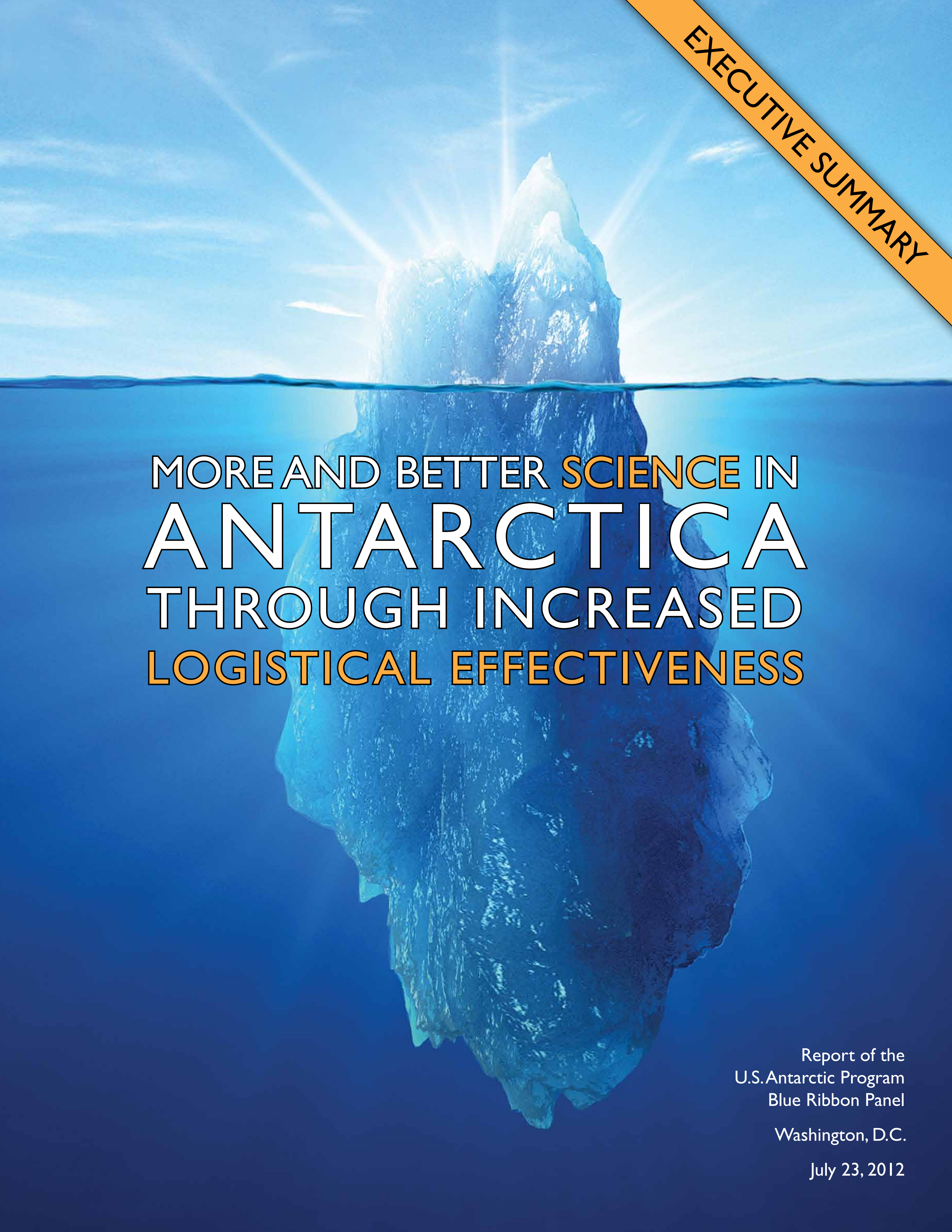


EXECUTIVE SUMMARY

MORE AND BETTER SCIENCE IN ANTARCTICA THROUGH INCREASED LOGISTICAL EFFECTIVENESS

Report of the
U.S. Antarctic Program
Blue Ribbon Panel

Washington, D.C.

July 23, 2012

This booklet summarizes the report of the U.S. Antarctic Program Blue Ribbon Panel, *More and Better Science in Antarctica Through Increased Logistical Effectiveness.* The report was completed at the request of the White House Office of Science and Technology Policy and the National Science Foundation. Copies of the full report may be obtained from David Friscic at dfriscic@nsf.gov (phone: 703-292-8030). An electronic copy of the report may be downloaded from http://www.nsf.gov/od/opp/usap_special_review/usap_brp/rpt/index.jsp.

Cover art by Zina Deretsky. Front and back inside covers showing McMurdo's Dry Valleys in Antarctica provided by Craig Dorman.

CONTENTS

U.S. ANTARCTIC PROGRAM BLUE RIBBON PANEL

WASHINGTON, D.C.

July 23, 2012

Dr. John P. Holdren
Assistant to the President for Science and Technology
& Director, Office of Science and Technology Policy
Executive Office of the President of the United States
Washington, DC 20305

Dr. Subra Suresh
Director
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear Dr. Holdren and Dr. Suresh:

The members of the U.S. Antarctic Program Blue Ribbon Panel are pleased to submit herewith our final report entitled *More and Better Science in Antarctica through Increased Logistical Effectiveness*. Not only is the U.S. logistics system supporting our nation's activities in Antarctica and the Southern Ocean the essential enabler for our presence and scientific accomplishments in that region, it is also the dominant consumer of the funds allocated to those endeavors.

It is our unanimous conclusion that substantial cost savings can be realized and more science therefore accomplished, some through rather straightforward operating changes and others requiring initial investment. The latter offer long-term gains that are justified on a discounted cash-flow basis, from safety considerations, or from science returns. The essence of our findings is that the lack of capital budgeting has placed operations at McMurdo, and to a somewhat lesser extent at Palmer Station, in unnecessary jeopardy—at least in terms of prolonged inefficiency due to deteriorating or otherwise inadequate physical assets. In this report we have sought to identify areas where increases in logistical effectiveness are particularly promising in comparison with their cost.

We are honored to have been asked to conduct this review and have been privileged to work with the many remarkable and dedicated individuals associated with the United States Antarctic Program.

Very truly yours,

Norman R. Augustine, Chair

Craig E. Dorman

Bart Gordon

Don Hartill

Louis J. Lanzerotti

Robert E. Spearing

Thad Allen

Hugh W. Ducklow

R. Keith Harrison

Gérard Jugie

Duncan J. McNabb

Diana H. Wall

The South Pole Telescope backlit by an aurora. Source: Don Hartill.

INTRODUCTION

Conducting world-class science is a centerpiece of U.S. activities in the Antarctic and the Southern Ocean, but the substantive research itself is only the visible part of the iceberg. The logistics effort supporting that science is the vast base of the iceberg—representing, in terms of person-days in Antarctica, nine times the number devoted to research activity (Figure 1). Interestingly, the 1:9 ratio of science to support is almost exactly the same as that of an iceberg's weight above and below the water. Substantial opportunities exist to devote a greater share of scarce resources to science by reducing the cost of logistics efforts. Addressing these opportunities is essential to prevent expenditure for support from consuming funding that is currently dedicated to science projects.

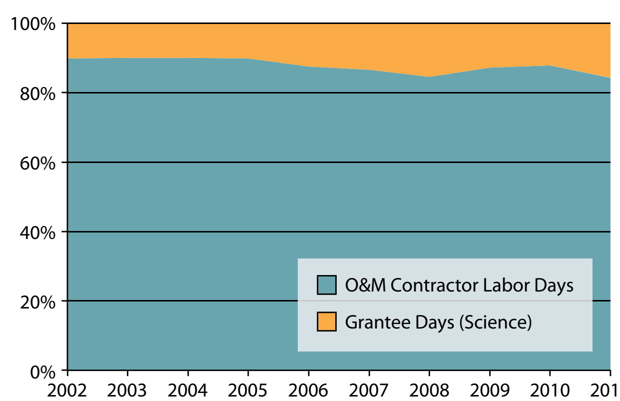
In 2011, the National Research Council published the report *Future Science Opportunities in Antarctica and the Southern Ocean*. The report focused on discovery-driven research and global change research. "Discovery" addresses fundamental questions such as the nature of dark energy and dark matter that make up 96 percent of our universe—yet neither has yet been observed. "Global Change Research" includes the study of trends in and the causes and impacts of climate change, such as sea level rise and changes in major ocean currents. Changes are occurring with the most pronounced effects in the polar regions, making those environments important bellwethers for these global issues.

Results of past research in discovery and global change have been significant. Such research discovered the ozone hole and its cause, leading to a ban on the manufacture and use of chlorofluorocarbons as refrigerants. It also determined that the Antarctic Peninsula has been the fastest-warming region on Earth over the past half-century, with temperatures rising an astonishing 5°F (2.8°C). Antarctica captures 61 percent of Earth's fresh water as ice. If the West Antarctic Ice Sheet disintegrated, sea level is projected to rise by approximately 10 feet (3.3 meters). If the Antarctic ice sheets melted in their entirety, sea level would rise some 200 feet (66 meters), threatening the one-fourth of Earth's population that lives along coasts at an elevation less than 200 feet.

Current scientific efforts in Antarctica include the IceCube Neutrino Observatory, one of the largest single research activities underway. A cubic-kilometer array of 5160 optical sensors has been emplaced deep in the 9000-foot (2700-meter) thick ice sheet near the South Pole to form the world's largest detector of neutrinos—chargeless, nearly massless particles that rarely interact with other matter. A principal goal of IceCube is the search for point sources of neutrinos, to explore high-energy astrophysical processes and help uncover the origin of the highest-energy cosmic rays. The combination of small neutrino interaction probability and these very rare events drives the need for a large detector. For most of these experiments, Earth itself acts as a shield against high-energy particles other than the neutrinos that are used for the research being pursued.

The National Research Council report concluded that future science activity in the Antarctic region will involve substantial organizational changes, broader geographical spread, increased international involvement, and a growth in the quantity and duration of measurements. Implanting and maintaining long-term observing systems require additional data storage, communications capacity, transportation reach, and autonomous operation. Accomplishing these goals simply by expanding traditional methods of logistical support would be costly, if possible at all.

Figure 1. O&M Contractor Labor and Grantee Days (Science)



THE PANEL

John P. Holdren, Science Advisor to the President and Director of the White House Office of Science and Technology Policy, and Subra Suresh, Director of the National Science Foundation, established a Blue Ribbon Panel (hereafter called "the Panel") in October 2011 to examine U.S. logistical capabilities likely to be needed in Antarctica and the Southern Ocean in the decades ahead and to seek means of enhancing their efficiency. The 12 panel members came from diverse professional backgrounds and, during their careers, have collectively undertaken 82 trips to Antarctica, including 16 to the South Pole and numerous trips aboard research vessels in the Southern Ocean. One member has wintered-over.

In addressing the Panel's work, the U.S. Department of State indicated the continuing importance of the U.S. presence in Antarctica. Correspondingly, the National Science Foundation and other U.S. federal agencies discussed the importance of research in Antarctica to their overall science pursuits on behalf of the nation during meetings with the Panel.

MEMBERS	
Norman R. Augustine, Chair	Don Hartill
Thad Allen	Gérard Jugie
Craig E. Dorman	Louis J. Lanzerotti
Hugh W. Ducklow	Duncan J. McNabb
Bart Gordon*	Robert E. Spearing
R. Keith Harrison	Diana H. Wall

* Mr. Gordon's membership on the Panel spanned from the Panel's creation (October 12, 2011) until May 11, 2012, when a change of his employment activities necessitated his withdrawal.

In carrying out its responsibilities, the Panel met in the Washington, D.C., area a total of six days, heard over 100 briefings, read thousands of pages of reports, and traveled to McMurdo Station, Palmer Station, South Pole Station, and various logistics centers—including Christchurch in New Zealand, Punta Arenas in Chile, the Antarctic Support Contract headquarters in Colorado and cargo facility in Port Hueneme, California, the 109th New York Air National Guard in New York State—and the National Science Foundation's headquarters in Arlington, Virginia. The Panel's members went aboard the U.S. Antarctic Research and Supply Vessel (ARSV) *Laurence M. Gould* and Research Vessel Icebreaker (RVIB) *Nathaniel B. Palmer*, and witnessed on the U.S. West Coast the offloading of the chartered supply ship *Green Wave*. During its deliberations, the Panel held Town Hall Meetings at all three U.S. permanent locations in Antarctica and established a website to receive comments and suggestions. It also visited Chilean and New Zealand stations in Antarctica and met with the New Zealand air and port authorities and the managers of the New Zealand Antarctic Programme in Christchurch.

Allotted 270 days to pursue its work, the Panel completed its effort on schedule.

OVERALL ASSESSMENT

U.S. activities in Antarctica are very well managed but suffer from an aging infrastructure, lack of a capital budget, and the effects of operating in an extremely unforgiving environment. Construction of the new station at the South Pole, requiring all personnel, building materials, and supplies to be transported by air, was a truly remarkable achievement, accomplished on schedule and nearly within the initially established budget.

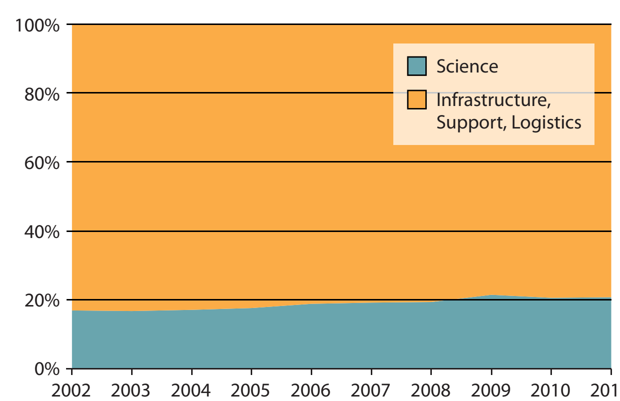
The Panel concludes that by making changes to the logistics support system, such as those proposed, substantial cost savings can be realized using net present value as the basic financial metric. In some instances, more detailed analyses will be warranted prior to making substantial funding commitments—a consequence of the amount of time and the number of individuals available for this independent assessment. In some instances, achieving the savings identified will require front-end investments that could be supported with additional funding, temporary reductions in research, or both. Funding derived solely from reductions in research, however, can support only a small fraction of the investments because of the scale of the logistical effort relative to science (Figure 2).

