Palmer Station Major Systems Study

Submitted To:
National Science Foundation
4201 Wilson Boulevard
Arlington, Virginia 22230

Prepared by:
RSA Engineering, Inc
2522 Arctic Blvd, Suite 201
Anchorage, Alaska 99504

December 29, 2010

Table of Contents

Palmer Station Major Systems Study
Prepared by: RSA Engineering, Inc
November 22, 2010

1. **Executive Summary:** Palmer Station was built starting in 1967 by the US Navy as one of three permanent Antarctica Stations maintained by the United States. The Station houses up to 46 people who study various types of marine and atmospheric science, or who support those science activities. There has been no master plan since that time. As a result, many of the systems are now over 42 years old and in need of replacement. This report examines every major system on station, and makes recommendations as summarized below. The community was consulted during the study, with good input received. Several other references were used, such as the "Dream Study", which is a compilation of suggestions by residents to improve the station that was conducted in November, 2007. Many, but not all, of the suggestions contained in that study are incorporated here.

   The site visit revealed the immediate need for corrections that touch on all of the systems - upgrades that impact fire/life safety, energy efficiency, environmental hazards, logistical bottlenecks, code violations, and operational inefficiencies. Considering the time required to actually implement these needed repairs and upgrades, it is highly recommended that the process begins as soon as possible to avoid potential fire, environmental damage, or injury to persons.

   Since the station is so compact and lacks heavy equipment or spare bedding to support construction of any major buildings or systems, the proposed work must be phased in three suggested work packages. The recommended work is discussed by those three phases:

   Phase One Work:
   - Rebuild the pier to extend it out further into the water to allow larger ships, such as the Nathaniel B. Palmer (NBP), to pull along side the pier and offload. At present, the NBP cannot access the pier due to shallow rocks near the pier. The pier is made of sheet pile that is rusted and is being washed out, losing pier fill which creates sink holes on the top of the pier surface. No over sized containers or equipment can be landed at Palmer Station unless the pier is enlarged and repaired. The pier repair project should also include the remodel of the small boat harbor to include a launch area, and a fingered fiber grate dock material.
   - Prepare the building sites for the new power plant with adjoining equipment shop, the new berthing module, the relocated Haz Mat

facility, the new waste water treatment plant, the relocated saltwater intake/RO combined module, and the bulk fuel storage areas. Material taken from this site preparation can be used to fill the pier expansion space between the existing sheet pile and the new outer face of the pier.

- Replace the two 125,000 gallons cylindrical upright tanks with six new horizontal double wall steel tanks, each sized at 25,000 gallons. The new scheme only stores up to 150,000 gallons, but the requirement for a redundant tank is met with a 25,000 gallon tank, since only one redundant tank is needed to be available for the largest tank in the tank farm.
- The 4" pipeline from the tank farm to the pier is 42 years old, and is rusted. This pipeline, along with the piping to the two day tanks, needs to be replaced with new epoxy coated piping. The proposed piping would be double wall with leak detection to further protect against fuel spills.
- Provide a new 22 bed berthing module, to be located north of the GWR building which would afford fantastic views of the glacier while being close to the rest of the residential sector. Initially the berthing would provide beds for the required construction crews who will build the phased upgrades, and after that it would permit 22 beds of single status rooms. Waste heat for the new berthing can be taken from the old power plant waste heat system, as the waste heat distribution system at the old power plant will remain after the new power plant is erected.

Phase Two Work:

- Erect a modular power plant housing two 250 kW generators (gensets) and one 150 kW genset with all new automatic switchgear and jacket water waste heat recovery. Exhaust gas waste heat recovery will be studied during the design phase and applied if justified. The new power plant would generate power at 277/480 volts instead of the existing 120/208 volts to reduce transmission losses and voltage drop across the station.
- Erect a new vehicle maintenance facility adjacent to the new power plant, since the one station mechanic is responsible for both equipment repair and power plant maintenance.
- Extend the waste heat loop to include the Bio Lab facility, the future waste water treatment facility, and the RO system for raw water pre-heat. Supplemental heat presently burns an average of 21,000 gallons of fuel per year for heat, make-up air, and domestic hot water production - all of which should be supplied with waste heat.
- Relocate and resize potable water production so the new RO facility is included in the saltwater intake module. This would

reduce pumping energy and electric heat trace on piping because the saltwater is presently pumped up to the GWR building, then raw RO water is pumped back to the Bio Lab for treatment, sanitization and storage, and then pumped back up to GWR for consumption. Also, the RO system will be revised to provided heated seawater to make the process more efficient.

- Relocate Haz Mat operations and milvans to the site of the old helicopter pad. Utilize milvans to form the new space, but enclose the assembly with pre-insulated steel panels for thermal insulation as well as weather protection and aesthetics. This also consolidates Haz Mat to one general area for operational efficiency.
- Install salt water fire hydrants to permit fire fighters a chance to prevent building fires from spreading throughout the entire station. The seawater intake module would have three pumps, all on VFD drives, that could spool up to provide required water to feed up to three 2.5" hose lines at once.
- Demolish unused buildings around Terra Lab to reduce fire danger, and retrograde all unused milvans off station.

Phase Three Work:

- Consolidate the warehouse functions to the GWR building after the power plant and boilers vacate the building. This would include eliminating the bank of old milvans along the road that are used for overflow warehousing.
- Expand IT space at both the Earth Station with a small addition to the side of the building cantilevered off the existing foundation, and also remodel the server and switch space in Bio Lab when the Bio Lab third floor berthing is vacated.
- Once all heating is consolidated to the new power plant, and the waste heat piping is extended to the Bio Lab, remove all day tanks and associated fuel piping that are located outside the buildings.
- Install a test section of “Fibergrate” on the walkway between Bio Lab and GWR building to evaluate if it improves safety and reduces snow removal labor. If Fiber Grate is not feasible, design and install a non-combustible covered walkway system.
- Remodel the Bio Lab berthing after all 22 beds are removed from the third floor of the building. The third floor could then be allocated to additional science activities, relocated IT servers and equipment, and office space. The front of the building would receive an addition so the existing polarhaven tent and the milvans can be removed. All ongoing science in the front of the building would then be enclosed in a permanent structure at Bio Lab. Included in the remodel would be code upgrades, new tyvek and 2.5" of pre-insulated steel siding, window replacement, and various other functional revisions.

- Provide a fire sprinkler system for the carpenter shop, utilizing the existing fire water tank that is located directly behind the carpenter shop. While sprinkler fitters are on site for this remodel, also upgrade any other fire sprinkler shortfalls and modifications required due to the Bio Lab addition and remodel.
- Analyze wind data over the last 10 years to determine if one or more wind generators are economically or environmentally feasible at the station, especially in light of bird strikes in the area. Also, review weather data to determine if solar energy collection is economically feasible.
- Install a small multipurpose room addition to the north side of the GWR building to enable community meetings and activities such as yoga or other light exercise programs. This could be a lean-to addition.
- Provide a waste water treatment plant using extended aeration technology to replace the primary macerator grinder treatment only, which would be a huge environmental upgrade.
- Complete applicable energy conservation measures (ECMs) identified in the 2008 RPSC energy study report that have not been completed up to the time of the phase three work.
- Convert the toilets and urinals from seawater flush to fresh water flushing so the black water can be treated at the new waste water treatment plant. New fixtures would be dual flush toilets, and 1 pint per flush urinals.

2. **Purpose:** The purpose of this study is to examine the existing facilities and operations to see if the system and facilities should be changed and make recommendations for consolidation and building revisions for better efficiency. There has been no system wide infrastructure upgrade since the facility was constructed over 42 years ago. Prior reports and studies will be utilized to avoid duplication of efforts, but assumptions and findings will be verified and questioned if appropriate. The key major system final recommendations contained in these reports and studies will be incorporated into the master plan layout proposed in this report.

3. **Scope:** The scope of the study includes an on-site review of the major systems with responsible RPSC personnel, and the gathering of information from users in order to make recommendations regarding overall station improvements in efficiency, energy conservation, environmental conservation, reliability, or safety.

4. **Acknowledgements:** Data for this report has been taken from various sources, including:

    a. On-site observations by Richard Armstrong

b. Interviews with RPSC congnizant employees, including;
   i. James Hilden, Architect
   ii. Bob Farrell, Palmer Station Area Director
   iii. Steven Wickins, Palmer Facilities Engineer
   iv. Lora Folger, IT Supervisor
   v. Mark Furnish, Waste Operations Manager
c. Prior studies that are referenced within this report

James Hilden accompanied me to the site, and produced sketches and drawings that are used in this document to help illustrate our consensus opinion of recommended solutions to present. Bob Farrell and Steven Wickins were consistently on hand to provide historical data, as-built data, and clarified other operational questions that their institutional knowledge could address. All residents at Palmer Station were extremely helpful, and they exhibited a true family type attitude, always ready to help one another and to better the Station and the Science it produces. The high morale and desire to maintain Palmer Station was clearly evident.

5. **Background:** Palmer Station was originally constructed by the US Navy with a pier constructed in 1967, and the first building (Bio Lab) in 1968, and the GWR building in 1969 at Gamage Point in Arthur Harbor, which is located at 64.0 degrees west longitude, and 64.7 degrees south latitude. The Station was constructed to provide a year round permanent research station for the United States Antarctic Program (USAP) as a science core. Polar marine biology, sea ice habitats, oceanography, land based nesting sites for seabirds and predators, and long term ecological research are some of the main topics studied at this site. The Station can house up to 46 people during the austral summer, and typically supports 10-20 people during the winter, but in recent years winter population has been increasing due to increased science activity.

Access to the site is by ship (typically the MV Laurence M. Gould) with voyages averaging 8-9 visits per year from Punta Arenas for resupply and personnel transport. The area at the station is generally ice free, and the Gould is constructed to break ice up to 12” thick.

The site at Palmer Station is very rocky, with solid rock in most places, but some loose rock fill in others. Development of a flat area for construction is expensive and difficult, which drives the compact layout of the station. This terrain justifies preparing all sites at one time so only one mobilization of blasters or earthmoving equipment is needed.

The building inventory is listed below, but the two main buildings are the Bio Lab and the GWR buildings, with numerous smaller support facilities. The two largest buildings are now over 42 years old. While the buildings have been upgraded over time with better insulation, better windows, and improved lighting, much remains to be done. It is now time to look at all of the major systems and provide a master plan for development and upgrade of these systems to provide a smaller carbon footprint, with higher energy efficiency, and more environmentally friendly systems such as the recommended biological wastewater treatment facility in place of simple maceration of sewage. The inventory of buildings, with their use description, square footage, and year constructed is provided below as taken from the RPSC "Palmer Station Facilities Assessment", dated December, 2008. See Reference 2.

BLDG #	BUILDING NAME	DESCRIPTION	SF	YR CONST
1	BOATHOUSE	SCIENCE SUPPORT	579	1987
2	BIO LAB	MIXED USE	10,629	1968
3	AQUARIUM	SCIENCE SUPPORT	1,014	1985
4	DIVE LOCKER	SCIENCE SUPPORT	487	1988
5	VOLATILE MATERIAL STORAGE	LOGISTICS AND WAREHOUSING	184	1986
6	CARPENTER SHOP	STATION SUPPORT	1,888	1987
7	SAUNA	PUBLIC AMENITY	120	1987
8	SEAWATER PUMPHOUSE	STATION SUPPORT	171	1985
9	HAZ OFFICE AND LIQUOR STORAGE	"THE BAT CAVE"	160	1984
705	RADIOACTIVE WASTE MILVAN	STATION SUPPORT	160	1992
706	HAZARDOUS WASTE MILVAN	STATION SUPPORT	160	1992
10	GWR	MIXED USE	8,520	1969
11	T-5	SCIENCE SUPPORT	640	1988
12	CLEAN AIR FACILITY-TBDEMO	SCIENCE SUPPORT	136	1988
13	HAZARDOUS MATERIALS BLDNG.	STATION SUPPORT	400	1986
21	FUEL PUMP HOUSE	STATION SUPPORT & OPS	234	1993
22	CONICAL MONOPOLE	STATION SUPPORT & OPS	0	1992
23	EARTH STATION RADOME	STATION SUPPORT & OPS	407	2002
25	COMPRESSED GAS STORAGE	OPERATIONS	150	1988
26	SEWAGE MACERATOR BUILDING	STATION SUPPORT	64	1990
28	FLAMMABLES STORAGE LOCKER	OPERATIONS	160	1992
29	CHEMICAL STORAGE VANS	OPERATIONS	320	2008
30	SEISMIC VAULT	SCIENCE SUPPORT	157	1992
31	EARTH STATION	SATELLITE EARTH STATION-INTERNET	195	2002
32	TERRA LAB (IMS)	SCIENCE SUPPORT	900	2005
33	VHF BUILDING	STATION SUPPORT	34	2004
40	OLD VHF CONTROL BUILDING	IT	70	1992
41	SMALL OVERNIGHT SHACK	RECREATIONAL	32	1988

