park Operations Emissions by Sector

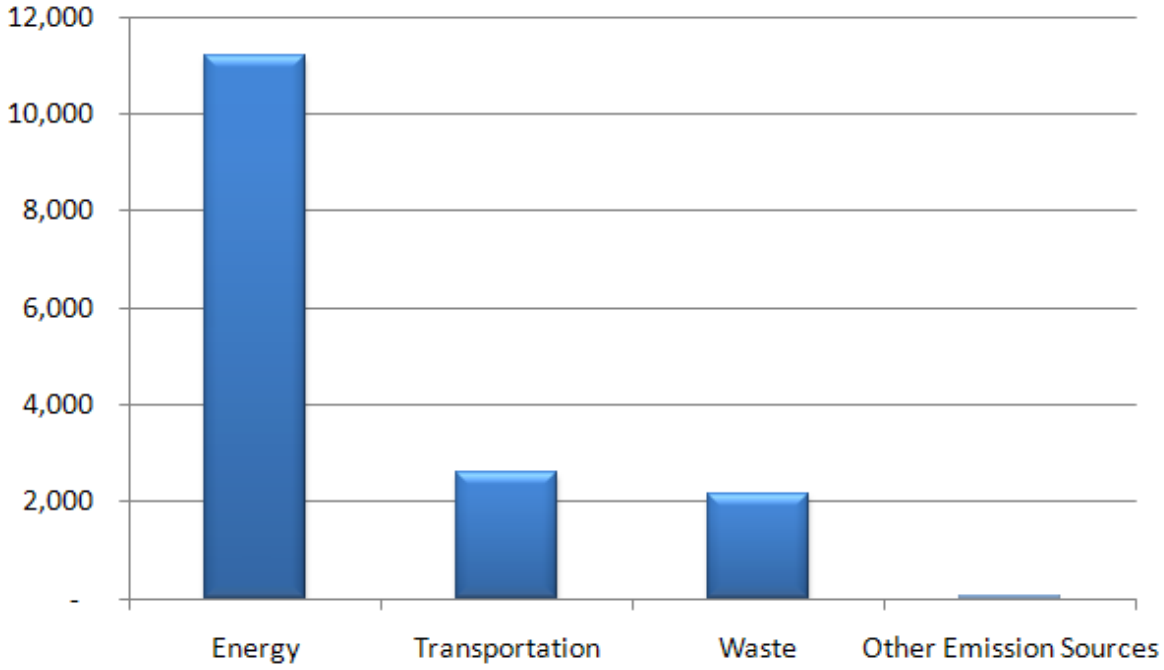


TABLE 2

Grand Canyon National Park 2008 Park Operations Emissions by Sector

	Emissions (MTCO2E)	% of Total
Energy	11,208	70.1%
Stationary Combustion	3,701	23.2%
Purchased Electricity	7,507	47.0%
Transportation	2,585	16.2%
Mobile Combustion	2,585	16.2%
Waste	2,149	13.4%
Solid Waste Disposal	1,887	11.8%
Wastewater Treatment	262	1.6%
Other Emission Sources	44	0.3%
Refrigeration	44	0.3%
Total Emissions	15,985	

Note: Totals may not sum due to rounding

Grand Canyon National Park Responds to Climate Change

The following actions were developed during the CFP workshop hosted by Grand Canyon National Park on October 14th and 15th, 2009, in order to meet the park's climate change mitigation and adaptation goals.

STRATEGY 1: REDUCE GHG EMISSIONS RESULTING FROM ACTIVITIES WITHIN AND BY THE PARK

Grand Canyon National Park has developed a set of actions in order to reduce GHG emissions from activities within and by the park. These strategies have been prioritized based on a qualitative assessment of a set of criteria including emission reduction potential, cost-effectiveness, feasibility, co-benefits, regional impact, and ability to rapidly implement.

Energy Use Management

Emission Reduction Goal: Reduce park operations' energy use GHG emissions to 30 percent below 2008 levels by 2020

Improving energy efficiency and implementing alternative energy sources reduces park-based fuel use, lowers GHG emissions, decreases electricity consumption, and offers monetary benefits for the park. Emissions inventory results indicate that 70 percent of the park's GHG emissions from Park Operations are from energy consumption. Consequently, Grand Canyon National Park identified actions to reduce energy-related emissions. Presented below are actions the park will pursue.

1 Promote energy efficiency and energy conservation in the park

Within 1-2 Years

- Implement green office policy that includes turning off lights and other electronics, enabling computer and monitor "hibernate" settings, using natural lighting, and reducing water use.
- Develop tips on conserving energy and include them in the park newspaper, "The Guide".
- Develop tip sheet for employees to learn how to make their homes more energy efficient.
- Develop a training program on sustainability that educates staff on energy, water, and fuel conservation.

2 Measure energy use throughout the park

Within 1-2 Years

- Conduct energy audits for all park buildings[4]. Where feasible:
  - Upgrade to programmable thermostats.
  - Install insulating jackets for water heaters and establish lower standard temperature settings.
  - Assess options for in-floor radiant heating systems in Pines housing area.
- Conduct water pump efficiency tests for all pumping systems and Waste Water Treatment Plants.
- Evaluate pumps, blowers, and motors for upgrade to high-efficiency or variable frequency drives (VFD).

[4] Energy audit findings may be used to implement actions not suggested in this action plan while some actions already noted in this plan may be contingent upon the energy audit findings.

3 Upgrade lighting options

Within 1-2 Years

- Finalize Park Lighting Guidelines for International Dark Sky certification.

Within 5 Years

- Upgrade all light bulbs and fixtures to energy efficient bulbs.
- Install dimmable ballasts when feasible.
- Install dark sky-compliant lighting in compliance with Park Lighting Guidelines.

Within 10 Years

- Utilize natural lighting using conventional glazing, light shelves, skylights, and cleresry windows in new construction and major rehabilitation projects.

4 Upgrade to efficient electronics and devices

Within 1-2 Years

- Assess energy efficiency of server systems during energy audit.
- Adequately ventilate or sunshield all electrical and mechanical equipment in warm weather.
- Provide smartstrips at all multi-appliance locations.

5 Improve building structures and envelopes

Within 1-2 Years

- Determine efficiency of existing insulation via energy audit and develop a replacement schedule.
- Perform building infiltration assessment to determine air tightness and work towards tight building envelope during the energy audit.
- Evaluate possibilities for energy-efficiency options during energy audit.
- Evaluate solutions for improving insulation in historic structures through Section 106 compliance.
- Develop schedule to bring existing buildings into LEED Existing Buildings Operations and Maintenance (EBOM) system when possible.

Within 5 Years

- Ensure that 100% new construction meets LEED certification standards.

Within 10 Years

- Phase out use of fossil fuel consumption in buildings.

6 Utilize alternative energy sources

Within 1-2 Years

- Install hydroelectric generator to produce electricity at Phantom Ranch, Cottonwood, and Roaring Springs.
- Purchase 100% renewable energy-generated electricity.

Within 5 Years

- Install solar hot water heating systems in housing and other park buildings as feasible.
- Evaluate opportunities to use biomass as replacement fuel.

Transportation Management

Emission Reduction Goal: Reduce transportation-related GHG emissions from park operations 20% by 2020

Reducing vehicle miles traveled, improving vehicle efficiency, and using alternative fuels can significantly reduce Grand Canyon National Park's emissions. As the inventory results indicate, GHG emissions from transportation comprise 16 percent of park operations emissions and 39 percent of the park's overall emissions which includes visitors and concessioners. Grand Canyon National Park set a goal to reduce transportation GHG emissions from park operations by 20 percent by 2020. GHG emissions from visitor-related transportation (Scope 3 GHG emissions) will be addressed through evaluation of opportunities and education. Presented below are the actions that the park will pursue to achieve this goal.

Transportation Management – Planned Actions

1 Reduce NPS vehicle and equipment fuel consumption

Within 1-2 Years

- Develop a Green Fleet Management Plan including policies, procedures, and protocols to "right-size" the vehicle fleet by number and type.
  - Analyze fleet fuel consumption patterns for efficiency improvements.
  - Set a benchmark for fleet-wide mile per gallon average.
  - Evaluate opportunity to replace conventional vehicles with alternative fuel vehicles (AFVs) including hybrid electric vehicles (HEVs), electric vehicles, compressed natural gas (CNG), and biodiesel.
- Promote efficient driving through the use of employee trainings and dashboard signage.
- Use alternative fuel vehicles in demonstration projects.
- Develop a No-idling Policy.

