

National Aeronautics and Space Administration



# JOHNSON SPACE CENTER

## 2017-2018 ANNUAL SUSTAINABILITY REPORT



# Update From the Sustainability Team

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The Johnson Space Center (JSC) is committed to Sustainability. This is apparent in Center Operations' projects that make better use of our resources, such as LED lighting installations and the Combined Heat and Power plant, while maintaining a safe and enjoyable workplace.

This year, JSC, Headquarters, and Marshall collaborated in a workshop to decide the goals that reflect a JSC vision for sustainability. Mentioned in that workshop was the Space Act of 1958 which states the founding purpose and function of NASA. It emphasizes a spirit of cooperation and peaceful objectives, none of which are lost in pursuit of sustainable operations. Here is a glimpse of those foundational goals from the original NASA charter:

*DECLARATION OF POLICY AND PURPOSE Sec. 102.*

*(a) The Congress hereby declares that it is the policy of the United States that activities in space should be devoted to peaceful purposes for the benefit of all mankind. (c) The aeronautical and space activities of the United States shall be conducted so as to contribute materially to one or more of the following objectives:*

*(1) The expansion of human knowledge of phenomena in the atmosphere and space;*

*(5) The preservation of the role of the United States as a leader in aeronautical and space science and technology and in the application thereof to the conduct of peaceful activities within and outside the atmosphere.*

*(8) The most effective utilization of the scientific and engineering resources of the United States, with close cooperation among all interested agencies of the United States in order to avoid unnecessary duplication of effort, facilities, and equipment.*

This compliments the myriad ways we can pursue projects and infrastructure and the importance of connecting with the surrounding community. We are guided by the principles of sustainability to engineer the most effective facilities and equipment for our purposes, and to reduce the duplication of efforts. This endeavor is the responsibility of each one of us, to identify in our work the ability to eliminate unnecessary expenditures of energy. We must persistently create a culture of responsibility to the planet in order to sustain the resources that help us meet our mission.

**-Stacy Shutts, JSC Sustainability Coordinator**

*Cover Photo: Earthrise shot by Apollo 8 mission astronaut Bill Anders on December 24, 1968. This image has become one of the most popular photographs ever taken and was iconic to the environmental movement. Credit: NASA*

*Background Photo: Acaba, Vande Hei, and Misurkin return to earth after 168 days in space. Credit: NASA*



# Sustainability at Johnson Space Center

Johnson Space Center strives to maintain a sustainable campus environment through implementing policies that improve air, energy, land, water, and material/waste resources in order to promote the health of the planet and operate in a way that benefits our neighbors. Building from NASA's agency sustainability policy to "execute the mission without compromising our planet's resources so that future generations can meet their needs," and the Agency Strategic Sustainability Performance Plan (SSPP), Johnson Space Center hopes to promote a future where the environment and living conditions are protected and enhanced.

***"execute the mission without compromising our planet's resources so that future generations can meet their needs"***

This Annual Sustainability Report documents efforts which advance

- **Matthew Strausser**, JSC Wildlife Biologist
- **Cadan Cummings**, JSC Planning & Integration Intern, Spring 2018

the sustainability of the Center and serve as an example of how NASA is playing an active role in our planet's continued conservation.

Each section of this report describes the roadmap for how sustainability is approached at JSC through detailing the applicable sustainability goals, interesting facts about the resource, and what individuals can do to help. This report is by no means an exhaustive list of current projects and more information is available on the JSC Sustainability Website at <http://www.nasa.gov/centers/johnson/about/sustainability>.

Johnson Space Center strives to follow sustainability guidelines that will ensure the continued environmental health of our campus, surrounding community, and world. The standards which we strive to follow are outlined in the Executive Order (EO) 13693- Planning For Federal Sustainability in the Next Decade. Aimed to mitigate greenhouse gas emissions and promoting resource conservation, EO 13693 sets efficiency marks for ten different metrics concerning topics such as water sustainability and waste management.





# 2. Agency Sustainability Goals FY2017 Scorecard

## Functional Area



## Criteria

### 1. GHG Emissions Reduction

1) Reduce Scope 1 & 2 GHG emissions by 18% in FY 2017 compared to a FY 2008 baseline. Total reduction target is 47% by FY 2025. These emissions pertain to sources owned or controlled by the government (e.g. government fleet, stationary sources) and purchased electricity, heat or steam.  
2) Reduce Scope 3 GHG emissions by 12% in FY 2017 compared to a FY 2008 baseline. Total reduction target is 32% by FY 2025. These emissions pertain to activities not directly controlled by government such as emissions from non-government vehicles (e.g. employee travel, commuting).

## Status

**Green:** Meets both goals  
**Yellow:** Meets one of the goals  
**Red:** Does not meet either goal

## JSC's Overall Score

**GREEN**  
1) Yes, 27% (-49K MtCo2e)  
2) Yes, 19% (-4K MtCo2e)



### 2. Sustainable Buildings

Meet the following targets: 1) reduce energy intensity in JSC goal subject (GS) facilities by 5% in FY 2017 compared to a FY 2015 baseline; 2) identify strategies to evaluate existing buildings for future compliance to the revised Guiding Principles, and achieving energy, waste or water net-zero status in GS facilities; 3) identify strategies to evaluate new buildings designs for incorporation of climate-resilient design elements.

**Green:** Meet all three targets  
**Yellow:** Meet two of the three targets  
**Red:** Meet fewer than two targets

**YELLOW**  
1) No, -4.9% (-11K Btu/gsf)  
2) Yes  
3) Yes



### 3. Renewable Energy

Have at least 10% of JSC's FY 2017 electricity consumption come from renewable sources. These sources include renewable energy generated and used on JSC, renewable energy generated on JSC but used off-site, and the purchase of renewable energy certificates from non-JSC sources.

**Green:** Source at least 10% electricity from renewables  
**Yellow:** Source at least 7.5% but less than 10% electricity from renewables  
**Red:** Did not source at least 7.5 % electricity from renewables

**GREEN**  
14% (21M Kwh)



### 4. Potable Water Intensity Reduction

Reduce Johnson Space Center's water intensity by at least 20% in FY 2017 as compared to a FY 2007 baseline.

**Green:** Reduce water intensity by at least 20%  
**Yellow:** Reduce water intensity by at least 18% but less than 20%  
**Red:** Reduce water intensity by less than 18%

**RED**  
16% (-12.7M gal/gsf)



### 5. Fleet Management Emissions Reduction

Meet the following targets: 1) reduce JSC's fleet per mile emissions by 4% as compared to an FY 2014 baseline; 2) ensure purchased or leased vehicle acquisitions are at least 75% EPA Act Alternative Fuel Vehicles.

**Green:** Meet both targets  
**Yellow:** Meet one of the two targets  
**Red:** Did not meet either target

**YELLOW**  
1) Data Not Available at Center level  
2) Yes

# Agency Sustainability Goals FY2017 Scorecard

## Functional Area



## Criteria

### 6. Sustainable Acquisition

1) Ensure sustainable performance and sustainability factors are considered to the maximum extent possible for all applicable procurements, 2) Meet statutory mandates that require purchase preference for sustainable acquisitions programs.

## Metrics

**Green:** Meets target  
**Yellow:** Meets 50% of target  
**Red:** Meets less than 50% of target

## Does JSC Meet Metric?

**YELLOW**  
1) Yes  
2) No, 77% compliant purchases  
(Improvement from 2016)



### 7. Pollution Prevention and Waste Management

Meet the following targets: 1) divert at least 50% of non-hazardous, non-Construction and Demolition (C&D) solid waste; 2) divert at least 50% of C&D waste.

**Green:** Meet both targets  
**Yellow:** Meet one of the two targets  
**Red:** Did not meet either target

**YELLOW**  
1) No, 48% diversion (Harvey impacted)  
2) Yes, 83% diversion



### 8. Energy Performance Contracts

Maintain at least two energy performance contracts. Performance contracting allows the government to partner with private industry on energy and water conservation projects and pay for them with the resulting cost savings.