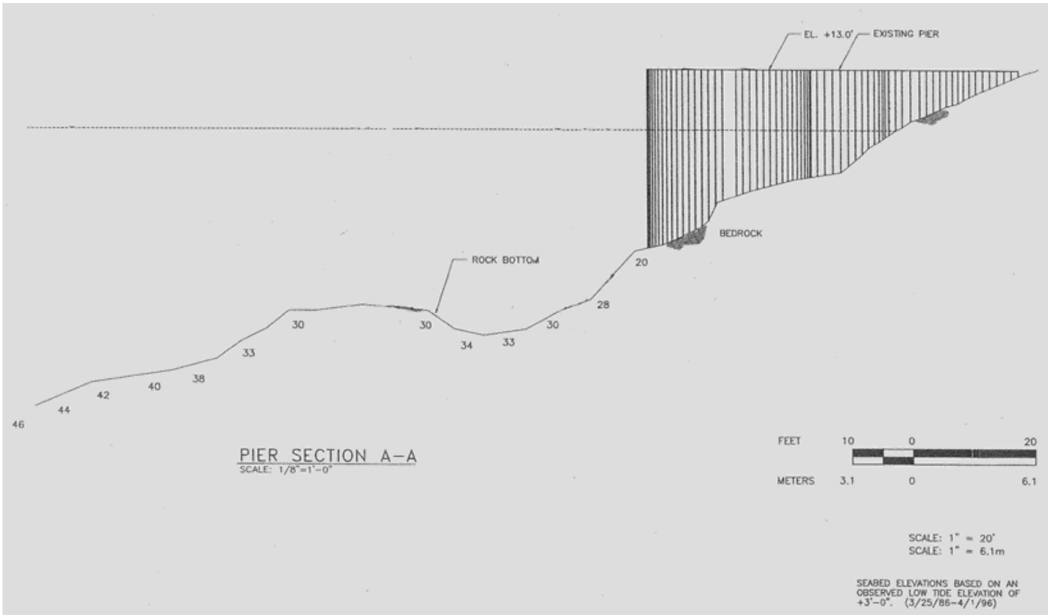
Key Systems or Facilities: Each of the affected facilities or systems is discussed below in order of recommended priorities, along with suggestions regarding their continued use or required upgrades.

6. **Pier Facilities:** A study titled *Re-supply and Science Support Evaluation of Palmer Station and the Antarctic Peninsula Region*, prepared by Martin, Ottaway, VanHemmen, & Dolan, Inc (MOVD report - reference #3) was commissioned for the National Science Foundation to evaluate the logistics support at Palmer Station, including the condition of the pier facilities. Most of the data for this section of the study is taken from that report, as it is very comprehensive. Since there is no airstrip at Palmer, the resupply and personnel transportation route is over the water, typically using the Laurence M Gould (LMG). The LMG has been under contract with the NSF since 1997, and that contract has now been extended to 2015.

   The icebreaker & research vessel Nathaniel B. Palmer occasionally services Palmer. The USAP would have more flexibility in use of support vessels by having a deeper draft at the pier. The operating draft near the pier is between 6 to 8 meters, with a reported rock ledge near the pier with a water depth of 9.15 meters (rock 19) which is the main draft restricting feature. See reference #3.

   The pier has been suffering from various problems that reflect the age of the facility, which was constructed in 1967. Corrosion has opened holes in the sheet piling cells that are filled with gravel and rock. The pier has shown significant deformation over the years, and now sits more than 5 degrees off plumb. Gravel runs out through the holes caused by corrosion in the sheet piling, creating sink holes in the surface of the pier. There is a fendering protection system provided by two Yokohama style fenders. Major maintenance on the pier reportedly took place in the late 1990's, and for the past 3 years RPSC has conducted maintenance patching of the underwater sections in the hopes of slowing its decline. These repairs were made at a very modest reported cost which is expected to extend the operational status of the pier for a few more years without the need for immediate significant investment.



The report went on to state that during the workshop held in Arlington Virginia, a pier option was presented that involved the encasement of the present pier into a new surrounding sheet pile structure. This option has various operational advantages and, depending on actual future logistics choices, could solve the pier issue for many years to come. The advantages to the encasement option reported by the MOVD report included:

- It will result in a similar structure that has served the facility will in the past, so it has low technical risk.
- It will not significantly affect or alter the ecosystem, or current in the area.
- It will very effectively recycle the existing pier including the fill.
- It will actually be a stronger design than the original pier due to its double walled construction.
- It will require a smaller amount of sterilized fill then other options.
- It is probably the lowest cost approach.
- It will increase the pier area (although only modestly).
- It can be constructed quickly.
- It could be constructed from the shore (actually from the pier itself).
- With planning it could allow continued operation along the berth.
- It might alleviate the draft issue by moving the pier face further offshore, but would not completely solve the problem.

No technical reasons were given for not removing some of the material on the bottom that is creating the draft issue, and using that material to fill the new cells. It was also indicated that a cargo crane at the pier would be advantageous, and that would also address the Zodiac hauling and launching issue.

The MOVD report also addressed the fact that NAVFAC Pacific prepared a preliminary design for a replacement pier, which would be a significant enhancement of the present pier capabilities that would also allow for future extension of the pier. The NAVFAC design encapsulates the existing pier and provides an additional sheet pile pier seaward of the present pier. If built, this design would allow both the LMG and the NBP to come alongside. The design would allow staging of a significant number of containers on the pier, and provide substantial safety enhancements to cargo operations.

Cost estimates for the NAVFAC design are $17,500,000 for the replacement pier. A preliminary design for a Zodiac boat ramp is $ 1,500,000 and a corrosion protection scheme would cost an additional $ 1,800,000.

RPSC provided a more modest replacement pier option in 2003. They recommended a jack up barge arrangement that is not elevated above the high tide level, and as such is exposed to waves and ice. This option would probably be sensitive to ice and wave damage. A second preferred option is a minor enhancement of the present pier design using sheet piling and fill.

The MOVD report analyzed many more logistical options which are not the focus of this report, so they are not repeated here. The purpose of this discussion is to highlight the need for action on the pier, the general options, and the reference document for additional, more detailed information regarding the pier.

The bottom line for the MOVD report is that the pier must be repaired so it is available for the foreseeable future.

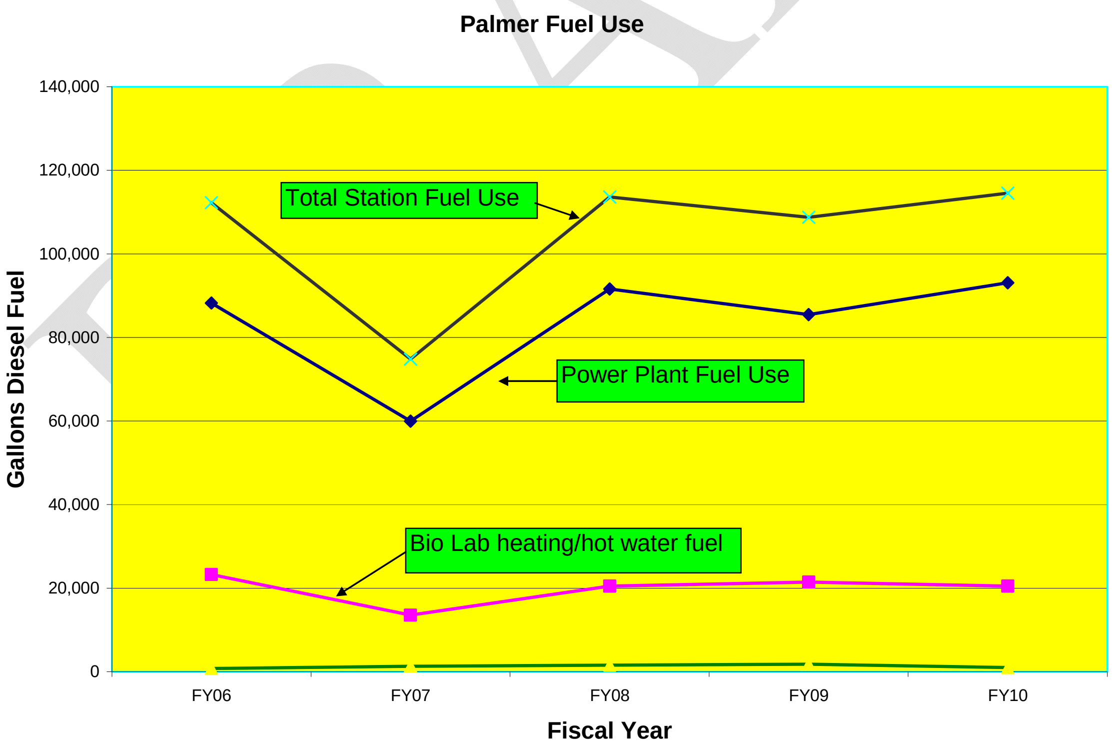
7. **Bulk Fuel Storage:** The Station has two 125,000 gallon cylindrical steel fuel storage tanks that were built in 1967. The tanks are not diked or double wall for any leak containment.

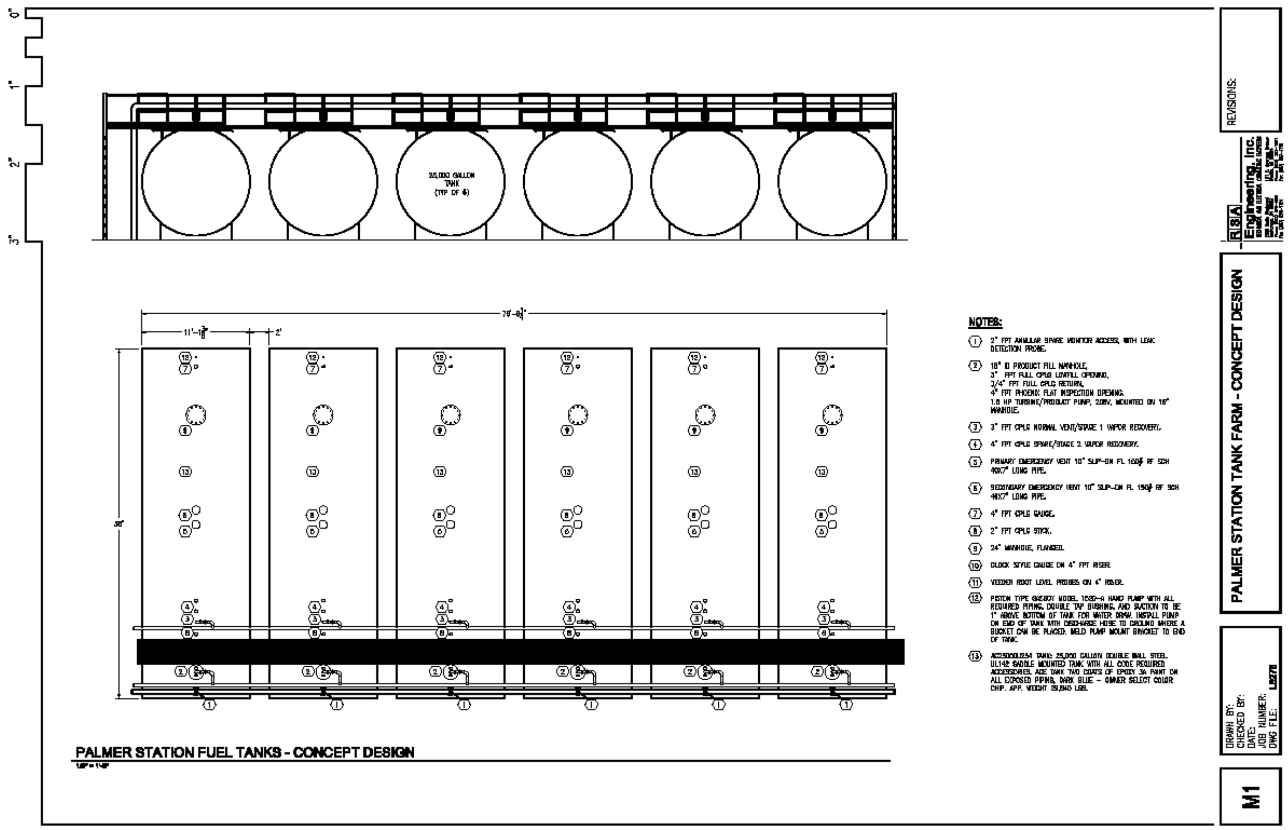
One tank holds about 25,000 gallons of contaminated fuel that contains water and other foreign materials elevating the cloud point and pour point of the fuel to cause it to cloud at room temperature, and solidify to wax at around freezing temperatures. Treatment of the contaminated fuel by heating, filtering, and adding various chemicals to depress the elevated cloud point and pour points was deemed not feasible, since the fuel would not respond to antigel chemicals when evaluated by two independent labs. See fuel analysis reference #4. Power Services analyzed the fuel and found the cloud point to be + 66 deg F, and the pour point to be + 33 deg F. The DLA Energy Lab at Fort Richardson agreed with those results, as there were two separate analysis performed. Rather than mix the fuel with jet fuel, filter it, and try some chemical treatment, it was decided that the fuel will be shipped off Station.