2 Reduce GHG emissions from visitors

Within 1-2 Years

- Promote visitor use of trails for alternative means of travel including hiking, biking, and walking.
- Expand Greenway trail network.
- Explore potential for bike lanes.
- Evaluate signage to encourage use of bike trails.
- Partner with surrounding state and local communities on alternative transportation initiatives.
- Work cooperatively with partners - public and private - to evaluate regional alternative transportation systems for park access.
- Evaluate opportunities to expand current alternative fuel shuttle buses to areas of heavy use and traffic.
- Evaluate North Rim Development Plan for alternative transportation options.
- Educate visitors about benefits of Green Travel (see Education and Outreach.)
- Continue to collect data on visitor transportation patterns, vehicle occupancy, and ridership to determine needs for alternative transportation.

3 Other

Within 1-2 Years

- Evaluate adaptive transportation management strategies.
- Provide advanced warning of parking conditions and options including variable messaging signs along Hwy 64 directing people to available spaces as an alternative to developing new parking spaces.
- Institute a system to deploy additional transit capacity when needed.
- Designate a "green" transportation manager charged with ensuring that transportation decisions are made in alignment with sustainability policies.

Waste Management

Emission Reduction Goal: Reduce park operations waste emissions to 50 percent below 2008 levels by 2015 through waste diversion and reduction.

The connection between waste and GHG emissions may not at first be obvious. However, waste management—in the form of source and solid waste reduction—can dramatically reduce GHG emissions. Landfills are the largest human-generated source of CH_4 (methane) emissions in the United States. Waste from Grand Canyon National Park facilities routinely travels nearly one hundred miles to the landfill. Reducing the amount of waste sent to landfills reduces CH_4 emissions caused by

decomposition as well as the GHGs emitted from the transportation of waste. The less the park and its visitors consume in terms of products and packaging, the less energy is used and fewer GHGs are emitted.

Grand Canyon National Park's park operation activities emitted 2,149 $MTCO_2E$ from waste management in 2008. Diverting or reducing the park's waste stream through increased recycling and waste management efforts will reduce both the amount of waste sent to landfills and resulting emissions. Presented below are the actions that the park will pursue to achieve the stated goal.

Waste Management – Planned Actions

1 Decrease waste through behavior change

Within 1-2 Years

- Evaluate effectiveness of existing recycling program intended for park visitors.
- If warranted by evaluation results, institute signage throughout the park and weave waste reduction messaging into interpretation programs.
- Require that construction contractors reuse or recycle materials used during building renovations and new site construction/remodeling projects and monitor for compliance.
- Provide biodegradable or reusable plates, cups, and, silverware for staff to use to reduce waste.
- Integrate metrics on environmental responsibilities into performance evaluations.

2 Establish new plans and policies that promote waste reduction

Within 1-2 Years

- Implement a Construction Waste Management Plan and Job Site Recycling Policy.
- Incentivize contractors to practice green purchasing.

Within 5 Years

- Work with solid waste branch to evaluate feasibility of transporting alternative recyclables not accepted by recycling contractor.
- Explore the possibility of cash incentives based on the volume of recycled materials. Work with recycling contractor to identify potential markets for recycled glass.
- Manage solid waste using an Integrated Solid Waste Alternative Program (ISWAP).

3 Develop infrastructure to effectively manage waste

Within 10 Years

- Develop a solid waste recycling center/transfer station to enable efficient tracking and disposal of waste and recycling streams.
- Compost food and other organic waste.
- Investigate composting opportunities to include backyard composting for park residents, and large scale opportunities for organic waste from park concessioners and operations (e.g., food waste, mule waste, and landscape vegetation).

4 Reduce consumption and reuse water - Planned Actions

Goal: reduce water consumption 25% by 2020

Similar to Waste Management, the connection between water use and GHG emissions may not be obvious. However, the greatest energy expense at Grand Canyon National Park is used to pump water from the inner canyon to the South Rim. Waste water treatment plants also use energy to produce reclaim water. Additionally, the by-product from water treatment operations is CH_4, one of the primary green house gases.

Within 1-2 Years

- Use reclaimed water more extensively throughout the park.
- Evaluate appropriate uses for existing reclaimed water.
- Investigate the development of infrastructure to enable these uses.
- Investigate creating a drive through bus wash using reclaimed water.
- Conduct an assessment of leaks in water delivery system.
- Investigate harvesting rainwater and filtering for potable use.
- Replace/upgrade trans-canyon water line where needed.

STRATEGY 2: DEVELOP AND IMPLEMENT A PLAN TO ADAPT TO CURRENT AND FUTURE IMPACTS OF CLIMATE CHANGE

While efforts are made to curb future impacts of climate change through GHG reduction actions such as those proposed in Strategy 1, the impacts of climate change continue around the globe. Atmospheric GHG concentrations are increasing, but even if these concentrations could be stabilized at today's levels, past emissions will continue to cause warming of the planet through the end of this century.[5] Adaptation strategies through proactive, "anticipatory planning" will be an important complement to curbing emissions in seeking to properly manage resources in the face of the effects of climate change.[6]

Climate change impacts that affect Grand Canyon National Park include increased temperatures and changes in precipitation patterns. These impacts are interrelated and make adaptation planning a complicated task. For example, increased temperatures and changes in precipitation can affect vegetation distribution, and large scale disturbance due to fire, insect outbreaks, and direct mortality. The potential for large scale disturbances of park resources and infrastructure highlights the need for proper adaptation strategy planning and implementation.

As a first step towards developing an overall adaptation strategy, participants in Grand Canyon's workshop were introduced to an overview of a "scenario planning" process. In advance of the workshop, experts and park staff developed a list of potential climate change impacts on various park resources (see Appendix A). This list of potential impacts was then used by the adaptation break-out group during the second day of the workshop. Three possible future climate scenarios were considered during the break-out session that included a range of social and political factors. Session participants then spent time brainstorming actions to take to adapt to the circumstances in each scenario. Follow-up meetings with session participants, subject matter experts, and senior management resulted in a single final list of recommended actions that are applicable to all three possible scenarios. Presented below is the final combined adaptation-related action list as well as descriptions of the three scenarios. The full list of actions developed for each of the three scenarios are listed in Appendix A.

Adaptation and Impacts – Planned Actions

Within 1-2 Years

- Coordinate with other agencies/partners and participate, as appropriate, with landscape/regional scale resource management efforts, such as Landscape Conservation Cooperatives.
- Evaluate climate change specific Citizen Science program, in alignment with existing volunteer program.
- Utilize existing science advisory group.
- Explore possible Common Garden plots research for incorporating into existing vegetation restoration, in collaboration with university researchers.

[5] IPCC 2007. Climate Change 2007: The Physical Science Basis. Intergovernmental Panel on Climate Change, Geneva Switzerland. Available online at < http://ipcc-wg1.ucar.edu/wg1/wg1-report.html>
[6] Easterling, et al. 2004. Environment: Coping with Global Climate Change – The Role of Adaptation In the United States. Prepared for the Pew Center for Global Climate Change.

- Continue to engage with the Cooperative Ecosystem Studies Units (CESU) National Network to access appropriate scientific and technical expertise.
- Continue to coordinate with other agencies, especially on issues such as fire management and cultural/historical sites.
- Incorporate climate change into all planning efforts and documents.

Within 5 Years

- Develop a GRCA adaptation plan/strategy in alignment with NPS Strategic Plan.
- Become involved in future scenario planning and other impacts/adaptation workshops, as appropriate.
- Conduct applicable vulnerability assessments.
- Document current conditions.
- Evaluate data and compile all appropriate data into a common, transparent database.
- Make available to public and partners.

Scenario A - "Current unusual becomes normal"

Scenario A is marked by the following ecological conditions:

- Warming at intermediate pace.
- Precipitation seasonality, magnitude, and variability are similar to past 20 years.
- Generally more arid, less snowpack, more summertime stress on water resources.
- More intense hydrologic cycle: storms, flooding.
- Patches of tree mortality.
- Insects.
- Fire mortality.
- Increased diurnal temperature variability.