**Green:** Initiate two energy performance contracts  
**Yellow:** Initiate one energy performance contract  
**Red:** No energy performance contracts initiated

**GREEN**  
Yes, Honeywell and CHP

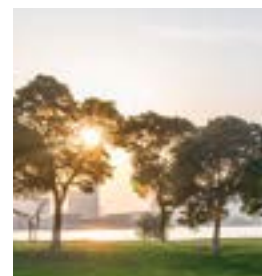


### 9. Electronic Stewardship

1) All computers and electronics have power management features, 2) Follow environmentally sound methods for disposal.

**Green:** Meet both targets  
**Yellow:** Meet one of the two targets  
**Red:** Did not meet either target

**GREEN**  
1) Yes  
2) Yes



### 10. Climate Change Mitigation

Determine long- and short- term mission criticality to inform 1) design of new construction and modernization to increase climate resilience, 2) evaluation of new construction for floodplain considerations, 3) determine design parameters that balance options to address climate change, cost, and security with low and no cost resilience measures, and 4) take actions to mitigate risk, cost, climate impacts, and phased adaptation over time.

**Green:** Progress in all four areas  
**Yellow:** Progress in three areas  
**Red:** Progress in two or fewer areas

**GREEN**  
1) Yes  
2) Yes  
3) Yes  
4) Yes

# 3. Sustainability Vision Workshop



2018 Sustainability Workshop Brainstorming Session. Credit: NASA



**JSC Sustainability Logo**  
 These 10 goals are combined by the resource they most directly impact- air, water, land, energy, materials, and people. This provides JSC employees another way to connect with the goals of the Executive Order and understand what it is we are sustaining for center operations and the NASA mission.

## Focal Points of Sustainability

- Partner with community groups • Alternative Transportation
- Reduced GHG Emissions • Net-Zero Buildings • Alternative Uses for Existing Resources • Foster Culture Change • Prioritize Energy-Efficiency • Maintain a Relevant Vision Plan • Foster Resilient Campus • Work with Local & Federal Regulations • Prioritize Water Sustainability
- Maintain a Sustainable Business Image • Manage an Energy-Efficient Fleet Prioritize Recycling • Sustainable Campus Landscaping • Optimizing Building Efficiencies • Pursue Renewable Energy Opportunities • Prevent Pollution • Be Leader in Educational Publications • Technology Stewardship

Johnson Space Center conducted a Sustainability Workshop in February 2018 to update the center sustainability vision and mission to serve as guidance for present and future projects. As part of the workshop, participants performed a SWOT-VP analysis which highlights Strengths, Weaknesses, Opportunities, Threats, Vision, and Purpose of Sustainability. In addition to drawing themes from participant responses, the workshop served as an opportunity to benchmark other federal centers and public institutions to learn how JSC can improve with sustainability efforts.

Using the information collected from the SWOT-VP analysis and document review sessions, workshop participants developed sustainability vision and mission statements that will act in guiding future sustainability efforts.

### Sustainability Mission Statement

*“Enable a better NASA by being a leader in good stewardship of our JSC Center, community, and planet for future generations.”*

### Sustainability Vision Statement

*“Empower a culture of responsibility to sustain a fiscally & environmentally resourceful campus in support of the Agency’s goals.”*



# 4 Sustainability

## Harvey and Resiliency Planning

### Hurricane Harvey

JSC was hit with record rainfall in August 2017. Although Mission Control stayed operable during this period, the rest of the Center was closed. The rainfall approximated the 250 year exceedance value for rainfall. JSC received funding to repair and, in some cases, improve and plan for more resilient infrastructure.

Projections from the NASA Climate Adaptation Science Investigators (CASI) Workgroup that closed in 2016 show that sea level rise will incrementally increase in the next 60 years, which may exacerbate the effects and level of storm surge experienced. In the past, responding to Ike storm surge, JSC made various improvements to infrastructure including flood resistant doors, equipment flaps and increased intakes. Currently, Center Operations is working to incorporate raised guard shacks as one measure of improvement to reduce flooding.

### JSC Resiliency Planning

Funding provided for recovery and improvements post-Hurricane Harvey includes development of a resiliency plan. This is an opportunity to improve existing emergency plans and risk assessments of the JSC site during worst case and emergency scenarios. Although climate risks are both top-of-mind and contextually relevant, other risks- such as cyber or chemical attacks- are important to assess as well in a resiliency plan.

This summer, Center Operations intern, Natalie Zimmermann, compiled a Situational Awareness and Trends document. This review of historical and

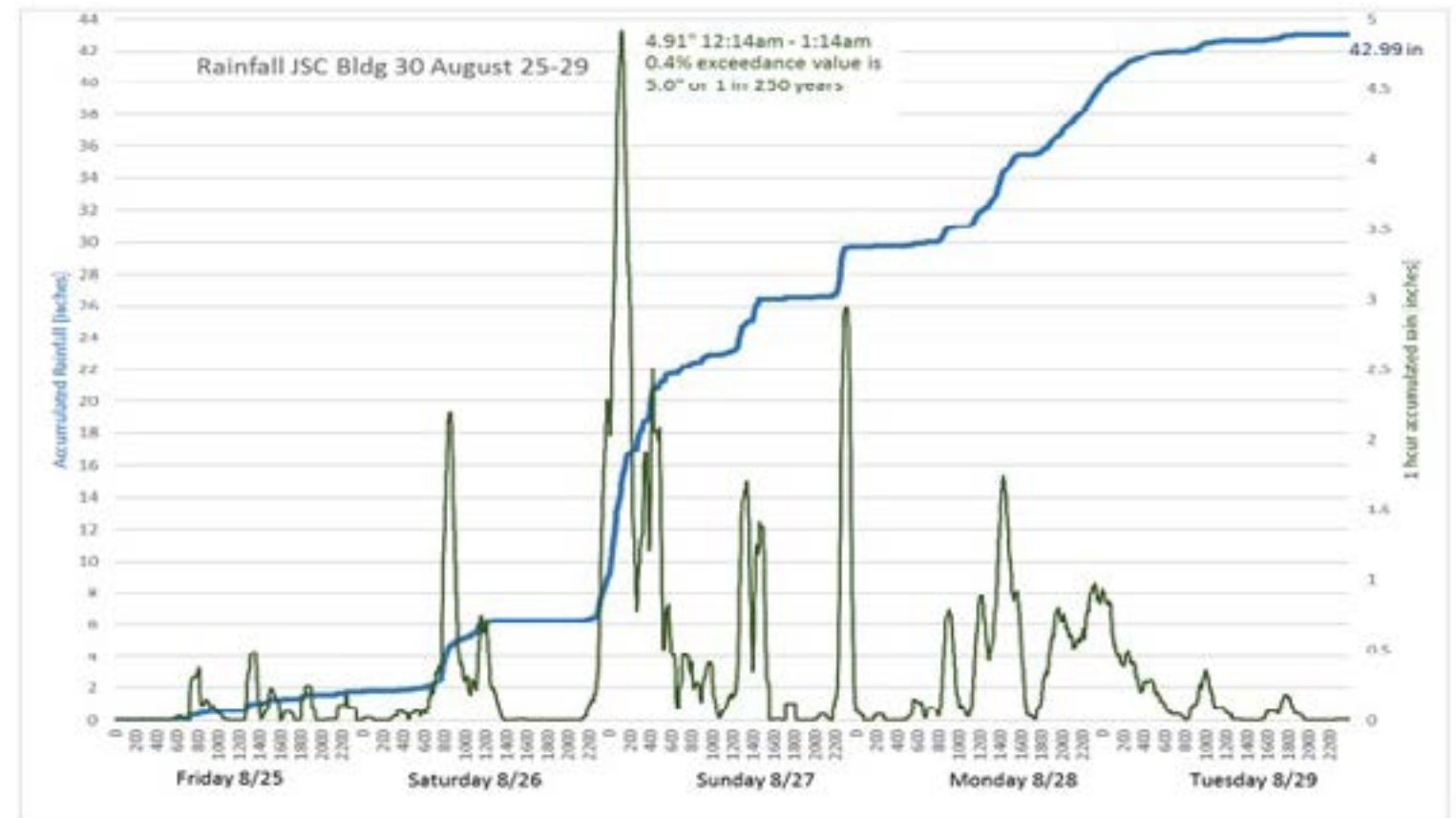
projected trends from data such as temperature, precipitation, and sea level rise, will be used as a baseline for stakeholders to review and assess critical infrastructure needs based on worst case scenarios and future predictions. It will also contribute to the NASA HQ Agency Climate Risks Assessment. Statutory authority for assessment of risks and climate awareness includes:

- a) 31 USC §1115 Helps in managing a high-risk management challenge identified by the Government Accountability Office, specifically NASA-Johnson Space Center's financial exposure to climate change.
- b) 31 USC §3512 References safeguarding funds, property and other assets at NASA-Johnson Space Center.
- c) 15 USC §2938 Agencies are mandated to use U.S. Global Change Research findings pursuant to their statutory obligations and responsibilities.
- d) 51 USC §60506 NASA is mandated to share climate information.