The bulk tanks have internal liners that were installed around 1994 in tank T-1, and 1999 in tank T-2 as an effort to provide double wall containment in the event of a tank failure. The liners are made of a polyethylene sheet material, with a geotextile padding on the bottom, as well as a padding material on the sides. The concept was to be able to open a drain in the lower part of the tank and if fuel was detected, the liner would have failed. The installed liner violates the International Fire Code, section 3404.2.7.11 which forbids any liner in storage tanks except those that are required to protect the tank from corrosion. Furthermore, the installed liners may be decomposing, which could be causing the black debris found in the contaminated fuel in tank T-1, which has the older liner. Also, the integrity of the liners is unknown. There is a small valve near the bottom of the tank that could be opened to check for fuel between the liner and the interior of the tank, but the pipe nipple between the tank and the valve is badly rusted, so attempts to operate the valve could result in an uncontrollable leak with no welding repair possible. If this happens, and since there is no other tank to place the fuel due to the contamination in tank T-2, there would be a true emergency created so the leak test was not performed. In addition to that significant environmental risk posed by having no dike or secondary containment, the tanks do not meet current code with respect to safety of the ladder, valving, etc.

Based on the 43 year age of the tanks, the obvious rust in places near the bottom of the steel, the fact that fuel became contaminated while being stored in the tanks, and the lack of spill containment facilities or currently required tank accessories, it is recommended that both bulk fuel storage tanks be drained, cleaned, and demolished as soon as new storage tanks can be put on line. Rather than duplicate the two 125,000 gallon tanks which can store up to 250,000 gallons, it is recommended that six 25,000 gallon horizontal double wall UL 142 steel tanks be installed, for a total capacity of 150,000 gallons. We are required to have a redundant tank to carry the capacity of the largest tank, so as presently configured; the redundant tank must be sized at 125,000 gallons. By replacing the tanks with 25,000 gallon tanks, the redundant tank only needs to be sized at 25,000 gallons. The design will leave room for installation of additional 25,000 gallon tanks if a local research vessel is positioned at Palmer requiring more fuel than just the station usage. It is further recommended that the tanks and pipeline be epoxy coated with a dark blue 2-part epoxy, which is the accepted NSF color, to adsorb solar energy and keep the tank slightly warmer, which would help prevent wax formation of the fuel.

Sizing of the tanks is derived from the historic fuel usage at Palmer, as recorded on the weekly SITREPS.





Proposed New Tank Farm Plan and Profile

Palmer Station Fuel Consumption Historical Data

	FY06	FY07	FY08	FY09	FY10
Power Plant Fuel Use	88,235	59,952	91,599	85,490	93,085
Bio Lab Heat & Hot Water Fuel	23,240	13,544	20,487	21,445	20,486
Equipment Fuel Use (Supplemental)	753	1,323	1,541	1,801	979
Total Diesel Fuel Requirement/year	112,228	74,819	113,627	108,736	114,550

Fuel Spill Flow Directions from Tanks and Pipelines

8. **Bulk Tank & Pipeline Spill Directions:** As can be seen from the photo above, a leak from one of the two bulk tanks, or from any of the pipelines will run directly to the ocean due to the terrain and close proximity to water. The existing configuration poses a significant environmental risk.

9. **Fuel Day Tanks:** There is one 4,000 gallon day tank installed outside of the power plant to serve the generators and GWR boilers, and a second 3,000 gallon day tank to serve the Bio Lab emergency generator and boilers. These tanks are filled manually via a 2" steel pipeline from one of the bulk tanks via the pump house. The tanks were being fitted with mechanical overfill protection devices (a float that closes a valve in the fill line) during my visit to prevent a re-occurrence of the fuel leak from overfilling that occurred two years ago. Both tanks are insulated with spray foam insulation. Scott Taube of RPSC observed these tanks during a visit to Palmer June 2-14, 2008. Scott's observation report is labeled as Appendix Q, (reference #4). He found code and

operational deficiencies, and recommended that both day tanks be replaced. The writer does not disagree with Scott's findings, although recommendations for future work will vary with Scott's. If all of the recommendations are followed to relocate the power plant to between GWR and the Earth Station, and to extend waste heat to Bio Lab, then all exterior day tanks and related piping can be eliminated. The emergency generator presently located in the Bio Lab would have to get an emergency day tank installed interior to keep the fuel warm if it remains at its present location. Keeping an emergency generator in a different location from the new permanent generator provides an additional level of redundancy if the new power plant were to burn down. It is important to keep an emergency genset to provide power for the planned seawater fire system. The emergency genset is, however, 120/208 volts, whereas the new generators are proposed to be 277/480 volts, so the generator would need to connect to the Bio Lab, and downstream of the new transformer, if it were to stay at its current location. A transfer switch would be needed to switch between the emergency source and the new source, and the output would need to connect to the low side of the planned step down transformer.

10. **Fuel Distribution and Dispensing:** There is a pump house located between the two bulk tanks that filters and pumps fuel from the active bulk tank down to the day tanks. The Bio Lab day tank could be filled by gravity, but the GWR building day tank would require the pump to operate for filling. The 4" steel pipeline from the pump house down to the dock is used to offload or on load fuel to ships at the pier. There is also a tee uphill from the boat house where a 2" steel pipe is routed in a direct bury configuration under the roadway and over to the area uphill from the Bio Lab. The 2" line tees near the Bio Lab 3,000 gallon tank to fill that tank. It then continues up to the GWR tank where it fills that tank.

    Problems observed with the fuel distribution system include:

    i. The steel pipe is 43 years old. The pipe is continuously exposed to salt air and water, so its useful life and reliability indicates it is no longer fit for service.

    ii. The direct buried steel 2" pipe that runs under the road to feed the day tanks is not protected from damage or corrosion, and does not have double wall leak containment or detection. Sections of the 2" pipe above grade indicate 20% of the pipe surface it pitted, and the buried pipe could well be much worse.

iii. The 4” above grade steel pipe does not have any spill containment or detection system, and exhibits corrosion.

iv. Sections of fuel piping serving the emergency generator are of sweat copper, which is prohibited by NFPA 31. If copper pipe is used, it must be brazed.

v. The diesel equipment (two telehandlers and one loader) are all fueled using a hose connected to the main 4” pipeline without the benefit of a metered dispenser. See picture.

The dispensing system does not comply with the International Fire Code, Chapter 22, Motor Fuel Dispensing. Specific issues include:

- Dispensing is required to be more than 10’ from buildings having combustible surfaces (boat house).
- An emergency disconnect switch is required, but none is provided.
- A listed fuel dispenser needs to be provided that contains a meter, shear valve, bollard protection, anti siphon in compliance with IFC 2206.7.
- Proper signage is required at the dispenser.
- Approved fire extinguishers are required at the dispenser.
- Dispensers shall be set to limit uninterrupted fuel quantity to 25 gallons, and require manual action to continue delivery per IFC 2204.3.7.
- The area used for fueling must be spill contained.
- The dispensers must be on a 6” high concrete island, and the island must be protected with bollards. IFC 2206.7.3.
- An emergency fire/impact valve must be installed at the base of the dispenser. IFC 2206.7.4.
- The dispenser hose shall have an approved breakaway device.

Due to the extremely close proximity of the fuel piping to the ocean, any sizeable fuel leak would most likely contaminate the shoreline with fuel. See photo of the fuel line along with flow direction arrows.

The following recommendations apply to the fuel piping and dispensing system:

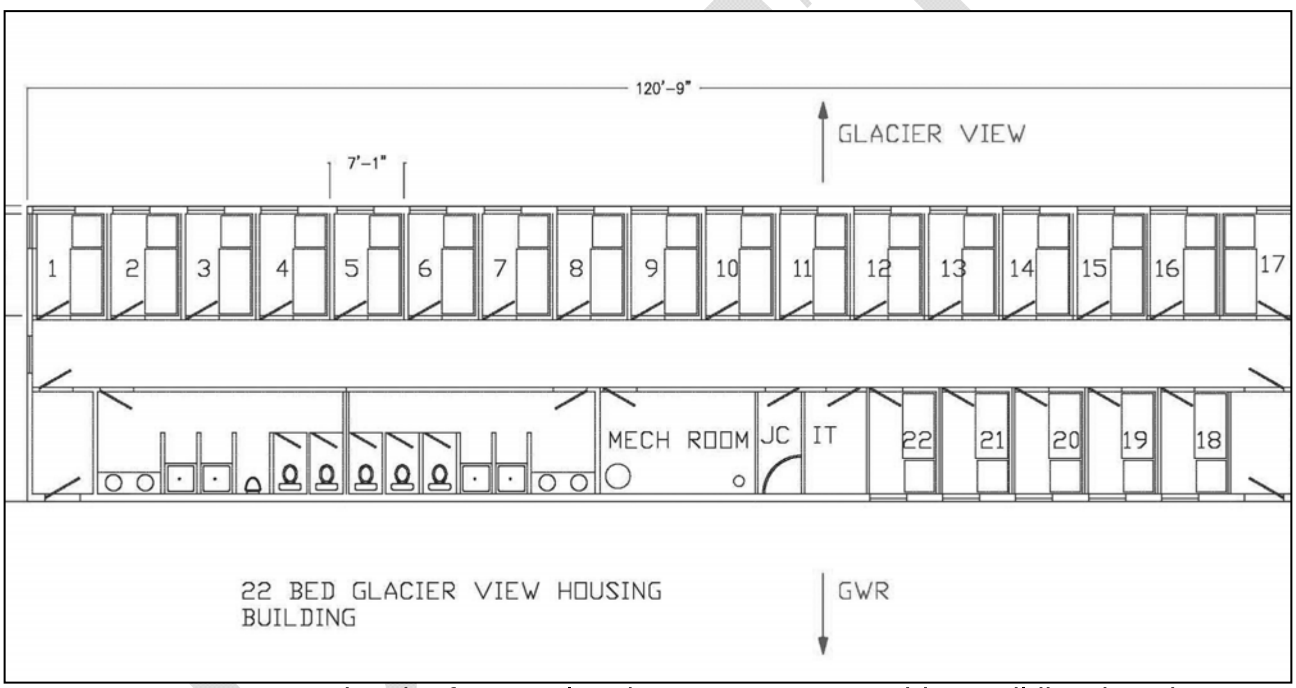
- Replace the 4" 42 year old steel pipe with new 4" schedule 80 welded epoxy coated steel piping.
- Replace the 2" steel pipeline that runs from the 4" main line to the 3,000 and 4,000 gallon day tanks with new 2" epoxy coated steel piping. The road crossing is of serious concern, since it cannot be determined if it is leaking as it is buried. This section of pipe shuld be replaced with a double wall fiberglass pipe system, including electronic leak detection. The road crossing work should be done immediately.
- Replace the entire fuel dispensing system with an approved dispenser, with accessories compliant with the IFC.
- Replace the sweat copper fuel piping at the emergency generator with brazed joints or steel piping.
- Eliminate the 3,000 gallon day tank serving the Bio Lab as soon as waste heat can be piped to the Bio Lab, and provide an independent day tank to serve the emergency generator if one is to remain in the building. If the power plant replacement project is approved, the GWR 4,000 gallon day tank would also be eliminated, and in interior day tank would be installed in the new power plant.

11. Berthing:

Palmer Station has a total of 46 beds in 23 double status rooms: 11 rooms with 22 beds in Bio Lab, and 12 rooms with 24 beds in GWR. Additionally, there are only two showers and two toilets to serve all 22 beds in Bio Lab, while there are 4 toilets and 4 showers in GWR.

The Bio Lab has some 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 berthing and the 2nd floor kitchen below. There is also no protection of the 1st and 2nd floor structure which supports the 3rd floor berthing, as required by code. Additionally, the rooms are too small for double occupancy, having only an estimated 60 SF per room, where 50 SF per person is required (120 SF for double occupancy).

Considering the fact that the Bio Lab needs additional Science Support space for offices and storage, and considering the high cost of a code upgrade remodel that still cannot provide the minimum required square footage for a double status room, it is recommended that all sleeping rooms at the Bio Lab be relocated elsewhere.