The Panel identifies the lack of a capital budget for the U.S. Antarctic Program (USAP) as the root cause of most of the inefficiencies observed—a situation that no successful corporation would ever permit to persist. If a formal, federally endorsed capital budget cannot be provided, then NSF should, at a minimum, formulate a capital plan for U.S. activities in Antarctica that adapts to the needs of science and can be used as a basis for subsequent annual budgeting. The funding of maintenance would likewise benefit from more rigorous planning.

Under current practice, when the National Science Foundation (NSF) and its contractors must choose between repairing a roof or conducting science, science usually prevails. Only when the science is seriously disrupted because the roof begins to collapse will it be replaced; until then, it is likely only to be repaired. Examples of this phenomenon abound: a warehouse where some areas are avoided because the forklifts fall through the floor; kitchens with no grease traps; outdoor storage of supplies that can only be found by digging through deep piles of snow; gaps so large under doors that the wind blows snow into the buildings; late 1950s International Geophysical Year-era vehicles; antiquated communications; an almost total absence of modern inventory management systems (including the use of bar codes in many cases); indoor storage inefficiently dispersed in more than 20 buildings at McMurdo Station; some 350,000 pounds (159,000 kilograms) of scrap lumber awaiting return to the U.S. for disposal; and more. The status quo is simply not an option; sooner or later the atrophying logistics infrastructure will need to be upgraded or replaced. Failure to do so will simply increase logistics costs until they altogether squeeze out funding for science. A ten percent increase in the cost of logistics will consume 40 percent of the remaining science budget.

Whatever the source of funds, the USAP logistics system is badly in need of remediation and will cost more to restore as each year of inattention passes. In the longer term, increased logistical efficiency could yield savings that would substantially increase the amount of research supported by NSF. Based on the current $125,000 median annual size of NSF grants, the savings achievable from just one of the Panel's recommendations—to reduce contractor labor costs by 20 percent—could fund nearly 60 new grants each year.

Figure 2. Breakdown of Total NSF Antarctic Science and Infrastructure Expenditure



U.S. FACILITIES IN ANTARCTICA

The three principal U.S. research stations are McMurdo (Figure 3a), where 90 percent of USAP participants are based or pass through on their way to research sites; the Amundsen-Scott South Pole Station at 90° South Latitude (Figure 3b); and Palmer Station on the Antarctic Peninsula (Figure 3c).

McMurdo Station

The population of McMurdo Station (Figure 3a), including scientists, the contractor workforce, and support personnel from NSF and other government agencies, varies from 130 to 1100. The total number depends principally on the time of year and the level of ongoing science and construction activity. The facility, initially established in 1955, nominally operates at full capacity 147 days of the year. Other months are devoted to station-based research and maintenance activities. McMurdo Station is the land, sea, and air portal to the South Pole, the Dry Valleys, major camps in West Antarctica, the Mt. Erebus volcano, ocean and penguin research locations, and numerous other field sites. Some of the U.S. facilities at McMurdo are relatively new, such as the Albert P. Crary Science and Engineering Center (21 years old), known locally as the "Crary Lab." Most structures are old and in imminent need of repair or replacement. The site, essentially a small town, was constructed with no clear master plan but rather in response to the tasks at hand and the availability of funds over the years. This somewhat haphazard arrangement inevitably leads to wasted resources and also raises serious safety concerns.

Amundsen-Scott South Pole Station

The new South Pole Station (Figure 3b) was dedicated in 2008 and is a state-of-the-art facility. It was constructed based upon an extensive assessment of future needs and concern for human safety. The station can be accessed for only about 100 days each Austral summer. It supports some 50 occupants during the winter and approximately 250 during the summer, and can be accessed by air or, as in recent years, by overland vehicle traverse from McMurdo. Appropriate maintenance is critical to sustaining the facility's operations.

Palmer Station

Palmer Station (Figure 3c) began operation in 1968. It is the smallest of the U.S. permanent stations, housing 15 to 45 people, depending on the season, and it can be accessed throughout the year. Most of its research activity is constrained to a two-mile (three-kilometer) distance from the base because of the limited operating radius of the small boats that provide local transportation (and the need to maintain proximity to rescue boats). There is no useful access by air for logistics support at the present time. A limited and aging dock is used for research support and resupply vessels, primarily ARSV *Laurence M. Gould* (*Gould*). RVIB *Nathaniel B. Palmer* (*Palmer*) cannot safely dock at Palmer Station due to an underwater rock spire near the pier. The dock and the boat ramp are in urgent need of repair or replacement, but Palmer Station's overall condition has not yet reached the level of obsolescence observed at McMurdo Station.

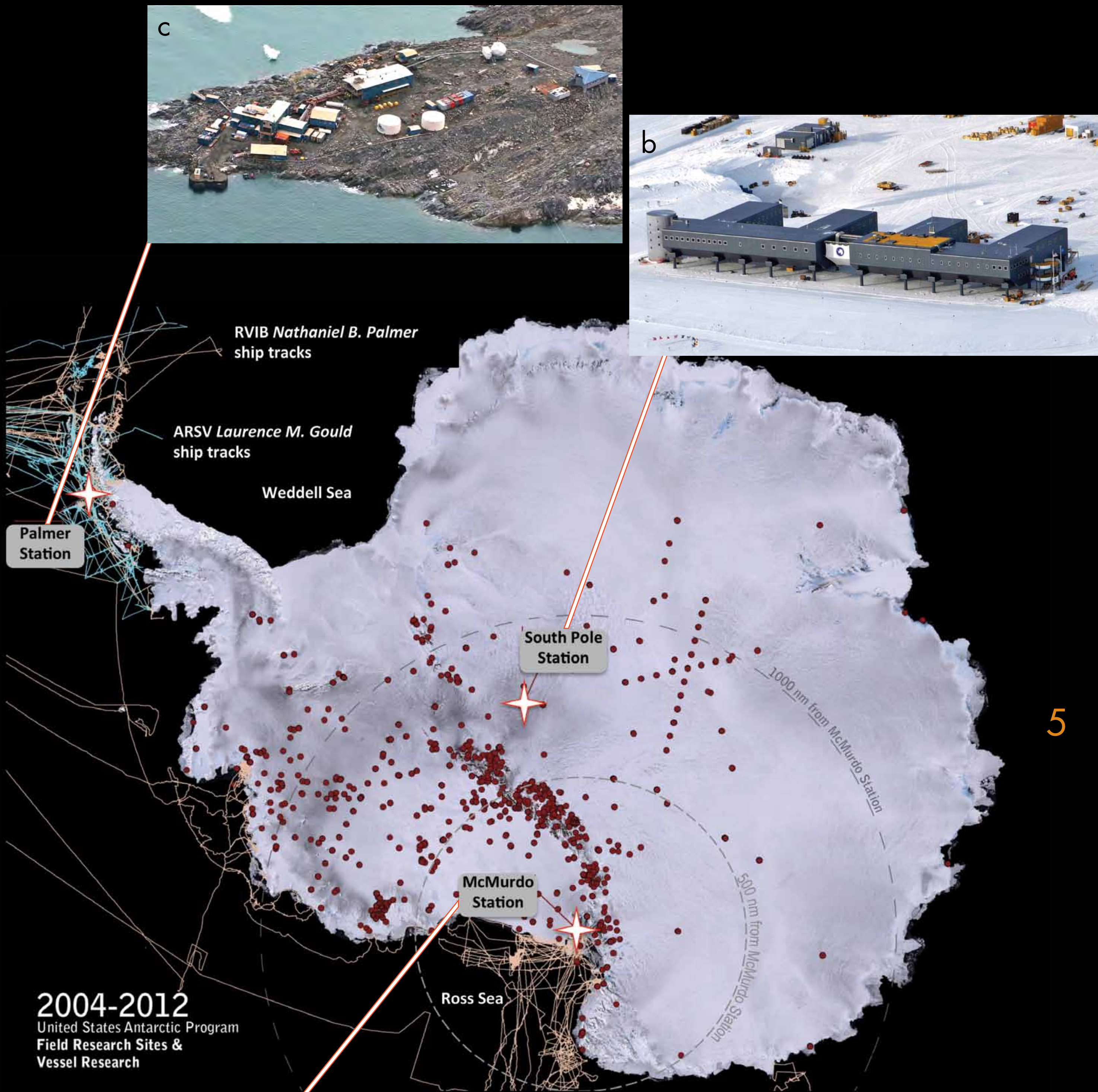


Figure 3. Map of Antarctica showing the principal USAP research stations, field research sites (red dots), and ship tracks of the ice-capable ARSV *Laurence M. Gould* (blue track) and RVIB *Nathaniel B. Palmer* (pink track). The gray dashed circle indicates the 1000-mile (1600-kilometer) range from McMurdo Station, the maximum useful payload delivery and return range of a ski-equipped C-130 aircraft. (a) McMurdo Station. Source: Joe Harrigan. (b) Amundsen-Scott South Pole Station. Source: Andrew Williams. (c) Palmer Station. Source: NASA.

Field Sites

The United States annually supports more than 50 field sites from its primary Antarctic bases during the summer months. Typically, these sites are reached by helicopter, small fixed-wing aircraft, or ski-equipped C-130 Hercules aircraft, designated LC-130 (Figure 4). Among the most commonly visited sites are those in the Dry Valleys near McMurdo (pictured on the inside covers of this report). This region is categorized as being among the driest and windiest deserts on Earth, yet it is surrounded by glaciers and contains lakes fed by glacial runoff.

Figure 4. (a) Basler, (b) Twin Otter, (c) helicopters, and (d) LC-130 aircraft used by the USAP in Antarctica. Sources: (a) Kevin Bliss, (b) Dominick Dirkse, (c) Charles Hood, and (d) George Blaisdell.

Figure 5. The USAP ice-capable ARSV *Laurence M. Gould* (left) and icebreaker RVIB *Nathaniel B. Palmer* (right). Source: Zee Evans.

Oceangoing Vessels

Two USAP-chartered research ships support the U.S. program in the Southern Ocean and Antarctic perimeter (Figure 5). The *Gould*, which operates primarily from Punta Arenas, Chile, and Palmer Station, works almost exclusively in the Antarctic Peninsula region. The *Palmer* operates from Punta Arenas in Chile, Lyttelton in New Zealand, and McMurdo Station. In recent years, the vessel has worked most frequently in the Ross Sea region and east of the Peninsula, but historically also worked in other Antarctic marine regions. At 15 and 20 years old, respectively, these ships are well into their 30-year operating expectancy and undergo continual maintenance to sustain their operations in the demanding Antarctic marine environment.

THE ENVIRONMENTAL CHALLENGE

Figure 6. Digging out oil drums buried by winter weather. Source: USAP.

Antarctica is the coldest, driest, windiest, most remote, highest (on average), darkest (for half the year) continent on Earth. Temperatures as low as –128.6°F (–89.2°C) and wind speeds of 154 miles per hour (248 kilometers per hour) have been recorded—as have temperature drops of as much as 65˚F (36°C) in 12 minutes. It is the most challenging place on Earth where continuous logistical support has ever been attempted (Figure 6). At the South Pole, the ice is over 9000 feet (2700 meters) thick. Buried under the ice in other parts of the continent are mountain ranges the size of the Alps and freshwater lakes larger than Lake Ontario.

The pressure-altitude at the South Pole is approximately 11,000 feet (3350 meters) and the absolute humidity is lower than that encountered on the Sahara Desert. In many places, water is available only in the form of ice. The combination of dryness and wind makes fire an ever-present danger. As the Panel landed at King George Island on its way to visit Palmer Station, they were alerted that the Brazilian station 21 miles (34 kilometers) away had been destroyed by fire, resulting in two fatalities. A few years earlier, a Chilean station was destroyed by a volcanic eruption, and the approach to McMurdo Station was partially blocked by an iceberg, nearly the size of Connecticut, calved from the Ross Ice Shelf.

Logistics lines to support activities in Antarctica are immense: 6900 miles (11,100 kilometers) from Port Hueneme to Christchurch; 2415 miles (3864 kilometers) from Christchurch to McMurdo; 840 miles (1340 kilometers) from McMurdo to the South Pole; 6700 miles (10,800 kilometers) from Port Hueneme to Punta Arenas; and 810 miles (1300 kilometers) from Punta Arenas to Palmer Station—the latter requiring a three-day crossing of the Drake Passage, considered by many to offer some of the roughest seas on Earth.

Almost all activities in the Antarctic Continent and the Southern Ocean must be considered to be expeditionary. Extraordinary effort must be devoted to safety and contingency planning. Opportunities for unanticipated hazards abound.

UNCERTAINTIES IN LOGISTICS PLANNING

Setting aside the ambiguities associated with the federal budgeting process, logistics planning in Antarctica is complicated by the shortness of the season during which the continent can be reliably accessed for logistical purposes, nominally 21 weeks by air at McMurdo Station and 15 weeks at South Pole Station. Using U.S.-owned heavy icebreakers, McMurdo Station could be accessed by ship during about ten weeks each year. As these ships have become unavailable and less-powerful icebreakers are used, the time in which to accomplish resupply by sea has been reduced to the four-week annual sea ice minimum—a challenging and unreliable practice.

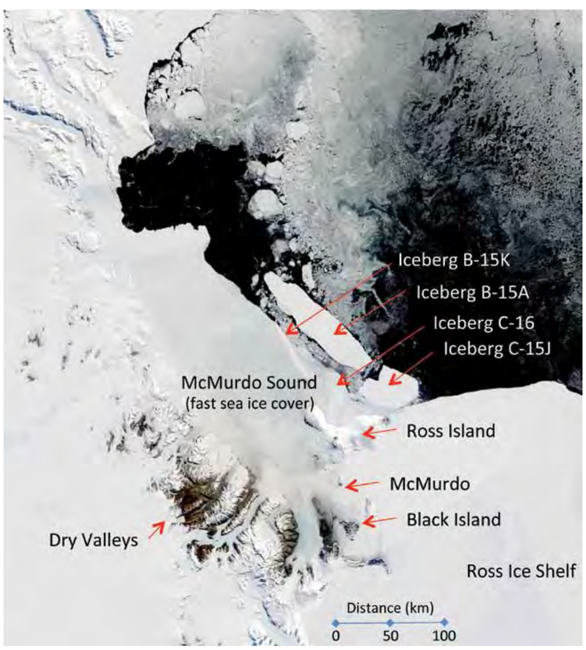


Figure 7. Satellite photo of the McMurdo area, 9 November 2004. The large iceberg B-15 and other icebergs reduced flushing of the sea ice near McMurdo Station, increased the extent of ice from the station from the typical 10 to approximately 50 miles (18 to 93 kilometers), and also increased the amount of hard, multiyear ice in the vicinity, greatly increasing the difficulty of accessing the station from 2001 through 2004.