In addition to these ecological conditions, Scenario A involves the following socio-political factors:

- Low levels of governance and leadership.
- Low levels of societal concern.

Scenario B - "On the road to Sonoran conditions"

Scenario B is marked by the following ecological conditions:

- Warming at intermediate pace.
- Changing precipitation patterns including much less winter precipitation, and more extended rains during the summer. Hydrologic cycle becomes more intense and includes more storms and the development of flooding.
- More intense forest die-off.
- Increasing grassland.
- Accelerating fire regime.
- Increase diurnal temperature variability.

In addition to these ecological conditions, Scenario B involves the following socio-political factors:

- High levels of governance and leadership.
- Low levels of societal concern.

Scenario C - "The new Sahara Desert"

Scenario C is marked by the following ecological conditions:

- Warming increases dramatically – the region is in a state of permanent drought.
- Changing precipitation patterns including severely decreased precipitation and more intense hydrologic cycle and includes more storms and the development of flooding.
- There are whole-sale forest die-offs, especially at lower elevations.
- Invasive plants fill in to dominate.
- Increased diurnal temperature variability.

In addition to these ecological conditions, Scenario C involves the following socio-political factors:

- High levels of governance and leadership.
- High levels of societal concern.

STRATEGY 3: INCREASE CLIMATE CHANGE EDUCATION AND OUTREACH

Climate change is a complex and easily misunderstood issue. Grand Canyon National Park can play an integral role in communicating about climate change to a vast audience. A better understanding of the challenges and benefits of reducing GHG emissions can motivate staff, visitors, and community members to incorporate climate friendly actions into their own lives. Grand Canyon National Park recognizes that the greatest potential impact the park can have on mitigating climate change is through public education. Thus, the park sees public education as an end goal of any climate initiative. From increasing the efficiency of public transportation to developing a green purchasing program, the actions Grand Canyon National Park takes to address climate change serve as opportunities for increasing the public's awareness of climate change. Presented below are key messages discussed during the workshop, the actions that are currently under way and which comprise the park's progress to date, and those actions that the park will pursue.

Key Messages

Implementing effective education and outreach programs requires a focused set of messages to relay to appropriate audiences. Grand Canyon National Park recognizes this fact and will develop several key messages about climate change to educate park staff, visitors, partners, and gateway communities. Strategies for communicating these messages include:

- Focusing on education about the issues and solutions without focusing on climate change itself.
- Communicating the park's long-term goals in increments to make them more tangible.
- Using positive framing and messaging.
- Ensuring that messaging addresses the greater Grand Canyon area, not just the park.

Park Staff

Incorporate climate change into park staff training, events, and performance plans

Developing a climate change education program for park staff is vital to increasing awareness about climate change among park visitors and fostering a sense of collective responsibility among staff to help reduce park emissions. By incorporating climate change education into staff development programs, Grand Canyon National Park will enable its staff to demonstrate their commitment through leading by example, and providing visitors with the tools and resources they need to reduce GHG emissions in the park and in their own communities. Potential actions include:

- Create a climate change training program for staff which will increase climate change messaging into interpretive/educational/informative/communication efforts.
- Regularly integrate climate change messaging into staff meeting.

Visitor Outreach

Understanding climate change and its consequences is essential to initiating individual behavioral change. Grand Canyon National Park realizes that it has a unique opportunity to educate the public in a setting free from many of the distractions of daily life. By using existing materials, developing park-specific materials, highlighting what the park is currently doing about climate change, and encouraging visitors to reduce emissions, Grand Canyon National Park can play an important role in educating the public about climate change.

Grand Canyon staff recognize the many different audiences that visit the Park, including recreational and non-recreational park visitors, "virtual visitors" who visit the park online, school-aged visitors, local, out of town, and international visitors, local tribes, and external audiences. Reaching these various audiences with climate change information and engaging them in the park's efforts requires appropriately focused messaging. The park has developed a number of strategies to reach these various audiences effectively. These strategies include:

- Improve and/or incorporate all signage to include climate change messaging, including shuttle bus reading panels, inside comfort stations, and employee housing. Include the CFP logo in all efforts.
- Continue to create, update, and improve webpages as well as the use of web and electronic technologies.
- Develop a short climate change message video to air before the evening programs and in the visitor center.
- Use Hermit's Rest, Desert View, or Lookout Studio as a focal point to discuss climate change impacts on wildlife, ecology, and vegetation.
- Explore options for making alternative transportation an attraction and not just a means for getting around the park through actions such as interpretive programs on shuttles.
- Participate in the Do Your Part program as part of the CFP initiative to engage the public.

Local Community Outreach

The gateway communities, agencies, vendors, and volunteers surrounding Grand Canyon National Park can play a significant role in supporting the park's climate change mitigation goals. As such, when appropriate, park staff will assist local communities with incorporating climate change messages into community events and find partners to promote climate change education at those events, and engage with surrounding agencies to coordinate effective outreach and education efforts. Potential actions include:

- Continue to encourage alternative transportation within the park community and engage the community with "things you can do" messages.
- Develop a means for "Green Travel", a reduced carbon to carbon neutral visit through the park's website.
- Encourage the use of the short climate change video, once developed, in local community venues.
- Use the interactive climate change curriculum for local school visits, once developed.

STRATEGY 4: EVALUATE PROGRESS AND IDENTIFY AREAS FOR IMPROVEMENT

By taking the actions established in strategies 1, 2, and 3 above, Grand Canyon National Park plans to reduce its emissions to the specified goals and begin adapting to the impacts of climate change. Achieving these goals will require an ongoing commitment by the park, which may include monitoring of mitigation actions, evaluating effectiveness of education and outreach efforts, monitoring of adaptation success, additional mitigation, education, and adaptation actions, and revaluation of goals. As part of this strategy, Grand Canyon National Park will:

- Monitor progress of implemented actions. This will include subsequent emission inventories to evaluate progress toward goals stated in this action plan.
- Evaluate success of education and outreach programs.
- Develop additional emission mitigation, education, and adaptation actions beyond those listed in this plan.
- Periodically review and update this plan.
- The park will track climate friendly actions, specifically in energy, transportation and waste strategies, through the environmental management system.

CONCLUSION

Grand Canyon National Park has a unique opportunity to serve as a model for its many recreational visitors (nearly 4.5 million recorded visits in 2008).[7] This report summarizes the actions the park wishes to undertake to address climate change. Specifically, the park realizes its ability to educate the public and serve as a valuable model for citizens. By striving to address GHG emissions within the park, sharing its successes, and educating the public to promote behavioral changes, Grand Canyon National Park will help mitigate climate change far beyond the park's boundaries.

Realistic commitments identified in this Action Plan and approved by the park's Superintendent will be implemented and included in the park's Environmental Management System (EMS). The mitigation actions included in this plan are complementary to the EMS and will help drive the park's efforts to reduce its impacts on the environment and meet EMS goals and objectives.

The National Park Service faces an uncertain future due to the possible effects of climate change. However, by seriously addressing climate change impacts and reducing emissions, Grand Canyon National Park will reduce its contribution to the problem while setting an example for its visitors. The strategies presented in this Action Plan present an aggressive first step towards moving Grand Canyon National Park to the forefront of Climate Friendly Parks.