Concept Sketch of a 22 Sleeping Room New Berthing Building (NTS)

The NSF has built the South Pole Station as a single status accommodation at the Elevated Station, providing much more privacy to each occupant, and a higher level of occupant satisfaction. It is recommended that the 22 beds in Bio Lab occupying 11 rooms be replaced with a new berthing building that has 22 single status rooms. This building can be placed north of the GWR building, with incredible views of the glacier at water's edge. A double loaded corridor is recommended, with rooms facing north and south, but all utility and bathrooms would face north where there are no special views. The new berthing building would be close to the GWR berthing, as well as the bar, lounge, and exercise room located there. A walkway should also be provided between the GWR and new berthing buildings. This walkway can also have the utilidor beneath it. Utility connections would include power, IT, waste water, potable water, and waste heat.

12. Power Generation:

The GWR building houses two 250 kW Caterpillar engine generators that supply electricity to all of Palmer Station. The current generation and distribution voltage is 120/208 volts, 3 phase. Due to the age of the generators, vintage 1988, and the associated switch gear, vintage 1968, RPSC and RSA Engineering propose to replace the existing power generation equipment to improve reliability, and relocate it from the GWR Building to an independent generator building for much better safety and code compliance. RSA Engineering also recommends that the replacement generators be specified to generate at 277/480 volts, 3 phase. The new site for the generator is an estimated 175' further away from the station, with the longest run being around 500'. At 120/208 volts, the voltage drop could become significant. By changing to 277/480 volts, the existing cable power carrying capacity is doubled, and the power loss due to heating is significantly reduced, in addition to the benefit of less voltage drop. All new large motors (anticipated large motors will be required for the planned waste water treatment plant, and for the salt water fire hydrant system) can then be 480 volt, which are cheaper and more efficient. The penalty to changing the voltage will be the requirement to install new step-down transformers at all electrical service entrances, with their attendant 3% estimated power loss.

The six generator replacement options listed below came from the RPSC Palmer Station Facilities Assessment, prepared by RPSC, dated December 8, 2008. Options proposed by RPS in their report are repeated below, although revised paybacks would be need to be calculated using prevailing fuel costs when the decision to change the gensets is ready to be made. The cost paybacks presented were from the RPSC 2008 calculations, now outdated.

Option One

Buy two new generators, switch gear, a transformer and a building large enough to enclose the electric generation equipment and the vehicle maintenance garage. The Caterpillar C-9, 275 kW prime, 480 volt engine generator would be an excellent choice. The new generator will conform to the lower emissions (EPA Tier 3) standards, which will substantially reduce emissions but also reduce fuel efficiency below what would be possible without the emission controls. We have calculated a 1.3% decrease in fuel consumption compared to the existing generators, and estimated the cost of this option at $1,636,923 (cost estimate in Appendix

R2) including a new building to house the generators and the garage. An indeterminate payback would derive from the modest fuel savings, reduced maintenance at least over the next decade, reduced engine exhaust emissions, substantial reduction in the risk of site-threatening equipment breakdown, and not least, much improved safety of staff by moving the power plant and the garage out from under the sleeping area.

Option Two

In place of Option One, Caterpillar has offered to furnish marine engine generators specifically designed to generate shipboard power. Since they are built with engine jacket and exhaust manifold heat recovery devices already installed, they offer the advantages of greater heat recovery and avoidance of the cost of heat recovery devices, but the disadvantage of emissions that meet only EPA Tier 2, not Tier 3 or 4 standards.

Each of these engines burns only 61.8% of the fuel consumption of one of the existing generators [13.6 versus 22 gallons per hour at 187.5 kW (75% of 250)]. The resulting estimated annual fuel savings over the present equipment is $122,080 (38.2% of $319,580) just in fuel burned in the engines. Heat recovery equipment on the engines will allow additional heating fuel savings. According to Caterpillar's data for this marine engine, 8417 Btu/minute (at 75% load) of rejected heat is recoverable for other purposes. That equates to 3.9 gallons of fuel or $14.43 an hour. This exceeds the total heating requirements of Palmer Station's five major buildings for the foreseeable future. What small increase in emissions that this engine produces over the EPA Tier 3 requirements is far more than offset by heating fuel not burned.

The 19,942 gallons of fuel burned for heating during the year ending at the end of April 2008 cost $73,785. That's an expense that could have been met with the engine's heat recovery equipment connected with cogeneration pumps and piping.

The annual fuel savings in the engine itself plus the cost of heating fuel not burned equals $195,865 ($122,080 + $73,785). The installed cost of this option has not been estimated because of insufficient data received from Caterpillar. Like Option 1, Option 2 includes a new building to house the generators and the garage. This option shares the indeterminate payback benefit of Option 1 but would cost less. If the NSF could accept the somewhat higher emissions from the marine engines, this would be a viable and attractive option. If accepted, overall emissions from Palmer would be substantially reduced by eliminating boiler flue gas.

Option Three

Use the three Ice Cube Drill Camp generators currently at the South Pole and scheduled to be available at the end of the 2012 summer season. These units would have to be refurbished most likely in California, then transported to Palmer Station. This option offers the advantage over Option One in having each generator and its associated heat recovery equipment and radiator already installed in its own insulated shipping container, and the switch gear and controls in a fourth container. The generators, each a Caterpillar 3306, 210 kW prime, 277/480 volts, can be manually paralleled through the switch gear. A transformer would have to be purchased to supply 208v 3Ø to the existing Palmer Station power grid.

These generators do not conform to the lower emissions (EPA Tier 3) standards, but each one burns about 64.5% of the fuel of one existing Palmer generator [14.2 versus 22 gallons per hour at 187.5 kW (75% of 250)] and will alone supply Palmer's current electricity needs at least 99% of the time. The estimated annual fuel savings for this option is $113,451 (35.5% of $319,580) and the estimated installed cost is $753,591 (cost estimate in Appendix R3). The resulting payback is 6.6 years. This option has the significant disadvantage that the equipment maintenance garage would remain in the GWR Building.

Option Four

Relocate two of the three WAIS generators at the conclusion of that project in 2014. This machinery now consists of one 40 kW and two 225 kW generators and associated switchgear. The 40 kW machine is old and not considered part of this option. Option Four offers the advantage over Option Three in that these two generators will have seen little service and not need refurbishing. A new building to house the power plant and garage has been estimated as part of this option which has the one disadvantage of a long delay before the generators can be moved to Palmer. The two WAIS generators have about the same fuel efficiency as the two presently at Palmer, so no energy payback can be expected.

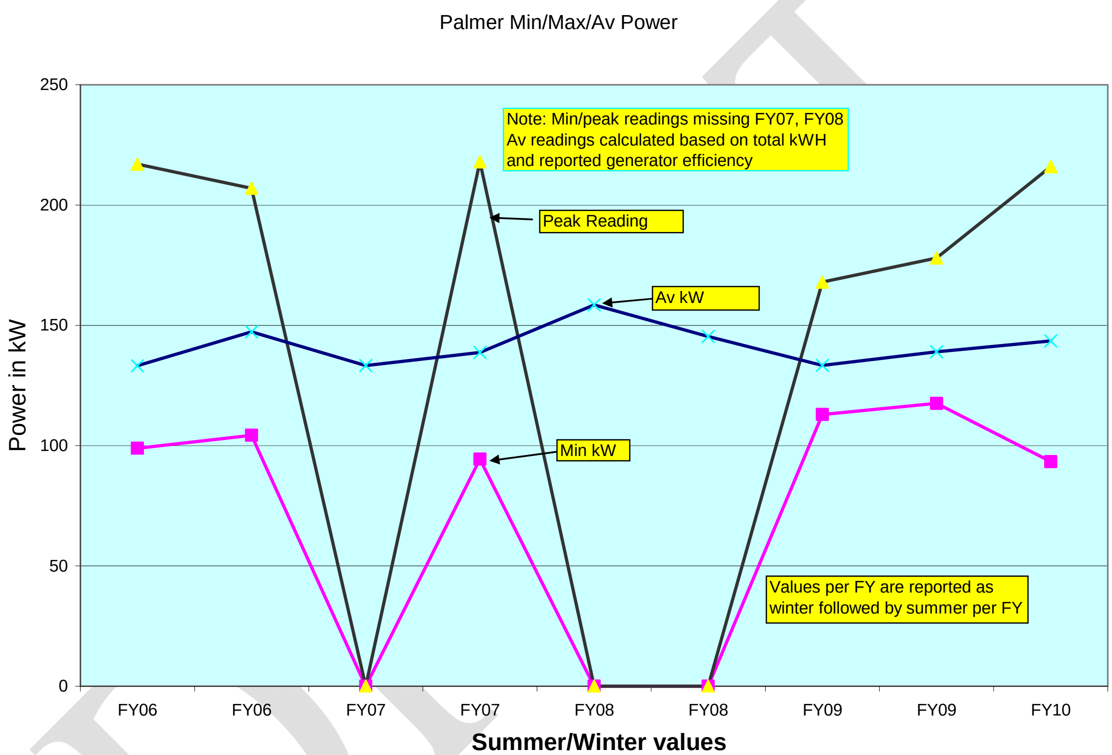
Option Five

An 1130 kW, 4160 volt Caterpillar engine generator at McMurdo's Power Plant, whimsically referred to as "a Cat in a box", will no longer be needed after 2010. Purchased as a standby unit during the Power Plant expansion and operated only during maintenance cycles, it will have operated only a few hours by the time that it is no longer needed at McMurdo. This unit could be returned to Port Hueneme at very low shipping cost, since the ships typically return near empty, and sold. The estimated $400,000 sale price could be applied to buy new generators for Palmer Station.

Option Six

Two wind turbine generators at Australia's Mawson Station supply an annual average of 65% of the station's electricity needs. See http://www.aad.gov.au/apps/operations/electrical.asp. Similar wind turbine generators could be considered for Palmer Station. See the related email in Appendix H3. An estimated cost of $5.8 million is shown in Appendix D."

Generator Sizing and recommendations by RSA Engineering
The SITREPS reports from FY2006 through FY2010 were used to form a basis for sizing and forecasting loads at the Palmer power plant. Weekly winter and summer data was compiled and averaged as shown in the table below:



Power load forecasts: Power load forecasts are based on average and peak loads recorded from FY-06 through FY10, with adjustments based on forecasted changes from past consumption. The historical data is taken from the SITREPS analysis which is a compilation of weekly reports of readings. Note that the power analyzer was down for half of FY07, and all of FY08 so no data is provided for those periods. The data is shown on the table below:

Palmer Data	Average	Peak
FY06-FY10	All years	All years
Minimum kW	104	118
Maximum kW	206	235
Average kW	143	159
kW-Hours	24,027	26,628
Power plant fuel use	1,733	1,840
Power Plant efficiency	14.0	14.5
Av weekly population	26	37

As shown in the table, the maximum power generated at Palmer Station was 235 kW. Since the power analyzer was not operational for a substantial period of time (over a year), there could have been higher peaks, because the peaks reported when the power analyzer is not operational are the peaks observed by the operator at the time of his periodic readings.

Recommended Genset and Switchgear Option: Similar to the RPSC Option 2, it is recommended that two new Tier 2 Caterpillar gensets with marine manifolds be selected for this project, if they are still available from Caterpillar. The reasons are:

- Jacket water waste heat recovery can be optimized without going to the complexity and ongoing maintenance expense of an exhaust heat recovery system. Most exhaust waste heat systems require continual maintenance to remove soot buildup.
- Marine manifolds have cooler surface temperatures, as opposed to bare exhaust manifolds and turbos that are extremely hot, which present a burn hazard to personnel, and a potentially higher fire hazard.
- The tier two gensets will burn with much higher fuel efficiency than the tier three engines, which over time will result in a huge operational cost savings. The fuel reduction experienced using this option, coupled with the avoided fuel burned from supplemental boilers will actually reduce the carbon foot print compared with the tier 3 options. This recommendation needs to be confirmed with NSF Environmental.
- Since Palmer Station is not within the United States, the requirement for compliance with Tier 3 or 4 requirements does not exist.
- New gensets are justified since there are no marine manifold equipped gensets presently in inventory, and since Palmer is remote, requiring reliable equipment.

- The size of the new gensets should be nominally 250 kW to cover maximum peaks while still keeping at least 40% loading during minimum loads.
- Caterpillar brand gensets are justified as a sole source since the USAP uses almost exclusively Caterpillar products, so spare parts and maintenance procedures are available and known. Cat has provided reliable service in the past to the USAP further justifying the selection.
- A third genset sized at 150 kW is recommended to provide the load matching during lower load periods through the use of automatic switchgear.
- New DDC controlled switchgear set is recommended, since the existing switchgear is original equipment from 1967, and better efficiency is attainable using more precise computer generator control. South Pole and McMurdo presently have Programmable Logic Control (PLC) controlled generator switchgear.
- A new main distribution panel should also be provided with the new power plant so a completely new, fully integrated, and tested assembly can be pre-fabricated and shipped to Palmer and set up with minimal downtime to the station.