In Antarctica, weather changes frequently and abruptly, necessitating contingency plans for most activities, particularly those in remote areas. The cost of energy is high and uncertain, and the behavior of the ice pack can hinder the delivery of energy and other critical supplies. During late 2011, a series of storms affecting harbor conditions left too little time for the McMurdo ice pier to thicken to sufficient strength, thus requiring deployment of a portable modular causeway system loaned by the Department of Defense (DoD). The Panel itself made the final landing of the season at the Sea Ice Runway, the airfield closest to McMurdo Station, before sea ice conditions deteriorated to the point that air operations had to be moved to a more solid but more remote location. At the Pegasus Runway, constructed on glacial ice, temperatures now rise more frequently to within a few degrees of the point where air operations are precluded.

Long-term uncertainties abound. Some Antarctic research activity will continue to shift from relatively simple to more highly integrated research that requires more complex support. Further, the impact on the Antarctic region of greatly expanded tourism remains to be determined. Many nations do not participate in the Antarctic Treaty. Seven countries have made claims to parts of Antarctica that remain in abeyance while the Treaty is in force—pointing to the importance of maintaining an influential U.S. science presence as a stabilizing influence. Finally, climate change in Antarctica could significantly complicate future runway and ice pier construction and thereby impact both air and sea operations.

ACTIVITIES OF OTHER NATIONS

Researchers from many nations cooperate well in conducting science in Antarctica. Mutual logistical support among nations, while already highly constructive, offers significant opportunities for further expansion, with associated cost savings. The mutual activities of the U.S. and New Zealand polar programs offer an outstanding example of the benefits of cooperation.

Many nations around the world are currently making significant investments to expand their activities in Antarctica (Figure 8). For example, South Korea is in the process of establishing a new station in the Terra Nova Bay region of the Ross Sea. Germany replaced an existing station in 2009. At approximately the same time, the United Kingdom replaced its Halley Station. Russia has stated its intent to launch five new polar research ships and reconstruct five research stations and three seasonal bases. Argentina recently announced plans to construct a new scientific base to replace one that was partially destroyed by fire. Belgium's Princess Elizabeth Station, now in summer operation, is said to be Antarctica's first zero-emission base. Chile's plans include developing Punta Arenas as a gateway to Antarctica for research, tourism, and mineral research traffic. China is proceeding with upgrades to three existing sites as well as building the new Kunlun Station and constructing several telescopes at Dome A, the highest site on the Antarctic Plateau (13,428 feet/4093 meters). India is preparing to occupy its third station, and other nations are undertaking projects to expand their presence and scientific activity in the Antarctic.

Figure 8. (a) German research station Neumayer III. Source: Ude Cieluch. (b) South Korean research and resupply icebreaker *Araon*, completed in 2009, which supplies the King Sejong Station and will supply their new Jang Bogo Station. Source: Dongmin Jin. (c) South African research and resupply icebreaker *Agulhas II*, completed in 2012. Source: *Engineering News* (online). (d) The Chinese Kunlun Station, completed in 2009. Source: Hu Yi, CHINARE.

ECONOMIC CONSIDERATIONS

The cost of providing logistics support on the Antarctic Continent is to a considerable degree driven by the number of person-days on the ice and the amount of fuel consumed in supporting their activities. Any actions that reduce either cost component can potentially generate significant financial savings.

Numerous expenditures need to be calculated to determine fully burdened costs. For example, placing fuel at the South Pole currently requires flying or traversing the fuel from McMurdo. Skiways for the LC-130 must be constructed or refurbished annually. To move the fuel and cargo from the United States to McMurdo requires oceangoing vessels, which in turn require an icebreaker to open a path in the sea ice on the approach to McMurdo. Docking the vessels requires periodic construction and maintenance of an ice pier for offloading. The people involved in this process generally fly to New Zealand and then to assignments at McMurdo or the South Pole, and must be provided housing, food, clothing, medical care, and other elements of life support.

Considering all that is involved, the true value of a gallon of fuel at the South Pole is, on average, nearly *eight* times its original purchase price. The large premium that will be realized from reducing energy consumption would seem to be evident; however, this and most other cost calculations affecting the USAP are highly nonlinear. That is, it is generally not possible to contract for "part" of a ship to transfer supplies to Antarctica or to conduct Southern Ocean research. Similarly, significant savings cannot be realized from flying partially loaded aircraft. On the other hand, at certain points there may be opportunities for significant savings, for example, by chartering smaller commercial vessels for resupply.

When it comes to the number of person-days on the ice, the opportunity for cost savings is clearer. It is always in the interest of economy to minimize the number of people traveling to the ice and their duration of stay, as well as to emphasize energy conservation. Doing so always produces at least some savings and the cumulative effects of individual actions can often eventually lead to major savings.

The Panel found that USAP researchers and other personnel possess limited awareness of the true cost of the resources provided to them. The same is true for personnel from many other nations who periodically use U.S. resources, such as runways, rescue support, and logistical assets. Educating users about the true costs of Antarctic research would promote greater conservation, and should become a major communications goal for the USAP.

Recent advances in technology, if adopted, could also substantially reduce costs. Examples range from making greater use of autonomous robotic field stations to employing underwater gliders to collect oceanographic data. To cite just one example, a single "flight" of a glider generated as much data as previous monitoring techniques produced in a decade.

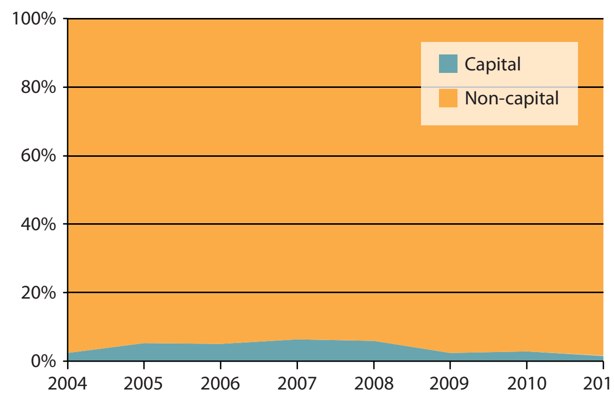
MAJOR ISSUES

The Panel's deliberations led it to focus on eight major issues, although numerous other important but generally less-consequential matters were also evaluated. All are addressed in the body of the main report. Here, we provide a brief overview of each of these major considerations.

1 Capital Budgeting

Capital investment by the USAP is extremely limited (Figure 9). The lack of a capital budget and supporting plan to replace out-of-date facilities, together with the lack of a funded plan to address major maintenance needs, has led to a deteriorating and inefficient infrastructure, particularly at McMurdo Station. Opportunities exist for significant financial savings over the longer term through improved maintenance and modernization. In a few instances, shortcomings have led to hazardous conditions. At present, problems associated with the U.S. government's prolonged budgeting cycle (well over a year) are compounded for the Antarctic program by its seasonal nature. Consequently, an item approved in the budget normally will not arrive in Antarctica for at least two years after its need was established. In the case of structures, matters are further complicated by a useful building season that stretches only a few months.

Figure 9. Capital as Fraction of Total NSF Antarctic Budget



2 Alternatives to McMurdo Station

McMurdo has been a preferred location for accessing central Antarctica from the time of the earliest explorers until the present day, but its susceptibility to heavy sea ice nonetheless makes its scientific activities dependent upon the availability of icebreakers, which are frequently in short supply and always expensive. If another location on the continent were capable of supporting activities at the South Pole, within reasonable proximity to a major Southern Hemisphere port, and offered the possibility of a deepwater landing for resupply ships as well as a nearby runway for heavy wheeled-aircraft operations, the USAP could avoid its dependency upon icebreakers. The Panel conducted a search using aerial photography, maps, in situ observations, and other sources to determine if such a location exists (Table 1). No reasonable alternative to McMurdo was found that would permit transshipping (sea, air, and land), or that would justify abandoning the investment made in fixed plant at McMurdo. It would cost on the order of $220 million in 2012 dollars to replace McMurdo as it currently exists.

Table 1. Comparison of potential options for location of USAP activities now carried out at McMurdo Station.

	McMurdo	Bay of Whales	Terra Nova Bay	Western Coats Land
Harbor for 9 m Draft Ship	Yes	No	No	No
Direct Off-load to Shore or Ice Shelf	Yes	Yes*	No	Yes*
Distance to South Pole (air)	1340 km	1270 km	1700 km	1370 km
Suitability for Wheeled Aircraft	Good; all year	No; only skiway	Moderate	No; only skiway
Sea Ice Extent at Minimum (typical)	10 nm	0 nm	0 nm	30 to >100 nm
Icebreaker Required to Access? (typical)	Yes	Yes	Yes	Yes
Suitability for Infrastructure	High	Low	Moderate	Low
Surface Access to Antarctic Interior	Easy	Easy	Difficult	Easy

most favorable / favorable / somewhat favorable / unfavorable

*Offload onto ice shelf, followed by traverse.

3 Icebreakers

The task of maintaining a U.S. icebreaking capability transcends NSF's responsibilities and resources. During the Boreal winter of 2011/12, the need unexpectedly arose to provide an icebreaker, U.S. Coast Guard Cutter (USCGC) *Healy*, for access to Nome, Alaska, which has no road or rail connectivity to the rest of the United States. An intensive storm followed by rapid sea ice formation prevented the usual barge-based fuel delivery to Nome—an incident that served as a reminder of the importance of icebreaking vessels. In recent years, NSF has contracted with Russian or Swedish firms to enable access to the Antarctic Continent, but these ships have not been reliably available to the USAP. As a contingency measure, the USAP has stored sufficient fuel at McMurdo to support activities at that base and at South Pole Station for at least two consecutive seasons in case sea resupply is interrupted for any one year. In such a case, a concurrent increase in air operations could, for the most part, substitute for ship-based cargo delivery, albeit at approximately four or ten times the cost per pound, depending on the aircraft used.

Even so, the fuel reserve and the ability to fly some of the required cargo serves more as an insurance policy than a long-term solution to U.S. national interests in both the Arctic and the Antarctic that might require icebreaking capability.

Repairs and renovations to USCGC *Polar Star* that are now underway could make that heavy icebreaker available to support McMurdo ship-based resupply operations beginning with the 2013/14 Austral summer. This project will extend the useful life of the vessel for approximately eight more years. Even with *Polar Star's* return to sea, however, the United States will possess only a single heavy icebreaker, one that is nearing the end of its service life.

The President has requested $8 million in the FY 2013 budget "to initiate survey and design for a new Coast Guard polar icebreaker." But even if construction is fully funded in the planned budget years, it will likely be at least eight years before such a ship becomes available. The Panel concludes that the budget request should be vigorously supported and encourages consideration of a design that addresses the USAP's needs, including for example the potential ability to conduct science from the icebreaker itself.

If the United States is to maintain an assured research capability and presence in Antarctica, particularly at the South Pole, it is essential to provide the U.S. Coast Guard (USCG) with the resources needed to conduct the break-in at McMurdo while at the same time meeting its responsibilities elsewhere. In accordance with Presidential Memorandum 6646, the USCG should be in a position to provide icebreaking services upon NSF's request. The USCG and many independent reviews have identified the vessels and associated funding that would be required. The Panel believes that ensuring U.S. government control of the above icebreaking assets is vital to U.S.-stated interests in Antarctica. If for any reason the USCG may not be able to provide the needed support, NSF should seek long-term commitments from U.S. commercial or foreign icebreaking services such as those that have been supplied in the past on a short-term basis from Russia and Sweden.

Figure 10. USCGC *Polar Star* with Military Sealift Command tanker *Paul Buck* at the McMurdo Station ice pier (in the foreground from left to right), with RVIB *Nathaniel B. Palmer* and icebreaker *Krasin* (Russia) in the background (left to right). Source: Brien Barnett.

Transportation on the Continent 4

Figure 11. Tractor and fuel bladders on the overland traverse. Source: Paul Thur.

The most critical logistics link on the Antarctic Continent is arguably that which extends from McMurdo Station to the South Pole. Until recently, the only access to the South Pole was by air, and because the South Pole has only a skiway, only the LC-130s that can land on skis could be used for resupply. The 840-mile (1340-kilometer) air distance between the two stations begins to approach that aircraft's useful range, limiting the payload delivered to the South Pole to about 26,000 pounds (11,800 kilograms). More recently, introduction of overland traversing from McMurdo to the Pole (Figure 11) now enables resupply of 780,000 pounds (354,000 kilograms) per trip but the round trip takes 45 days. Modern technology for crevasse-detection and formation-following vehicles would make it possible for a single driver to operate more than one tractor in a traverse, further reducing the cost of maintaining the facility at the South Pole. It would also reduce the demand for LC-130 flights and, ultimately, could enable reducing the size of the LC-130 fleet.

Based on projected demand for flights to support USAP science and operations, if the traverse platform is automated as the Panel recommends, it is estimated that a 40 percent reduction in the number of LC-130 aircraft in service (from ten to six) is realizable. The most straightforward approach would be to retire the four NSF-owned aircraft and outfit one of the remaining six as a research vehicle. This all-ANG fleet would maintain the U.S. reach across Antarctica while also permitting important science data to be acquired from an aerial platform rather than costly field camps.

In addition to producing substantial cost savings, such a streamlined fleet would be substantially freed from fuel and cargo deliveries to the South Pole, affording the USAP considerable flexibility. LC-130 aircraft could be allocated to support ground-based research, conduct airborne research, and provide backup in case of an interruption of traverse operations.

Figure 12. U.S. Air Force C-17 aircraft on the Pegasus Runway at McMurdo Station. Source: Dominick Dirksen.