[7] Grand Canyon National Park: Park Statistics. Available online at: http://www.nature.nps.gov/stats/viewReport.cfm

APPENDIX A: ADAPTATION & IMPACTS WORK GROUP NOTES

SECTORS AND POTENTIAL IMPACTS TO GRAND CANYON NATIONAL PARK ***Note: input submitted from S&RM, V&RP(*), PMT (**) OPAC (***)*** ***# = impacts also listed, %=impacts exclusively listed in table for Flagstaff Area National Monuments (FLAG)***		
	Sub-Sector	**Impacts**
Natural Resources	Hydrology & Water Resources	• Loss of snowpack and associated effects on the timing and quantity of spring & summer flows • More winter precipitation falling as rain instead of snow, earlier snow melts, and associated changes in stream and river flow that includes relative increases in the winter and early spring and decreases in late spring and summer months # • Increase in extreme runoff and flooding; increased in magnitude and frequency of flooding in fall and winter; earlier and reduced peak flows # • Reduced summer flow volume; reduced or eliminate late summer low flow; higher stream temperatures due to higher air temperatures and lower water levels # • Ecological impacts to floodplain and riparian areas with decrease in spring flooding on higher elevation and snowmelt streams # • Increases in frequency of heavy precipitation events # and longer droughts • Changes in flood risks are likely to result in substantial changes in sediment transport and channel formation processes, and is likely to affect ecological processes that are sensitive to changes in the probability distributions of high flow events such as habitat stability, biodiversity, and trophic structure # • Stream channel instability associated with adjustment to larger floods # • Warmer drier summers result in depleted groundwater resources and impacts to fish including endangered Humpback chub that relies almost solely upon spring fed tributary input for survival; impacts to fish, wells, perennial water, aquifers, etc. % • Changes in regional water supply # and demand % • Reduced snow pack on N. Rim and N. Kaibab may reduce availability of water for fire suppression activities. * • Increase in frequency and severity of drought, possible increase in duration. % • Increases in frequency of flash floods; floods are expected to increase due to the

		combined effects of warming and increasingly intense winter storms. %
	Aquatic Ecosystems	• Warming temperatures will increasingly stress coldwater fish (at several life history stages) which may aid native fish in tributaries and mainstem. • Potential to affect most freshwater life history stages of warm(advantage) and cold water fish (disadvantage) # • Nonnative coldwater fish species may decrease in abundance or distribution due to warmer water temperatures, however, non-native warm water species are likely to increase. The threat from warm water non-natives upon native fish populations is unknown and may be substantially worst that the current predation and competition scenario. • Loss of summer/drought based water flow with loss of snowpack and spring recharge could hurt reintroduced Shinumo Creek humpback chub and other fish populations in tributaries • Warming of tributaries and mainstem may offer opportunities to expand the range and abundance of native fish. • Shifting of aquatic habitat - elevation & latitude-changing species composition & habitats # • Potential to affect most freshwater life history stages of fish and aquatic macroinvertibrates. Increased frequency and severity of flood flows during winter can affect over-wintering juvenile fish and eggs in the streambed. Eggs of fall and winter spawning fish may suffer higher levels of mortality when exposed to increased flood flows. Higher water temperatures could also accelerate embryo development and cause premature emergence. • Nonnative fish and invertebrate species may increase in abundance or distribution due to warmer water temperatures. • Higher surface water temperatures exacerbate pollution issues • Loss of aquatic macroinvertebtrates.
	Vegetation	• Changes in geographic distribution of vegetation species (i.e. latitude and elevation). • Species composition and distribution of all life zones could change. Cold species composition will migrate up in elevation, while new warm species may become established at the bottom of the canyon. Subalpine meadows will change due to increased tree establishment and changes in forb:grass ratios. • Endangered species, rare plants, and relict plant populations may face extirpation; additional species may become rare or endangered as ranges contract. Additional

		species may become endemic to the park, which could serve as a refuge. • High-elevation atmospheric pollutants (ozone levels) increase and could affect vascular and non-vascular plants; and ozone sensitive species % • Higher elevation plant communities may decrease dramatically or disappear • Changes in distribution and extent of invasive species infestations. New invasive species may be able to infest the park taking advantage of changed environmental conditions and disruptions to native plant communities. • Warmer and drier climates may influence the frequency and location of pest species in North and South rim forests. Climatic suitability for pests such as mountain pine beetle may increase at higher elevations, leading to increased tree mortality. • Changes in precipitation patterns may influence the frequency and location of plant pathogens and diseases (i.e. increase in powdery mildew due to increased humidity and changes in intensity and seasonality of precipitation). • Species composition of forests may change in response to higher temperatures and drought stress. Fire frequency and intensity may change, resulting in compositional shifts in both overstory and understory vegetation. • Riparian areas may change in extent and composition due to reduced stream flows and higher temperatures. % • High elevation vegetation types such as spruce-fir may not regenerate as quickly following disturbance. # • Extent of vegetation types may expand/contract, for instance piñon-juniper may begin to encroach on ponderosa pine on N. and S. Rims and ponderosa pine may encroach on mixed-conifer on N. Rim. * • Species composition and distribution of vegetation communities will change. Forest line and treeline may decrease due to higher temperatures and decreased snowpack. Grasslands and meadows will change due to increased temperatures and establishment of more xeric species. % • Increased invasive species due to increased disturbances from species die-off. % • Warmer and drier climates may influence the frequency and location of pest species in forest environments. % • Species composition of vegetation communities may change in response to higher temperatures and drought stress. % • Higher temperatures may result in increased mortality in ponderosa and pinion pine populations. %

	Wildlife	• Changes in geographic distribution of wildlife species (i.e. latitude and elevation). # • An analysis of potential climate change impacts on mammalian species in the U.S. national parks indicates that on average about 8% of current mammalian species diversity may be lost. The greatest losses across all parks occurred in rodent species, bats and carnivores. Reduced snowpack may result in species such as coyotes expanding their distribution % • Temperature and precipitation patterns contribute to dependable springs, which sustain populations such as desert bighorn. These populations could disappear. • Some insect species will hatch earlier in the spring, due to warmer temperatures, but before the vegetation (food source) leafs out, causing mass starvation. • Invasion by non-natives such as the javelina. • Fragmentation of large ecosystems may occur due to increased disturbance and vegetation changes, disrupting existing wildlife ranges # • Changes in timing of migration, reproduction, dormancy, and changes in productivity Pollinator populations may be affected by the changing phenology of flowering plant species. # • Distribution of high-elevation animals may shift or be lost due to warmer temperatures, lower snowpacks (duration and extent), and changing subalpine/alpine species composition. # • Distribution of low-elevation animals may shift into high-elevation forests within the park from sources outside the park.
	Disturbance (fire, pests, pathogens, avalanche)	• Fire frequency and intensity may increase due to higher temperatures, increased drought, and decreased snow pack. # • Fire: Increase in length of fire season, severity of fires, and number of acres burned; non-native invasive grasses provide continuous fuelbeds and increase wildfire severity. There is high likelihood that this outcome will prove to be true, but some uncertainty still exists. With changes in the pattern of precipitation (more rain in extreme events) there may be variable response from non-native grasses. This could limit the frequency and extent of fires. # • Pest/Pathogen: increased winter temperatures facilitate pathogen/pest survival # and interaction intervals % • Increase in Wind-fall and flooding disturbance # • Potential increase in length of fire season, severity of fires, and number of acres burned due to higher temperatures, increased drought, and decreased snow pack. *

		• Non-native invasive grasses may provide continuous fuelbeds and increase wildfire severity in piñon-juniper and inner canyon vegetation types. * • Lightning patterns generally dictate fire frequency in the park, so fires could be more or less frequent depending on predictions of lightning activity.* • Potential for increase in forest pathogens with warmer temperatures and shorter snow pack in higher elevation N. Rim forests. *
	Soil	• Increasing sediment input events due to more intense precipitation events may benefit sandbar habitat and camping beaches along the mainstem Colorado River. • Intensity may increase the severity of extreme events (e.g. arroyo development, etc.) % • Less soil moisture build-up during slow snow melt period in winter. • Less soil moisture during growing season (related to vegetation mortality and fire regimes in those two sections) # • More precipitation runoff during summer thunderstorms (as opposed to "soaking in") due to a change in the monsoon activity, based on the past 60 years of data. The monsoon now comes 10 days later, and wet spells are shorter, giving the soil time to dry out.
	Air Pollution/Viewshed	• High-elevation atmospheric pollutants (ozone levels) increase • Higher variability in climatic elements can lead to more extreme conditions, including higher wind speeds and changes in average wind vector. This can lead to higher amounts of dust in the atmosphere from the drier soils. • Decreased visibility due to increased wildfires from drought increasing the aerosols in the lower atmosphere • Greenhouse gases, which are mostly carbon dioxide, are released during wildfires, feeding atmospheric warming • Changes in precipitation patterns due to an increase in cloud condensation nuclei from wildfire aerosols
Cultural Resources	Historic Structures	• Loss/condition degradation of historic structures from wildfire, erosion, flooding, landslide, pest/exotic organisms invasion and changes in wet/dry cycle duration and extent +*** # • Adverse impacts to historic structures from increases/decreases in visitation and utilization # • Changes in precipitation/temperature regimes may result in a need to re-evaluate HVAC and electrical systems #

