PALMER STATION

MASTER PLAN 1.0

JANUARY 18, 2016

ANTARCTIC SUPPORT CONTRACT

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INTRODUCTION

Palmer Station is one of the National Science Foundation's three permanent Antarctic research stations, and is located along the Antarctic Peninsula. Research conducted here is important to our understanding of the history and processes of our planet and takes place year round.

The purpose of this Master Plan is to identify both constraints and opportunities for future redevelopment of Palmer Station and to serve as a guide for that development. The Palmer Master Plan recognizes the physical constraints of the existing site, including topography, local climate, and logistics, and then develops an energy and operationally efficient plan that will support continuing and evolving scientific research.

MISSION STATEMENT

The infrastructure modernization will ensure that Palmer Station remains a viable platform for supporting Antarctic science for the next 35 to 50 years, whereby this modernization will:

- Result in comprehensive redevelopment of Palmer Station into a more energy- and operationally-efficient campus, optimized for support of research vessel supported missions, as well as local marine, avian, and other long term ecological field science.
- Allow predictable operational costs, support personnel requirements, and improve operational efficiency.
- Reduce energy consumption for facilities and operational support.
- Provide a reliable, safe and healthy working environment for USAP personnel and visitors.
- Provide the flexibility to adapt to the changing needs of U.S. science in Antarctica over a 35-50 year planning horizon.
- Reflect the "active and influential presence" in Antarctica in a manner consistent with U.S. stature in the international research community.
- Reflect the professional nature of the National Science Foundation and the scientific activities carried on within the station.

OBJECTIVE

The primary objectives of this Master Plan are to respond to the valid recommendations stemming from earlier plans and to guide future development of Palmer Station in an orderly and thoughtful way so it supports an evolving Antarctic Sciences mission.

PURPOSE

This Master Plan will serve as a guide to future development of Palmer Station. It will be a living document, adaptable through time to serve a dynamic set of needs.

Specific areas of focus include:

1. Site, including Fire Protection, Life Safety, Environmental Safety, Materials Storage and Distribution, Electrical Distribution, and Pedestrian/Vehicular circulation.
2. Buildings, to seek arrangements to increase operational efficiency and function.
3. Logistics Management, to optimize warehousing and delivery processes while reducing footprint.
4. Information Technologies, to decrease complexity and increase reliability and flexibility.
5. Energy Conservation, to increase facility efficiency and incorporate renewable energy sources.
6. Quality of Life, to improve both the living and working experience at Palmer.
7. Resiliency, to ensure continued operations in the event of an emergency or unplanned event.

DEFINING PARAMETERS

ASSUMPTIONS

To achieve the primary goals of improving: 1) logistical efficiency, 2) resource efficiency, and 3) quality of life, the following parameters guide this Master Plan:

- The population is expected to not exceed 46 people during the austral summer (October - May) and be as low as 20 during the winter (June - September). However, design will allow the population to be scalable based on approved science requirements.
- The Master Plan will be designed independent of funding phasing, however phasing needs to be realistic with what is achievable.
- A station resiliency strategy is to be considered when establishing building and functional layouts.
- Design will allow for expansion and contraction of science seasonally and over the decades. Program size may increase and/or decrease in supported science or population due to budget constraints and realization of program scope efficiencies.
- Accommodations for single and limited double occupancy rooms will be incorporated into the lodging mix.
- Selected existing structures and utilities will be demolished after their replacement facilities are constructed, unless they are identified in this Master Plan to be re-purposed.
- To support redundant (back-up) utility systems, utility distribution will be a looped/gridded system to the extent feasible. Utilities include power, water required for fire suppression, waste-heat, waste water, information technologies, direct digital controls, and fuel.
- Facilities should be designed to provide a reasonable level of adaptability to evolving needs.
- The finished station must result in a station that appropriately supports science over a planning horizon of 35-50 years.
- A new pier is required to continue current station and logistical operations more efficiently and safely. A new pier also would improve safety and efficiency of major station construction.
- The master plan must address currently existing, non-compatible occupancies located in BioLab and GWR.
- The station will continue to reasonably support Long Term Ecological Research (LTER) activities during construction; however, the level of other science that will be affected during construction has not been determined.

DESIGN PRINCIPLES

- Design and construction materials and systems must not be complicated, rather they must be simple, with components that are standardized to the greatest extent possible to promote ease of assembly, installation, operations, and maintenance.
- Reliability reduces maintenance staffing and associated costs.
- Integrated social spaces supports the collaboration and the sense of community within Palmer.
- Flexibility and adaptability supports the evolving nature of scientific inquiry in Antarctica.
- A reduced footprint increases logistical efficiency, and resource efficiency.
- The site will be designed to respond appropriately to environment, terrain, weather conditions, and vessel and vehicular movement.
- The site is to be designed with final state orderliness in mind. In addition to building placement, site development must address the importance of site appearance, sensitively addressing the locations of shipping containers, recycling bins, dumpster enclosures and site utilities.
- Healthy environments must be attained within all development.
- Design must be indicative of the stature of the National Science Foundation, the professionalism of the staff and the integrity of the science being conducted on the peninsula.

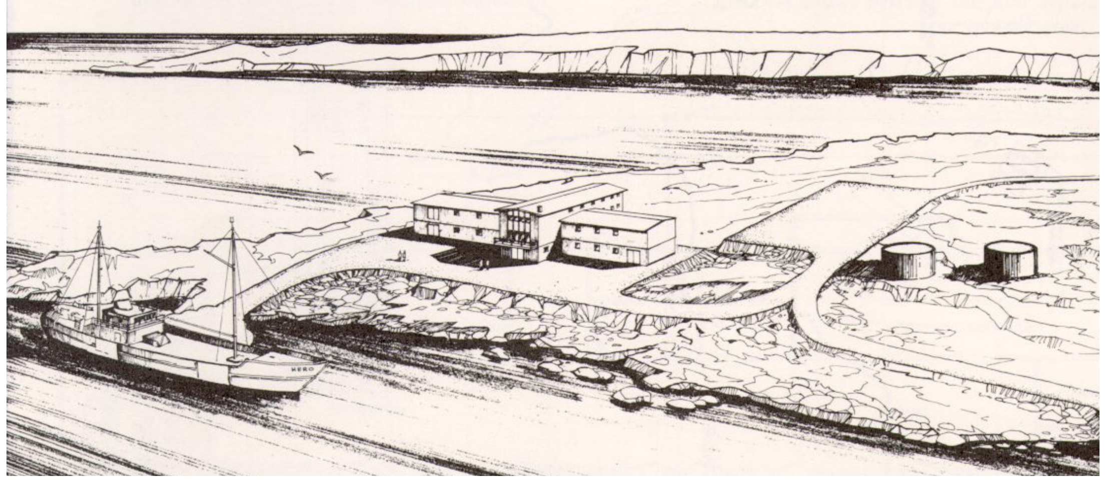
HISTORY/BACKGROUND

Following the International Geophysical Year (IGY) in 1957-58, biology became an increasingly important component of U.S. Antarctic research. With the large variety and relatively easy access to marine fauna and flora in the Antarctic Peninsula, the U.S. scientific community began to focus on the region as an excellent place to establish a permanent U.S. presence. In 1962, the U.S. Government began serious consideration of a permanent research station in the peninsula area.

The chosen location needed to provide:

- a biologically rich environment;
- accessibility by ship and potentially by heavy aircraft;
- a large enough ice-free area to accommodate the station's buildings; and
- access by small boat from the station to nearby research sites.

ORIGINAL CONCEPTUAL SKETCH



HISTORY/BACKGROUND

Thirty-three potential station sites along the peninsula were surveyed in early 1963, from the South Shetland Islands in the north to Adelaide Island in the south. The United States ultimately settled on a location at Arthur Harbor on the southwest shore of Anvers Island. In 1964, U.S. Navy personnel erected temporary buildings at Norsel Point near an abandoned British base. This new American research base was named Palmer Station after Nathaniel Brown Palmer, who, in 1820, became the first American to record a sighting of Antarctica.

From 1965 until 1969, members of the United States Naval Construction Battalion ("Seabees") personnel worked to complete the permanent station at Gamage Point, a location more accessible by ship than the initial location. The plans for Palmer Station also included a ship to support science throughout the peninsula. A vessel named *Hero*, after the vessel that brought the station's namesake to Antarctica, arrived at Palmer Station on Christmas day in 1968 and began support operations.

The Palmer Station pier was constructed in 1966-67 to accommodate the *Hero*. Building #2, the Biology Laboratory (BioLab) was completed by the end of the 1967-68 austral summer, which allowed the station to be officially moved from the original site to the current station in March 1968. The second main building, Building #10, GWR (Garage, Warehouse, Recreation) was completed during the austral summer of 1969-70. In 1973, the Navy and the National Science Foundation (NSF), which oversees the operation and management of the United States Antarctic Program (USAP), contracted out these services to a civilian firm for the first time.

The following is a partial timeline of how the station has grown in size and capability over the last 40-plus years. In 1981-82, the "Anvers Island Air Chemistry Facility" (Clean Air Facility) was constructed. Today this building is used as office space. The Carpenter Shop was completed in 1983-84 and moved from the ground floor of BioLab; this space was then converted to additional lab space and a dive locker. In 1986-87, an addition to the Carpenter Shop was completed. In 1985-86 the Aquarium Building and the Boat House were completed. Then in 2005 the Terra Lab (International Monitoring Station) was constructed and now houses the projects formerly located in two other buildings (the Clean Air Facility and T5), while also providing expanded facilities for the air-sampling program. The most recent significant construction project at the station took place in 2013 was a boat ramp, which greatly improved the ability to safely launch and recover Zodiac inflatable boats for research and search and rescue operations in the immediate vicinity of the station.

Palmer Station has grown far beyond its humble beginnings of a handful of buildings and fewer than 10 on-site personnel, to 24 buildings today that includes permanent 20' sea containers used for storage and a full station complement of 46 support and science personnel. Logistically, the station is now supported by a modern, ice-strengthened research and supply vessel. Supplies are handled through a port facility in Punta Arenas, Chile, and the vessel is equipped with cargo capacity sufficient for the station's current needs and a full suite of oceanographic sensors to support science around Anvers Island and the entire Antarctic Peninsula.

Palmer's importance in providing long term ecological data will continue to evolve over the next 35 - 50 years.