An example of the historical data for division 8, Houston's division, shows drought conditions. Upward trends in drought conditions have proven most drastic during the fall season. Data like this will help inform JSC stakeholders of risks that hold the potential for affecting employees or infrastructure. Planning for these risks will help JSC prepare and plan for resiliency in the face of likely or worst case scenarios.

**-Stacy Shutts, JSC Sustainability Coordinator**

Hurricane Harvey Rainfall, Building 30 Mission Control Center



### Successful Hurricane Mitigation Efforts



Raised tunnel air intake

Flood gates outside B30

Flood doors on tunnel exhaust vents

Sealed doors in facilities throughout Center to protect mechanical rooms

All new facilities are rated to withstand 130mph winds



# 5. Sustainability Success Stories

In 2018, there were many JSC sustainability successes. On the following pages, we outline the following notable accomplishments, many of which are ongoing:

- **Ride Sharing**
- **Free Range Bike Program**
- **Building 21 Construction**
- **Living Lab**
- **Prairie Chickens**
- **Biobased Products**
- **Combined Heat and Power Plant**
- **JSC Landscape Standards**
- **Bike to Work Day**

This report by no means presents an exhaustive list of current projects and more information is available on the JSC Sustainability Website. E-mail [JSC-Sustainability@mail.nasa.gov](mailto:JSC-Sustainability@mail.nasa.gov) to share your successes or ideas for improving sustainability at JSC.

Warnecke Miller, from JSC's legal office, and her children helped out at the 2018 **Volunteer Wetland Planting Day at Exploration Green**. Pictured with Mary Carol Edwards, Wetlands Coordinator for the Texas Watershed Community Partners.



# Sustainability Success Story Fuel Efficient and Vanpool Parking

## Low-Emitting / Fuel-Efficient Parking Decals

Building 21 presented an opportunity for JSC to get rewarded for decreasing its transportation footprint. The United States Green Building Council (USGBC) makes standards and certifies Leadership in Energy and Environmental Design (LEED) buildings. The "Location and Transportation" category intends to reduce (GHG) from vehicles. An entity can achieve credits by designating low-emitting/fuel-efficient vehicle parking.

Data from the EPA shows that of the total U.S. greenhouse gas emissions (GHG) in 2016, transportation accounted for nearly 28.5% from combustion of petroleum-based fuels. According to the USGBC Reference Guide, the intent of incentivizing the purchase of green vehicles is to decrease public health risks and emission of nitrogen oxides, sulfur oxides and particulate matter.

To qualify, green vehicles must meet third-party standards that comprehensively measure both fuel efficiency and emissions. Greenercars.org provides a current list of such vehicles. A Building 21 occupant with a qualified vehicle (correlating vehicle make, model, and year) may request a "green leaf" decal from the Building 21 Facility Manager. This decal is placed on the driver's windshield next to the registration sticker.

The reward for building users who drive green vehicles is access to closer parking spaces to the building's entrance. JSC Security monitors the LE/FE spaces for violations based on the green leaf decal, which are pursuant to "reserved parking" regulations. For a list of those vehicles, visit <https://greenercars.org/news/list-leed-qualified-cars>.

- **Carl Diehl**, LEED Project Manager at Gilbane



**Did you know** Another way to receive reserved parking, save on gas, and vehicle maintenance is the **MetroStar Vanpool**. Report this cost of transportation quarterly in the JF220 form to [bridget.l.broussard-guidry@nasa.gov](mailto:bridget.l.broussard-guidry@nasa.gov). Your taxable income will be reduced by the amount that you paid that year.



# Sustainability Success Story

## Alternative Commuting

**Our carpool group would love more members! We are very flexible on timing and the more folks involved, the more possibilities there are for schedules lining up!**

### Bike to Work Day

On April 19, 2018, approximately 70 people hit the roads early in the morning to bike to work. For the third consecutive year JSC cyclists and members of the sustainability team organized a community Bike to Work Day, and the event continues to grow in awareness and community support. This year alone, Nassau Bay, Webster, and League City contributed their efforts to the event with police support, street cleaning, or employee time-off.

Six groups of cyclists, organized geographically and assigned a champion to lead the ride, arrived at the Gilruth Center. Local bike shops, bike mechanics and supporting organizations were at booths to greet the cyclists. After food and comraderie, JSC employees ride to their offices, making time to shower at the Gilruth or onsite facilities.

Kirstyn Johnston has led the charge for Bike to Work Day. She moved to Houston from Boulder, Colorado, and wanted to see more effort put towards bike infrastructure for safer commutes in this area. With her initiative, JSC has discussed these goals with entities such as the Texas Department of Transportation and the Houston-Galveston Area Council.



- **Kirstyn Johnson**, Bike to Work Day Organizer

### Ridesharing

I am a Flight Controller/Instructor for the International Space Station (ISS) program and I live up in Midtown Houston. I love living in the city because I can bike to everything up in town. The drive to and from work can be a little tough, but I am part of a carpool with some other JSC coworkers and that helps lessen the load. The carpool was started 6-7 years ago in the Attitude Determination and Control Officer Motion Control Group (ADCO/MCG) and the lead has rotated over the years. I am leading it now, but for the last few years, Steve Deterling, Mission Systems Operations Contract (MSOC) manager, and I have traded coordinating responsibilities every 6-12 months.



We have about half a dozen regular members that live in Montrose/Midtown. Members enter their schedule regarding carpool availability in a spreadsheet, and then I plan for who drives/rides each evening and send out a message to our group chat in WhatsApp. We have three parking spots that allow us to park a little closer when we carpool. I really enjoy being able to get to and from work without actively driving sometimes, and it feels great to help have one less car on I-45. It's also a unique opportunity to chat with coworkers in other directorates that we may not ever meet otherwise. Those cross-directorate conversations can help foster the kind of collaboration across organizations that is part of the JSC 2.0 vision.



I also try to bike to work every 1-2 months with my partner, who also works at JSC. It's a 25 mile ride and takes just under 2 hours, mostly on Rt. 3 until Space Center Blvd. Early on Friday mornings, the traffic isn't bad at all. The showers in B12 are key! We stage a car on Thursday night and drive home that afternoon with the bikes on the back of the car (the roads are just too busy to bike north on Friday afternoons). We have biked down with coworkers at a variety of different cycling experience levels. Even if you're new to biking, if you have spare tubes, a couple bottles of water, and a positive attitude, you can do it!

Our carpool group would love more members! We are very flexible on timing and the more folks involved, the more possibilities there are for schedules lining up! Feel free to contact me via email if you'd like to carpool (or bike with us) – [megan.l.harvey@nasa.gov](mailto:megan.l.harvey@nasa.gov)”

- **Megan Harvey**, ADCO/MCG  
- Edits by **Steven P. Deterling**, MSOC Manager





# Sustainability Success Story

## Free Range Bike Program

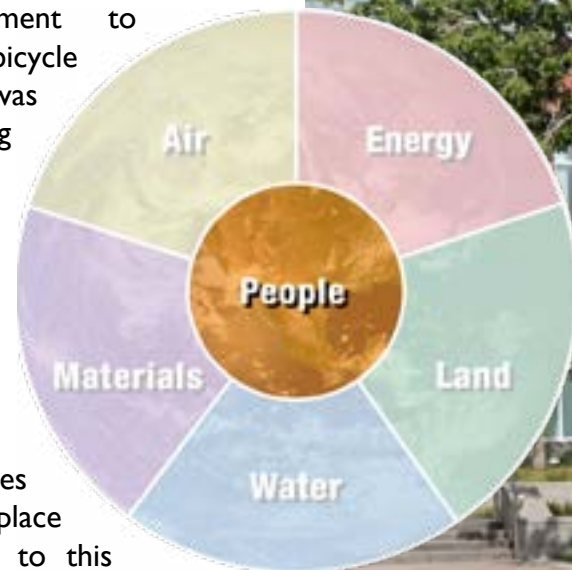
The Free Range Bike Program started 15 years ago as a Christmas gift to the JSC employees from the Center Operations Director, Joel Walker. This was a new and sustainable way to truck from building to building at a faster pace and a little wind in their face. With no sign in or sign out method for these new bikes, employees could freely hop on one, ride to their destination and ride back at their leisure.

