Arctic-tecture for the Global Commons

by
Andrea Brennen

B. A. Mathematics, B. A. Studio Art
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Submitted to the Department of Architecture in partial
fulfillment of the requirements for the degree of

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Abstract

Environmental agendas in architecture have enjoyed an increased attention recently, as a result of the emerging 'sustainable' design ethos. This framework of sustainability initiates a rethinking of the scale of an architectural site – a building must be understood as situated not only in a specific territory, but also in relation to a much larger and more abstract global environmental system. With this new systemic understanding of a "site," comes the opportunity for a different mode of architecture -- one in which the architect has a hand in designing not only the architectural object, but also tactics for and potential effects of its implementation.

Operating in the spirit of Stewart Brand's *Whole Earth Catalog* -- a 1970s counterculture bible for "whole systems" thinking -- this thesis examines Antarctica as a testing ground for an expanded mode of architecture. Antarctica, with its extreme environment, scientific value, and legal status as a Global Commons, is a site that cannot be understood in any way other than through its relationship to a larger global environmental system. This reality, when combined with the continent's mystique, creates an unparalleled opportunity for architectural innovation.

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Andrea Brennen graduated with high honors from Grinnell College in 2004 with a double major in mathematics and studio art. Her work has been exhibited at the Venice Biennale, the Rotterdam Biennale, and the Canadian Center for Architecture, and published in *Volume* and *ARQ Future*. She is interested in how environmental issues are changing the practice of architecture and spends nearly all of her free time rock climbing.

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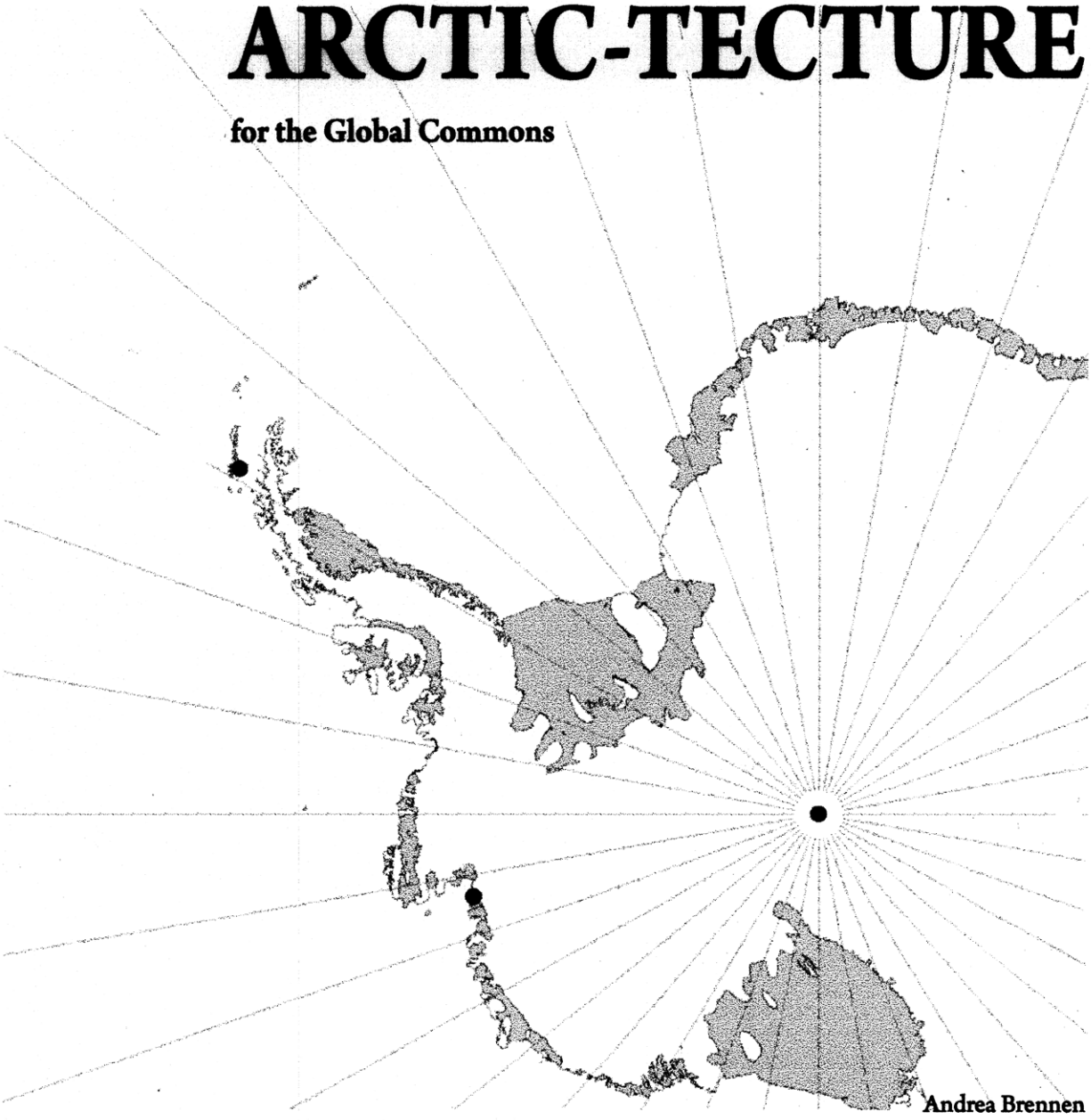
To my mom for the unconditional encouragement, my brother Scotty for keeping me focused on the things that are most important, and my dad for always being excited about my crazy ideas.

And to Matt...for being awesome, and unbelievably supportive.

ARCTIC-TECTURE

for the Global Commons



Andrea Brennen

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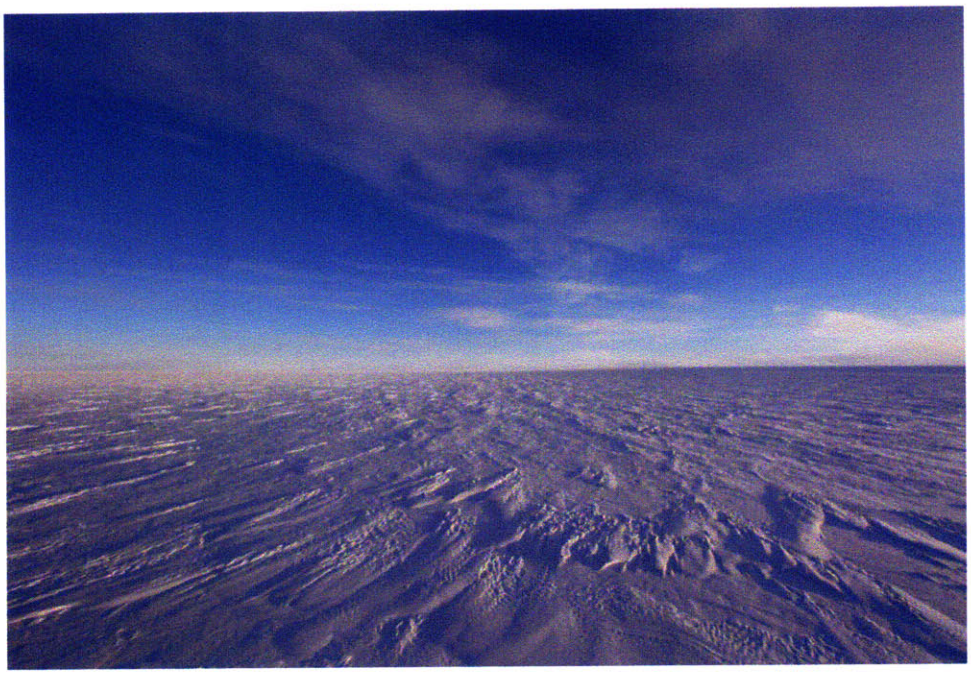

"Even in a world of empires, Antarctica was a domain where empire turned abstract, almost absurd; where you could clearly impose only a kind of vacuous diagram of possession on the snow."

-- Francis Spufford

Antarctica's remote location, dramatic environment, and absent indigenous population have fostered a mystique that is rivaled by few locations other than outer space. Even in an increasingly interconnected and homogenized world, this last *terra incognita* remains so far away and so logistically difficult to tame that it still retains an air of mystery left over, it seems, from an earlier age.

Many have spoken of this unreal, imagined quality that differentiates Antarctica from other parts of the world; Sara Wheeler writes that for her, "Antarctica existed most vividly in the mind. It was a metaphorical landscape, and in an increasingly grubby world it ha[s] been romanticized to fulfill a human need."[1]

Many have viewed this Antarctica, a mythical empty landscape, as "the perfect tabula rasa."[2] Upon this frozen empty slate, national governments have projected innovative and radical visions of governance -- multilateral management, nuclear disarmament, and immense-scale environmental preservation.

Daniel Defoe, in his "An Essay Upon Projects," discusses the importance of this sort of vision, or "projecting."[3] Defoe explains that, in the face of extreme logistical difficulties and unlikely odds of success, "projecting" new visions of society and opportunities of future riches provides an image of what could be, and with it, the motivation to proceed.

Antarctica is an especially interesting example of the type of projecting that Defoe discusses. The continent's remoteness, mystique, and perceived undesirability, have encouraged experimentation with new ideas and unconventional agreements. Some of these ideas, once deemed successful in Antarctica's frozen no-man's-land, have even managed to migrate northward, into the rest of the world.[4]

With regards to Antarctica, it seems that the world has had nothing to lose and everything to gain.

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1 Wheeler, Sara. Terra Incognita. London: Jonathan Cape. 1996. Page 3.

2 Wheeler 2.

3 Defoe, Daniel. "An Essay Upon Projects." 1697. Course Reader for Public Works: Totality + Infinity. Page 17.

4 After the 1961 Antarctic Treaty set a precedent for nuclear-weapon free zones, this model was followed in Latin America in 1967, the Sea-bed in 1971, and the South Pacific in 1986 (Suter 7). In this way, Antarctica can be seen as a testament to how radical and innovative ideas can take hold.

Antarctica was the last continent to be explored and remains the largest unclaimed area on earth. It has no indigenous population and today is inhabited only by transient scientists and support staff. It is the closest thing to a "pristine wilderness" that exists on earth. Although the continent is larger than the US and Mexico combined, represents 10% of the world's landmass, and holds 65% of the world's fresh water frozen in its miles-thick ice sheet,[5] it is represented on most world maps as a marginalized fringe at the bottom of the page.

Long dismissed as an 'out of the way' wasteland, Antarctica might seem like a strange site for an architectural thesis. Antarctic buildings don't typically make it into the canon of architecture history, and most people tend to think of Antarctica as a vast expanse of nothingness – no cities, no culture... no architecture. However, architecture (or at least the act of building) has played a surprisingly prominent role in Antarctica's brief history. Over the last century, nearly fifty national governments have sponsored the construction of a variety of scientific research facilities and associated infrastructure (airstrips, roads, etc.) on the continent. In addition to allowing for the extraction of scientific information (which has been called Antarctica's "main export,"[6]) these facilities have provided a means for various nations to assert their sovereignty over this southernmost continent, a land rife with contested territorial claims.[7]

Antarctica is legally designated as a Global Commons, a term used to refer to "areas or resources that do not or cannot by their very nature fall under sovereign jurisdiction."[8] An international Antarctic Treaty, ratified by the governments of 12 signatory nations in 1961, established this Commons status and today, representatives from 46 nations regularly attend Antarctic Treaty Consultative Meetings, at which the future of Antarctic activity is debated and determined. Voting power, however, is limited to representatives from 28 nations -- those whose governments have been deemed (by their peers) to have demonstrated "substantial interest" in the continent. According to the original 1961 Treaty, a government can demonstrate "substantial interest" only by constructing and continually operating a scientific research facility on the ice.[9] In other words, the only way for governments to claim their piece of the Global Commons is through architecture.

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5 Suter, Keith. Antarctica: Private Property or Public Heritage? Leichhardt: Pluto Press Australia, 1991. Page 4.

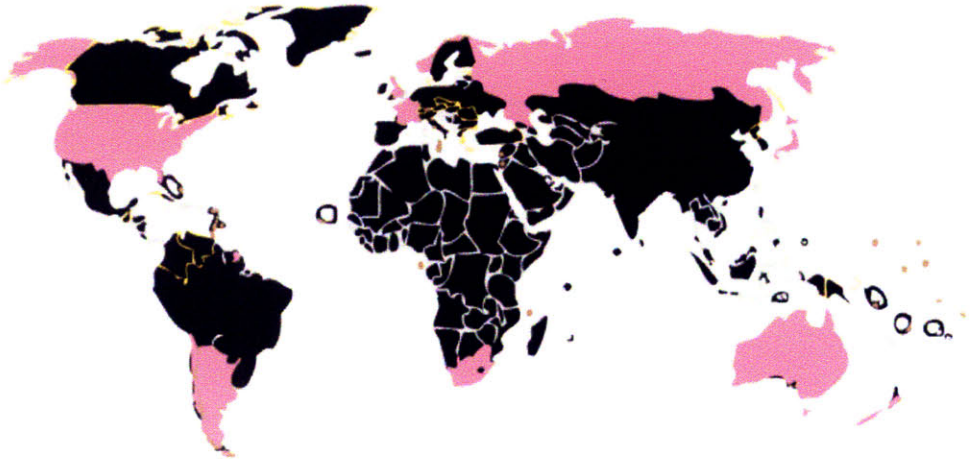
6 Schofield, Clive H. Introduction. World Boundaries – Volume 1. By Schofield. New York: Routledge, 1994.

7 Perhaps because of Antarctica's lateness of discovery, mechanisms of claiming territory such as "discovering," or formally taking possession of a place -- that were common in a previous colonial era -- were contested in Antarctica from the beginning.

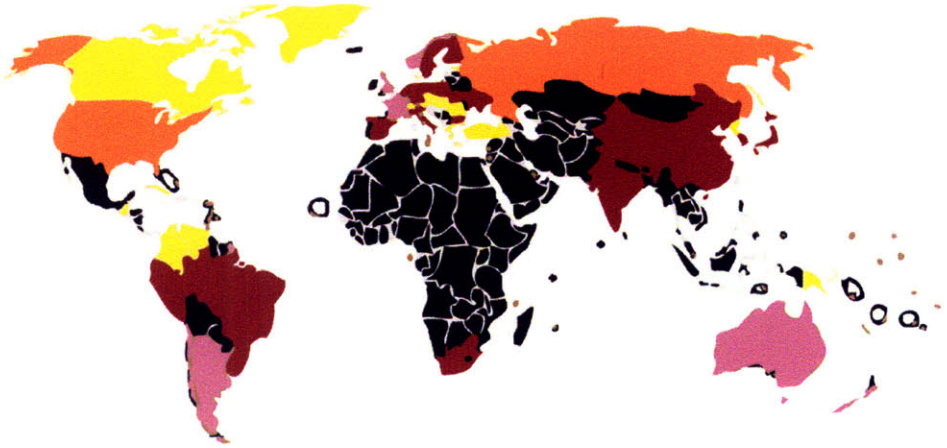
8 Vogler, John. The Global Commons: Environmental and Technological Governance. New York: John Wiley & Sons: 2000. Page 1.

9 Article IX, Section 2.

Original signatories to the 1961 Treaty



Nations currently participating in the Antarctic Treaty System



- signatory, consulting, territorial claim
- signatory, consulting, reserved right for territorial claim
- signatory, consulting
- signatory, accending status

However, there are a number of conditions that limit Antarctica's operation as a Global Commons. First, the 1961 Antarctic Treaty stipulates that this territory is the common property not of individuals or humanity at large, but rather, of state governments. Second, while Antarctica might symbolically or rhetorically be shared by all national governments, in reality, Antarctic sovereignty belongs only to those governments with the financial wherewithal to build a building there – an incredibly expensive endeavor.

Meanwhile, over the past decade there has been a drastic rise in Antarctic tourism. There are currently no facilities or infrastructure to support this tourism and because of the continent's peculiar legal status, there is also no governing body with the authority to regulate it. There is growing concern among scientists and environmental advocates that Antarctica's emerging and unregulated tourism industry will have dire consequences on the continent's fragile ecosystem.[10] Ironically, this problem is exacerbated by increasing press concerning the melting of Antarctic ice sheets due to global warming; it seems that tourists want to experience the calamity of global climate change first hand... even if it means they are personally contributing to the problem. While this lack of regulation is a significant problem, this thesis argues that those who argue for the abolition of Antarctic tourism are overlooking one of the continent's main assets -- its status as a global public space. Besides, given the difficulties associated with policing the seventh continent, perhaps the more pragmatic course of action is to plan for the inevitability of tourism.[11] There is, at this site, a tremendous opportunity to design a facility that sets an example for Antarctic development -- a facility that addresses the environmental urgencies at hand, takes advantage of the opportunities presented by the site's peculiar constraints, and offers an architectural manifestation of the global commons.

This thesis argues that today, an environmental approach requires designers to rethink the scale of an architectural site – a building must be understood as situated not only in a specific territory, but also in relation to a much larger and more abstract global environmental system. One might even argue that as environmental concerns are foregrounded, the site itself becomes an agent in architectural production, or rather -- to borrow from Ulrich Beck – architectural decisions are made in such a way, not to produce desired effects, but rather, to avoid negative ones.[12] Particularly when operating in a place like Antarctica, the architect must understand and propose tactics for designing not only the architectural object, but also its implementation, operation, and even its eventual destruction.

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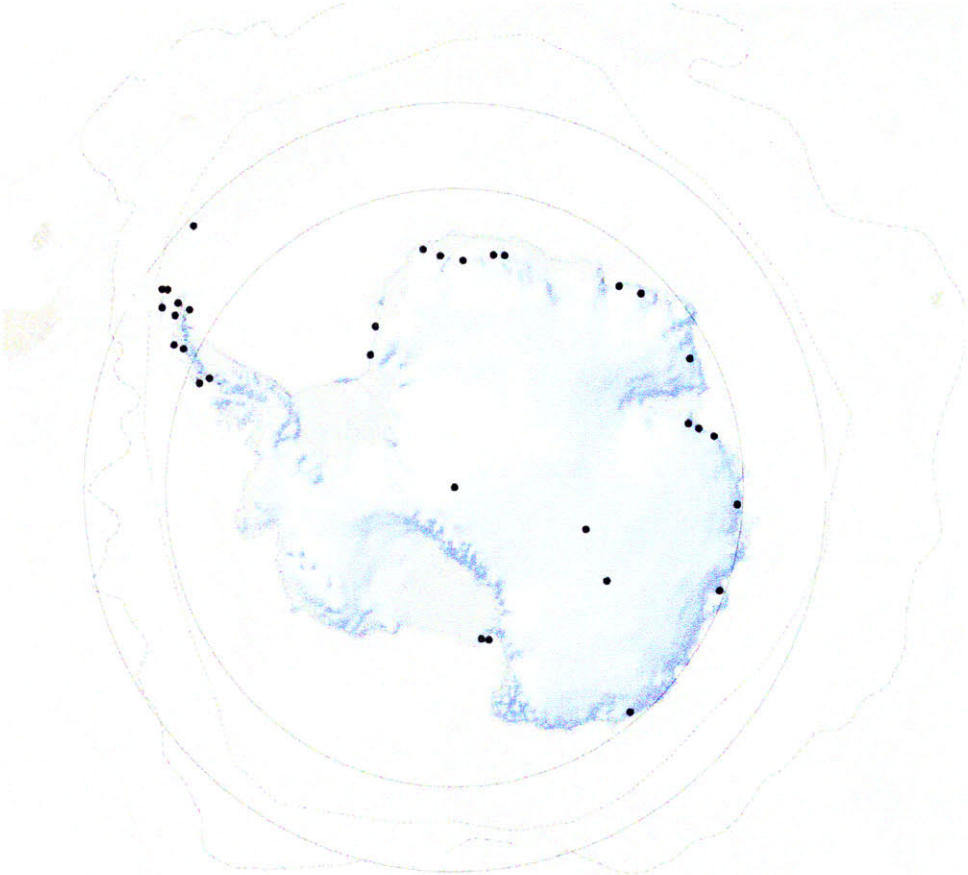
10 This argument was echoed in the recent NPR story "Antarctica's March of the Tourists" that aired on Climate Connections in March of 2008.

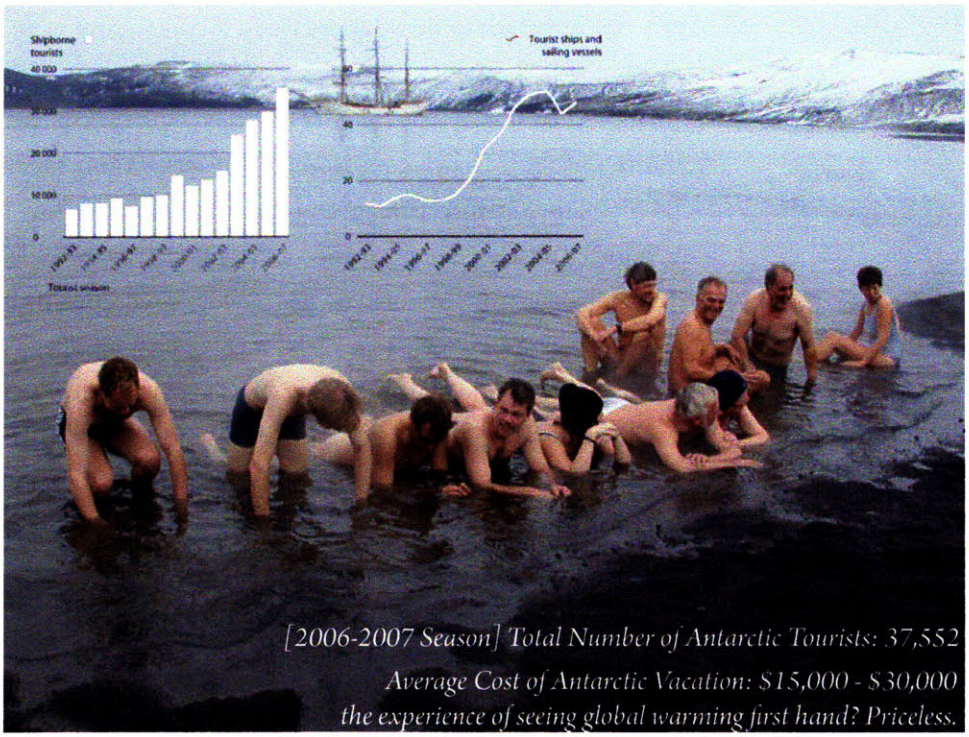
11 See also Hardin, Garrett. "The Tragedy of the Commons." *Managing the Commons.* Ed. Garrett Hardin and John Baden. San Francisco: W.H. Freeman and Company: 1977.

12 Beck, Ulrich. *Risk Society: Towards a New Modernity.* Translated by Mark Ritter. London: Sage Publications, 1992. Page 9. Originally published as *Risikogesellschaft: Auf dem Weg in eine andere Moderne* by Suhrkamp Verlag, Frankfurt am Main, 1986.

Antarctic research facility locations.



Trends in Antarctic Tourism.



Source: http://maps.grida.no/go/graphic/trends-in-antarctic-tourism

Stewart Brand & the *Whole Earth Catalog*

In 1966, Steward Brand initiated a public campaign to lobby NASA to release satellite images of the earth taken from space. With the distribution of a few hundred buttons around the UC Berkeley campus (which read "Why haven't we seen a photograph of the whole earth yet?") Brand launched a project that would eventually become the *Whole Earth Catalog*, the pilot issue of which brought these first images of the whole earth to the public. Many have written about the influence those images had once released, on the environmental movement in particular and society in general – heightening a public sense of the interconnectedness and vulnerability of environmental systems. Through the *Whole Earth Catalog*, Brand not only sought to raise awareness, but also to promote a new pragmatic approach to environmentalism, born out of a philosophical merging of military-industrial technocracy and Western-American countercultural ideals.

Before the 1960s, American environmental advocacy was dominated by a conservationist paradigm, an approach which dismissed industrialized technology as the antithesis of nature. In stark contrast to this view, Brand's *Whole Earth Catalog* celebrates technological achievement and a pragmatic modification of the environment. 'Design' is upheld as an extremely important conceptual tool for the invention of the pragmatic tools (devices) to which much of the catalog is devoted. The catalog's mantra of "access to tools" conveys Brand's intention to create a countercultural version of LL Bean, containing product descriptions, book reviews, updates on new technologies, and announcements of events. Brand envisioned the catalog as a new type of information delivery service that would provide access to physical and conceptual tools necessary to feed his survivalist / do-it-yourself approach to environmental and social improvement.

Brand's interest in Systems Theory informed both the content and structure of the *Whole Earth Catalog*.[13] Drawing on Norbert Wiener's writing on cybernetics, Brand intended to develop a self-sustaining and continually expanding information network that reinforced an association between individual action and global (political) ramifications. The individualism promoted by the catalog, a reflection of Brand's libertarian leanings, sends a political message to readers: small-scale tools offer a means of bottom-up social transformation, and personal choices lead to community (and ultimately global) change. With access to the required tools, each individual has the power to make decisions regarding how to conduct his or her own life.[14] Brand's version of environmental rhetoric offers an ironic combination of escapism and optimistic pragmatism. His belief in the existence of technological solutions to social and political problems reverberates through the catalog's contents, emphasizing the potential of an architecture conceived of as a tool for action and individual use.

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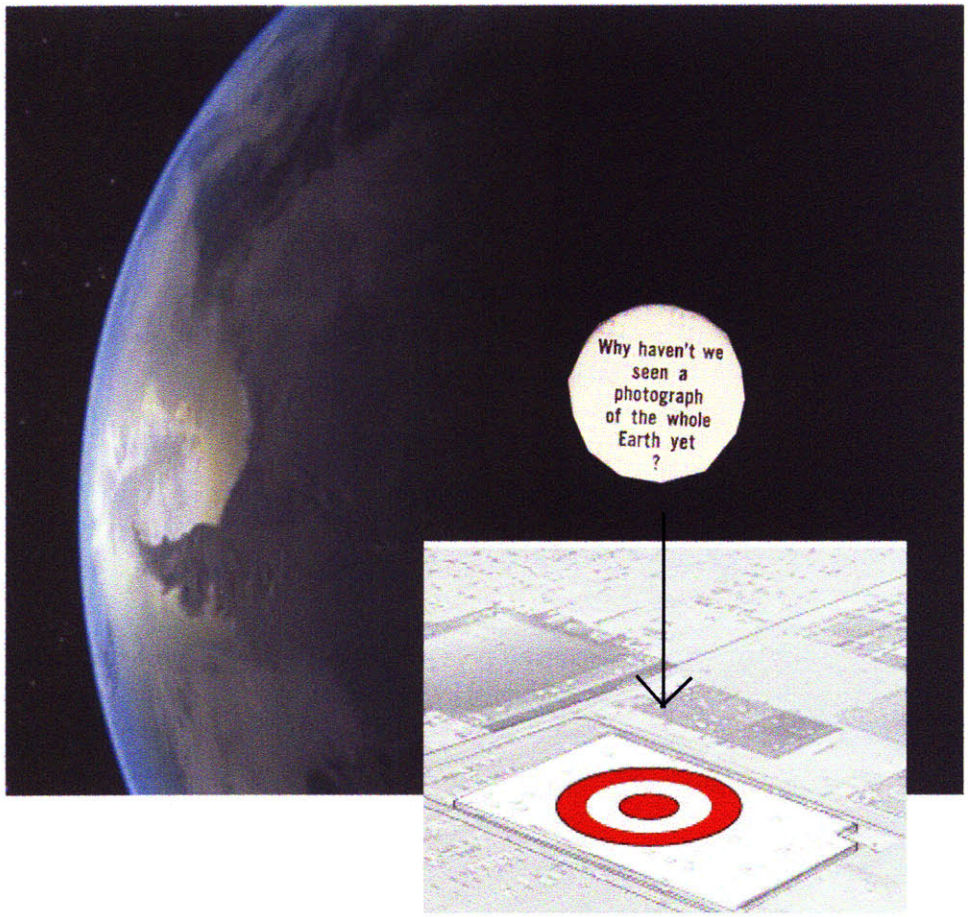
13 Turner, Fred. *From Counterculture to Cyberculture: Steward Brand, the Whole Earth Network, and the Rise of Digital Utopianism*. Chicago: University of Chicago Press, 2006. Page 79.
14 Turner 83.

Tactical opportunism (a definition):

An (entrepreneurial) approach that aims to take advantage of what's there, and thus requires a thorough examination of site conditions: geographic and physical, as well as legal, logistical, metaphorical, and rhetorical. This expanded site analysis involves identifying urgencies and opportunities for action. Surveying the scene in such a way allows for a selective exploitation of certain conditions, constraints, and opportunities (not unlike the revealing of legal loopholes), in order to expose a range of possibilities. This approach is systemic in nature, recognizing that architectural production implicates a wide range of factors and agents; architects can design a strategy for implementation as well as an inhabitable object. Operating strategically within this expanded notion of a 'site' requires a series of new tools for architecture. For example...

Google Earth: new technological tool



We've come a long way from Stewart Brand's campaign to get NASA to release images of the earth taken from space; today companies like Target are using architecture as global signage...Google Earth allows architects to visualize vast space as a contiguous territory and to understand an architectural project in a much larger (global) context. It also allows for the remote collection of site information, and, potentially, an opportunity to experience architecture remotely.

Footprint Analysis: new methodological tool

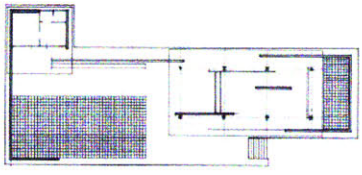
Sustainability is transforming the terms by which architecture is valued. No where is this more visible than with regards to the architectural conception of 'footprint.'

Historically, a building's 'footprint' was simply where (and how) it interacted with the ground – the surface or space occupied by a structure. Initiated in part by (ecologist) William Reese's book *Our Ecological Footprint: Reducing Impact on Earth*, the idea of an architectural 'footprint' has expanded to incorporate the much more abstract notion of the building's impact, effect, and demand on the environment at large. This re-defined architectural footprint is often interpreted as the resource usage of a building – the embodied energy it consumes and the carbon it emits.

A 'sustainable' design approach is often equated with the simplified ideal of 'minimizing footprint,' a philosophy that, when pushed to its extreme, is often incompatible with the very act of building. Additionally, defining architectural 'footprint' as a collection of energy metrics rather than a site plan positions footprint analysis in the realm of the engineer, rather than the architect.

The emphasis on building performance -- often to the exclusion of other design factors -- begs the question: what if, despite its inherent connection to issues of resource use and energy consumption in the built environment, 'sustainability' is an architectural problem without an architectural solution?

pre-sustainability FOOTPRINT
the space occupied by a structure
(denotes spatial boundaries)



post-sustainability FOOTPRINT
a building's impact on the environment
(denotes system boundaries)

Offsetting: new conceptual tool

To offset (definition)

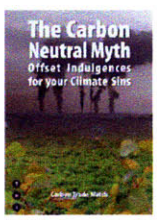
1. An agent, element, or thing that counteracts, or compensates for something else.
2. Something developed from something else.

According to Wikipedia, a carbon offset is a means for reducing greenhouse gas emissions. Although there are six primary categories of greenhouse gases, carbon offsets are measured in metric tons of carbon dioxide-equivalent (CO2e); one carbon offset represents the reduction of one metric ton of carbon dioxide, or its equivalent in other greenhouse gases. The Kyoto Protocol has sanctioned offsets as a way for governments and private companies to earn carbon credits which can be traded on a marketplace. In the much smaller voluntary market, individuals, companies, or governments purchase carbon offsets to mitigate their own greenhouse gas emissions from transportation, electricity use, and other sources. The Nature Conservancy ["protecting nature, preserving life"] can help you determine and offset your own personal carbon footprint with their on-line calculator and Carbon offset program: see http://www.nature.org/initiatives/climatechange/calculator/

Viewing the earth as one big interconnected environmental system that can be described and understood through a series of quantifiable energy metrics [carbon output] makes the idea of offsetting possible. Once all actions are abstractly converted into units of carbon [a new universal currency?] one action/product/intervention can be exchanged or substituted for any other. However, this makes one wonder what is actually being offset: pollution or guilt? In *The Carbon Neutral Myth: Offset Indulgences for your Climate Sins* [Carbon Trade Watch, 2007] Kevin Smith likens modern day carbon trading to the buying of indulgences, a medieval mercantile practice by which one could expiate sin by engaging in monetary exchange with the church.

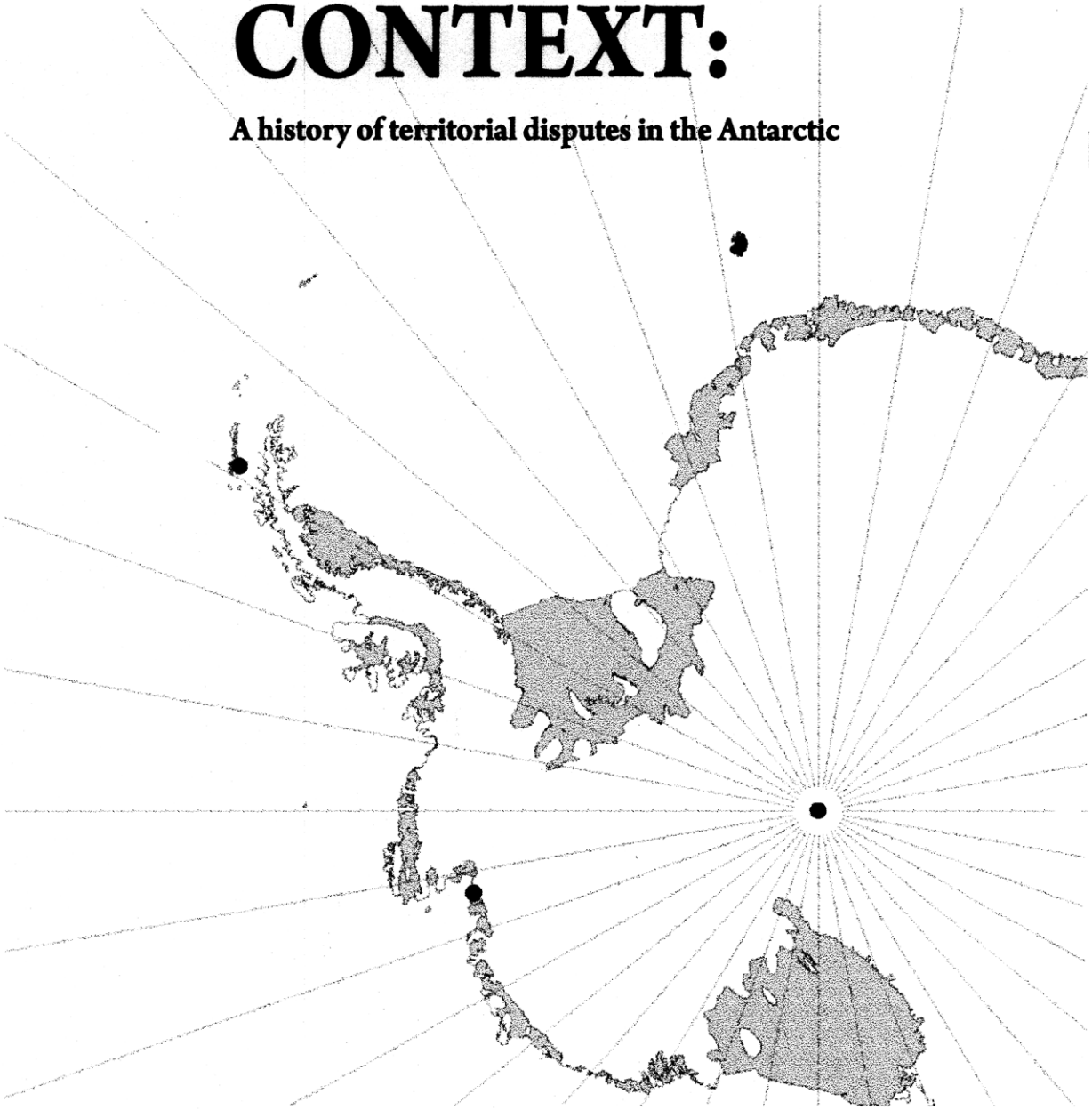
Smith writes: "Carbon offsets are the modern day indulgences, sold to an increasingly carbon conscious public to absolve their climate sins. Scratch the surface, however, and a disturbing picture emerges, where creative accountancy and elaborate shell games cover up the impossibility of verifying genuine climate change benefits, and where communities in the South often have little choice as offset projects are inflicted on them...Promoting more effective and empowering approaches involves moving away from the marketing gimmicks, celebrity endorsements, technological quick fixes, and the North/South exploitation that the carbon offsets industry embodies."

Download the PDF at:
www.tni.org/detail_pub.phtml?know_id=56&menu=11c

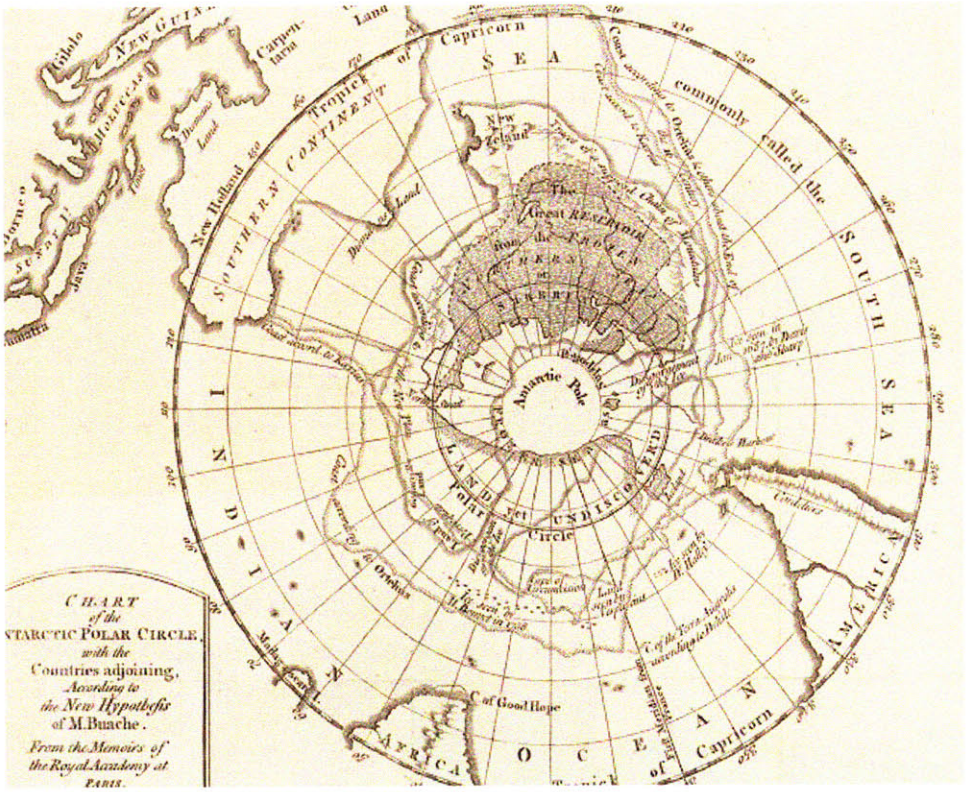


CONTEXT:

A history of territorial disputes in the Antarctic



French Map of Antarctic Pole, 1788.



The Heroic age of Exploration

Antarctica's short history, as it is generally told, begins at the turn of the 20th century, with the continent's "Heroic"[1] age of European exploration.[2] Although a British naval expedition led by James Clark Ross is credited with having discovered the Antarctic mainland in 1841,[3] logistical difficulties prevented serious exploration of the continent until the early 1900s. This "Heroic" age was defined by the adventures and tragedies of Antarctica's early explorers. Robert Falcon Scott, Ernest Shackleton, Apsley Cherry-Garrard, Roald Amundsen, Douglas Mawson, Nobu Shirase, and others documented the hostile other-worldliness of Antarctica and cemented its place in thousands of imaginations.

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1 I'm using quotation marks around "Heroic" as seems to be a convention among historians. Francis Spufford writes that the quotation marks represent a skeptical nod to the "nationalistic fervor" that surrounded these early expeditions (3).

2 Antarctica's presence in historical lore can be traced back much earlier, however, from Polynesian legends of southern lands discovered by Te Aratanga-nūkū and Ui-te-Rangiora, to Aristotle's projected presence of Antarktikos (a southern landmass that counterbalanced the "northern" landmass surrounding the Mediterranean Sea) to Alexander Dalrymple's unyielding assertions that a huge southern continent, as of yet undiscovered, must be explored and claimed for Britain.

3 There was Antarctic activity before this, and Ross's "discovery" is contested. George Shelvocke, an Englishman, accidentally entered the Southern Seas in 1719 after a fierce storm diverted his ship away from its charted course around the tip of South America. One hundred years later, the British *Williams*, piloted by 28-year-old William Smith, first sighted Desolation Island in 1819 and the Antarctic Peninsula in 1820. That same year, Fabian Gottlieb von Bellingshausen, commander of two Russian ships, the *Vostok* and the *Mirnyi*, apparently became the first to set eyes on Antarctic ice shelves, recording a "solid stretch of ice running from east through south to west" (Mulvaney 85) a mere three days before Smith arrived at the Peninsula. It was later that same year that American Nathaniel Palmer arrived in Hughes Bay.