1967

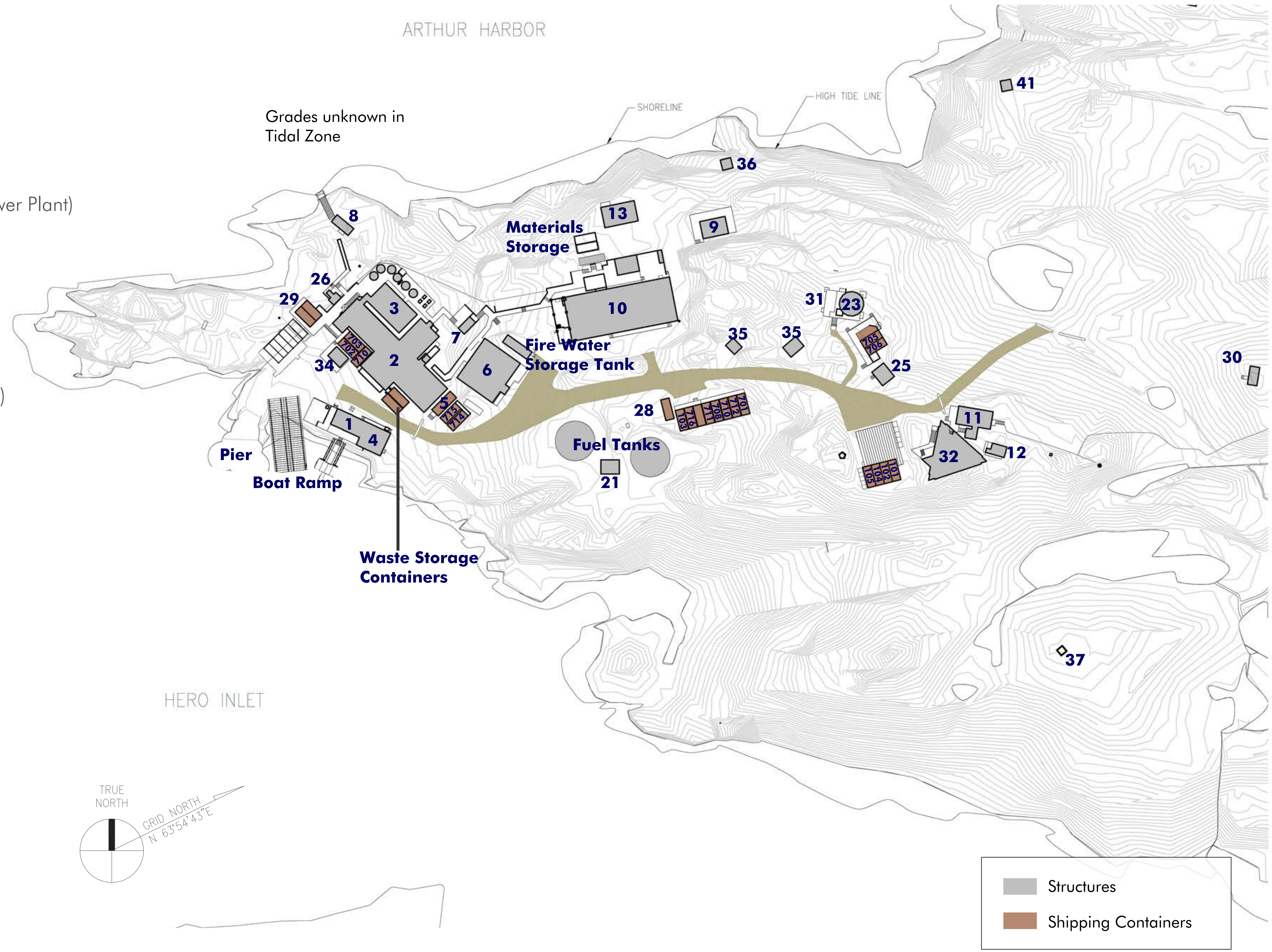

1980


PALMER TODAY

EXISTING CONDITIONS

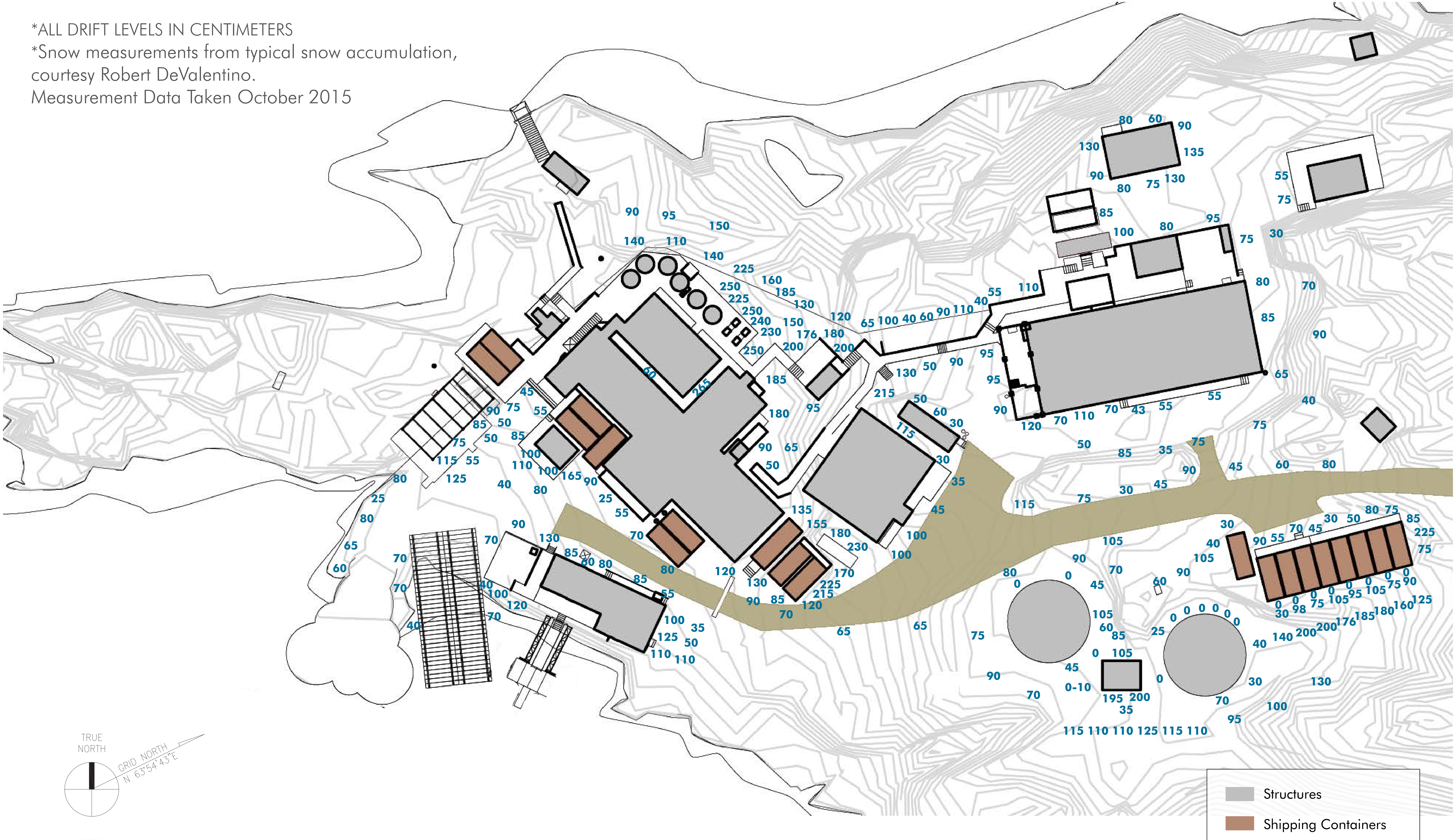
EXISTING SITE PLAN

1 Boathouse
2 BioLab
3 Aquarium
4 Dive Locker
5 Volatile Material Storage
6 Carpenter Shop
7 Sauna
8 Seawater Pump House
9 Hazardous Storage Building
10 GWR (Garage, Warehouse, Recreation & Power Plant)
11 T-5 Staging and Storage
12 Clean Air Facility
13 Materials Storage
21 Fuel Pump House
23 Earth Station Radome
25 Cylinder Building
26 Sewage Macerator Building
28 Flammable Storage Locker, Fuel Drums (SLIM)
29 Chemical Storage Vans
30 Seismic Vault
31 Earth Station
32 Terra Lab
34 Birder Hut
35 Material Storage
36 Tent Site
37 Antenna Tower
41 Small Overnight Shack
101-105 Hazardous Waste Storage
701 Science
702 Consumables Storage
703 Instrument Storage`
705 Radioactive Waste Storage
706 Hazardous Waste Storage
708 Admin
710 Oil Spill Response Storage
711 FMC Equipment Storage
712 IT
713 Refrigerated Storage
714 Refrigerated Storage
716 Dry Goods

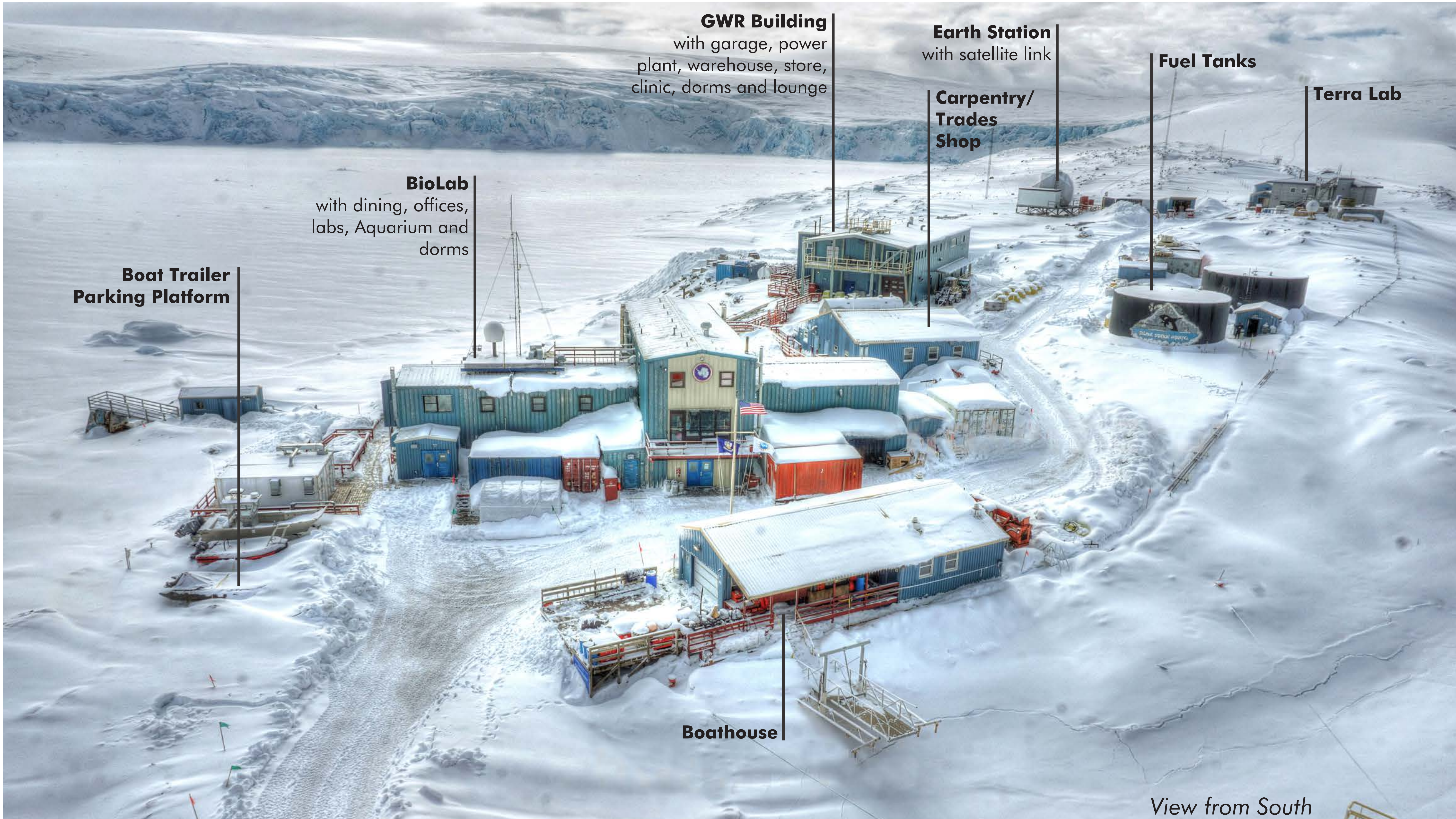


TYPICAL SNOW DRIFTING

*ALL DRIFT LEVELS IN CENTIMETERS
*Snow measurements from typical snow accumulation, courtesy Robert DeValentino.
Measurement Data Taken October 2015



EXISTING CONDITIONS



GLOSSARY

GLOSSARY

- **U.S. Antarctic Program (USAP):** the United States' Government program, administered by the National Science Foundation, for research and related activities regarding Antarctica
- **ASC:** Antarctic Support Contract. The current prime logistical contractor to the NSF's United States Antarctic Program
- **CTBT:** Comprehensive Test Ban Treaty
- **DBIA:** Design-Build Institute of America
- **Grantee:** A scientist who has received a grant from the National Science Foundation
- **GWR:** Garage, Warehouse, Recreation Building
- **IBC:** International Building Code
- **IFC:** International Fire Code
- **IGY:** International Geophysical Year
- **IT&C:** Information Technology and Communications. Antarctic Support Contract functional work group overseeing telecommunications and computers
- **LTER:** Long-Term Ecological Research
- **Mbps:** Megabits per second
- **MEP:** Construction industry term standing for mechanical, electrical and plumbing
- **Milvan:** Vernacular for cargo containers used for shipping and storing supplies
- **NSF:** National Science Foundation, an agency of the U.S. government
- **O&M:** Operations and Maintenance. Usually refers to cost burdens not construction
- **Retrograde:** To return cargo from the field to any station, or from any of the stations or vessels to Chile, New Zealand, or the United States
- **RF:** Radio Frequency
- **RHIB:** Rigid-Hulled Inflatable Boat
- **VoIP:** Voice over Internet Protocol

ARCHITECTURAL DESIGN GUIDING PRINCIPLES

The principles that follow are recommended to guide the specific architectural design of Palmer Station. These principles should inform and drive all aspects of the building design, from layout and massing, to the organization and character of interior spaces, to the design of the building enclosure, from both technical and aesthetic points of view.

These guiding principles are primarily a reflection of the NSF/USAP Mission and the environment of Palmer's Arthur Harbor site.

ARCHITECTURAL DESIGN GUIDING PRINCIPLES

REFLECTION OF USAP MISSION

The primary intent of this document is to produce a long-range strategic plan that is a reflection of the NSF's USAP mission, one of progressive and dynamic scientific inquiry. To that end, appropriate materials are to be designed into and used during the execution and construction of the proposed campus, which includes increasing the energy efficiency of the buildings that will remain. The ultimate design must result in a station that is adaptable to the ever evolving needs of science. In addition, the design must enable the NSF to appropriately and commensurately support a maximum amount of science, and also scale down the level of support as necessary. Facilities should be designed to be reflective of their function and reflective of the quality of the work being accomplished within. The designs should be adequately flexible to support varying science needs as well as to accommodate evolution of building technologies. The designs should also provide opportunities for collaboration and exchange of information.

PROMOTE ENVIRONMENTAL STEWARDSHIP

The NSF promotes and practices environmental stewardship, so the implementation of the Master Plan will be no exception. Resource efficiency intended to reduce the demand on fossil fuels will be achieved by a number of efforts.

High-performance building envelopes will decrease heat loss and maintain residual interior temperatures with less reliance on heating sources. Proper building orientation to optimize day-lighting and to take advantage of the austral summer's sunlight will reduce reliance on electrical lighting systems and generated power. Proper building siting will minimize resultant snow build up and consequent snow removal. High-performance mechanical systems will operate efficiently and use proven and standardized equipment, thus reducing O&M maintenance. Structural efficiencies gained by using repetitive bay, cross bracing and cantilevered elements will save on construction costs and engineering effort. Monitoring and control systems (smart grid) will promote energy use awareness and, by extension, overall environmental stewardship.

Finally, to maximize resource efficiency, the re-use of existing materials and systems, the capture of waste heat and the use of available renewable energy sources should be considered as the Master Plan is implemented.

ARCHITECTURAL DESIGN GUIDING PRINCIPLES

PROMOTE WELLNESS

To promote wellness, the Master Plan recommends space for physical activity, sound rest, relaxation and recreation, diverse enough to appeal to the interests of its population.

The Master Plan addresses the need to promote teamwork, cooperation, collaboration, and recognition of accomplishments, as well as fostering productive interaction, by recommending various venues for both formal and informal gatherings, social and professional activities.

The design should consider acknowledging the history, development and personnel of the united States mission in Antarctica.

Example of social space

PROJECT AN IMAGE OF EFFICIENCY, STATURE, PERMANENCE AND DURABILITY

The Palmer Station development, as a reflection of not only the National Science Foundation, but also of the United States of America, must project environmental responsibility, organization, permanence, and professionalism in this part of the world. The design must be demonstrative of the stature of the United States in the global scientific community and must be world class in its function and appearance.

IS OF ITS PLACE

The architecture must be responsibly designed to be responsive to its immediate environment, but must also reflect the United States of America's active and influential presence in Antarctica.

The siting and orientation of the buildings must respond to the unique topography of this site. In addition, buildings must respond to this sometimes harsh climate through high performance building envelopes, with building forms and structural systems to effectively withstand the elements of wind, snow, rain, ice, and wind-driven rain.

FACILITY CONSIDERATIONS

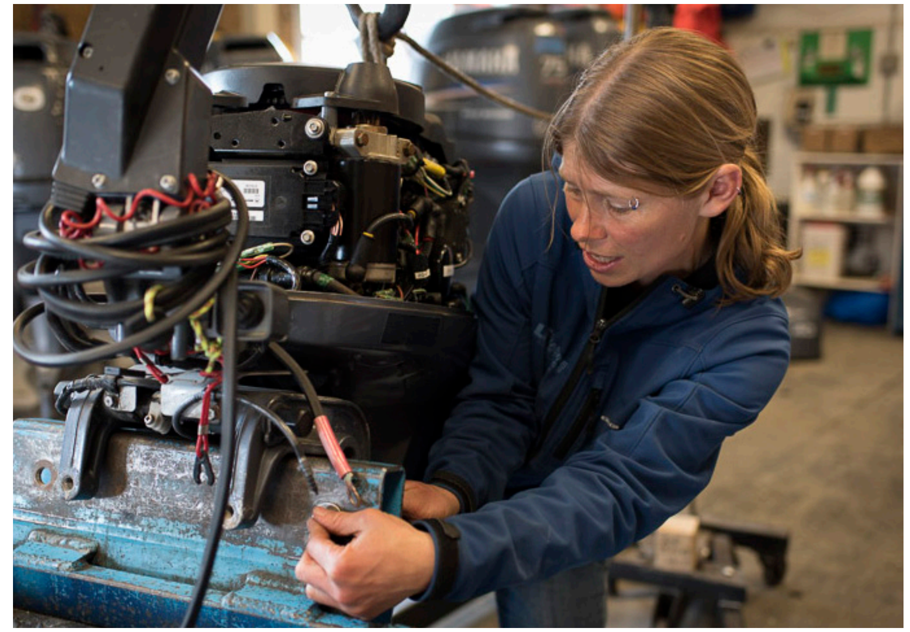
While Palmer Station does not experience temperatures as extreme as South Pole or even McMurdo, careful energy efficient design considerations are important. Palmer Station facilities will be designed with the following parameters in mind:

Wind gusts of 135 MPH - 165 MPH
Design snow load of 50 PSF
Minimum Design temperature of -10° F
Maximum Design Temperature of 50° F
Coastal marine environment, high humidity and salty air which can be highly corrosive
Average snow fall of 13’
Average rain of 30”
Primary wind direction is from the NE to the SW

PIER (TO BE REPLACED)/BOAT RAMP/FLOATING DOCK

Constructed in 1967, the existing pier is well beyond the end of its useful life. This Master Plan recommends that a pier replacement take a high priority, the details of which can be found within the final section of this document, titled "Pier."

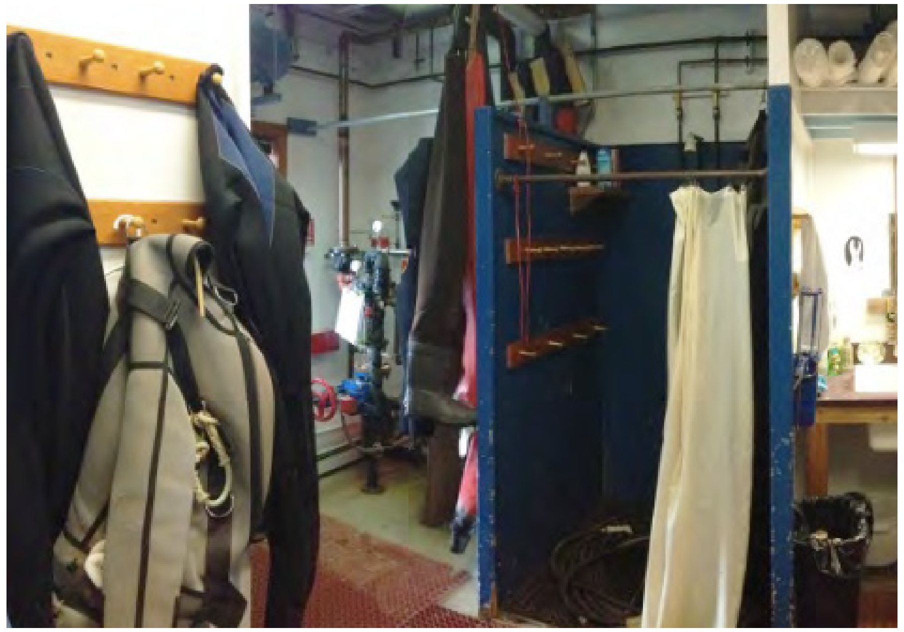
The condition of the existing sheet pile cellular pier is such that it is losing rock fill from a number of different locations, including from holes in individual sheet piles and from sheets that have not been adequately toed into the underwater granite rock foundations. Numerous sheets have been previously patched underwater, and many more sheets are thinning to the extent that the existing cells are not salvageable and a new berthing pier should be built, salvaging existing fill to the greatest extent possible. The existing boat ramp and floating dock, both in very good condition, are recommended to remain.