		• Loss/condition degradation of historic structures by changes in snow/ice loading and wind speed, particularly on the North Rim +*** #
	Archeological Resources	• Loss/degradation of over 4000 archeological sites by erosion, deflation, changes to vegetative cover, changes in soil conditions • Loss/degradation of 3,179 archeological sites by erosion, changes to vegetative cover, sites adjacent to water features by changes in stream course, water level, soil moisture and acidity % • Pictographs and petroglyphs damaged/ degraded by changes in rainfall/snowfall quantities, chemically reactive pollutants, ultraviolet light exposure, moisture, fire frequency and intensity # • Changes in visitation patterns may affect archeological sites # • Adverse impacts to sites by modifications of operating patterns of Glen Canyon Dam relative to reservoir conditions in Lake Powell and Lake Mead • Changes in vegetative communities and habitat allowing for changes in wildlife patterns such as encroachment of javalina into the South Rim and inner canyon areas, causing digging and rooting in archaeologically sensitive areas • Changes in vegetation communities, increases root penetration of cultural features and buried soils %
	Ethnographic	• Changes in vegetation may influence Traditional Cultural Practices. # • Changes in vegetation may alter ethnographic resource collection areas resulting from changes in vegetative growth patterns (for example, impacts from climate change on Pinyon Pines and traditional collection of pinyon nuts) # • Climatic changes may affect spring sources considered important to traditional practitioners and wildlife utilizing these sources • Direct and indirect impacts to resources and to the people who place importance on those resources. For example, climate change affecting the abundance (or lack thereof) of a mammal used for food would be a direct and significant impact to both the species and those relying on it. On the other hand, the degradation of an archeological site might have a more indirect or secondary impact on the people who consider it a TCP.

		• Potential change in access to an identified TCP, impacting a tribe's cultural identity. • Plant communities that tribes rely on for ceremonial and medicinal purposes may be impacted. Availability of resources and access to both specific resources and sites of traditional importance may be adversely affected.
	Museum	• Loss/degradation of museum collections caused by changes in humidity/temperature # • Accelerated degradation of Historic Structure furnishings resulting from changes in humidity/temperature/ultraviolet light exposure • Increased energy demands /costs to maintain required museum environmental conditions # • Changing insect/arachnid populations may present new threats to collections. # • Increased demands on museum management facilities and staff as required by environmental monitoring and management load increases. # • Loss/condition degradation of museum storage repositories and exhibit spaces from wildfire, erosion, precipitation patterns # • Species shifts could increase the workload and importance of natural history collections. Increased fire frequency could increase the exposure of cultural resources, making them vulnerable to looting and/or degradation. This could increase the need for data recovery.
	Cultural Landscapes	• Changing vegetation patterns may alter Cultural Landscapes creating a need to re-think management goals and maintenance. # • Loss/degradation of Grand Canyon Village National Historic Landmark district cultural landscape resulting from increases in invasive plants and decreases in soil cover in and around the district • Loss/degradation of 3 cultural landscapes resulting from invasive exotic plants % • Changes in weather patterns and drier weather patterns (and potential increase in fire frequency and intensity) may result in significant changes to traditional cultural landscapes and designed landscapes throughout the park. • Earlier spring may result in longer visitor season which may influence Cultural Landscapes. %
Visitor Experience	Wilderness/	• Changes in recreational boating (see Natural Resources – Hydrology & Water

	Recreation/Night Skies/Soundscapes	Resources) • Changes in backcountry use due to changing temperatures and duration of hot season, water availability, and changing fire regime (smoke, hazards) • Shift in seasonal visitor use • Impacts to viewshed and the quality of the dark night sky (see Air Quality) • Changes in temperatures could alter soundscapes (temperature effects the movement of sound • Increased fire frequency could result in the increased need to use helicopters and mechanized equipment in wilderness
Facilities	Circulation/ Transportation	• Increased rain events could require upsize/redesign of culverts, water catchment, roadside ditches **
	Structures	• Heating and cooling needs for buildings will need changing ** • Changes to building HVAC to take on more green approach (reduce/eliminate GWP and GHG refrigerants) ** • More consideration to on-site energy production for existing structures (PV, wind, geothermal) ** • Increased temps could require installation, construction of drinking water facilities along inner canyon trails **
	Utilities	• Decrease in volume/availability of south rim potable water – could require better, more intensive treatment of existing waste water, reclaim water, for potable use ** • Increase demand on waste water treatment plant ** • Changes in precipitation/temperature regimes may result in a need to re-evaluate HVAC and electrical systems ***
	Fleet Management	• Greener fleet **
Protection & Visitor Services	Recreation	• Potential for longer visitor use season on N. Rim which may require more ranger, emergency response, and support staff. * • Increased temps could make the need to have more potable water available along trails **
	Emergency Response	• Resources for planned and unplanned fire management activities may be diminished

		as fires burn hotter and longer in other parts of the region or country. * • Search and rescue responses may increase with higher temperatures in the inner canyon and on the plateaus. This will affect ranger, helicopter, emergency response, and support staff. *
	Elementary Education and Visitor Programs	• Increased knowledge base needed in order to properly teach students about climate change, and to answer questions related to it. • Increased information on climate change and its impacts to the Grand Canyon ecosystems presented through curriculum based programs, interpretive programs, exhibits, publications, waysides, and park website. • Increased dissemination of messages regarding how visitors can reduce their carbon footprint while visiting the park. • Increased dissemination of messages regarding how the park is reducing its carbon footprint. • Increased use of alternative fuels for program support (EE currently uses a hybrid vehicle). • Potential increased use of distance learning technology to conduct programs for schools, reducing the need to use fuels for travel.

Administration	Park Housing	• Threat to employee housing from wildland fire threat and other external threats • Depletion of funds caused by excessive energy consumption in structures being provided electricial and carbon based fuel sources • Warmer climates pay increase extended seasons, resulting in increased number of employees and their associated consumption of water and other utilities.
	Procurement	Increased cost in purchasing materials used to construct and repair greener buildings Loss of vehicles from the Fleet to help decrease emissions Higher cost of purchasing vehicles such as Hybrids to offset emissions produced Loss of vehicles for normal daily usage to support transporting firefighter to outlying wildland fires

	Duel Duty Stations	Increased carbon emissions dictate a decrease in transportation between such things as duty stations such as Flagstaff, Grand Canyon South Rim, North Rim etc. With a decrease in onsite visits would result in increased savings in a lesser need for vehicles, fuels, etc.
	Budget	Decreased visitation results in a decrease in revenue received which directly correlates to a decrease in projects completed thru FLREA dollars. An increased awareness of environmental concerns may increase visitation which would result in an increase in revenue collected.
		Loss of the ability for frequent travel will result in an increase of available dollars
	+++	As a World Heritage Site, GRCA can become a model by which others may wish to follow
	+++	Construction of parking lots and additional spaces results in more private vehicle transportation throughout the park, resulting in increased emissions, increased damage to road surfaces, loss of use of mass transit systems.