Recommended Generator and Switchgear Housing with VMF Facility: While it would be advantageous to provide "Cat in the Box" type generation within pre-fabricated milvans, maintenance would be far more difficult. When considering the need for the waste heat exchange equipment, separated radiators, and finishing boilers, as well as automated switchgear, a stick built power plant appears to be the best long term option for Palmer Station. Since this is a small station, with typically only one mechanic who has to tend to the generators as well as all heavy equipment repair, it is recommended that the generator building be constructed to include a vehicle maintenance shop so the one person can watch over both functions at the station.

Waste Heat System: While there is some of the available hydronic waste heat being used to heat the GWR building, the Bio Lab, boat house/dive locker, Aquarium and Carpenter Shop are still heated using fuel oil boilers located at the Bio Lab. The recommendation is to extend the waste heat system to the existing boiler room in the Bio Lab through a plate and frame heat exchanger configuration so the two systems are hydraulically separated which will reduce pressure problems between the two systems, and would also reduce the amount of a potential glycol leak if a pipe were to fail. The Bio Lab presently uses about 20,000 gallons of fuel per year (see fuel consumption table earlier in this report). All of that fuel consumption could be deleted if we extend waste heat to the Bio Lab, since all of the fuel is used in the boilers for heating and domestic hot water production. Additionally, waste heat should be extended to the proposed new wastewater treatment plant, as well as to the proposed new RO/seawater intake building so the seawater can be heated before it enters the RO system, which would make that system much more efficient.

13. **Potable Water Generation and Distribution:** The station produces all the required potable water from Reverse Osmosis (RO) machines that take sea water and filter it under very high pressure to produce potable water. The system starts with seawater which is pumped from the ocean on the north side of the station. There is a pump house very close to the water that houses three 5 hp, 3450 RPM constant speed pumps that pressurize the sea water so it passes through sand filters before being piped to both the Aquarium and the GWR building that houses the main RO unit. Two of the three constant speed 5 hp pumps run continuously during the summer, and one runs continuously during the winter. The sand filters are backwashed on a rotating basis, so basically each day a different sand filter is backwashed. It is reported that silt from the nearby glacier tends to foul the sand filters, which presents extra maintenance.

    In addition to the Aquarium and the RO equipment, the salt water is piped to all of the urinals and toilets for use in these fixtures. The balance of the plumbing fixtures on station use RO potable water. The salt water enters the RO machine in the generator room located in GWR for processing. Water entering the RO machine is typically heated for maximum efficiency, but the water at Palmer Station is not heated. The RO machine has a 7.5 HP electric motor, and produces 2 GPM of continuous potable water, and 7 GPM of salt water that is wasted back to the ocean. The potable water is then piped back to the Bio Lab where it gets soda ash injected, and then enters one of two 2,574 gallon holding tanks. When the tanks are full, they flood to a floor sink in the room which is continually wasted to the ocean. Treated and sterilized potable water is then piped from the storage tanks through UV filters, and out to both the Bio Lab fixtures, as well as back up to the GWR building.

    There is also a back-up RO unit located in the Bio Lab boiler room. The back-up unit is a Matrix Model Silver B2500 extreme low temperature model. It produces 1.75 GPM of potable water, and 10.5 GPM of concentrate flow at a membrane pressure of 760 PSIG. Again, the incoming salt water is not pre-heated, which would make the system more efficient.

    It is recommended that the RO machine presently located at the

GWR building and the emergency RO machine should both be relocated to a new combined seawater intake/RO processing building. The salt water for the Aquarium can continue on to that facility, but no further salt water distribution would be needed.

Station personnel have suggested swapping the seawater inlet to Hero Harbor, and rejecting the treated sewage effluent to an area near the present saltwater intake. The advantage to doing this is that the seawater would have less silt from the glacier, and the intake would be less exposed to icebergs that are more prevalent in the current intake location. Also, visitors entering the Station from the pier would not be seeing a sewage effluent line when they enter, as the revised location would be away from their view. This suggestion was reviewed and rejected because the ship continuously discharges seawater at elevated temperatures due to cooling of the marine engines. The ships' cooling water effluent could impact the Aquarium because of elevated temperatures. The seawater intake will therefore remain where it is presently located. It is proposed to revise the sewage effluent discharge to below the surface of the water near the rebuilt pier.

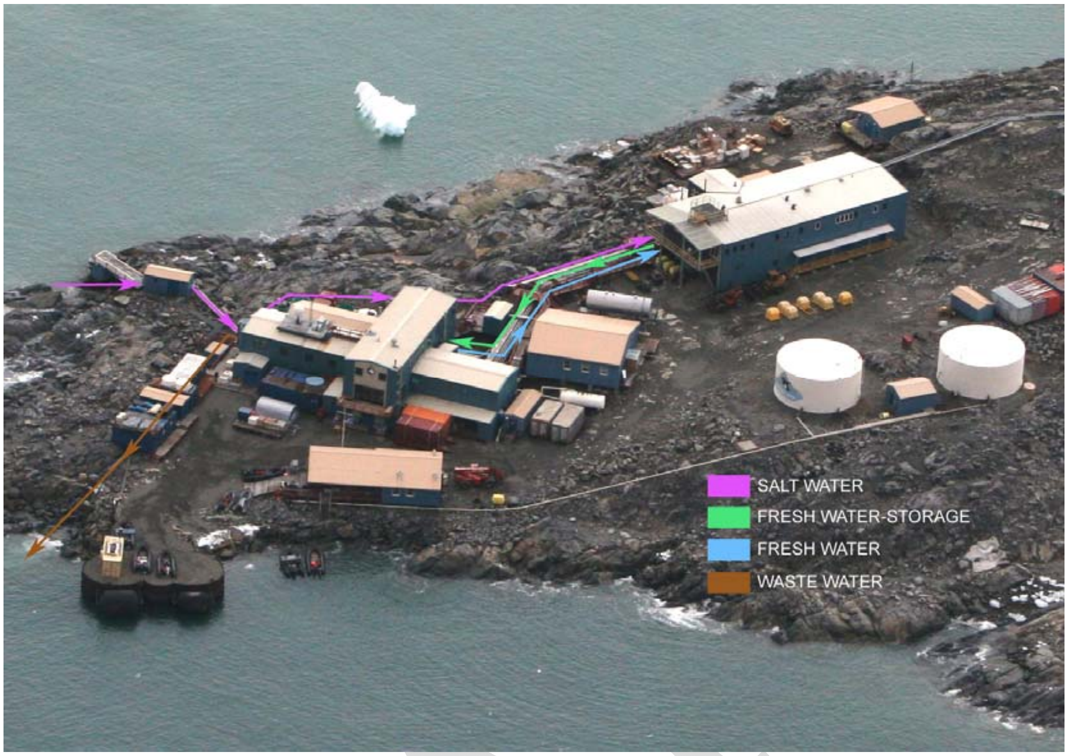
There are four heat traced water pipelines that go between the GWR building and the Bio Lab: Salt water to GWR, RO water from GWR untreated, treated (soda ash at inlet to the storage tanks, UV sterilizer at outlet of storage tanks) water which returns back to GWR. Black water is mixed with RO waste from GWR to the masticator. The untreated RO water line will be demolished when the RO unit is relocated near the sea water intake, and the salt water supply line will be demolished when the urinal and toilets in GWR are converted to fresh water. This reduces the heat trace load by two circuits. The relocation of the RO equipment also eliminates the additional pump head needed for the salt water to be piped up to the GWR building, since RO treatment would occur adjacent to the saltwater intake.

A new seawater pump/RO building would house all new 480 volt seawater pumps. The new pumps would be sized to provide water at varying flows through the use of variable frequency drives, and they would be sized to respond to demands to fill the Aquarium quickly, to provide adequate fire water to service the proposed new salt water fire hydrant system, as well as to provide the needs for the RO intakes. The variable frequency drive (VFD) would vary the speed of the pumps to only what is needed for the RO, fire and Aquarium demand. This should create a significant energy savings. In addition, by relocating the RO equipment adjacent to the seawater pumps, the elevation difference to the GWR is removed, requiring still less energy to pump the seawater.

The RO equipment itself should be revised to more closely match the station potable water requirements, but taking into account that the toilets and urinals would be revised to use potable water so the sewage can be treated in the proposed waste water treatment plant. At present, considerably more RO water is made than that used, since the machines are never turned off, so excess water is simply wasted back to the ocean. The amount of wasted water is calculated below to be an average of 489,792 gallons per year, costing an estimated $22,0413/year average based on the cost of $.045/gallon to convert, pump, and treat the water. The cost to produce RO water was provided by Laura Rip, RPSC Energy Engineer. Either smaller RO equipment should be installed, or the equipment should be automatically cycled to meet demand, if possible.

Palmer Station Water Consumption History

	FY06	FY07	FY08	FY09	FY10	5-yr Av	5-yr ttl
Annual Water Produced-av/wk	18,125	18,369	18,267	18,631	19,459	18,570	92,851
Annual water produced min/wk	5,940	20,640	16,910	16,710	10,320	14,104	70,520
Annual water produced max/wk	23,190	21,300	19,370	20,900	31,480	23,248	116,240
Annual water produced-av/hour	108	109	109	111	116	111	
Annual water produced/year	924,360	973559	949895	968800	1011868	965,696	4,828,482
Annual water used-av/wk	9,370	9,370	9,636	7,913	8,412	8,940	
Annual water used-min/wk	3,700	3,700	5,600	100	39	2,628	
Annual water used-max/wk	18,100	18,100	14,700	16,500	21,100	17,700	
Annual water used-av/hour	56	56	57	47	50	53	
Annual water used/year	532,950	496,600	501,050	411,500	437,423	475,905	2,379,523
Annual water wasted/year	391,410	476,959	448,845	557,300	574,445	489,792	2,448,959
Average annual GPD/PP	52	46	46	48	42	47	
Money wasted at $.045/gallon	$ 17,613	$ 21,463	$ 20,198	$25,079	$ 25,850	$ 22,041	$ 110,203



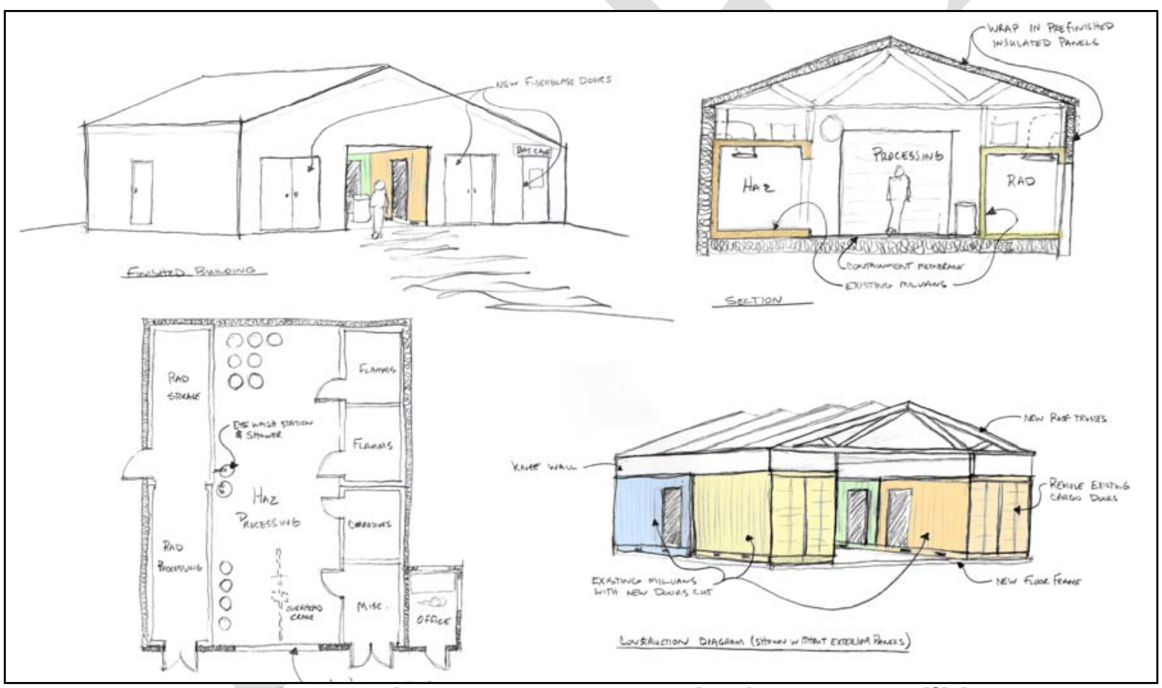
Seawater/RO raw water/Treated Water Circuit

14. **Hazardous Materials:** The Haz Mat milvans located at the entry to the station from the pier do not provide adequate ventilation, lighting, or emergency plumbing for safe and efficient hazardous waste processing. They are scattered in several locations, so it is advisable to consolidate all of the Haz Mat operations to one area. The area just down hill from the Terra Lab already has a flammable storage building, as well as a gas cylinder storage area. It is proposed to relocate the Haz Mat to the old helipad. The old helicopter pad is a flat area just downhill from the Terra Lab. The pad has not been used for helicopter landing in recent memory, and is now occupied by four milvans which are used for long term storage of hazardous waste drums. The recommendation is to remove the old steel mats that have been placed to establish a level surface. The surface should be redressed, and the Haz Mat operation should be placed at this location. In order to keep costs at a minimum, and to utilize what assets are at the station, a design using four existing milvans, with roof trusses spanning a 16' open space between the milvans is recommended. The assembly could be wrapped with pre-insulated steel siding to maintain heat loss to a minimum, and present an architecturally pleasing appearance at a very reasonable cost. We would not plan on using the milvan doors, but rather install man doors that are much easier to operate. The building would also include an emergency shower and eyewash, with tempered water stored in an electric water heater. The pipes to the shower and eyewash would need to be heat traced since the building would only

be heated when workers are sorting hazardous materials, which is not a full time effort. We are also recommending some sort of containment in the processing area using HDPE or some other type of containment where feasible.