It started with a total of 10 bikes and has grown to 360+ free range bikes across the center, which increases the chances that a bike will always be available to anyone on-site who desires to ride. As the center became more innovative with JSC 2.0, so did the free range bike program. Today, the bikes have QR code labels that can be scanned to report a broken bike to the center's bike repair technician. This keeps the bikes maintained properly and the center free of multiple defunct bikes as eyesores. Overall, the program has assisted with increasing exercise for the employees, lowering greenhouse gas emissions and getting employees where they need to be in a timely manner.

**“Overall, the program has assisted with increasing exercise for the employees, lowering greenhouse gas emissions and getting employees where they need to be in a timely manner.”**

Further encouragement to participate in the bicycle share program was undertaken this spring when bluetooth tracking capabilities were added. With the introduction of bluetooth tracking, Johnson Space Center community members are able to more easily find bicycles nearby their workplace or parking area. Up to this point, approximately 200 bicycles have been retrofitted with Bluetooth beacons along with 25 Bluetooth tracking stations in buildings across the JSC campus.

**-Syreeta Watkins**, Free Range Bike Program Manager



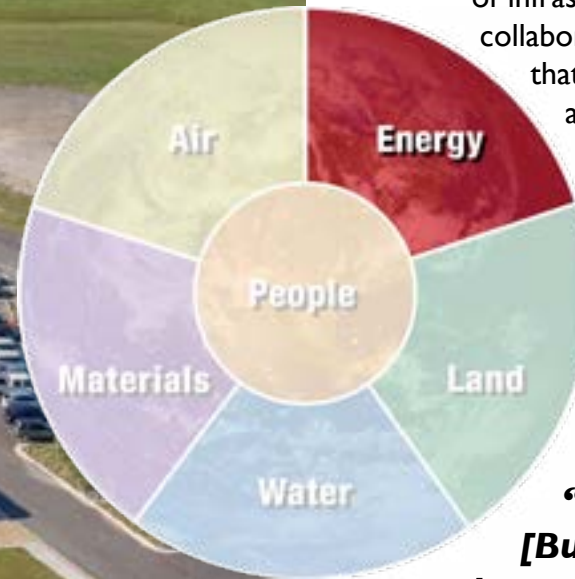
**Did you know** the free range bike program is partially composed of abandoned bikes that were left in disrepair and fixed up by the center for public use, what better way to re-use a resource?





# Sustainability Success Story

## Building 21 Construction



Construction of building 21 wrapped up on July 26, 2017 and is now occupied by the Human Health and Performance Laboratory. The building is an achievement for JSC campus sustainability because it was built to consolidate several obsolete facilities into one. This decreases the footprint of infrastructure at JSC while fostering collaboration and creativity among staff that support diverse biomedical and biological sciences. From an environmental perspective, Building 21 adds to the already well-established list of green buildings on campus as upon certification it will become the 10th LEED certified building on the JSC campus.

**“...Upon certification [Building 21] will become the 10th LEED certified building on the JSC campus.”**

Energy-efficient features are first evident in the north/south building orientation of the outside exposures. Unique to most other buildings on the JSC campus, Building 21 was designed

### **Building 21 At A Glance:**

- 118,000 square feet
- 17 laboratories, 44 offices, 250 open workstations, eight huddle rooms
- 8,000 square foot high bay as well as microscopy and tissue culture rooms
- Showcases 57 works of art that commemorate the history of space exploration

**Did you know** the Human Health and Performance Laboratory formerly occupied part of Building 37 which was the site of the Apollo quarantine program and lunar rock receiving lab?



to angle toward the existing street yet also match the daily sun path. This design feature makes the structure blend into the existing infrastructure while decreasing the utility demands for the building. This also enhances the workplace environment by incorporating large naturally lit areas that connect the two wings and foster collaboration between different biomedical and biological science groups.

In addition, the combinations and placement of offices, huddle rooms, laboratories, and conference rooms, makes smart use of the footprint to foster collaboration and maximize productive spaces.

**- Jeff White, B21 Construction Project Manager**

Photo: Aerial view of Building 21. Credit: NASA



# Sustainability Success Story

## Living Lab

The HSB Living Lab at Chalmers University in Gothenburg, Sweden, has been contributing to innovation at JSC since 2016. Thanks to Larry Toups of the Exploration Mission and Planning Office of EISD, four workshops have contributed ideas and collaboration across the globe! Between the Johnson Space Center, Rice University's Oshman Engineering Design Kitchen (OEDK), and Chalmers University, virtual collaboration has allowed professionals and students to co-create on various topics such as laundry, cooking, growing food and recycling wastes to reduce environmental impact.

The results have led to prototypes designed and built by Rice senior engineering students for apartment-sized greenhouses, hydroponics, sensor, lighting, and space configurations for small spaces, and garbage disposals that provide easy access to ground foods for compost systems. On a few occasions, students have followed up the workshops with demonstrations of their prototypes in the JSC cafeteria, where they receive informal feedback from NASA employees. At one point, lighting engineers were providing advice to students demonstrating hydroponics, and on another the

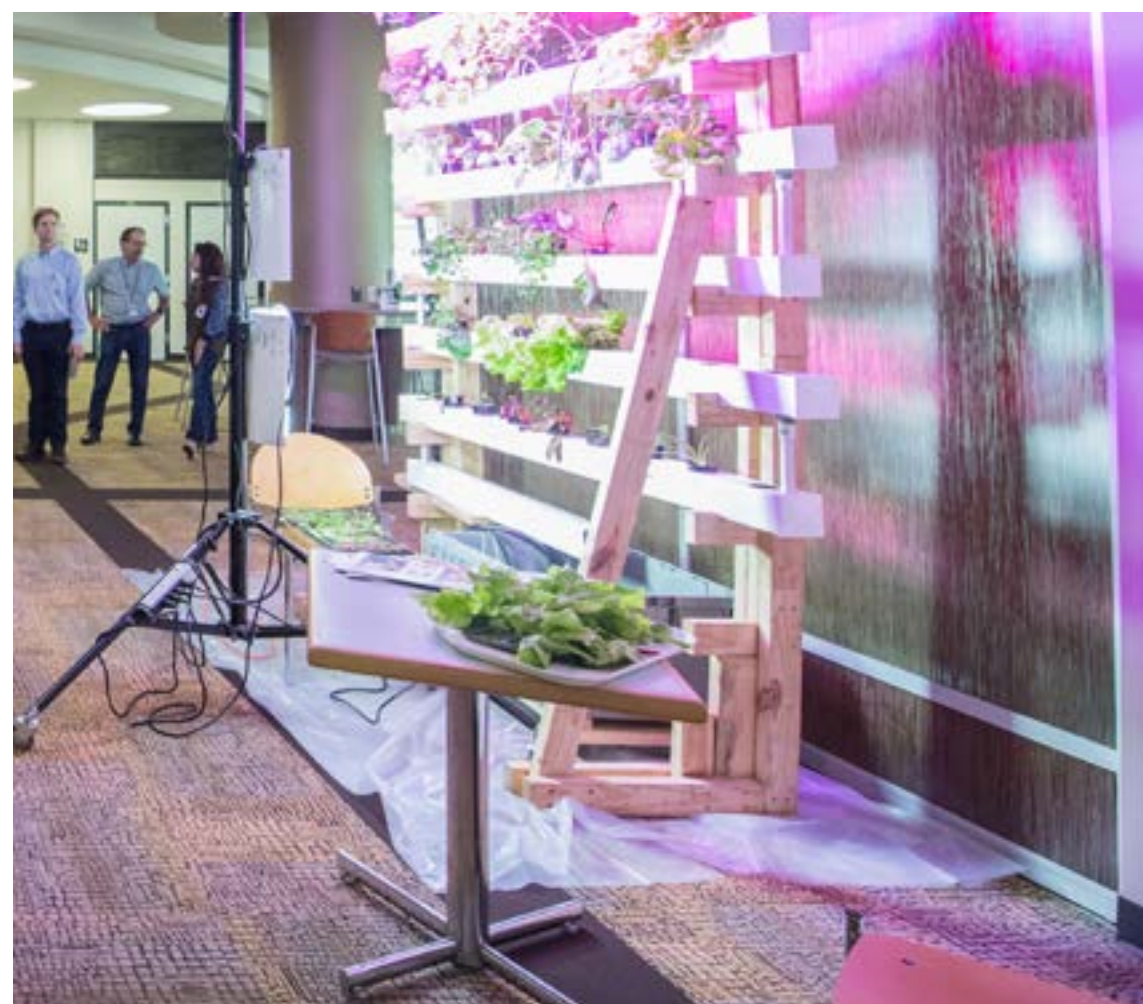
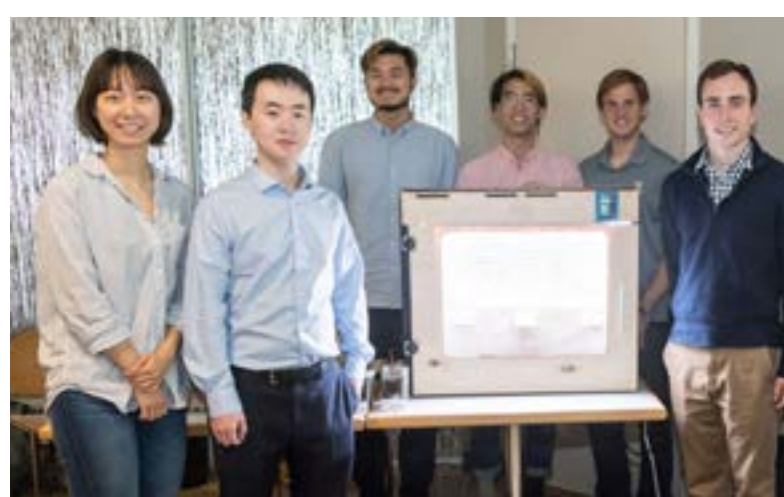
students were communicating the benefits of the compost and variable turn rates and durations of processing.