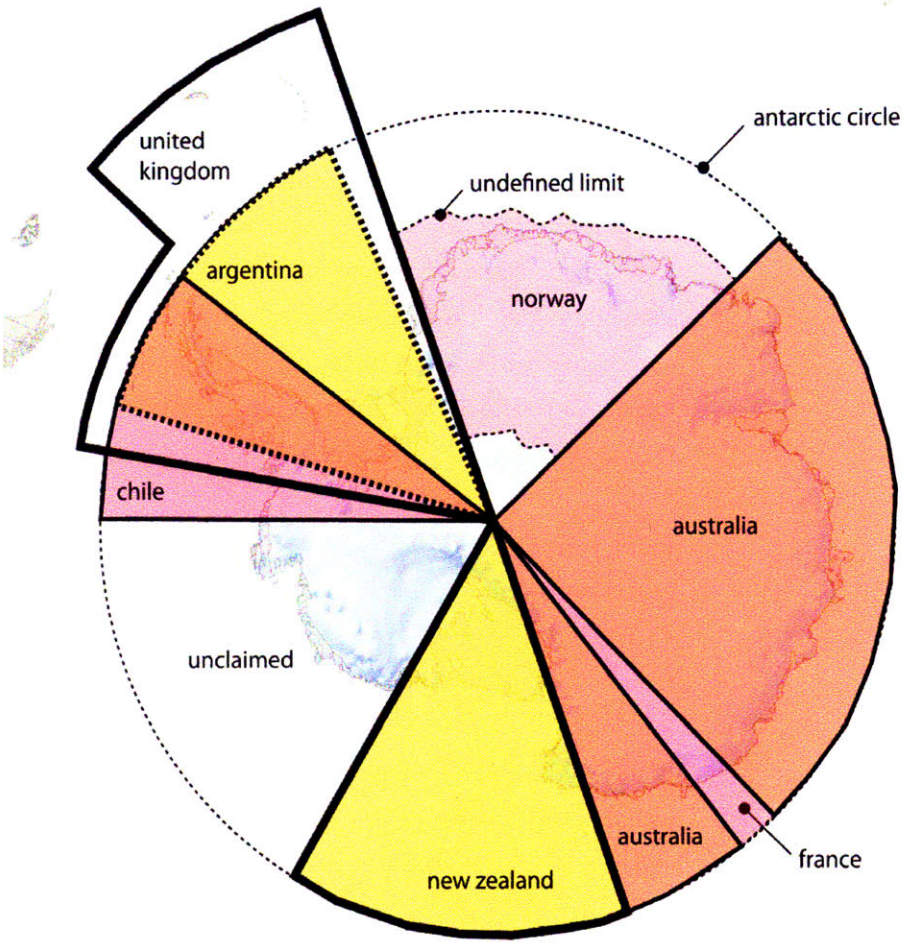
These early accounts provide a general impression of Antarctica as a hostile, frigid and relentless place. Frederick A. Cook, one of the first humans to experience an Antarctic winter writes in 1900: "Nature frowns upon us and refuses to reward our dearly-bought venture. She guards the mysteries of the frozen south with much jealousy... as if to say, 'you can look, but you must not enter.'"[4] Nevertheless, Cook also describes the prevailing (European) drive to conquer this unyielding land; arguing that the battle over nature "should be fought, though it promises to be the fiercest of all human engagements. Science demands it, modern progress calls for it, for in this age a blank upon our chart is a blur upon our prided enlightenment."[5] The diverse backgrounds of Antarctica's early explorers are evidence of what was, even then, an international desire to map and claim the territory.

The British *Discovery* expedition was based on Ross Island from 1901 to 1904; a French expedition was the first to map the Antarctic Peninsula in 1903; a Norwegian led the first successful expedition to the South Pole, reaching their destination in 1911; 1912 saw expeditions from Japan, Germany, Australia, and New Zealand. The first man to fly over the South Pole (in 1929) was an American.[6] This multi-national cast of characters was responsible for a profusion of territorial claims, made in the names of their respective governments. Amundsen's team, for example, celebrated their 1911 arrival at the South Pole with the placement of a Norwegian flag.

These early expeditions also saw the beginnings of Antarctic science. For example, Scott's 1910-13 *Terra Nova* expedition produced not only a tragic story of mythic proportions, but also six volumes of observed geologic & biologic phenomena, meteorological happenings, and planetary magnetic field data. Considering the tragic end to his expedition, Scott received significant posthumous criticism for collecting nearly 35 lbs. of rock specimens on his trudge back from the pole. This early science was, according to some, "subordinated to the language of conquest;" for early explorers, who "were battling against a hostile nature in the Antarctic,"[7] understanding this enemy was their only hope.

4 Cook, Frederick A. "Into the Night." *The Ends of the Earth: an Anthology of the Finest Writing on the Antarctic*. Ed. Francis Spufford. New York: Bloomsbury, 2007. Page 13.
5 Cook 14.
6 Richard Byrd's flight is often cited as marking the beginning of a new "Mechanical" age of Antarctic exploration.
7 Spufford 6.

Pre-WWII Territorial Claims to the Antarctic



Early Territorial Claims & Cold War Complications

Citing the discoveries made during a series of English expeditions, Britain made the first formal Antarctic land claim in 1908. This claim included all land (and islands) south of 50°S, between 20°W and 80°W, with the exclusion of the Southern parts of Chile and Argentina that fall within those boundaries.[8]

As early as 1920, Britain made its desire to enlarge its Antarctic holdings public knowledge. Leopold Amery, British under-secretary of state for colonies issued a memorandum to Australian and New Zealand governors stating: "every inhabited land in the direction of the Antarctic regions is already British... it is desirable that the whole of the Antarctic should ultimately be included in the British Empire."[9] In response, the governor-general of New Zealand claimed for his country what would henceforth be known as the Ross Dependency, the territory south of 60°S, between 160°E and 150°W longitude.

8 The exclusion of Chilean and Argentine territory was actually not originally accounted for in Britain's 1908 claim, but their claim was amended in 1917 to avoid a potentially embarrassing and unpopular political situation.

9 This quote was reproduced in Mulvaney, Kieran. *At the Ends of the Earth: A History of the Polar Regions.* Washington: Island Press, 2001. Page 124.

These early claims were a product more of abstract cartography than detailed exploration; they made no reference to geographic features, only projected latitudinal and longitudinal boundaries. Future claimants would also define their respective territories with longitudinal boundaries to the east and west. Given the convergence of these abstract cartographic lines, all Antarctic land claims share the bizarre feature of coming to a point at the South Pole. This prioritizing of rational science over geography is highlighted by writer Jenny Diski, who called Antarctica "not a place, though it was a position on a navigation chart."[10] Roald Amundsen's 1912 expedition notes also attest to the particular abstractness of the Pole. After days of arduously traversing South across a seemingly endless and featureless ice plateau, one sled driver ultimately yelled "Halt!" upon seeing a reading of 90°S on his sledge-meter.[11]

In the years following Britain and New Zealand's abstract claims, three other European governments followed suit. Australia claimed 2.4 million square miles between 160°E and 45°E (representing 40% of the continent) as the Australian Antarctic Territory (AAT). France held onto a small pie-shaped sliver which they named Terre Adélie. Norway, not wanting to be excluded from future whaling opportunities, had already claimed Bouvet Island and in 1939 with the support of the Nazi party,[12] they expanded their holdings to include a large area west of the AAT. Shortly after, (in 1940 and 1943, respectively) Chile and Argentina, presumably eager to prevent a European take-over of the continent, made especially visible claims to Antarctic territories. Unlike the previous claims by Britain, New Zealand, France, Australia, and Norway, Chile's and Argentina's claims overlapped -- with each others' claims, as well as with Britain's. These conflicting claims led to a series of minor British and Argentine military actions that continued up until the Falklands conflict in 1982.[13]

Although the United States government had not made any formal territorial claims as of WWII, it had overseen a fairly consistent American presence on the continent. The U.S. had launched its first official voyage to Antarctica in the 1830s, during which nearly 1,600 miles of coastline was surveyed. Later, Byrd's successful Antarctic flight over what he named Marie Byrd Land (after his wife) would be the precursor to a second major, nationally-funded American Antarctic expedition. Championed by Franklin Delano

10 Diski, Jenny. "Cabin 532." *The Ends of the Earth: an Anthology of the Finest Writing on the Antarctic.* Ed. Francis Spufford. New York: Bloomsbury, 2007. Page 171.

11 Amundsen, Roald. "Topsy-Turvy," an excerpt from The South Pole (1912). Reprinted in *The Ends of the Earth: an Anthology of the Finest Writing on the Antarctic.* Ed. Francis Spufford. New York: Bloomsbury, 2007.

12 The Nazi party expressed significant interest in Antarctica. During a 1939 hydroplane expedition, 5-ft long aluminum darts engraved with swastikas had been dropped over territory (in Queen Maud Land) that they intended to claim. Also, 1944 British expedition Operation Tabarin, was apparently, motivated in part by mounting concern over Nazi use of Antarctic islands for refueling German warships (Mulvaney 127-9). For more on Nazi Polar activity see Christof Friedrich's *Secret Nazi Polar Expeditions.*

13 Mulvaney 129.

Roosevelt, the goal of this United States Antarctic Service voyage was to take steps towards what would be the first permanent year-round settlement of Antarctica. Shortly after WWII, The U.S. Operation High Jump became the most extensive expedition ever to visit the continent – 13 ships carrying 4,700 people, 8 seaplanes, 6 R4D transport planes, 6 helicopters, 8 Army amphibian cargo carriers, 10 Caterpillar tractors, and various other over land vehicles scoured the ice.[14] The majority of that expedition's effort was directed towards the exploration and documentation of Marie Byrd Land, a region extending west from the Antarctic Peninsula to the Ross Sea. Not coincidentally, this region was the only remaining unclaimed portion of the continent. There is little doubt that Operation High Jump was seen as a means of increasing the basis for a U.S. claim to Antarctic territory. A U.S. Department of State memorandum plainly declared their intention to "consolidate United States sovereignty over the largest practicable area of the Antarctic continent."[15] Some have speculated that the U.S. interest in Antarctica was motivated, at least in part, by a desire to use polar territories for military training in anticipation of potential Arctic battles against the USSR.[16]

Surprisingly, The United States never made a formal claim to any part of Antarctica. Kieran Mulvaney, author of *At the Ends of the Earth: A History of the Polar Regions*, surmises that "the view steadily evolved in Washington that the country's desired aims [i.e. control over the largest practicable area possible] could be achieved just as easily, or even more so, without claiming territory."[17] The United States had yet to recognize any Antarctic claims, arguing that a valid claim of sovereignty depended on continuous settlement, not just discovery. At this point, any US claim would implicitly substantiate all claims previously made by other governments. Instead, Mulvaney explains that "by not playing that game, the United States would be free to operate wherever it wanted in Antarctica."[18] Despite increasing evidence of Soviet interest in the continent, the USSR followed the U.S. government's lead, not making any formal territorial claims.

Meanwhile, the early 1950s saw the first wave of Antarctic construction; as of 1952, there were five research bases in operation. Argentina had built three year-round facilities: Orcadas, San Martin, and Esperanza; Chile had constructed its first base, Arturo Prat as a seasonal facility, and then built a year-round facility, O'Higgins, the following year; Britain was operating one seasonal base, Signy.[19] It is not a coincidence that all of these early facilities were constructed by the three nations with overlapping territorial claims. In fact, the Chilean and Argentine governments were even beginning to experiment with

14 Mulvaney 134.
15 Mulvaney 136.
16 Mulvaney 136.
17 Mulvaney 135.
18 Mulvaney 136.
19 COMNAP website

permanent Antarctic settlement by encouraging their citizens to live at scientific research bases for periods of several years.[20] This was the beginning of the use of architecture as an assertion of power in Antarctic politics.

The IGY (and the importance of Architecture)

In the early part of the 19th century, Alexander von Humboldt managed to persuade both British and Russian governments to establish scientific research bases all over the world in order to study geomagnetism. His efforts, a surprisingly successful example of early international scientific collaboration, lead to the first International Polar Year in 1882.[21] A second Polar Year was held 50 years later, in 1932-33, focusing almost exclusively on the Arctic. Breaking the 50 year pattern, physicist James Van Allen and Lloyd Berkner, a developer of early radar technologies, campaigned to have a third International Polar Year scheduled for 1957-58, in order to take advantage of a periodic solar phenomenon; that year, the sun would approach its solar maximum, meaning heightened electromagnetic levels, increased sunspots, and abnormally brilliant displays of northern and southern lights. The idea grew in popularity, appealing to the International Council of Scientific Unions, the World Meteorological Organization, and non-Polar scientists the world over. Thus, the plans for an International Polar Year were transformed into those for an International Geophysical Year (IGY) that would focus on two relatively uncharted realms of modern science: outer space, and Antarctica.

The IGY, touted as a brilliant example of scientific cooperation in the face of Cold War political tensions, might have been the most complex international scientific activity ever undertaken. Thousands of researchers embarked on thousands of studies, funded by dozens of countries. Much of the research transpired at fifty different Antarctic research facilities, the majority of which were constructed in anticipation of the IGY. These stations were built and operated by 12 national governments: seven had made land claims: Britain, New Zealand, France, Australia, Norway, Chile, Argentina; and five had not: the US, The USSR, South Africa, Belgium, and Japan.

Antarctic research findings were shared across national lines, prompting at least one historian to argue that "scientists of the world were better ambassadors for peace than the politicians."[22] Data collected during the IGY advanced knowledge in the fields of meteorology, atmospheric radiation, auroral physics, geomagnetism, geology, glaciology, geomorphology, cartography, seismology, volcanology, oceanography, biology, and marine biology. An international organization, the Scientific Committee on Antarctic Research was formed in 1958 to oversee the pooling of research findings and to ease scientific cooperation across national boundaries.[23] However, perhaps the most important

20 Suter 4.
21 Suter 17.
22 Suter 17.
23 Suter 19.

artifact to emerge from the IGY, at least in geopolitical terms, was a proposal for what was to become the 1961 Antarctic Treaty.

Without a doubt, the IGY and its associated international scientific cooperation had a major positive effect on Antarctic politics in the following decade. However, it would be naïve to overlook the political motivations of the nations involved, particularly those of the US and the USSR. Mulvaney writes: "the Kremlin welcomed the IGY as an opportunity to become involved in Antarctica without having to endure hostility from other interested nations." Similarly, the Eisenhower administration dedicated vast amounts of money and resources to the construction of several new facilities. In addition to promoting science, these facilities reinforced the US presence in the Antarctic.[24] The most notable of these facilities was the Amundsen-Scott Station, symbolically located at the South Pole. The construction of this station is a particularly salient example of how political maneuverings were overshadowed by the public rhetoric of scientific research. At a 1955 IGY planning meeting in Paris, when the USSR announced their plans to build a station at the South Pole, committee chairman Georges Laclavére countered that the US had already begun working at that site, and that, since all resources would be shared, two bases there would be repetitive. However, it wasn't until the following year that the Eisenhower administration agreed to allocate funds for the project.[25] Construction of the Amundsen-Scott South Pole Station began in 1956, under the direction of Navy Admiral George Dufek, who also happened to be the tactical leader of the US Navy's "Operation Deepfreeze." Thus, in the name of research and cooperation, and with the blessing of the international scientific community, the US government built a building at the Pole and occupied the Southern end of the earth with American armed forces.[26]

The Antarctic Treaty

Riding on the public relations coattails of the IGY's international scientific cooperation, the US initiated talks with the twelve nations (Argentina, Australia, Belgium, Chile, France, Japan, New Zealand, Norway, South Africa, the UK, the US, and the USSR) that had built facilities during the IGY, suggesting that they collectively formulate a treaty regarding the continent's governance. Less than two years later (October 15, 1959), representatives from the twelve countries met in Washington D.C. and produced a the Antarctic Treaty; by June of 1961, it had been ratified by all participating members.

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24 Mulvaney 140. In fact, the planned number of US facilities was increased from 9 to 18, as a result of increased Soviet involvement in the IGY (Suter 18)

25 Mulvaney 140.

26 The military occupation of Antarctica was supported by anti-communist propaganda back in the US. For example, a 1959 article in *Missile and Rockets* published the following sentiment: "At the frozen bottom of the earth Russia is moving into a position from which its missile squadrons could outflank the free world. Half of Antarctica is rapidly turning from white to red..." (Mulvaney 143).

The primary aim of the Treaty, as stated in the preamble, is to ensure "in the interest of all mankind that Antarctica shall continue forever to be used exclusively for peaceful purposes and shall not become the scene or object of international discord."[27] In order to achieve this goal, the treaty prohibits nuclear explosions, weapons testing, the disposal of radioactive waste, and any military activity that is not in support of science. The treaty cites the IGY specifically; Article II states that the "scientific investigation in Antarctica and cooperation toward that end, as applied during the International Geophysical Year, shall continue."[28]

However, perhaps the most ingenious provision is included in Article IV, and deals with the continent's disputed territorial claims. Section 2 reads: "No acts or activities taking place while the present Treaty is in force shall constitute a basis for asserting, supporting or denying a claim to territorial sovereignty in Antarctica. No new claim, or enlargement of an existing claim, to territorial sovereignty shall be asserted while the present Treaty is in force."[29] Instead of resolving the conflicting claims to Antarctic territory, the treaty effectively postponed this debate until some unspecified time in the future. The seven land claimants were assured that their claims would remain in tact, but in the mean time, the national governments of the 12 Consultative parties were granted "complete freedom of access at any time to any or all areas of Antarctica."[30] The only limitations to speak of were that all information concerning research facilities and planned expeditions had to be made public (to the other Consultative nations), and the behavior of individuals in Antarctica would fall under the jurisdiction(s) of their respective national governments.

It perhaps goes without saying that the Treaty places no restrictions on non-signatory countries or individuals from those countries. It does, however, state that additional nations could attain Consultative status, but in order to do so they had to demonstrate "significant interest" in Antarctica by "conducting substantial scientific research activity there, such as the establishment of a scientific station."[31] In this way, the Treaty codified what had become an Antarctic tradition of declaring/obtaining sovereignty through building. It also, perhaps more pragmatically, drastically limited the number of nations that could participate in the management of Antarctica to those who could afford the enormous costs of building there. This Global Commons was available to any national government, but for a price.

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27 National Science Foundation Office of Polar Programs (OPP) website. www.nsf.gov/od/opp/antarct/anttrty.jsp

28 www.nsf.gov/od/opp/antarct/anttrty.jsp

29 www.nsf.gov/od/opp/antarct/anttrty.jsp

30 This right of access is specified in the context of a freedom to observe and inspect any facilities present on the continent, in order to confirm that they are in accordance with the peaceful and scientific aims of the treaty.

31 Article IX, Section 2. The granting of consultative status is overseen by the current group of Consultative parties.

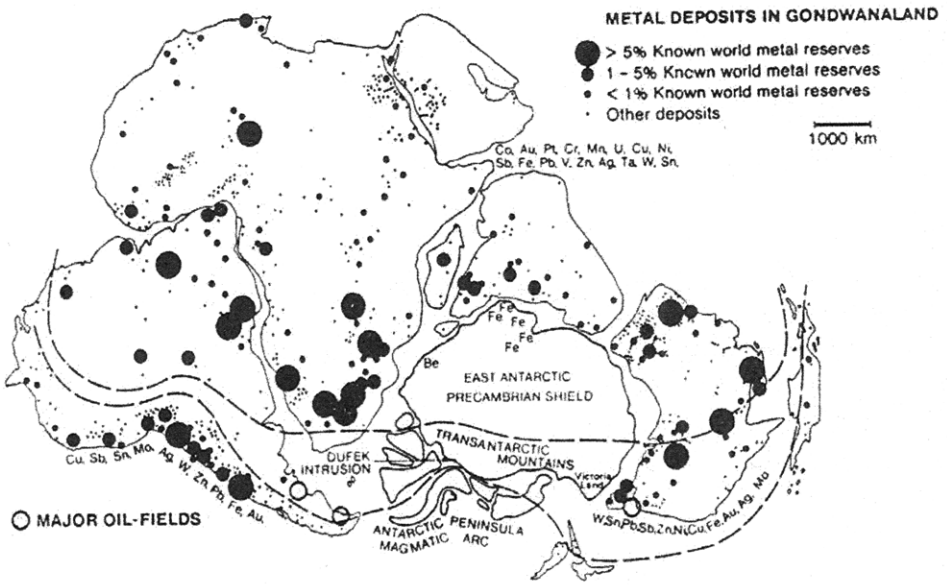
The Antarctic Treaty is often touted (at least in International Law literature) as an innovative and successful example of international cooperation. John Vogler, for example, calls it "the closest thing to a 'world order miracle' that the world has known."[32] The Treaty has been praised both for its radical vision of peace, as well as for its pragmatic nod to national self interests. Clive H. Schofield emphasizes the Treaty's innovation, writing that the management of Antarctica "is welcome evidence that there are alternatives to territorial conflict operating successfully in the modern world."[33] Also praising the Treaty's radical vision, Peter J. Beck notes that the Antarctic Treaty was the first post-WWII demilitarization agreement that concerned a large geographic region; he argues that this paved the way for other demarcations of nuclear weapon-free zones.[34] Emphasizing, instead, the pragmatism of the Treaty, Vogler recognizes the success with which the Treaty preferences the sovereignty of individual states. He says that the managerial system works "precisely because decision-making is in the hands of a restricted group of states ... which have a direct stake in and control over the issues."[35] Christopher C. Joyner generalizes this idea, arguing that "national governments implement and comply with international rules and norms because such behavior is perceived to enhance their national interests."[36] The tension between these two main ideas -- the vision of an internationally managed territory, and the reality of state control over that territory -- would be explored further in the post-1961 conceptualization of Antarctica as a Global Commons.

The Global Commons: From Resource to Responsibility

In the decade following the signing of the 1961 Treaty, Antarctica became the source of increasing international attention. Antarctica had been set aside as a Global Commons, but there was considerable debate over what this should mean. Should Antarctica be viewed as a *res nullis*, the property of no one, or a *terra communis*, a resource shared by the world? And less ideologically speaking, regardless of the positive rhetoric of the 1961 Treaty, why should 12 nations possess the right to determine the future of a global common land? These two questions unfolded into a debate that reflected several contemporary themes of international politics: colonialism, the benefiting of the industrialized world at the expense of developing nations, and the ideological battle over exploitation vs. conservation of resources.[37] This heated debate was fueled by evidence of large mineral deposits on the Antarctic continent.

32 Vogler quoting Falk, 78.
33 Specifically, "alternatives to the partitioning of territory between states." Schofield xvi-xvii.
34 Beck, Peter J. "Antarctica: The Antarctic Treaty System after thirty years." World Boundaries – *Volume 1*. Ed. Schofield Clive H. New York: Routledge, 1994. Page 85.)
35 Vogler 81.
36 Joyner 356.
37 Suter 1.

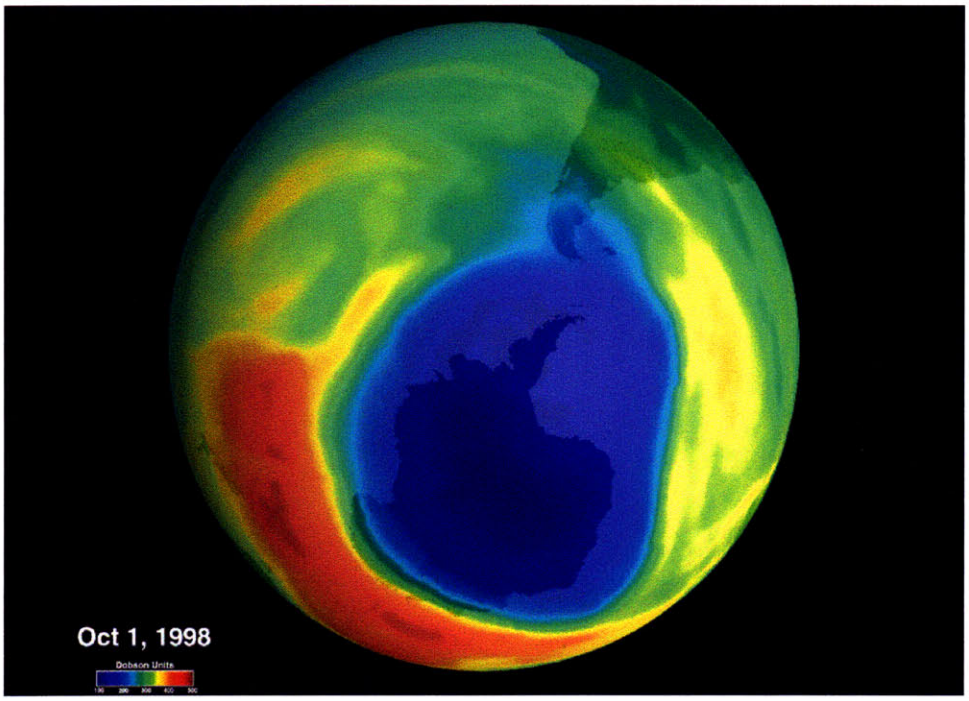
Global Commons as Resource



According to the then-emerging science of plate tectonics, Antarctica was once part of the major Gondwana landmass, along with India, Madagascar, Africa, Australia, New Zealand, and South America.[38] Given this, scientists began to wonder if Antarctica shared certain geological traits, such as mineral riches, with some of its former Gondwanan neighbors. Speculation was augmented by a US Geological Survey that estimated the presence of 45 billion barrels of oil and 115 trillion cubic feet of natural gas beneath the Ross, Weddell, and Bellingshausen Seas; (the USGS later emphasized that these numbers were *estimates.*[39]) Nonetheless, the potential riches (especially in a time of insecure world oil supply) put a new spin on Antarctica's frozen territorial claims. It was, apparently, one thing to temporarily[40] set aside claims to a far-away land with no perceived value; it was a very different thing to do so when there was money to be made. The minerals debate also prompted smaller countries to refute the right of the "Antarctic Club"[41] to profit from what should belong to everyone. A precursor of things to come, Arvid Pardo, Malta's Ambassador to the UN, argued to the general assembly in 1967 that the sea bed, another Global Commons, ought to be regarded as a Common Heritage of Humankind. According to Pardo, this shared heritage must be internationally regulated, preferably by the UN, not parsed off to individual nations who would exploit it as they saw fit.[42]

38 Gondwana and Laurasia (the landmass that fragmented into North America and Eurasia) were created when Pangaea split into Northern and Southern portions.
39 Mulvaney 149.
40 The treaty had an intended lifespan of 30 years.
41 Suter 69.
42 Suter 70.

Global Commons as Responsibility

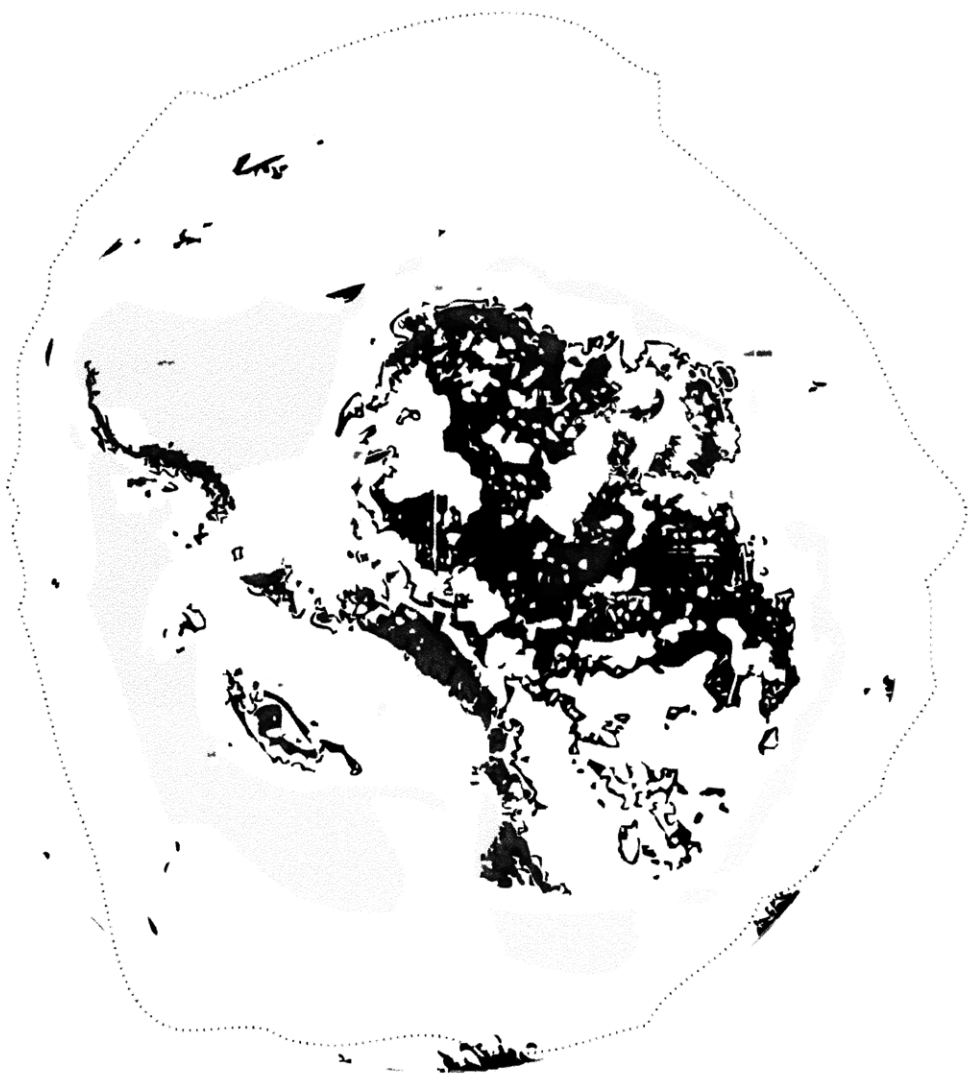


While a resource debate was unfolding at more moderate latitudes, Polar scientists were noticing Antarctica's perilous and critical role in global climatic and atmospheric systems. Shortly after Sherwood Rowland and Mario Molina's 1974 announcement of the danger of chlorofluorocarbons, researchers at the British Antarctic Survey base at Halley Bay discovered a "hole" in the ozone layer above Antarctica.[43] Scientists discovered that the extreme cold of the Antarctic winter, augmented by circumpolar winds at atmospheric altitudes, produced the perfect (or rather, worst possible) conditions for CFC-induced ozone depletion.[44] World CFC pollution was effectively being registered above Antarctica, providing proof of the planet's interconnected atmospheric systems. This deteriorating ozone layer initiated the implementation of policy changes, but it also inspired a change in many people's perception of the Antarctic continent. Instead of the early 20th century explorers' hostile, foreboding frontier, scientists in the 1970s and 80s saw a precarious ecosystem in need of protection. This changing perception of Antarctica was furthered even more by the development of the new theory of global warming.

Antarctica plays a disproportionately large role in the climate change debate; it offers an unsurpassed registration of historical climatic data, but it also suffers certain effects of climate change that are quite exaggerated compared to other parts of the globe. Antarctica's several mile thick ice sheet holds a valuable archive of hundreds of thousands of years of varying atmospheric conditions. Scientists like Stephen Schneider (a US specialist in

43 The "hole" was actually a seasonal waning in stratospheric ozone levels – ranging from a 35% reduction in some places to a near 90% depletion in others – that emerged in the austral spring, partially repaired itself over the late summer, but nevertheless appeared again the following spring.
44 Mulvaney 223.

Receding Sea Ice &
Antarctic Landmass



climatology,) extol the value of ice core samples, such as those extracted at the Russian Vostok Station, that have helped scientists to construct a 160,000 year record of carbon (and other greenhouse gas) levels in the atmosphere.[45] Scientists measuring Antarctic temperatures have recorded an average annual increase of 3-4°F (and 7-9°F in winter), a much more substantial increase than elsewhere on the globe.[46] These rising temperatures not only threaten Antarctic wildlife, but inspire fear of negative ramifications for the rest of the world. In 1990s, the Larsen-A Ice Shelf (a mass of ice roughly the size of Luxembourg) broke off from the rest of James Ross Island; the Larson-B Ice Shelf calved a 650 square mile chunk; and the Wilkins Ice Shelf retreated 22 miles (representing thousands of square miles of ice lost). These melting ice shelves (contrary to popular lore) do not actually contribute to a rise in sea levels because they are already floating. However, their melting frightens scientists who envision scenarios where temperatures could increase enough to melt ice shelves such as the Ross or Ronne-Filchner, that

45 Suter 122.
46 Mulvaney 227.

currently sit atop Antarctica's rocky landmass. These shelves effectively serve as damns for inter-continental ice streams; if they were to melt, scientist say this could contribute to a collapse of the entire West Antarctic Ice Sheet, leading to a worse-case-scenario of a 13-20 ft. rise in global sea levels.[47] Although this scenario is far worse than anything predicted by the IPCC (Intergovernmental Panel on Climate Change) it, and other dire predictions offered "proof" that Antarctica was not just an ecosystem in peril, it was a global liability. Keith Suter summed up this paradigm shift, writing that "protecting Antarctica is no longer just a... matter of human self-interest. Potential rising sea-levels and a hole in the ozone layer mean that protecting the Antarctic equals protecting ourselves."[48]

Antarctica's emerging identity as a place that the world had a responsibility to *save* (as opposed to a place that the world had an opportunity to *conquer*) was cemented by two key documents, both of which became critical texts of the environmental movement. These documents were Garret Hardin's 1977 essay "The Tragedy of the Commons," and the 1987 report, *Our Common Future,* published by the UN World Commission on Environment and Development.

"The Tragedy of the Commons"

Hardin's essay addresses the problem of the commons in general. Challenging Adam Smith's "invisible hand" concept articulated in *The Wealth of Nations,* Hardin argues that society cannot trust individuals to promote the interest of the public.[49] In his much cited "Tragedy of the Commons," he makes his point using the metaphor of a common pasture where herdsmen freely graze their cattle. Hardin explains that up to point, this commons arrangement works fine. However, the herdsman, "as a rational being" inevitably "seeks to maximize his gain."[50] Each herdsman grazes more and more cattle in the common pasture in order to take advantage of free resources and to prevent his competition (other herdsman) from using those resources. There inevitably comes a point when the number of cattle exceeds the land's capacity to support those cattle and tragedy ensues. In the end, Hardin states, "Freedom in a commons brings ruin to all."[51] With regards to Antarctica, Hardin's argument was often cited in support of increased regulation. Joyner, for example, discussed the need for "regimes" that could oversee the "sustainable management" of the global commons.[52]

47 Mulvaney 229.

48 Suter 7.

49 Hardin, Garrett. "The Tragedy of the Commons." *Managing the Commons.* Ed. Garrett Hardin and John Baden. San Francisco: W.H. Freeman and Company: 1977. Page 19.

50 Hardin 20.

51 Hardin 20.

52 Joyner 357. Hardin might not agree with this interpretation, however. Later on in his essay, he writes about the logistical difficulty of managing the commons. He explains that while prohibition of access can be legislated (though not always enforced) successful management of the commons requires legislating "temperance" which is much more difficult. Hardin notes that there is often no watchdog mechanism to prevent corruption among the people who issue regulations concerning the commons; Hardin asks: "who shall watch the watchers themselves (23)?" However, it is not surprising that the latter half of Hardin's essay is seldom referenced, considering that he blames the problem of the commons on overpopulation. Hardin

According to the environmental movement, Antarctica's minimal regulation was bound to be disastrous.

Our Common Future

The second important document contributing to Antarctica's new image was *Our Common Future*, also known as the Brundtland Report. This document was the outcome of a UN independent commission, chaired by Gro Harlem Brundtland, that had been formed to investigate long-term strategies for global environmental sustainability. The report defined a mindset of sustainable development[53] and articulated an associated plan for managing the Global Commons.[54] The report outlined some of the controversies surrounding Antarctica, including the question of mining and the elitism of the consultative party system, but it also emphasized the achievement of the Antarctic Treaty in terms of setting an example of "peace, science, [and] conservation;" this was a "foundation," the report states, "on which humanity must build.[55] Suddenly, the management of Antarctica became a metaphor for the larger issue of how the world dealt with resources and development. The Brundtland Report emphasized how, in 1961, Antarctica was upheld as an example of peace and international cooperation; now, thirty years later, it could become a symbol of environmentalism. In order for Antarctica to be "managed in the interests of all humankind," its "unique environment" had to be conserved.[56] *Our Common Future* conflated what *had* happened in Antarctica (science and de-militarization) with what *could* happen in Antarctica (conservation), requisitioning the continent as part of a larger mission of sustainability. If there was one moment when the rhetoric of the debate over Antarctica changed -- from peace to preservation -- this was it.

The 1980s

The call for environmental protection of Antarctica was not completely new; after all, India had presented a memorandum to the UN General Assembly way back in 1956 that called for all nations to "ensure that no activities in Antarctica [would] adversely affect climatic and other natural conditions."[57] However, the environmental agenda gained momentum in the 1980s, providing grist for the mill in a growing third-world criticism of the elitism of the "Antarctic Club."[58] Once again, increased political debate was followed by the construction of more Antarctic facilities. In 1981, Indira Gandhi initiated the top secret-classified Operation Gangotri mission that sent 21 Indian scientists to Antarctica[59]

argues for increased regulation not of land use, but of reproduction. He writes: "[the] freedom to breed is intolerable...the only way we can preserve and nurture other and more precious freedoms is by relinquishing the freedom to breed...injustice is preferable to total ruin" (23).

53 According to the report, sustainable development "meets the needs of the present without compromising the ability of future generations to meet their own needs."

54 *Our Common Future* addresses the high seas and the geosynchronous orbit in addition to Antarctica.

55 See Chapter 10, Section III, Sub-section 1, "Guard Present Achievements."
The entire text of *Our Common Future* can be found at habitat.igc.org/open-gates/ocf-10.htm

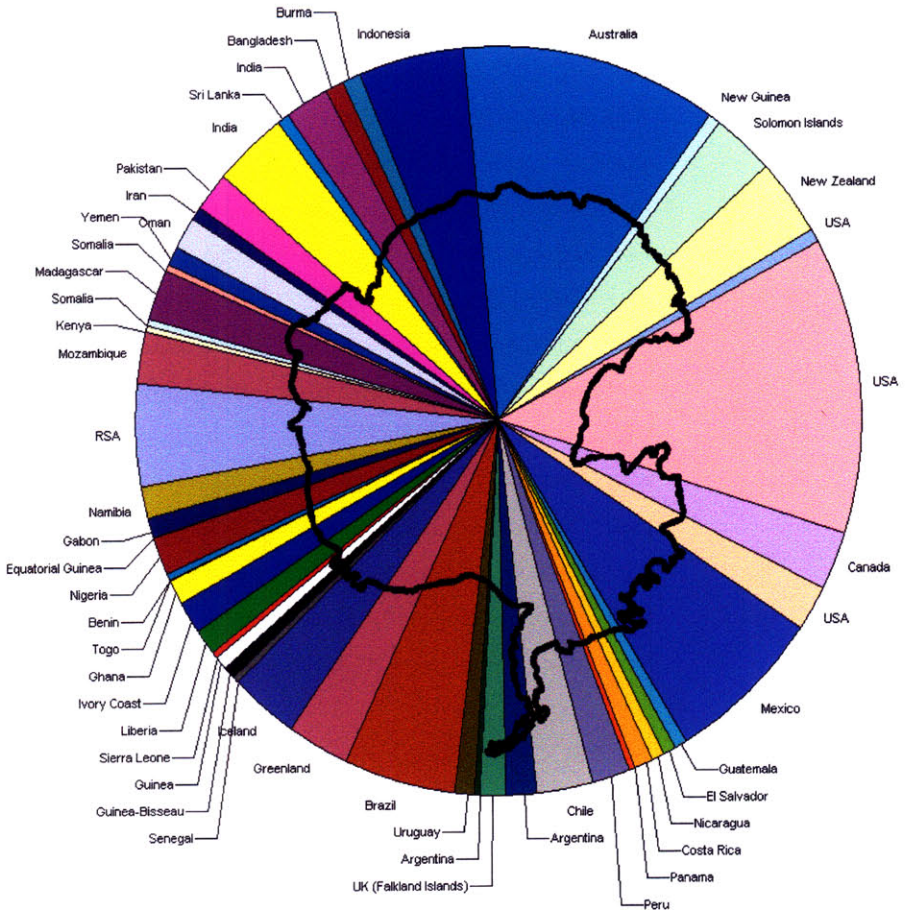
56 See Chapter 10, Introduction to Section III.

57 Suter 74.

58 Referring to the small number of Consultative Party nations. Suter 69.

59 Slightly under-prepared for Polar travel, the Indian government charted a ship, the Polar Circle, from the Norwegian government.