The cost to heat an un-insulated milvan is estimated by RPSC mechanical engineer Mark Bartram to be 65.5 MBH or 19.2 kW on a design day. By wrapping the entire facility with 2.5" pre-insulated steel panels, we can provide an electric unit heater that would be operated using a spring wound timer to heat those areas that are used for processing, while processing is occurring.

The relocation of the Haz Mat milvans presently located near the pier must occur before the WWTP is installed, since the WWTP would be constructed in the present location of the "Bat Cave", a Haz Mat processing milvan.



Proposed Hazardous Waste Processing/Storage Builidng

15. **Salt Water Toilet/Urinal Conversion:** The Waste Water Treatment Plant (WWTP) cannot process saltwater, so the waste stream must be converted from salt water to fresh water. This process will also involve upgrading the toilets to elongated bowl, dual flush water saving fixtures. The urinals will be converted to ultra-low 1 pint per flush fixtures to conserve fresh water if copper waste and vent (DWV) piping continues to be used. If the urinal waste piping is converted to plastic or cast iron, than waterless urinals could be used, since the uric

salts only attack copper DWV piping. The conversion of the plumbing fixtures from saltwater to low flush fresh water is precedent to the startup of the WWTP.

16. **Waste Water Treatment:** Palmer Station waste water treatment system consists of only maceration of solids before the waste stream is discharged into the ocean. A study was recently performed by AECOM (see reference 1) for the National Science Foundation through Raytheon Polar Services. The study provided a comparison of the various biological treatment technologies available to Palmer Station. Chemical treatment options were omitted from the study because of potential environmental and safety impacts associated with the use of the chemicals. Wastewater flow and composition was determined prior to the analysis in order to provide an appropriate treatment option. The study did consider cold climate, the small and varying population between the austral summer and winter seasons, equipment handling weight and size constraints, as well as the constraints on power, maintenance, operations, technical support, and most important, available real estate. The resultant summary of three basic processes, including sludge stabilization, sludge dewatering, and UV disinfection concluded that the extended aeration option is best for Palmer Station, not only from a cost standpoint, but also from a point rating system that considered all the relevant factors. The summary of options presented in the report is shown below:

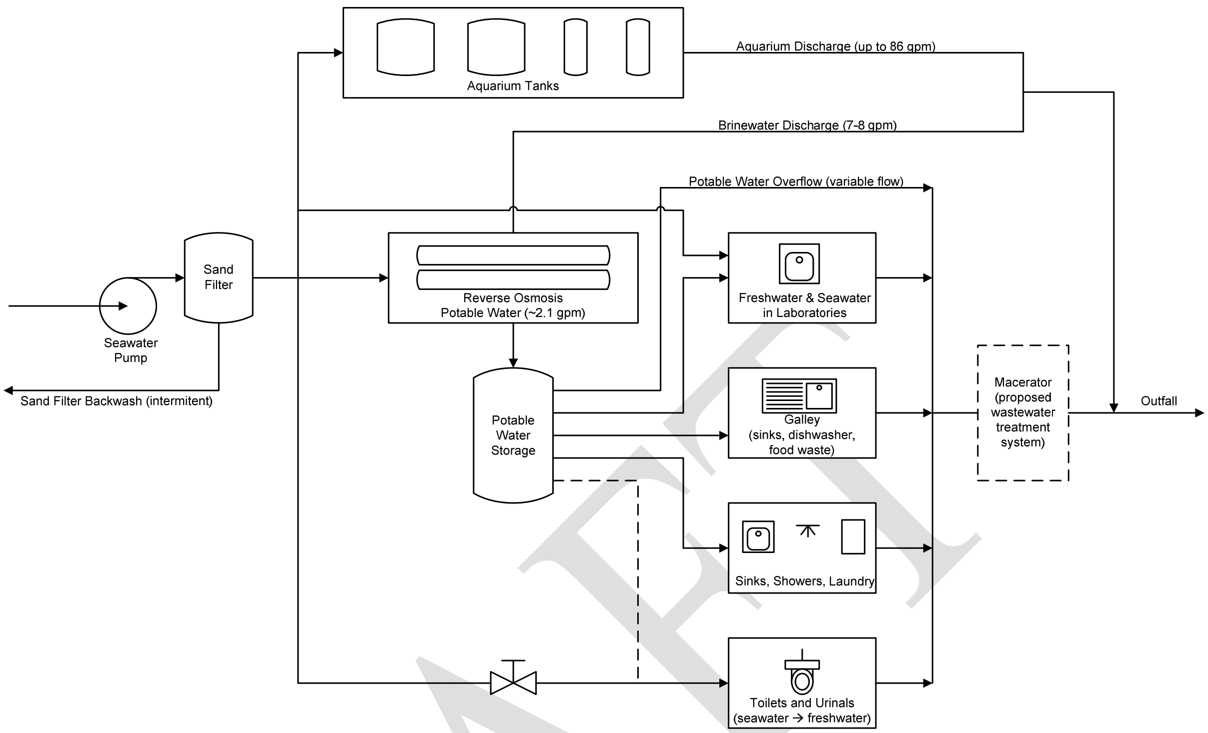
Cost and Power Requirement Summary for Treatment Systems

Source: AECOM Study – Reference 1

Process	Cost & Power[1]	Secondary Treatment	Sludge Stabilization	Sludge Dewatering	UV Disinfection	Total
Extended Aeration	$	$137,000	Included	$157,000	$23,000	$317,000
	kW-hr	73.8	Minimal	20	33.6	127.4
Rotating Biological Contactors	$	$305,900	Included	$157,000	$23,000	$485,900
	kW-hr	40	Minimal	20	33.6	93.6
Membrane Bioreactors	$	$642,000	Included	$157,000	$23,000	$822,000
	kW-hr	180	Minimal	20	33.6	233.6

Existing Wastewater Flow Diagram

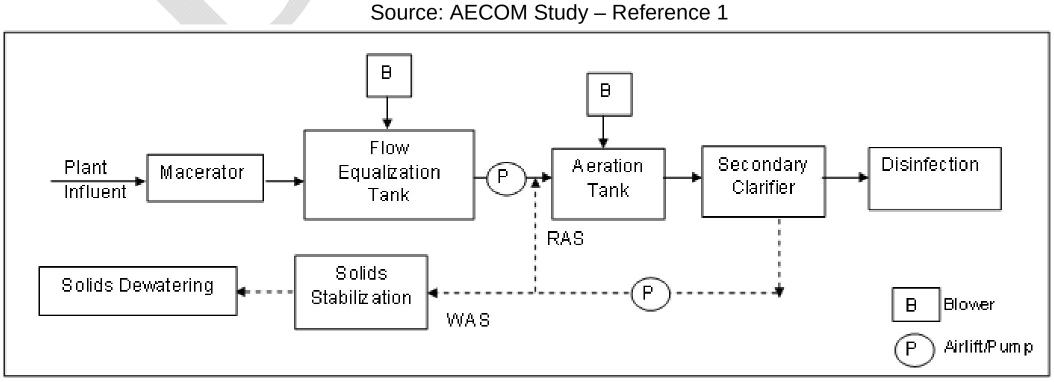
Source: AECOM Study – Reference 1



Based on the results of this study, the final recommendations for the extended aeration option should be implemented at Palmer. Additionally, the seawater system used for flushing toilets and urinals should be replaced with a treated water system, but the toilets should be replaced with dual flush fixtures, and the urinals should be replaced with waterless type fixtures provided that copper drain waste and vent piping (DWV) is not used to the point of dilution, which is the first confluence of a larger flow, such as a toilet or shower due to the corrosive effect of urine on the copper. With copper DWV lines, urine attacks the pipe up to the point of dilution as seen at the South Pole. An alternate to the waterless urinals is a 1 pint per flush urinal system that could still be used with the copper DWV piping.

Extended Aeration Flow Diagram

Source: AECOM Study – Reference 1



Major Equipment for Conventional Extended Aeration

Source: AECOM Study – Reference 1

Description	Size or Quantity
Flow Equalization Tank	
Quantity	1 (1 duty, 0 standby)
Length (ft)	3.5
Width (ft)	12
Tank Side Water Depth (ft)	5.4
Flow Equalization Tank Transfer Pump Motor (HP)	0.5 (1 duty, 1 standby)
Extended Aeration Tank	
Quantity	1 (1 duty, 0 standby)
Length (ft)	6
Width (ft)	12

RPSC did find this last summer when their environmental engineer collected annual wastewater samples that without the dilution factor of the Aquarium added to the outfall, the wastewater stream is above EPA suggested CCCs and CMCs for some metals. This is not a surprise; however this was the first time composite samples of an unconsolidated outfall was collected by temporarily rerouting the Aquarium discharge. This is a major performance factor that needs to be included in the future basis of design, and subsequently evaluated in the bid proposals. Results are provided below.

Palmer Effluent Analysis without Aquarium Effluent Dilution

Effluent Parameter	Result (mg/L)	EPA Saltwater CMC (mg/L)	EPA Saltwate r CCC (mg/L)
Copper	0.260, 0.190, 0.248, 0.240, .403	0.0048	0.0031
Lead	0.011, 0.0112	0.210	0.0081
Nickel	0.0169	0.074	0.0082
pH	5.3, 5.5, 9.4	6.5 – 8.5	
Total Dissolved Solids	877.5, 870, 882, 2324.5, 825, 546, 1491, 604, 1195, 7786, 2128	250	
Silver	0.0051, 0.0315, 0.0023	0.0019	N/A
Zinc	0.148, 0.148, 0.163, 0.169, 0.243	0.090	0.081

Source: Nate Biletnikoff, RPSC

Palmer Station Unconsolidated Wastewater Outfall (w/o Aquarium discharge and dilution factor added)

Subsequent to the completion of the AECOM report, an additional WWTP system was evaluated. This additional system utilizes technology used on shipboard WWTP systems. The analysis concluded the following advantages and disadvantages:

Advantages

1. Compact Design

All of these commercial wastewater treatment systems offer very compact design due to the limited space available on the vessels. With more and more stringent regulations, some of these systems offer advanced process to produce high quality effluent. Some systems come with features such as flow equalization basin and UV disinfection systems, the type of features that can be applied to Palmer Station.

2. Easy to Construct

Since these systems are designed for marine vessels, they are easy to install. Most of these systems are of the “plug-and-go” type.

Disadvantages

1. Sludge Handling

These commercial wastewater treatment systems do not address the need for sludge handling, one of the major concerns at Palmer Station. Therefore, sludge handling processes such as aerobic digestion and sludge dewatering as addressed in the previous evaluation report will still be required regardless of the type of commercial wastewater treatment systems. Therefore, the footprint of a complete treatment would be larger than the commercial system alone.

2. Flow Equalization

While some commercial systems are equipped with a flow equalization basin, some do not. As such, space for flow equalization may still be required. This would result in a larger footprint.

3. Energy Consumption

Some of the systems use MBR technology. While the technology can offer a very high quality effluent, it also consumes higher energy demand as stated in the previous evaluation report.

4. Chemical Handling

Some commercial systems are equipped with chlorination/dechlorination as a mean of disinfection. As one of the concerns at Palmer Station is to reduce chemical usage, these systems will not be desirable for the use at the station.

5. Level of Effort

Another concern addressed in the previous evaluation report is to minimize the level of effort needed to operate the wastewater treatment at Palmer Station. Despite the compact design, commercial systems using MBR technology are likely to require a higher level of operating support compared with the activated sludge systems.

Summary

While commercially available, ship-based wastewater treatment systems offer a compact design and ease of installation, the systems did not include sludge handling processes. They do not usually include flow equalization or UV disinfection. When taking into account these necessary processes at Palmer Station, the final footprint for a complete treatment system at the Station is likely to be larger than the hardware pictured in the brochures.