BOATHOUSE (TO BE REPLACED)

The current building is too small to reasonably accommodate work on larger Zodiacs and cannot accommodate the new RHIBs when they come online. This Master Plan recommends the construction of a new Boathouse towards the other side of the pier closer to Gamage Point. The boathouse must be large enough to accommodate a single Rigid-Hulled Inflatable Boat (RHIB) or two zodiacs. This new location will allow improved access for pulling boats out of the water via the existing ramp and provides space to maneuver equipment into the new Boathouse. As technology has evolved, more and more research at Palmer is utilizing underwater gliders to perform surveys, remotely collect data, and support scientific efforts. In addition to supporting boating operations, the boathouse will also provide space for the maintenance and testing of these gliders prior to and after their deployment into the field.

The recommended location of the Boathouse has the potential of allowing a second small boat ramp to be located on the north side of Gamage Point as a secondary point of entry into the water. Recent observations have noted that the current boat ramp area gets iced in more frequently than in the past due to increased amount of flowing ice. When the existing boat ramp within Hero Inlet gets iced in, the other side of Gamage Point is often free of ice; when Gamage Point is iced in, Hero inlet is free of ice. This Master Plan recommends an optional secondary boat ramp and associated trolley system, hoist, or other method to efficiently transport boats into the boathouse without the need for powered vehicles and trailers.



DIVE FACILITIES (TO BE INCLUDED IN NEW BOATHOUSE FACILITY)

Built in 1990, the Dive Facility, located within the existing boathouse, is undersized for current dive operations and lacks efficient functionality in terms of both personnel flow and energy use. It lacks adequate space for proper rinsing, cleaning, and maintenance of dive equipment as well as efficient work flow for supporting diving operations. This Master Plan recommends the integration of a new Dive locker facility within a new boathouse.

Hazardous Processing Van

Hazardous Storage Building

Flammable Storage

HAZARDOUS MATERIALS PROCESSING/STORAGE (TO BE REPLACED)

Currently, the storage and processing of hazardous waste, hazardous materials, volatiles, chemicals, and flammables is located in many different buildings and sea containers spread around station that includes:
(4) sea containers for Hazardous waste storage (101, 102, 104, and 105 on site plan)
(2) sea containers for Flammable and Corrosive materials (29 on site plan)
(1) small shed for fuel drum storage (28 on site plan)
(1) larger building for Hazardous materials storage (13 on site plan)
(2) sea containers for hazardous and radioactive waste processing (705 and 706 on site plan)
(1) Container for volatiles storage (5 on site plan)

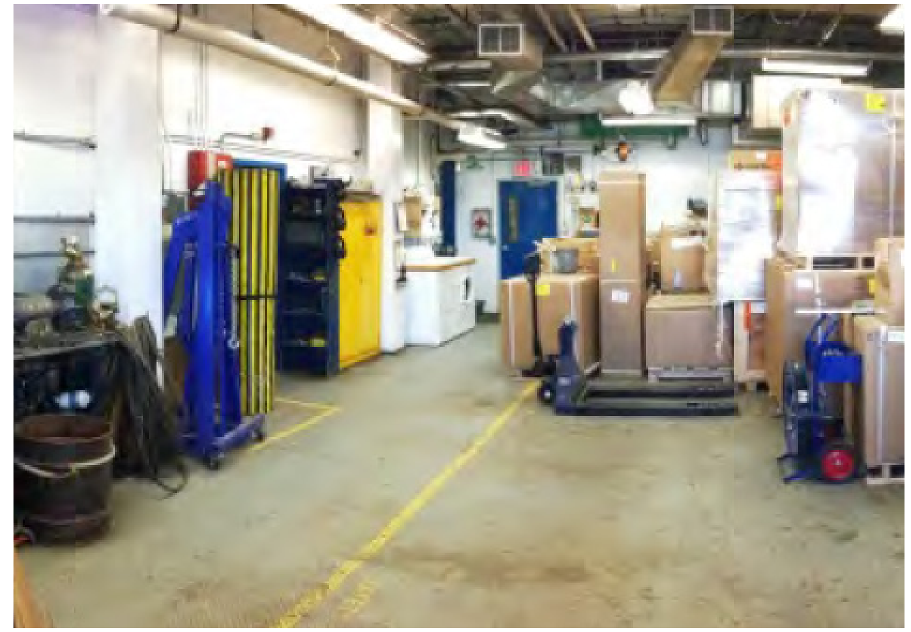
Building 13 - Built in 1986, this building is structurally sound and provides storage for all operational hazardous materials (paint, adhesives, batteries, etc.). The building has a new fire alarm system but no Station voice communications system. Hazardous waste accumulation drums are staged outside on a covered deck overlooking the harbor. Materials are loaded onto the deck facing the GWR building and brought into the building via the double doors.
Chemical Storage Milvans (29 on site plan) - These two storage vans are in reasonable condition, but as they are modified sea containers, will rust before too long and as they are located in front of Palmer Station are the first things to be seen.
Building 5 – Volatiles Storage (Building 5 on site plan) - This building is a modified sea container in poor shape. The space is heated, but lacks adequate insulation. This type of storage needs a permanent structure.

The remaining structures are standard uninsulated sea containers that are used to process and store hazardous waste, and other hazardous materials.
This Master Plan recommends a new Hazardous Materials Processing/Storage facility, located at existing tank pad #1, which is a location that balances safety and convenience. The intent of this new building is to consolidate hazardous materials including the storage of chemicals, flammables, volatiles, as well as hazardous waste into a single common location in order to store and process these materials in a safe and efficient manner. It is recommended that waste storage and handling also be housed within the new facility.

FUEL TANKS (TO BE REPLACED)

Palmer Station's fuel is supplied from two 125,000 gallon cylindrical steel storage tanks that were built in 1967. This provides the station with the required 125,000 gallon fuel capacity and the necessary capacity for redundancy. The tanks lack secondary containment berms or a double wall for any leak containment. Currently, one tank holds about 25,000 gallons of contaminated fuel that needs to be shipped off station. Based on the 43 year age of the tanks, the obvious rust in places near the bottom of the steel, and the lack of spill containment facilities or currently required tank accessories, it is recommended that both bulk fuel storage tanks be drained and demolished as soon as new replacement storage tanks can be built and put into service. Bulk Tank #1 was given an out-of-service inspection in 2015 and was given another 15 years before a re-inspection was needed. The fuel in Bulk Tank #2 will be used in ambient as temperatures increase to allow the wax in the fuel to return to liquid, thus reducing the volume of fuel to be drained from the tank allowing the tank to be inspected.

New fuel tanks will be located above the main station to allow for the simplest and the most effective fuel distribution to all necessary buildings. This will allow the removal of the Fuel Transfer/pump house as it no longer will be required for station distribution. The Gould's on-board pumps can provide the required pumping during fuel offload. The tanks will be of a horizontal cylinder design meeting all required codes for fire safety and spill containment. Because the new fuel tanks are required for safety and environmental concerns as well as to create the necessary space for the Power Plant/Garage and Hazardous material processing and storage, the fuel requirements are expected to remain similar to the current capacity requirements until the full Palmer Master Plan build out is achieved. At that point, fuel requirements will be less and increased redundancy will be gained within the system. Multiple smaller tanks mean the backup capacity is reduced to the size of the largest tank. It is anticipated that Palmer will require (6) 25,000 gallon capacity, double hulled tanks to provide the station with enough fuel capacity, reserving one tank for backup fuel storage. This tank size allows for the tanks to be prefabricated off site, shipped in, and installed. New double-walled fuel piping would be installed from the pier to the new tanks for filling from the Gould. The new tanks would tie into existing fuel distribution infrastructure until new facilities come online as the full Master Plan build-out is completed.



POWER PLANT/GARAGE (TO BE REPLACED)

The Palmer Station Power Plant and Garage are located in the “GWR” Building (Garage Warehouse Recreation) beneath lounge and berthing space. The Power Plant is comprised of two aging 250 kW, 120/208V Caterpillar diesel engine generators and manual switchgear. While GWR is heated using available waste heat from the engines, the bulk of the heat available from the engines isn’t utilized as there isn’t infrastructure to distribute the extra heat to other buildings on station.

Given the nature of Palmer’s evolution and development and changing needs over the years, incompatible occupancies were introduced to make use of what space was available, resulting in efficiency and code compliance issues. There isn’t proper fire separation between the different occupancies of the power plant, lodging, warehousing, lounge and fitness center. Due to the age of the generators, vintage 1988, the associated switchgear, vintage 1968, and engine fuel efficiency, emissions, and reliability upgrades, this Master Plan recommends replacing the existing power generation equipment to improve reliability, and relocating it from the GWR Building to an independent generator building for improved safety and efficiency.

The construction of a new power plant and garage facility would be co-located on the flat pad currently occupied by the lower fuel tank #2. This location provides excellent separation from the everyday activities of the station and provides improved fire separation. Whether the power plant is comprised of mictorturbines or the more traditional internal combustion engines, the new power generation equipment would be capable of producing and efficiently distributing power and heat via an improved utilities distribution system. The garage would be built adjacent, capable of servicing two pieces of equipment. Examples include a Skytrak telehandler, and Caterpillar IT loader used to move material, boats, and snow around station. Each of the two garage bays would be sized 10% larger than the largest piece of equipment that is currently being used on station to provide necessary access around the vehicles for maintenance as well as any changing equipment needs. Also included would be a mechanic washroom and office.

FIRE/POTABLE WATER STORAGE TANKS

The existing fire water storage tank is inadequate to support fire suppression needs in the new Warehouse area. The source of the water for this tank is seawater from the intake, through the Reverse Osmosis units in the water treatment plant that is then stored in the water tank. The 9000 gallon fire suppression tank is filled using a pressure pump in the BioLab mechanical room that is fed from fresh water tanks.

A new storage tank will be located at the new Station that will support both a 20 minute duration design sprinkler discharge (40,000 gallons) and a 10,000 gallon domestic water reserve. Assuming no discharge for fire suppression, the water in the tank is expected to turn over every 55 days during minimum occupancy (20 people) and every 24 days during maximum occupancy (46 people).



BIOLAB (TO BE REPLACED)

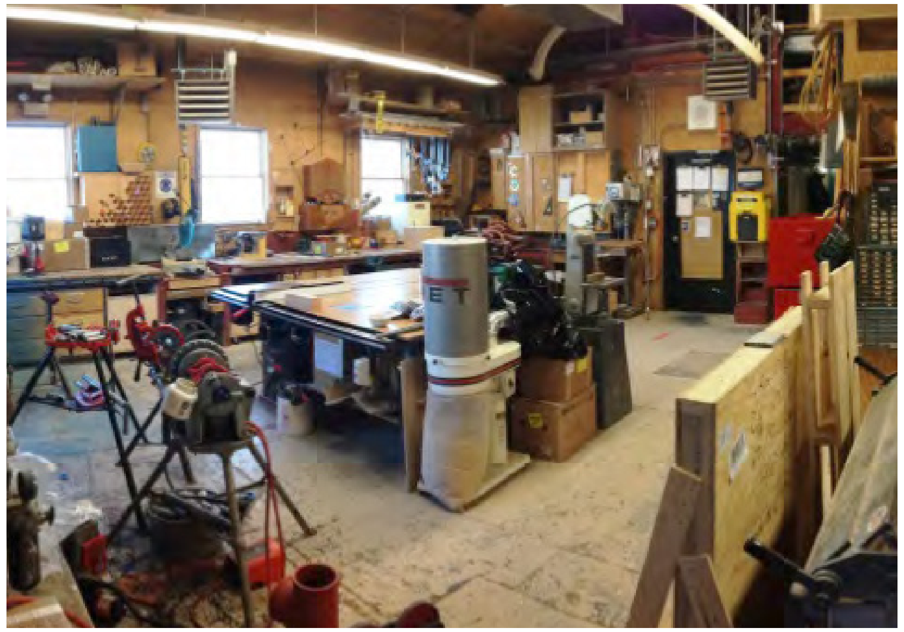
BioLab is the main building for the Station and was constructed in 1968. The ground floor houses the laboratory spaces where most science teams work. There are dedicated spaces for shared equipment like microscopes, muffle furnaces and balances. The main level, located on the second floor, contains the station dining room and kitchen and includes a large dry food storage area, a scullery for dish washing and small walk-in freezer and refrigerator units. The IT data center, the station's main communication equipment and administrative offices are also on this level, adjacent to the dining room. The top floor is all lodging, with 11 double occupancy bedrooms, a linen closet and two restrooms (men's and women's).

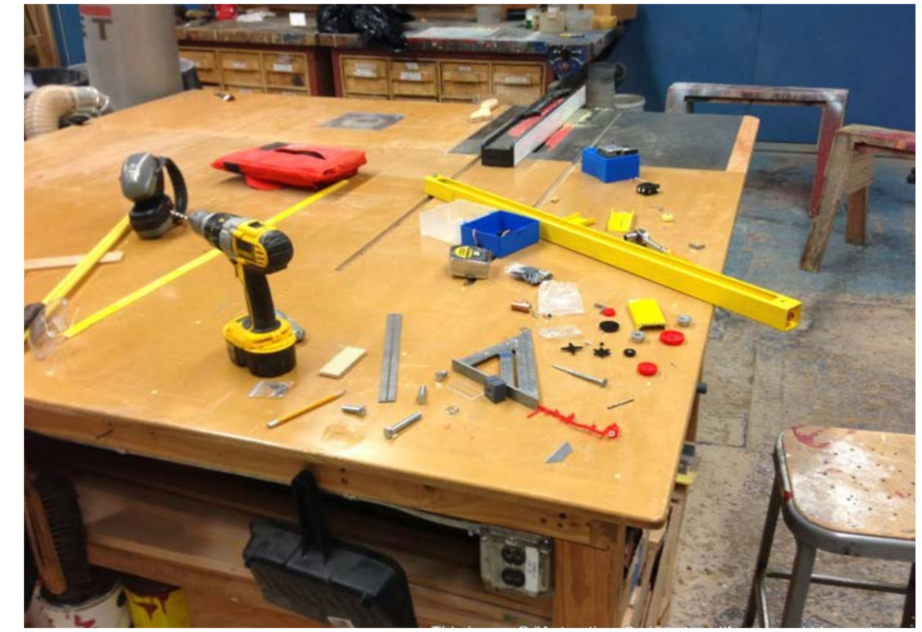
BioLab work consists of groups doing combinations of the following:

- Chemistry work (need bench space for instruments, several dedicated circuits for each lab, fume hood and chemical storage space)
- Electronic work (prepping gliders or equipment that will go in field, workbench space in a dry place)
- Aquarium work (wet lab, all GFI circuits, drains in floors)
- Sample processing (wet lab space, but also a dry side for analytical equipment)
- Field work (space to wash, dry, and store field equipment)

The existing BioLab building layout and construction is not compatible with its current functions of Laboratory, Aquaria, Administration, Lodging, and Food Service (including kitchen, dining and food storage) due to the many code compliance issues regarding the proper separation of these differing occupancies as well as protection to the structure to support the 3rd floor lodging. The lodging rooms currently have an estimated 60 square feet per room for two people. Room sizes in the proposed building will be addressed at the programming phase. BioLab lacks adequate insulation and efficient windows.