5 Hard-Surface Ice Runway at the South Pole

As noted, the only large aircraft currently capable of operating at the South Pole is the LC-130. Snow compaction techniques have been developed that could make it possible to construct a runway at the South Pole capable of supporting wheeled aircraft. C-17 aircraft (Figure 12) flying from McMurdo Station could deliver a payload of 110,000 pounds (50,000 kilograms, four times the LC-130's capability). Use of the C-17s would further free the LC-130 fleet to support field sites that are anticipated to increase in number, importance, and remoteness throughout the Antarctic Continent.

Energy 6

Significant cost savings could be realized by making greater use of alternative energy sources in Antarctica, accompanied by a reduction in fossil fuel consumption. Examples include expanding the use of wind power at McMurdo (Figure 13), better insulating buildings not scheduled for near-term replacement, and burning scrap wood and used oil in modern furnaces rather than returning it to the United States for disposal. Such action would have the important ancillary benefit of reducing the environmental footprint of U.S. activities in the region.

Figure 13. Wind turbines at McMurdo Station. Source: George Blaisdell.

7 Communications

The communications connectivity and bandwidth available at the South Pole significantly limit the science that can be conducted in the Antarctic interior today and in the future. For example, IceCube, after on-site data processing, transmits 100 gigabytes of data daily—about 15 percent of the data collected—via the National Aeronautics and Space Administration's (NASA) "high" data rate (150 Mbits/sec) Tracking and Data Relay Satellite System (TDRSS) (Figure 14). Other projects also demand support from TDRSS, leaving the satellite communications system at the limit of the USAP's current capacity. Further, satellite service is fragmented into small windows of time averaging no more than four hours daily. The only continuous satellite communications capability at the South Pole is extremely slow (28 Kbits/sec), with a limited seven-hour window of additional satellite availability at higher speed (the Geostationary Operational Environmental Satellite [GOES]-3 satellite, at 1.5 Mbits/sec). With the exception of the low-speed service, these satellites have already lasted well beyond their design life and are at risk of imminent failure due to age.

Figure 14. Tracking and Data Relay Satellite. Source: NASA.

Many research projects are best performed when data-gathering protocols can be adjusted in near-real time. Severe bandwidth limitations encourage researchers to be on site rather than at their home laboratories in the United States. These barriers to remote access work against reducing costs sought by minimizing the number of people on the ice.

8 Safety and Health

Although gradual improvements in safety conditions and practices have resulted in a "reportable-injury" rate that is generally comparable to similar commercial activities (e.g., the North Slope in Alaska), the Panel noted a variety of safety concerns. They include compactors with safety interlocks that can be overridden, a dangerous boat access ramp, a pier meant to support shallow-draft oceangoing ships that has a large underwater rock adjacent to it, and a woodshop with no fire sprinkler system.

The infirmary at McMurdo was described to the Panel as representative of a 1960's clinic serving a U.S. community of comparable size located in a much less hazardous environment (Figure 15a). Some dormitory rooms designed for two occupants house five residents (Figure 15b), virtually guaranteeing that if one person becomes ill with a contagious disease, all will be afflicted. During a 2007–2008 influenza outbreak, at least one-sixth of the McMurdo population (48 percent of the 330 persons tested) suffered from the flu. Mandatory flu shots have largely alleviated repeat incidents, but the containers of hand sanitizer that have proven extraordinarily effective at controlling disease in many U.S. facilities are largely absent. Improving preventive health measures would have significant economic benefits. When an individual suffers a work-halting illness in Antarctica, not only is that person unproductive, but he or she also becomes a burden to other members of the community.

Figure 15. (a) The McMurdo Medical Clinic. Source: Don Hartill. (b) Original two-person room at McMurdo Station, now housing five persons. Source: Travis Groh.

Figure 16. When ice conditions in McMurdo Sound made the approach to the pier so difficult that the tanker could not make it to the pier, the fuel was offloaded over the sea ice via hoses. The USAP recognized this vulnerability and has since decreased fuel usage and increased fuel storage capacity so that it now has a two-year supply on hand.

SINGLE-POINT FAILURE MODES

Perhaps the most effective means of assuring that projects are not unexpectedly disrupted, personnel injured, or equipment damaged is to eliminate "single-point failures." Single-point failures are circumstances in which the failure of one element of a system renders the entire system incapable of performing its function. In cases where total elimination of such modes through the provision of redundancy or other means is not practicable, larger-than-usual margins should be provided for the critical links that remain (Figure 16). This approach, when backed by a "fail-gracefully/fail-safe" philosophy, has been demonstrated to produce a high probability of successfully accomplishing goals.

Many USAP features as they exist today raise concerns regarding single-point failures. A list of the more significant of these, in order of deemed concern, follows:

- The Antarctic Treaty and related instruments (potential circumvention)
- U.S. icebreaking capability (lack of assured access)
- Broadband communications for South Pole Station (interruptions to telemedicine, impact on research)
- Pier at Palmer Station (vulnerability to major accident)
- Multimode hub at Christchurch (earthquake, airport restructuring)
- Pegasus Runway at McMurdo (melting, accidents)
- Fire Suppression Systems requiring electric power (inadequate backups)
- *Gould* and *Palmer* (aging with long replacement cycle)
- Single automated dishwasher at McMurdo (food service for as many as 1100 people)

RECOMMENDATIONS

Below is a summary of the Panel's top ten overarching recommendations, in priority order, with brief parenthetical examples of implementing actions. Please see the full report for supporting information.

1. ANTARCTIC BASES. Continue the use of McMurdo, South Pole, and Palmer Stations as the primary U.S. science and logistics hubs on the continent. (There is no reasonable alternative, particularly concerning McMurdo.)

2. POLAR OCEAN FLEET. Restore the U.S. polar ocean fleet (icebreakers, polar research vessels, mid-sized and smaller vessels) to support science, logistics, and national security in both polar regions over the long term. (Follow through on pending action in the President's FY 2013 Budget Request for the USCG to initiate the design of a new icebreaker.)

3. LOGISTICS AND TRANSPORTATION. Implement state-of-the-art logistics and transportation support as identified in this report to reduce costs and expand science opportunities continent-wide and in the Southern Ocean. (Replace some LC-130 flights with additional traverse trips by automating the traverse and by constructing a wheel-capable runway at South Pole Station for C-17 use; reduce the LC-130 fleet.)

4. MCMURDO AND PALMER FACILITIES. Upgrade or replace, as warranted by an updated master plan, aging facilities at McMurdo and Palmer Stations, thereby reducing operating costs and increasing the efficiency of support provided to science projects. (Modify or replace the pier and reconstruct the boat ramp at Palmer Station, install fire suppression—with backup power—in unprotected berthing and key operational facilities, upgrade medical clinics, and improve dormitory use to prevent the transmission of illnesses.)

5. USAP CAPITAL BUDGET. Establish a long-term facilities capital plan and budget for the USAP. (Provide phased plan for modernization of USAP facilities.)

6. SCIENCE SUPPORT COSTS. Further strengthen the process by which the fully burdened cost and technological readiness of research instrumentation and observing systems, as well as overall projects, are considered in the review and selection of science projects. (Increase overall awareness of the true cost of resources provided in Antarctica.)

7. COMMUNICATIONS. Modernize communication capabilities in Antarctica and the Southern Ocean to enable increased science output and reduced operational footprint. (Provide increased bandwidth on as well as to and from the continent.)

8. ENERGY EFFICIENCY. Increase energy efficiency and implement renewable energy technologies to reduce operational costs. (Provide additional wind turbine generators at McMurdo, better insulate selected buildings, and invest in technology for converting trash-to-energy and burning waste oil so that it does not have to be returned to the United States.)

9. INTERNATIONAL COOPERATION. Pursue additional opportunities for international cooperation in shared logistics support as well as scientific endeavors. (The existence of numerous national stations in the Peninsula region offers a particularly promising opportunity for an international supply system.)

10. ANTARCTIC POLICY. Review and revise as appropriate the existing documents governing Antarctic Policy (Presidential Memorandum 6646 of 1982 and Presidential Decision Directive 26 of 1994) and implementing mechanisms for Antarctica, taking into account current realities and findings identified by the National Research Council report and the present report. (Focus on policy and national issues as opposed to operational matters.)

Implementing and Ancillary Actions

In support of the overarching recommendations cited above and the additional findings cited in the report, the Panel offers a number of specific implementing actions. The ten most important candidates among them are presented in priority order within each of the following separate but related categories: (1) Essential for Safety and Health, (2) Readily Implementable, and (3) Significant Investment/Large Payoff. Additional actions beyond these highest priority actions in each category are noted in the relevant chapters of the report.

Essential for Safety and Health

The Panel considers the following actions to be mandatory because of the potential adverse consequences of failing to pursue them:

- Modify or replace pier at Palmer Station.
- Reconstruct boat ramp at Palmer Station.
- Provide backup power or gravity-feed for all fire-suppression systems.
- Add fire suppression in woodshop at Palmer Station.
- Increase emphasis on workplace health and safety through much greater use of signage, "near-miss" reporting, and widespread use of antibacterial liquids (such as Purell); in addition, modernize medical clinic at McMurdo.
- Move power generators out of housing buildings and move dormitory spaces away from kitchens at Palmer Station.
- Consolidate hazardous materials at Palmer Station into one storage area.
- Manage populations at Antarctic stations such that currently crowded conditions do not remain a health hazard and morale issue.
- Replace compromised flooring in McMurdo warehouse (Building 120).
- Implement a more comprehensive system of safety inspections and ensure that appropriate corrective actions are followed through to completion.

Readily Implementable

The following actions could be undertaken without substantial financial expenditures or inconvenience while offering disproportionately great benefits:

- Establish within NSF's Office of Polar Programs a small systems engineering/cost analysis group to continually seek opportunities for cost reduction and better ways of supporting science needs.
- Conduct a review to reduce contractor personnel requirements by approximately 20 percent, particularly among those positioned on the ice. Place primary emphasis on reducing population at field camps.
- Establish within NSF, and possibly jointly with other agencies, modeled after DoD's Advanced Research Projects Agency (DARPA), funds for developing enabling technologies that could significantly enhance USAP operations. Examples of the latter include advanced gliders, robotic field stations, and automated formation-keeping for traverse vehicles, all of which may be of use in both polar regions.
- Provide two Rigid-hull Inflatable Boats (RIBs) at Palmer Station to substantially enhance safety of research performed at that site and cost-effectiveness.
- Use some newly freed LC-130 flight hours to support airdrop operations and deep-field support.
- Work with Christchurch International Airport and Lyttelton Port of Christchurch to assure that USAP needs are considered in the master plans now being produced by New Zealand.
- Review U.S./international logistics activities' "balance sheet" for equity in offsets.
- Adding to existing partnerships with other nations, explore possibility of mutual support between McMurdo and the new South Korean station.

- Continue reliance on NSF's merit review system to ensure that science programs are justified for continued support. (This has been very effectively accomplished by the French and other national Antarctic programs, with significant savings being realized.)
- More stringently enforce requirement for all instrumentation and related devices deployed at unattended field sites be designed for module-level serviceability and undergo pre-deployment environmental qualification.

Significant Investment/Large Payoff

The following actions may require relatively significant up-front investments but also have the potential, on a discounted (and generally conservative) cash-flow basis, to produce material, positive net present values:

- Reduce LC-130 usage by increasing the number of traverse trips between McMurdo and the South Pole by incorporating automated formation-keeping to reduce personnel demands.
- Construct a runway capable of supporting wheeled aircraft at the South Pole to permit C-17 operations.
- Consolidate warehousing at McMurdo into the minimum practicable number of structures and minimize outside storage.
- Designate Pegasus Field as a permanent site, with appropriate fire, rescue, air traffic control, ground transportation, and fuel support. Retain Williams Field to support LC-130 operations. Discontinue constructing the Sea Ice Runway each year.
- Deploy an optimal number of additional wind turbine generators at McMurdo Station.
- Modernize LC-130s with eight-bladed propellers, fuel-efficient engine modifications, and crevasse-detection radars.
- Replace the legacy logistics management software applications with a commercially available Enterprise Resource Program, and significantly expand use of bar coding.
- Implement a phased program for ground vehicle modernization.
- Construct a solar heated vehicle storage building at South Pole Station.
- Determine feasibility of converting waste wood, cardboard, and paper at McMurdo (that must otherwise be retrograded to the United States) into clean electric power and useful heat.

CONCLUDING OBSERVATIONS

During its evaluation, the Panel discerned a widespread and commendable "can-do, make-do" culture within the USAP. Flaws in the system, however, diminish the ability of the Program's participants to make the most of their research. These flaws persist despite substantial financial and human investment. Overcoming these barriers requires a fundamental shift in the manner in which capital projects and major maintenance are planned, budgeted, and funded. Simply working harder doing the same things that have been done in the past will not produce efficiencies of the magnitude needed in the future; not only must change be introduced into *how* things are done, but *what* is being done must also be reexamined. In this regard, the ongoing introduction of a new prime support contractor provides an extraordinary, albeit brief, window to bring about major change.

Although many opportunities for cost savings have been cited, this report has not attempted in all cases to determine the required front-end investment. For example, it is the Panel's collective judgment, based primarily upon years of experience, that a reduction in contractor personnel of some 20 percent should be feasible. A more detailed analysis will be needed for this and other cases.

The Panel emphasizes that the USAP is facing major expenditures for the replacement of existing inefficient, failing, and unsafe facilities and other assets. Delays in initiating the needed work will only increase the cost and further squeeze the research funding that is already only a fraction of the total dollars. While significant savings are in fact achievable through operational efficiencies, the front-end investments that are needed if the United States is to continue USAP activities at the present level cannot all be justified solely on an economic basis. Some upgrades are essential for personnel and equipment safety. The Panel has sought to identify changes that hold initial investment to the minimum reasonable level.

In spite of the above challenges, USAP science and science support could be vastly enhanced within about five years. The improvements could be funded by increasing for each of the next four years the USAP's annual appropriation for support by six percent relative to the FY 2012 appropriation (an additional $16 million per year), diverting six percent of the planned science expenditures over the next four years to upgrades of the science support system ($4 million), and permitting the savings accrued from the five highest payout projects (Table 2) and the 20 percent reduction in contractor labor to be reinvested in upgrading support capabilities ($20 million per year).