These workshops offer a platform for professionals to enter questions - like those in the NASA@work Challenge- to get a multitude of backgrounds engaging on an issue. Steve Rader of NASA@Work has mentioned the benefits of this cross-discipline influence, noting that a recent study showed that up to 70% more solutions come from collaboration of this type than of specialists narrowed on a problem without outside influence.

**“70% more solutions come from collaboration of this type than of specialists narrowed on a problem without outside influence.”**

This is one avenue of influence to vet decisions and ideas from current students, professors and professionals.

- **Larry Toups**, JSC Exploration Missions Planning Office





# Sustainability Success Story

## Prairie Chickens

Attwater's Prairie Chicken is a species of endangered bird endemic to the Western Texas Gulf Coast. The species was listed as endangered in 1967 and in 1973 the Endangered Species Act provided protection to the birds. Current population estimates suggest that fewer than 40 individuals exist in the wild. In partnership with the Houston Zoo, Johnson Space Center has developed a breeding facility on two acres of land located in the northwest quadrant of campus. As of Spring 2018, the facility is home to thirty-eight individuals, all of which are adult breeding age. The joint project partnership between JSC and Houston Zoo started in 2005 and is ongoing with birds bred at Johnson Space Center and egg hatching occurring at the Houston Zoo.

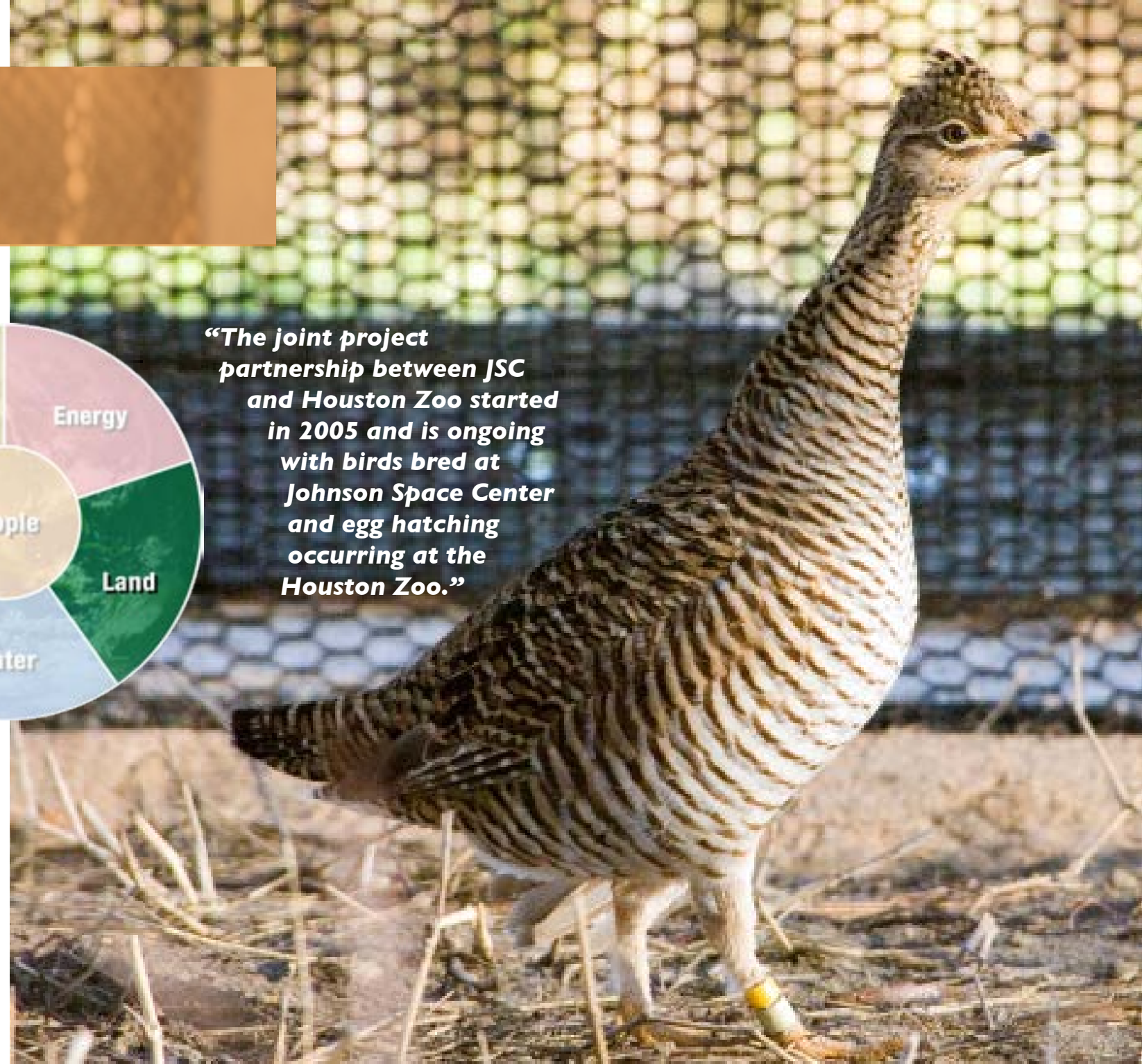
These ground-dwelling birds are a species of grouse which can be distinguished by their brown, black and buff-colored feathers. Weighing in at around 1.5 to 2.0 pounds, the species is a medium-sized bird which generally is approximately 17-18 inches tall. Similar to most species of birds, Attwater's Prairie Chicken is sexually dimorphic which means that male and female individuals exhibit different characteristics. Male individuals have elongated feathers as well as a bright orange or yellow air sac on either side of their neck. Conversely, female birds lack air sacs and are generally slightly taller than male individuals.

From a behavioral perspective, prairie chickens are distinctive because they perform mating practices June through mid-May called booming, a sound made by males amplified by inflating their air sacs. During booming a male bird taps its feet quickly across the ground- also known as drumming- to attract female individuals. Female birds then build a nest from grasses and other materials on the ground where they lay around 10 to 12 eggs. Eggs hatch approximately 25 days later with around seventy percent lost to predation. Fortunately Johnson Space Center, has constructed a protective mesh building to prevent predators from harming the prairie chickens or their eggs. Predators include hawks, owls, coyotes, raccoons, skunks, fire ants, opossums, and snakes- are of which are present at Johnson Space Center.