A "more egalitarian" proposal for division of territory based on projected frontage.



to study the effect of extreme climatic conditions on Indian seasonal monsoons. Soon after, India established a permanently-staffed research facility, asserting the right of non-Consultative party states to the secluded continent.[60] A few years earlier, Germany had attained Consultative status after constructing a facility, but no developing country had ever attempted to gain political sovereignty in Antarctica. India's efforts were supported by Malaysian prime minister, Dr Mahathir Bin Mohamad, who (in his 1982 address to the UN General Assembly) likened the Consultative parties' control over Antarctica to colonialism, proclaiming "the days when the rich nations of the world can take for themselves whatever territory and resources that they have access to are over."[61] Considering the ensuing stir, it was probably not coincidental that both India and Brazil, developing countries (with GDPs substantially large to establish the requisite scientific presence) were invited to join the ranks of the Consultative parties just a few months after Mohamad's impassioned speech. After some dispute, India accepted, acquiring formalized decision making power over Antarctica, but at the expense of agreeing to uphold the Antarctic Treaty System. The possibility of turning over Antarctica to the UN, (a suggestion popular among developing nations at the time) was officially dismissed.

60 Suter 74.
61 Suter 77.

After tensions between developed and developing countries had (temporarily) abated, the environmental debate over Antarctica came to a head in the late 1980s, when Consultative parties drafted legislation to regulate Antarctic mining. CRAMRA, (Convention on the Regulation of Antarctic Mineral Resource Activities), pledged that "no Antarctic mineral resource activity shall take place until it is judged ... that the activity in question would not cause damage to Antarctica's environment and global weather patterns."[62] A glaring omission was the proposal's failure to address who would judge the potential for "damage" and by what means. Environmentalists the world over, organized via the Antarctic and Southern Ocean Coalition (ASOC),[63] responded to the CRAMRA by declaring a much more radical notion, namely that mining should be banned and Antarctica should be declared a "World Park."[64] While this argument was an environmental one at heart, it also re-addressed the issue of Antarctic sovereignty. Given the environmental resource at stake (the *last remaining* pristine wilderness), the ASOC argued that the Antarctic Global Commons should not remain "nation-state property" but rather, should become "the property of humankind."[65] The title of Keith Suter's early 1990s book sums up this debate quite succinctly; it is called *Antarctica: Private Property or Public Heritage?*

The ASOC's World Park proposal gained support from visible international personalities such as Jacques Cousteau, Sir Peter Scott (Robert Falcon Scott's son), and Al Gore. However, when this support had no effect on the Consultative parties' attitudes towards CRAMRA, the ASOC decided that desperate times called for desperate measures. The future of Antarctica was in the hands of the Consultative party states and the 1961 Treaty stated that Consultative status was open to those who demonstrated an ongoing presence in Antarctica (by building a facility there). Greenpeace, a member organization of the ASOC, decided to try beat the Consultative parties at their own game by going to Antarctica, building a permanent base there, and then demanding access to Consultative party meetings. Whether or not they ever achieved a seat at the Antarctic Club table, Greenpeace assumed they could at least focus public attention on the continent.

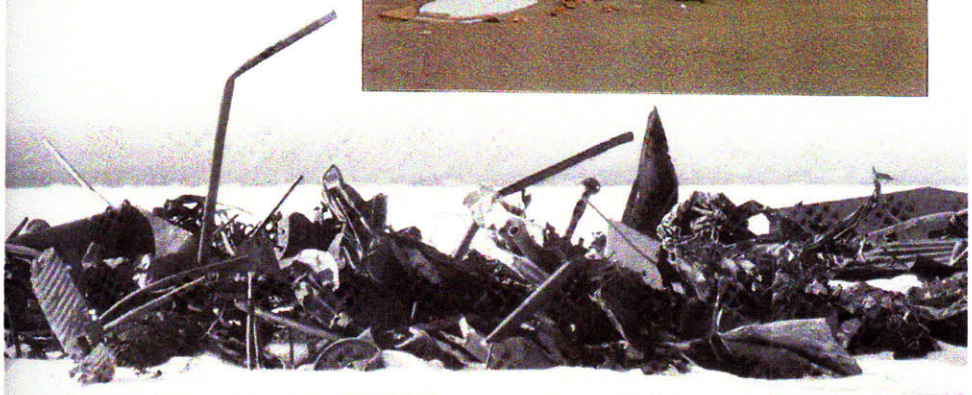
According to the Greenpeace website, "The task was a daunting one. No non-governmental organization had ever set up a base in Antarctica ... countries that already had bases in the region were unanimously hostile to the idea ... their antagonism ... masked their reluctance to encourage outside scrutiny."[66] After one failed attempt, in 1986 the *Greenpeace* sailed from New Zealand carrying a pre-fabricated facility and 4

62 Suter 56.
63 Founded by Washington DC attorney Jim Barnes.
64 This idea was first officially proposed by New Zealand in 1975 at a meeting of Consultative Parties, but found little support. Source: "World Park Antarctica" on Greenpeace website. www.greenpeace.org/international/about/history/how-we-saved-antarctica
65 Schofield 105.
66 "World Park Antarctica." On www.greenpeace.org/international/about/history/how-we-saved-antarctica

volunteers, a mechanic, a radio operator, a scientist, and a doctor; the "World Park Base" they established was fully operational by January of 1987. Greenpeace intended "World Park Base" to be a "model for good ecological practice," an early example of sustainable architecture. Evidence of their low-impact building philosophy was demonstrated four years later, when activists made a political statement out of dismantling their Antarctic base and leaving the continent without a trace.[67] During Greenpeace's four year stint on the ice, volunteers took it upon themselves to become Antarctica's on-sight environmental watchdogs. Taking full advantage of Article VII, which guarantees free access to Antarctic facilities for the purpose of inspection, volunteers documented shocking instances of pollution and questionable waste-disposal practices at several scientific facilities. Some of their photographs were published in *The Greenpeace Book of Antarctica: A new view of the seventh continent.*[68] Greenpeace never did receive Consultative party status, but their highly publicized efforts ("World Park" has been called the "most expensive environmental protest ever mounted"[69]) contributed to CRAMRA's failure to receive the required (unanimous) support from Consultative party nations. Christopher Joyner calls Greenpeace's role in preventing the signing of the Antarctic minerals treaty "enormous," explaining how their high profile public campaign generated a sense of civic responsibility toward Antarctica.[70]

67 Cross, Michael. "Greenpeace to leave Antarctica without a trace." *New Scientist* 20 April 1991.
68 May, John. *The Greenpeace Book of Antarctica: A new view of the seventh continent*, with a foreword by Sir Peter Scott. London: Dorling Kindersley Limited, 1988.
69 Cross.
70 Joyner 377. A particularly visible scandal – during which French officials forcibly removed 15 Greenpeace volunteers who were protesting the construction of a new airstrip that required dynamiting nesting penguin habitats (a controversial idea even among French scientists) – may have contributed to France's early refusal to sign CRAMRA. Australia's early refusal to sign CRAMRA is also noteworthy. The Australian government's distaste for Antarctic mining was surmised by then-prime minister Bob Hawke: "Minerals Convention is basically flawed. It is based on the clearly incorrect assumption – current in the 1970s – that

A Page from *The Greenpeace Book of Antarctica*



ACCIDENTS WILL HAPPEN
When things go wrong, both the land and the atmosphere may be polluted, as can be seen from this garage fire (above). Very often, too little attention is paid to cleaning up the results. The skeleton of this crashed helicopter (right) lies in the Wright Valley long after the event.

Instead of CRAMRA, the legislation that was ultimately approved by all Consultative parties on the 30th anniversary of the original Treaty was the 1991 Protocol on Environmental Protection. This document designates Antarctica as "a natural reserve, devoted to peace and science,"[71] and bans mining for a minimum of 50 years. The Protocol also dictates a strict protection of Antarctic flora and fauna, heavy regulation of waste disposal,[72] and the description of an Environmental Evaluation procedure, to which all future Antarctic activities would be subjected.

Today

For all of the 1991 Environmental Protocol's effort to "enhance the protection of the Antarctic environment and dependent and associated ecosystems,"[73] it places no limitations on new construction. In fact, since the Protocol does not amend the 1961 Treaty provision that non-Consultative nations can only achieve Consultative status through demonstrating their investment in the continent via constructing a new facility; it can, ironically, be understood as a "conservation" measure that encourages unlimited development.

Article 8 of the Protocol describes the regulation procedures that new construction (and all other Antarctic activities) must undergo. These consist of an "Environmental Impact Assessment," during which the proposed activity is presumed to leave "(a) less than a minor or transitory impact; (b) a minor or transitory impact; or (c) more than a minor or transitory impact." Activities granted (a) or (b) require no further regulation to speak of, but category (c) activities must undergo a more rigorous "Comprehensive Environmental Evaluation." This involves (among other things) identifying the "unavoidable impacts" of the activity, and noting any "uncertainties" about future impacts. Sections 3 through 6 of Annex I, Article 3, specify a timeline during which the evaluation must be submitted to all Consultative parties so that they may comment on these plans. Then, according to Article 4, an eventual decision about whether or not to proceed "shall be based on the Comprehensive Environmental Evaluation as well as other [unspecified] relevant considerations." However, the protocol does not specify any means for preventing activities judged to have negative environmental impacts; it only seems to mandate that they be announced in advance. While Annexes II and III provide much more detail about

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mining in the Antarctic could be consistent with the preservation of the continent's fragile environment" (Suter 59). This sentiment was, perhaps, strengthened by the 1989 Exxon Valdez 240,000 barrel oil spill in Prince William Sound, Alaska.

71 Protocol on Environmental Protection to the Antarctic Treaty (1991). Article 2: Objective and Designation.

72 Annex III, Article 1, which states that wastes must be, "to the maximum extent practicable, be returned to the country from which the activities generating the waste were organized" has seen particularly strict interpretation as it relates to increasing tourist activities. Antarctica is officially no longer a *res nullis*; regulation of its "pristine last frontier" in the name of environmental protection forbids anyone who is not a formally-approved scientist from a Consultative party nation to poop on the continent.

73 Preamble to Protocol on Environmental Protection to the Antarctic Treaty (1991). Sedac.ciesin.org/entri/texts/Antarctic.treaty.protocol.1991.html

the required protection of wildlife and allowed mechanisms for waste disposal, there is no specific mention of anything related to the design or construction of new Antarctic facilities, other than the stipulations that 1. "research essential to understanding the global environment" should be a "fundamental consideration in...planning"[74] and 2. parties intending to construct new facilities must "consult with other parties with regard to the choice of sites."[75]

This relatively lax regulatory policy has "overseen" the construction of several new facilities and infrastructural projects, all of which claim to be more sustainable than the rest.[76] Belgium's new Princess Elisabeth Station, the "most environmentally friendly Antarctic research station to date,"[77] was fully constructed in Brussels late last year before its prefab components were disassembled in anticipation of transport to Antarctica some time in the next few months. The facility will be powered entirely by solar and wind energy.[78] The design scheme for Britain's new Halley VI station was selected as the most "eco-friendly"[79] among entries to a 2005 competition. This mobile, modular facility (the buildings "pods" are constructed on "skis" and can be towed by tractors[80]) boasts a "climbing wall, television lounge, kitchen, gym, game room, music room, and sauna"[81] in addition to a hydroponic vegetable garden. The United States' brand new Amundsen-Scott South Pole Station was chosen by *Popular Science* as one of the top engineering achievements of 2007.[82] Its most notable "sustainable" feature is a jackable column system that allows the building to be raised above increasing snow drifts, thus "doubling" the facility's useful life.[83] Recent coverage of these projects does not address the fantastically unsustainable practice of shipping building components and materials to Antarctica by airplane.

Despite significant controversy from both Consultative and non-Consultative party nations, last year the United States completed construction of its "Ice Highway." This newest addition to Antarctic Infrastructure connects the Amundsen-Scott facility at the

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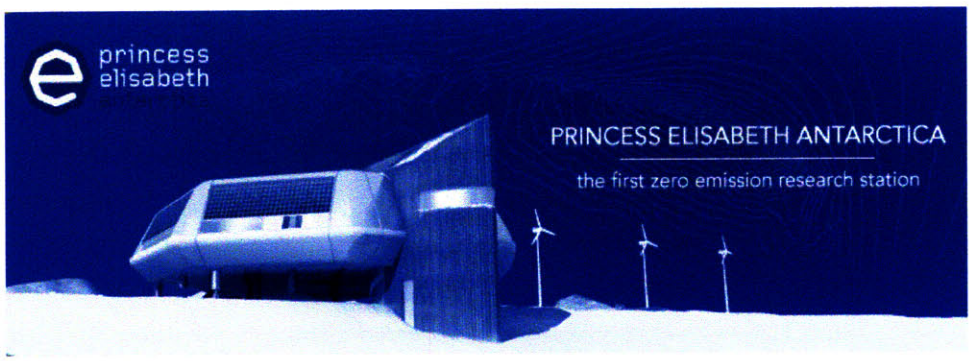
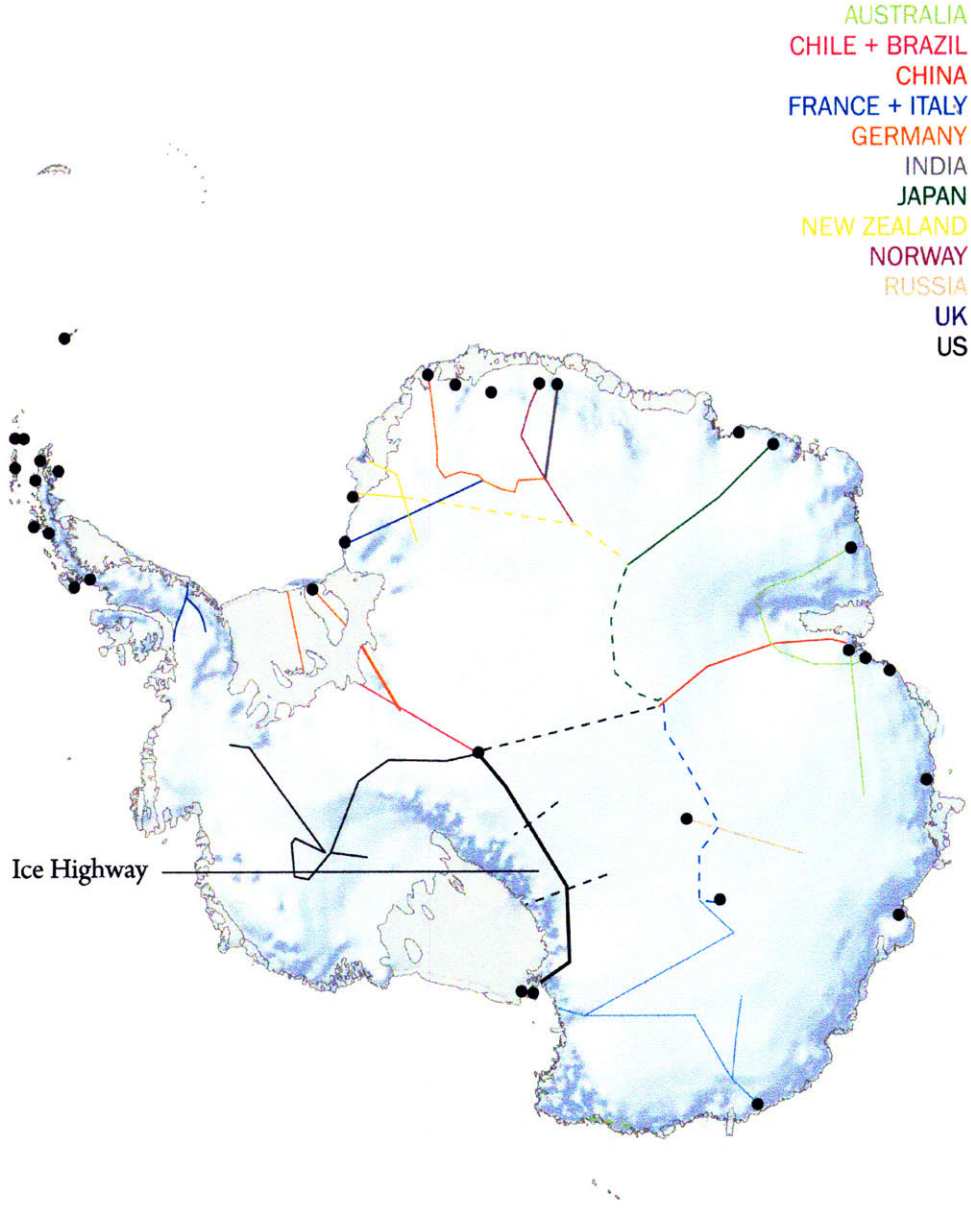
74 Article 3, Section 1.
75 Article 6 (entitled "cooperation"), Section 1, d.
76 It's surprisingly difficult to get a sense of how many buildings there are in Antarctica. The official COMNAP (Council of Managers of National Antarctic Programs) website lists a total of 66 stations (www.comnap.aq/operations/facilities), and Wikipedia claims there are 81 "outposts" on the continent (http://en.wikipedia.org/wiki/Category:Outposts_of_Antarctica), but the Greenpeace Book of Antarctica listed a total of 90 "bases and refuges" that were operating on the continent as of twenty years ago (May, 178. Data compiled by Martin Baker).
77 Bright, Adam. "Overachievers We Love." Popular Science. Vol. 269 No. 6, December 2006. p 24.
78 Brown, Jeff L. "Antarctic Station Runs on Renewable Energy." Civil Engineering. December 2007: p 20-22.
79 Holden, Constance. "Architecture for the South." Science. Vol. 309 No. 5735, 29 July 2005. p 696.
80 "Going to Extremes." Economist. Vol. 376 No. 8436, 23 July 2005: p 75.
81 Daley, Jason. "Shelf Life." Outside. February 2007. p 15.
82 http://www.popsci.com/popsci/flat/bown/2007/engineering/item_45.html
83 The facility was designed by Hawaii-based firm Ferraro Choi. For more information on its "sustainable design strategies" see http://www.ferrarochoi.com/sustainarch/NSF/index.html



Research Stations and Roads



South Pole with McMurdo Station, the headquarters of American Antarctic activity.[84] The ASOC went on record stating that the project "poses profound issues relating to protection of the Antarctic wilderness." However, the US remains undeterred, emphasizing that the Ice Highway complies with environmental regulations[85] and is of indispensable scientific importance. Its construction will, purportedly, ease the collection of ice core samples which contain an important record of atmospheric carbon levels.[86] Regardless of other Consultative parties' eagerness to accept global warming-related research as a worthy reason to construct a highway halfway across Antarctica,[87] it has proved to be a successful means of raising money to fund project. An article in *Nature* claimed that the "United States Antarctic effort has received a tripling in funding over the past ten years due to interest in ozone and global change."[88] The American Ice Highway can be read as evidence of a disconnect between *de jure* Antarctic regulations and *de facto* proceedings. It also, perhaps, suggests that while the public rhetoric of Antarctic activity might have changed from maintaining peace to preserving the environment, the reality of state-centered, self-interested activity -- justified through the pursuit of scientific research -- has remained constant.

Tourism

Recently, Antarctica has seen a new kind of international traffic: tourism. Last year over 35,000 tourists travelled to Antarctica. Over the past ten years, the number of ship-born tourist has increased by 400%; the number of land-based tourists has increased by 750%.[89] Other than cruise ships, there are currently no facilities to accommodate tourists and due to Antarctica's legal status as a Global Commons, there is no governing body to oversee the continent's growing tourism industry. There is one international organization dedicated to tourism in Antarctica: the International Association of Antarctic Tour Operators, but it serves more as a promotional body than a restrictive one and membership is voluntary.

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84 This project is being overseen by Raytheon Polar Services.

85 Lyne, Jack. "Science-Driven 'Ice Highway' Hitting Rough Sledding in Antarctica." Site Selection. 13 December 2004.
www.siteselection.com/ssinsider/snapshot/sf0412123.htm
Although it sure *seems* like a highway would leave a "(c) more than a minor or transitory impact," there is a surprising lack of information about this project in general and it's compliance with the Environmental Protocol specifically.

86 See The ITASE (International Trans-Antarctic Scientific Expedition) website for more information: www2.umaine.edu/itase/content/Science/Proposed_routes.html.

87 The Ice Highway also formalizes a US land route that cuts through French, Australian, and New Zealand-claimed territory.

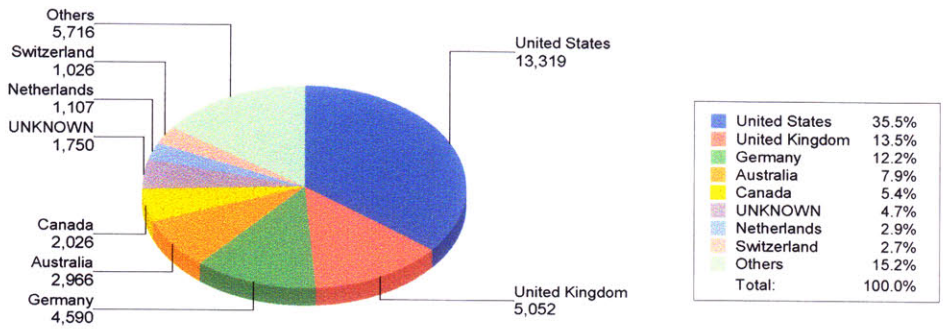
88 Airriess Airriess, C.A. "Green issues fuel funding." Nature Vol. 350 No. 6316, 28 March 1991: 295. This tripling has, apparently, been enough to cover the NSF's recent $134 million dollar "South Pole Modernization Project," and the Ice Highway's reported $350 million dollar initial capital investment. (Financial information comes from the National Science Foundation's 2005 facility plan. Page 33.)

89 http://maps.grida.no/go/graphic/trends-in-antarctic-tourism

The most common way to travel to Antarctica is by cruise ship, leaving either from Ushuaia (Argentina), or Hobart (Australia). No documentation or visas are required. Cruise ships travel along Antarctica's coastline, anchoring periodically to allow small groups of tourists in zodiacs to come ashore and wander around. To the dismay of Antarctic scientists, it is not uncommon for these unregulated groups of tourists to seek shelter and medical attention at scientific research facilities located near the coasts.

There are a number of potentially negative consequences of unregulated Antarctic Tourism. These include, but are not limited to: pollution, especially oil spills from cruise vessels; littering and other negative impacts on landing sites; introduction of foreign species (especially bacteria); disturbance to breeding wildlife; introduction of disease; disturbance to ongoing scientific research; and strain on existing resources and facilities. An especially visible example of the strain on scientific resources was the recent sinking of the M/S Explorer in November of 2007. Given Antarctica's lack of a coast guard, a Norwegian research vessel was called upon to rescue the tourists aboard.

Antarctic Tourism Demographics



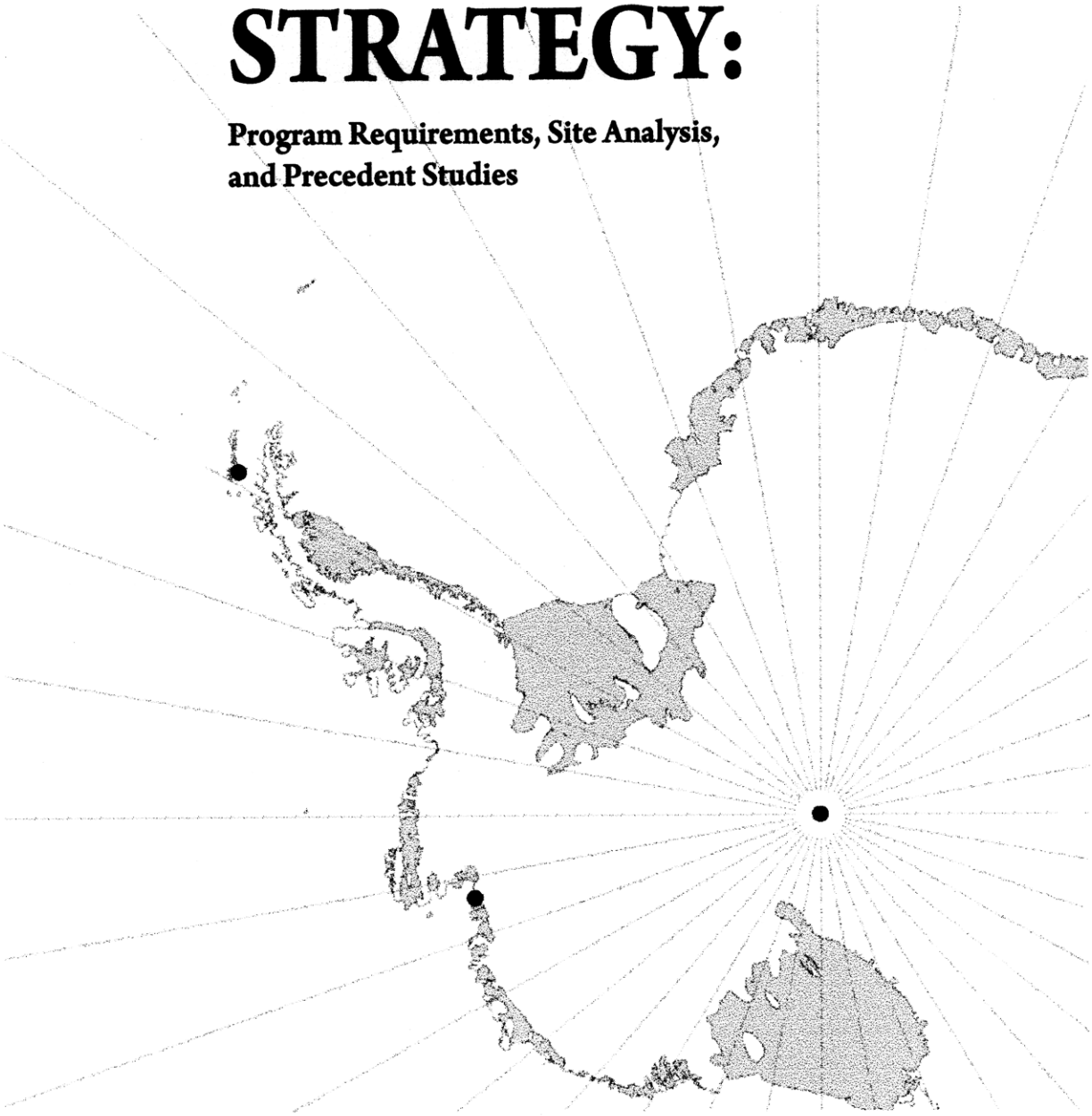
Despite all of these potentially negative impact, Antarctic tourism, if done right, doesn't have to be all bad. In fact, Bernard Stonehouse, a polar researcher who studies the impact of tourism in the Antarctic, suggests that tourists can play a beneficial role on the continent by effectively acting as environmental watchdogs that keep tabs on the behavior of governmentally sanctioned activity there[90] – not unlike the Greenpeace volunteers at their "World Park Base".

Antarctica's unstable territorial status has been complicated by ongoing debates over who -- which national governments and/or which individual people -- should have the right to access and oversee the Global Commons. Recently, a rapidly growing and unregulated tourism industry has added an additional actor -- the tourist -- to the fray. The terms of the debate over Antarctic sovereignty are once again changing, now that there is a means for individuals to have regular access to the continent. The impacts of this individual access will depend upon the way in which this new industry is developed...

90 In an interview with Henry Nicholls. "Keeping an eye on Antarctica." *New Scientist* 2640. 26 January 2008. http://www.newscientist.com/channel/opinion/mg19726401.800-interview-keeping-an-eye-on-antarctica.html

STRATEGY:

Program Requirements, Site Analysis, and Precedent Studies



Programmatic Strategy

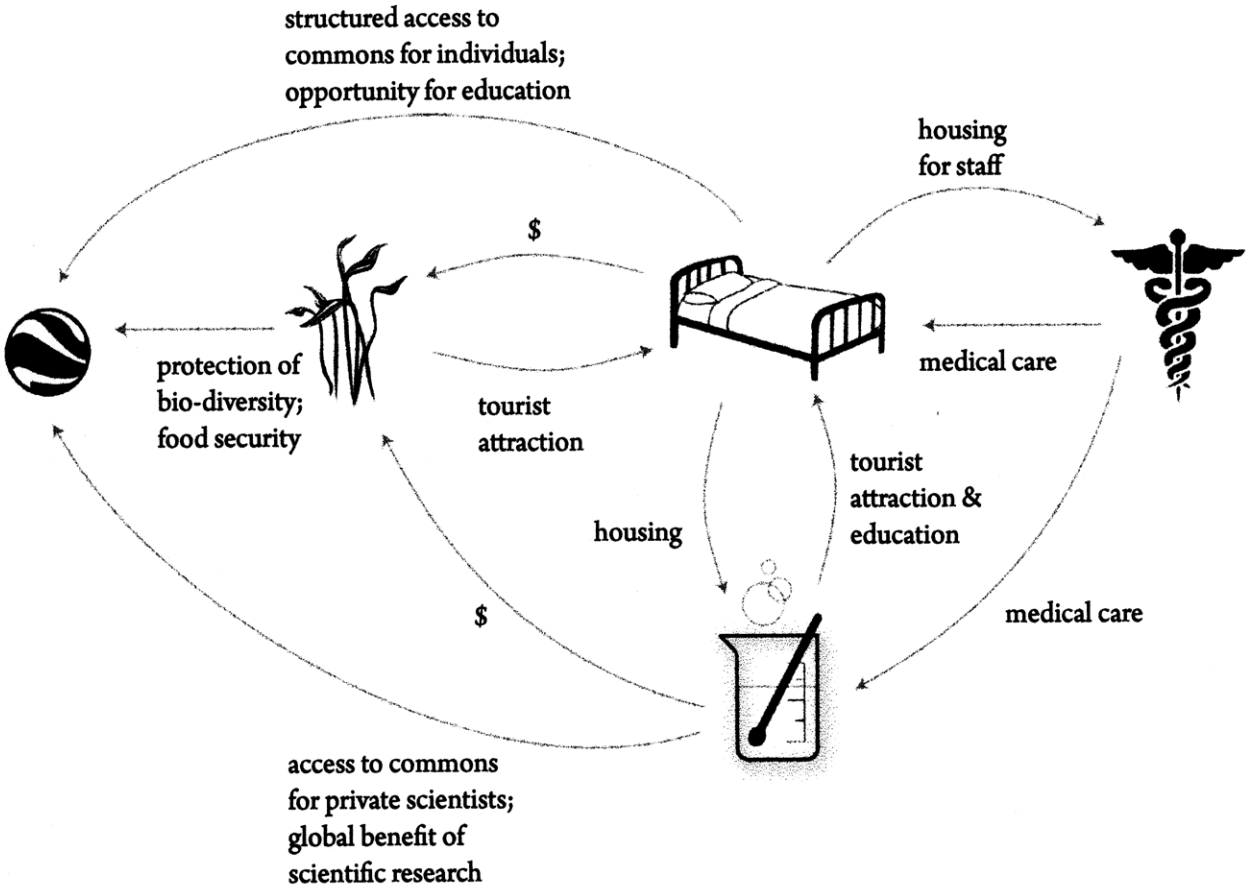
This thesis is a proposal for the initial development of Antarctic tourism. Taking into consideration the expanded notion of site predicated by an environmental approach to architectural design, the project aims to operate within a larger systematic understanding of Antarctic site constraints. The proposal involves four distinct programmatic components, distributed over three sites on the continent. The interventions work together, operating as a cohesive functional, financial, and logistical system.

The **hotel** will concentrate tourist activity, by providing a destination.

The **clinic** will accommodate tourists' medical needs, relieving stress on government-run scientific research facilities

Open **lab space** will be available for individual scientists to lease, with the support of institutional, corporate, or private grants. This will provide an alternative for researchers lacking the support of their respective government's Antarctic program.

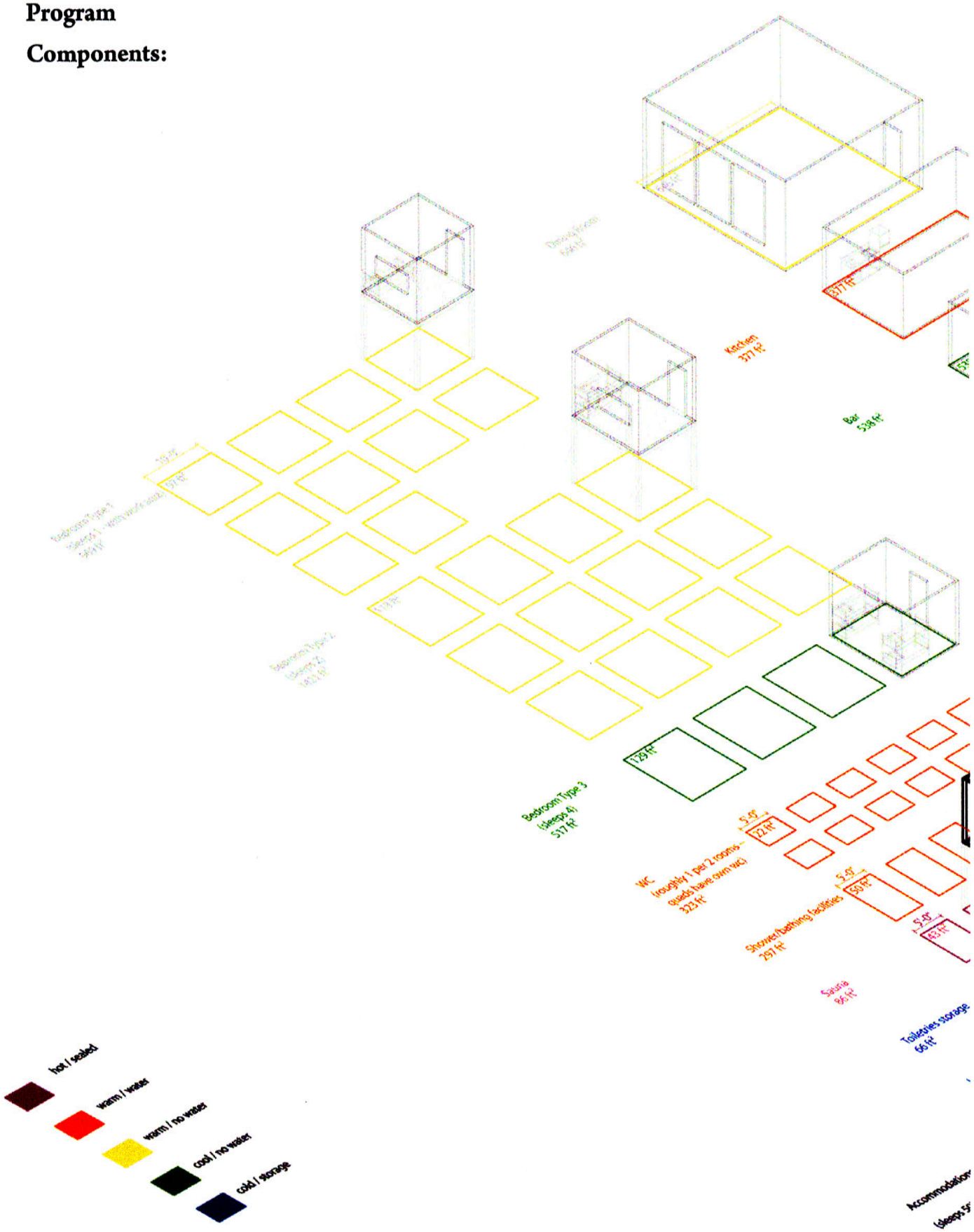
A **biological vault**, inspired by the Svalbard Seed Vault recently built in Norway, will provide a safe and secure storage facility for biological specimens from across the globe. This is a last-resort effort to protect global food sources from a range of threats such as war, natural disasters, or agricultural mismanagement. Unlike the Norwegian vault, it will not be controlled by a national government, but rather, will be located in the Global Commons.



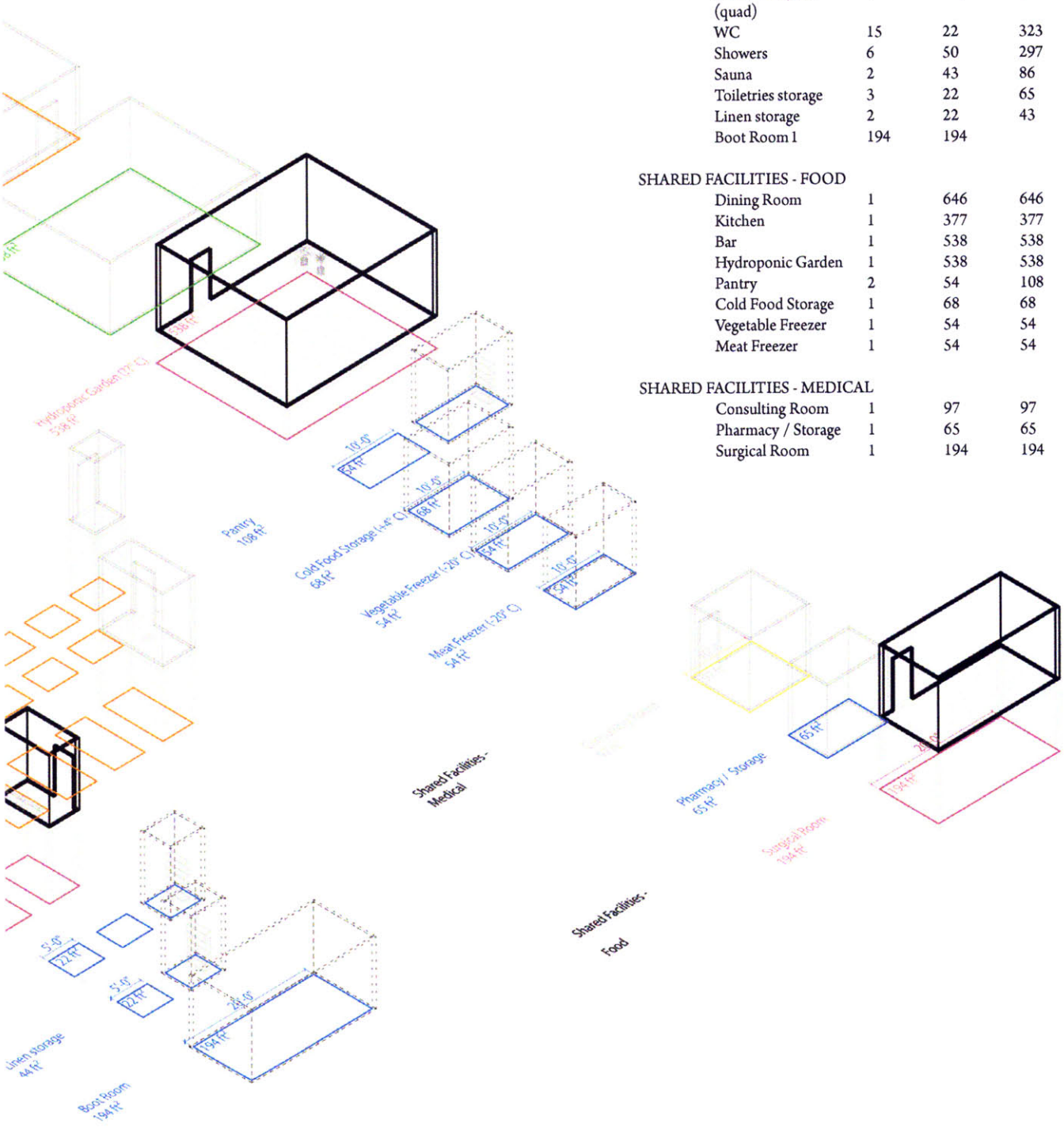
consequences:	**OFFSET BY**	benefits:
providing a destination could lead to more tourism, increasing the potential for environmental destruction.		controlled access to commons provided; increased tourism dollars and transport infrastructure used to support bio vault.