The investments thus made would be repaid in approximately seven years if the five highest payout projects produce the expected return and a 20 percent reduction in contractor staff is in fact possible and implemented. Thereafter, the annual savings generated will allow the USAP to increase science awards while ensuring safe and effective science support and appropriately maintained facilities. Given the important improvements in safety and science opportunities contained within the above option, a seven-year financial breakeven is considered by the Panel to be a reasonable investment, particularly when compared to the cost of not making one.

Once the recommendations made herein have been implemented, it will be possible to substantially increase science activity—assuring a stable overall budget.

It should be noted that this construct does not address the extremely important icebreaker issue that transcends the Antarctic program's resources and responsibilities, at least as they are understood by the Panel.

Table 2. Net Present Value Analysis

	INVESTMENT, $M	NET PRESENT VALUE, $M
Automate and Double Number of Traverses	1.80	15.00
Increase Number of Wind Turbines at McMurdo	0.50	1.40
Construct Solar Garage at South Pole	0.03	0.75
Install Wood Burner at McMurdo	0.40	0.70
Burn Waste Oil at McMurdo	0.09	0.70

This study was conducted at the request of the White House Office of Science and Technology Policy and the National Science Foundation.

WHITE HOUSE OFFICE OF SCIENCE AND TECHNOLOGY POLICY

www.whitehouse.gov/administration/eop/ostp

Congress established the Office of Science and Technology Policy (OSTP) in 1976 with a broad mandate to advise the President and others within the Executive Office of the President on the effects of science and technology on domestic and international affairs. OSTP is also authorized to lead interagency efforts to develop and implement sound science and technology policies and budgets, and to work with the private sector, state and local governments, the science and higher education communities, and other nations toward this end.

NATIONAL SCIENCE FOUNDATION

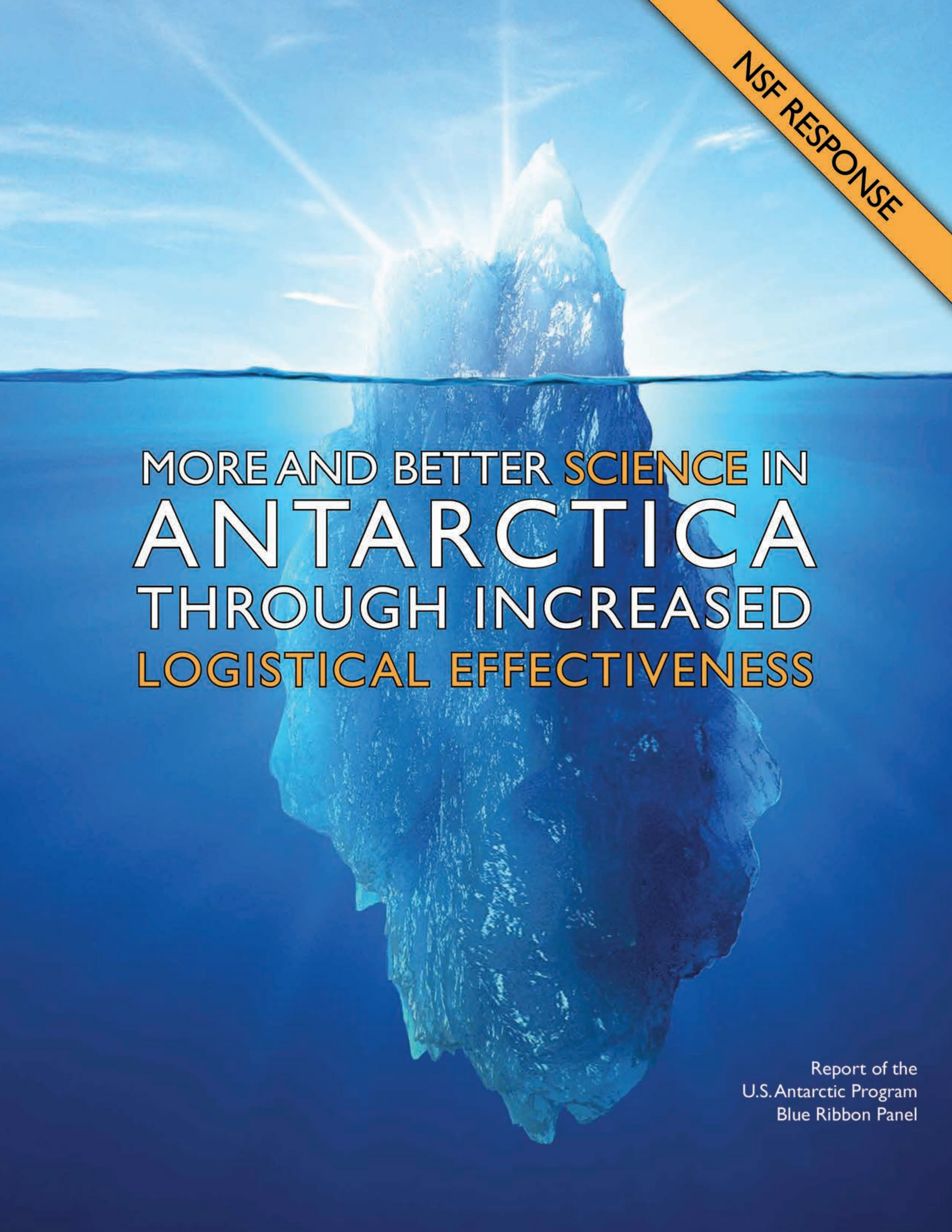
www.nsf.gov

The National Science Foundation (NSF) is an independent federal agency created by Congress in 1950 "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense…" NSF funds approximately 20 percent of all federally supported basic research conducted by U.S. colleges and universities.

THE U.S. ANTARCTIC PROGRAM

www.nsf.gov/od/opp/ant/memo_6646.jsp

The U.S. Antarctic Program (USAP) is the nation's program for maintaining an active and influential presence in Antarctica through the conduct of scientific research consistent with the principles enunciated in the Antarctic Treaty. In accordance with Presidential Memorandum 6646 (February 5, 1982), NSF is responsible for managing and budgeting for the USAP as a single package.



NSF RESPONSE

MORE AND BETTER SCIENCE IN ANTARCTICA THROUGH INCREASED LOGISTICAL EFFECTIVENESS

Report of the
U.S. Antarctic Program
Blue Ribbon Panel

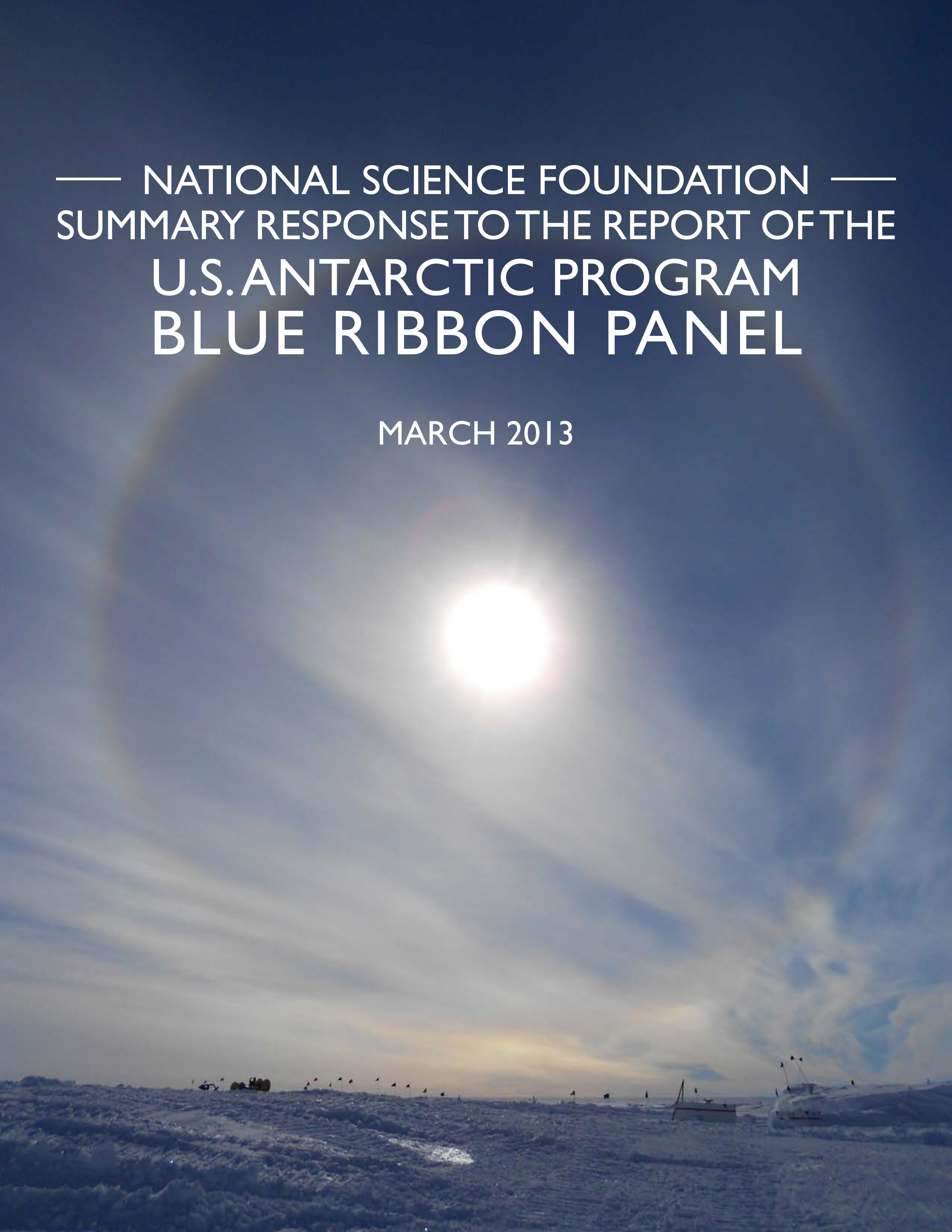
CONTENTS

Cover art by Zina Deretsky, National Science Foundation

Facing page: A New Year optical "halo" over WAIS Divide drilling site in West Antarctica. *Credit: Don Voigt, Pensylvania State University*

NATIONAL SCIENCE FOUNDATION
SUMMARY RESPONSE TO THE REPORT OF THE
U.S. ANTARCTIC PROGRAM
BLUE RIBBON PANEL

MARCH 2013



NATIONAL SCIENCE FOUNDATION
4201 WILSON BOULEVARD
ARLINGTON, VIRGINIA 22230

OFFICE OF THE
DIRECTOR

March 19, 2013

Mr. Norman R. Augustine
Chair, U.S. Antarctic Program Blue Ribbon Panel

Dear Mr. Augustine,

On behalf of the National Science Foundation, I thank you for leading the United States Antarctic Program (USAP) Blue Ribbon Panel (BRP) and for the significant time and effort that you and your Panel devoted to prepare your report released in July 2012. I am grateful to the BRP for your thoughtful examination of U.S. logistical capabilities that are likely to be needed in Antarctica and in the Southern Ocean in the decades to come.

The release of the BRP report, "*More and Better Science in Antarctica Through Increased Logistical Effectiveness*", co-commissioned by the Office of Science and Technology Policy (OSTP) and the National Science Foundation (NSF), could not have been more timely. In our Presidentially-mandated role as the manager of the USAP on behalf of all of the U.S. government, NSF must be a vigilant steward of world-class, innovative science as well as science support in Antarctica and the Southern Ocean. Your findings made it very clear that a number of near-term and long-term improvements are needed to ensure continuation of a robust and sustainable USAP into the future.

Upon delivery of your report on July 23, 2012, I charged a group of senior leaders at NSF (referred to as the "Tiger Team") to develop a point-by-point and summary response to the numerous report recommendations. The National Science Board (NSB) reviewed these NSF responses at their December 2012 and February 2013 meetings, and strongly endorsed them (see the letter from the NSB Chair attached to this report). The Tiger Team exercise is now formally complete.

I am pleased to enclose the NSF Summary Response to your report, organized according to your ten overarching recommendations. You will note that we agreed with the majority of your recommendations, and that substantial progress has already been made on many fronts in implementing these recommendations. While others will require further study before final decisions on the recommendations are made, we now have in place the means for disciplined, multi-year tracking and planning for additional improvements. We look forward to implementing, over the next several years, safe, modern, energy-efficient and cost-effective science facilities and support systems for research in Antarctica.

I am confident that the changes we have put in place will enable us to sustain and strengthen our world-leading U.S. Antarctic Program. This is due in no small measure to your invaluable contributions for which I express my profound gratitude to you and to your distinguished BRP members.

Sincerely,

Subra Suresh
Director

National Science Board

March 14, 2013

Dr. Subra Suresh, Director
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear Dr. Suresh:

In its policy development and oversight roles for the National Science Foundation (Foundation), the National Science Board (Board) has a longstanding interest in the vitality of the United States Antarctic Program (USAP). The Foundation's responsibilities in Antarctica go far beyond its traditional mission of supporting ground-breaking research, touching on everything from foreign relations, to national security, to undertaking logistics challenges more commonly associated with forward deployed military units.

The challenges of conducting and supporting research in Antarctica are many, not the least of which are budgetary challenges that have prevailed in recent years. They have put significant stress on U.S. research endeavors in the Southern Ocean and Antarctica, prompting the Foundation, in conjunction with the White House, to undertake an end-to-end review of research priorities and activities as well as a review of existing Antarctic infrastructure and logistics. The Board applauded the decision to undertake these reviews as they serve as important steps in ensuring that the U.S. Antarctic science stays at the forefront of discovery and innovation while the USAP infrastructure and logistics remain effective, affordable and sustainable.

The Board read with great interest and has now evaluated the external report summarizing the infrastructure and logistics review (*More and Better Science in Antarctica Through Increased Logistical Effectiveness*), known as the Blue Ribbon Panel report, and was recently briefed by the Foundation on its response and approach to recommendations contained in the report. The external report contains ten overarching recommendations ranging from recapitalization of facilities to increasing international cooperation to governance and policy considerations. The Board, through its Committee on Program and Plans (CPP), has carefully monitored the progress of both the review and NSF's response and as a whole is pleased to see that in many cases, the Foundation already has taken significant steps toward implement suggested recommendations and is in the process of developing a longer-range implementation strategy to respond accordingly.