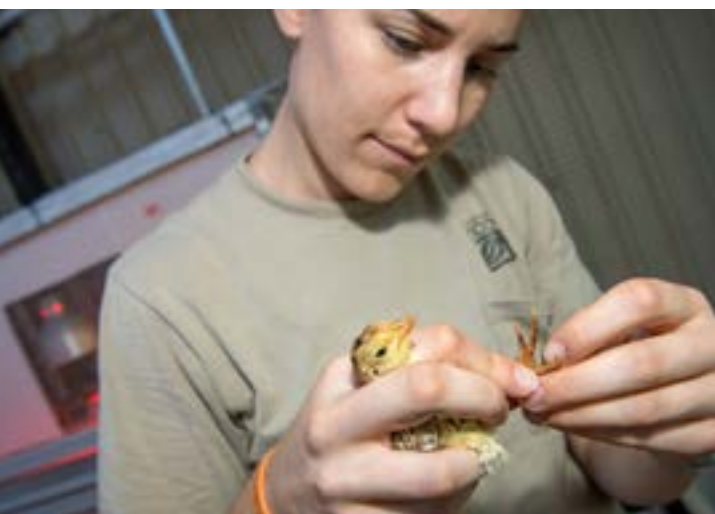
The species generally eats grass shoots, flower petals, and small insects such as grasshoppers. Urbanization had a substantial effect on the available prairie lands for Attwater's Prairie Chickens to inhabit. At one time, the habitat for Attwater's Prairie Chickens included six-million acres of prairie extending down



**“The joint project partnership between JSC and Houston Zoo started in 2005 and is ongoing with birds bred at Johnson Space Center and egg hatching occurring at the Houston Zoo.”**



*Below photos: Texas Master Naturalist Galveston Bay Area Chapter team battles invasive species*



the Texas Gulf Coast. Tragically, the Gulf Prairie has dramatically decreased in size with current estimates suggesting that approximately one-percent of the prairie remains.

- **Sandy Parker**, Master Naturalist
- **Mollie Coym**, Senior Bird Keeper at the Houston Zoo

**Did you know** the Attwater's Prairie Chicken was once a key species to the Texas Coastal Prairie but now is limited to JSC, Houston Zoo, and less than 40 individuals in the wild?



# Sustainability Success Story

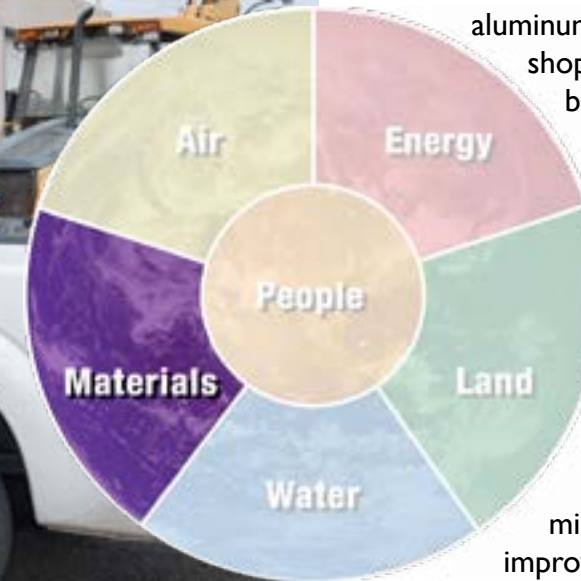
## Biobased Products



**B**iobased products are items that are made from plant-based materials. By law, all federal agencies are required to purchase specific items with recycled or biobased content. In many circumstances, biobased products have the potential to improve efficiency and reduce waste generation in comparison with their petroleum-based counterparts. JSC continues to make strides towards increasing biobased purchases and finding more effective and environmentally friendly alternatives for various processes onsite. In FY 2017, JSC personnel implemented several pilot projects for biobased products to assist in this initiative.

JSC Facilities Support Services Contract coordinated with the NASA Headquarters' Recycling and Sustainable Acquisitions Principal Center to try a biobased passenger vehicle engine oil in three vehicles. Through a partnership between NASA and the Department of Defense/Defense Logistics Agency, the product and used oil testing were provided at no cost to NASA for an entire year. Based on test results, the used biobased oil tested remained within usable parameters, indicating appropriate product performance and potentially future use at NASA.

The JSC Fabrication Shop personnel initiated a pilot study for a biobased metalworking coolant when the current biobased product was discontinued by the manufacturer. Another compliant, biobased product was required that meets JSC's stringent aerospace requirements. JSC personnel already reduced waste with the initial switch to the first biobased coolant and wanted to maintain the same or better efficiency with any new products. The



coolant also needs to be compatible with a variety of metals, including aluminum and titanium. The in-machine trial started in early 2017, and shop personnel have reported positive results. In 2018, the selected biobased coolant went through additional testing and obtained approval for machining titanium, which will allow for the shop to fully convert to the new biobased product. Results from this project are already being shared with other NASA Centers.

These efforts represent only a portion of what JSC and other NASA Centers are doing to increase environmentally preferable purchasing and reduce waste generation. Efforts across NASA are ongoing to meet regulatory requirements and improve performance. Together, JSC can continuously become more efficient and environmentally friendly while completing our mission to lead human space flight. If you have any ideas for process improvements or opportunities for environmentally friendly product alternative trials, please contact the JSC Environmental Office at [JSC-Environmental-Office@mail.nasa.gov](mailto:JSC-Environmental-Office@mail.nasa.gov).

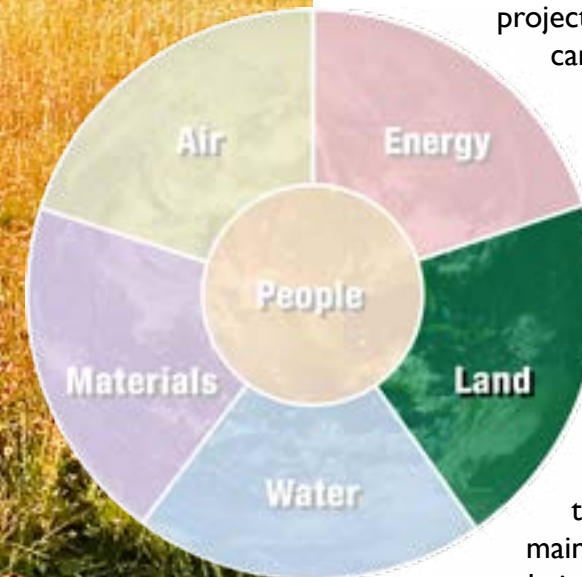
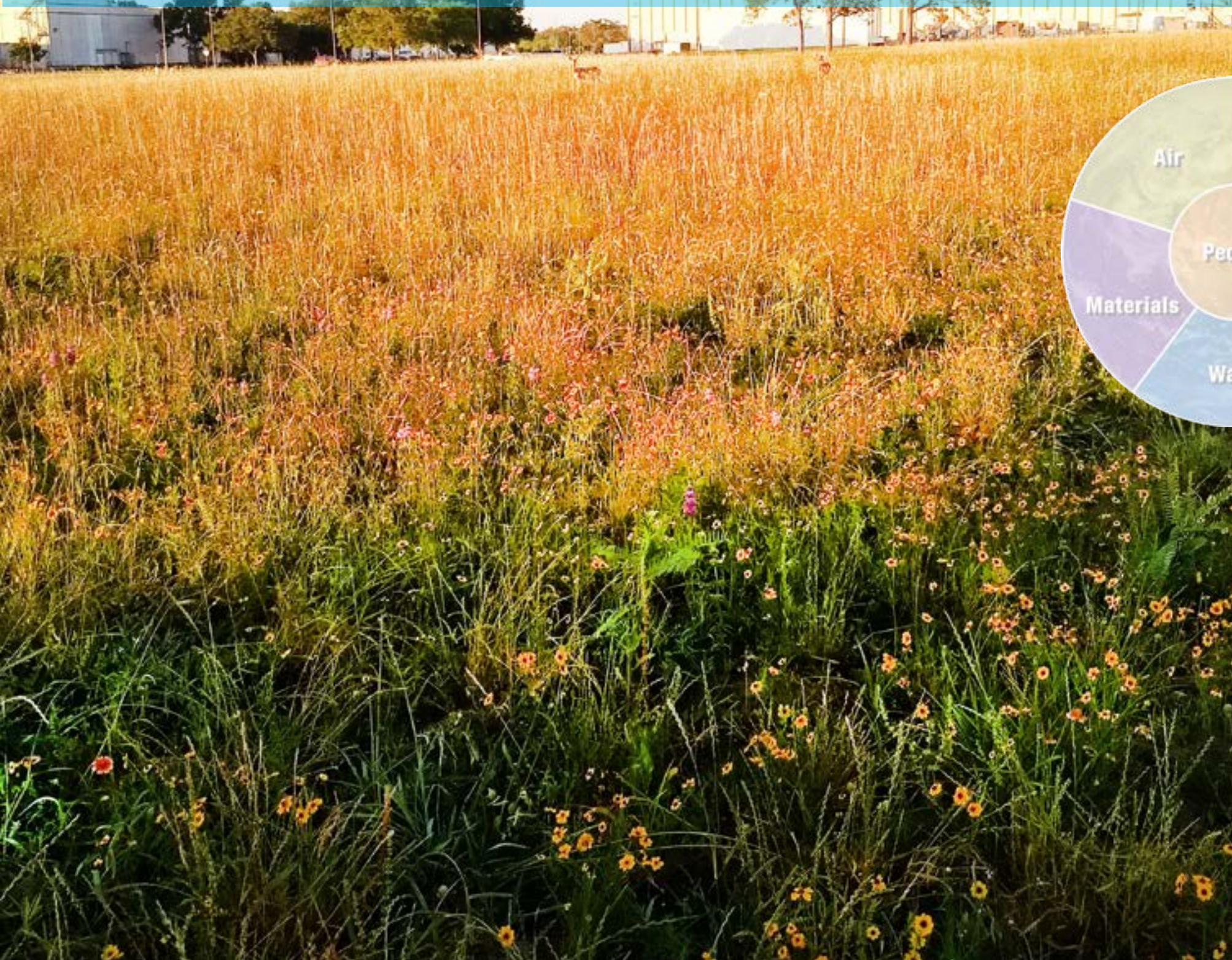
**- Jennifer Morrison, JSC Sustainability and Recycling Lead**