APPENDIX B: EDUCATION & OUTREACH NOTES

Education & Interpretation

Focal Areas:

1. Personal Services (abbrev. PS) – Adult outreach, formal/informal programs
2. Non-personal Services (abbrev. NP) – Website, exhibits, media
3. Environmental Education (abbrev. EE) – All things kid oriented
4. Internal (abbrev. INT) – Local, School, partners, business, division, residents

Timeframe for Implementation:
Short Term (abbrev. ST) – 2 years
Long Term (abbrev. LT) - 2019

Focus on education without saying the word climate change
Develop messaging in a regional manner – "greater GRCA area"
Make sure to use positive framing and messaging
Communicate park's long-term goals in increments

Identified Focal Area	Time-frame for implementation	Action
INT	S/LT	Work with other Divisions and partners to identify climate change talking points, vocabulary, messaging, and themes
INT	ST	Develop a Brown bag series for park staff including concessioners, partners, and occasionally visitors
	LT	Develop an interactive curriculum for school visits surrounding climate change. This could include information about carbon foot printing, and contests surrounding reducing waste
EE	LT	Engage the community with "things you can do" messages including information on classroom composting
INT	ST	Encourage alternative transportation within the park community through fun competitions
INT	LT	Work with the bus company so that commuters can use it, or develop a commuter bus.
NP/INT	ST	Reduce the amount of physical materials that the park gives out at the Visitor's Center. This includes actions like: developing a 2 sided copy policy, overhauling handouts, re-do flipbooks, developing information for ipods and cell-phones, integrate GPS info. . Consider charging money for handouts.
NP	S/LT	Make a bigger effort to take back/recycle handouts after use. This may include laminating some handouts to increase the duration that they could be used.
NP	ST	Consolidate handouts

NP	S/LT	Hand out just a map at the entrance, then include more information at the visitor's center.
INT	ST	Begin collecting ideas and information from visitors about means of reducing impact. This might include a public suggestion board
NP	LT	Develop a suggestion blog for the website
INT	ST	Work with concessioners to educate visitors by increasing signage in rooms and on tables
NP	S/LT	Overhaul all signage to include climate change messaging, including the reading panels on shuttle buses, inside bathrooms/stalls, and inside employee housing
NP	ST	Use web/electronic technologies to reach the internet demographic. This could include podcasts and apple applications
NP	ST	Improve the webpage and include a carbon footprint quiz
INT	LT	Establish a green outreach person to introduce green concepts
INT	ST	Develop a competition among divisions wherein the winning division gets the superintendent's "discretionary fund" to purchase sustainable supplies
NP	ST	Develop a 5 minute eco video to air before the evening programs and in the visitor center
NP	S/LT	Develop a means of having a carbon neutral visit through an interactive video/website. This may involve partnering with other agencies (NASA) and universities. This video could air in lobbies of theatres, before movies, or even during the super bowl
INT	ST	Develop a "think before you print" campaign
INT	LT	Once practices are implemented like organic cotton sheets and towels, develop messaging around these practices in rooms
NP	ST	Work to integrate the CFP logo throughout the park
NP	ST	Link the GRCA and CFP websites together
NP/EE	ST	Develop a JR Ranger climate change page
NP	LT	Have wireless in parks so that interpreters and others can download handouts for timely use in mobile devices without printing
INT	ST	Develop a regular set of meetings with partners (agencies, tribes) and a regional forum to foster discussion and participation
INT	ST	Hold a biennial conference on research on the Colorado Plateau that is NOT just for scientists, but also for cultural, natural, and social sciences
INT	ST	Hold trainings for all partners each year including guides, and Xanterra
INT	ST	Work with the Colorado Plateau Parks
INT	S/LT	Work with NASA to develop a regionally focused training course (e.g., January "Earth to Sky")
INT	ST	Integrate climate change messaging into all seasonal trainings
NP	LT	Incentivize guests using less energy by installing meters in hotel rooms

		to show energy use.
NP	LT	Create a video game to educate people about how to interpret their energy bills
PS	LT	Focus messages communicated from Lookout Studio, Hermit Ramps, Desert View on ecology, wildlife, and climate change
PS	ST	During the Kolb tour, don't turn on all of the lights
NP	ST	Develop a feature to educate about water and climate change in the Visitor Center
INT	ST	Integrate Xanterra and other concessioners to the green team as regulars
EE	ST	Develop an immersive experience to encourage youth in surrounding communities to understand ecological and climate change concepts
EE	LT	Send a ranger to school/after school programs to educate about climate change in NPS. Have ranger develop contests for ideas from kids. Develop a summer scholars program
EE	ST	Develop a Grand Canyon Semester at NAU.
PS	S/LT	Set the example when giving presentations in the park by biking or using the shuttles, etc.

APPENDIX C: ENERGY, TRANSPORTATION, AND WASTE NOTES

Energy

Action	Action Description
Conserve First	Encourage energy conservation in all park activities by shutting off lights, using natural lighting, turning off electronics or setting to hibernate, reduce water use, automatic shut off functions, add conservation tips to The Guide
Develop a mandatory energy-saving training program	All park staff will take an energy and water conservation and management training course. Volunteers from these courses will conduct trainings for the park community. Signage will be posted to remind residents and staff of day-to-day best practices.
Establish/revitalize Operations and Maintenance schedule	Continue to incorporate O&M schedule into Maximo to make sure scheduling is followed
Install programmable thermostats	Evaluate all existing buildings and residential housing for thermostats and upgrade to programmable thermostats
Computer power management settings	Ensure all computers' power management settings follow current Energy Star recommendations during day hours. Shut off computers at night and work to achieve buy-in with IT operational staff to institute appropriate process updates
Install energy efficient light fixtures	By 2012 upgrade all light bulbs in park to energy efficient bulbs. Work with APS Solution for Businesss Program (covers 50% of cost). Optimimze lighting through inventory and evaluation process in conjunction with night-sky program.
Daylighting	Effectively utilize natural lighting by bringing it into buildings via conventional glazing, light shelves, skylights, and clerestory windows.
Dimmable ballasts	Install dimmable ballasts when able to pair lighting with photosensors to reduce need for electricity use.
Ducts	Assess ducts for leaks, insulation, and efficient layout as part of the energy audit process.
Purchase energy efficient electronics	Replace all residential unit appliances to energy-efficient models. Work with GSA to ensure products are available
Establish and implement procurement policy	Work with procurement and vendors to make sure that

	CFLs, T-8 and energy efficient appliances are available. Adhere to the auditing procedure of the Green Purchasing document.
Default all computers and printers to double-sided printing	Set the default settings on all computers and copiers to double-sided (easy to change back to one-sided when needed.)
Smart Powerstrips	Provide smart powerstrips at all multi-appliance locations.
Replace an existing boiler or furnace with an energy-efficient model	Choose best available technology and/or high-efficiency boiler for McKee building
In-floor heating	Supplement in-floor radiant heating with more efficient systems at Pines housing. Asses efficiency of available systems (tankless system or solar). Remove carpet and install tile to promote heating flow.
Servers	Ensure that all new server upgrades will be to energy-efficient systems and consider virtualization of servers
Upgrade windows	Develop a replacement schedule to replace old windows spectrally selective glass, double-glazed, low-e systems, gas filled or electrochromic windows that provide better insulation and solar selectivity. Follow DOI Secretary standards. Develop acceptable solutions for historic buildings.
Establish guide for employees for home energy efficiency	
Durability	Ensure that all materials used in building envelop upgrades are durable to withstand elements, pests
Insulation	Perform building assessments to determine the R-value of existing insulation and develop a replacement schedule. Evaluate sensitive solutions for historic structures.
Infiltration	Perform building infiltration assessment to determine are tightness. Include professional weather stripping and caulking installations
Install photovoltaic (PV) panels	Intall PV farm to generate electricity for new 64 unit using USFS partner.
Renewable energy in concessioner contracts	Include requirements for use of renewable energy in concessioner contracts
Purchase electricity from a renewable energy provider	Purchase 100% of park's renewable energy from proposed wind farm in Valle or through other providers of renewable energy
Complete and energy audit of all structures	Conduct energy audie on all park buildings. Partner with local utilities. Leverage APS funding opportunities.
Indian Garden water pumps	Work with APS to conduct pump efficiency tests for all pumping systems and water reclamation plant.