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This activity highlights the ongoing need to look for efficiencies in the program and the Board will continue to pursue those efforts in the coming years. In the short-term, the Board looks forward to ongoing discussions with the Foundation regarding efforts to implement report recommendations. It also encourages the Foundation to continue to explore creative approaches to meeting present as well as future USAP infrastructure needs and, where consistent with and enhancing the Foundation's mission, consider working with third parties to leverage Foundation resources.

Finally, the Blue Ribbon panel report, and the Foundation's response to it, represent an important first step toward ensuring an ongoing active and influential U.S. presence in Antarctica. The Board strongly endorses the Foundation's response to the logistics and infrastructure review.

Sincerely,

Dan E. Arvizu
Chairman

cc: Dr. Kelly K. Falkner, Director
Division of Polar Programs,
Geosciences Directorate

Landsat Image Mosaic of Antarctica. Representatives of the National Science Foundation, the U. S. Geological Survey, the National Aeronautics and Space Administration and the British Antarctic Survey worked cooperatively to produce the Landsat Image Mosaic of Antarctica, a map that combines more than 1,100 hand-selected Landsat satellite scenes digitally compiled to create a single, seamless, cloud-free image. *Credit: U.S. Geological Survey*

THE 2011-12 UNITED STATES ANTARCTIC PROGRAM TWO-PART REVIEW

As affirmed by Presidential Memorandum 6646 (1982), the National Science Foundation (NSF) is designated as the single point manger responsible for budgeting for and managing the United States Antarctic Program (USAP) on behalf of the Nation. Through the USAP, NSF provides funding for research in Antarctica and the Southern Ocean and also provides the associated logistics support.

In 2010, the NSF Office of Polar Programs (OPP), in coordination with the Office of Science and Technology Policy (OSTP), initiated a two-part review of the USAP.

NRC STUDY

In the first phase of the review, NSF sponsored the National Research Council (NRC) to convene a Committee of Experts to identify the major science questions that will drive research in Antarctica and the Southern Ocean in the coming decades. The Committee's full *Statement of Task* and the full list of members are provided in Appendix A.

The Committee on "Future Science Opportunities in Antarctica and the Southern Ocean" was formally convened in January 2011. Several of the committee members visited Antarctica. The Committee held three meetings in various geographic locations in order to enable the widest possible input to its study. The Committee also distributed a community survey to more than 1,000 Antarctic and Southern Ocean researchers and the broader Polar science community and received over 200 responses. Input was received from representatives of other Federal agencies with interests in Antarctica, including National Oceanic & Atmospheric Administration (NOAA); National Aeronautics & Space Administration (NASA); U.S. Geological Survey (USGS); and U.S. Coast Guard (USCG). In addition, the Committee reviewed background articles and reports.

The final report, entitled *Future Science Opportunities in Antarctica and the Southern Ocean*, was released in September 2011.[1]

BRP STUDY

In October 2011, Dr. John P. Holdren, Director of OSTP and Dr. Subra Suresh, Director of NSF, co-commissioned a Blue Ribbon Panel (BRP) of external experts to conduct the second phase of the USAP review. This phase was designed to examine U.S. logistical capabilities likely to be needed in Antarctica and the Southern Ocean to support the science drivers identified by the NRC Committee, and to seek ways to enhance logistical efficiency to support world-class science. Building on the findings of the NRC Committee, the BRP was charged with conducting an independent review of the current USAP to identify and characterize a range of options for supporting and implementing the required national scientific endeavors, international collaborations, and strong U.S. presence in Antarctica. The Panel's full *Charge* and membership are included in Appendix B.

The BRP met in the Washington, D.C., area for a total of six days. Some members traveled to McMurdo, Palmer, and South Pole Stations. They visited various USAP logistics centers, including Christchurch, New Zealand; Punta Arenas, Chile; the Antarctic Support Contract headquarters in Centennial, Colorado, cargo facilities in Port Hueneme, California, and the 109th New York Air National Guard in Schenectady, New York. The Panel's members also went aboard the U.S. Antarctic Research and Supply Vessel *Laurence M. Gould* and the Research Vessel Icebreaker *Nathaniel B. Palmer*, and witnessed the offloading of the chartered supply ship *Green Wave* on the U.S. West Coast at Port Hueneme, California. Members visited Chilean and New Zealand stations in Antarctica and met with the New Zealand airport and port authorities and the managers of New Zealand's Antarctic program in Christchurch, New Zealand. The BRP also established an electronic mailbox to receive comments and suggestions from the USAP community.

The BRP Report, entitled *More and Better Science in Antarctica through Increased Logistical Effectiveness*, was formally delivered by the Committee to OSTP and NSF on July 23, 2012.[2]

1 Copies are available from the National Academies Press, 500 Fifth Street, NW, Washington, D.C. 20001; (800) 624-6242; www.nap.edu.

2 Copies of the report are available through: http://www.nsf.gov/od/opp/usap_special_review/usap_brp/rpt/index.jsp

DEVELOPING THE RESPONSE TO THE BRP REPORT

Immediately following delivery of the BRP report, NSF Director Subra Suresh charged a group of senior leaders from throughout NSF to guide development of the response to the report's recommendations. The *Charter* for this group, known as the "Tiger Team", and the full membership of the Tiger Team are included as Appendix C.

The Tiger Team began by developing and populating a matrix to record responses to each of the BRP's 84 recommended actions. They determined that NSF agreed with the majority of the recommendations and provided explicit reasoning for the few cases in which it could not agree or needed further analysis to develop a future course of action. The status of implementing activities to achieve improvements was also recorded in the matrix. In the face of rapid progress being made on many of the recommended improvements, it was determined that the matrix should serve as a living document and be updated regularly as a means for NSF management to track progress.

The Tiger Team drafted a summary document to capture major elements of the NSF response including a newly developed *Long-Range Investment Plan* and a budget that will take into account critical infrastructure renewal requirements at McMurdo and Palmer stations. The specific infrastructure improvements and replacements for both stations are to be guided by Master Plans that are currently being updated. The approach, activities and overall recommendations of the Tiger Team and key highlights of the ensuing improvements enacted to date were reviewed with the National Science Board (NSB) at their December 2012 meeting. The Tiger Team met with the NSB during the February 2013 meeting to review budget- and procurement-sensitive elements of the response. Following feedback from the NSB, the Tiger Team updated and refined the summary response contained herein for public release.[3]

NSF and its Division of Polar Programs in the Geosciences Directorate look forward to executing and managing the numerous improvements recommended by the BRP that will most certainly place the USAP on a robust trajectory to sustain and strengthen world class U.S. Antarctic research in the coming decades.[4]

3 The House Committee on Science, Space and Technology held a hearing on the BRP report on November 15, 2012. Witnesses included Mr. Norman R. Augustine, Chair, U.S. Antarctic Program Blue Ribbon Panel, Dr. Subra Suresh, Director, National Science Foundation, General Duncan J, McNabb, USAF (ret), Member, U.S. Antarctic Program Blue Ribbon Panel, and Dr. Warren Zapol, Chair, Committee on Future Science Opportunities in Antarctica and the Southern Ocean, National Research Council. Both a video recording and the full text for the hearing are available through: http://science.house.gov/hearing/full-committee-hearing-us-antarctic-program-achieving-fiscal-and-logistical-efficiency-while

4 In January 2013, the Office of Polar Programs within the Office of the Director was officially merged into the Geosciences Directorate as the Division of Polar Programs. No changes in personnel or budget were associated with this realignment. The authorities for executing NSF's responsibility for single point management of the USAP remain as they were before the realignment.

A. BACKGROUND

The U.S. maintains a world-class science program in Antarctica to advance the frontiers of knowledge and in so doing maintain its active and influential role in the Antarctic Treaty System, which has now been in force for over 50 years. High-level reviews of the U. S. Antarctic Program (USAP) have been conducted approximately every 10 to 15 years since 1970, when by presidential mandate NSF was designated as the single point manager of the USAP on behalf of the United States. These program-wide overviews supplement ongoing internal and external studies of various aspects of the USAP. The last review, delivered in 1997, resulted in the 2008 commissioning of a modernized South Pole Station. The most recent two-part review of the USAP was initiated in 2010 to ensure that the nation continues to pursue the best trajectory for conducting science and diplomacy in Antarctica over the next twenty years—a trajectory that is environmentally sound, safe, innovative, affordable, sustainable, and consistent with the Antarctic Treaty.

A National Research Council (NRC) committee completed the first phase by examining likely science drivers for the coming decades in Antarctica and the Southern Ocean. Its report, *Future Science Opportunities in Antarctica and the Southern Ocean*, was delivered in December 2011. The NRC envisioned that future science activity in the Antarctic region would entail substantial organizational changes, broader geographic spread, and increased international involvement and growth in the quantity and duration of measurements. Implementation and maintenance of more science observations and coordinated observing systems will introduce new demands on data storage, communications capacity, transportation reach, and autonomous operations.

The NRC report findings and other studies informed the second part of the review whereby a Blue Ribbon Panel (BRP) was charged with conducting an independent assessment of the USAP logistics support system. The Panel was asked to identify and characterize a range of options for supporting and implementing the required national scientific endeavors, international collaborations, and strong U.S. presence in Antarctica.

The BRP report, *More and Better Science in Antarctica through Increased Logistical Effectiveness*, was formally released on July 23, 2012. The BRP concluded that ushering in a new age of Antarctic science simply by expanding traditional methods of logistical support would be prohibitively costly. Instead, they recommended numerous ways to more efficiently and cost-effectively support research while maintaining high standards of safety and increasing the flexibility to support evolving science foci in the future.

The BRP report contained 10 overarching recommendations covering the following topics:

- Antarctic Stations
- Polar Ocean Fleet
- Logistics and Transportation
- McMurdo and Palmer Facilities
- USAP Capital Budget
- Science Support Costs
- Communications
- Energy Efficiency
- International Cooperation
- Antarctic Policy

The recommendations were further categorized into 84 implementing and ancillary actions organized according to the following categories:

- Research Facilities and Equipment
- People
- Technology
- Transportation
- Supply Chain
- Energy and Utilities
- Communications and Information Technology
- Human Care
- Environmental Stewardship
- International Considerations
- Governance

B. SUMMARY RESPONSE

This document provides summary information on major actions the National Science Foundation (NSF) has taken and plans to take in response to the BRP report. It is organized according to the 10 overarching topics noted above.

ANTARCTIC STATIONS

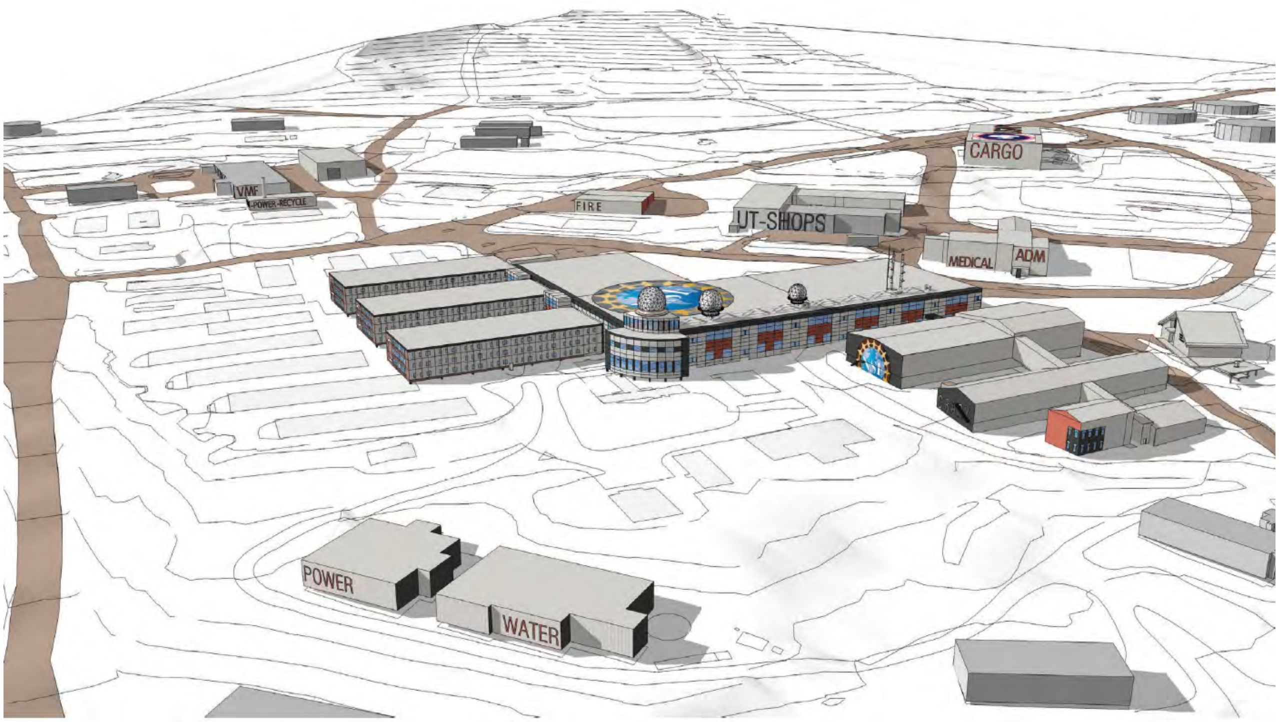
The BRP recommended that NSF continue the use of McMurdo, South Pole, and Palmer stations as the primary U.S. science and logistics hubs on the continent, and noted in particular that there is no reasonable alternative to McMurdo.

NSF concurs with the BRP's recommendation and notes that it is consistent with current U.S. policy. Presidential Memorandum 6646 (1982) requires that the USAP "be maintained at a level providing an active and influential presence in Antarctica designed to support the range of U.S. Antarctic interests," including year-round occupation of the South Pole and two coastal stations.

McMurdo presents the combination of logistical characteristics best suited for supporting resupply operations by sea, air and land, and is particularly opportune for supporting resupply of the U.S. station at the geographic South Pole. Furthermore, McMurdo offers ready access to the Dry Valleys, Mt. Erebus, the southern most penguin colonies, the Ross Ice Shelf, and other nearby areas of keen scientific interest. South Pole Station offers uniquely advantageous observing conditions important for astrophysics, geospace science, atmospheric, and seismic studies. South Pole also serves as an excellent high altitude logistics and refueling point for deep field operations in the Antarctic interior. Palmer Station, on the Antarctic Peninsula, provides essential access to marine ecosystems and organisms and ice shelf systems in what is one of the most rapidly warming regions on the planet.