# Sustainability Success Story

## JSC Landscape Standards



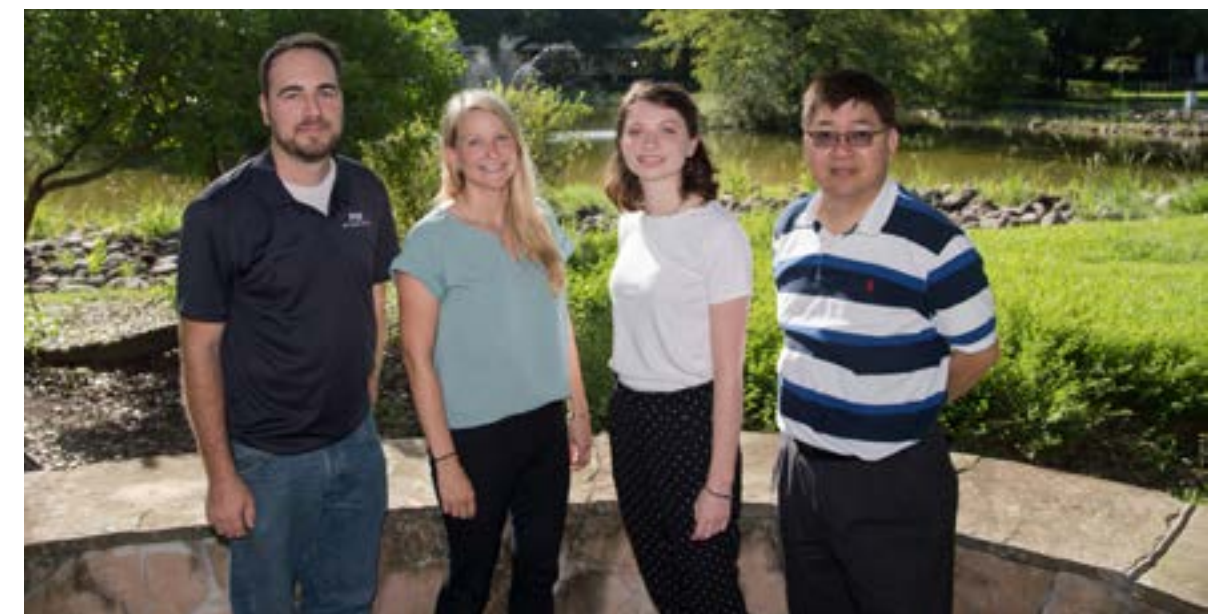
JSC aims to execute NASA's mission without compromising our Earth's resources, so that the future generations can meet their needs. We aim to use public funds effectively and efficiently to promote the health and safety of our environment. The JSC Landscape Standards aim to do just that, and streamline the process of sustainability by providing guidance standards to help maintain and strengthen the identity and character of our campus.

They outline landscaping best practices for both maintenance and new construction. Adhering to the JSC Landscape Standards guidelines, while undertaking new projects and maintaining existing ones, preserves the beauty of our campus at JSC while protecting natural wildlife and preventing harm to the surrounding habitats.

**“The JSC Landscape Standards have been developed to be a resource for JSC planners, engineers, and contractors when planning new projects and continuing the maintenance of existing ones.”**

The JSC Landscaping Standards are a policy statement that reflect our sustainability goals at JSC. They outline guidance for the landscaped areas on site, such as maintaining aesthetics, reducing maintenance cost, lowering water demand, and creating healthy wildlife populations. To promote the exchange of ideas and best practices, the JSC Landscape Standards will be a living document with regular updates addressing lessons learned and current best practices.

- **Rena Schlachter**, Master Planner, JSC Planning and Integration  
 - **Natalie Zimmerman**, JSC Center Operations Intern, Summer 2018



JSC Landscape Standards Key Contributors (left to right): Matthew Swanson, Rena Schlachter, Natalie Zimmerman, and Yong Yi. Not pictured: JSC former interns Jessica Moore and Cadan Cummings.

Field populated with Texas natives after demolition of ArcJet facility at JSC. Smaller image taken in spring bloom.



# Sustainability Success Story

## Combined Heat and Power Plant



Aerial view of building 24 and the newly constructed CHP. Credit: NASA

The Combined Heat and Power Plant (CHP) at JSC was planned in response to the vulnerability of brownouts faced in the Houston region. These occur when the electrical grid is strained to meet demand, causing limited power to be delivered to consumers. In JSC's case, this is a threat to critical operations.



In a decade's time, this successful partnership has come to fruition! By utilizing an Energy Savings Performance Contract (ESPC), the capital for installation, operations and maintenance costs are

financed for a period of 22 years. Energy savings are used to pay back the ESPC contractor.



Reduced carbon emissions and reduction in reported energy use by almost half are two of the results this system was designed to accomplish. In this system natural gas is brought on-site to generate electricity, versus the previous mode of operations in which all electricity was purchased from the grid. With one fuel, natural gas, electricity, steam and chilled water are produced. This is a tri-generation system.

Regardless of the net reductions in energy used, the CHP is a combustion power plant, which triggers different environmental reporting requirements for the Greenhouse Gas emissions on-site. It may appear that JSC is now using more energy, it is due to the fact that we are generating more electricity on site rather than purchasing from off site. This reported as site vs. source emissions. It allows JSC to take credit for making the power where we use it and not suffering from any line losses from a remote location. We also benefit from the use of the waste heat.

**“Overall, the CHP is estimated to save just under 20,000 metric tons of CO2 emissions/year!”**

**- Melissa McKinnley, CHP Project Manager**

**Did you know** the CHP will generate approximately 70 percent of JSC's peak electrical load, making it possible for JSC to operate critical resources after natural disasters such as hurricanes and floods?