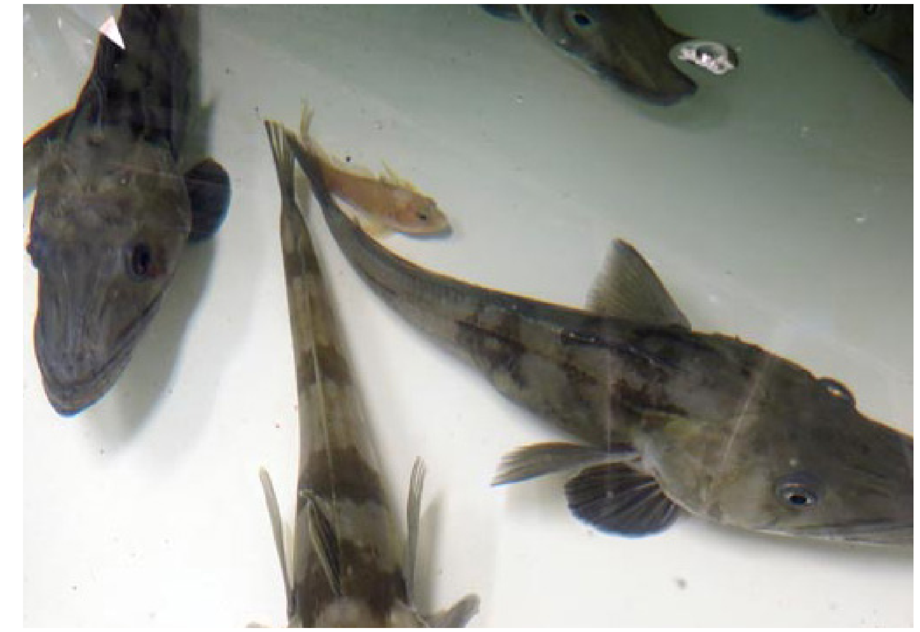
This new consolidated facility will contain not only the existing functions of the BioLab (Aquaria, Labs, Administration and Food Service), it will also include the Carpentry/Trades Shop. The new building would properly separate these individual spaces for both fire safety, and ventilation. This Master Plan recommends the continued use of the BioLab during construction of its replacement facility.





CARPENTRY/TRADE SHOP (TO BE REPLACED WITHIN THE NEW CENTRAL SERVICES LAB FACILITY)

Built in 1987, this facility provides support to both field science projects as well as station maintenance. This building houses the Facilities engineer, Carpentry, Electrical, and Plumbing shops, and Trades Storage. This currently stand-alone building lacks energy efficiency and adequate insulation, sufficient ventilation to bring in fresh air and vent fumes, adequate storage for the different trades, and a useful layout for the efficient operation of all trades. In the current shops, storage is located in attic space above the main shop. This layout is inefficient and presents safety challenges when retrieving everyday items from storage above. The current location does not provide adequate fire separation to BioLab nearby, and to fit within the recommended Master Plan, needs to be relocated. The Carpentry shop not only supports facilities maintenance for Palmer Station, but it provides support for science groups on and off station, necessitating the close proximity to lab facilities. To continue supporting science groups efficiently, it is recommended to be replaced and integrated within the new "Central Services/Lab" Facility to efficiently support operations.



AQUARIUM (NEW, TO BE REPLACED WITHIN NEW "CENTRAL SERVICES/LAB" FACILITY)

The Aquarium was built in 1985 with two environmentally controlled labs added in 1992. Much of Palmer Station's research revolves around its aquariums, its ability to maintain the ambient seawater temperature, as well as sufficient seawater flow. Currently, there are 5 outdoor tanks, 4 indoor tanks, 2 cascade tanks, with additional outdoor and indoor hookups for grantee provided equipment. The aquariums are used as a means for observation under carefully controlled parameters, as well as a closed system environment to monitor fish and take readings of their biologic processes and health. The current indoor aquarium is adequate; however, significant improvements could be made. The current aquariums are supplied seawater from an aging seawater intake utilizing centrifugal pumps that heat the water passing through. Additionally, valves and aquarium environmental controls are poorly located and require climbing over and around the tanks to operate. Over the years, the seawater and humidity inside the aquarium has caused corrosion to electrical panels, doors, aquaria structures, and flooring. When designing the new aquariums, care must be taken to reliably provide the aquarium with cold, clean seawater, as well as working space around aquariums, with easy access to flow and temperature controls. The fish near Palmer Station have shown a high degree of sensitivity to changes in temperature. A more accurate, sensitive, and robust system for controlling both the flow and temperature of the incoming seawater must be included. Improvements to the seawater piping, insulation, heat trace, and pumps would significantly reduce the heat gained from the point of intake to the aquarium. The use of a chiller could allow for precise temperature control, as well as eliminating the heat gained as the seawater is brought from the ocean through the pumps up to the aquariums.

Outdoor aquariums allow for additional research opportunities and variables to be investigated. While some can be located near the building, or underneath a covered walkway, some must maximize access to direct daylight, meaning location and orientation must be considered to minimize shadowing from buildings.

DINING (TO BE REPLACED WITHIN NEW "CENTRAL SERVICES/LAB" FACILITY)

Because Palmer is in a remote location with a small population, shared responsibility, collaboration, teamwork, and a strong sense of camaraderie are all important aspects to station life and the success of each science season and overall operations. It is important to provide spaces that cultivate and facilitate such cooperation. The dining and kitchen facilities at Palmer are one of these spaces. The new dining facility must continue to facilitate this cooperation as it is currently the central space that brings everyone together not only during meal time. It is a central meeting area, and major thoroughfare that helps to continue the spirit of cooperation and teamwork. This Master Plan recommends that a centrally located Dining and Kitchen facility be maintained within the new central services/lab facility.

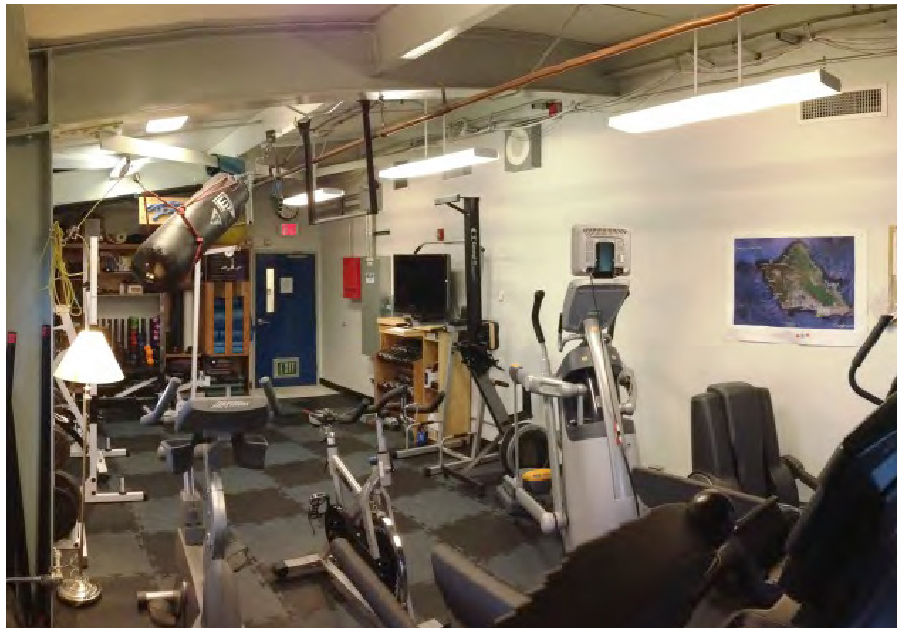


GWR (GARAGE WAREHOUSE RECREATION) (TO BE RENOVATED)

GWR is the second main building at Palmer and was built in 1969-70. GWR is multi-use with a garage, power plant, and storage on ground floor. The second floor contains lodging, medical services, a recreation area, lounge and gym. These are incompatible uses between the first floor (storage, garage shop, and two generators that provide power to the entire station) and the second (lodging). The power plant and garage should be removed from this building and moved to a separate building. The current space can then be converted to warehouse space to reduce the use of sea containers outside.

One of the important tenets of the USAP mission calls for the responsible use of limited resources throughout its facilities. GWR has many issues with proper separation between conflicting occupancies, but at its core, its structural system is sound. Under this Master Plan, the structure of GWR would be re-used for the new warehouse, medical services, and main recreation facilities. Similar locations for the current lounge areas, as well as exercise room would be utilized. The zones currently occupied by the power plant, garage, and parts storage, as well as lodging would become a large warehouse space once a new power and garage facility are built.

Currently, 20' sea containers, or "milvans", are used to store the majority of Palmer Station's materials aside from items sensitive to freezing. These sea containers can be found lined up outside buildings anywhere space is available, some of which have become permanent fixtures to the extent that they have been given building numbers. This Master Plan recommends that required high bay warehouse space be added within the remodeled GWR. Overall station building square footage may appear to increase substantially, but in fact, the intention is to create more efficient warehousing space and retire the use of sea containers used for permanent storage.



FITNESS CENTER AND LOUNGE (TO REMAIN IN RENOVATED GWR BUILDING)

Fitness and Lounge facilities are recommended in this Master Plan to remain on the second level of the renovated GWR Building. Here, they occupy a central location and provide an acoustical separation between the new working and lodging facilities of Palmer Station.

Fitness Center
The gym is equipped with cardio equipment including a couple treadmills, stationary bikes and elliptical machines. There are two audio visual displays to keep exercisers entertained during cardio work outs. There are free weights, barbells, benches and a punching bag. A storage shelf in the back of the room houses personal exercise equipment including yoga mats, balls, weight belts, etc. Floor space is at a minimum so has no real space for group exercise classes.

Lounge/Recreation
The lounge is another multi-use space on station. It features a projector screen for watching movies, playing video games and weekly science lectures. Furniture is on casters to accommodate ease in moving furniture to the lounge area for morning stretching, yoga or other group well-being and fitness activities. The Lounge also houses the station library and DVD collection. There is not enough seating for everyone during peak season so bean bags and the floor are sometimes utilized for extra seating. The space is also used for staff meetings.

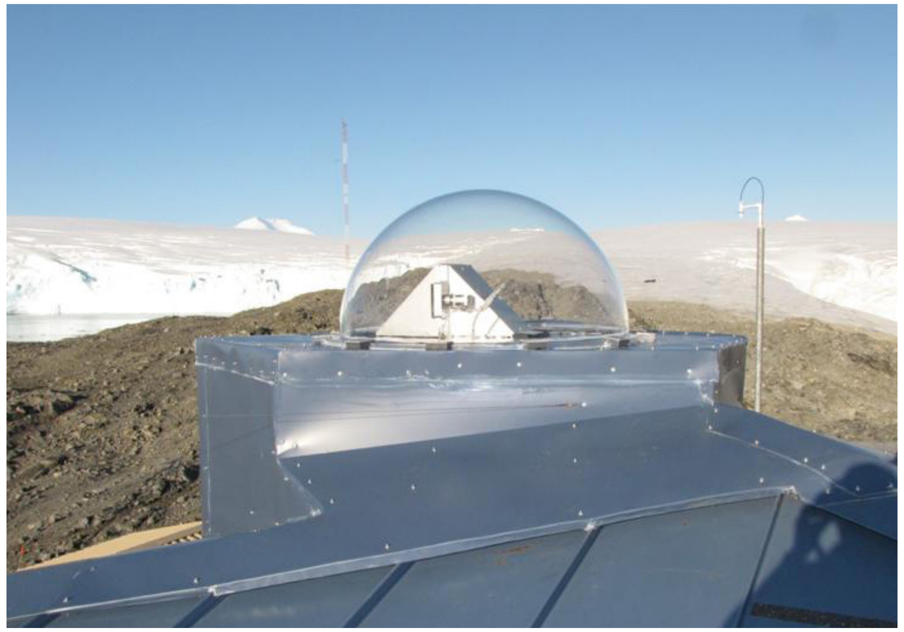
The lounge is a cozy gathering place for social gatherings. Station members can enjoy a game of pool or darts and the sliding glass doors open out onto a deck that overlooks the front of station and Arthur Harbor. A card table with bar stools and popcorn machine are also popular. Occasionally the pool table will be rolled into the Lounge to make room for dancing.

LODGING (TO BE REPLACED WITH NEW 2-STORY FACILITY)

Palmer Station currently includes a total of 46 beds in 23 double occupancy rooms: 11 rooms/22 beds in BioLab, and 12 rooms/24 beds in GWR. Additionally, there are only two showers and two toilets to serve all 22 beds in BioLab, while there are 4 toilets and 4 showers in GWR. BioLab has significant code issues related to the mixed residential and business occupancy that is occurring in the building. There is no vertical separation between the corridors on the third floor sleeping rooms or between the rooms, creating a fire and a noise/privacy issue. There is also no horizontal fire separation between the 3rd floor lodging area and the 2nd floor kitchen below. There is also no adequate fire protection between the 1st and 2nd floor structure which supports the 3rd floor lodging, as required by code. Additionally, the rooms are too small for double occupancy, having only an estimated 60 SF per room. Lodging room sizes will be addressed at the programming phase. Because the BioLab needs additional Science Support space for offices and storage, and considering the high cost of a code upgrade renovation that still cannot provide the minimum required square footage for a double occupancy room, it is recommended that all sleeping rooms at the BioLab be relocated elsewhere.

This Master Plan recommends that a new lodging facility be constructed north of renovated GWR Building. This would eliminate the occupancy separation issues, provide primarily single rooms with the potential for double occupancy rooms, and isolate the sleeping quarters from noise-generating activities. Designers must be sensitive to the siting to ensure the design capitalizes on topography and views. The proposed lodging facility will be rotated to fit within the existing contours on the land to aid in snow removal and vehicle access.

A double loaded corridor is recommended with sleeping rooms facing primarily north and bathrooms and utility rooms facing south toward the GWR building. The new lodging building would be close to the GWR lounge and exercise room. An enclosed and elevated walkway is proposed to connect this Lodging Building with the renovated GWR building. This walkway will serve double-duty, as it also contains weather-protected utilities, including power, IT, waste water, potable water, fire water, and waste heat.



TERRA LAB (TO REMAIN)

Constructed in 2005, this is a relatively new building that supports both NSF scientific investigation and the US Department of Energy's Comprehensive Test Ban Treaty (CTBT) air sampling activities. The building is in good condition, structurally sound and functional for its intended use. Improvements to this building will be performed as ongoing maintenance activities and are not included in the Master Plan.



EARTH STATION (TO REMAIN)

The earth station radio frequency (RF) shelter holds critical communications and data center equipment. Voice over Internet Protocol (VoIP) and all Internet services rely on this equipment. The station shares a 3 mbps satellite data connection. Built in 2002, this is a structurally sound building. Improvements to this building will be performed as ongoing maintenance activities and are not included in the Master Plan.

PLAN

This Master Plan recommends a new Central Services/Lab building that is located approximately twenty feet north of the existing BioLab.

The proposed facility is comprised of 3 floors in order to consolidate the station's footprint and maximize energy efficiency. The ground floor includes the Aquaria, laboratories and associated support spaces. Exterior uncovered Aquaria are provided at the northwest corner of the building. The second floor includes Dining, Kitchen, Food Storage and Trades shops, and associated trades materials storage. The 3rd floor contains administrative offices.

This plan allows for nearly-continuous operation of Palmer Station through the various phases of construction. In addition to ensuring near-continuous operation, the location of the new Central Services/Lab Building aligns with the existing BioLab. Upon completion of the new Central Services/Lab building, the existing BioLab could be demolished, leaving a wide, highly-functional corridor for vehicular movement.

In this plan, lodging on the second-level of the GWR building is removed, allowing for efficient "high-bay" warehousing below.

The displaced lodging is accommodated in a new two-story Lodging building that is located directly to the north of the Central Services/Lab building. The lodging facility consists of primarily single-occupancy rooms, a small portion of double-occupancy rooms, bathrooms, showers and janitorial support spaces. Because this building flanks the shoreline, many rooms will overlook the harbor and glacier to the north, while several south-facing rooms will have distant views to the mountain range and sea. Rotation of Lodging facilitates snow removal operation. Water-side access for maintenance and life-safety will be maintained.