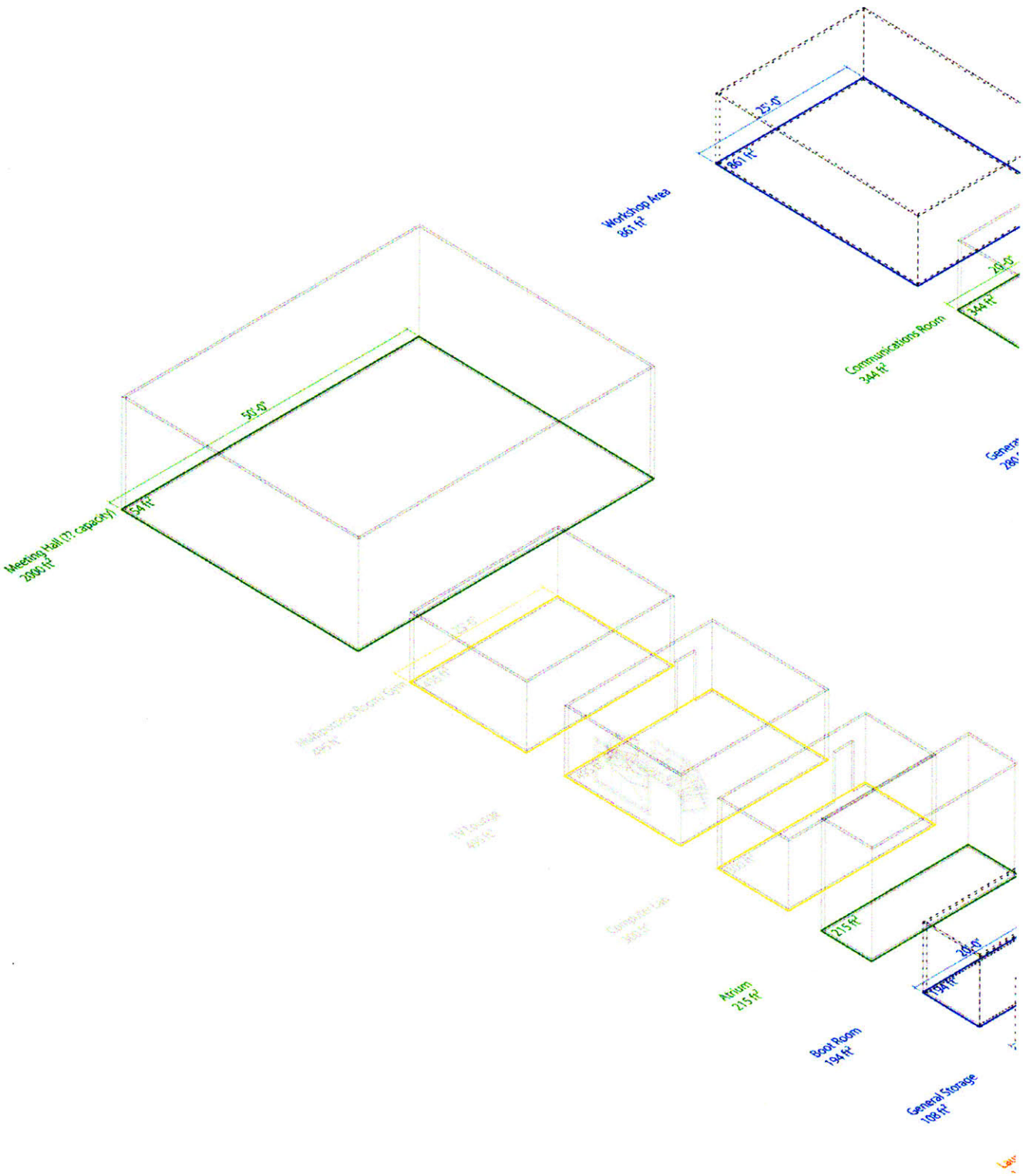
Program

Components:



	#	area/unit (sq ft)	area/type (sq ft)
ACCOMMODATIONS (50 beds)			
Bedroom Type 1 (single/workspace)	10	97	969
Bedroom Type 2 (double)	12	118	1421
Bedroom Type 3 (quad)	4	129	517
WC	15	22	323
Showers	6	50	297
Sauna	2	43	86
Toiletries storage	3	22	65
Linen storage	2	22	43
Boot Room 1	194	194	
SHARED FACILITIES - FOOD			
Dining Room	1	646	646
Kitchen	1	377	377
Bar	1	538	538
Hydroponic Garden	1	538	538
Pantry	2	54	108
Cold Food Storage	1	68	68
Vegetable Freezer	1	54	54
Meat Freezer	1	54	54
SHARED FACILITIES - MEDICAL			
Consulting Room	1	97	97
Pharmacy / Storage	1	65	65
Surgical Room	1	194	194



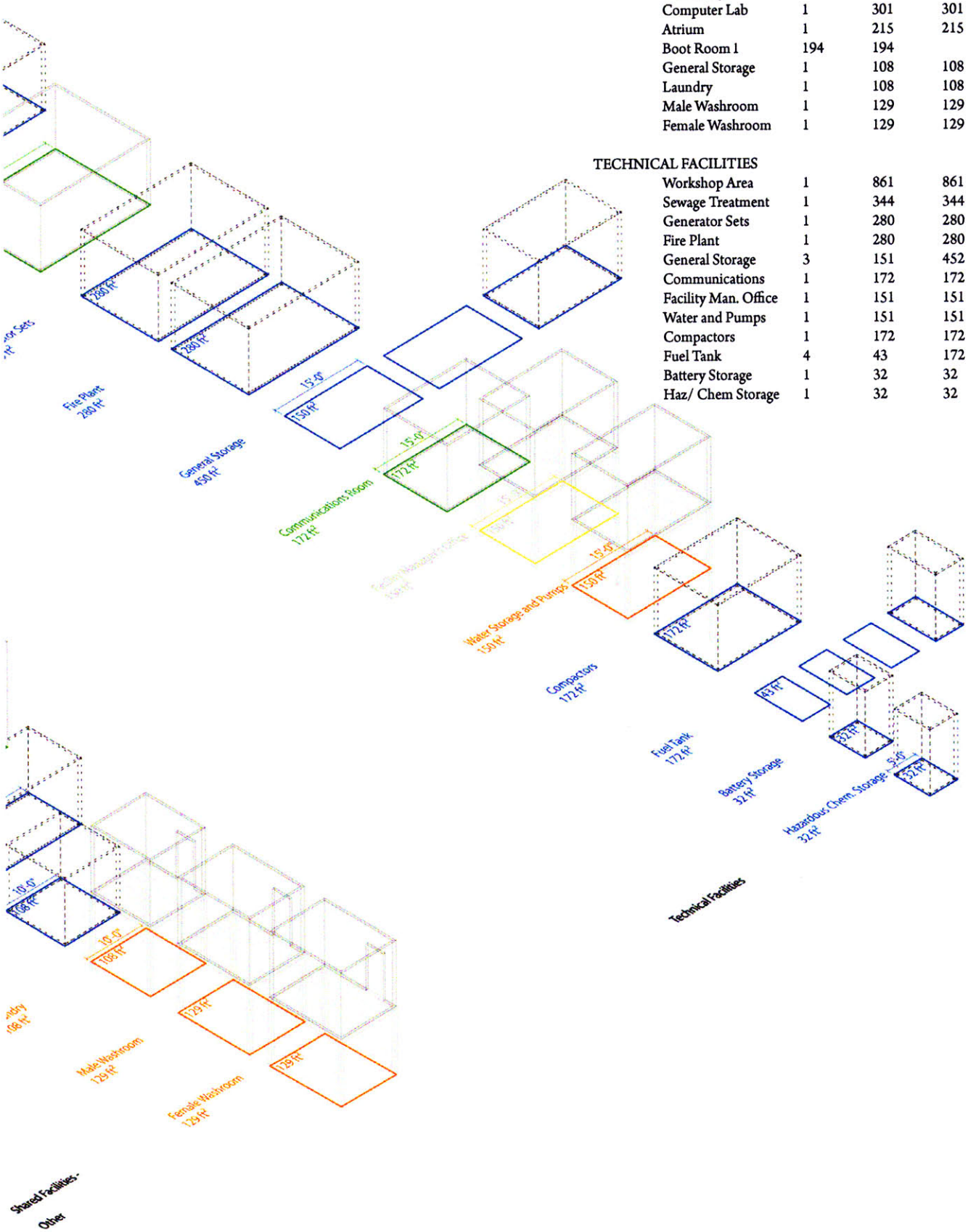

Workshop Area
861 ft²
25'-0"
861 ft²
Communications Room
344 ft²
20'-0"
344 ft²
Meeting Hall (? capacity)
2800 ft²
50'-0"
54 ft²
Atrium
215 ft²
215 ft²
Boot Room
194 ft²
20'-0"
194 ft²
General Storage
196 ft²

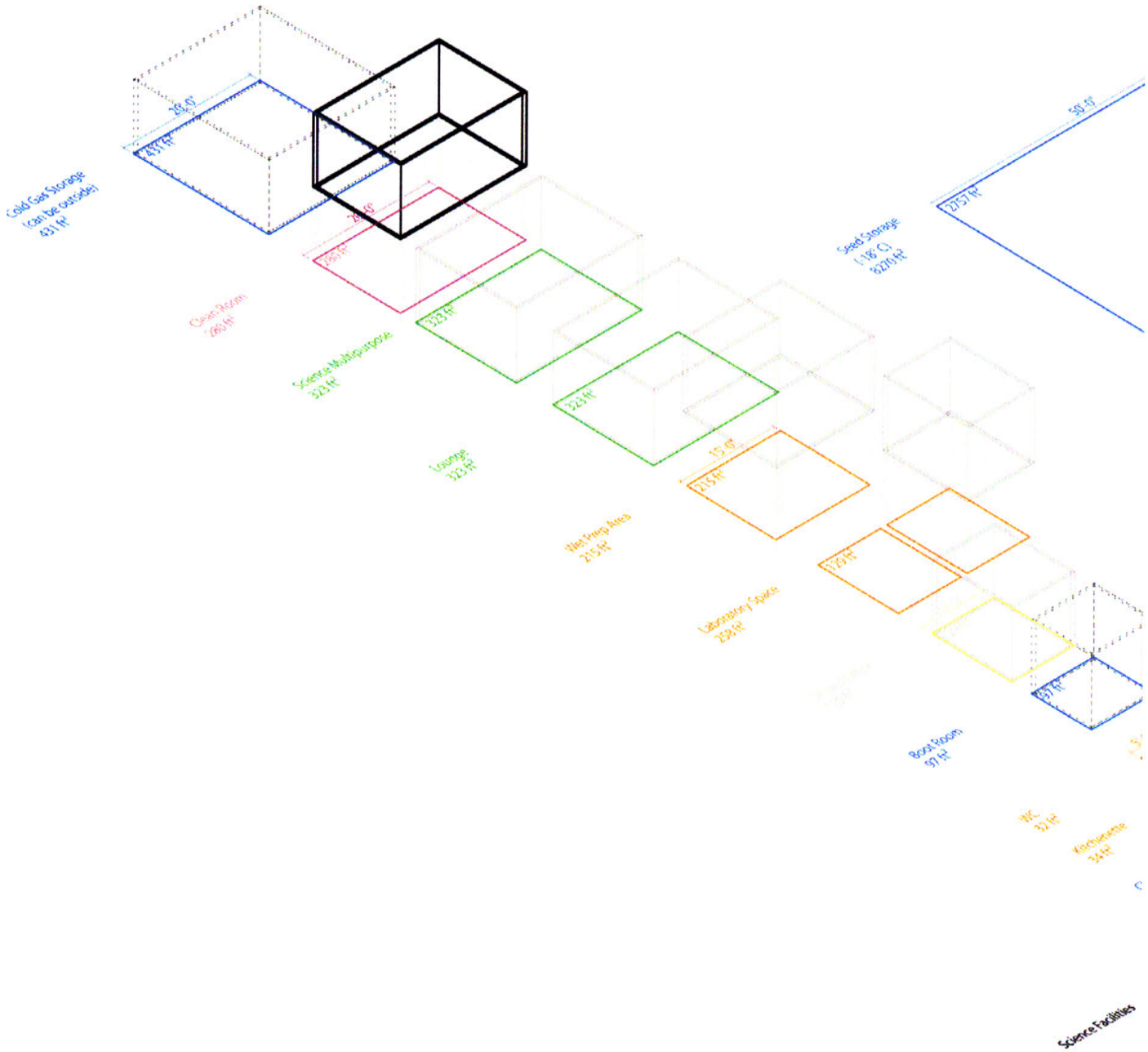
SHARED FACILITIES - OTHER

Meeting Hall	1	2000	2000
Multipurpose/ Gym	1	495	495
TV Lounge	1	495	495
Computer Lab	1	301	301
Atrium	1	215	215
Boot Room 1	194	194	
General Storage	1	108	108
Laundry	1	108	108
Male Washroom	1	129	129
Female Washroom	1	129	129

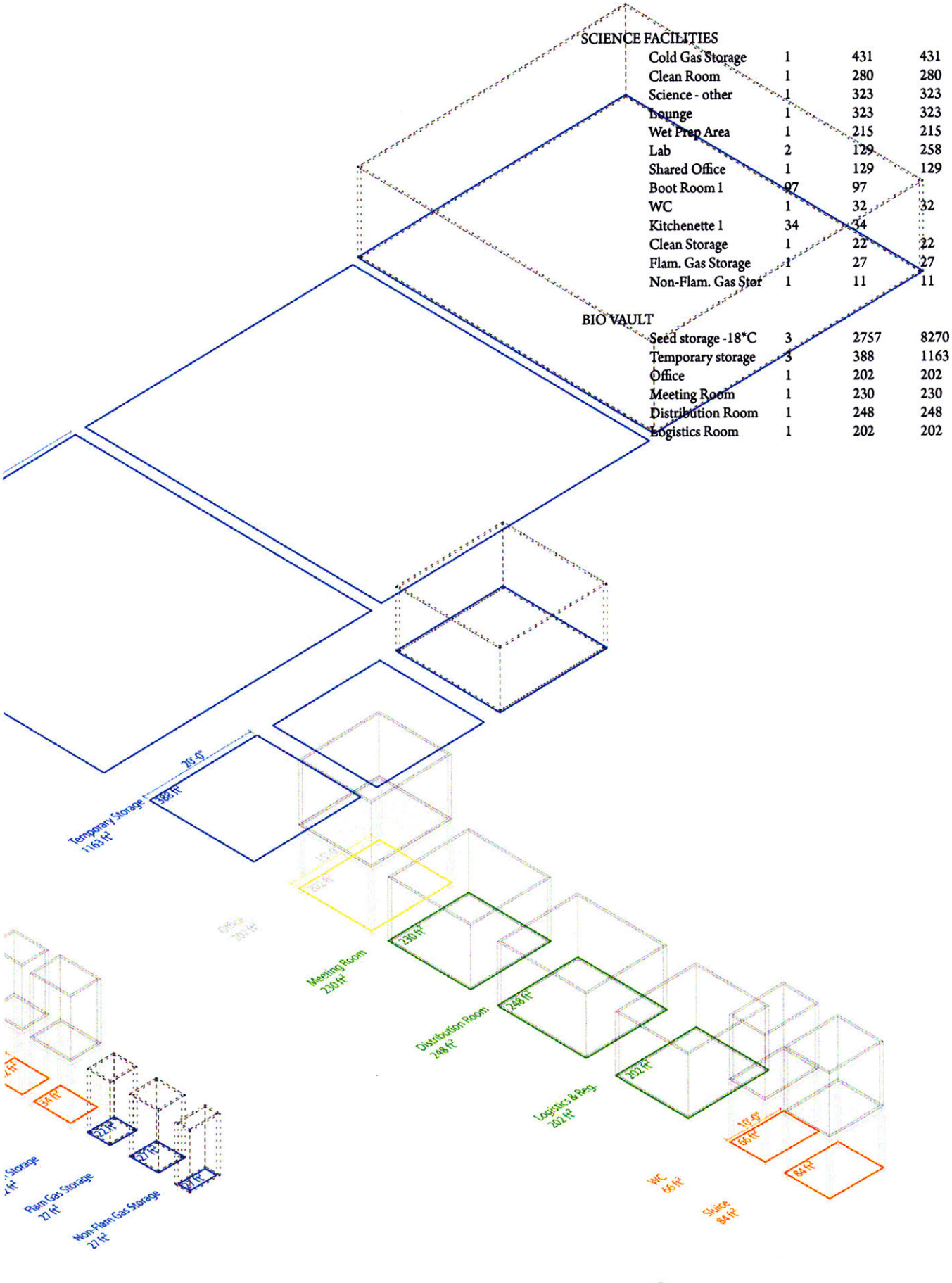
TECHNICAL FACILITIES

Workshop Area	1	861	861
Sewage Treatment	1	344	344
Generator Sets	1	280	280
Fire Plant	1	280	280
General Storage	3	151	452
Communications	1	172	172
Facility Man. Office	1	151	151
Water and Pumps	1	151	151
Compactors	1	172	172
Fuel Tank	4	43	172
Battery Storage	1	32	32
Haz/ Chem Storage	1	32	32





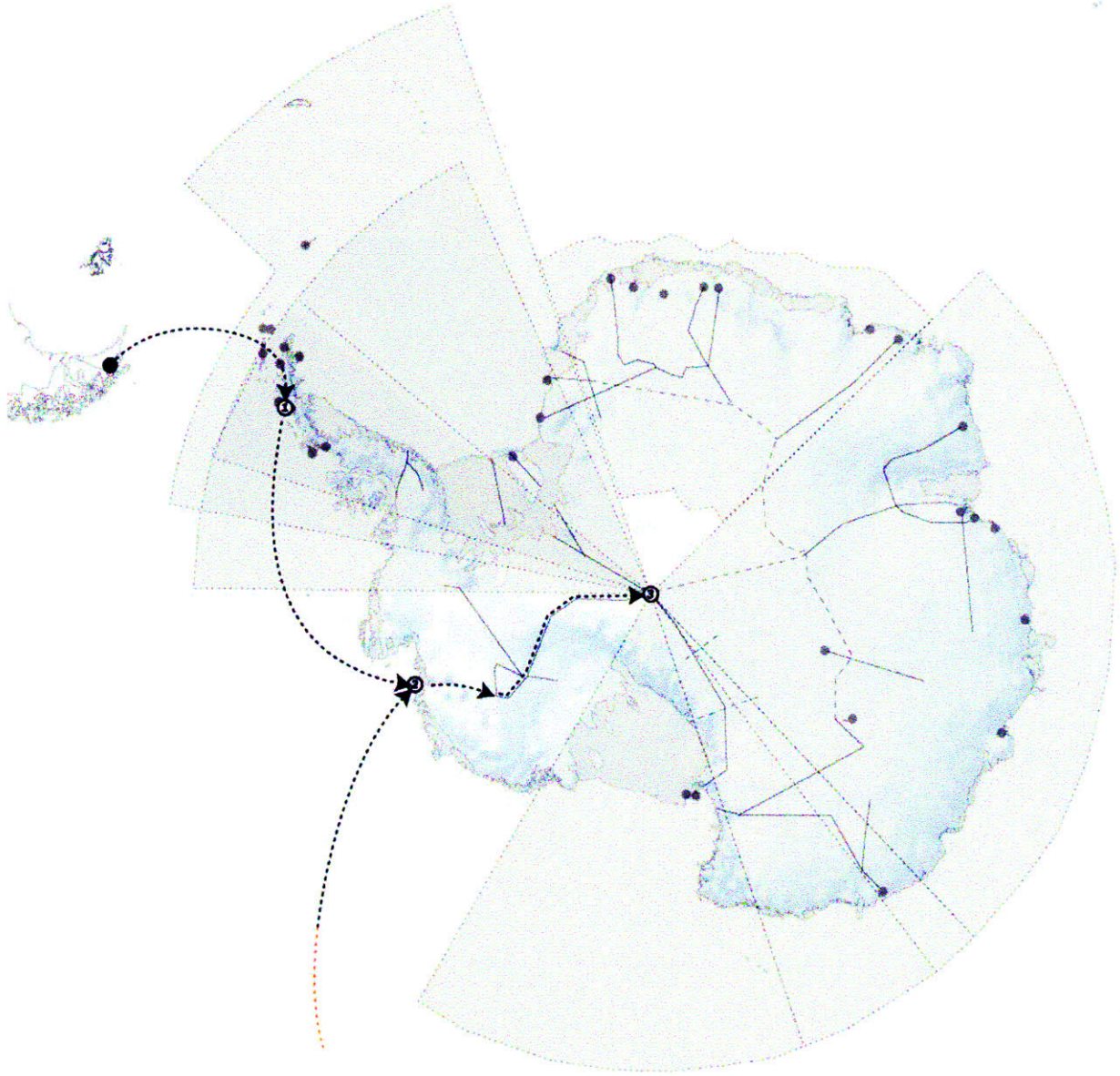
Science Facilities



SCIENCE FACILITIES			
Cold Gas Storage	1	431	431
Clean Room	1	280	280
Science - other	1	323	323
Lounge	1	323	323
Wet Prep Area	1	215	215
Lab	2	129	258
Shared Office	1	129	129
Boot Room 1	97	97	
WC	1	32	32
Kitchenette 1	34	34	
Clean Storage	1	22	22
Flam. Gas Storage	1	27	27
Non-Flam. Gas Stor	1	11	11
BIO VAULT			
Seed storage -18*C	3	2757	8270
Temporary storage	3	388	1163
Office	1	202	202
Meeting Room	1	230	230
Distribution Room	1	248	248
Logistics Room	1	202	202

Seed Vault

Site Strategy



Station 1:

Whaler's Bay, Deception Island,
Antarctic Peninsula -- hotel, clinic

The most popular and frequently visited Antarctic destination, this region has the greatest need for a centralized tourism infrastructure. This facility will accommodate 50 tourists (an average no. of passengers on a small Antarctic cruise ship); it will also house a medical clinic that will service this as well as other popular peninsula sites.

Station 2:

PIG Field Camp, Pine Island Glacier,
Marie Byrd Land -- lab space, glacier monitoring station

Never officially claimed by any country, this truly is no-man's-land. This station will make laboratory space available for scientists to lease. Additionally, a way station here will handle processing and temporary storage of items en route to the bio vault. Shipments can arrive here from Station 1 on the Antarctic Peninsula (taking advantage of the tourism transport infrastructure already in place) or they may arrive from elsewhere. The facility will accommodate a much smaller number of temporary inhabitants, who might be tourists, scientists, or people travelling with seed shipments, detained due to inclement weather.

Station 3:

The South Pole -- international meeting hall, biological storage vault

Locating the international bio vault at the south pole will allow the facility to utilize the 2-mile thick polar ice sheet for refrigeration of the facility. The logistical difficulties associated with travelling to the location will provide a degree of security; however, locating the seed bank near the pole will provide several means of access. There is a US-operated airstrip at the south pole as well as an ice-highway that runs from the pole to Ross Island. An existing compacted-ice road will be extended to connect the pole facility with Station 2. This location will also allow scientists who lease laboratory space in this facility to have access to the unique geophysical conditions at the south pole.

Why not locate the vault at Station 2?

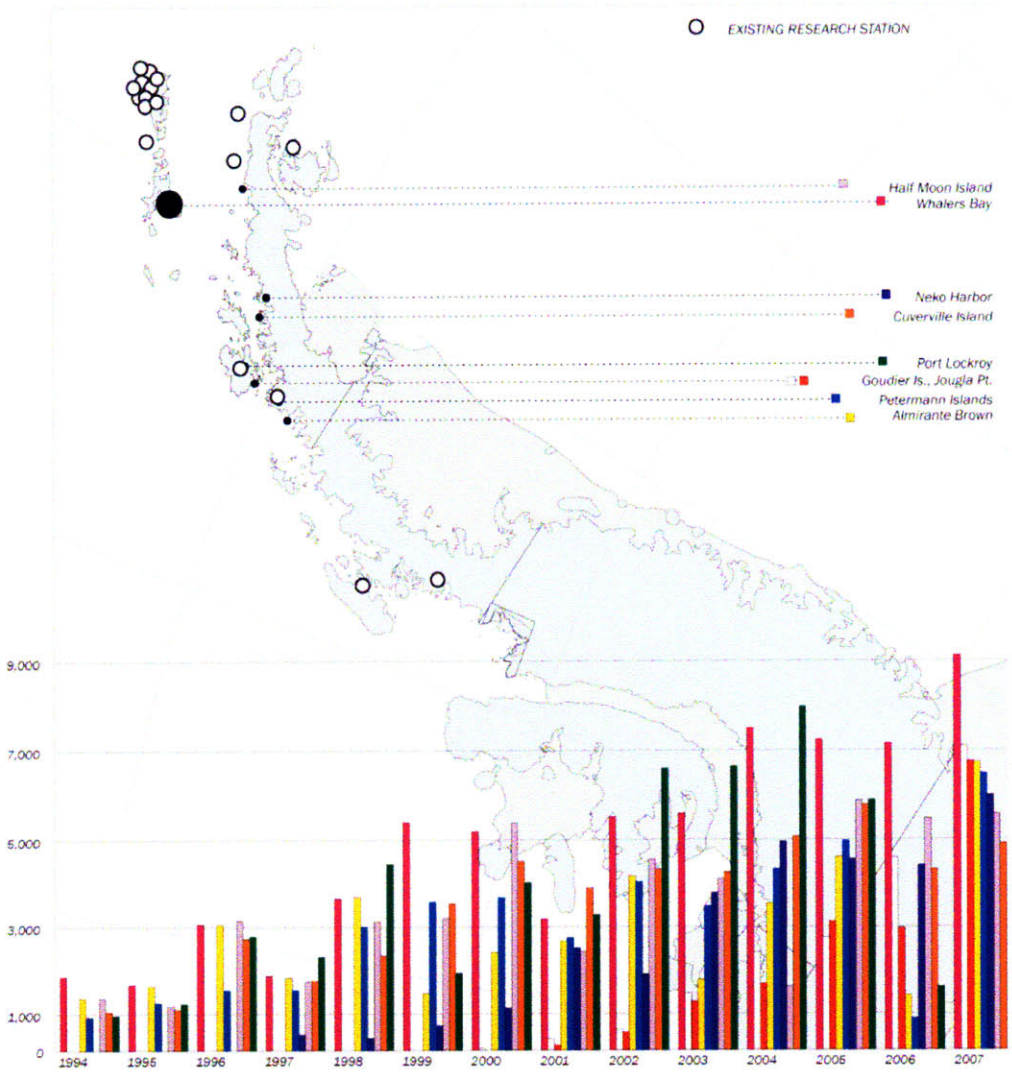
There are benefits to a coastal location -- any (seaworthy) ship can reach the location to deliver biological specimens. However, Antarctica's coastal ice shelves are notoriously unstable; the sea ice undergoes alternating periods of thickening and calving as the seasons (and ocean temperature) change. The instability of this condition is expected to increase due to rising global temperatures. A facility located on the ice shelves of Marie Byrd Land must have a flexibility that can accommodate changing foundation conditions. This sort of instability does not allow for the necessary permanence associated with the bio vault program.

Station 1:

Whaler's Bay, Deception Island, Antarctic Peninsula.

Whalers Bay is located at 620 59'S, 600 34'W, on Deception Island, South Shetland Islands, Antarctic Peninsula. It falls within British, Argentine, and Chilean territorial claims. The site has a long history of human habitation dating back to the early 1900s, when it was one of the most important Antarctic whaling sites. (The remnants of this whale processing infrastructure remain on site.) It is currently one of the most popular Antarctic Tourism Destinations and is located in close proximity to other popular peninsula sites.

Number of Visitors per Season

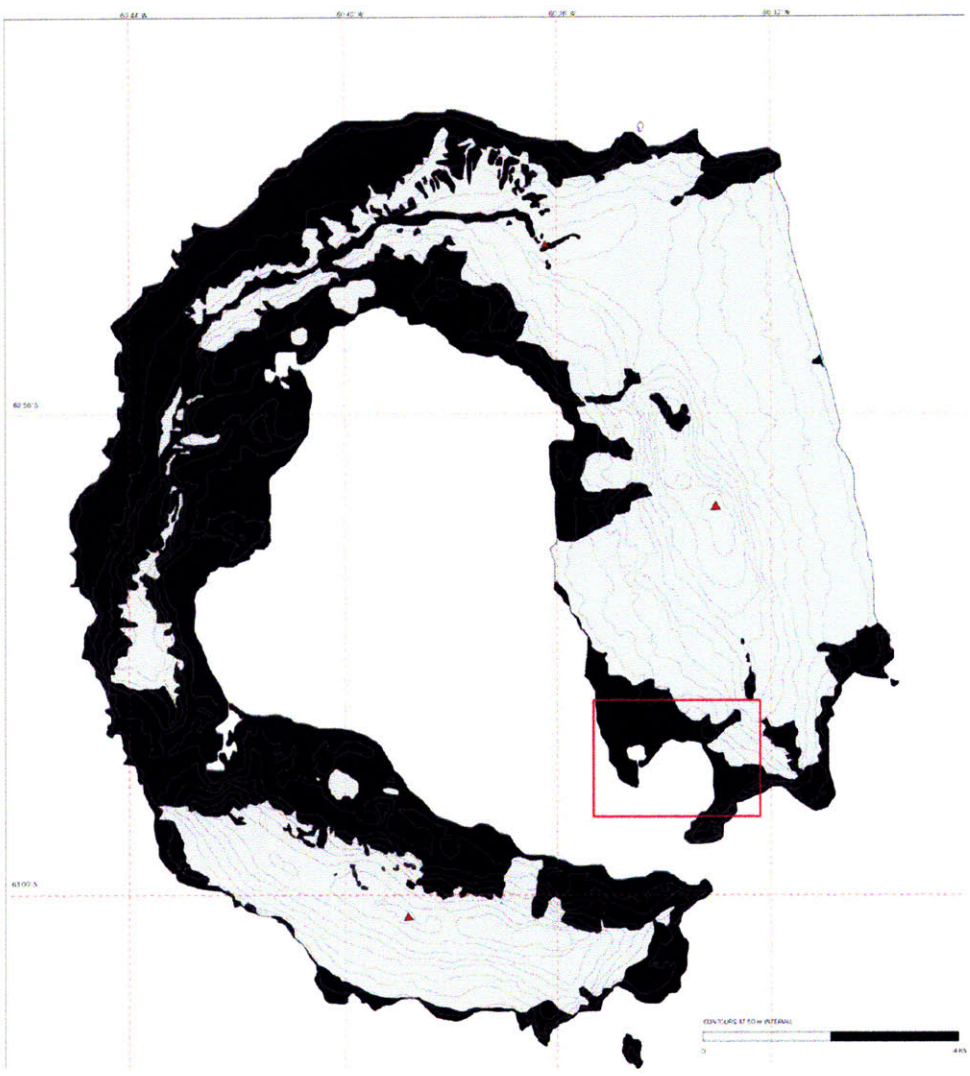


In 1943, the UK established a permanent base (Base B) in Whaler's Bay, in an old whaling station. However, the station was abandoned in 1969 after suffering severe damage from a lahar (mud slide) that followed a volcanic eruption. There is currently no active scientific research facilities at Whaler's Bay; thus, a new facility here would create minimal disturbance to ongoing Antarctic science.

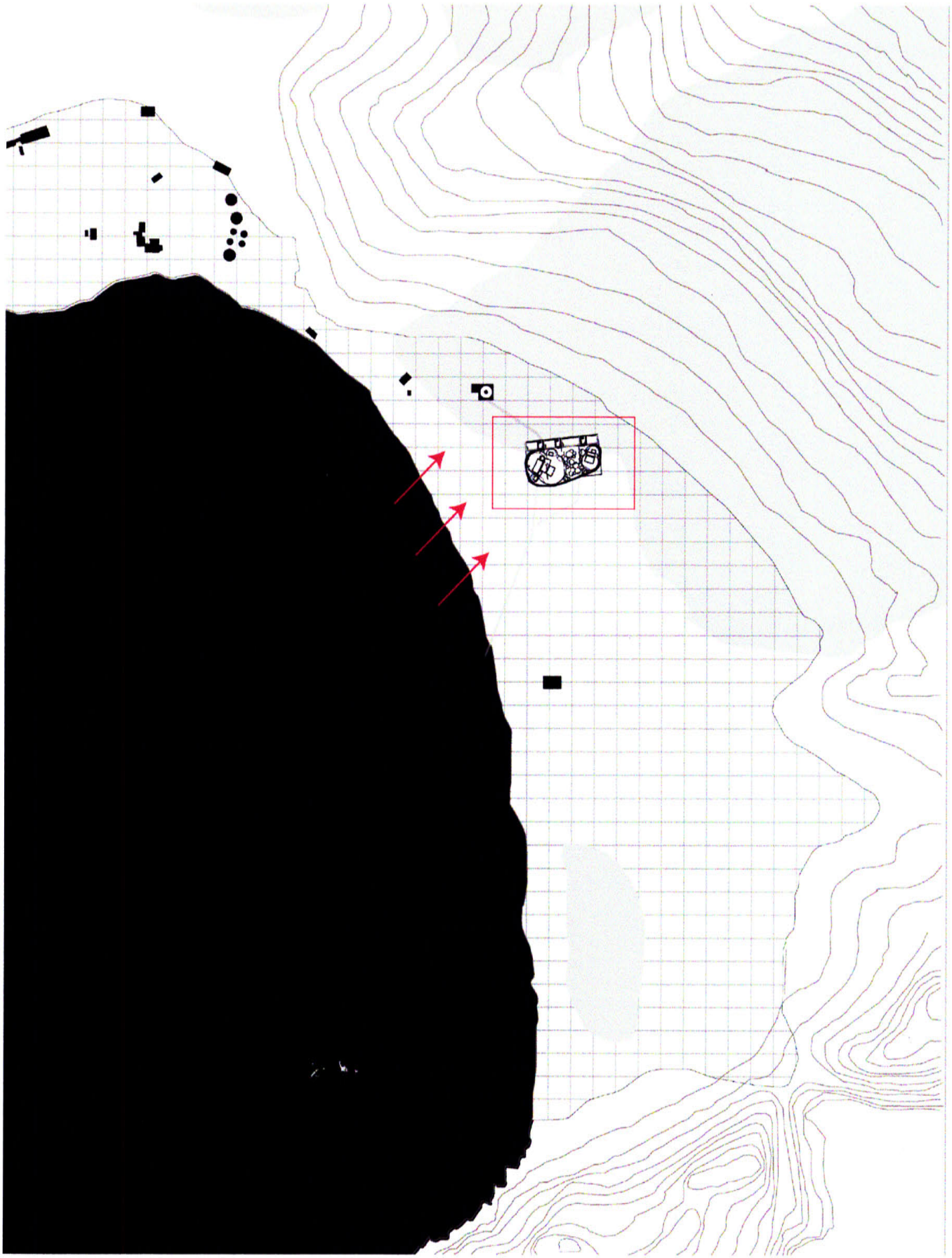
Deception island is a flooded caldera. It is one of the only places in the world where one can sail into the center of a restless volcano and the area is of exceptional botanical and limnological importance; it is a breeding site for Kelp gulls, Antarctic Terns, and Cape Petrels. The geothermal activity creates extreme micro-climates of steaming fumaroles and heated water, making the site a good source for extraction of geothermal energy.

Additionally, the shape of the island creates a naturally safe harbor.

Deception Island



Station 1: Site Plan



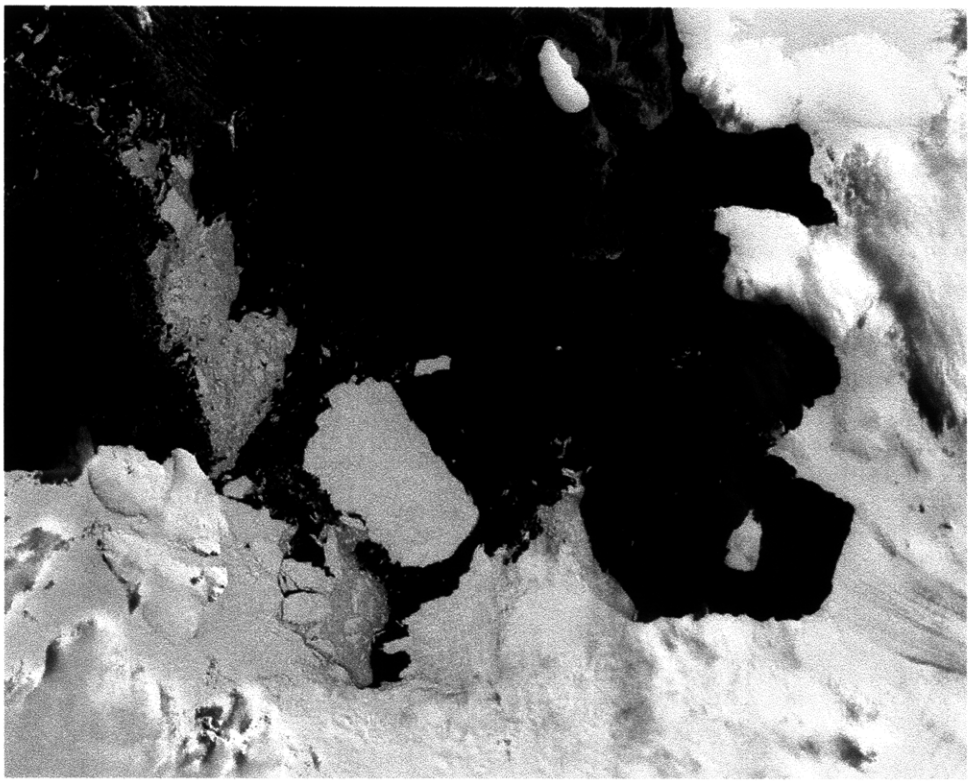
Station 2:

PIG Field Camp, Pine Island Glacier, Marie Byrd Land.

Pine Island Glacier is currently listen on NASA's glacial watch list and there is already a research effort in place here, set up to monitor the receding ice. The PIG project installed an "automatic weather station" on the ice shelf as part of a research effort to record weather patterns. This includes two cameras – one looking south and one looking north towards Pine Island Bay -- and two gps receivers are outfitted to phone data to a server at NYU. Collecting weather imagery will help scientists to understand how rate of ice flow is related to atmospheric conditions.

The location of Station 2 takes advantage of these installed imaging technologies as a security measure for facility. By locating the dock in the purview of Camera B, and the processing facility in the view of Camera A, anyone, anywhere in the world can visit http://pigiceshelf.nasa.gov/index.php to view the facility, keep tabs on operations, etc. (This will also help with publicity and fund-raising efforts for the PIG project.)