POLAR OCEAN FLEET

Following a survey of the USAP's polar ocean fleet, the BRP concluded that action should be taken to restore the fleet to support science, with appropriate research icebreaking capability, as well as logistics and national security, via appropriate operational icebreaking capability, in both polar regions over the long-term.



Artist's rendering of the long-term plan for McMurdo Station. The McMurdo Long-Range Plan, currently in the concept stage, incorporates operational efficiencies by consolidating functions, reducing personnel requirements, and improving energy usage. Improvements are also planned for support to local science and science conducted at sites served by McMurdo, such as the Dry Valleys, temporary camps located throughout the Continent, and the South Pole Station. Another goal of the Plan is to ensure that McMurdo is flexible and agile to support future science. *Credit: U.S. Antarctic Program/National Science Foundation*

With respect to icebreakers, NSF is participating in an interagency effort, led by the U.S. Coast Guard (USCG), to assess government-wide requirements for icebreaking. USCG will consider this information as it proceeds with design and construction of a new polar class icebreaker (initial funding requested in the 2013 President's Budget for USCG). NSF is also actively engaged with USCG in monitoring progress on the reactivation of the USCG Cutter *Polar Star (WAGB-10).* It currently appears that this vessel will be available for the 2013/14 break-in to McMurdo Station and possibly for the subsequent 7-10 years.

NSF is pursuing options for meeting future science activities that require a Polar Research Vessel (PRV). A University-National Oceanographic Laboratory System (UNOLS) led community-based refresh of the mission needs requirements for a PRV was delivered in February 2012. A lease/buy analysis is currently underway to inform the Foundation's decision regarding possible acquisition of a research icebreaker.

NSF agrees with the BRP that it would be beneficial to identify additional opportunities to leverage resources with our international partners. Further leveraging could be promoted through the research community, the Council of Managers of National Antarctic Programs (COMNAP, an international organization of National Antarctic Program operators), and program-to-program exchanges. Significant potential for collaborative logistics and research may exist in the Antarctic Peninsula region where NSF and other nations have, or would like to pursue, active programs. For example, consideration is already being given to shared use of vessels and development of an air link. NSF is currently reviewing opportunities and developing a roadmap for potential science and operational collaborations in this region. Once completed in 2013, the roadmap will serve as the basis for formal discussion with our international partners.

LOGISTICS AND TRANSPORTATION

The BRP recommendations associated with transportation underscore the importance of having a range of logistics options available for supporting research in the field.

NSF has worked to diversify these options through extensive research and development of overland traverse capabilities, and also by integrating new fixed- and rotary-wing aircraft in support of the USAP over the last fifteen years.

South Pole Traverse. NSF will incorporate robotics technology, a project with a very high return on investment, in the overland traverse platform. This technology will reduce the cost of resupplying South Pole Station while improving the efficiency of the operation. The goal is to double the number of traverses to South Pole from two to four by FY 2016, achieving an estimated net annual savings of $2.0 million dollars. To achieve this aggressive goal, NSF is working with other Federal agencies and industry to integrate commercial off-the-shelf products into the traverse fleet.

Funding for implementation will be included in a future budget request. Once funded it will take

Long-distance, over-snow, heavy-haul traverse trains provide an efficient alternative to airlift for moving cargo, fuel, and science equipment to remote sites. *Credit: The Whillans Ice Stream Sub-glacial Access Research Drilling Project*

The Yeti robot (pictured in the foreground) was used successfully last season to remotely locate sub-surface areas with buried structures or voids so that the overlying snow could be made safe for surface activities. *Credit: James Lever, U.S. Army's Cold Regions Research and Engineering Laboratory* approximately two years to procure and implement. NSF plans to continue the practice of piloting system improvements in Greenland during the boreal summer and then implementing these improvements in Antarctica during the following austral summer.

An ancillary benefit of further developing the traverse platform is the opportunity it affords for future research. As previously demonstrated, science enabled by traverse can take many forms. For example, paleoclimate studies were undertaken as part of the traverse-supported International Trans-Antarctic Science Expedition (ITASE) before and during the International Polar Year. The exploration via clean drilling of a subglacial lake under the Whillans Ice Stream during the 2012-13 season also capitalized on traverse support.

LC-130 Fleet Reduction and South Pole Hard Surface Runway. NSF is engaged with its Department of Defense (DoD) partners to explore the feasibility of implementing other recommendations made by the Panel. Two primary topics under discussion are the recommendations to reduce the operational LC-130 fleet from ten to six aircraft, and to construct a compacted snow runway at South Pole Station to allow wheeled aircraft operations. While NSF believes that construction of such a runway is technically feasible, there are many operational issues associated with landing wheeled aircraft at the South Pole (such as infrastructure and equipment for fire and emergency response, refueling, and cargo handling) that must be understood in order to conduct a cost-benefit analysis. Such an analysis would also need to take into account cost savings and efficiencies gained as a result of reducing the population at South Pole Station and increasing the traverse capabilities. A further complicating factor for USAP air support is the seasonal warming that has been impacting wheeled operations at McMurdo's Pegasus Runway. For the past three seasons, local temperature conditions have limited wheeled aircraft operations during the mid-December to late-January timeframe. In December 2012, the runway became completely unusable for wheeled aircraft due to melting exacerbated by volcanic dust blown from Black Island; portions of the snow road from Pegasus to McMurdo were also made impassable to all but tracked vehicles. During this period of time, only LC-130 aircraft enabled access between New Zealand and locations within Antarctica. These recent developments are causing NSF to review whether further consolidation at the Pegasus site and increased reliance on wheeled aircraft are advisable.

MCMURDO AND PALMER FACILITIES

The BRP recommended that aging facilities be upgraded according to master plans in order to reduce operating costs and increase efficiency for science support.

NSF is currently in the process of updating the master plans for both McMurdo and Palmer stations. For McMurdo, the Master Plan is in the final stages of development. The Master Plan addresses most of the large-scale investments recommended by the Panel for operational efficiency and safety. For example, it seeks to minimize the need to handle materials multiple times, to improve energy efficiency and to consolidate functions to reduce personnel requirements. Activities are being sequenced in discrete phases to ensure continuity of operations as upgrades proceed. A Palmer Station Systems Study was released in 2010. This study considered some of the health and usability issues that were raised by the BRP. In accordance with the BRP's recommendation, an in-depth study of the fire suppression systems at all USAP operating locations will be undertaken in FY 2014. In the near-term, NSF has continued to take steps to ensure that fire protection systems are fully operational in critical facilities in Antarctica such as berthing and food preparation areas. NSF will consider the results of these studies and update its long-range investment plan, discussed below, for priority investments.

The USAP recently upgraded the emergency response equipment at McMurdo Station. *Credit: George Blaisdell, National Science Foundation*

Specific to boating operations at Palmer Station, NSF has taken actions to improve the safety and efficiency of boating operations at Palmer Station. NSF is working on assessments in preparation for replacing the pier and mitigating a hazardous underwater rock ledge that currently limits the size of vessels that can directly access the station. An improved pier is expected to take two years to complete once funding has been identified. In the meantime, a temporary fender system is being employed to keep docked ships away from the underwater obstruction. Safety concerns related to small boat embarkation/disembarkation have been resolved through installation of a floating dock at Palmer Station. The Antarctic Support Contractor is working with vendors to finalize requirements for RIBs (rigid-hull inflatable boats) that are expected to be delivered and operational in FY 2014 to safely extend science operations farther from the station than is currently possible. A boat ramp to facilitate safe launch and recovery of all small craft has been designed and is scheduled to be constructed and operational in this same timeframe.

A new floating dock and ramp system at Palmer Station provides improved safety and efficiency for conducting small boating operations in support of marine research. *Credit: Rebecca Shoop and Bob Farrell, Antarctic Support Contract*

USAP CAPITAL BUDGET

In order to improve and maintain USAP facilities and infrastructure, the BRP recommended that NSF establish a capital plan and budget for the Program.

NSF agrees that planning tools are needed to guide its longer-term approach to improvements and maintenance within the constraints of the federal budgeting process.

NSF has developed a Long-Range Investment Plan (LRIP) and associated budget, using myriad inputs including needs identified by the user communities consisting of support contract employees, DoD partners, NSF-funded researchers, and other agencies relying on USAP support in Antarctica. The LRIP is also informed by other long-range planning activities in which NSF regularly engages, such as the updates for Palmer and McMurdo stations that are currently underway. These updates entail a complete review of current requirements, an assessment of current facilities and equipment to meet requirements, and recommendations for corrective action and improvements.

As needs are identified, project proposals will be generated and prioritized against factors such as mission criticality, alignment to vision, program interface, cost/benefit, risk assessment, and readiness (among others). A project will be added to the LRIP in accord with the determination of its priority. NSF will adopt a portfolio management approach to lifecycle management, which will be built into the LRIP over time to sequence major investments such as vehicle fleet replacement and major maintenance. The LRIP captures planned and in-process capital investments in terms of budget outlays and cash inflows. Budget Outlays are categorized according to Capital Investments and Life Cycle Support. Cash Inflows become available as projects are completed, through appropriations, and from returns on investments already made. The LRIP is constructed to provide a high-level view of outlays and inflows over a rolling five-year period.

The LRIP process represents a further step in improving the USAP's budget structure, but for this system to be effective, significant management attention—and discipline—will need to be paid to avoid encroachment on these funds by competing priorities within the overall infrastructure and logistics budget. Stakeholders within Polar Programs have agreed that the LRIP budget is appropriately and adequately sized and have pledged to respect the designation of these funds for investments.

Due to the inclusion of procurement- and budget-sensitive elements, distribution of the LRIP is limited to a management group with direct responsibility for implementation and oversight of the USAP.

The USAP recently introduced more versatile dump trucks at McMurdo Station. These multi-purpose, commercial trucks have beds that can be converted for varied uses such as for towing, cargo movement, and hauling bulk materials. This reduces the types and numbers of vehicles required and capitalizes on the savings to be gained from standardization. *Credit: Martin Reed, Antarctic Support Contract*

SCIENCE SUPPORT COSTS

The BRP recommended that NSF further strengthen the process by which the fully burdened cost and technological readiness of research instrumentation and observing systems, as well as overall projects, are considered in the review and selection of science projects.

NSF agrees that increased cost awareness could be beneficial. This recommendation reinforces NSF actions over the last several years to bring greater cost awareness to proposal reviewers via discussions of operational support, and to principal investigators during the award negotiation process. The actions are evolving as NSF and the Antarctic Support Contractor improve the robustness of cost information. NSF engaged the services of the expert who supported the BRP to complete development of the cost model that will identify discrete elements of cost and make it easier to predict the impacts on cost of various actions. Once completed, the cost model will be a useful tool for developing messaging related to costs for the USAP community. This cost model, along with continual improvement of science project planning activities, will also be useful for developing budget plans for the evolving science program and for ensuring that NSF can protect commitments that are made. It will aid in understanding the impacts of funding fluctuations in the USAP budget as well. In short, it will assist NSF in making well-informed and balanced decisions about USAP operations.

NSF will expand pre-deployment testing and evaluation activities now used for larger and more complex projects. For example, both the deep ice core drill and the CReSIS (Center for Remote Sensing of Ice Sheets) radar technologies were tested extensively in Greenland before being deployed in Antarctica. NSF has also strengthened requirements for field instrumentation proposals to achieve two principal objectives that tie directly to recommendations of the NRC and BRP reports. First, proposal solicitation language now requires that instrumentation be developed with holistic considerations of simplicity and reliability of deployment, service, and operational support in addition to achieving the scientific requirements for particular observations. This is intended to minimize the operational footprint and thus contain costs associated with deployment, servicing, and retrieval of scientific instrumentation. Second, solicitation language requires instrument development proposals to explicitly describe and employ project management best practices, such as defining milestones for development and testing, establishing criteria for evaluating whether or not milestones are met, and conducting readiness reviews prior to deployment. These changes

An image from the Whillans Ice Stream Subglacial Access Research Drilling project (WISSARD) borehole camera. In January 2013, scientists and drillers with this interdisciplinary project announced that they had sucessfully used a first-of-its-kind, biologically-clean hot-water drill to directly obtain samples from the waters and sediments of subglacial Lake Whillans. *Credit: The Whillans Ice Stream Subglacial Access Research Drilling Project* are already in effect for the current competition (proposal are due in April 2013).

Finally, NSF recently established the Antarctic Research and Logistics Integration Program Manager position with responsibilities that include funding for scientific instrumentation development and ensuring that appropriate instrument development plans are in place prior to an award. This program manager will engage across all of NSF to identify reviewers of the appropriate expertise for such instrument development proposals.

To achieve improved methods for observations as recommended by the NRC and BRP reports, the Antarctic Science programs will be investing $4 million per year beginning in FY 2014 in new or improved instrumentation to accomplish science while reducing the human footprint. The proposal solicitation language described above guides competition for these funds. These actions have been announced in discussions with the community and at town halls at venues such as the American Geophysical Union meeting. NSF will also use workshop venues, such as the Polar Technology Conference series (http://polartechnologyconference.org), to foster science community progress in this direction.

COMMUNICATIONS

The BRP recommended that NSF modernize communication capabilities in Antarctica and the Southern Ocean to enable increased science output and reduce operational footprint.

NSF appreciates the value of communications for science and operations and works to balance needs and desires through evaluation of requirements, cost/benefit analyses, and implementation of alternatives. NSF currently has the capability to provide high-bandwidth communications to all Antarctic field sites, although not continuously at all sites. Data-intensive activities such as the IceCube Neutrino Observatory and the South Pole Telescope employ filtering and compression techniques developed in partnership with other parts of NSF in order to ensure that critical data are provided on a

Tracking and Data Relay Satellite. *Credit: NASA.*

near real-time basis. In addition, NSF maintains a program for actively pursuing all available options for improving high-bandwidth communications. This program includes participation by other agencies such as NASA and DoD. In preparation for the BRP review, NSF funded an "analysis of alternatives" for Antarctic communications that reviewed requirements as well as the cost and feasibility of a range of communications solutions. There appear to be cost-effective solutions that make use of satellites retired from other uses to meet NSF needs for the foreseeable future.