# Sustainability Success Story

## Building 12 Green Roof Research

Texas A&M University (TAMU) formalized a partnership with JSC in the beginning of 2018 with the intent to study native species adaptability on the Building 12 green roof. The roof has undergone several iterations since its inception in 2012. With an interest to reduce irrigation and maintenance needs (primarily weeding), 11 species have been planted in 44 randomized plots along the roof's paved pathway. Through two years of study, the horticultural researchers from TAMU will identify vulnerability to seasonal changes, susceptibility to pests or disease, as well as variations in irrigation.

Ultimately, the tests will determine appropriate species for this very localized and novel location and soil. Upon completion, TAMU will

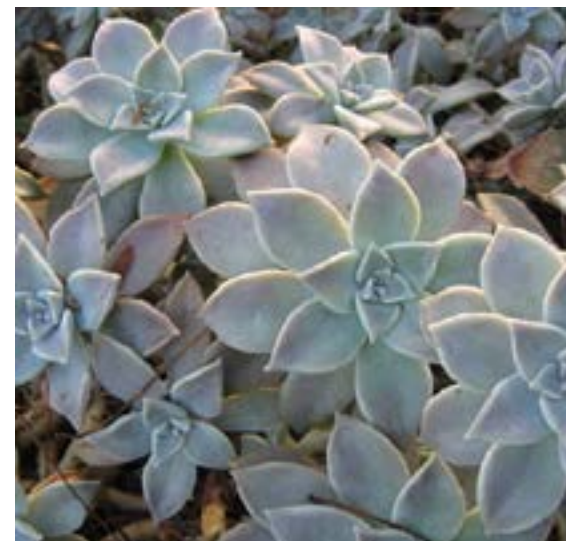
leave the successful plants with JSC to further propagate, and report the results. Most green roof research is done at ground level, or in trays sitting on top of a roof, while this study is actually utilizing an existing, established green roof system to evaluate the plants.

- **Whitney Griffin**, PhD Lecturer,  
Department of Horticulture Sciences



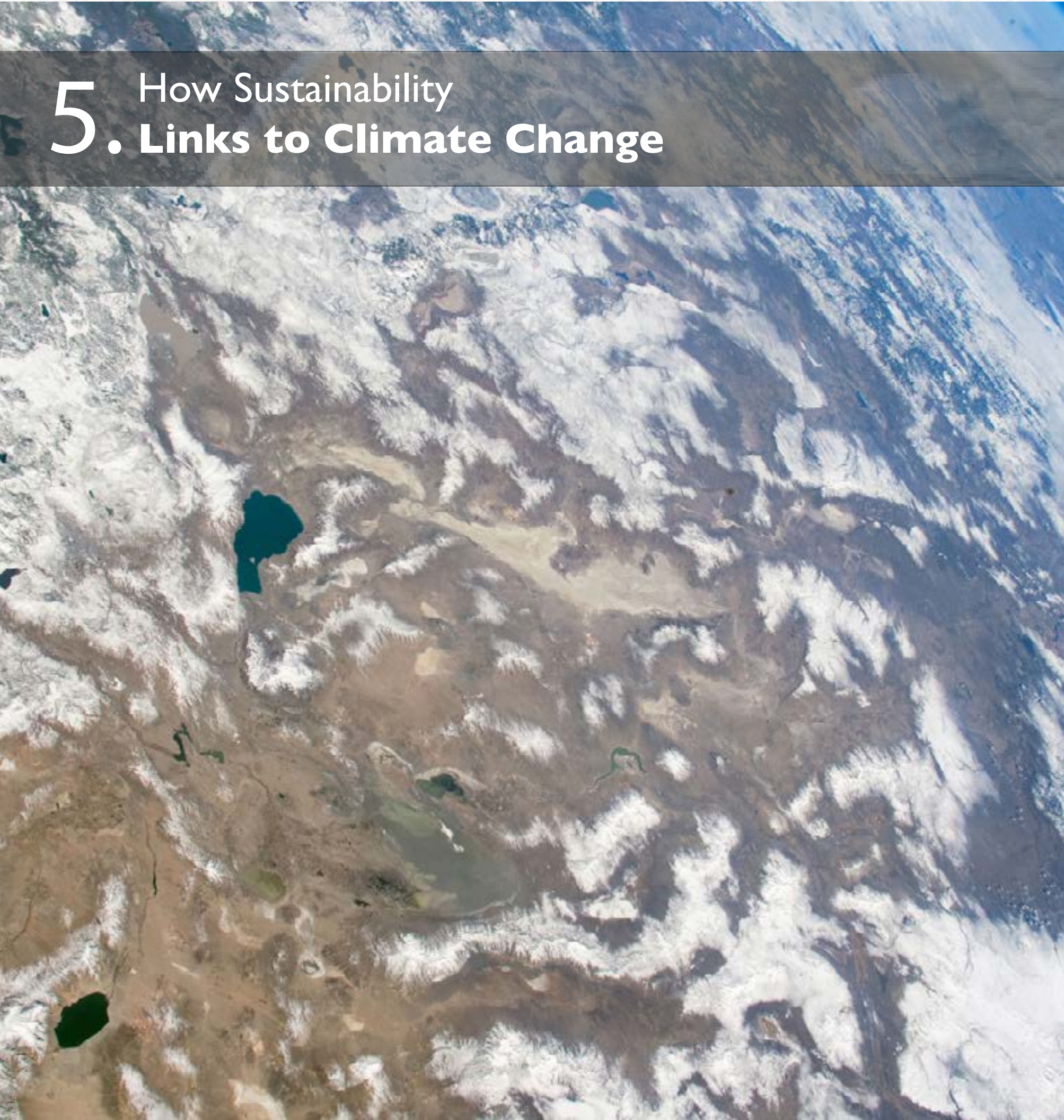
Native species, clockwise from top left:

- *Cyanotis somaliensis* 'Furry Kitten'
- *Dyckia choristaminea* 'Frazzle Dazzle'
- *Aptenia cordifolia* 'Variegata'
- *Phyla nodiflora* 'Frog Fruit'
- *Graptopetalum paraguayense* 'Gray Ghose Plant'
- *Sedum mexicanum* 'Mexican Sedum'
- *Sedum Sunsparkler*® 'Firecracker'
- *Sedum x Graptosedum* 'Darley Sunshine'
- *Hypoxis hirsuta* 'Common Goldstar'
- *Zephyranthes candida* 'White Rain Lily'
- x *Sedeveria* 'Peckerwood'





# 5. How Sustainability Links to Climate Change



Background photo: Mount Rainier from ISS during National Park Week. Credit: NASA

Sustainability and climate change have an intertwined relationship that is highly influenced by natural and human living conditions. Johnson Space Center is located near the Gulf of Mexico, as well as countless wildlife refuges, and is surrounded by rich biodiversity that is greatly affected by temperature and precipitation changes. Here at JSC, we can help to mitigate the effect of climate change on our campus through planting native species as well as building our infrastructure to consume less resources.

**“Here at JSC, we can help to mitigate the effect of climate change on our campus through planting native species as well as building our infrastructure to consume less resources.”**

In addition to being environmentally beneficial, both native landscapes and green infrastructure have the added benefit of improving economic

sustainability through decreasing the site electricity and water costs. Our continued adherence to sustainability also will dictate how our campus will respond to climate change by mitigating our risk for extreme weather events.

Planning for future climate change effects is beneficial to the continued success of Johnson Space Center because it mitigates the cost of hurricanes and floods in addition to reducing the repairs required following extreme weather events. One such initiative that aids in Johnson Space Center’s climate change resilience is the newly constructed combined heat and power (CHP) powerplant located on campus. Having a built-in power source on campus mitigates our risk post-events as it allows critical infrastructure to return to operation faster while also allowing mission critical activities to continue to function in cases where the grid is compromised.

- **William Stefanov**, Associate ISS Program Scientist for Earth Observations



**Did you know** that weather is different than climate? You can feel outside or see weather from your office window (i.e. rain, snow, sunshine) over hours and days, while climate is the long-duration trend of how the ecosphere behaves over the course of several months to decades.



National Aeronautics and Space Administration

Lyndon B. Johnson Space Center  
Johnson Space Center, Houston, TX 77062



*Moon from 10,000  
nautical miles. Image  
captured after the  
transearth insertion as the  
Apollo 11 crew traveled  
back to Earth.  
Credit: NASA*