Number of Visitors per Season



Velocity Data for Pine Island Glacier

Lat	Long	Speed	Bearing	ErrSp	ErrBr	Date1	Date2	Label	Notes
-74.948	-101.254	2545.0	310	4.3	0.0	1986-12-21	1988-12-18	""	0
-74.960	-101.287	2563.2	310	1.9	0.0	1986-12-21	1988-12-18	""	0
-74.971	-101.279	2573.8	309	3.1	0.0	1986-12-21	1988-12-18	""	0
-75.054	-101.490	2709.4	309	3.8	0.0	1986-12-21	1988-12-18	""	0
-74.892	-101.044	2378.2	309	6.3	0.0	1986-12-21	1988-12-18	""	0
-74.937	-101.157	2504.9	309	11.1	0.1	1986-12-21	1988-12-18	""	0
-74.943	-101.174	2551.1	309	2.3	0.0	1986-12-21	1988-12-18	""	0
-74.950	-101.189	2488.6	309	4.5	0.0	1986-12-21	1988-12-18	""	0
-74.969	-101.237	2543.4	309	5.9	0.0	1986-12-21	1988-12-18	""	0
-74.890	-101.004	2371.8	308	7.3	0.0	1986-12-21	1988-12-18	""	0
-74.954	-101.165	2543.4	309	7.2	0.0	1986-12-21	1988-12-18	""	0
-74.967	-101.198	2573.8	309	4.7	0.0	1986-12-21	1988-12-18	""	0
-74.980	-101.229	2570.6	308	5.3	0.0	1986-12-21	1988-12-18	""	0
-74.901	-100.994	2367.5	308	8.3	0.1	1986-12-21	1988-12-18	""	0
-74.907	-101.011	2396.5	308	10.5	0.0	1986-12-21	1988-12-18	""	0
-74.926	-101.059	2433.9	308	11.3	0.1	1986-12-21	1988-12-18	""	0
-74.952	-101.124	2493.6	308	10.6	0.0	1986-12-21	1988-12-18	""	0
-74.996	-101.239	2635.0	309	9.5	0.0	1986-12-21	1988-12-18	""	0
-74.905	-100.970	2370.0	308	7.5	0.0	1986-12-21	1988-12-18	""	0
-74.911	-100.986	2380.4	308	8.5	0.0	1986-12-21	1988-12-18	""	0
-74.918	-101.002	2405.7	308	1.4	0.0	1986-12-21	1988-12-18	""	0
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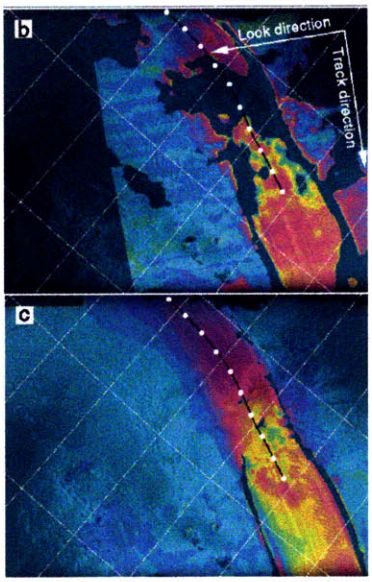
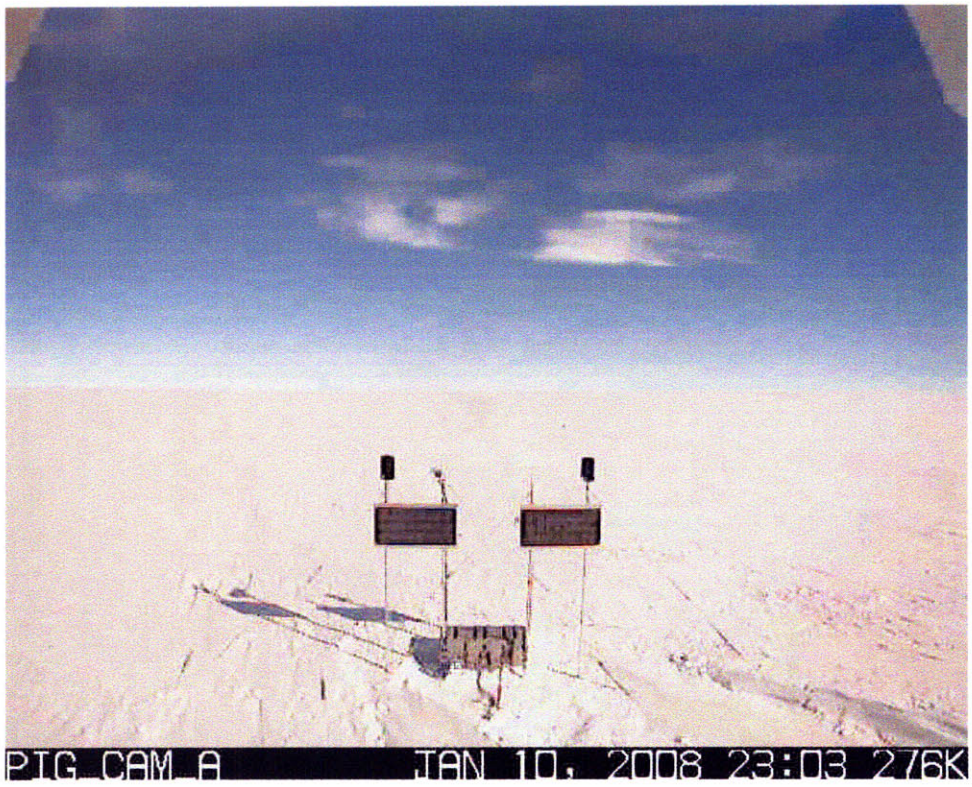
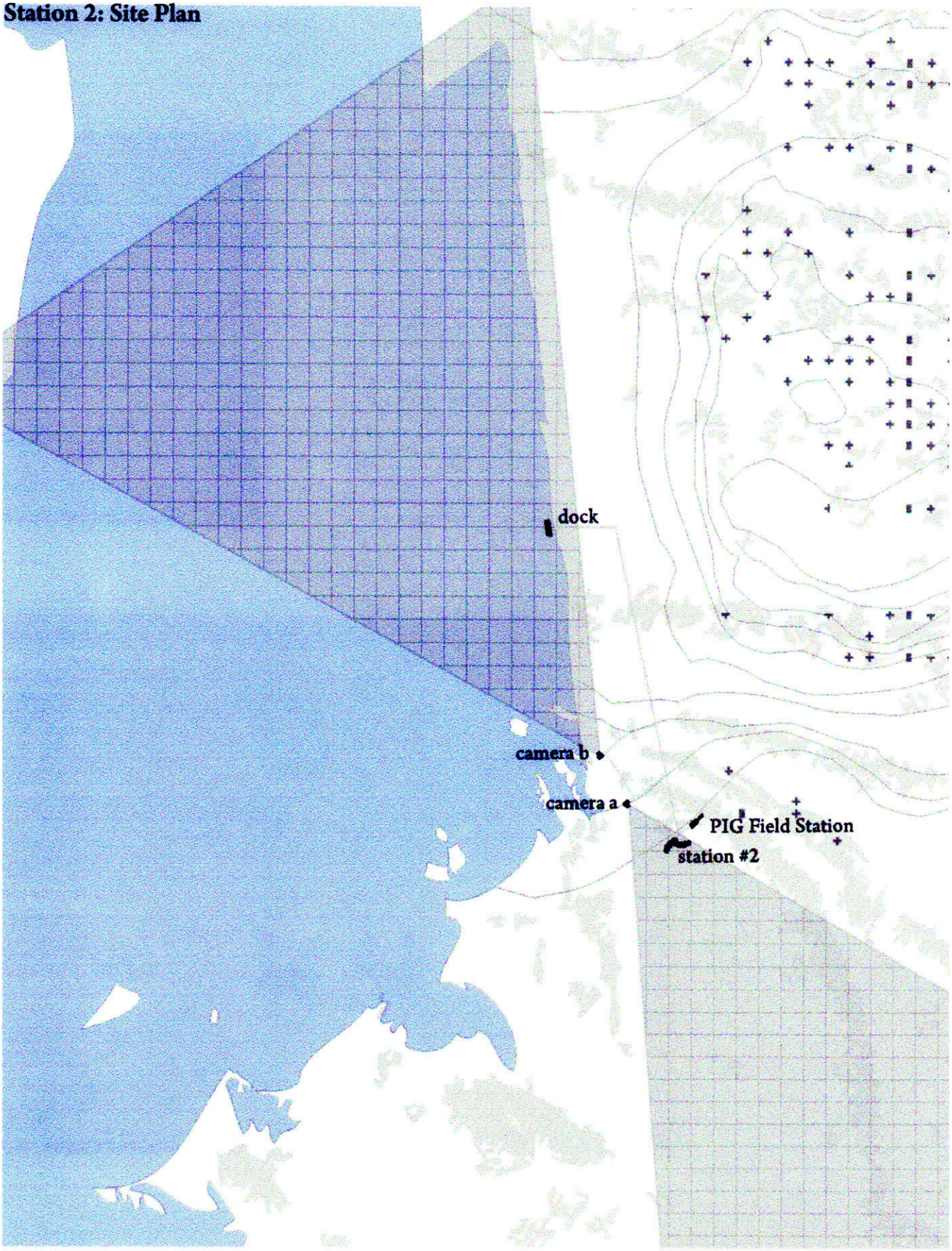
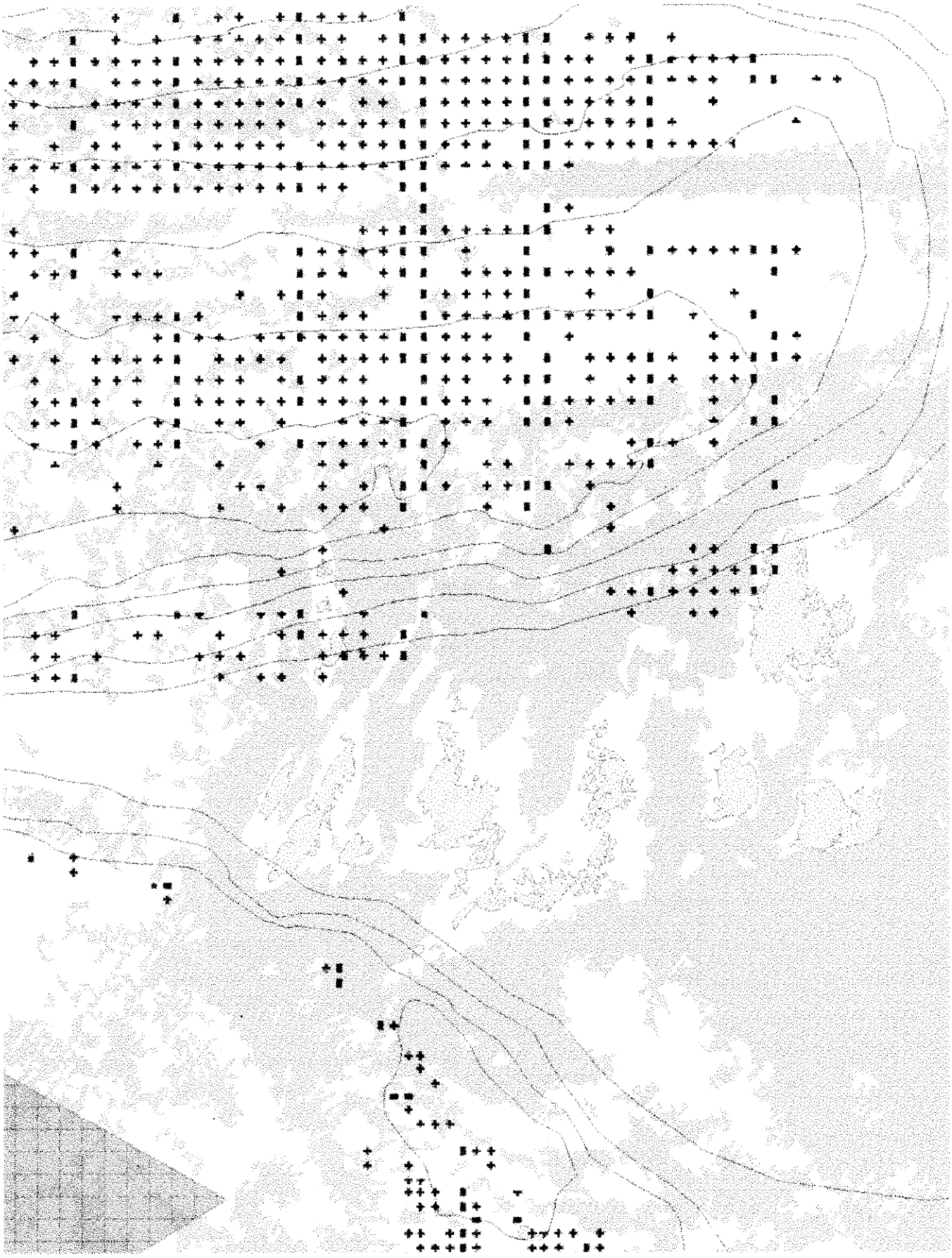


PIG Field Camp, View from Camera A



Station 2: Site Plan



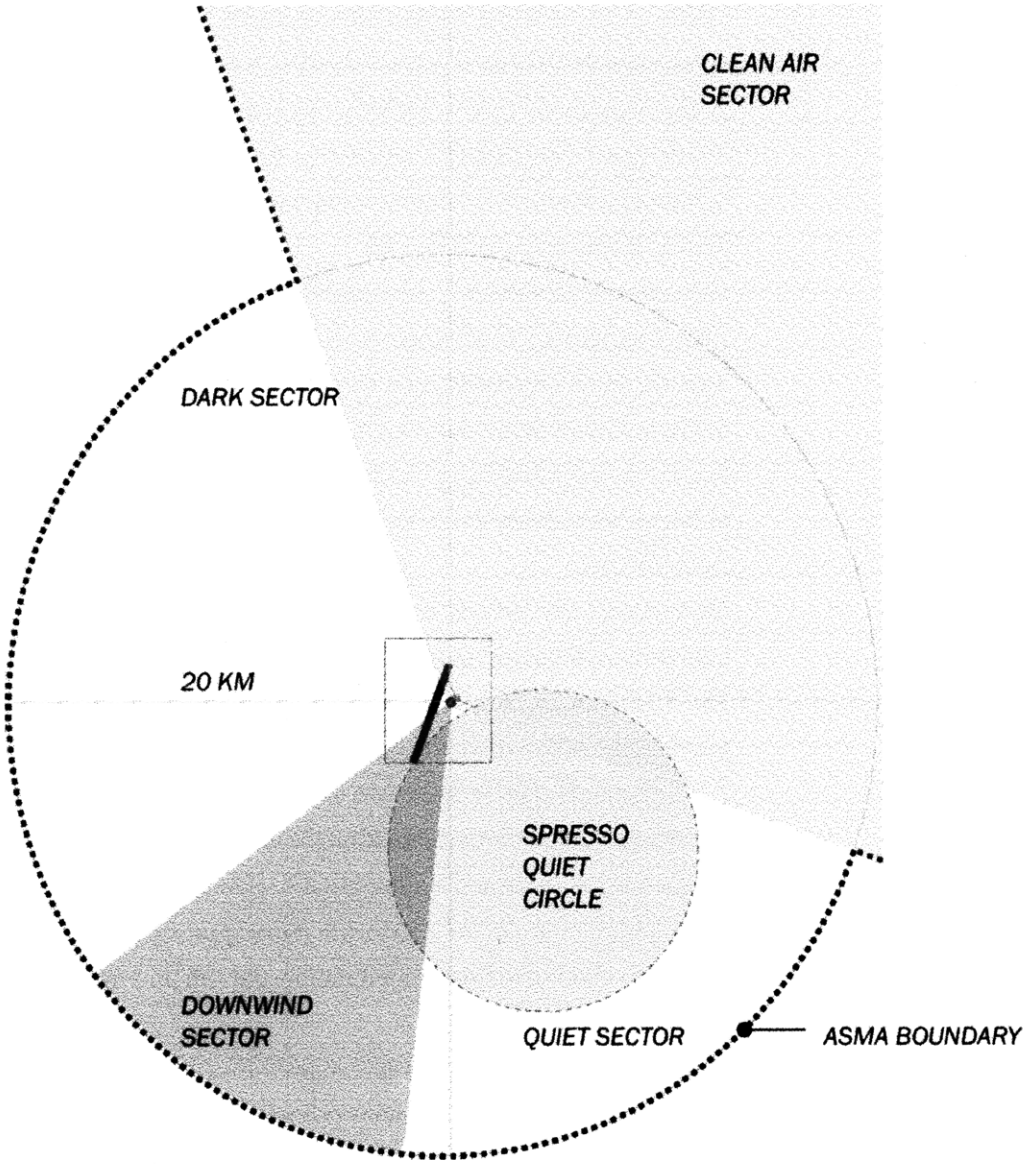


Station 3: The South Pole.

Siting of Station 3 takes into account the constraints presented by the United States Government Office of Polar Programs (overseer of Amundsen-Scott South Pole Station at the South Pole) as presented in their 2007 Management Plan for Antarctic Specially Managed Area No. 5, Measure 2 , Annex A.

This map illustrates the peculiar zoning at the South Pole – specific areas are designated for different types of scientific research as a means of minimizing interference. Each zone has very specific regulations concerning the types of environmental effects that may be produced in that sector. For example, in the Quiet sector, noise and equipment activities are limited so as not to disturb seismology and other vibration-sensitive pursuits. Activities in the Dark Sector must not interfere with established levels of light pollution or electromagnetic interference, etc.

Station 3 is sited in the Downwind Sector, an area in which both scientific and operational activities are permitted, provided they do not create obstructions for balloon launches or aircraft operations. The facility is located along a secondary designated polar approach route -- 205° E of grid north. (The primary approach route is along a 204° E of grid north, and is designated with visibility markers). Station 3 is located in relatively close proximity to the existing compacted-ice airstrip, but outside of the US Operational Zone.


CLEAN AIR
SECTOR
DARK SECTOR
20 KM
SPRESSO
QUIET
CIRCLE
DOWNWIND
SECTOR
QUIET SECTOR
ASMA BOUNDARY

Measure 2, Annex A 2007 (Excerpted)

Management Plan for Antarctic Specially Managed Area No. 5: Amundsen-Scott South Pole Station, South Pole

1. The South Pole is located on the polar plateau at 90° S.

2.The ice sheet at the South Pole is constantly shifting, and moves the ASMA no. 5 approximately 10 m each year towards the Weddell Sea.

3. The Ceremonial Pole – symbolic of all expeditions that have reached the South Pole -- is designated as HSM (Historic Site or Monument) no. 1.

4. Although the exact location is unknown (given that it is buried under ice) Amundsen's Tent is designated as HSM no. 80.

5. An area of 26,400 km2, encompassing the Amundsen-Scott Station and monitoring sites is designated as an Antarctic Specially Managed Area (no. 5) to manage human activities for the protection of scientific, environmental, and historical values.

6. The boundary of the Area is a circle around the South Pole Station with a radius of 20 km, and a wedge extending 150 km from the Atmospheric Research Observatory (ARO) building, bounded by 110° and 340° from the ARO. This wedge makes up the Clean Air Sector (CAS).

[Pollutants from aircraft and other sources in polar regions can travel hundreds of kilometers, affecting measurements of boundary layer air and contaminants in the snow. The ARO building is situated upwind of the station and the 150km radius of the CAS provides the necessary buffer for ensuring accurate measurements.]

7. The point of origin of the ASMA and sectors (other than the CAS) is designated as the circular aluminum tower staircase on the elevated station, as this is a readily recognizable feature on the maps and on the ground. [Due to the movement of the ice sheet, the geographic location of the ASMA will move approximately 10 m per year. All sectors are defined in relation to the elevated station and will thus maintain their positions relative to each other.]

8. There are four types of managed zones within the area.

9. The Operational Zone contains primary human activity. Scientific activities may be conducted in the Operational Zone if they do not conflict with operational activities.

10. The Scientific Zone has been established to protect certain types of scientific activity from disturbance. Operational activities may be conducted in the Scientific Zone if they do not conflict with Scientific Activities.

11. The Scientific Zone contains four sectors. Where two sectors overlap, the procedures for all applicable sectors apply.

12. The Clean Air Sector is bounded by a line extending 340° from the SW corner of the ARO building and another line extending 110° from the SW corner of the ART building. The De-Motorized Zone is an additional semi-circular area extending 50 m downwind of the ARO building. No aircraft operations are allowed within 2 km of the snow surface in the CAS.

13. The Quiet Sector is an area where noise and equipment activities are limited for seismology and other vibration-sensitive pursuits. The Quiet Sector extends out to 20 km from the elevated station, occupying the area in between the CAS (110°) and the Downwind Sector. It also includes the SPRESSO quiet circle, with a radius of 7.25 km drawn from the SW corner of the SPRESSO facility, which is located 8 km SE of the elevated station.

14. The Downwind Sector was established to provide an area free from obstructions for balloon launches, aircraft operations and other activities. Both scientific and operations activities are permitted. The Downwind Sector extends 20 km from the elevated station and is bounded by the Quiet Sector and the Dark Sector.

15. The Dark Sector was established to preserve conditions of low light pollution and low electromagnetic interference. It is bounded by the Downwind Sector and the CAS (340°). The South Pole VLF (Very Low Frequency) antenna is located within the Downwind Sector; its location will vary slightly from year to year, but in November 2003 its north end was located at: 89° 57.3813' S 15° 45,1500' W.

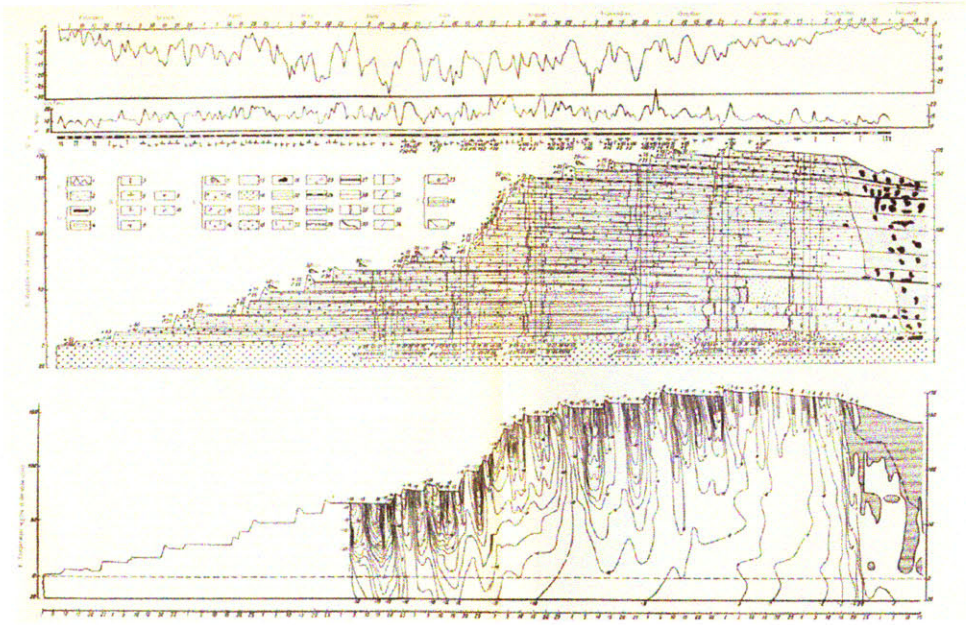
16. The Historic Zone encompasses sites designated for their historic value; it includes HSM 1 and HSM 80. The Historic Zone is located within the Operations Zone, but may be expanded in the future.

17. The Hazardous Zone is designated to safeguard hazardous sites found in and around the original (1957) South Pole Station; entrance to the Hazardous Zone is prohibited at all times.

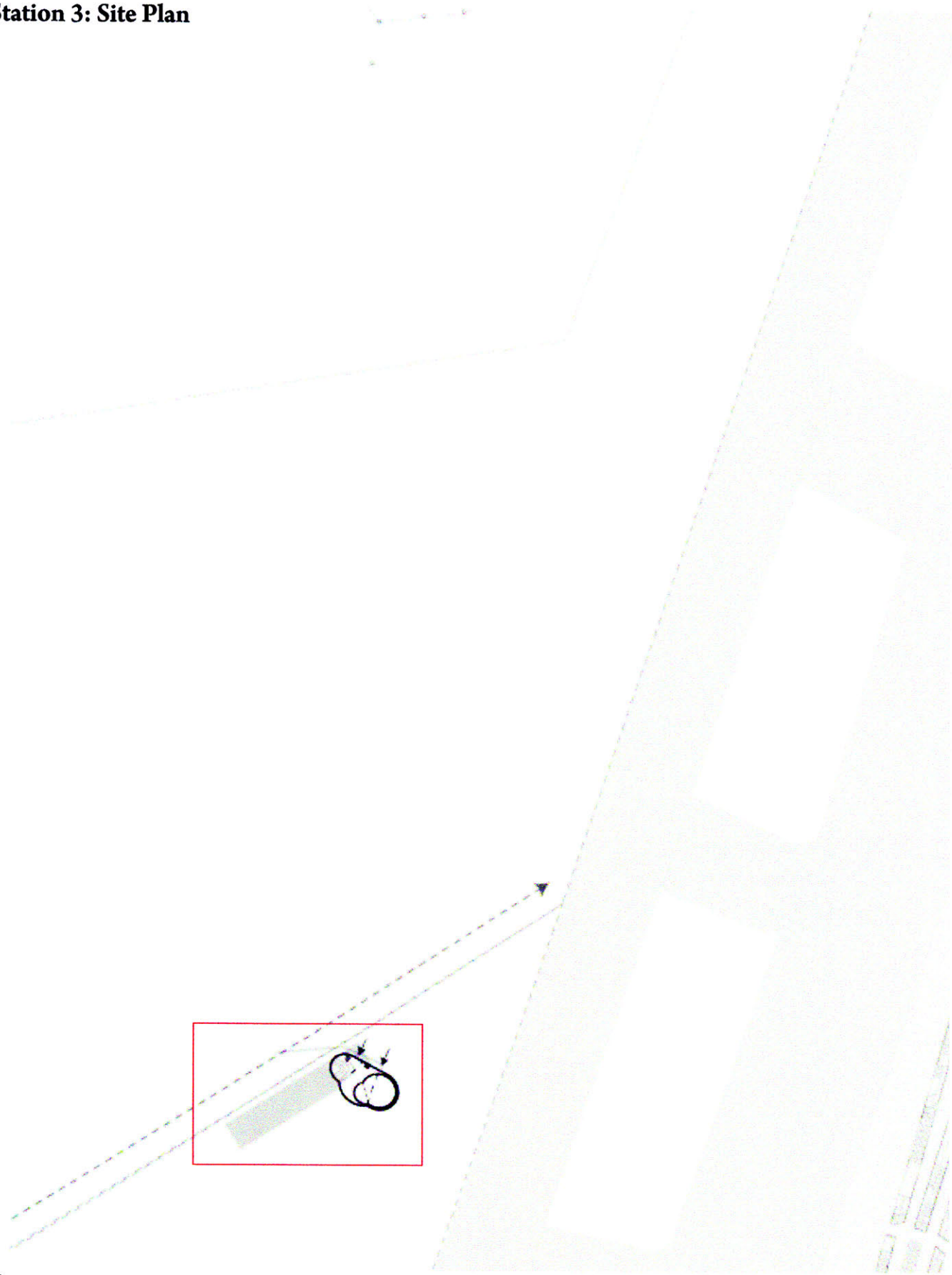
18. All approaches to the Area should be made along a route 204° E of grid north.

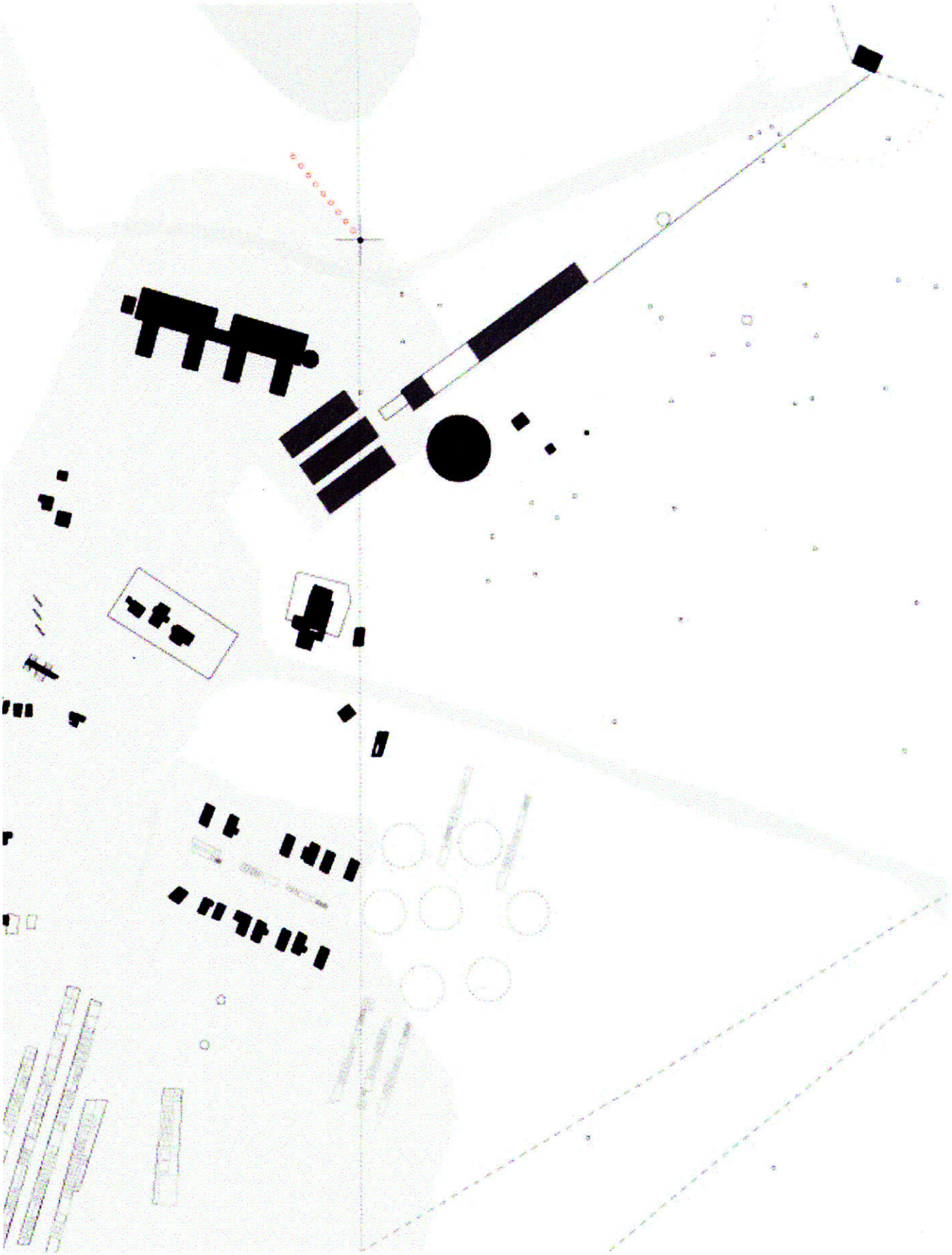
19. Visibility Marker are located at regular intervals along the following bearings (°E of N): 113, 204, 270, 353.

Sectional Temperature Data taken from Polar Ice Sheet

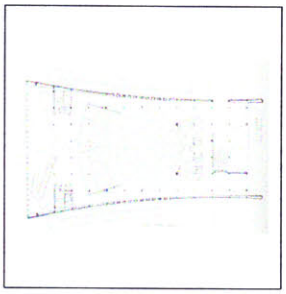


Station 3: Site Plan





Precedents:
Global Public Spaces



UN GENERAL ASSEMBLY
Institutionalized "Randomness"

Each country assigned same number of chairs for delegates; country sitting front & center position decided annually by lottery; other countries organized alphabetically. (source: James Graham, UN expert.)

PARIS WORLD EXPOSITION, 1867
Symbolic Egalitarianism

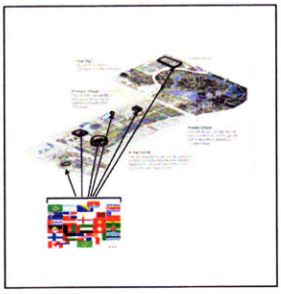
Country expositions organized radially to fill circular plan; amount of space delegated depends on esteem in which french government holds given country. (source: haron.sfsu.edu/publications/PARISEXPOSITIONS)

WORLD CENTER SCHEME
Formal "Universalism"

A 'international form' that claims to be universal enough to transcend boundaries. [see also: the international style]

VENICE BIENNALE
Pavilion-Model

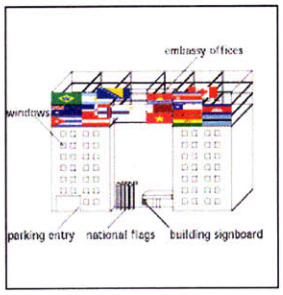
Each country occupies its own designated space; but all doors are open to cross-cultural traffic.



BEIJING'S OLYMPIC GREEN

International by program

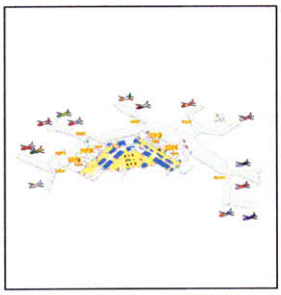
A space made global by virtue of its (temporary) program:
a series of venues (temporarily) inhabited by people from all over the world.



TOKYO EMBASSY

International by Necessity

Each country occupies its own designated space in close proximity to others; international interaction not necessarily encouraged or anticipated...but might happen in the elevator. (source: Atelier Bow Wow Found in Tokyo)



SCHIPHOL AIRPORT

International by accident

International passengers from global locales de-board planes and pass through terminal on their way elsewhere.

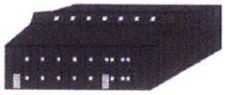
EPCOT

Hybrid

With its reputation as a tourism destination, its country-themed pavilions, and its geodesic dome, Epcot combines aspects of the program-driven, pavilion, formal, and symbolic models.

Precedents:
Antarctic Building

Case Study #1



SUMMER ACCOMMODATION MODULE

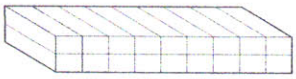
Davis Base [AUSTRALIA] | AANBUS | 2007

capacity : 58 people -- 38 accommodation rooms, 20 of which have a 2nd 'air transit' bed; ablution and laundry facilities, storage, desk space

Logistics

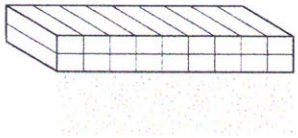
prefab construction from 18 x 40' containers allow structure to be shipped on Vasiliy Golognin 2006 re-supply voyage, and make possible quick construction and future expansion

Heat Loss



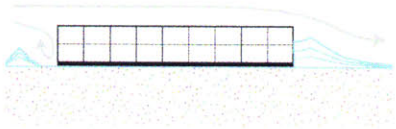
modular containers joined together to reduce amount of surface area; 100mm thick polystyrene insulation panels

Foundation Stability



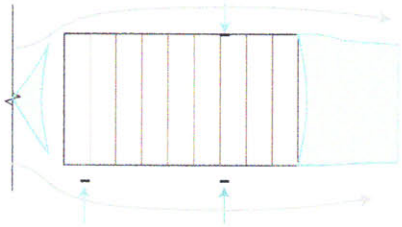
soil: mixture of gravel moraine and rock outcrop do not contain substantial ice; building placed on ground

Snow



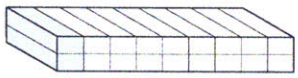
building oriented so that long sides are parallel to prevailing winds [buildings also arranged parallel to each other] Drifts form up+downwind of building, but access between remains clear

Entry



entrances designed so that dominant wind blows across (areas of least amount of snow accumulation)

Emergency Preparation



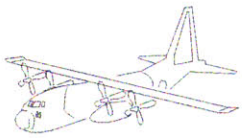
modules can be shut off from one another to isolate problem areas; 2 additional containers provide internal fire stairways; structure kept under 500m2 to avoid necessity to install sprinkler system [which would require heating building year-round]

Case Study #2

AMUNDSEN-SCOTT STATION | South Pole [USA] | NSF |2008

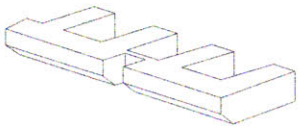
summer capacity : 104 people - winter capacity : 48 people - kitchen - serves 150 during summer and can accommodate 265 days worth of supplies for 50 people eating ~5000 calories per day; bio med unit [impossible to fly out during the winter]

Logistics



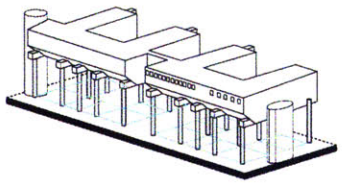
every piece of the station and all machinery required to construct it was flown in on a ski-equipped Hercules LC-130 plane with maximum cargo capacity of 11.5x2.4x2.4m [38x8x8 ft]

Heat Loss



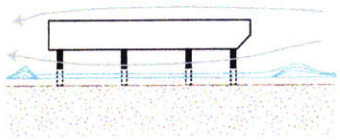
mixed use programming consolidated into one facility to minimize exposure to the elements; much of facility can be closed down during winter to minimize energy needs

Foundation Stability



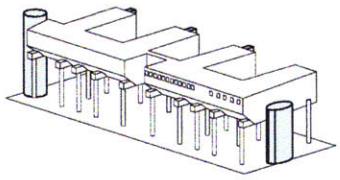
3.21 kilometers of ice underfoot; this ice is slowly flowing towards the ocean at 10.5 m per year; a 1.8m foundation was built from .15m increments of highly compacted ice. station 'floats' on lattice of 50 grade beams that distribute the weight of the building and elevated, supported by 36 3.5m high columns.

Snow



columns equipped with 50-ton hydraulic jacks that can raise structure 24 feet as snow accumulates to increase life of the building by 30 years; structure profile shaped like airplane wing facing prevailing wind [15mph]; Venturi effect causes snow to blow under station instead of accumulating

Entry



entrance elevated above ice sheet and enclosed

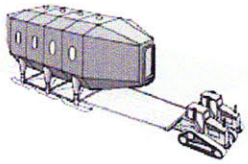
Emergency Preparation

no information available

Case Study #1

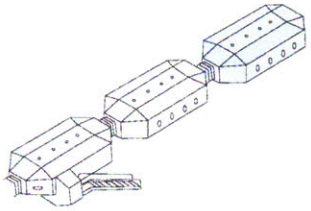
HALLEY VI [under construction] | Brunt Ice Shelf [UK] | BAS | Faber Maunsell+Hugh Broughton Architects | Accommodations modules: summer capacity : 52 people - winter capacity : 16 people; Command module: communications room, surgery; Main module: lounge, dining room, kitchen, food storage; gym, tv room, conference area; Energy modules [resupplied annually]; Science modules [offices, labs]

Logistics



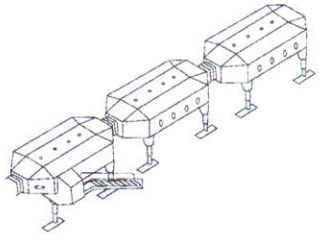
eight individual [and somewhat-standardized] modules linked together in a linear composite structure; large pre-made sections reduce construction work on site [bedrooms pre-made as 'pods' and placed on steel space frame]; module legs mounted on skis, enabling towing by bulldozers.

Heat Loss



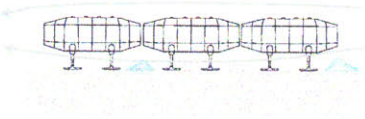
pods can be shut down or eliminated as needed to reduce energy use; pod geometry has good surface to volume ratio.

Foundation Stability



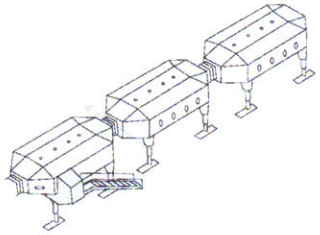
each pod is supported by a pre-fabricated steel space frame, sitting atop hydraulic ram legs; if unstable ice is encountered beneath the structure, it can be moved elsewhere.

Snow



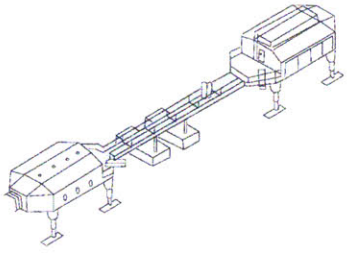
pods are aerodynamic in cross section and elevated above the ground plane to prevent snow accumulation; linear structure is situated perpendicular to prevailing winds; once a year the structure will be raised as snow is bulldozed out from beneath the supporting columns.

Entry



entrance elevated above ice sheet and shielded from prevailing winds

Emergency Preparation



the eight modules are divided into two wings, separated by a raised walkway ['link bridge'] designed to stop the spread of fire; three existing buildings were moved to the site to serve as emergency shelters.

Design Principles

Recently constructed facilities served as a means of understanding relevant building constraints, as well as some tested strategies for confronting Antarctica's extreme climatic conditions. Cross-referencing the strategies employed in these facilities with the Arctic design principles outlined by Eb Rice's *Building in the North*, and Harold Strub's *Bare Poles : Building Design for High Latitudes*, led to the extraction of a series of "principles" for Antarctic construction.

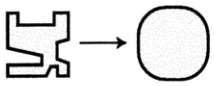
Logistics

1. use what's there

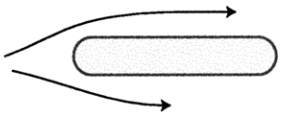
2. use prefab components
[which are quick and easy to assemble; small and light to ship]

Heat Loss

1. minimize surface area to volume ratio



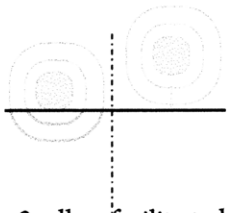
2. design aerodynamic profile and orient parallel to prevailing wind



Foundation Stability

1. distribute load (over ice)

2. elevate heated elements to avoid thaw bulb



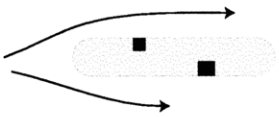
Snow

Option 1: allow facility to be buried over time

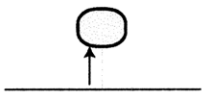
Option 2: allow facility to be moved

Entry

Option 1: locate entrances perpendicular to prevailing wind

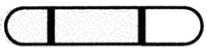


Option 2: enter from below

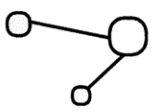


Emergency Preparation

Option 1: create one contiguous structure composed of self-contained segmented areas

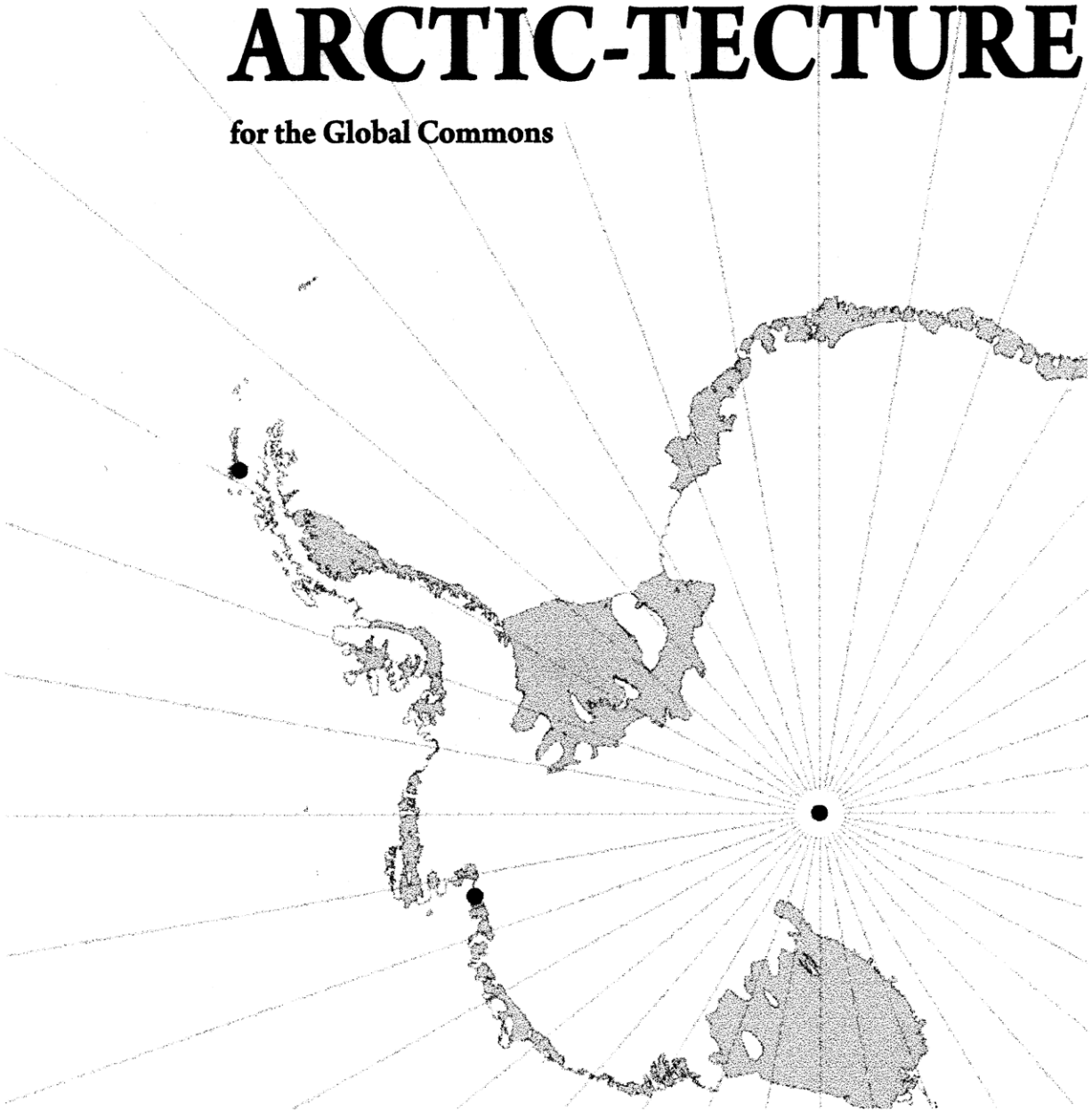


Option 2: create many different structures that are interconnected in some way.