Transportation

Action Description
Encourage staff carpooling for commuting to work. Develop carpooling information and support services for staff. Look at changing Mountain Lion shuttle system to make it more convenient to take public transportation. Currently not enough carpooling across divisions and concessions. Explore Coconino County van pool and develop a ride board to promote carpooling. Encourage employees to take shuttles. Limit employee parking as a way to encourage carpooling. Consider satellite offices and subsidies for alt transportation.
Establish an employee bike-to-work program. Establish bike paths to Maintenance and other key areas that are currently not accessible. Establish a free yellow bike program for all employees. Establish bike rack/parking areas/infrastructure at all major locations
Use webinars/conference calls to avoid excessive travel, both within and outside of the park. Purchase necessary equipment for teleconferencing and videoconferencing - ensure quality. Offer training on all teleconferencing and videoconferencing systems to ensure that staff know how to use them. Promote flexible work spaces to allow employees to work remotely.
Prohibit staff vehicle idling unless required for vehicle maintenance. Create dashboard idling guidelines and post in vehicles.
Prohibit and enforce visitor vehicle and bus idling. Post signs and information with Park idling rules.
GSA can supply AFV shuttles powered by natural gas. Procure hybrid vehicles specifically for employee travel to Flagstaff.
Expand current alternative fuel shuttle buses to areas of heavy use and traffic, i.e. popular destinations in the park. Explore options for making transit an attraction and not just a means for getting around the park such as placing interpretive programs on shuttles. Continue to evaluate visitation against alternative transportation opportunities. Consider adding a shuttle to Bright Angel Point
Educate all visitors about benefits of driving high occupancy/efficiency (>40 mpg), public transportation or alternative fuel vehicles ahead of their trip. Ensure that Website, radio etc. makes the case for a low transportation impact visit.
- Conduct a feasibility study to expand shuttle systems to surrounding communities; research grant opportunities for community transportation plans. Work cooperatively with partners - public and private - to design and promote alternative transportation systems for park access and circulation. In-park transportation systems should be linked to establish core public transportation systems whenever feasible, through cooperation with public transportation agencies and gateway communities.
- Support policies that "open the door" for private investment in alternative transportation that is in keeping with the Park's mission.

- Out of the box suggestions: Increase entrance fees, support concessioners/partner transit services, charge for parking, limiting access to specific areas
Expand user-friendly trail network to allow visitors to enjoy the scenic sights of the park outside their vehicles. Address gaps in current greenway network. "Sell" Grand Canyon as a hike and bike destination by highlight the opportunities for hike bike travel throughout the park. Conduct a pilot for bicycle rentals and establish bike routes - publicize and sign. Explore potential for bike lanes. Explore yellow bike program for visitors. Ensure that there is comprehensive signage and lighting that encourages use of Greenways.
Work with Concessionaires to implement and then expand commuter and cargo trains from Williams
Explore opportunities to collect data on visitor transportation patterns, vehicle occupancy, ridership.
DOE requires Federal agencies to collect vehicle acquisition, inventory, and fuel-use data from their fleets and report the information to DOE using FAST, an online tracking system accessible at http://fastweb.inel.gov.
Traveling the speed limit reduces excess engine load and decreases fuel consumption
Upcoming EIS for Air Tours should make sure to include a rigorous analysis for Air Tour impact.
- Analyze fleet fuel consumption patterns for efficiency improvements
Evaluate and replace AFVs. Options include: Hybrid electric vehicles (HEVs), electric vehicles, compressed natural gas (CNG), biodiesel. Already have a CNG and biodiesel fueling station in the park.
- Increase fleet mpg - Benchmark existing fleet-wide mile per gallon average and raise the average through vehicle replacement to exceed California's fuel economy standards. (35 MPG)
- Right-size the vehicle fleet by the number and type. - Use a Vehicle Allocation Methodology (VAM) to achieve a fleet that is the right size and type. A VAM defines appropriate vehicle type and use for specific tasks and counters the tendency to size-up.
- Incorporate alternative fuel guidelines into fleet specifications - Work with GSA to catalogue available AFVs and set minimum AFV goals for your park.
Showcase new technologies
Use biobased lubricants and greases, cleaners, and recycle used oil. Use biobased without added petroleum synthetics.
Designs should maximize permeable area and minimize runoff. Reuse on-site materials. Use pervious paving. Use low VOC, water-based road striping paint. Pulverize existing pavement for aggregate base, cold in-place recycling of existing pavement, use hot mix asphalt with recycled content (asphalt, glass, rubber tires). Specify road base aggregate from recycled concrete, asphalt, and brick.
Instead of adding new parking spaces, Provide advanced warning of parking conditions and options.

Variable messaging signs in Tusayan directing people to available spaces. Make sure a system for messaging is in place that goes all the way back to I-40 about parking.
If routes are underutilized have a system in place to deploy additional transit capacity. Would require someone to be monitoring system usage.
Out of the box suggestion: In the event that all parking fills up don't allow more cars in and make sure that. Only allow overnight parking in the Canyon. Provide a one-time parking pass that only allows cars to park once in Grand Canyon Village
New position charged with ensuring that transportation decisions are made with an eye towards sustainability. Could sit in interpretation.

Waste

Action Description
- Ensure that staff are aware of their roles and responsibilities to reduce waste, including outside contractors. Continually inform maintenance crews about recycling and composting policies at the park; conduct periodic trainings. Ensure that all resources (e.g. plates, cups, silverware, etc.) are available for staff to comply.
- Ensure that all positions understand their responsibilities and that those responsibilities are stipulated in performance evaluations. Require an annual training.
Incorporate into EMS goals; leverage spreadsheet tracking and CLIP tool functionality. Track and report recycling data (e.g., quantity and type of material).
Work with Solid Waste to check feasibility of transporting alternative recyclables not accepted by Norton. Investigate other options to have recyclables taken off-site. Look at possibility of getting cash incentive for volume of recycled materials. Identify with Norton potential venues for recycling glass
Need to be more aggressive with our messaging campaign 1) interpretation practices - Does everyone need a brochure, etc. encourage people to give back their outreach materials; 2) actual signage on the recycling bins - Language barriers is the largest barrier here. Need to have universal signage - may be more icon based signage; 3) weaving the message into interpretation programs. Investigate both small scale and large scale composting - small scale for residents in park, and large scale for organic waste (e.g., food waste, mule waste, landscape vegetation, etc.) from park concessioners etc.
Establish a propane cylinder recycling program. Find uses for existing reclaimed water and investigate the development of infrastructure to enable these uses.
Include facilities to effectively deal with household hazardous waste.

Require that construction contractors reuse or recycle materials used during building renovations and new site construction/remodeling projects.

Record waste management data in an EMS or a spreadsheet tracking system.

Create an orientation packet and provide information on policies and practices for recycling, green procurement, and other aspects of your park's waste management policy. Conduct brown bag lunches and training seminars for all park personnel on topics related to waste reduction. Include information on park sustainability, green procurement, and recycling policy in new employee orientations.

Establish guidelines for waste minimization: use durable, reusable utensils and mugs, buy in bulk, use items with reduced packaging, and provide recycling receptacles.

Reuse construction waste on-site, reuse elsewhere, or sell for recycling materials of value including lumber/wood, drywall, metal, rubble, cardboard, fixtures, hardware, and wiring. Require drywall contractors to recycle waste. Test for lead and asbestos where needed. Don't reuse old fixtures, windows, toilets, etc. that are not energy efficient, unless there is historic value. Work with haulers to prevent contamination of waste sorting. Ensure no illegal dumping occurs off job site. Require a Construction Waste Management or Recycling Plan; track quantities of recyclables. Make sure contract language addresses waste plan/recycling. Check on "take-back" policies (e.g., ceiling tiles, cardboard, carpet, drywall).

Old building materials should be reduced, reused, and salvaged in that order. Don't salvage inefficient materials or components. Make sure reuse of vintage items represents an environmental gain.

Share best-practices and formalize/coordinate recycling programs for electronic, printing, and other office waste.

Go beyond recycled content as an environmental attribute. Other attributes may be more important (such as zero VOC paint for interiors, or certified wood over plastic lumber).

This is ongoing - look at purchasing high-quality carpets that will last longer. Work with vendors who will take back carpet and recycle.

Use bio-based lubricants throughout park fleet, chainsaws etc., and avoid the use of plastics where possible.

Already recycling oil and purchasing in bulk.

Raise awareness to field operations personnel, procurement officials, supply and requirements personnel, as well as to charge card purchasers. Channels for promotion include: trade and professional journal publications, vendor shows and trades fairs, workshops and employee training, branding logos, etc.

Low-flow shower heads and faucet aerators can reduce water consumption by as much as 50%, and reduce your energy cost of heating the water also by as much as 50%.

Replacement of low-flow fixtures is ongoing (majority already done).

Prevent pollution and use green products. Keep storm drains clean. Clean up spills but do not hose into streets. Dispose of pesticides and tank in sate properly. Check state and local requirements.

Establish a program for printer ink and toner refills.