In addition, should a vessel-installed treatment system fail or require major maintenance, the system can be repaired and maintained once the vessel is in port. For Palmer Station, equipment maintenance and repair needs to be done on site. Therefore, equipment redundancy was included in the previous evaluation report. A level of redundancy and supply of critical spare parts should be taken into account if a commercial marine-based treatment system is considered.

It should be noted that the treatment processes considered in the previous evaluation report considered similar packaged units for the technology alternatives. Once the sludge handling and dewatering, flow equalization, disinfection, electrical and mechanical room were taken into account as a complete treatment system at Palmer, the footprint becomes larger than just the packaged unit itself. Should any of the commercial treatment systems be considered further, a more detailed analysis is recommended.

Based on the above subsequent evaluation, it is recommended to stick with the original AECOM recommendation for an extended aeration treatment facility. The new facility, however, should be slightly larger than that required for a WWTP, since the location of the WWTP near the pier necessitates a place for fuel spill containment that is used for fuel offloading. There is also a need for a place to house emergency services gear and changing, so these functions could be located in a room adjacent to the new WWTP.

17. **Fire Hydrant System:** There is no fire truck on station, so the ability to control a fire externally to prevent spread to other buildings is currently accomplished using gasoline powered seawater pumps and fire hoses in series to reach the various structures. This method takes valuable time to set up in an emergency and it requires open water to access a seawater source. It is therefore recommended that a permanent, fixed salt water hydrant system be installed from the pier area up to the Terra Lab. See attached sketch for the proposed route. This would at least put a resource to help contain a major fire from spreading throughout the entire station. The seawater pump complex discussed above would include pump sizing to be able to respond to large demands for salt water through VFD control of the pumps.

18. **Warehousing:** There is considerable use of standard milvans, or 20’ long x 8’ high x 8’ wide steel containers with wooden floors and large swinging

doors on one end. The storage vans are all around the station, and greet the visitor as he disembarks from the ship at the pier. The units are currently in place around the front of the Bio Lab, presenting an unsightly view of the facility.

Some of these milvans have been modified to provide heaters, ventilation, and lighting, but they are typically not insulated. Most of the warehousing milvans will be removed from service at Palmer since the area that presently houses the power plant and boilers would be vacated when the new power plant building is erected. One significant exception to reuse of the milvans is for the hazardous storage area, and that is discussed above.

Assuming that the new power plant is constructed above the GWR building, and below the Earth Station, the space vacated by the old power plant can become warehouse space, which would be adjacent to the existing warehouse anyhow. This would be an ideal use of the vacated space, since it would allow the station to remove many of the milvans around the station that are presently used for low volume storage. The work flow of warehousing would make operations much more simplified, and easy to account for and find materials. A new overhead door is proposed for the remodeled warehouse area to allow for milvans breakdown when they arrive from the vessel. If the vehicle maintenance facility is relocated to a new shop adjacent to the proposed power generator building, the old VMF could be used to stage incoming milvans. Alternatively, cargo could be taken from milvans at the pier and relocated to its final destination.

19. **IT Expansion at Earth Station and Bio Lab:** The IT systems at Palmer have been all added after the fact, since no IT was in place during original building construction. The NSF requirements for redundant servers and UPS systems put a significant demand for space on the station. It is recommended that an addition be placed on the east wall of the earth station, measuring 6’ wide x the length of the existing electronics shelter. This space would contain the redundant servers, UPS devices, cooling equipment, and various switches and related equipment. At the Bio Lab, consideration will be given to accommodating the needs of IT by either acquiring some of the space on the third floor that has been berthing, or possibly taking more space in the 2nd floor. Additionally, the new buildings, such as the new 22 room berthing module, will have an IT closet on each floor to provide a place to land IT cables for that floor, in addition to a switch, a UPS, and related cooling equipment.

Specific additional IT concerns and requirements related to us by the Station IT personnel are listed below:

NOC - (Network Operations Center or Data Center):

- Does not have to be in the same building as IT offices
- Could be separate "NOC in a Box", to free up prime office/lab space and optimize cooling / fire suppression / noise reduction / scalability
- Cooling for servers
- Fire suppression
- Noise reduction
- ~ 160 square feet

Bio Lab - Office and bench space

- Current space is not used efficiently (large space is broken up by unused racks)
- Facility UPS is in place
- Need bench space for electronics technician and computer technician repair work, in addition to desk/office space for 4 people
- Existing bench space would be fine if it did not also serve as an office for two people
- ~ 120 square feet for bench work space (not including desk/office space for 4 people)

Wiring closets

- New areas need wiring closets on each floor to accommodate network infrastructure.
- Wiring closet standards are specified in EIA/TIA 568 & 569. The size will vary depending on the floor space they are serving.

Heated storage

- Heated storage for computer and communications equipment
- An additional 100 square feet.

RF Shelter (satellite earth station):

- Need additional rack space and place for larger capacity UPS
- Cooling/fire suppression same as existing
- If it is all one room, adding another 6.5 feet towards GWR (6.5'x18'') would be adequate. If the existing wall on the GWR side remains (i.e.: 2 rooms), then it would need to be 9'x16'.

VHF Shelter

- The shelter is extremely cramped now; the door must be left open because it is too small for a person to work inside. Additional space is required to create a safe working environment around existing equipment.
- Need better cooling system. Equipment is currently damaged by snow/water blowing in.
- Add another Bally building of similar size with concrete platform or get additional/larger sections and new roof?
- Expanding the building to 10'x10' would handle all the existing equipment.

20. **Station External Walkway Circulation:** There is a wooden walkway that connects the Bio Lab with the carpenter shop, FEMC office, GWR warehouse, and the GWR stairwell, as well as a lower walkway to the Aquarium, hot tub, and around to the front of the Aquarium and Bio Lab. The walkways are clearly an advantage for getting people between the various buildings, but the surfaces are typically snow and/or ice covered. There is considerable expenditure of labor to shovel or chip ice off the walkway. Additionally, the walkways have been deemed to be an unsafe aspect of the station due to the significant slip and fall hazard.

    Various solutions were investigated, including a heated walkway surface, such as snow melt. This approach is very energy intensive, and is not practical.

It is recommended that consideration to enclosing the walkway using non-combustible materials, such as steel studs and steel siding. Provide glass or lexan windows every 10 feet or so, and include LED lights along the ceiling of the enclosed walkway. Since there is a high wind in the area, the foundations to the existing walkway should be tied down into the surrounding rock using rock anchors. Additional structural analysis would be appropriate if the enclosure is pursued. The esthetics of an enclosed walkway must be reviewed against the assumed safety and reduced maintenance of an enclosed walkway.

21. **Bio Lab Remodel:** Assuming that the 22 bed berthing module is approved, all 11 of the sleeping rooms in the Bio Lab can be vacated. The third floor space can then be remodeled into offices for Science and support people, or for minor Science storage. Some other remodel features proposed for the Bio Lab are:
    - Small projects that will not fit in the Science lab on the first floor could also be placed in the newly available space in the third floor.
    - The front entry to the building should be remodeled so the entry makes more of a statement, since it is difficult to even find the entry now with the placement of the milvans and other storage. The project proposes to extend the roof line to the east to fill in the area presently occupied with milvans used by Science. The area would become a stick built permanent addition to the Bio Lab, and would be used for the new entry, storage of the waterproof personnel gear would move to a

separate room and out of the entry vestibule, and the remainder of the space will become Science storage or additional lab space.

- There are two new freezer type milvans in the rear of Bio Lab near the kitchen storage. It is proposed to enclose the vans with 2.5” pre-insulated steel panels, and provide freezer type doors in place of the swinging leaf doors to make access easier, and to enhance the visual appearance of the vans.

22. **Fire Sprinkler Systems:** The two main buildings, Bio Lab and GWR have a pre-action fire sprinkler system. There is also a CO2 extinguishing system at the existing GWR and Bio Lab generator rooms, and the earth station. There is also a dry chemical system at the Haz Mat building and a halon system in the volatiles building.

    The carpenter shop, which is located directly adjacent to the fire water storage tank, has no fire sprinkler system. Due to the combustible materials loading in this building, it is recommended that the carpenter shop get a wet pipe sprinkler system. The system could tap the water line from the adjacent water storage tank, and a new fire riser would be installed at the tap to isolate and control flow to the carpenter shop.

23. **Energy Efficiency Projects:** The 2008 comprehensive report on energy efficiency includes a significant number of Energy Conservation Measures (ECMs). Some of those ECMs are addressed in this report, while others are ongoing upgrades, such as lighting upgrades from T-12 to T-8 lamps,

and ballast upgrades from magnetic to electronic. Many of these ECMs should be implemented on an ongoing basis, but those not completed by the time the Station is in the Phase III portion of redevelopment, should be completed in this phase.

24. **Alternate Energy:** There are three principal methods to collect renewable energy at the Station: Wind, tides, and solar. The reported average wind speed is 12.5 mph, typically in the 6-22 mph range, with the average maximum wind speed per month being 69 mph (46-101 mph range). The temperatures at the station hover around freezing year round, and the air is typically very humid with close dry bulb and dew point temperatures, making icing a significant concern. Additionally, there are birds in the area that may be impacted by the presence of a wind generator. Finally, the cost to install the devices on the island could be so high as to never have a payback due to maintenance, icing, and installation costs. Existing weather and sunlight data has been sent to Ian Baring Gould at the National Renewable Energy Labs (NREL) so they can perform a preliminary analysis to determine if it would be even feasible to research wind energy further.

    Dr. Polly Penhale, Environmental Scientist with the NSF, has provided data through a colleague, Bill Fraser, concerning bird strikes in the existing Palmer Station antenna field that needs to be considered before advancing any plans for wind turbines at Palmer Station. "*Since 1986, we have shipped out 327 birds that we can associate with some certainty as having died due to collisions in the antenna fields (i.e., birds found under the antennas and usually exhibiting telltale trauma such as broken wings). If you consider that our last shipment was in 2005, that would be an average of about 17 birds per year for the 19 years in the record. There are 7 species represented in this record, South Polar Skuas (102), Kelp Gulls (51), Snow Petrels (86), Antarctic Terns (5),Cape Petrels (51), Wilson's Storm Petrels (23) and Cormorants (9).These numbers, by the way, are conservative, as often birds are found that are beyond salvage, hence these are not retrieved.*

    In terms of the significance of this mortality to the total breeding population, the 51 gulls (25 pairs) represent roughly 25% of today's population based on censuses, while the skuas (102 or 51 pairs) represent about 6% and the cormorants 13%. We cannot come up with similar numbers for the other species because we do not have population estimates for them. However, I think the more relevant metric, at least in my opinion, is not so much the mortality relative to the Palmer-wide population, but rather relative to the local population, i.e., Bonaparte Point. In this case, for both skuas and gulls for example, relative mortality is at almost 100%; in other words, they are almost locally extinct. We know *this because most of the population was banded, and it is these banded birds that we have mostly found dead. Also relevant is that these were birds with known breeding histories (some since the 1970s), hence their loss represents a huge loss to long-term life history research."*

Tides at the Station are relatively small, with the mean high water at +1.1 feet compared to the mean low water at -1.1 feet. The total tidal fluctuation recorded over two years was 7.22 feet according to the Palmer Harbor Rock Removal Project Report dated August 1999 by John Wright. See reference #3. Considering the presence of brash ice lasting from hours to days, ice chunks and small icebergs, and occasional solid ice that can be walked on, tidal power generation does not appear to be viable.

For solar thermal or solar voltaic systems, clear days are the most productive. Clear skies at Palmer are an infrequent phenomenon, with overcast or rain sometimes occurring weeks on end. The typical sky condition does not appear to support solar energy collection. Actual cloud cover data has been requested and will be forwarded to NREL for their confirmation of feasibility of harvesting any sort of alternate energy at Palmer.

25. **Building Demolition:** The station has two buildings very close to the new Terra Lab. Since the Terra Lab represents a significant investment in the facility as well as the instruments inside, it must be protected. Outside of the saltwater fire hydrant system planned to be extended to the building, it is not feasible to bring a freshwater fire protection system to the building. The best protection is to assure adjacent buildings do not catch fire and spread to the Terra Lab. There are two buildings that are within a few feet of the Terra Lab, the T-5 building (building 11) and the Clean Air Facility. The Clean Air Facility currently houses one experiment which is being run in parallel with its replacement in Terra Lab, so it could be demolished. The T-5 building is presently used for storage, and the contents can be moved to another location (possibly as an addition to the proposed new hazardous materials facility). It is recommended that these two buildings be demolished as soon as is feasible. These two buildings had been slated for demolition as soon as the Terra Lab was completed, but that just has not happened yet. The time has come.

    Additionally, it is recommended that all of the milvans except those identified for continued use be demolished from the station.