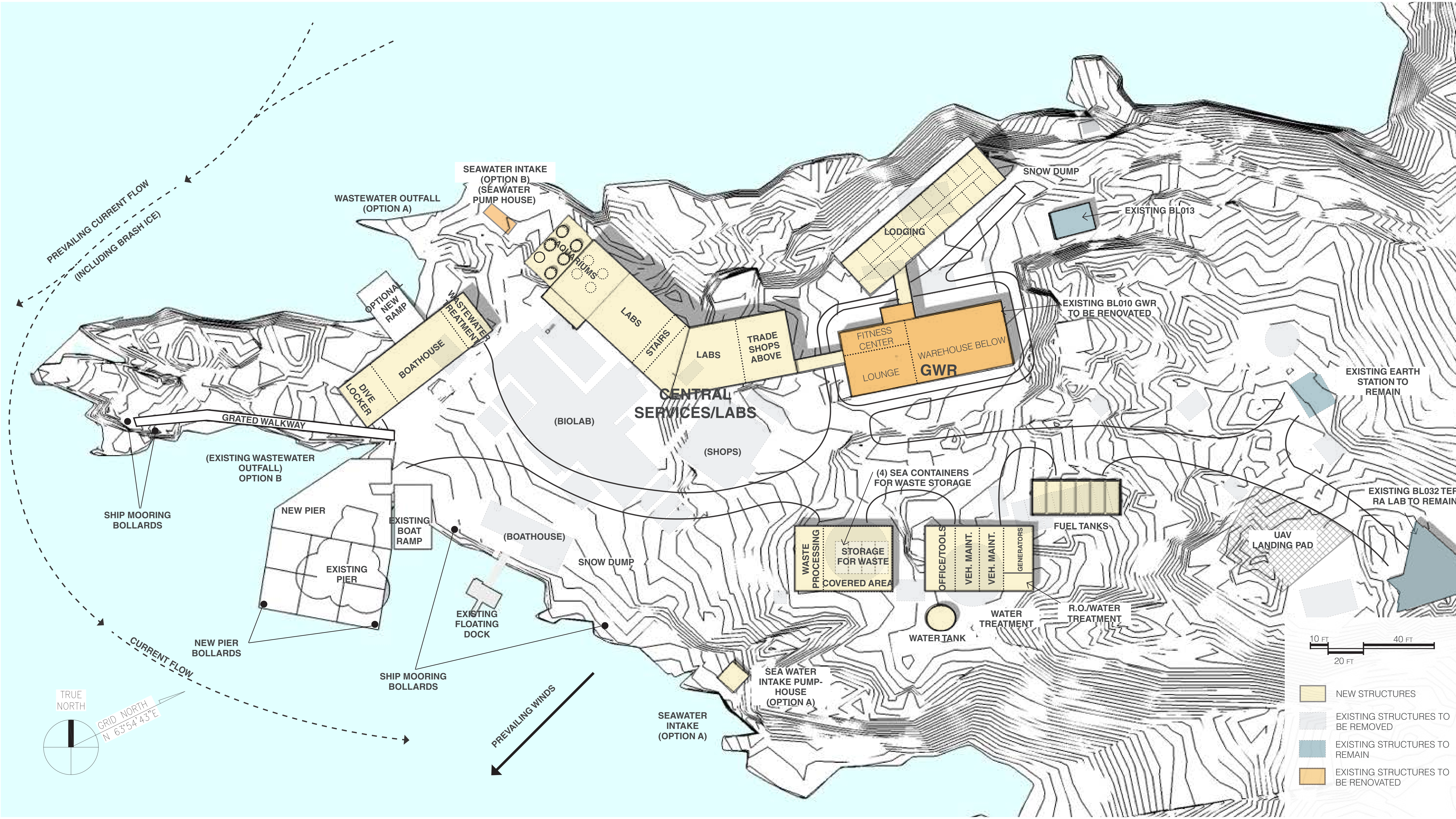
Two new facilities, (a new Power Plant/Garage and a Waste Processing/storage facility) are located at the two existing fuel tank sites. These two tanks, currently over-sized for Palmers' demands, will be replaced by a series of smaller, more appropriately-sized, double-hulled fuel tanks located immediately north-east of the Hazardous Waste/Processing facility.

By locating a new boathouse/dive locker away from the existing facility, the master Plan allows for a complete continuous operation of Palmer Station through the various phases of construction. Furthermore, by locating the boathouse and Central Services/Lab away from the South shoreline, the clear and safe movement of small boats and services vehicles is enhanced. A grated walkway is intended to assure safe vessel mooring operations. Bollards are indicated on the Site Plan.

The location of the boathouse/dive locker allows for an optional second boat ramp. This results in potentially enhanced flexibility in operations, given that oftentimes the northern and southern shores experience different ice and wind conditions.

Given the increasing use of UAV (unmanned aerial vehicles) and their ability to carry equipment for scientific pursuits, this Master Plan recommends a UAV landing zone be located at the old helo pad. The typical wind out of the north will allow them to come in over Hero Inlet and still have room to turn to the west if they need to abort, and it allows them to get some lift while on the pad and quickly gain airspeed if they depart into the wind.

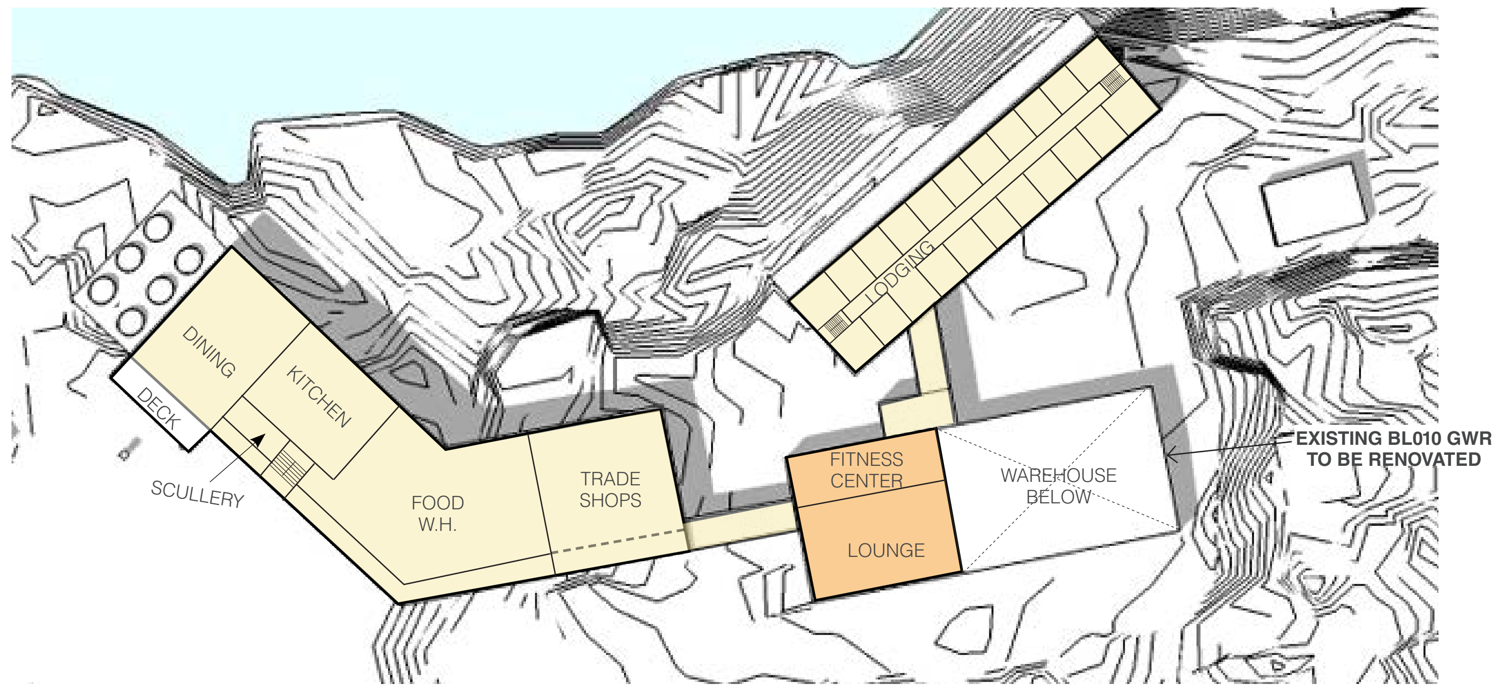
SITE PLAN


PREVAILING CURRENT FLOW
(INCLUDING BRASH ICE)
WASTEWATER OUTFALL (OPTION A)
SEAWATER INTAKE (OPTION B) (SEAWATER PUMP HOUSE)
AQUARIUMS
LABS
STAIRS
LABS
TRADE SHOPS ABOVE
LODGING
SNOW DUMP
EXISTING BL013
EXISTING BL010 GWR TO BE RENOVATED
FITNESS CENTER
LOUNGE
WAREHOUSE BELOW
GWR
EXISTING EARTH STATION TO REMAIN
OPTIONAL NEW RAMP
WASTEWATER TREATMENT
BOATHOUSE
DIVE LOCKER
GRATED WALKWAY
CENTRAL SERVICES/LABS
(BIOLAB)
(SHOPS)
(EXISTING WASTEWATER OUTFALL) OPTION B
(4) SEA CONTAINERS FOR WASTE STORAGE
EXISTING BL032 TERRA LAB TO REMAIN
FUEL TANKS
UAV LANDING PAD
SHIP MOORING BOLLARDS
NEW PIER
EXISTING BOAT RAMP
(BOATHOUSE)
SNOW DUMP
EXISTING PIER
WASTE PROCESSING
STORAGE FOR WASTE
COVERED AREA
OFFICE/TOOLS
VEH. MAINT.
VEH. MAINT.
GENERATORS
R.O./WATER TREATMENT
WATER TREATMENT
WATER TANK
NEW PIER BOLLARDS
EXISTING FLOATING DOCK
CURRENT FLOW
SHIP MOORING BOLLARDS
SEA WATER INTAKE PUMP-HOUSE (OPTION A)
SEAWATER INTAKE (OPTION A)
PREVAILING WINDS
TRUE NORTH
GRID NORTH N. 63°54'43"E
10 FT
20 FT
40 FT
NEW STRUCTURES
EXISTING STRUCTURES TO BE REMOVED
EXISTING STRUCTURES TO REMAIN
EXISTING STRUCTURES TO BE RENOVATED