ENERGY EFFICIENCY

The BRP recommended that NSF increase energy efficiency and implement renewable energy technologies to reduce operational costs.

NSF agrees that maximizing the use of alternative and renewable energies at all operating locations is a necessary goal given the rising cost of fuel. Significant strides have been made in this area, driving down annual fuel consumption through reductions in personnel and the overall operational tempo. For example, during the 2012-13 season, the population at South Pole Station was reduced from 250 to 168 personnel, resulting in a 30 percent reduction in fuel usage at the station. Additional study to determine the optimal use of these resources will be needed. The study will necessarily draw on the long-range planning activity that is currently underway for McMurdo and the Palmer Station Systems Study. Projects to implement improvements will be included in the LRIP.

In the short-term, NSF and Antarctica New Zealand (AntNZ) continue to work cooperatively

NSF and AntNZ partnered to introduce wind energy for their adjoining stations. Under optimal wind conditions, the turbines produce approximately one megawatt of power, which is sufficient to power all of Scott Base and approximately 30 percent of McMurdo's current power needs during the peak summer months. Actual fuel savings over the two-year test period were in excess of 300,000 gallons. Plans are currently under way to further optimize operation of the wind turbines. *Credit: Mike Casey, Antarctic Support Contract*

to determine the feasibility and advisability of expanding the use of wind turbines in McMurdo. In addition, significant returns to both the USAP and AntNZ are thought to be achievable by optimizing operation of the current system. At no cost to NSF, the New Zealand program supplied engineering and technical personnel to review and optimize the existing power production and distribution systems on Ross Island. The overall goal is to modernize the infrastructure and reduce overall power demand so that the majority of power can be provided from the existing one-megawatt wind turbine system.

NSF partners with the Department of Energy to identify opportunities to expand the USAP's use of alternative and renewable energy, such as the electric vehicles that are now in use at McMurdo Station. *Credit: Peter Rejcek, Antarctic Support Contract*

NSF has an ongoing partnership with the Department of Energy for exploring the use of alternative and renewable energy for its Antarctic (and Arctic) operations. The Antarctic Support Contractor has a division that focuses on waste-to-energy programs and will be researching the viability of converting the USAP's waste stream to building heat and estimating the investments that would be needed. With this information, NSF will compare the risks, costs, and benefits of alternatives relative to the current method of transporting material off-continent. The analysis is targeted for completion in 2013.

INTERNATIONAL COOPERATION

The BRP recommended that NSF pursue additional opportunities for international cooperation in shared logistics support as well as scientific endeavors.

As previously noted, NSF is actively pursuing additional opportunities to leverage resources with our international partners. For example, pursuant to more general agreements to cooperate, annual implementation plans that benefit the USAP are developed with international partners. Such arrangements are discussed year-round through recurring face-to-face meetings, frequent e-mail and telephone contact, and through the annual meetings of COMNAP and SCAR (Scientific Committee on Antarctic Research, an advisory body to the Antarctic Treaty). NSF engages with other national programs through international organizations such as COMNAP to look for opportunities to standardize equipment and take advantage of volume pricing. NSF is also looking to expand arrangements in the Ross Sea region as well as in the Antarctic Peninsula. Countries including Australia, Italy, France, South Korea, and New Zealand have active logistics programs and bases in the Ross Sea region and represent cost-sharing opportunities for the USAP, while several countries offer opportunities in the Peninsula area. NSF will continue to work with our international partners to ensure active and open data sharing that is a hallmark of the Antarctic Treaty and facilitates more efficient science.

ANTARCTIC POLICY

The BRP, citing current realities as well as findings identified in the NRC and BRP reports, recommended that existing documents and implementing mechanisms governing Antarctic Policy be reviewed and revised as appropriate.

Presidential Memorandum 6646 and Presidential Decision Directive/NSC-26 provide NSF with the appropriate level of authority and guidance. The Department of State has indicated there is no need to revisit these policy statements at the current time. NSF stands ready to support their effort if they choose to initiate such an action.

APPENDIX A

The U.S. Antarctic Program:
Future Science Opportunities in the Antarctic and Southern Ocean

Statement of Task

Under the auspices of the National Research Council (NRC), the Committee on Future Science Opportunities in the Antarctic and Southern Ocean will identify and summarize the changes to important science conducted on Antarctica and the surrounding Southern Ocean that will demand attention over the next two decades. The committee will assess the anticipated types and scope of future U.S. scientific endeavors and international scientific collaborations over a ~20-year period in Antarctica and the Southern Ocean. Membership should include leading polar scientists that span a wide range of expertise who actively participated in Antarctic research in recent years, and scientists with broad experience in global and international research. The committee should identify and summarize likely future science requirements of the U.S. research community, including the needs of the federal mission agencies that depend on U.S. Antarctic Program (USAP) infrastructure and logistics. At present, those agencies are NASA, NOAA, USGS, DOE, EPA, the Smithsonian Institution and the Department of State, which relies on infrastructure support from the Program for official inspections of foreign facilities in Antarctica. The committee should:

- build upon the work of other organizations (e.g., ICSU, SCAR, etc.), draw upon recent scientific achievements in Antarctica and the Southern Ocean including those reported during the 2007-2009 IPY, and utilize previous workshops and reports (e.g., those from the NSF and NRC that pertain to future research directions in Antarctica);
- identify changes to anticipated types and scope of scientific programs for the U.S. in Antarctica and the Southern Ocean over the next two decades;
- examine appropriate opportunities for international Antarctic scientific collaborations based on recent U.S. experiences from the International Polar Year and other anticipated activities;
- report any new emerging technologies should they be found while reviewing the scientific achievements that enhance the U.S. ability to realize important future opportunities or the application of new technologies that enable the collection of scientific data in more effective or efficient ways; and
- comment on the broad logistical capabilities and technologies that, from a science delivery perspective, would need to be improved or require major changes to enable the anticipated types and scope of future U.S. scientific programs, with the intent of informing the concurrent FACA Blue Ribbon Panel that will examine and have a central focus on logistical operations in Antarctica.

In carrying out its work, the committee is expected to draw on existing reports, results of national and international workshops, strategic plans of involved federal agencies, recommendations of professional scientific societies and other organizations, and any other sources it might find useful. The committee is not expected to set priorities among scientific research areas, nor is the committee to discuss budgetary issues. The primary goals are to identify important future research directions in Antarctic and to inform the companion review looking at logistical planning and operations. Together these two studies are intended to help ensure that logistical operations are capable of supporting important forefront scientific research in Antarctica over the coming decades.

MEMBERSHIP

The Committee on “Future Science Opportunities in Antarctica and the Southern Ocean” members included:

Warren M. Zapol, (Chair), Harvard Medical School and Massachusetts General Hospital, Boston, Massachusetts

Robin E. Bell, Lamont Doherty Earth Observatory, Palisades, New York

David H. Bromwich, Ohio State University, Columbus, Ohio

Thomas F. Budinger, University of California, Berkeley, California

John E. Carlstrom, University of Chicago, Chicago, Illinois

Rita R. Colwell, University of Maryland, College Park, Maryland

Sarah B. Das, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts

Hugh W. Ducklow, Marine Biological Laboratory, Woods Hole, Massachusetts

Peter Huybers, Harvard University, Cambridge, Massachusetts

John Leslie King, University of Michigan, Ann Arbor, Michigan

Ramon E. Lopez, University of Texas, Arlington, Texas

Olav Orheim, Research Council of Norway, Oslo, Norway

Stanley B. Prusiner, University of California, San Francsico, California

Marilyn Raphael, University of California, Los Angeles, California

Peter Schlosser, Columbia University, Palisades, New York

Lynne D. Talley, Scripps Institution of Oceanography, La Jolla, California

Diana H. Wall, Colorado State University, Fort Collins, Colorado

APPENDIX B

Office of Science and Technology Policy

National Science Foundation

November 3, 2011

MEMORANDUM TO THE MEMBERS OF THE ANTARCTIC BLUE RIBBON PANEL

FROM: John P. Holdren, Assistant to the President for Science and Technology and Director, Office of Science and Technology Policy

Subra Suresh, Director, National Science Foundation

SUBJECT: Charge to the Blue Ribbon Panel

The Blue Ribbon Panel should assess the current U.S. Antarctic Program operations, logistics, and management and make recommendations on a long-term strategy to deliver an efficient and effective national research program for Antarctica and the Southern Ocean, informed by the recommendations of the National Research Council. To this end, the Panel should consider:

- the status and capabilities of the current U.S. Antarctic infrastructure;
- appropriate opportunities for international collaborations;
- the role of and future requirements for permanent stations, remote camps, mobile stations, ships, and aircraft support;
- the management and logistics support options required to support the projected scientific program; and,
- complementary R&D activities (e.g., satellite measurements, technology development, etc.) that would help make Antarctic activities even more productive and affordable over the long term.

The Panel is strongly encouraged to consider and recommend innovative operational and technological approaches to maximize the scientific impact of the U.S. program in a necessarily constrained budget environment.

MEMBERSHIP*

The 12-member USAP Blue Ribbon Panel included:

Mr. Norman R. Augustine (Chair)

Admiral Thad Allen

Dr. Hugh W. Ducklow**

Rear Admiral Craig E. Dorman

Mr. Bart Gordon***

R. Keith Harrison

Dr. Don Hartill

Dr. Gérard Jugie

Dr. Louis J. Lanzerotti

General Duncan J. McNabb

Mr. Robert E. Spearing

Dr. Diana Wall**

* Full biographies are included in the Blue Ribbon Panel Report at http://www.nsf.gov/od/opp/usap_special_review/usap_brp/rpt/antarctica_07232012.pdf.

**Drs. Ducklow and Wall served on the NRC study and so provided formal continuity between the studies.

***Mr. Gordon's membership on the Panel spanned from the Panel's creation (October 12, 2011) until May 11, 2012, when a change in his employment activities necessitated his withdrawal.

APPENDIX C

USAP BLUE RIBBON PANEL REPORT TIGER TEAM CHARTER

AUGUST 2012

Purpose:
Senior Management team chartered by the NSF Director to guide a comprehensive response to the 2012 U.S. Antarctic Program (USAP) Blue Ribbon Panel (BRP) Report "*More and Better Science in Antarctica through Increased Logistical Effectiveness*"

Membership:
Acting Head of the Office of Polar Programs (OPP): Kelly K. Falkner (lead for the team)

Assistant Director Biology Directorate:
John Wingfield

Assistant Director Engineering Directorate:
Tom Peterson

Assistant Director Computer & Information Science & Engineering: Farnam Jahanian

Head of Office of International Science & Engineering: David Stonner

Senior Advisor for Strategic Initiatives, Office of the Director: Dedric Carter

Division Director, Astronomical Sciences, Mathematical & Physical Sciences Directorate:
Jim Ulvestad

Acting Assistant Director Geosciences Directorate:
Marge Cavanaugh

Charge to the team:
Review the USAP BRP report and guide completion of an NSF written point-by-point response to its recommendations by December 2012.

The Tiger Team will convene during the September-December, 2012 timeframe. OPP will provide the Tiger Team, for its review, copies of the BRP and precursor National Research Council "*Future Science Opportunities in Antarctica and the Southern Ocean*" reports. OPP will provide the Tiger Team with a summary of the current status for each of the recommendations and will also review the process underway in OPP for drafting an integrated master plan to cover 5+ years of capital investment and savings measures. The Tiger Team will direct particular attention to approaches for implementing recommendations that would benefit from or be beneficial to enhanced cross-Foundational and external engagement. The Team should also identify and provide the rationale for any recommendations that it advises that NSF should not implement. The Tiger Team will roll up point-by-point responses into a summary document tracking with the top ten issues as laid out in the executive summary.

The lead will be responsible for capturing in writing the team's activities and guidance for its review by e-mail prior to delivery to the Director and Deputy Director. The lead will collaborate with team members to brief upper management regularly (≈ biweekly) during the working period.

The Team is working to an initial deadline of November 15 in order to prepare the director for possible questioning at the Nov 15 hearing and for a Nov 16 dry run of a December 4th or 5th presentation of the response to the National Science Board.

Activities Timetable
(As amended 26Sep12 & 11Mar13)

- Team members receive and read BRP report (≈2.5 hr, Sep 5).
- Preview OPP's status summary of BRP recommendations (≈0.5 hr, Sep 21).
- Team members meet with OPP personnel to discuss recommendations and develop action items toward the comprehensive response to be delegated as appropriate (2 hrs, Sep 26).
- Team reviews and endorses via e-mail "already done" subset of recommendations (week Oct 1-5).
- Team reviews "recommendations not adopted" with justifications and meets to discuss. Team assigns thinking/writing subgroups to priority remaining recommendations. Examines suggested text and "policy" for acknowledging NSF USAP support in publications (1 hr, Oct 15).
- Team meets to discuss and collate response to all other recommendations. Captures priority actions to involve engagement of OPP with other units within and outside of agency (2 hrs, week of Oct 17-19).
- OPP creates draft roll up response document selecting examples that speak to top 10 areas of Executive Summary and extracts talking

points for Director’s congressional hearing testimony on November 15. Circulates for Team consideration (Oct 24-26).

- OPP drafts and Team meets with OPP staff to review the presentation content for NSB, BRP, OAC, congress, and public (1 hr week of Nov 1-2),
- Team reviews OPP presentation of the comprehensive response to the NSB (1 hr, Nov 16).
- NSB presentation delivered (Dec 4-5).
- Team meets after NSB engagement to advise on any adjustments of strategy needed to finalize comprehensive response (1 hr, week of Dec 10-15).
- Team and Director reviews response status update and response summary prior to NSB meeting (Feb 7-18).
- NSB presentation delivered (Feb 20).
- Team reviews the summary document changes via e-mail (Mar 4-8).
- Division of Polar Programs incorporates input and finalizes response summary document for clearance, layout, printing and posting to web by Office of Legislative and Public Affairs (deadline Mar 19).
- Team participates in final conference call to the BRP lead by Director Suresh (Mar 20).
- Tiger Team stands down (Mar 20).

NSF 13-77

National Science Foundation

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