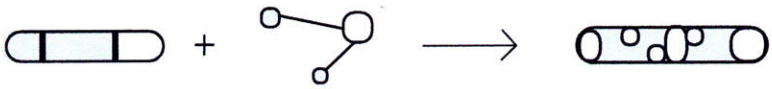
ARCTIC-TECTURE

for the Global Commons

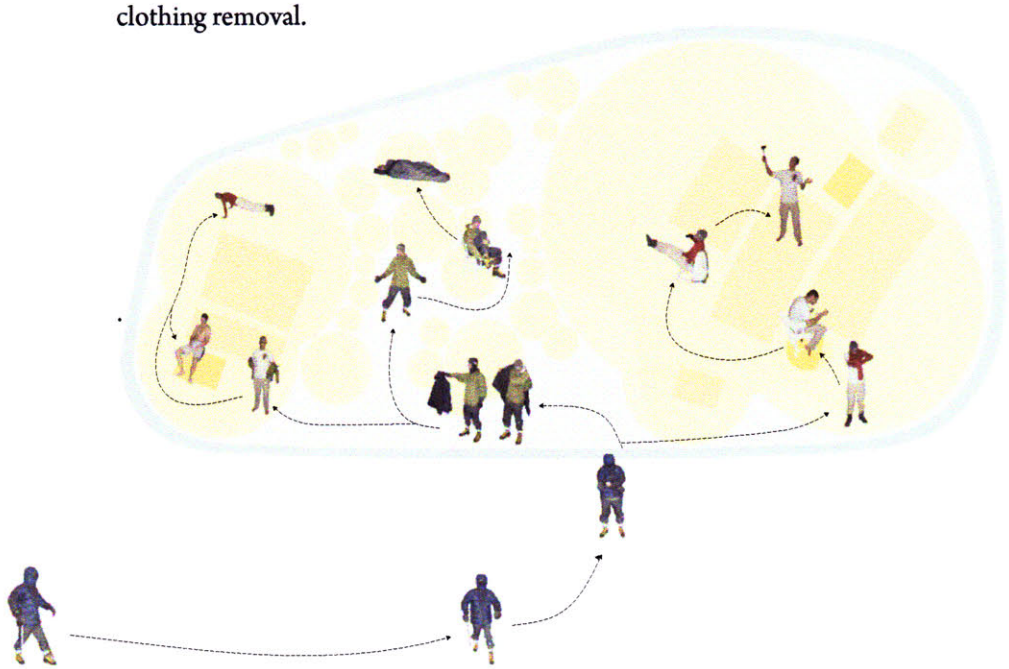


Programmatic Strategy

One programmatic and material strategy is developed and deployed across all three sites. The architecture is composed of a series of nested inflatables -- independent, pre-fabricated units located inside a larger structure. The program is organized according to specific temperature requirements, with warmer program components nested within cooler ones in order to maximize the amount of insulating airspace between warmer spaces and the exterior environment. This strategy combines multiple solutions used in the antarctic precedent projects consulted, in an effort take advantage of the benefits of both. The thermal benefits of one contiguous structure (with an optimized surface area to volume ratio) is combined with a plan for emergency preparation. In the even of an emergency, independent units can be closed off to isolate the problem while people are evacuated to another part of the structure. This same tactic doubles as a heating strategy; since self-contained spaces have independent temperature controls, unused spaces can be temporarily deflated or closed off, and need not be heated.



Inflatables are extremely lightweight to ship, take advantage of the high insulation value of air, and can be easily moved. Nesting programs and organizing them according to temperature variation, allows for a more efficient use of the heating system. For example, much of the circulation and storage space happens in colder areas. This nested organization prioritizes an awareness of both the internal environment of the building as well as the external environment of the site. It also choreographs a sequence of putting on and removing clothing that happens as occupant moves from colder to warmer spaces. Spaces are dimensioned with this in mind -- based upon a new graphic standard developed for clothing removal.

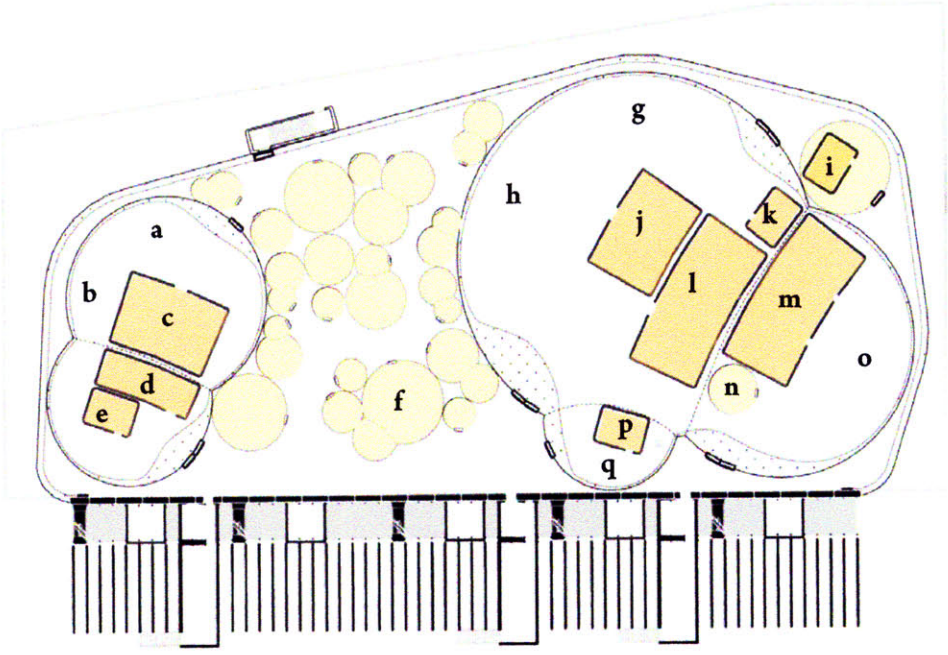


Station 1
Program

a] dining area
b] food storage
c] kitchen (hydroponic garden above)
d] bathhouse
e] sauna
f] rooms
g] viewing area
h] atrium/meeting hall
i] clean room
j] lounge
k] bathroom
l] gym/multipurpose room
m] benches
n] office
o] workshop and storage
p] surgical suite
q] clinic reception

Morpho POLAR PODS (temporary)

Prefab Wet Modules (fixed - with plumbing)

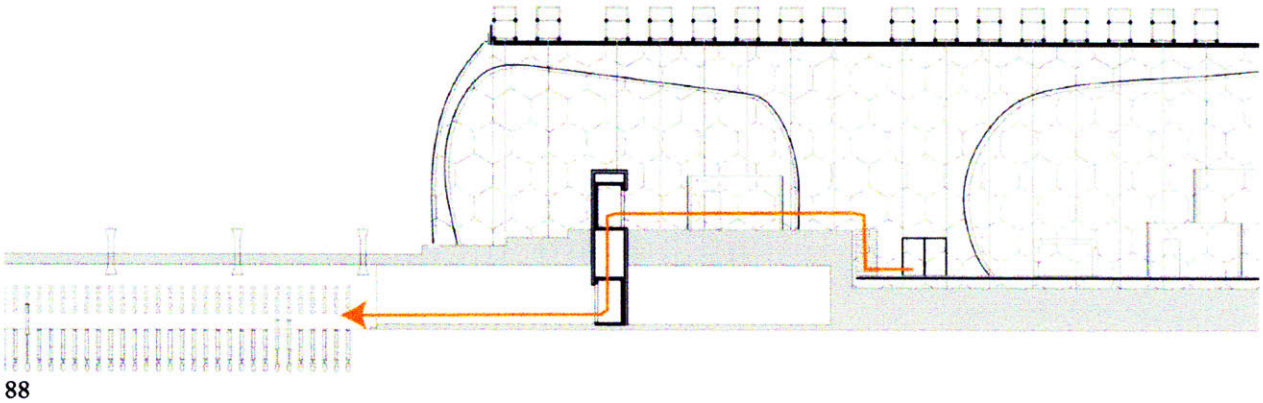


Morpho POLAR PODS

A line of temporary inflatable pods is developed to accommodate variation in inhabitation needs. These Morpho POLAR PODS are used for programs that do not need plumbing, such as sleeping and office space. Tourists can purchase their own POLAR POD to sleep in, or if they prefer, use one of the PODS stored on site. When not in use, extra PODS are deflated and stored, changing the interior landscape of the facility.

In order to deal with the problem of snow accumulation, the structure is elevated, sitting atop a foundation built from compacted ice. Construction of the foundations makes use of the same building method used in the building of Antarctic roads. Two different precedent-tested snow strategies are also combined -- part of the facility (the ice foundation) is designed to be buried in the snow, while the other part (the nested inflatables) is elevated above.

When possible this ice foundation is made inhabitable; for example, in Station 3 the walls and floor of the Biological Vault storage area are built entirely out of ice. (This allows the vault to make use of the existing site conditions for cold storage of its contents.) Although snow accumulation will eventually bury the vault altogether, a means of entrance through the elevated portion of the facility is preserved.



Inflatocookbook

An inflatable is an event, like circus tents used to be. Dogs bark, kids gather, old ladies get up tight, cops drift by, youths take off their clothes.
Inflatables are trippy, cheap, light, imaginative space not architecture at all. They're terrible to work in. The blazing redundant surfaces disorient; one wallows in space. When the sun goes behind a cloud you cease cooking and immediately start freezing (insulation schemes are in the works). Environmentally, what an inflatable is best at is protecting you from a gentle rain. Wind wants to take the structure with it across the county, so you get into heavy anchoring operations.

To give inflatables their well-earned due, they are wonderful recreational structures. High and scary but thoroughly safe. Like an immense water bed, or slow-motion trampoline, or squishy mountain. Person-flinging giddiness maker.

This book of Ant Farm's has all the basic design and materials information to puff up your own dream sky hill.
—SB

Inflatocookbook

$3.00 postpaid

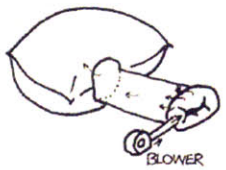
from:
THE ANT FARM
Box 471
San Francisco, Calif. 94101 or WHOLE EARTH CATALOG

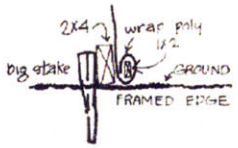
If your inflatable is going to be up outdoors in any wind, it will need an anchoring system. For small volume (500 sq. ft. of floor area or less) interior weights should work; these could be sand bags or water bags. Larger structures require heavier anchoring. There are a number of ways of doing it: integrally made tie downs, buried edge, weighted edges, taped edge, or tension net anchors. Buried edge is good for a semi-permanent installation where you can dig a trench. A taped edge is good for a small installation on a smooth floor, tie downs and tension nets are good for sites with existing things to tie to (trees, fire hydrants), or where it would be easy to drive tent stakes or augers.

The anchoring system must withstand not only windloading but also the internal air pressure of the structure. Precise structural calculations should be left to 2 engineers, 3 Ph.D., mathematicians, and a computer, but a little rough math can give you a close enough estimate of what anchors to use. We will deal first with inflation pressure and second with wind loads.

40' VINYL PILLOW Dielectrically welded vinyl pillow with double blowers, net, and earth-augur anchors. 2 doors, variety of colors and weight vinyl. $2,000–2,500. Rents for $150/day. Other sizes and shapes (see pentapus) made to order.

WARNING:
FUNKY GENERATORS EAT FAN MOTORS





A slit cut across the wrinkles will tend to spread open and leak air. Not recommended

Morpho POLAR PODS

from:
NEMO Equipment, Inc.
Nashua, NH
www.nemoequipment.com

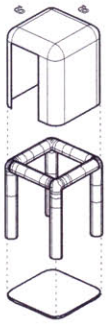
There is no substitute for confidence in your gear, especially in your shelter...That's why NEMO has adapted one of their most popular tents, the Morpho AR, for use in the Antarctic. The Morpho POLAR, a new model of inflatable nomadic dwelling is a perfect all-weather shelter for extended travel. With remarkable strength, easy setup, and beautiful simplicity, Morpho POLAR can handle it all: vicious blizzards, high winds, and frigids nights.

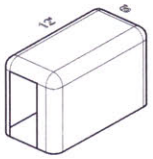
The Morpho POLAR's airbeams can withstand twice as much force as standard aluminum poles, which ontribute to the Morpho POLAR's outstanding performance in high winds.

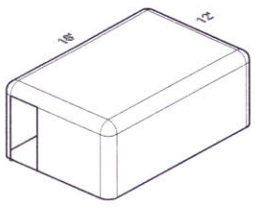
The Morpho POLAR IP, SUITE, and EXTENDED are sold with custom designed Nemoid Foot Pump, for faster inflating.

The Morpho POLAR is available in three sizes:

Morpho POLAR 1P.
At 6'x6'x7' and 4.8 lbs. the Morpho 1P is perfect for individual use and short term stays.
Morpho POLAR SUITE.
At 6'x12'x7' and 5.2 lbs. the Morpho SUITE is spacious for two.
Morpho POLAR EXTENDED.
At 12'x18'x7' and 7 lbs. the Morpho EXTENDED can be used for a variety of purposes.







Vinyl Cements

I have been developing a portable, collapsible, insulated shelter in which I have been using a nylon reinforced vinyl requiring a suitable adhesive.

I would like to advise the person who refers to himself as the 'Virginian' in Pax River, Maryland that Bostik Adhesive Specialists, a subsidiary of USM Corp. in Middleton, Mass., produces an excellent adhesive for vinyl. It is referred to as 4067 a nitrile rubber base adhesive and 7130, a synthetic resin base. Both are excellent and are often used industrially for vinyl inflatables.

James W. Smith
Providence, R.I.

The personal history that's still alive in my memory begins when I was twenty-two. When I was twenty-two I thought that what I wanted more than anything in all the world was to be a scholar, a student of literature, an expert on the metaphysical poets with particular emphasis on John Donne. I had a bachelor's degree but that didn't seem like enough. I felt like I'd got that degree without ever really reading anything, without ever really learning how to read. I wanted to read, to study, to experience the words of the masters. It seemed like such a gentle thing. The library, the department, the lectures, all were images of utmost quiet and tranquility to me then, and I wanted nothing more than to be quiet, to read and write and think, to live the classic life of the mind right here in the middle of the Twentieth Century.

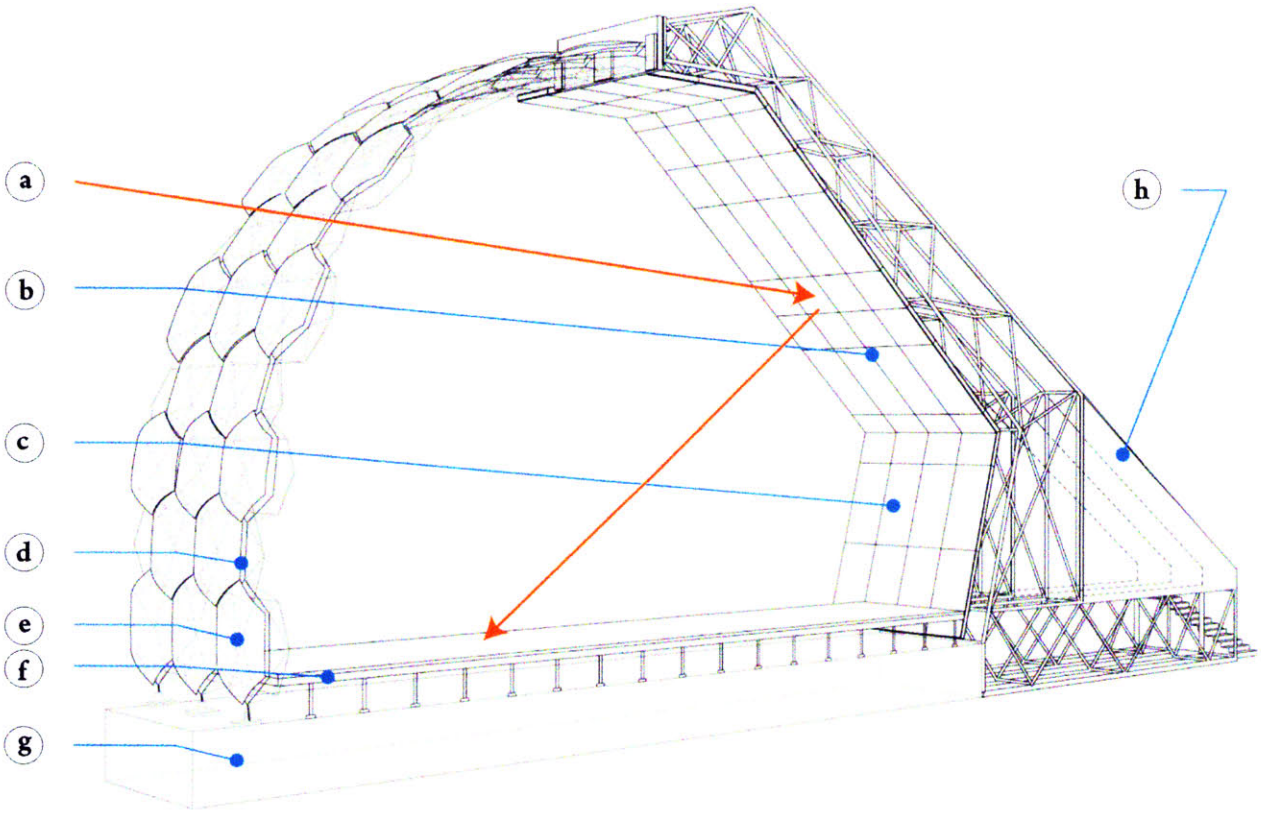
Graduate school was good the first year. I did okay in the classes, and I was into some personal writing that satisfied me. I didn't take myself seriously as a writer, you understand. But I enjoyed it, it was expression, and I felt like I had a whole lot to express. I remember writing a short story about a flower, a daffodil that learned how to sing. Every afternoon the daffodil would give a concert for all the other flowers in the meadow. The story was published in the campus literary magazine and a lot of people told me they thought it was pretty good.

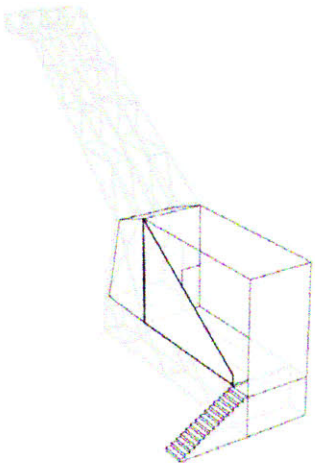
The problem with my career as a scholar was the Master's Thesis. I did well in the lecture courses and seminars, but I just couldn't hack that thesis. The reason I couldn't hack it was I really didn't want to write a thesis. I'd sit down and try to write about the metaphysical poets and every time I'd wind up saying stuff about myself. I worked over a year on that paper, and when I'd finished I had three hundred pages that simply told my life story from birth through graduate school. Of course I knew the professors wouldn't accept the manuscript as a thesis, so what I did was have it typed up professionally, and bound to look like all the other theses on the shelf. And one day I sneaked into the stacks and when nobody was looking I slipped it up on the shelf and left it there. Then a few weeks later I left the University, I left Norman altogether and entered the next phase of my life's adventure.

(continued)

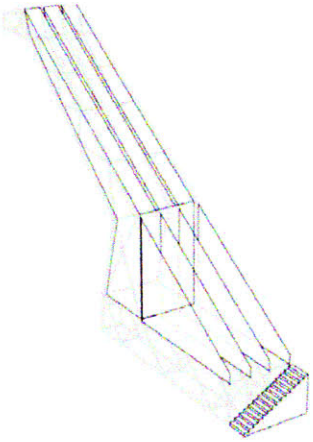
Structural System

All three of the facilities share a common cross section -- a curved inflatable wall, and a superstructure (a spine of trusses constructed from aluminum tubing) to anchor the inflatable in place. Typically, inflatable architecture relies on differential air pressure for structural support; an air pump runs continuously to elevate the internal air pressure above the external. However, this practice is not very energy efficient, since the air pump(s) must be running at all times. The inflatable system designed for this project -- a modified version of the technology employed in the Eden Project (Cornwall UK) is a better solution. Individual inflatable pillows made of ETFE are suspended within a hexagonal lattice frame, build from 3" aluminum tubing. Each of the ETFE pillows is inflated separately and sealed, so a continuous air pump is not required; additionally, damages to the inflatable surface are localized within an individual pillow, so the structural and thermal integrity of the entire structure are not compromised. Due to the extreme climatic conditions of the site, two layers of inflatable pillows are used. The exterior is hexagonal only; the interior is a combination of hexagonal and triangular pillows. The interior layer is used to avoid the existence of a thermal break at the connection point between the inflatable system and the spine (see detail drawings on page 111). This design prioritizes one direction, inscribing a diurnal cycle during the austral summer (during which there are 24 hours of daylight). For roughly 12 hours per day, the facility receives direct sunlight; solar radiation comes in through the ETFE pillows and is reflected off the back wall (SIPS panels with a reflective coating are hung from the truss-spine), maximizing the potential for solar heating.

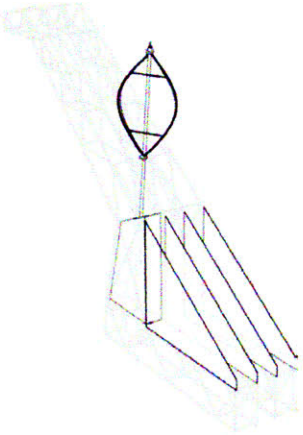




Entrance Module



Snow Melt + Water Collection Module

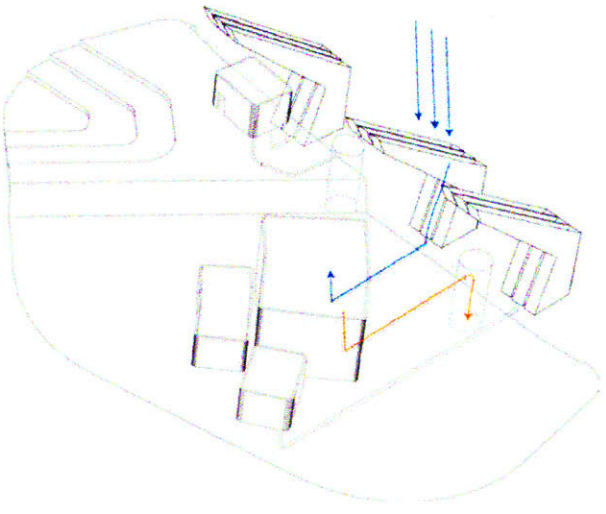


Vertical Axis Wind Turbine Module

Building facilities and mechanical equipment are localized in the spine. Three different modular units based upon the same truss-frame-- an entrance module, a snow melt + water collection module, and an energy generation module (with a vertical axis wind turbine) -- an are distributed along the spine; their locations correspond to the water and energy needs of various program modules within the structure.

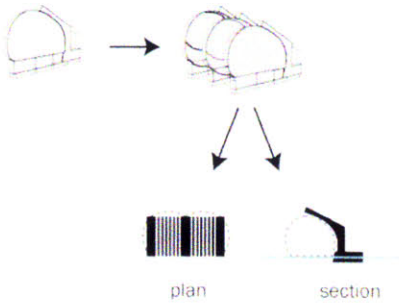
The water collection module has three troughs in which snow is collected. Solar panels on the inside of the structure help to generate enough energy to melt the snow and store the melt-water in tanks beneath the troughs. Sewage is piped underneath the elevated floor, frozen, and temporarily stored in buried cisterns beneath the spine until it can be moved to larger cisterns elsewhere.

a] incoming solar radiation
b] metallic coating to reflect incoming solar radiation and decrease heat loss
c] SIPS paneling
d] 3" aluminum tubing-hexagonal lattice
e] ETFE inflatable pillows
f] elevated floor to mitigate thaw bulb effect
g] compacted ice foundation
h] fins support snow pack (for counter-balance weight)



Formal System

A formal system is developed with the intention of minimizing overall surface area to volume ratio (to increase heating efficiency) and to create an aerodynamic profile (to minimize snow accumulation). As described above, the exterior form is (generally speaking) a large inflatable bubble held in place by a structural spine. The precise form of this bubble is determined by the placement and orientation of the trusses that make up the spine. A series of operations are deployed across the three sites in order to achieve particular formal effects that are appropriate to specific site and program conditions. In this way, each of the three sites becomes a test of certain formal operations, with regards to specific site conditions.



Operations

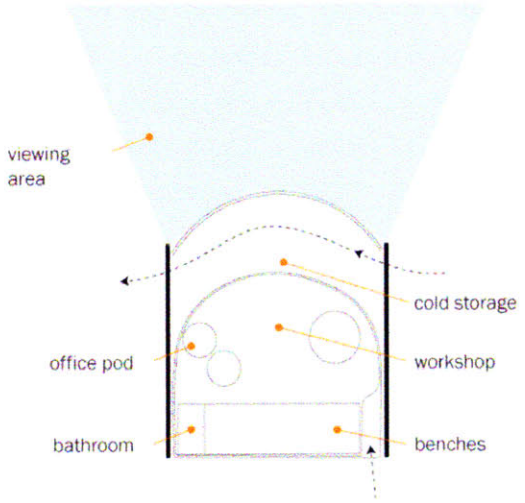
nest_
increase temperature

rotate_
max/min sun exposure

splay_
augment/diminish
view

pinch_
separate/join adjacent
spaces

sink_
submerge/elevate
structure



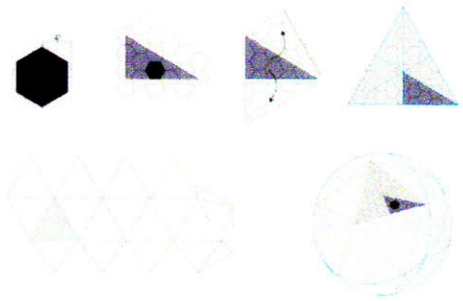
LAB MODULE
(plan)

For example, Station 2, which is primarily laboratory space and glacier monitoring infrastructure, is designed in such a way as to prioritize the act of watching the surrounding environment. The facility is oriented to maximize the amount of landscape that can be seen from within. A lack of corners and minimal obstructions produce a seemingly boundless view of the horizon.

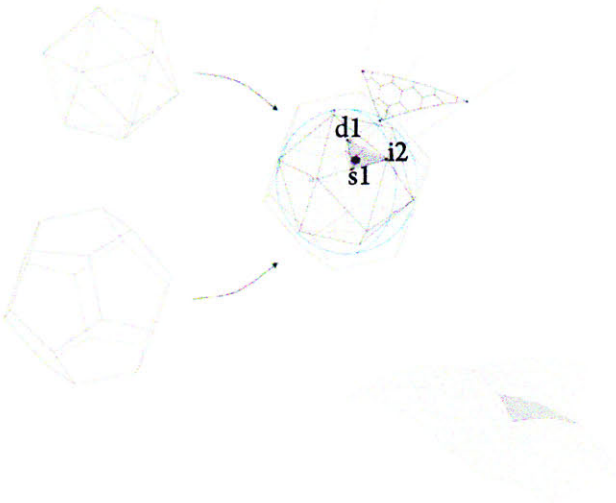
This facility is conceived of as a collection of lab module-units, each of which includes bench space, office pods, an open workshop area for large equipment, and a place for cold storage.

Bubble Geometry & Hexagonal Tiling

The form of the exterior inflatable wall is developed through a geometric system that is based upon the dimensions of an individual hexagonal frame-unit. A hexagonal system has structural benefits, and allows for better visibility than a triangular system would (due to fewer structural members). The geometric system is described below, and is based upon an initial choice of hexagonal frame size: one that can be inscribed in circle with radius of 4.' This initial hexagon is used to create a right-triangular unit that tiles in such a way so as to preserve the hexagonal pattern when the unit is reflected in any direction. This triangular unit, through reflection, can be used to build a larger equilateral triangle, copies of which can be used to construct a regular icosahedron[1] (or any number of other polyhedra.)



This regular icosahedron, along with its dual-pair,[2] a regular dodecahedron[3] are (respectively) circumscribed within and about a sphere. The original triangular unit is rotated and stretched so that its vertices are no longer planar to the face of the icosahedron, but rather are located at the points noted below: i2 (a vertex of the icosahedron), s1 (on the surface of the sphere), and d1 (a vertex of the dodecahedron). This new triangular unit (shown in grey) is the projected onto the surface of the sphere (an enlarged view is shown below).

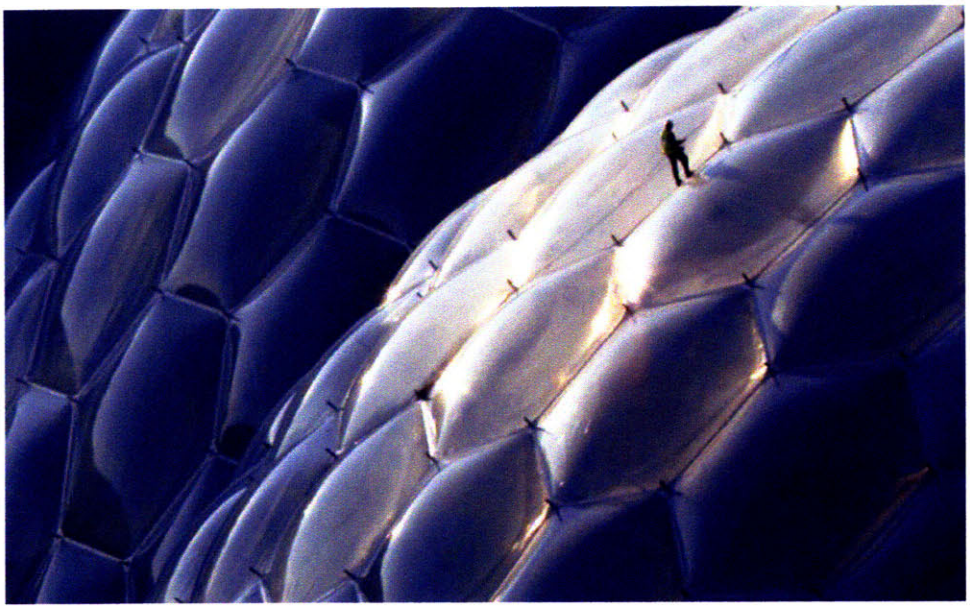


1 A regular icosahedron is a 20-sided convex regular polyhedron, the faces of which are all identical equilateral triangles.

2 Regular polyhedra are arranged into dual pairs; dual polyhedra are such that the vertices of one correspond to the faces of the other.

3 A regular dodecahedron is made up of 12 identical pentagonal faces.

The Eden Project
Cornwall, UK

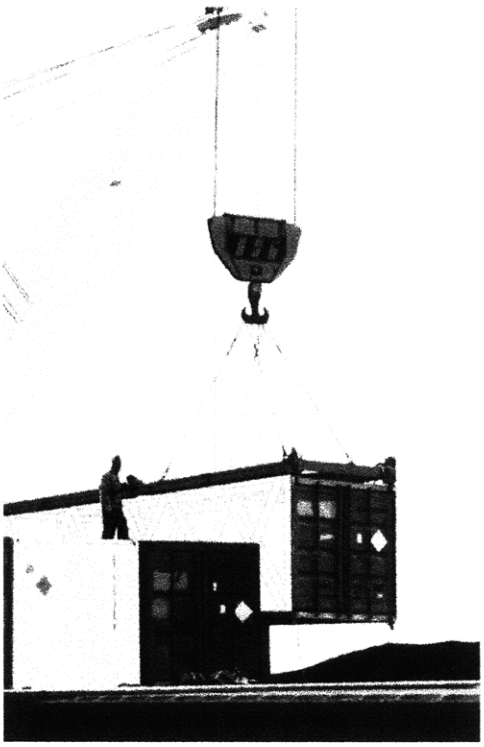


This new projected unit still maintains regular hexagonal tiling when reflected, but can now form double-curved surfaces. This general approach is then adapted to form the exterior bubble. In order to accommodate the program requirements, the base geometry is based upon three joined icosahedra instead of one. This method of deriving a hexagonal tiling minimizes the curvature of each individual hexagonal unit (which is better for the suspended ETFE pillows) and also standardizes the sizes of the aluminum tubing used to create the hexagonal framework.

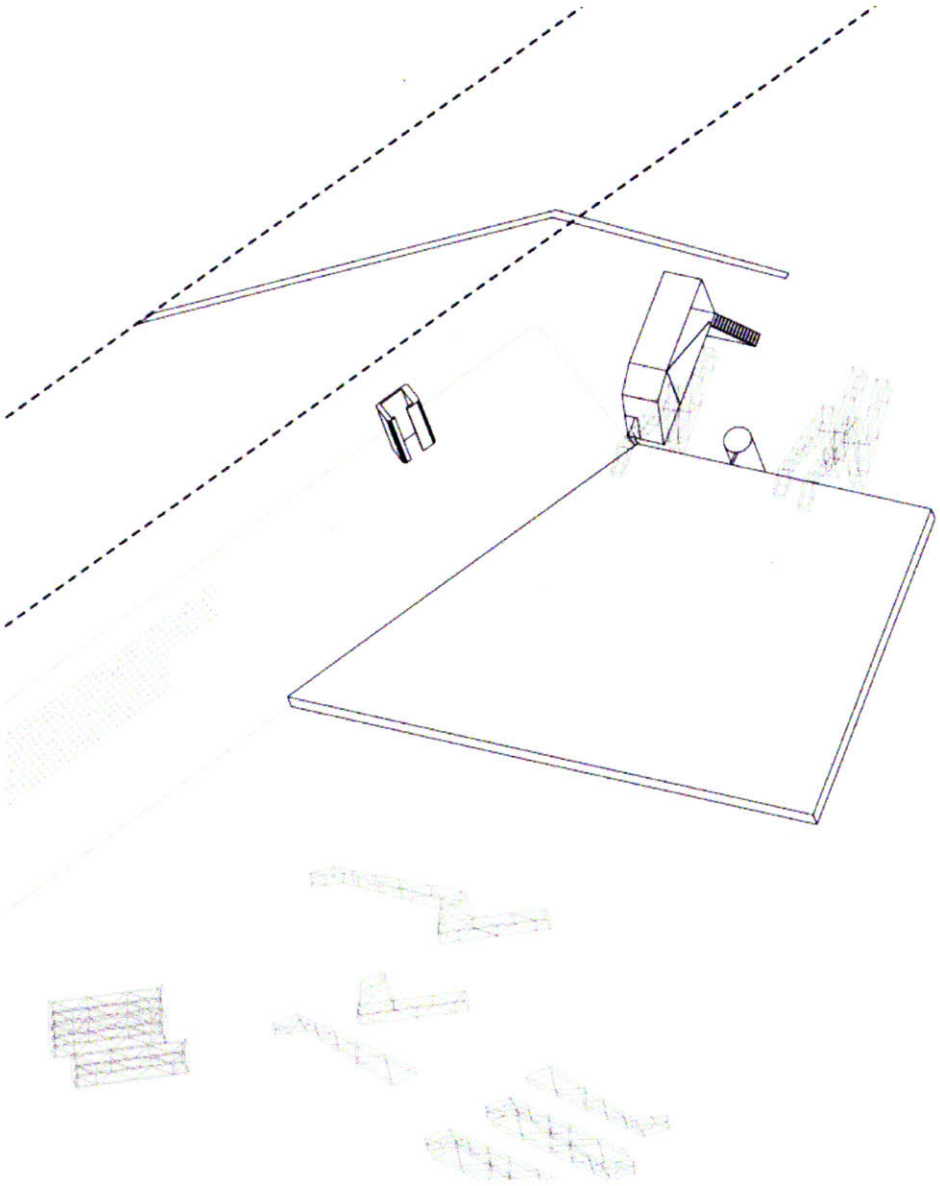
Logistical Strategy

The logistical strategy is based upon an attempt to make use of whatever is already available on site, in an effort to minimize the exorbitant cost of shipping construction materials to Antarctica. The building foundations are all made out of compacted ice that is mined on site and formed into large blocks. This same ice-masonry technique is used to construct the Biological Storage Vault at Station 3. Ice and Snow are also used in the structural spine to add mass to the trusses. As precipitating snow accumulates, it fills the spaces between the snow fins on the backside of the trusses, acting as a structural counterweight. (On the other side of the building, the shape of the exterior inflatable skin will help to minimize snow accumulation; that which does accumulate can be blown off by a low-flying helicopter.)

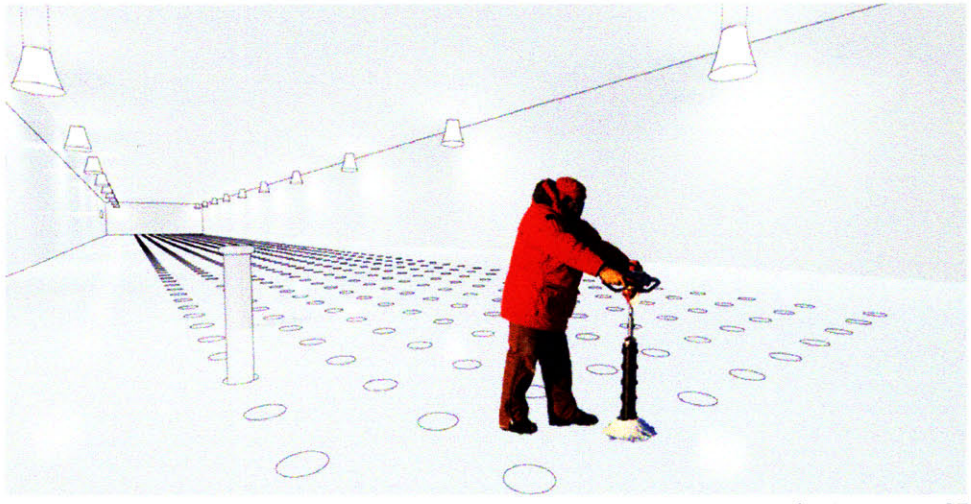
Those materials that must be imported from elsewhere are lightweight and require minimal assembly on site. The trusses and hexagonal lattice, made from hollow aluminum tubing, are built from a standardized kit of pre-fabricated parts, all of which are small enough to stack in standard shipping containers. ETFE is also very lightweight to ship, and the inflatable pillows make use of another (the only other?) building and insulation material natural occurring on site: air. In the Vault, biological contents are stored in custom designed cylindrical shelving units that fit into holes drilled into the ice floor using a standard ice corer (machinery which is already on site). This way, the facility takes advantage of the site itself -- and the 2 mile thick ice sheet underfoot -- as a means of cooling the Vault contents.