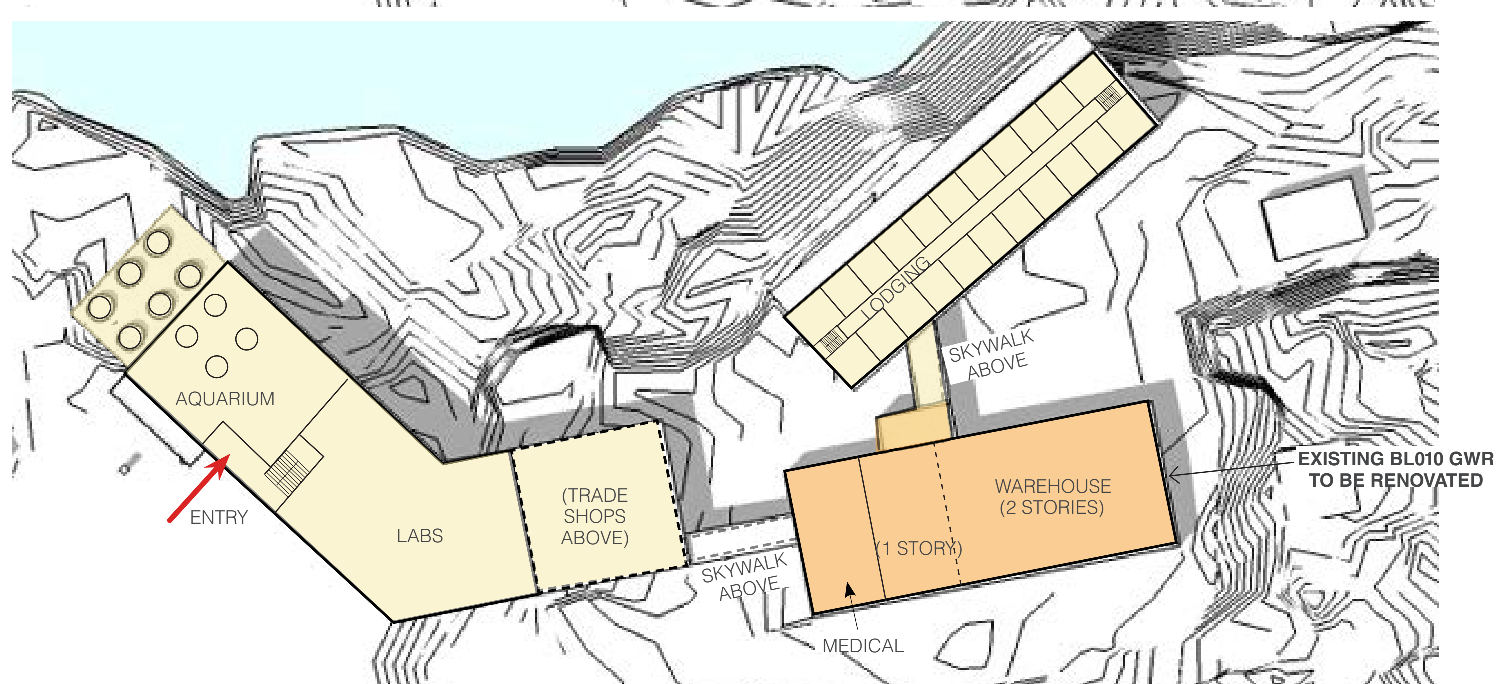
FLOOR PLANS

LEVEL 3

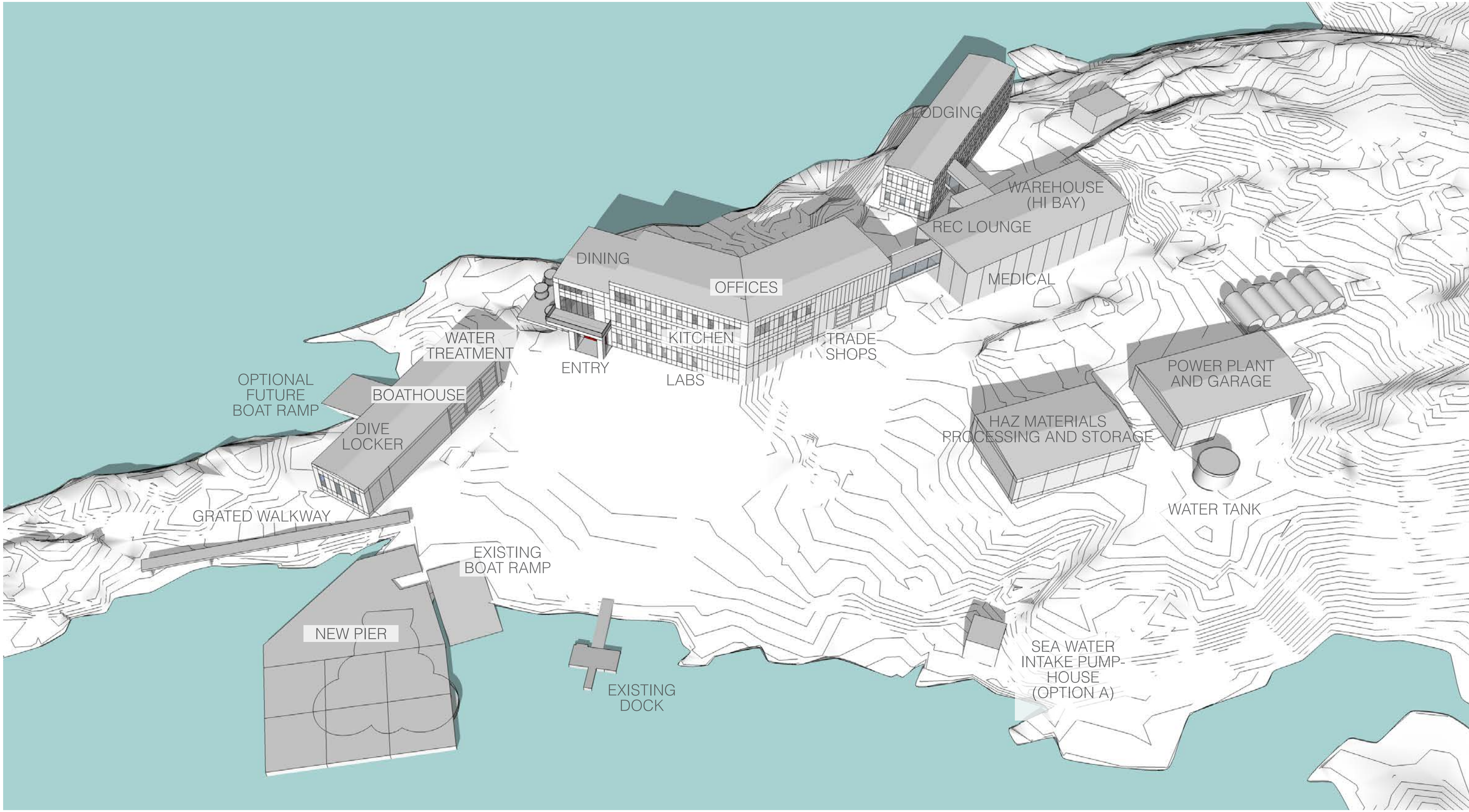
LEVEL 2



LEVEL 1



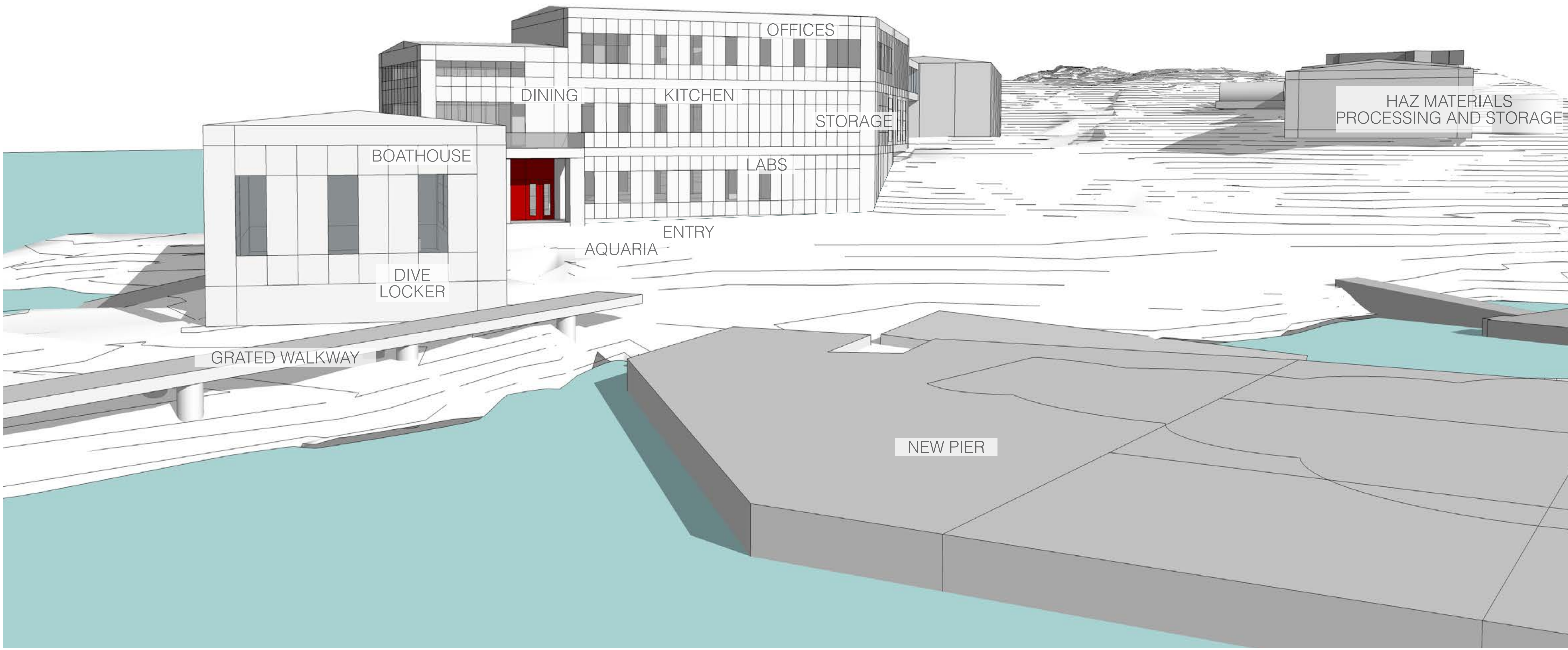
BIRDS-EYE VIEW



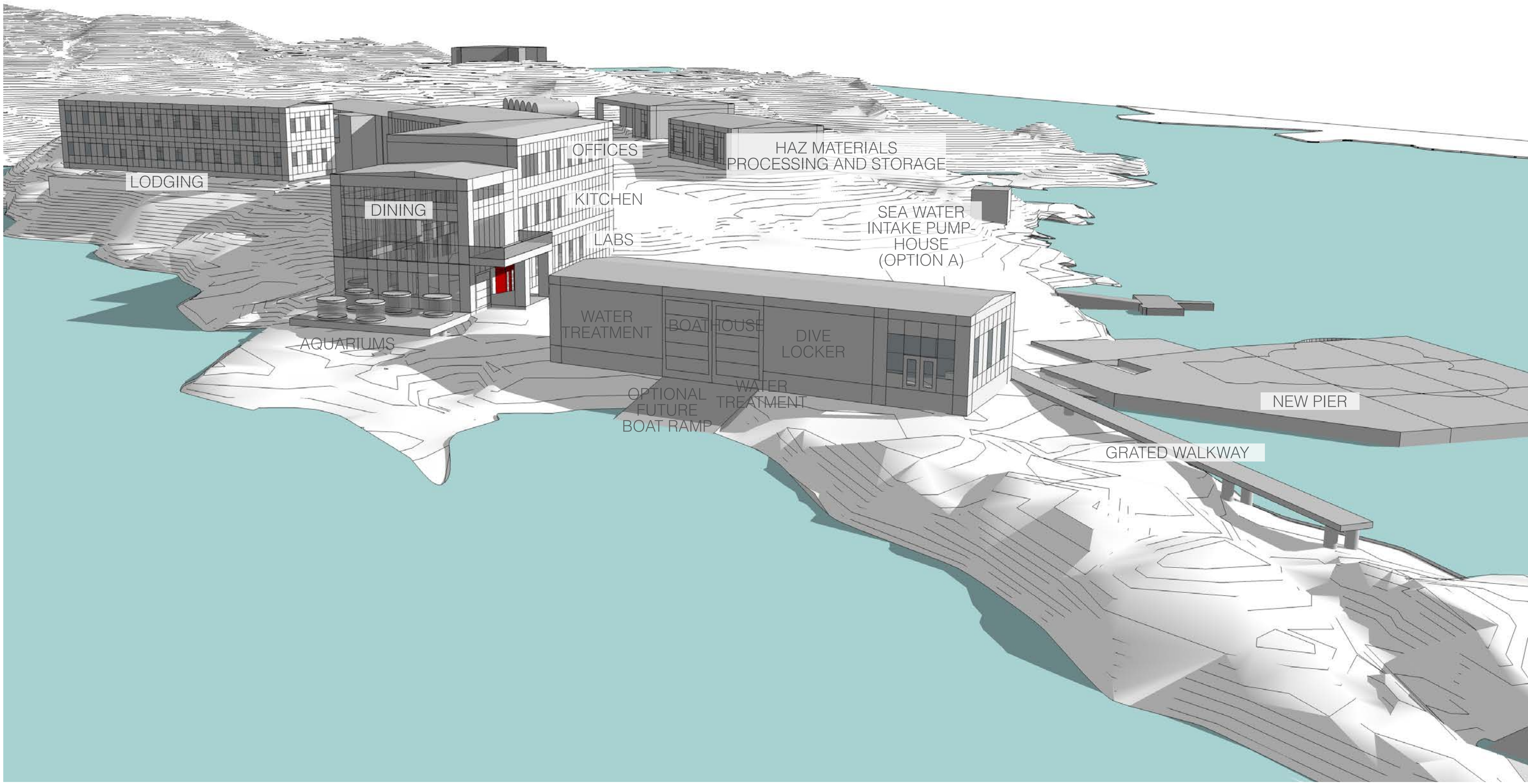
VIEW FROM SOUTHWEST

VIEW FROM NORTH

VIEW FROM SOUTH (ARRIVAL)



VIEW FROM NORTHWEST



PHASING PLAN

1. Build
   - Palmer Pier

   Relocate
   - Storage Containers to areas indicated as 1A

2. Build
   - New Fuel Tanks
   - Fuel Distribution Network

3. Demolish
   - Fuel Tanks and associated Pump House

4. Build
   - Hazardous Waste Processing
   - Hazardous Waste Storage
   - Power Plant/Garage
   - Water Treatment
   - Wastewater Treatment
   - Water Tank
   - Seawater Intake
   - Utility distribution network between new buildings and existing GWR

5. Demolish
   - First floor GWR, including:
     - Power Plant (Interior)
     - Garage within GWR (Interior)

   Build
   - New Lodging Building

   Extend
   - Utilities to lodging

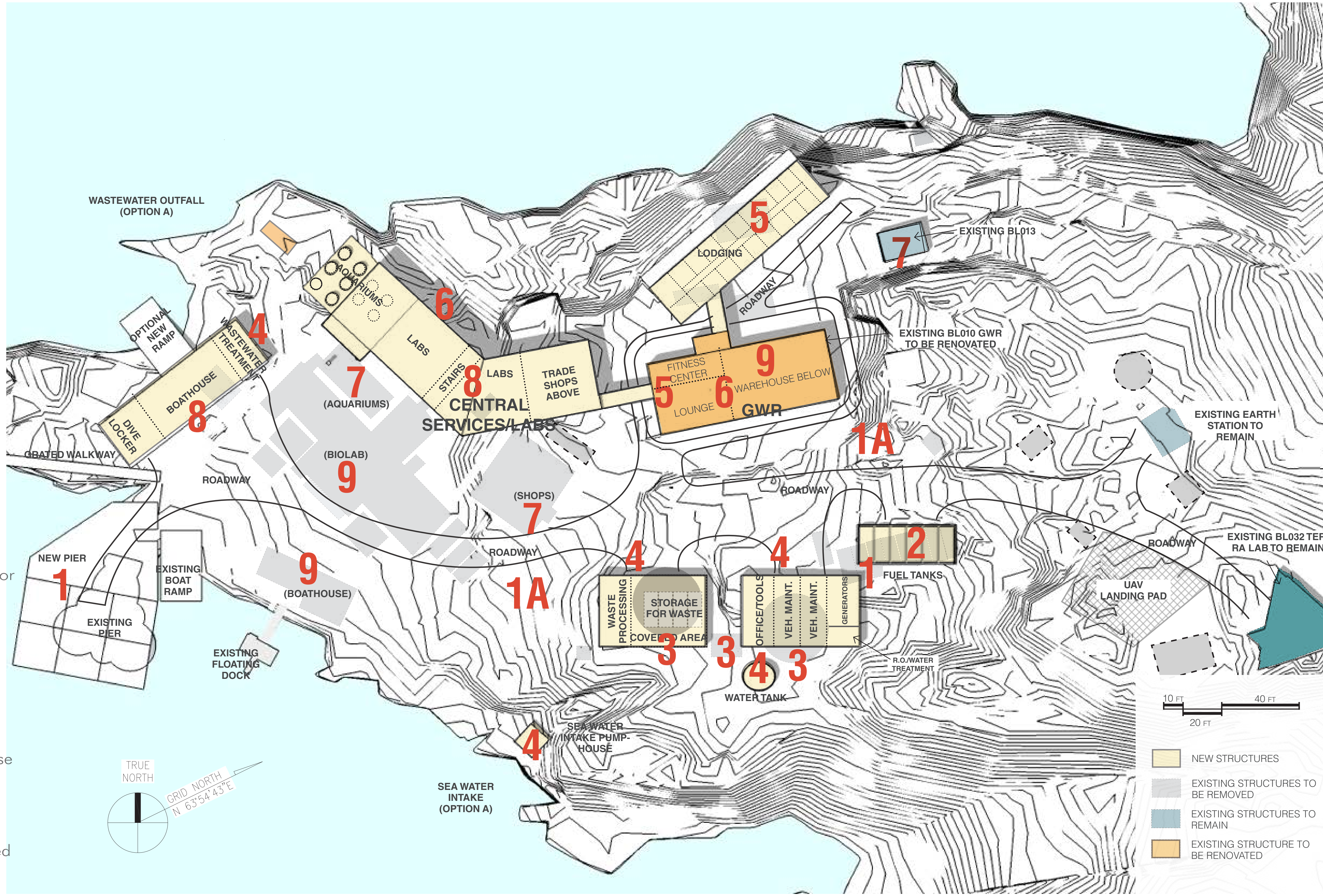
6. Relocate
   - Aquariums into GWR 1st Floor
   - Provide temp utilities around Biolab building

7. Demolish
   - Aquarium
   - Carpentry Shop

8. Build
   - Central Services/Labs
   - Boathouse
   - Provide permanent utilities through Biolab and Boathouse Buildings

9. Build
   - Renovate GWR

   Demolish
   - Biolab and remove associated Shipping Containers
   - Boathouse



UTILITIES

UTILITIES

UTILITY DISTRIBUTION

The site at Palmer Station is rocky, with solid rock in many places. Similar to the existing condition, utilities will be distributed above ground as much as possible in order to avoid expensive trenching. In order to minimize road crossings where they must be buried, site utilities will be co-located to leverage common pathways and supporting infrastructure.

POWER GENERATION / DISTRIBUTION

The existing Power Plant is comprised of several aged systems and is recommended to be replaced in its entirety. The generators, circa 1988, are approaching their useful life while the switchgear, circa 1968, is well past its useful life. A new Power Plant, which includes new generators, new switchgear, and a gravity fed fuel line would increase station power reliability and station power generation safety. The new Power Plant location increases distribution distances, so to minimize line losses and allow for more efficient equipment selection for both electrical and mechanical systems, power generation will be at 480Y/277 volts. Distribution via this voltage results in smaller cable sizes which reduces both initial and operational costs. A backup power plant with a gravity fed fuel line will be provided in a separate facility for emergency scenarios. Distribution for the primary power will be collocated to the greatest extent possible with other utilities. When crossing vehicle pathways, utilities will be buried or recessed in a culvert. Combined heat and power (CHP) style generation (by combustion engine with heat recovery or by microturbine) will be considered, but the implementation of CHP technology depends on the scale and energy, both thermal and electrical, consumption throughout the year. It is noted micro-turbine (MT) technology offers advantages over conventional reciprocating engine generators, including higher reliability, less noise, lower emissions, reduced maintenance and smaller footprint.

WASTE HEAT RECOVERY / DISTRIBUTION

Due to efficiencies gained by consolidating facilities and utilizing modern construction envelopes, it is expected most, if not all, of the station's heating needs will be satisfied by heat recovered from the generators or from electricity generated from renewable resources. It is recommended this recovered heat be distributed to the main station facilities with heating fluid via insulated piping. To simplify utility pathways and leverage common infrastructure, it is recommended the heat recovery loop be co-located with other site utilities in the utilidor.

Based on historical data and expertise from station personnel, 30% propylene glycol solution is adequate to provide freeze protection for the hydronic systems. Therefore, the heating fluid should be a mixture of 30% propylene glycol and water, with inhibitors added as needed to ensure protection of the heating piping. It is recommended the facility heating systems will be designed to use low temperature (140 degree F) heating fluid and high delta T (40 degree F) to maximize heat recovery efficiency and provide excess capacity via high temperature (180 degree F) fluid during extreme cold periods. To ensure conservative equipment and system selections, it is recommended the heating pumps and distribution piping be designed for low delta T (20 degree F) flow. However, the system should be operated at high delta T (40 degree F) to minimize pumping energy whenever possible. Likewise, all pumps, piping, insulation and system appurtenances should be designed to support operation at 180 degrees F. To simplify utility distribution to remote facilities (e.g. Terra Lab) and leverage future sustainability initiatives, it is recommended remote facilities be heated with electric resistance heating.

RENEWABLE ENERGY

The existing energy production does not include renewable sources. The electrical distribution system is recommended to be flexible and allow for renewable sources to feed onto the grid. It is recommended that a full study be performed to determine benefits and impacts of introducing renewable resources.