APPENDIX D: LIST OF WORKSHOP PARTICIPANTS

Sharyl Allen	Grand Canyon Schools Superintendent
Mike Archer	NPS/GRCA, Chief Ranger – Visitor and Resource Protection
William Auberle	NAU, Professor, Civil and Environmental Engineering
Bob Baker	Grand Canyon Railway, Director of Train Operations
Jan Balson	NPS/GRCA, Deputy Chief, Science and Resource Mgmt.
Judy Bischoff	CESU, Cooperative Ecosystems Studies Unit Leader
Megan Bloomer	Xanterra, Director of Environmental Affairs
Liz Boussard	Public Policy and GIS Consultant
Carl Bowman	NPS/GRCA, Exhibit Planner, Interpretation
Windy Bunn	NPS/GRCA, Fire Ecologist
Asher Burns-Burg	ICF International
Amy Caldwell	NPS/GRCA, Chief of Administration
Kerry Cebul	ICF International
Diane Chung	NPS/FLAG, Superintendent
Barry Clark	NPS/GRCA, Safety Specialist
Janet Cohen	NPS/GRCA, Tribal Liaison, Science and Resource Mgmt.
Kim Crumbo	Grand Canyon Wildlands Council
Dale Elliot	NPS/IMR
Anita Davis	NASA
Jen Dierker	NPS/GRCA, Archeologist, Science and Resource Mgmt.
Wayne Dobberpuhl	APS, Sr. Engineer
Rick During	Forever Resorts, Assistant General Manager
Rick Ernenwein	NPS/GRCA, OPAC, Recreation Planner
Phil Fessler	NPS/GRCA, PMT, Project Manager
Tom Geiger	NPS/GRCA, Deputy Chief, Facility Management
Joseph Goodman	Georgia Tech Research Institute
John Grahame	Coconino County
Ken Guillory	NPS/GRCA, Solid Waste/Sanitation, Facility Mgmt.
Martha Hahn	NPS/GRCA, Chief, Science and Resource Mgmt.
Jeri Hall	NPS/HOAL, Training Manager, Natural Resources
Stacey Hamburg	Sierra Club, Grand Canyon Conservation Program
Ron Hand	Sustainable Design Solutions, Architect
Deirdre Hanners	NPS/GRCA, Environmental Protection Specialist, Facility Mgmt.
Holly Hartman	University of Arizona, Director, Arid Lands Information
John Harvey	NPS/GRCA, Roads, Facility Mgmt.
Kirstin Heins	NPS/GRCA, Science and Resource Mgmt.
Judy Hellmich-Bryan	NPS/GRCA, Chief, Interpretation
Clarence Herron	NPS/GLCA, Facilities Manager
Steve Homan	NPS/GRCA, Civil Engineer, Facility Mgmt.
Erin Huggins	NPS/GRCA, Park Ranger

Bruce Hungate	NAU, Professor, Biological Sciences
Linda Jalbert	NPS/GRCA, Planner, Wilderness Coordinator, Science and Resource Mgmt.
Tim Jarrell	NPS/GRCA, Chief, Facility Mgmt.
Matt Johns	NPS/GRCA, Science and Resource Mgmt (volunteer)
Trinkle Jones	CESU, Cultural Resource Coordinator
Don Kiel	APS
George Koch	NAU, Professor, Biological Sciences
A.J. Lapre	NPS/GRCA
Doug Lentz	NPS/GRCA, Deputy Chief, Concessions
Greg MacGregor	NPS/GRCA, Chief, Project Mgmt.
Lori Makarick	NPS/GRCA, Vegetation Program Mgr. Science and Resource Mgmt.
Shannan Marcak	NPS/GRCA, Public Affairs
Chris Marks	NPS/GRCA, Assistant Fire Mgmt. Officer, Visitor and Resource Protection
Steve Martin	NPS/GRCA, Superintendent
Scott Mason	Delaware North, Assistant General Manager
David Maxwell	NPS/WASO, Monitoring Specialist
Joan Mayer	NPS/GLCA
Julie Thomas McNamee	NPS/WASO, Air Resources and Climate Change Liaison
Margaret McRoberts	NPS/IMR
Stephen Mead	NAU, Interim Chair, Dept. of Civil Engineering
Jeff Meilbeck	NAIPTA
Ted Melis	USGS
Wes Neil	Around the Bend Adventures
Laura Nelson	NPS/GRCA, Concessions
Shawn Newell	NAU, Landsward Program Director
Morgan O'Connor	Grand Canyon Railway, Director of Environmental Affairs
Willie Odem	NAU, Professor of Civil and Environmental Engineering
Dan Oltrogge	NPS/GRCA, Fire Management Officer
Maureen Oltrogge	NPS/GRCA, Public Affairs Officer
Jim O'Sickey	NPS/GRCA, Supervisory Fee and Revenue Analyst
Rosa Palarino	NPS/GRCA, Wildlife Biologist, Science and Resource Mgmt.
Laurie Parish	NPS/GRCA, Fire Assistant
Kathryn Parker	NPS/GRCA, Climate Change Coordinator, Science and Resource Mgmt.
Kevin Parkes	NPS/GRCA, Administration
Andy Pearce	NPS/GRCA, Interpretation
Mike Quinn	NPS/GRCA, Interpretation and photographer
Barb Ralston	USGS
Lori Rome	NPS/GRCA, Interpretation
Angela Saner	NPS/FLAG
Charlie Schelz	NPS/FLAG
Susan Schroeder	Grand Canyon Association
Chris Shaver	NPS/WASO, Chief of Air Resources
Laura Shearin	NPS/GRCA, Concessions
LeAnn Skrzynski	Kaibab Band of Paiute Indians, Environmental Program Director

Christi Sorrell	NPS/GRCA, Science and Resource Management
Racheal Stanton Bennett	NPS/GRCA, OPAC, Environmental Protection Specialist
Allyn Stern	NPS/GRCA, Special Assistant to the Superintendent
Chris Steuer	ICF International
Vicky Stinson	NPS/GRCA, PMT, Project Manager
Jon Streit	Xanterra
Carl Taylor	Commissioner, Coconino Board of Supervisors
Gordon Taylor	Xanterra, Regional General Manager
Lisa Thomas	NPS/SCPN, Coordinator
Patti Thompson	NPS/GRCA, Concessions
David Trenchard	Delaware North
Marge Ullmann	NPS/GRCA, Interpretation
Greg Utech	NPS/GRCA, Administration
Tom Whitham	NAU
Megan Wilkins	NPS/GLCA
Palma Wilson	NPS/GRCA, Deputy Superintendent
Tim Windle	NPS/GLCA, Civil Engineer
Hertha Woody	Sierra Club, Executive Committee, Plateau Group

APPENDIX E: ACTIONS IN PROGRESS

ENERGY USE MANAGEMENT

- Engaging concessioners and partners in reducing energy use:
- Reviewing concessioner contractual language to include sustainable practice requirements
- Partnering with local universities and other agencies on energy efficiency studies, audits and building audits (i.e. leverage local resources beyond utility companies)
- Transitioning to energy efficient electronics
- Replacing residential unit appliances to energy efficient models
- Managing metered energy data through web-based system.
- Replacing inefficient boilers and furnaces

TRANSPORTATION MANAGEMENT

- Establishing an employee bike-to-work program.
- Planning bike paths to Maintenance and other key areas that are currently not accessible.
- Assess opportunities for bicycle rentals
- Establish a free yellow bike program for all employees.
- Establish bike rack/parking areas/infrastructure at all major locations.
- Using reclaimed materials for new roads and paving.
- Using biodiesel park-wide.
- Replace two-stroke engines with four-stroke.
- Implementation of Transportation Management Plan.

WASTE MANAGEMENT

- Installing low-flow fixtures.
- Managing non-point wastewater through pollution prevention and the use of green cleaning products.

- Using a park-wide Green Purchasing Plan to promote the purchase of environmentally friendly products such as insulation, carpets, paints, adhesives, etc. with low or no volatile organic compounds (VOC's).
- Conducting annual Green Purchasing training with emphasis on reducing waste
- Measuring, tracking, and reporting waste stream data (including landfill, recycling) to monitor reductions and success in diverting waste from the landfill.
- Establishing a propane cylinder recycling program.
- Compost mule waste.

ADAPTATION

- Incorporating climate change into several planning efforts and documents.

EDUCATION

- Developing an interactive curriculum for school visits surrounding climate change
- Using web and electronic technologies to reach the internet demographic, including podcasts and webpage content