Kit-of-Parts assembly

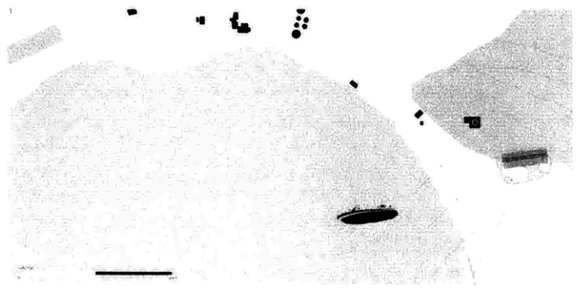


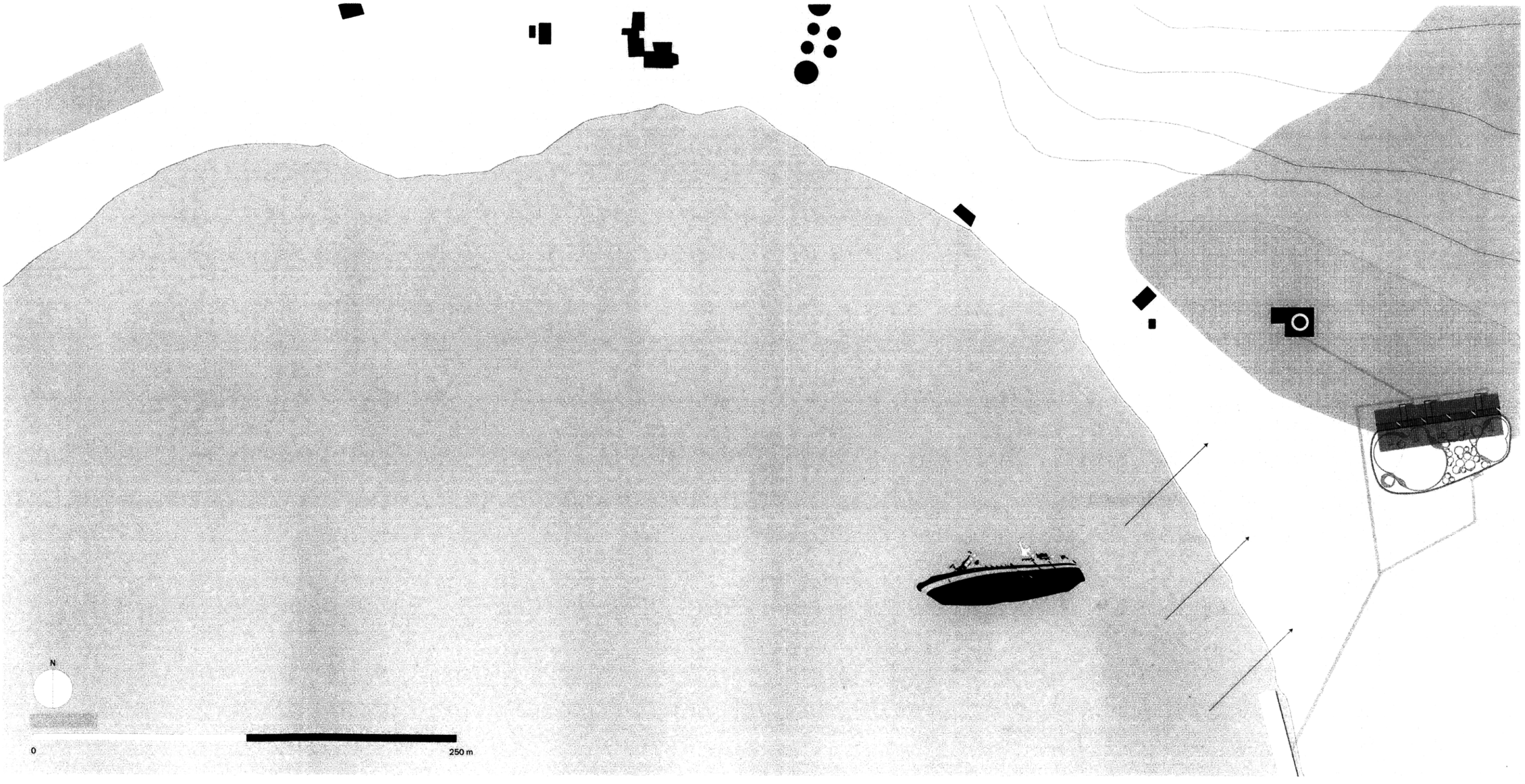
Standard Ice-Corer used to drill holes for Bio Vault storage



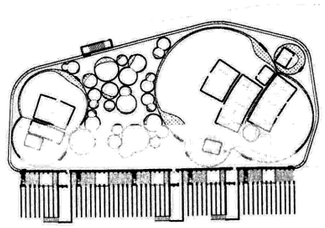
Station 1: Global Commons for Tourism

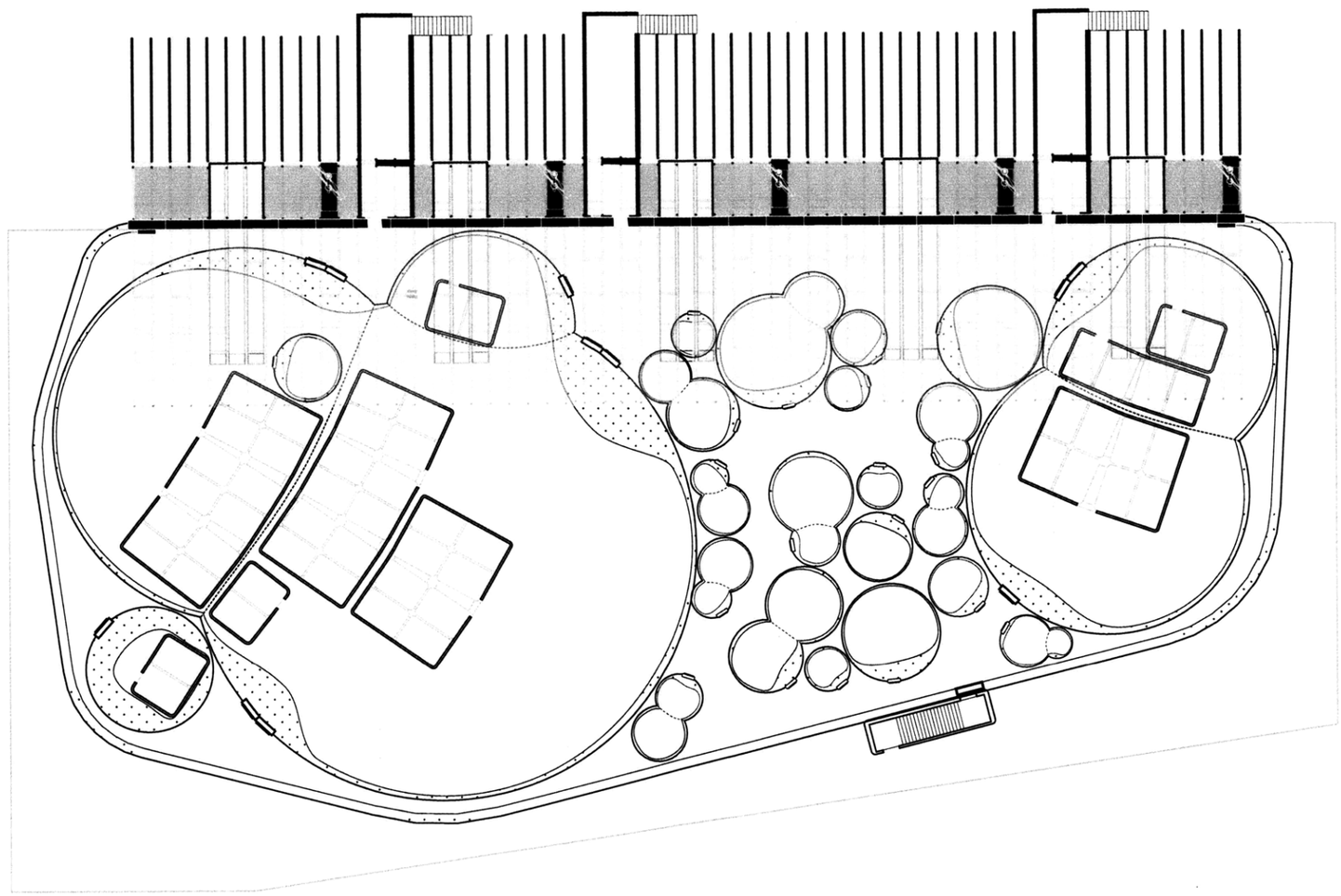
Program: Hotel and Medical Clinic
Site: Whaler's Bay, Antarctic Peninsula



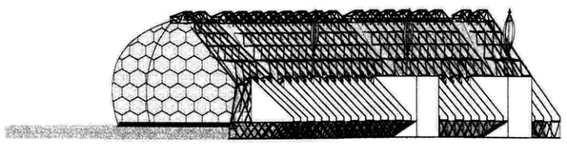

N
0
250 m

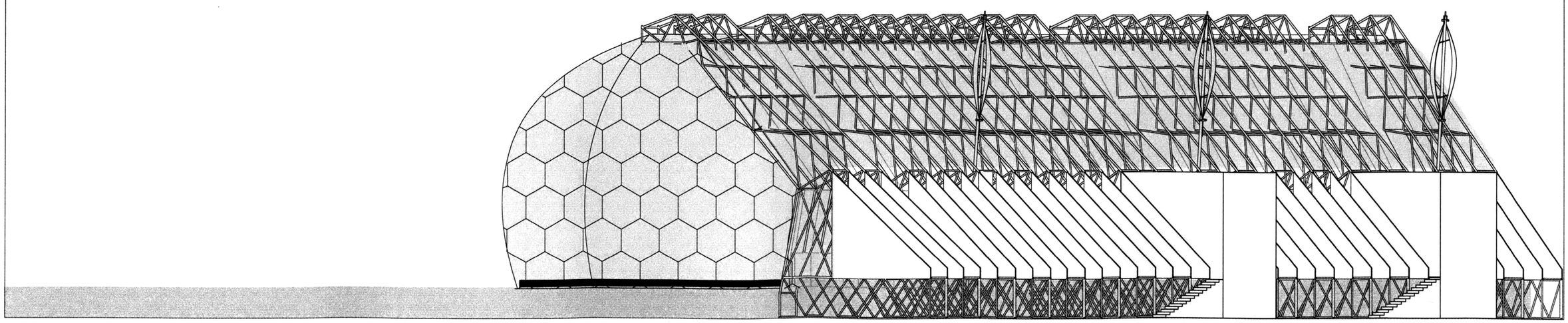
Station 1: Plan
1/32" = 1'



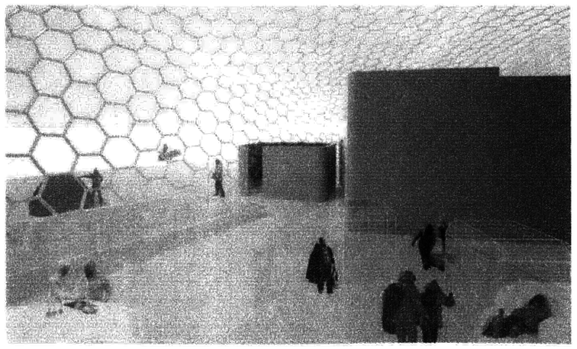


Station 1: Elevation





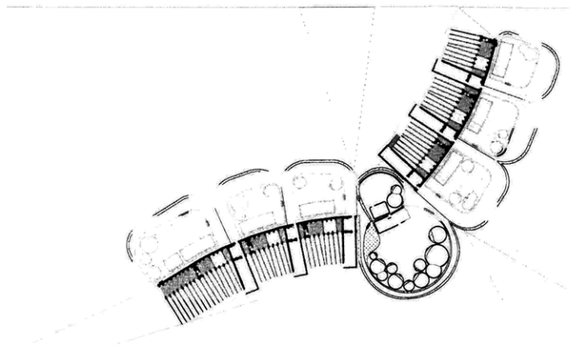
Station 1: Interior View

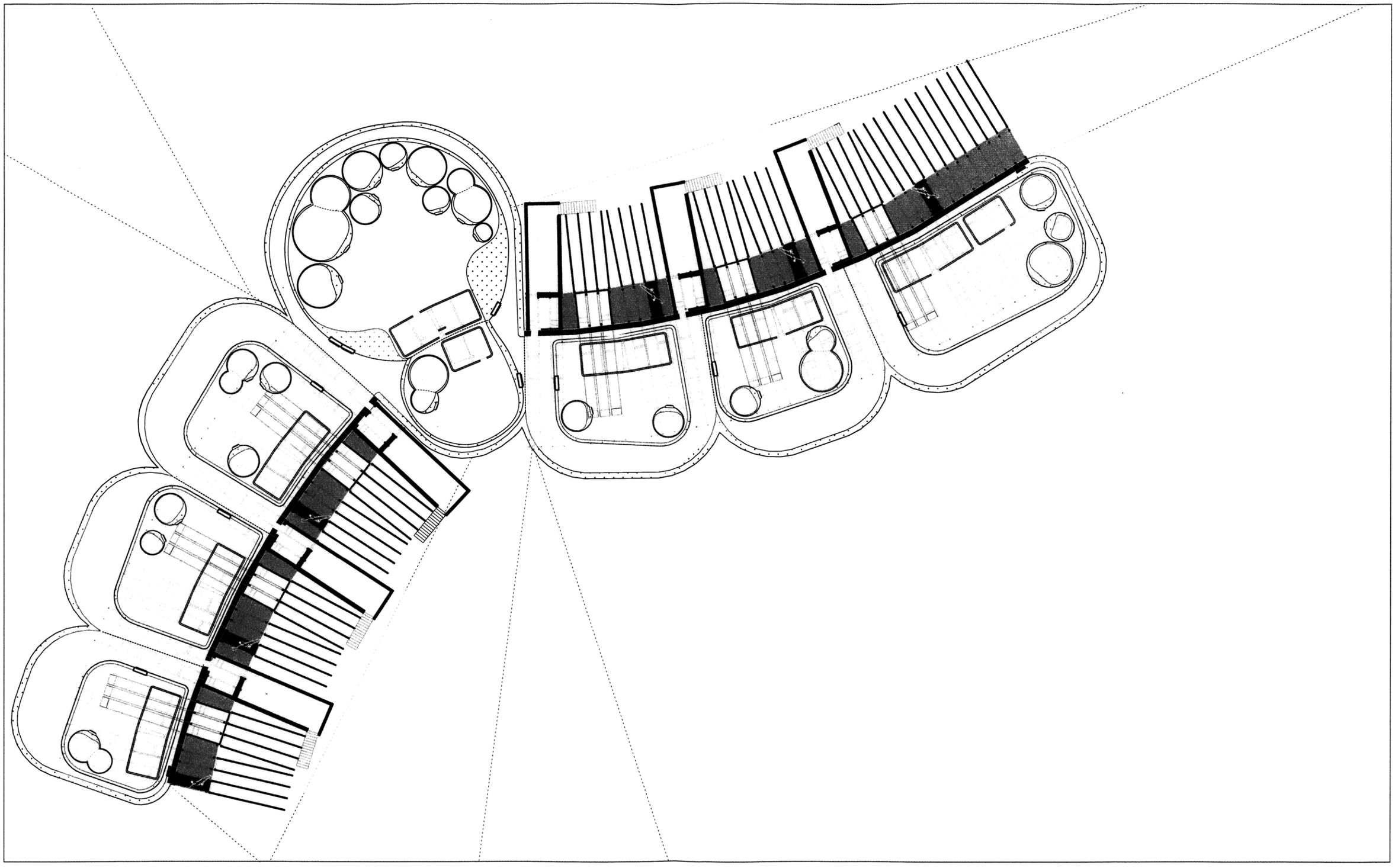


Station 2: Plan
1/32" = 1'

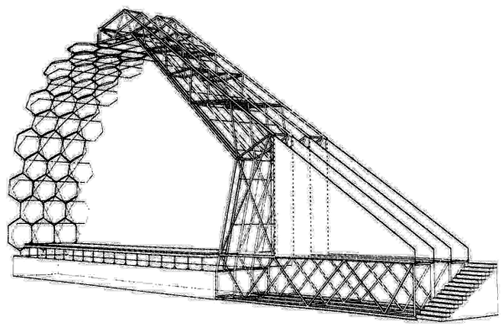
Station 2: Global Commons for Science

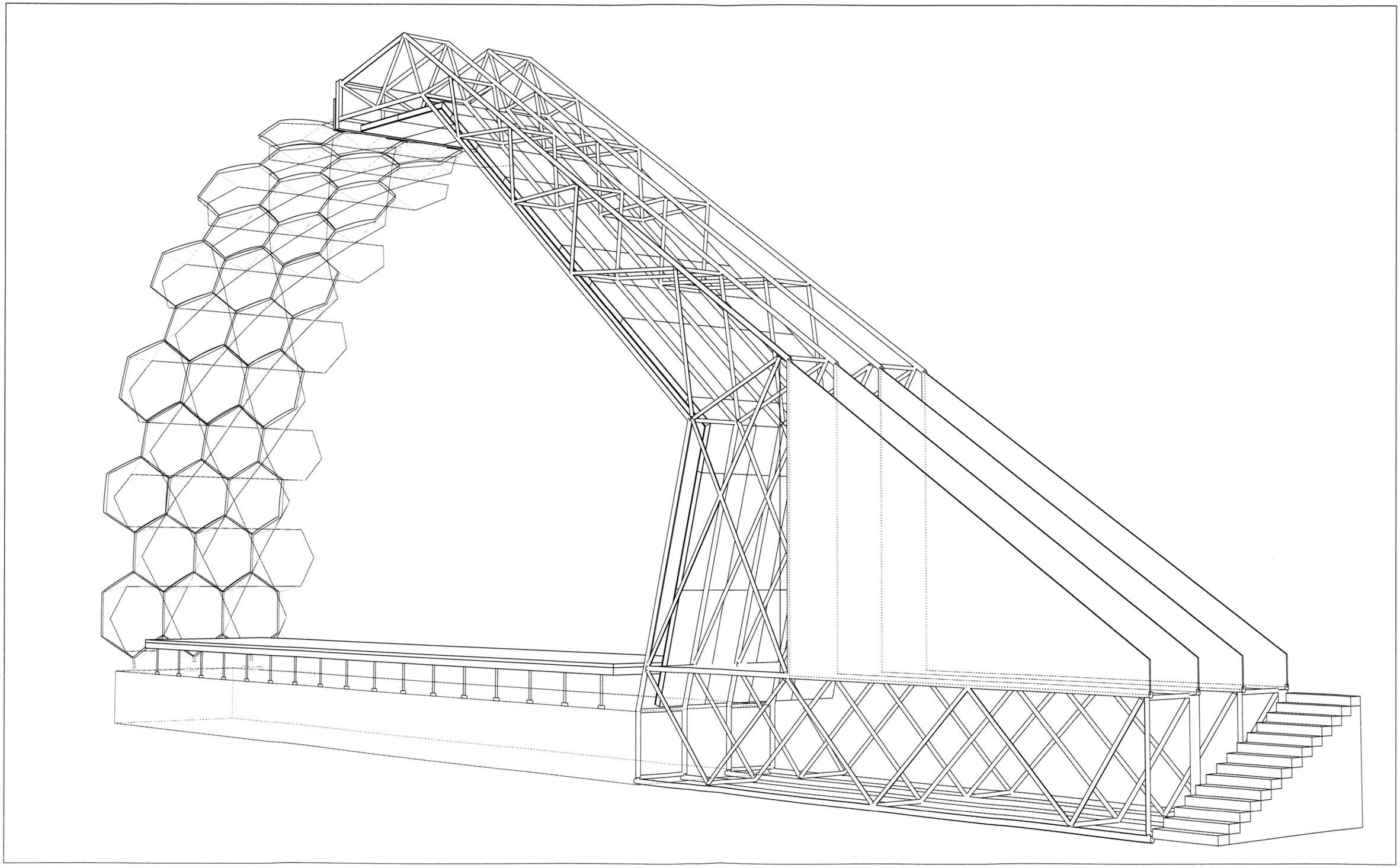
Program: Laboratory space, Glacier Monitoring Station
Site: Pine Island Glacier, Marie Byrd Land



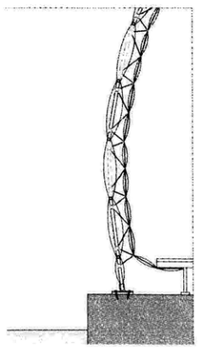


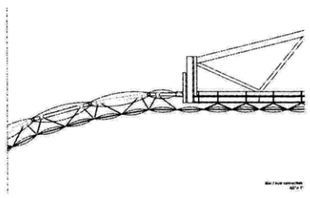
Station 2: Sectional Axon

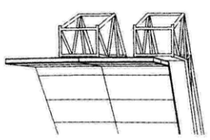


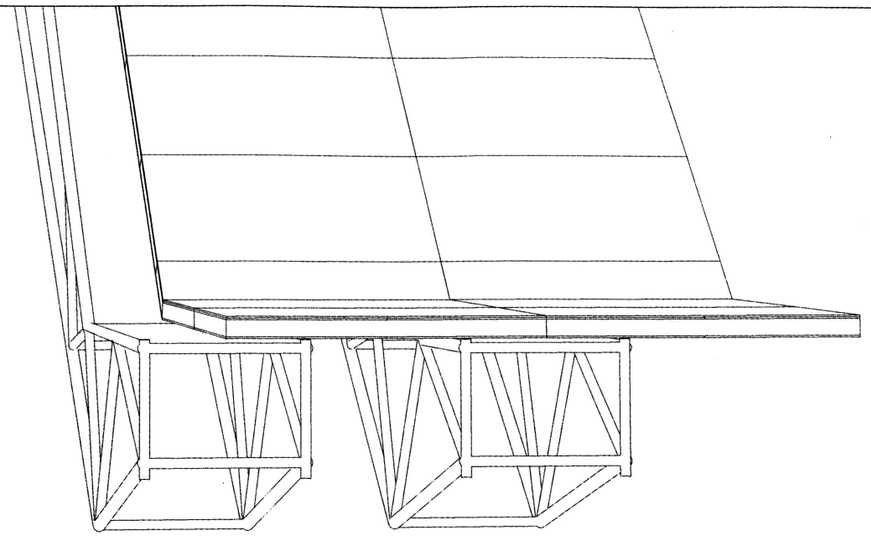


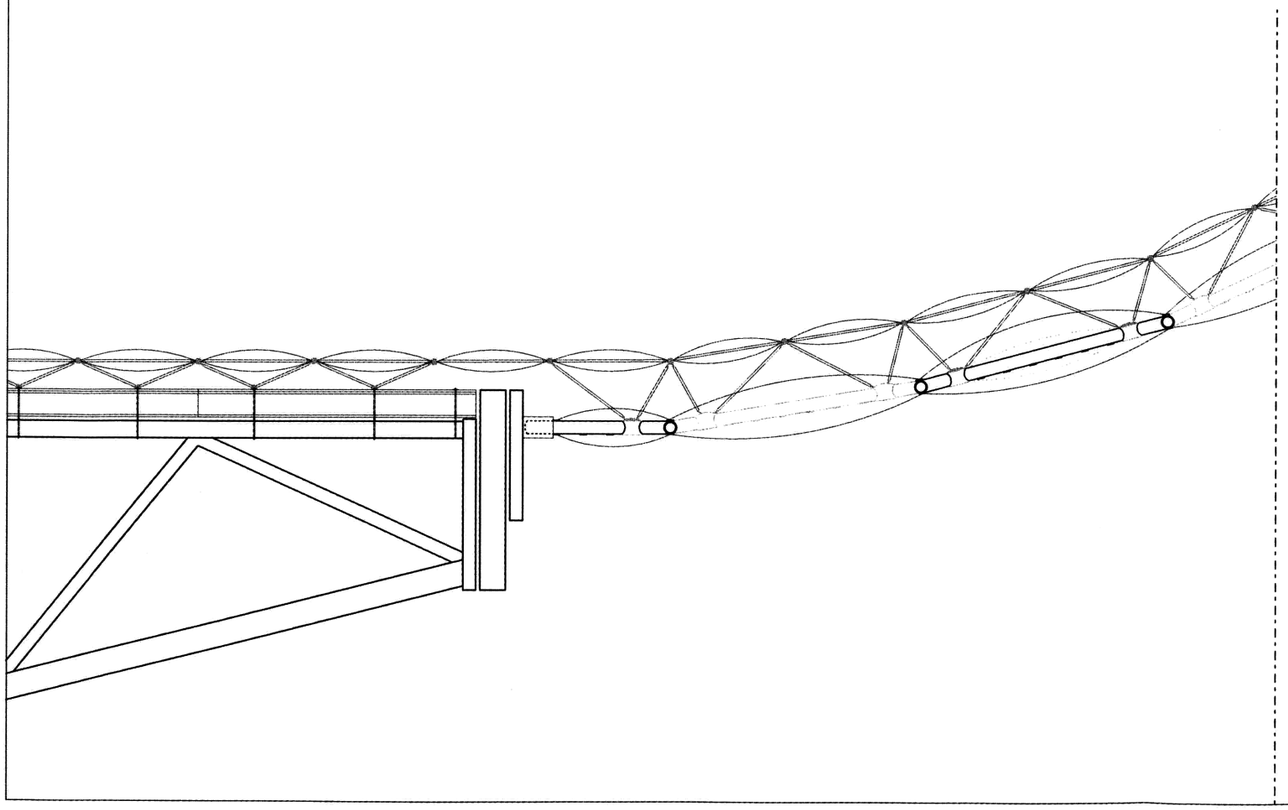
Station 2: Connection Details

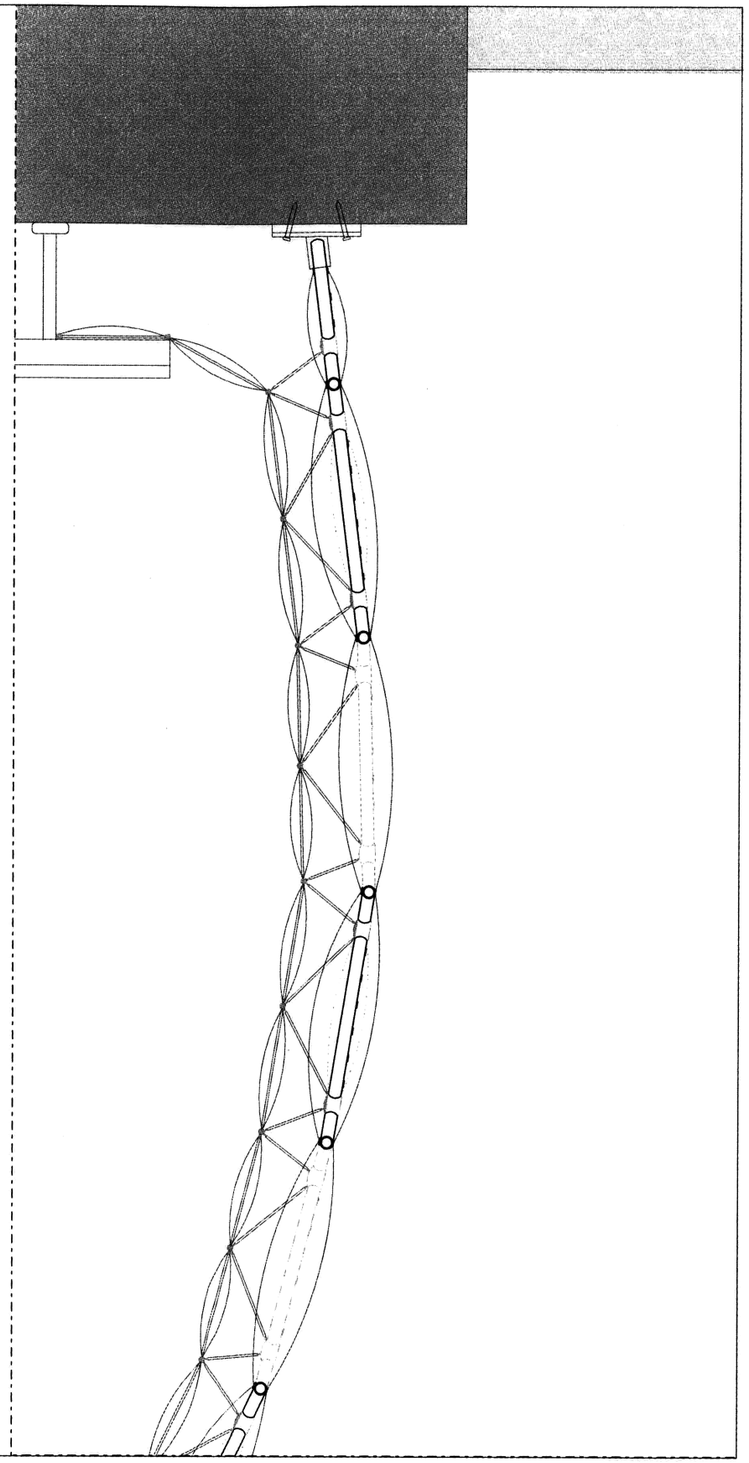




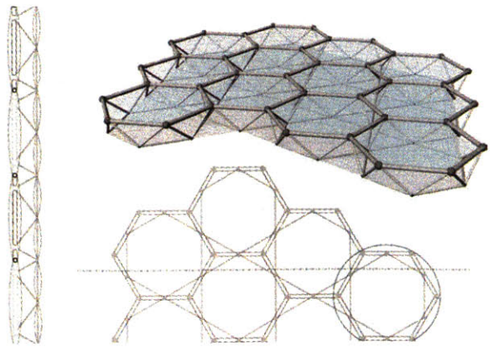


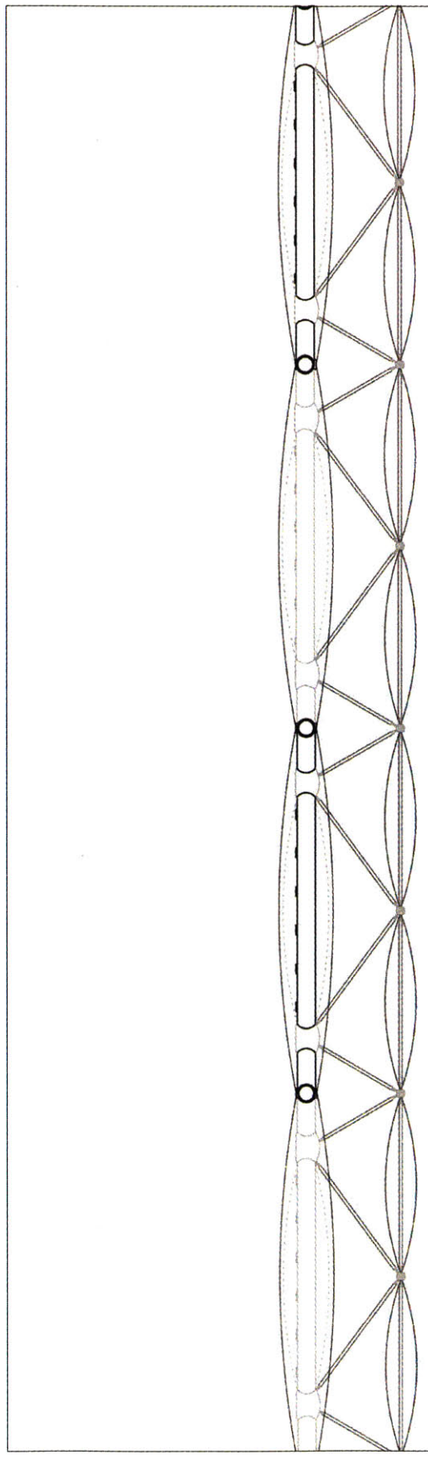


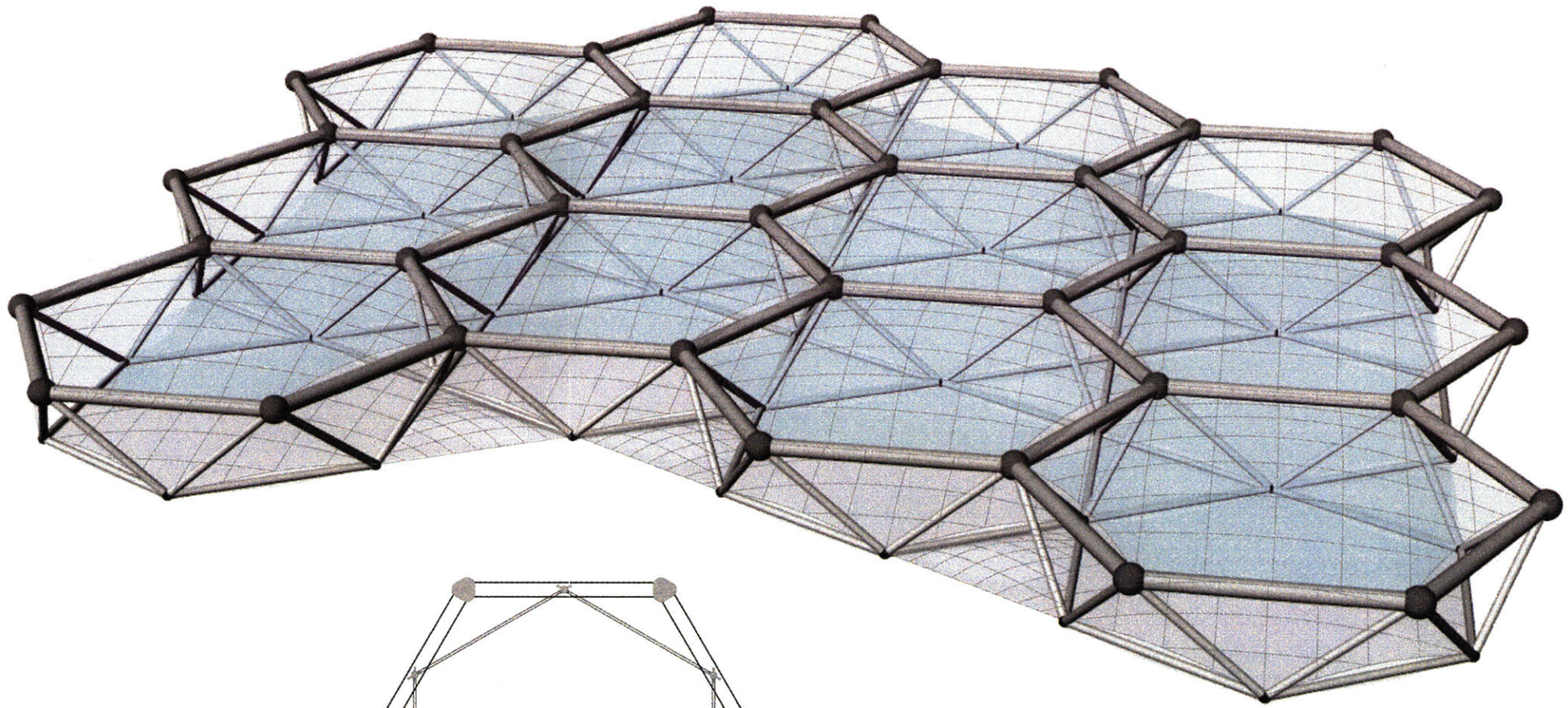


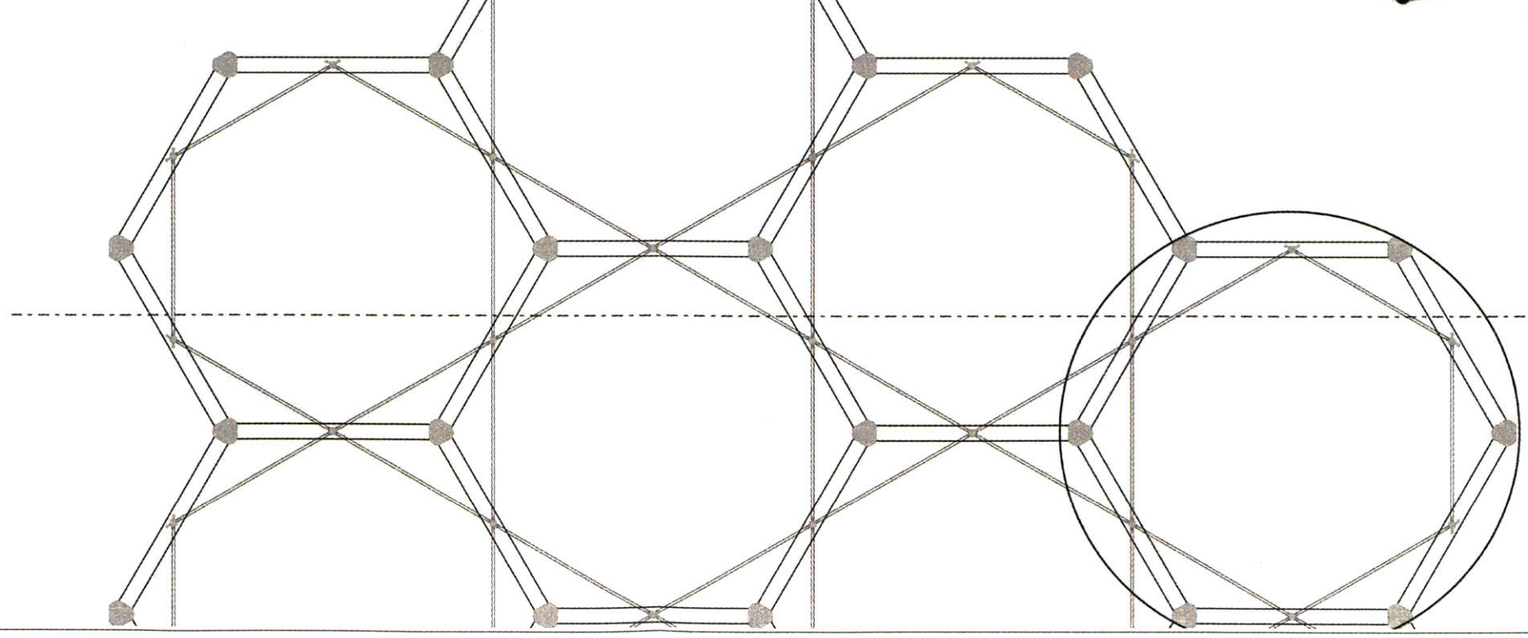


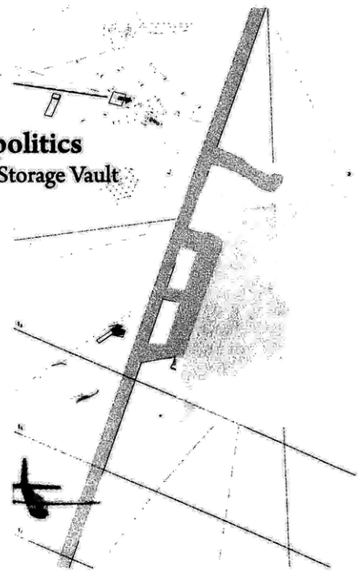
Station 2: Skin Detail











Station 3: Global Commons for Geopolitics

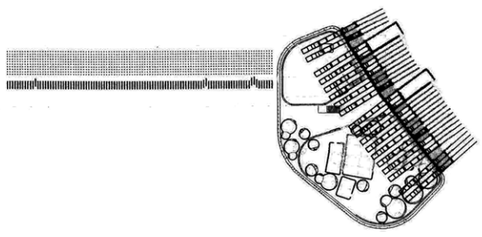
Program: International Meeting Hall, Biological Storage Vault
Site: The South Pole