FUEL STORAGE / DISTRIBUTION

The existing fuel storage tanks are difficult to maintain and lack secondary containment. Therefore, it is recommended new fuel storage tanks be provided. To facilitate installation and maintenance, six 25,000 gallon double-walled tanks will be installed, providing 125,000 gallons of storage with an auxiliary 25,000 gallon tank in reserve. Based on current fuel usage, the planned 150,000 gallon storage will be turned over approximately every six months. It is proposed the fuel storage tanks be located east of the Power Plant to simplify flow to both the Power Plant and backup generator location. As station power generation needs diminish through the introduction of sustainable technologies, it is recommended the number of active fuel tanks is reduced to maintain a six-month reserve.

UTILITIES

To the greatest extent possible, it is recommended the fuel loop be co-located with other site utilities to leverage common pathways and supporting infrastructure. To reduce power generation complexity and the risks associated with potential fuel spills, it is recommended that fuel distribution to individual buildings be minimized. To enhance distribution reliability, it is recommended fuel piping be flanged or welded steel piping. To ensure compliance with Antarctic Treaty requirements, it is recommended a new fuel fill box be provided as part of the new Pier, along with new double-containment fuel piping extended to the new fuel tanks. To minimize risk during fuel offloading, it is recommended that automatic level and fill controls be provided.

Currently, water-borne equipment (e.g. zodiacs) is fueled adjacent to the boathouse, increasing the risk of fuel discharge into the bay. It is recommended that a dedicated boathouse fueling station be provided that includes a spill-containment basin and emergency shut-off controls. Likewise, current ground equipment (e.g. loaders and skycranes) fueling has no containment strategy, increasing the risk of ground contamination. It is recommended that a dedicated equipment fueling station be provided that is located away from the waterfront, and includes a spill-containment basin and emergency shut-off controls. Fueling equipment and operations must comply with current marine fuel dispensing criteria, which is now NFPA 30A, Code for Motor Fuel Dispensing Facilities and Repair Garages and NFPA 303, Fire Protection Standard for Marinas and Boatyards which also lists requirements for Spill Prevention, Control, and Countermeasures (SPCC).

SEAWATER INTAKE

The current seawater intake location at the north side of the peninsula is subject to damage from sea ice. On several occasions, the intake pipes have been damaged, interrupting seawater collection and disrupting Aquarium Science programs. Additionally, the existing pump house configuration is inefficient and too small for the intended purpose. The seawater intake pumps are configured as horizontal end-suction type pumps, which lose their prime if the intake piping is not fully airtight. Additionally the pumps are crowded close together, complicating maintenance activities.

Two options for the location of seawater intake are suggested for further study. Option A locates seawater intake at the south side of the peninsula, near the new Power Plant, while Option B locates the seawater intake near the current location at the north side of the peninsula.

To simplify pump maintenance, it is recommended the intake site be reconfigured with a new pump house at the shoreline. To avoid issues with maintaining pump prime, seawater pumps will be configured as either submersible or vertical turbine. The pump configuration will be determined during a pre-design activity to optimize efficiency, facilitate maintenance, and ensure the seawater is as close to ambient temperature as possible (maximum temperature gain of 1 degree F or as directed by Aquarium Sciences). Further, it is recommended the seawater pumps be sized to support both Aquarium Science (estimated at 80 GPM) and domestic water filtration 20 GPM). To ensure continued operation during primary pump failure or planned maintenance, it is recommended that a backup pump be provided.

It is recommended seawater be drawn through a screened inlet protected by native rocks and gravel. It is recommended the seawater inlet be sized to accommodate the largest design flow, currently estimated to be the nominal fire protection flow of 2,000 GPM. It is also recommended to evaluate the possibility of a dual seawater inlet that would allow continued operation during planned maintenance or failure of the primary inlet. To facilitate maintenance, it is recommended the seawater fire pump be configured as a vertical turbine type. Seawater feeding the site fire hydrant system should be filtered using a graduated series of filters to protect fire protection equipment.

UTILITIES

SEAWATER DISTRIBUTION

It is recommended seawater be distributed from the seawater intake pump house to the water treatment system at the new Power Plant via insulated piping. To ensure continuous science support, it is recommended the seawater piping feeding Aquarium Sciences tee off prior to feeding the domestic water treatment system. The seawater piping feeding Aquarium Sciences should be insulated and configured to ensure the seawater is as close to ambient temperatures as possible (maximum temperature gain of 1 degree F or as directed by Aquarium Sciences).

DOMESTIC WATER GENERATION / DISTRIBUTION

It is recommended domestic water be generated via a reverse osmosis (RO) treatment system using seawater. To facilitate re-generation of domestic water storage following a fire suppression event, it is recommended the treatment system support a minimum flow of 10 GPM and a daily output of 10,000 gallons as described below. The details of the treatment system, including pre-treatment, UV disinfection, and chlorination, will be determined during design. To leverage common piping and water treatment resources, it is recommended a common potable/fire water system be provided. The system would share storage, distribution piping, heat trace, and recirculation strategies. To provide daily system pressurization and flow, a small domestic water booster system is recommended. The domestic water booster pump system would include variable speed drives (VSD) to provide variable flow operation and a redundant pump for backup operation in event of primary pump failure or planned maintenance. A utility monitoring system (UMS) should be provided to ensure proper control and monitoring of system water generation, flow and usage. The UMS should report all data to a central monitoring location and off-site to a CONUS location as needed.

It is recommended a larger dedicated fire pump provide pressure and flow to support internal firefighting operations at all connected station facilities. The fire pump would be activated upon a drop in system pressure, coupled with sprinkler system flow notification, and will automatically shut down when the water tanks reach a low level condition. To ensure piping freeze protection and prevent system stagnation, it is recommended a recirculation pump be provided. Domestic water would be distributed via insulated piping using the utilidor system. Where exposed to freezing temperatures, it is recommended distribution piping be insulated and heat-taped. All cold piping within conditioned spaces should be insulated to prevent condensation. Sizing will be determined during design. To eliminate inefficient ship runs needed to replenish onboard fresh water, it is recommended a new domestic water feed line be extended to the new Pier to provide fresh water for docked vessels. All connections to the site water distribution system (domestic water, fire water and pier support) will include backflow prevention to protect the site water supply.

Per NFPA requirements, the water tanks are to be replenished within eight hours of a fire event. However, it is recognized this requirement presents a significant burden on the fresh water generation systems and is not practical. Furthermore, the fire suppression system is backed up by the seawater hydrant system, which is capable of providing full and continuous fire flow in the event of inadequate fresh water capacity. Therefore, it is proposed the recommended generation capacity of 10,000 gallons per day (i.e. five day replenishment cycle) is adequate to support fire fighting operations.

WATER STORAGE TANKS

The existing fire water storage tank is inadequate to support fire suppression needs in the new Warehouse area. As outlined above, the current recommendation is to provide a combined domestic water and fire suppression loop. To support this usage, it is recommended to size the water tanks for both a short duration sprinkler discharge and emergency domestic water reserve. It is recommended the short duration sprinkler discharge be based on a 20-minute flow. This is intended to allow fire fighters to respond to a flow notification, assemble at the fire, evaluate the performance of the suppression system, and if needed, interconnect the wet-pipe suppression system with the seawater hydrant system.

It is recommended the emergency domestic water reserve be sized to support full station occupancy for approximately five days. This is intended to allow at least ten days of rationed water use in the event of a catastrophic water treatment system failure, providing adequate time for treatment system repair and/or replacement via ship.

UTILITIES

Based on the above recommendations, it is proposed a new dual-purpose 50,000 gallon storage tank be located adjacent to the new Power Plant that will support both a 20 minute duration design sprinkler discharge (40,000 gallons) and a 10,000 gallon domestic water reserve. Assuming no discharge for fire suppression, the water in the tank is expected to turn over every 55 days during minimum occupancy (20 people) and every 24 days during maximum occupancy (45 people).

SEAWATER HYDRANT / STANDPIPE SYSTEM

The planned fire suppression systems and water storage tanks are anticipated to provide a design flow of 2,000 GPM for a duration of 20 minutes. To mitigate the risk of maintaining firefighting operations over an extended period, it is recommended a supplemental seawater hydrant and standpipe system be provided. However, it is recognized a fire event may occur that exceeds the anticipated demand. Hydrants would be provided within 100 feet of all facilities, along with dry standpipe connections at all facilities to supply interior hose stations for interior firefighting operations.

It is also recommended a supplemental fire sprinkler system connection (FDC) be provided at each facility containing a pipe sprinkler system. The supplemental connection would be used to backfeed seawater into the fire sprinkler system should an extended firefighting event occur. The hydrant seawater would be distributed via minimum 8" piping using the utilidor system. The seawater pumps would be pressure-controlled to activate automatically on a drop in system pressure.

WASTEWATER

Currently, the wastewater is macerated at the treatment shed and discharged near the existing pier. Although full treatment of sanitary waste is not a requirement of the Antarctic Treaty, doing so would greatly reduce Palmer Station's environmental impact on local ecology. It is recommended new treatment equipment be provided that separates solids from the waste stream and de-activates organics and pharmaceuticals before discharge. Features of the wastewater treatment equipment, including filters, macerators, UV treatment, etc will be determined during design.

It is anticipated the Wastewater treatment equipment would be located in the northeast end of the new Boathouse, allowing gravity flow from all connected facilities.
Two options for the location of wastewater outfall are suggested for further study. Option A locates wastewater outfall at the north side of the peninsula, near the boathouse, while Option B locates the wastewater outfall near the current location at the south side of the peninsula, just west of the pier.

Finally, to minimize the local environmental impact of heated effluent, it is recommended excess seawater from Aquarium Science will be combined with treated effluent prior to outfall.

IT&C

It is recommended that a new looped fiber optic and copper outside plant backbone cabling system be provided from the Earth Station to the new IT data center and to the campus. The loop design is anticipated to be sized to allow for future growth of the IT&C demands of the station. The IT&C loop is recommended to be co-located with other site utilities.

The USAP Information Technology Infrastructure is designed around the IT service requirements for the program. These service requirements are tightly integrated into the business processes for the program, work center needs, and future technology trends.

One focus of the Palmer Station Master Plan is to design facilities that can support whatever IT&C infrastructure may be implemented in the future based on service criteria and program requirements. Since much of the analysis required for this is being completed in parallel to the Master Plan project, many of the IT&C design criteria are based on current service delivery to Palmer Station. As future service criteria and program requirements are developed, the IT&C design criteria will likely, and should change. As such, the conceptual design for the Palmer Station Master Plan are for illustrative purposes. Detailed specifications will be further developed during the design phase.

UTILITIES

CABLE-PLANT DESIGN CRITERIA

- Outside cable plant intended to build out a core backbone that is adequately sized to allow for future growth.
- Outside cable plant will utilize a Physical ring architecture segmented into redundant sections to provide resiliency to the infrastructure.
- Inside cable plant intended to use modern structured cabling systems, BICSI standards, horizontal & vertical risers and wiring closets for intermediate service distribution.

ASSUMPTIONS

- New Outside cable plant may require a transitional solution to accommodate the phasing of the overall work.
- Outside Cable-plant will be modified within scope of the Palmer Station Master Plan, not all Outside Cable-plant will be replaced.

PRIMARY DATA CENTER AND OFFICES (NETWORK OPERATIONS AND ADMINISTRATION)
FACILITY DESIGN CRITERIA

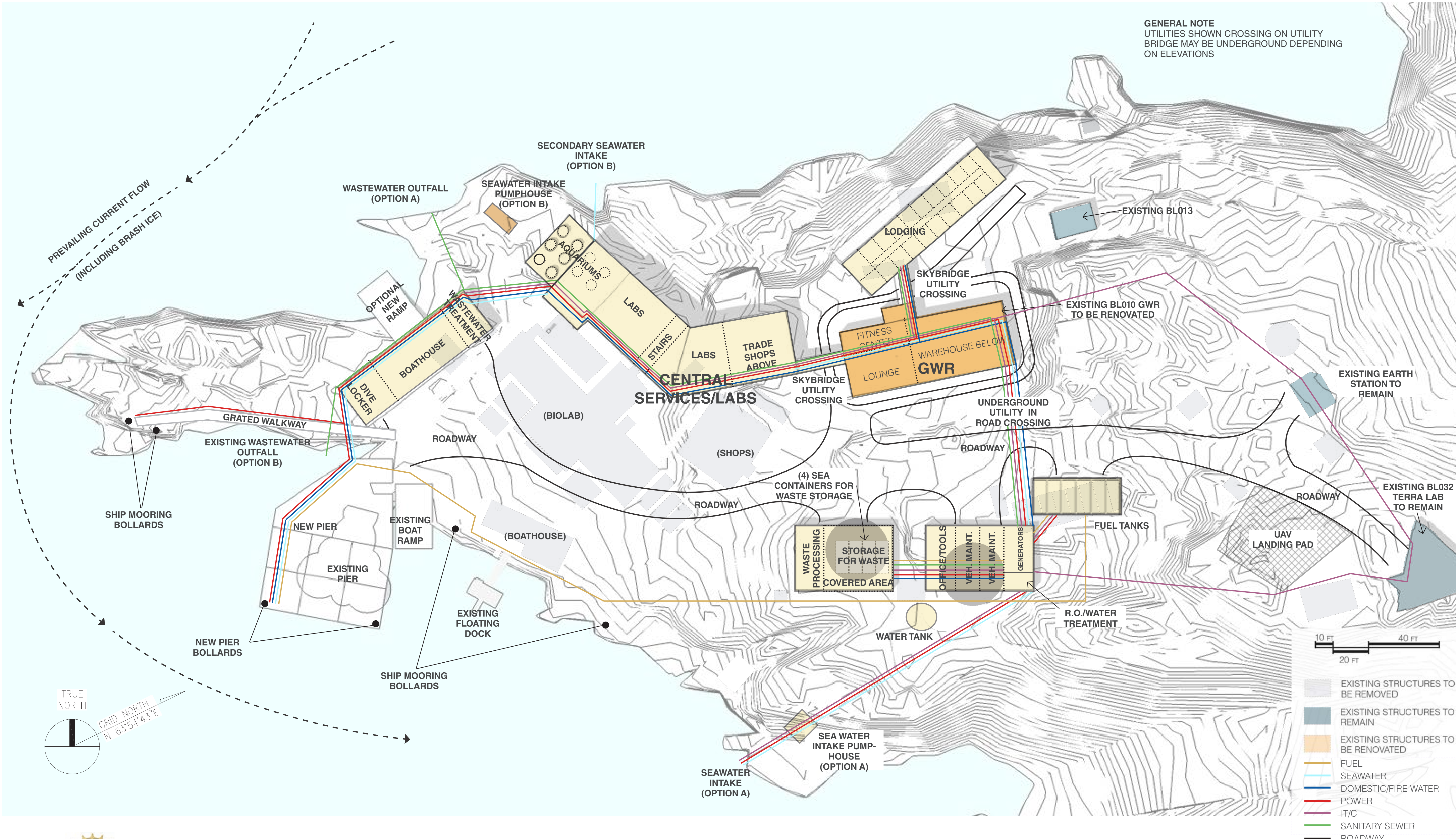
- All spaces to have lockable access doors.
- Data Center space to meet current Industry Best Practices for Power, Fire Suppression, Environmental, Security and Design criteria
- Backup generator with automatic switching for Data Center/facility
- UPS system for Data Center and critical workstations independent of other customers
- Redundant HVAC system that allows maintenance on HVAC without losing environmental conditions
- Redundant building entry physical plant pathways to station cable-plant ring
- Raised flooring with removable 2'X2' floor tiles
- Roof access with a catwalk to mount instrumentation and small RF antennas
- Data center designed to 2008 ASHRAE Environmental Guidelines
- Provides full network, telephony, communications systems for Palmer Station
- Offices provide space for Network Engineer, Systems Administrator, SATCOM/Communications Engineer separate from data center
- Office space includes work bench space for server, PC and RF communications repairs separate from data center
- Office space includes central network and SATCOM monitoring capabilities separate from data center

RECOMMENDATIONS FOR PRE-DESIGN ANALYSES

The recommendations cited herein are based on historical usage, operator expertise and consultant input. However, it is recognized that future improvements in materials and equipment and/or processes may present better design alternatives. Therefore, it is proposed that pre-design analyses be performed to determine the best long-term solutions for select project features as outlined below:

- Life Cycle Cost Analyses (LCCA) of Alternative Heating Strategies (e.g. waste heat loop) for the Terra Lab
- Alternatives for heating carrier pipe, e.g. fiberglass reinforced plastic (FRP) or HDPE pipe.
- Alternatives for Seawater and domestic water carrier pipe, e.g. fiberglass reinforced plastic (FRP) or HDPE pipe.
- Seawater intake configuration (e.g. pump recommendations, intake methods, intake configuration, optimal location).
- Alternatives for CHP implementation.
- Alternatives for fuel tank configuration and pumping strategy.

UTILITY PLAN



PIER

Three types of piers are deemed to be acceptable for the new berthing pier, which are: (a) a rock-socketed pile support pier with a structural deck and a perimeter skirt to control ice incursions; (b) a bulkhead pier containing rock backfill and (c) a hybrid of a pile supported pier and a bulkhead pier with backfill. It is noted that the bulkhead/backfill pier option would require importing a relatively large quantity of processed and sterilized infill, and would require means to lock-in the toe of the bulkhead wall into the granite rock foundations. Of these, it is the team's opinion that the hybrid pier will be the most cost effective as it allows for the reuse/disposal of the existing sheet piles and infill material within the bulkhead portion of the new pier.

Figure 1 shows that the construction siting can accommodate vessel off loading and on loading, staging of storage containers, and personnel off loading and on loading (even during construction).

PIER

Figures 1 and 2 show plan and pier cross-section (for a hybrid pier), respectively. Figure 1 (plan) shows:

(a) With an 8 degree angle change from the alignment of the current pier face, the keel of the *Nathaniel B. Palmer* maintains a 1m under keel clearance once the relatively minor rock outcropping has been trimmed-down. Based on an initial site visit and basic assessment from diving operations, it is anticipated that the outcroppings can be removed without the use of heavy equipment or explosives. This will confirmed once the geo-technical survey is completed.

(b) The indicated plan area aligns with the new shore road alignment and allows adequate room for the requisite number of sea containers (4) to be handled effectively and safely on the pier.

(c) The main cranes for both the *Gould* and the *Palmer* are indicated to have adequate reach to move cargo to and from the vessels and the working face of the pier.

(d) An optional dolphin (an independent, fixed marine structure used to extend berthing/mooring capabilities) may be included to provide a broader berthing area for simplified and more secure berthing.

Construction methodology is highly dependent upon the details of the final design, which will be determined by the contractor's designer. Therefore, discussion of construction methodology for one feasible/representative pier conceptual design is contained in the following section on construction staging. Nevertheless, the design requirements should include at least the following terms:

(a) The station outfall shall remain operational at all times; whether by maintaining an open channel to the ocean, or by providing a culvert.

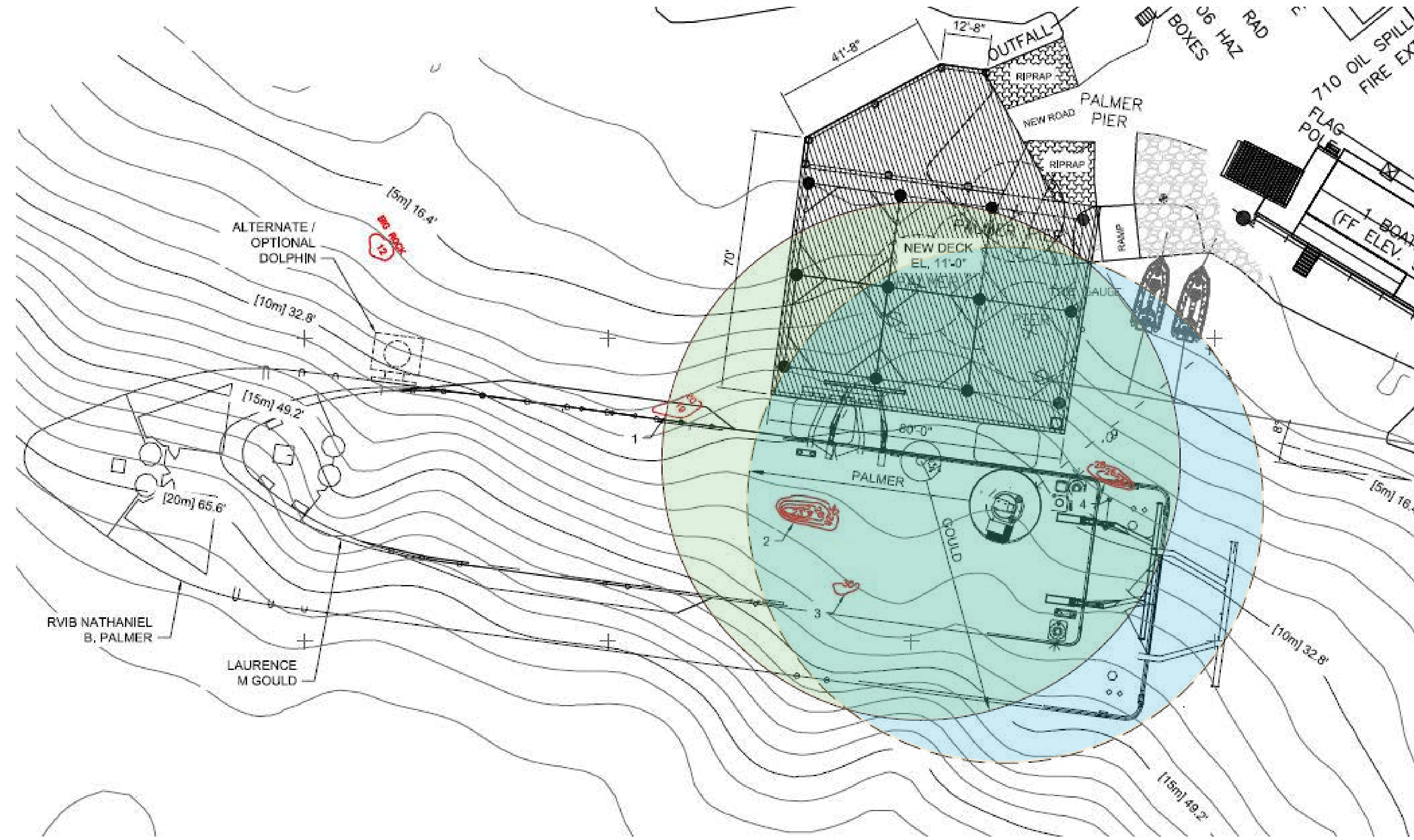


Figure 1 General Plan View Layout of New Pier

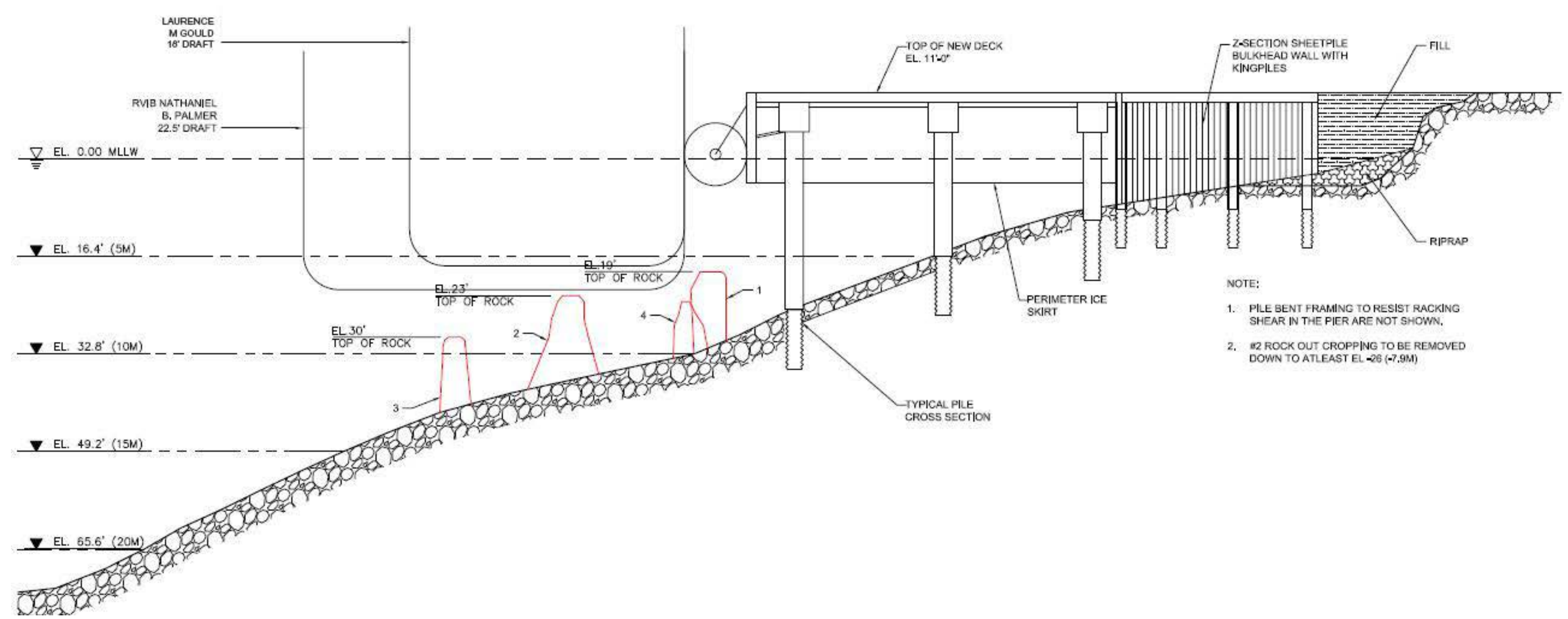


Figure 2 Representative Cross-Section View of a Possible Pile Pier – Bulkhead Pier Hybrid

(b) The final pier layout shall maintain at least a 3.28-ft (1m) underkeel clearance beneath the *Palmer*; which requires that any rock be removed below the *NBP* to a minimum depth of El -26-ft (7.9m).

CONSTRUCTION STAGING SUGGESTIONS:
The following construction staging recommendations represent only one feasible construction methodology for the recommended hybrid pier configuration.

(a) Prefabricate as much of the pile supported pier and of the bulkhead walls as practicable;

(b) Elect to use both the *Palmer* and the *Gould* to transport supplies (with pier components prefabricated to fit into sea containers or on deck for transport), equipment (assumed to include a heavy excavator with attachments for: augering, excavating, and grabbing, as well as vibrating and extracting sheet piles for demolition of the existing pier), and personnel across the Drake Passage.

CONSTRUCTION METHODOLOGY:
Regarding specific construction methodology considerations, it is recommended that the most direct manner to construct the new pier would be to use the existing pier as a staging area.

(a) First, build portions of the socketed pile pier as a trestle by launching pre-assembled steel deck templates (with beams, girders, bracing and precast concrete double-tee deck panels and joint sleeves for receiving/guiding the steel pipe piles) around the west and south faces of the existing pier. It is assumed that the rock sockets will be hydraulically chiseled and augered clean underwater by an imported large (long reach) tracked excavator with quick release attachments.

(b) Launch the pre-assembled deck templates (including deck panels) laterally using “Hilman Rollers”, and horizontal & vertical jacks, and then install the piles through the templates and connect them to the pre-hydraulically chipped and augered rock sockets using grout within the rock socket.

(c) Install a rock socketed King-pile/sheet pile combi-wall bulkhead (using the excavator and prefabricated bulkhead wall components) on three sides of the shallow water portion of the pier.

(d) Use the excavator to transfer gravel from the top of the existing pier cells to the decks of the completed west portion of the pile pier; and transfer the existing sheet pile, and larger stone within the existing cells, into the three-sided bulkhead wall pit/cell.

(e) Once the existing pier is demolished, using the excavator, complete the bulkhead wall cell with a gravel roadway re-established from the west portion of the new pile pier to shore.

(f) The remaining portions of the south section of the pile pier would be completed in a similar fashion as the west portion, except that instead of using the existing pier as a staging area, the newly completed portions of the new pier would be used as the staging area.

PIER

Construction of a new pier requires careful evaluation and analysis of the environmental impacts and permits obtained allowing such a project to proceed. This process can take anywhere from 18-24 months to obtain the necessary permits through NOAA. Once a schematic design is complete, the requisite analysis and environmental permitting shall be undertaken. This will require the careful analysis of the impacts to the environment and local wildlife and must be addressed and approved prior to start of construction.

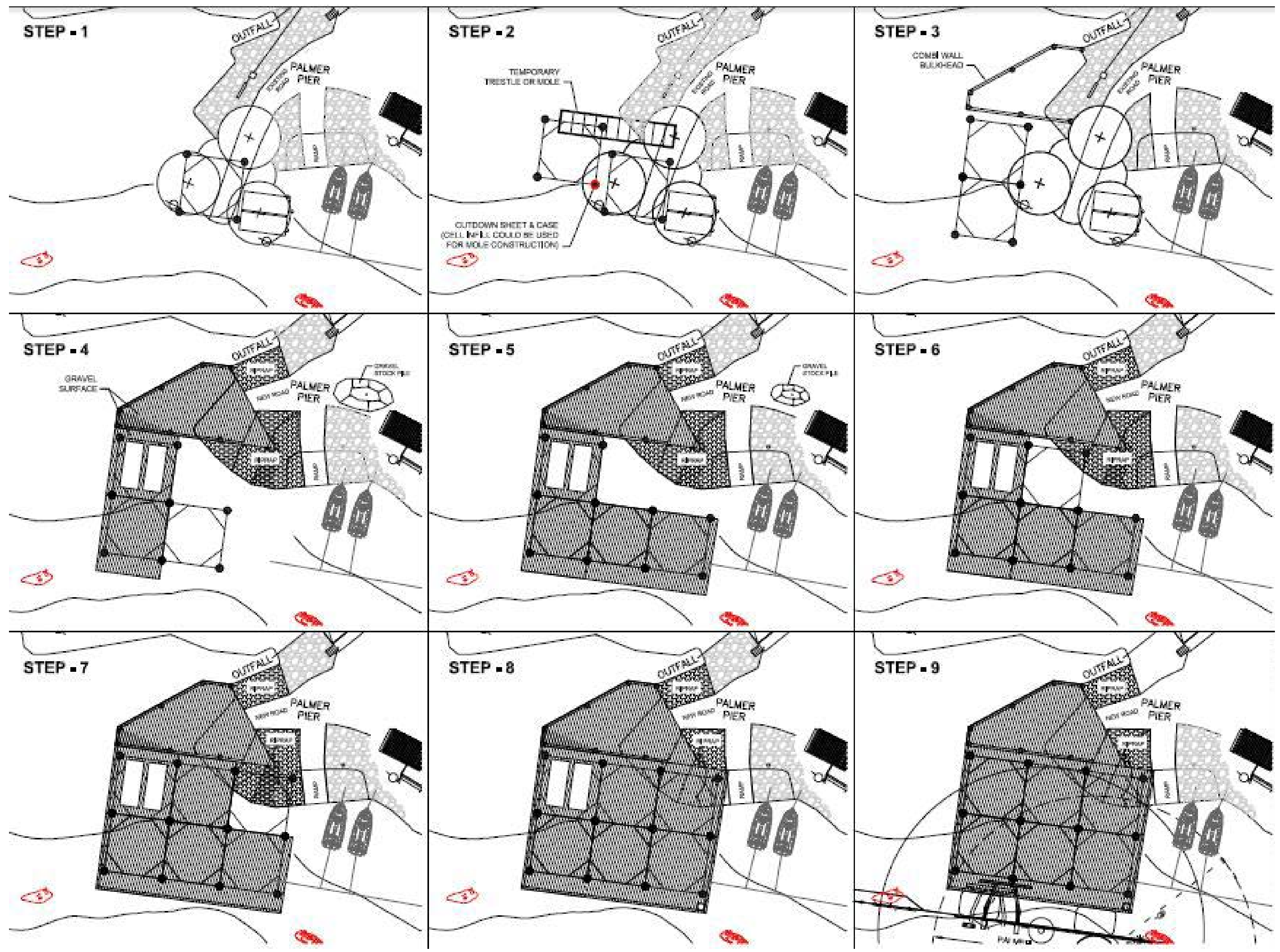


Figure 3 Suggested Staging Sequence

REFERENCES

REFERENCES

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