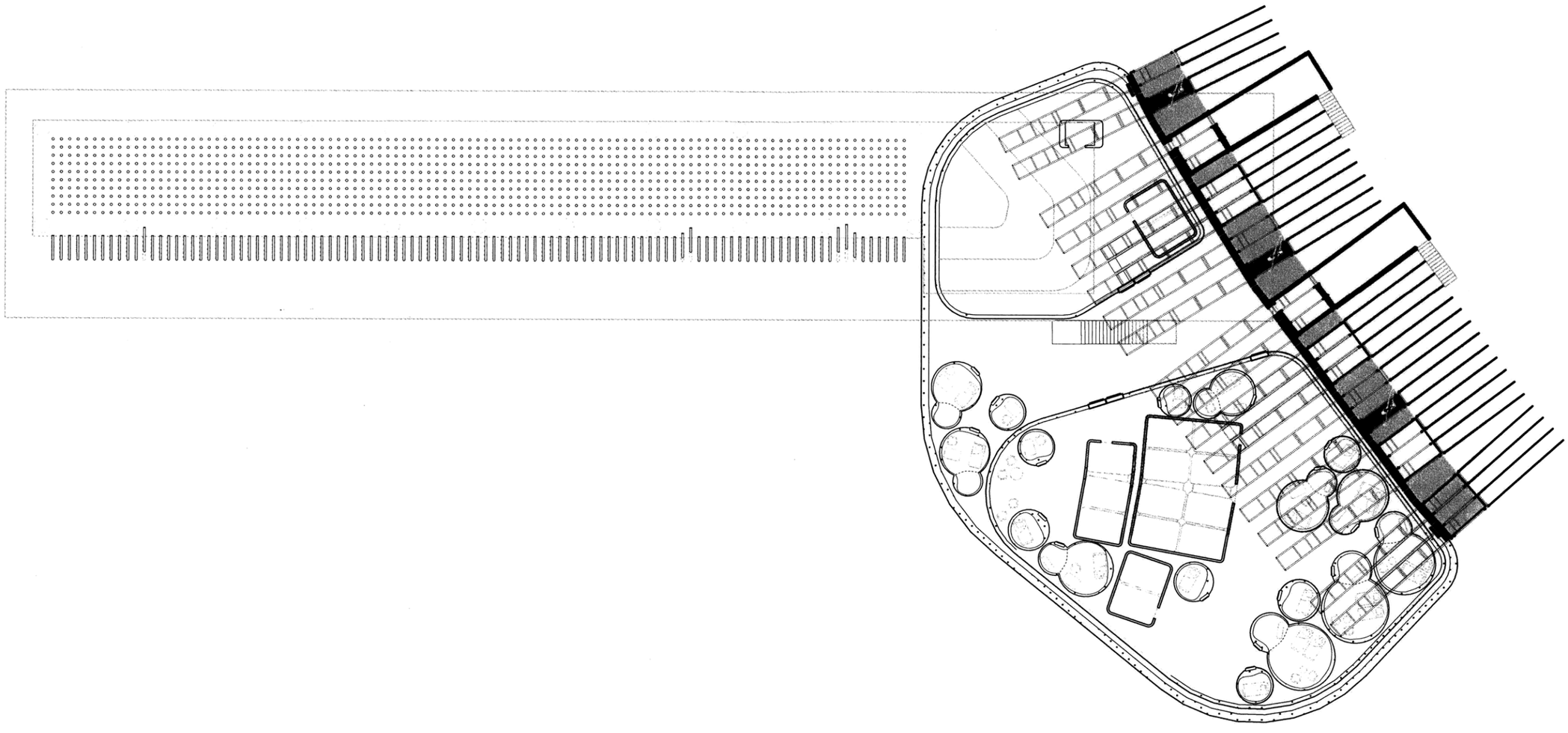
1

2

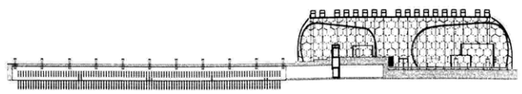
3

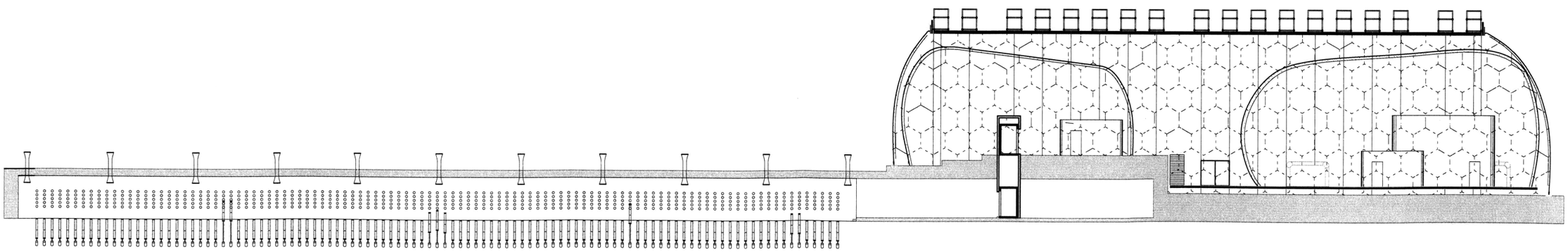
Station 3: Plan
1/32" = 1'



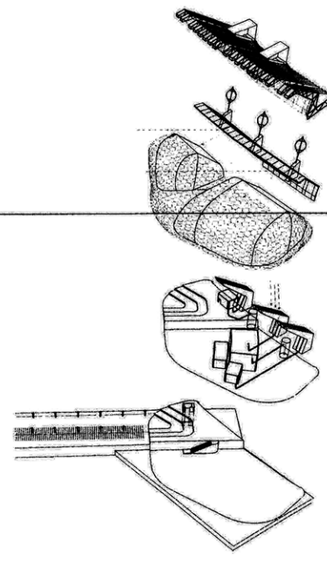


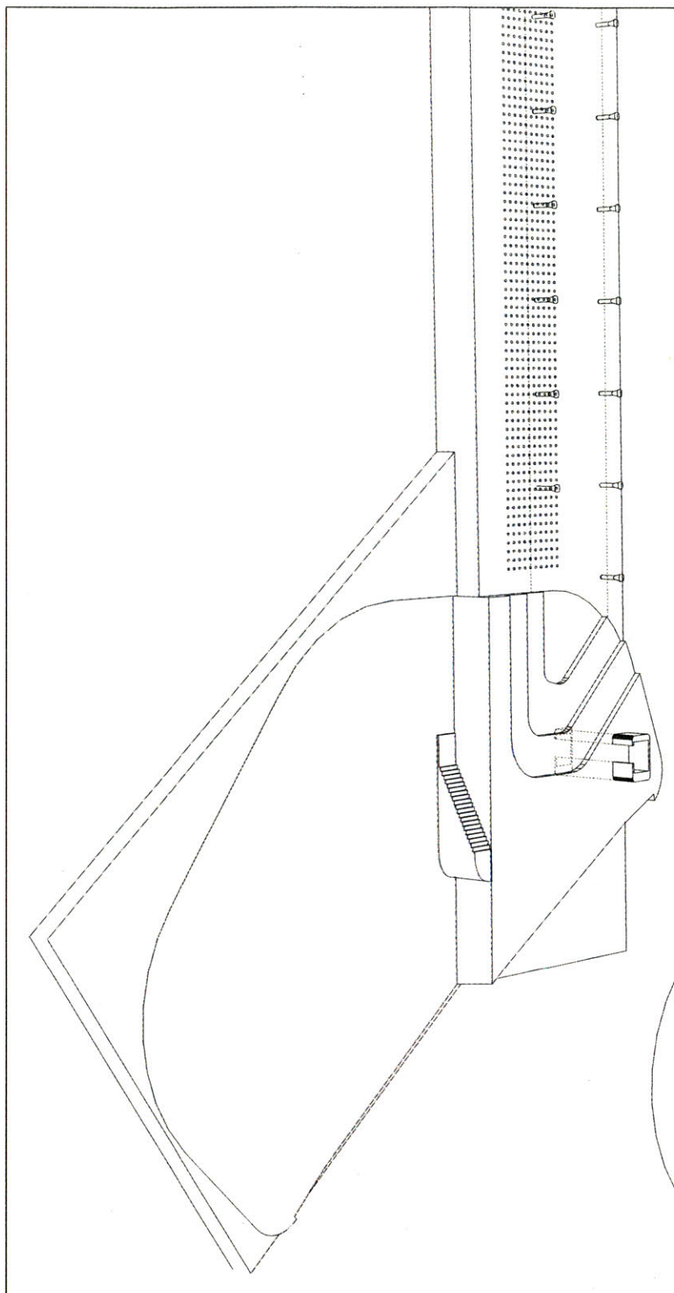
Station 3: Section
1/32" = 1'

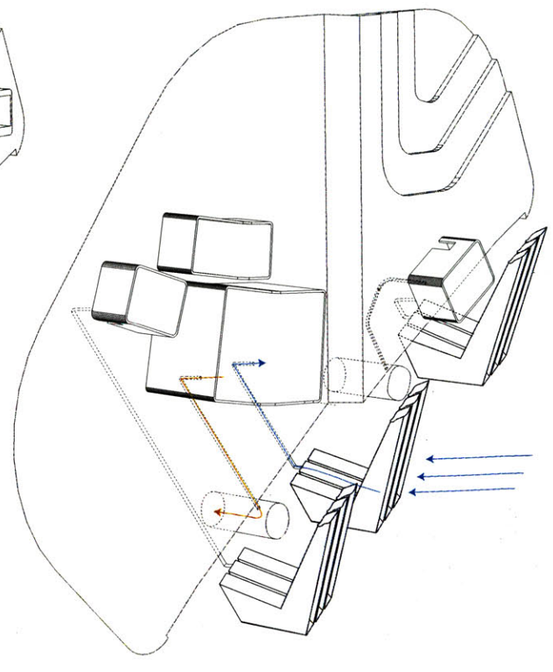


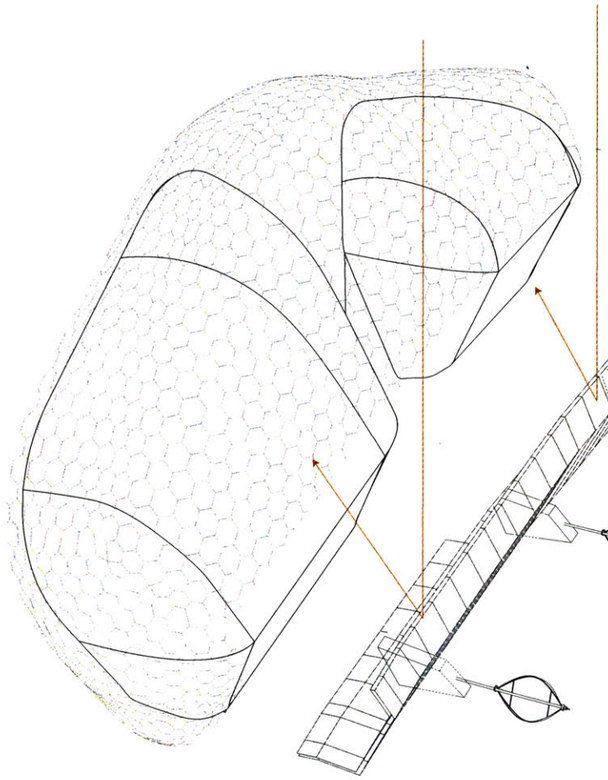


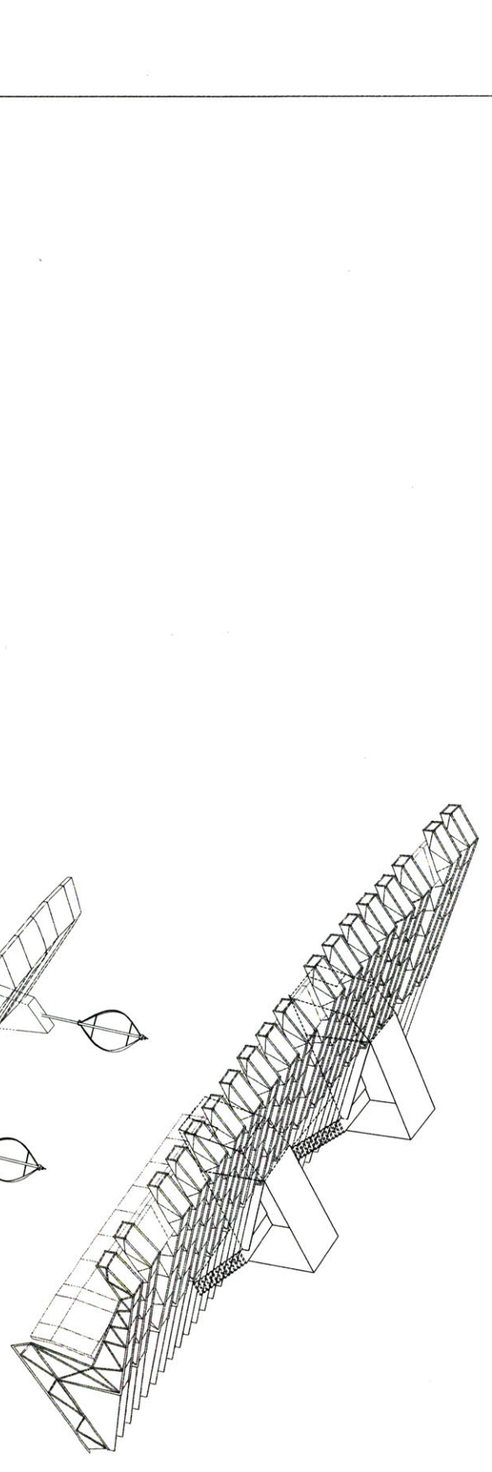
Station 3: Exploded Axon

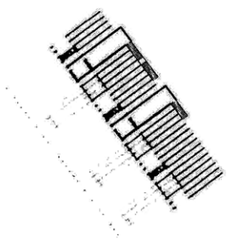




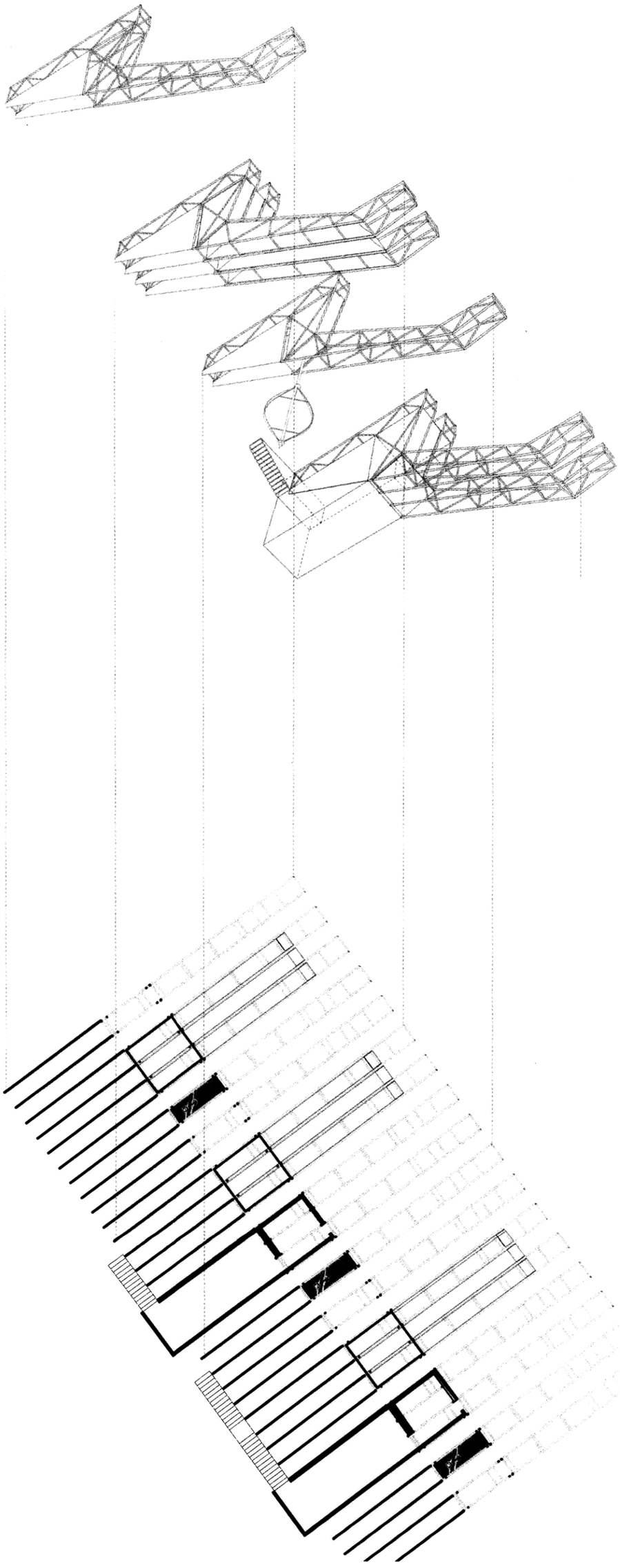




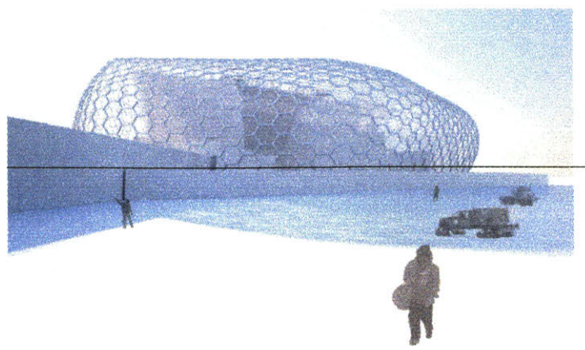


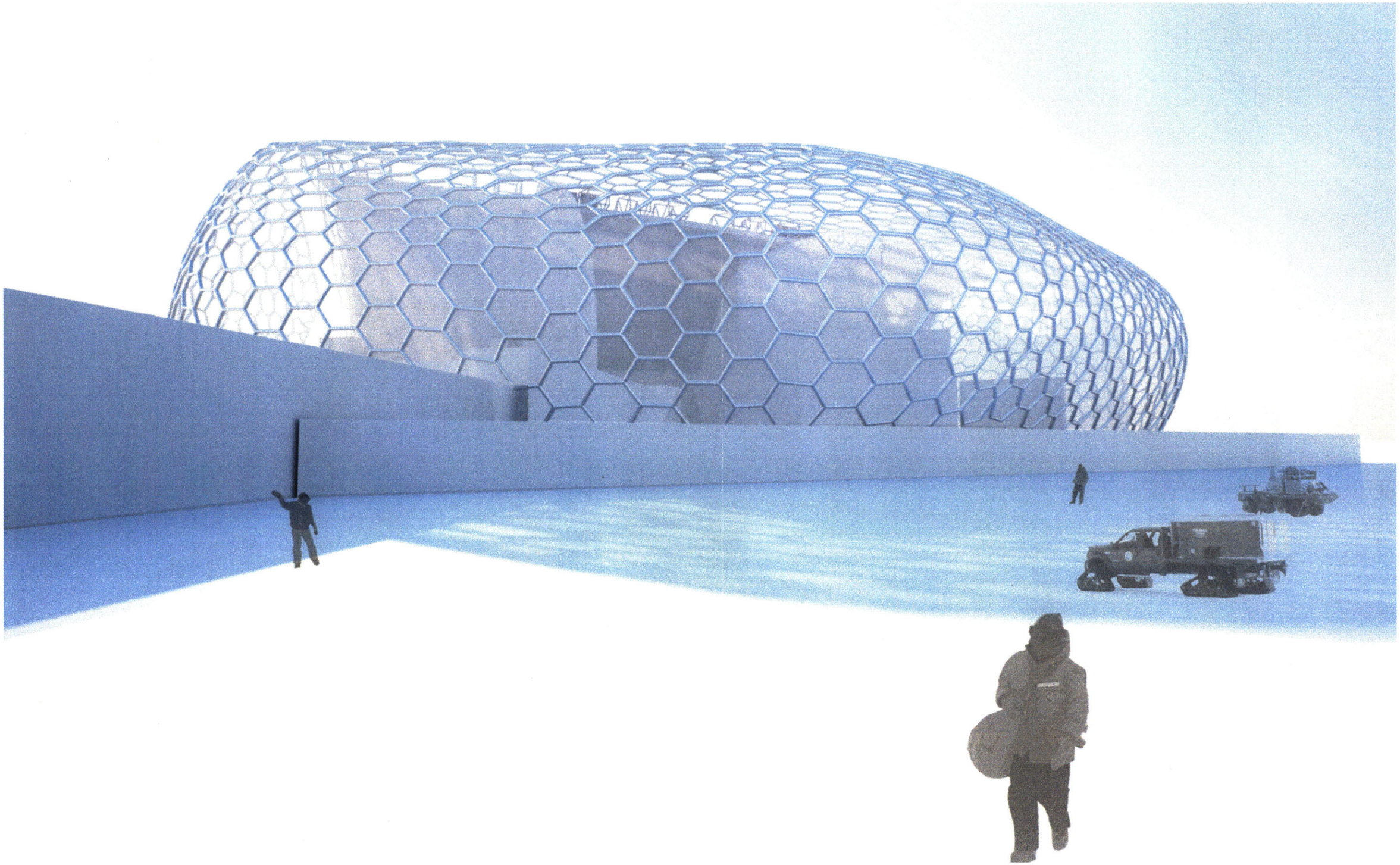


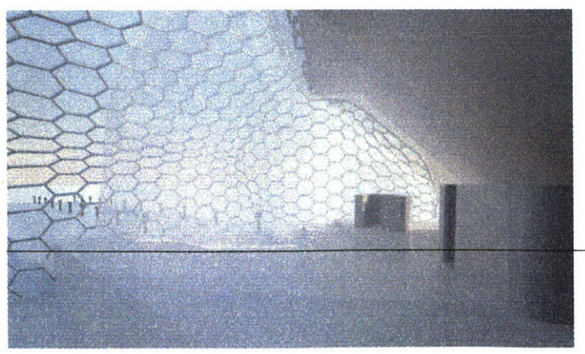
Station 3: Structural Spine



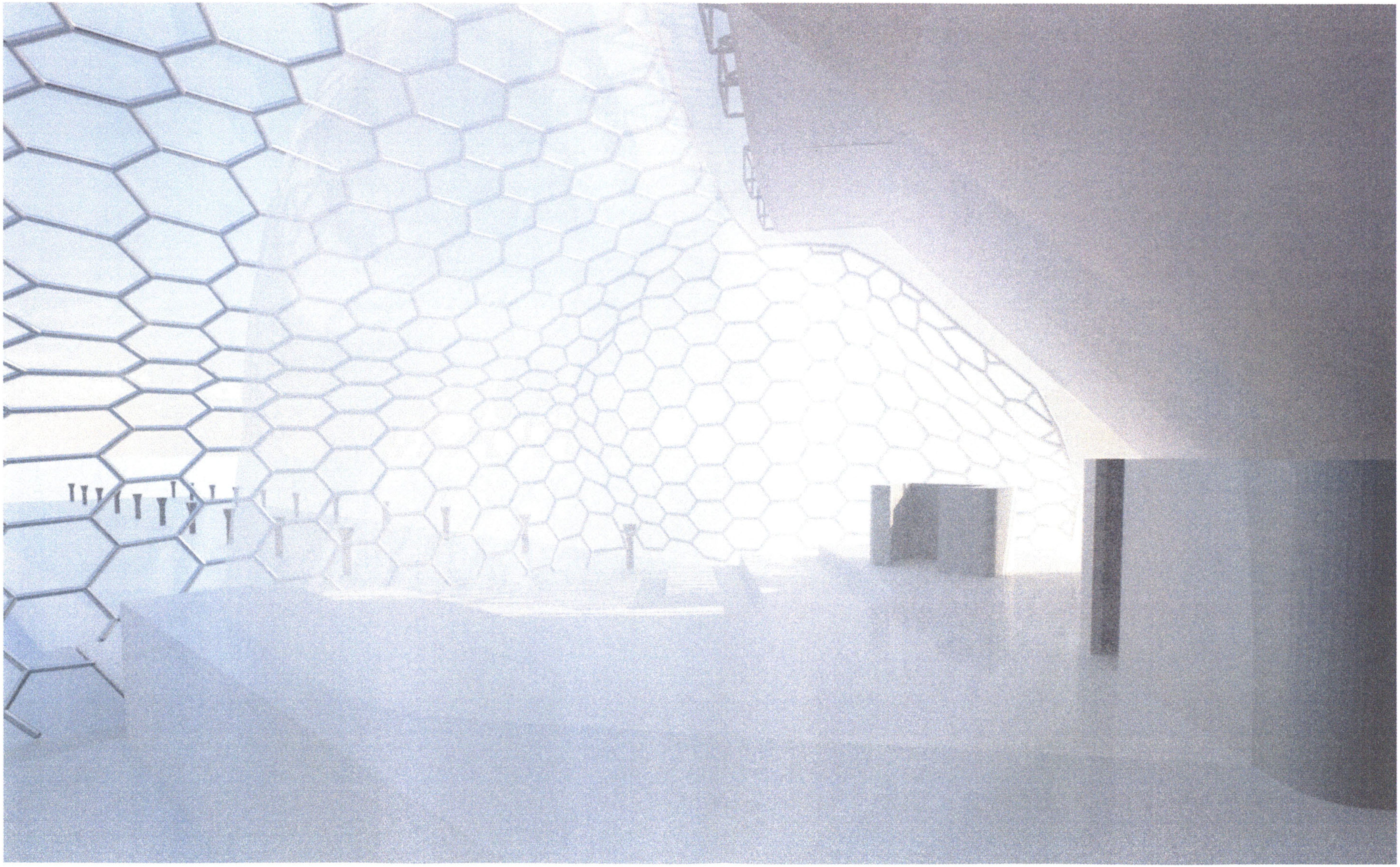
Station 3: Exterior View



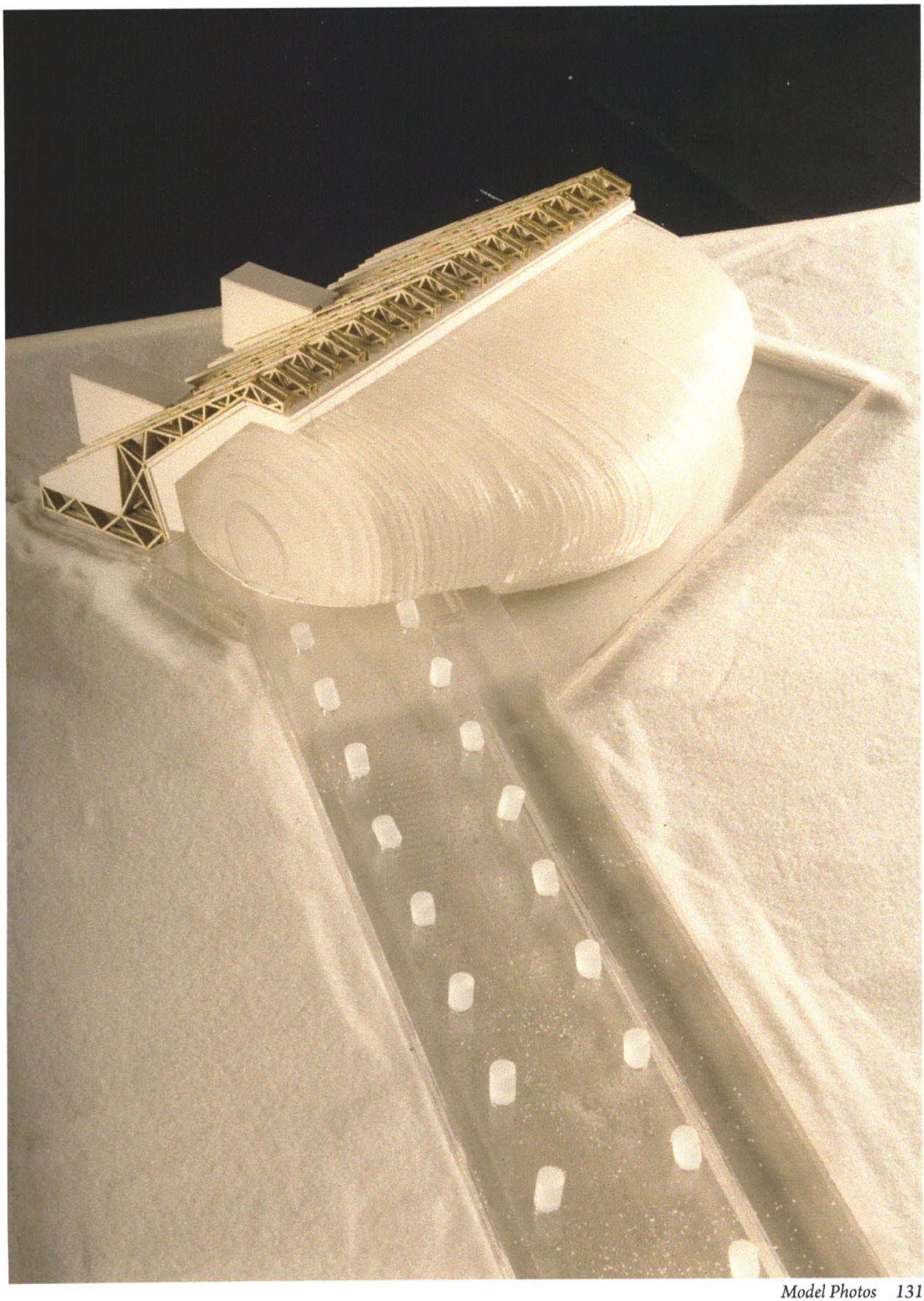


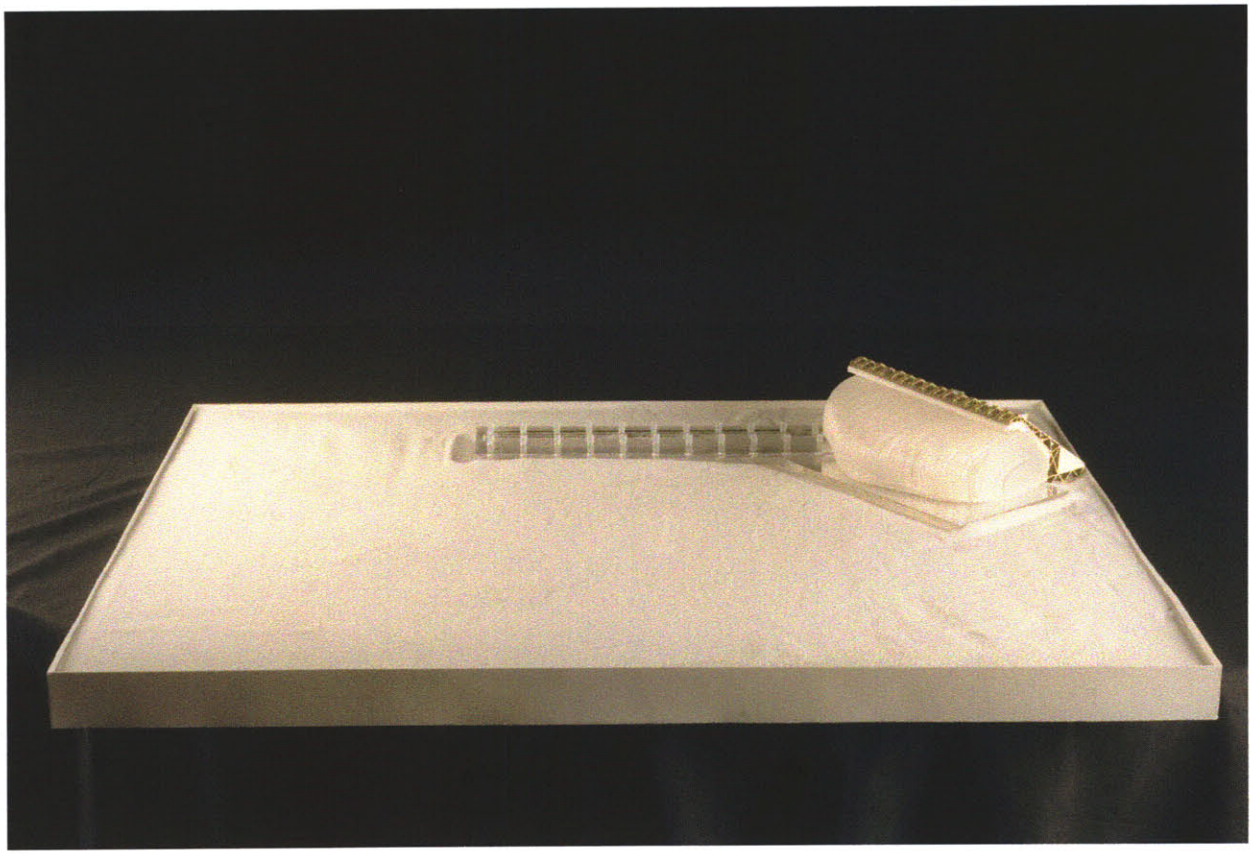


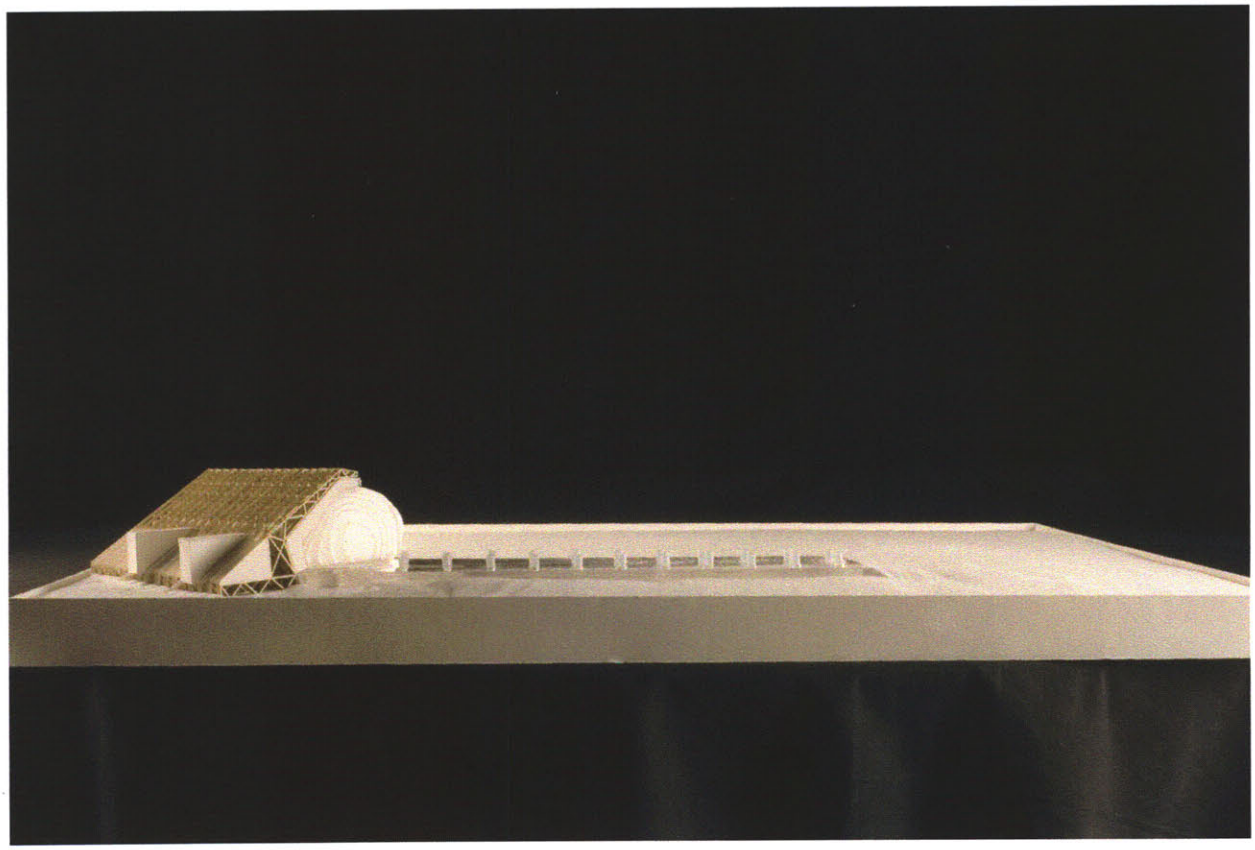
Station 3: Interior View

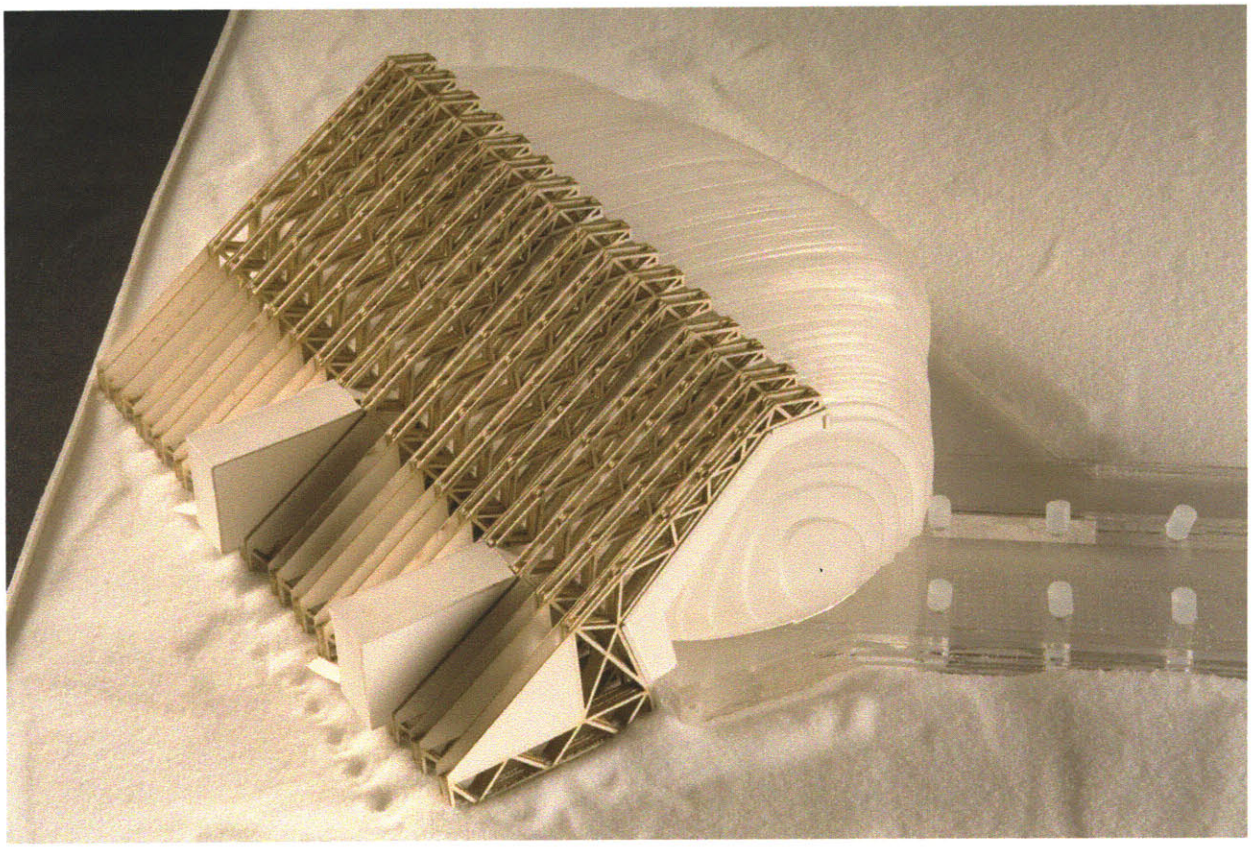


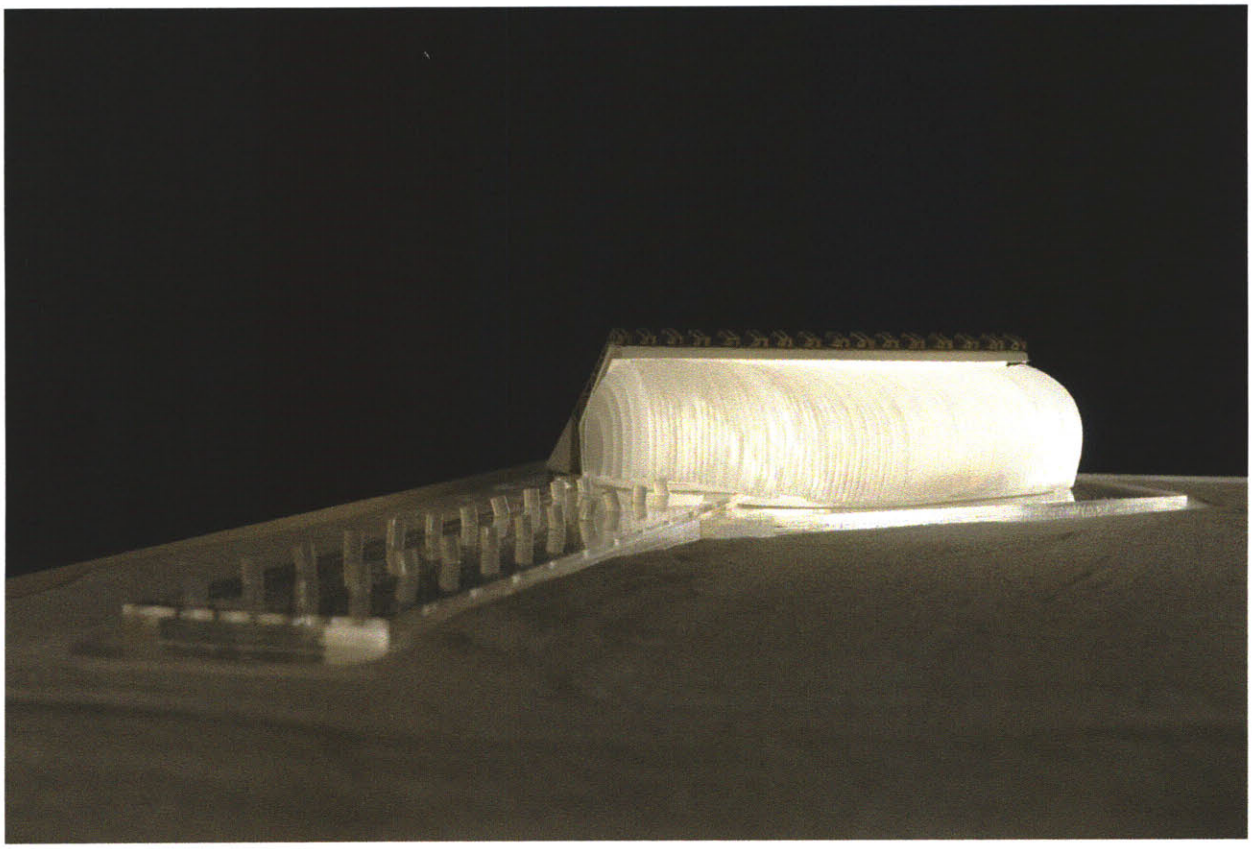
Station 3: View of Vault











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www.comnap.aq/operations/facilities

Greenpeace in Antarctica
www.greenpeace.org/international/about/hisotry/how-we-saved-antarctica

ITASE (International Trans-Antarctic Scientific Expedition
www.umaine.edu/itase/content/Science/Proposed_routes.html

National Science Foundation office of Polar Program: www.nsf.gov/od/opp

Scientific Committee of Antarctic Research: www.scar.org

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