26. **Electric Metering:** Electric metering will be provided at each major building service entrance, and metering will be connected to the central DDC system. Separate meters will not be provided on each small Connex

building or smaller shelters, but rather those that are served by a larger panel or carry a more significant load will be metered.

27. **BTU Metering:** BTU meters will be provided at each of the two major buildings, the boathouse, the new berthing building, as well as at the generator heat exchanger. With this arrangement, all waste heat generated will be accounted for, and the waste heat usage will be broken out by the two main buildings, with the rest being the difference between waste heat issued and waste heat used by buildings or lost in pipelines.

28. **Multi-purpose Room Addition:** The station has no multi-purpose room that could be used as a small gym (other than the exercise room). Activities such as yoga, all hands meetings, band practice, band performances, or any other station social activities. An addition to the GWR building on the north east face is recommended where the deck is presently located. This location would be between the new proposed berthing and the existing GWR berthing, so it would be centrally located to the berthing. Since the GWR building is already existing, the costs would be relatively modest considering that the existing building, existing power, and existing toilet facilities could be used reducing the needed addition amenities to only the room itself.

29. **Station Architectural Appearance to Public:** Palmer Station does not present a good image to the visitor arriving at the pier. The first things seen are a raw sewage outfall into the ocean adjacent to the dock. Next the visitor sees the “Bat Cave”, including a row of rusty milvans that are used for hazardous waste. When walking toward the station, the visitor sees a Polar haven tent, with 3-4 more rusted milvans used for storage. It is difficult to find the actual entry to the station with all of these facilities. There is certainly no architectural statement made at the front entry to the Bio Lab. It is recommended that the front of the station get a face lift to accentuate the front entry, while permanently enclosing the front of the station with a building enclosure which would allow removal of all the milvans and the tent in front of the station. This remodel, along with the relocation of the Haz Mat milvans to the old helicopter pad will improve the appearance of the station. Energy savings will also be realized, since the un-insulated milvans and Polarhaven are heated, creating inefficiency. The Polarhaven, for

example, loses about 20 MBH of electric heat, whereas if incorporated into the permanent building, it can be heated with waste heat.

30. Glacier Search & Rescue Spaces:

Glacier Search & Rescue (GSAR, 6-10 members, year-round) has the current spaces/requirements for storage/use:

A. Staging/dress-out point, personal gear: Ten posts are needed along the wall of the warehouse (shared wall with the store) to hang team member backpacks, harnesses, place boots along the floor.

B. Team gear storage/issue: Two locking cabinets are needed in the warehouse where team and personal gear is stored/maintained, and ~4 additional shelves in the recreation aisle.

C. ~50 sq. ft. are needed in T5 of additional gear staging and cold storage, including backboard and basket litter, SKED, litter wheel, skiway flags, spare helmets and backpacks, etc. T-5 is recommended to be demolished, so this function should be considered for the new Haz-Mat building, to the rear of the office.

D. A GSAR cache box on stilts in the backyard is recommended, sized at approximately 4'x4'x8' to contain emergency clothing and bedding, crevasse rescue gear (prior to purchase of Snow balance), which is often used for summer storage of glacier maintenance gear (echo drill and auger, poles and flags) and flight support gear (helo/skiplane windsock, poles and flags for skiway, etc.) currently back in T5. This would also be placed to the rear of the Haz Mat office addition.

E. After training and call-outs (~1-2x/mo), the rescue team will spill out over into much of the back of the warehouse and significant space in the garage for a couple days, to layout and hang gear to dry and be repackaged/restaged. Ideally they have a slightly-larger location for the storage/issue of gear (current cabinets/shelves are stuffed and use/access blocks hallways).

F. They also request staging/dress-out point for personal gear that isn't a hallway or choke point (so all members can get to/from their gear to suit up, and station personnel don't need to squeeze by the hanging gear and potentially snag their arm or shirt on an ice axe, etc. when accessing warehouse shelves).

G. The GSAR current locations for space around station have worked (central to station to muster/gear-up, grab larger/rescue team items from T5 as they head toward the glacier, etc), key issues are too little space/inadequate access, blocking hallways and spilling over into warehouse and garage after every use, and constrained by required heating/environmental control for personal gear storage and post-use drying.

H. Fire Team gear storage/issue space (current back of T5,) should be consolidated with GSAR storage and dress-out. Many of the teams might be able to have their section of cabinets, hangers, shelves, etc. around a common dressing/drying space.

31. Fire Team Space Requirements:

The Fire Team consists of 4-6 SCBA equipped responders, 2-3 First responders and a 2 member Pump team. These members are scattered throughout the station, covering multiple jobs and areas. The SCBA dress-out stations are currently located in the GWR stairwells, Bio Lab Hoist room, Terra Lab and one or two other varying locations. The ultimate goal would be to have two sets of gear for each team member, one in the berthing area and one in the work center. As it stands right now, the dress-out areas are cramped and when multiple members are trying to dress at once they are stepping over each other. In fire response, speed is essential, so ample space in each building would improve chances in an incident. Space for an additional SCBA dress-out station should be 4'x4' with ample headroom (more than a staircase). This area should include outlets for charging radios, flashlights, and have ample wall space for hanging gear.

Equipment for the Fire Team is currently located in the rear of the T-5 building. It is an ample space for the gear. The T-5 building is proposed to be demolished, so the team would then have to revert to storing gear in the rear of the haz-mat office area. This function should occur in the existing dive locker to the rear of the boathouse.

Space for an individual SCBA dress-out station should be 4'X4' with ample headroom (more than under a staircase). This area should include outlets for charging radios, flashlights, etc. and have ample wall space for hanging gear. Space for fire equipment storage is a 20'X10' space. This function should occur in the existing dive locker to the rear of the boat house.

32. Phasing Plan: Due to the extremely tight configuration of buildings and usable ground at the station, a phasing plan is essential to provide a logical sequence of construction for a significant upgrade of the station. The plan must begin with a major repair and upgrade of the pier, because the new modular buildings envisioned for the power plant, waste water treatment plant, and berthing facilities will all require a dock facility to offload large and heavy containers. The first piece of equipment needed at station would be a 20 ton hydraulic crane that could be used to drive piling for the pier, off load large containers, demolish the buildings and tanks slated for demolition, and support all of the major construction. With this in mind and assuming the existence of a new crane, the following phasing is proposed:

a. **Phase One:** This phase includes the logistically required work, the work that is essential to pier upgrades, and the most urgent infrastructure upgrades that are necessary due to environmental or operational requirements. The items in phase one include:

   i. **Pier Rebuild:** The recommended pier upgrade option includes a relatively astute construction of a second sheet pile pier face in front of the existing pier, as well as a dolphin to the east of the pier. The rock obstructions below the water that prevent the MV Palmer from docking need to be removed, and that rock should be used to help fill in the space between the existing sheet piping and the new piling.

   ii. **Site Preparations:** While relatively level sites have been selected for siting the new power plant, the relocated Haz Mat storage and processing area, the new bulk fuel storage area, the Generator and VMF area, the WWTP area, the Saltwater intake and RO building area, and the proposed new berthing area all have some minor site preparations needed. Any rock blasted or removed from these areas as part of the site preparation could be used to fill in the pier space between the old and new sheet piling.

   iii. **Bulk Fuel Tank Replacement:** These tanks pose a substantial environmental risk and must be replaced. Neither of the two 125,000 gallon bulk fuel tanks is reliable, and neither is diked for secondary containment. The condition of the liner in the tanks is not known because of the high risk of breaking the fitting at the base of the tank used for checking liner integrity. If that fitting breaks, there would be literally no way to stop fuel from flowing out of the tank and down to the ocean due to the rusted nature of the tank in that area. Therefore, we do not know if the liner is intact or not, and cannot safely test the containment system

– which violates the International Fire Code in the first place. New cylindrical tanks need to be placed on the same site as the existing bulk tanks, so as soon at tank #1 is emptied and demolished, the new double wall cylindrical tanks can be placed on that site.

iv. **Fuel Pipeline Replacement:** The condition of the original equipment 4" fuel pipeline, along with the 2" run outs below the road to the day tanks presents an unacceptably high environmental risk to the station. The 4" line needs to be replaced with a new epoxy coated steel pipe system. There is a 2" bare steel fuel line under the road that is an extreme risk for corrosion, and since it is not contained, it could be leaking and not be detected until a significant spill has occurred. This 2" line under the roadway must be replaced as soon as possible. The remaining 2" fuel piping will almost be demolished as soon as the new power plant and extended waste heat system is on line, so that piping, which is above grade, can be observed for leaks until it is demolished. The heat trace to these lines has been turned off, since the warm moist atmosphere has been creating an accelerated corrosion situation that has now pitted about 20% of the schedule 40 pipe.

v. **New Berthing Building:** One significant constraint to a large infrastructure upgrade is the need for beds to accommodate the construction crews. It is not desirable to displace or pause Science operations, and the support people are essential to keep the station operating. Therefore, it is recommended that a pre-fabricated berthing module be part of the phase one upgrades so the 22 beds can be used to house construction workers during all phases of the upgrades before turning over the beds and evacuating Bio Lab.

b. **Phase Two:**

i. **Power Plant:** Since the switchgear is original equipment, and since the gensets are at the end of their useful life, this project has priority. The extension of the waste heat system cannot occur until the new power plant is located so a utilidor extension can be constructed.

ii. **Waste Heat Extension:** The extension of waste heat to the Bio Lab will bring an immediate reduction in fuel consumption, with attendant reductions in operating cost. This is one of the fastest payback projects on the list, so it should be done concurrently with the power plant replacement.

iii. **Potable Water Generation:** The RO process equipment needs to be relocated to a new site close to the saltwater intake pumping module to avoid excess energy wasted on excessive piping head loss or heat tracing. Once the new power plant is constructed, the existing RO equipment can be relocated to closer to the seawater intake, thus making the old generator room ready for demolition and remodel to warehousing space.

iv. **Haz Mat Relocation:** Some of the Haz Mat operations are presently located where the proposed waste water treatment plant will be placed. Therefore, the Haz Mat processing and office milvan “Bat Cave” and related milvans need to be relocated. The Haz Mat operations will all be consolidated at the old helicopter pad, as discussed earlier.

v. **Salt Water Toilet/Urinal Conversion:** The conversion of the plumbing fixtures from saltwater to low flush fresh water is precedent to the startup of the WWTP.

vi. **Fire Hydrants:** While this is a high priority, the proposal will require some trenching equipment to bury the HDPE lines and to set the hydrants, so it should be done while heavy equipment is on site with other construction.

vii. **Building Demolition:** There will be a fair amount of demolition as a result of the station wide upgrade. Since two buildings are identified for demolition, in addition to all of the bulk fuel tanks and pipelines, retrograde shipping can become congested if building demolition were to wait for phase three.

c. Phase Three:

i. **Waste Water Treatment Plant:** This project has environmental priority, since Palmer Station is so exposed to the public, and since a WWTP could be constructed and operated relatively easily. For these reasons, it has been placed in the phase two priority list.

ii. **Warehousing Consolidation:** The most significant aspect of the warehouse consolidation project will be the use of the space in GWR that will be vacated by the power plant and boilers. The power plant is scheduled in Phase II, so this project must follow in Phase III.

iii. **IT Expansion at Earth Station and Bio Lab:** The addition of buildings and remodels of spaces will be concurrent with related IT expansion. There will be increased pressure on the station for places to house servers, UPS equipment, switches and related equipment, as well as an IT closet on each floor. The expanded space at the Earth Station should occur in this phase or sooner.

iv. **Day Tanks & Piping:** Once the new power plant is installed, and all waste heat is in place, the two 3,000 gallon day tanks and related piping can be retired. This cannot happen before the new power plant, so this project is assigned to Phase III.

v. **Walkway Enclosure:** If found to be justified and desired, this project can go any time. Assuming all available beds will be used by the projects in Phase I and II, this project has been assigned to Phase III.

vi. **Bio Lab Remodel:** This project is assigned to Phase III because it is not viewed as essential as its precedent projects. Also, the remodel work on the third floor cannot take place until the bedrooms are vacated, and personnel move to the new berthing which may be occupied by construction workers until the major amount of the upgrades are completed. During this remodel, the make up air system serving the labs should be examined for upgrade and better controls to reduce the amount of air used during low Science needs. Additionally, activated carbon filters should be consider for the north MUA unit since that unit reportedly ingests fumes from the road adjacent to the Bio Lab, as the telehandler and other large equipment move past the intake frequently.

vii. **Sprinkler Upgrades:** A fire sprinkler contractor will be needed on station to remodel the sprinklers in the Bio Lab during that remodel. The Carpenter Shop is also recommended to receive a new wet pipe sprinkler system. It is recommended that all other sprinkler upgrades and remodels be done at the same time.

viii. **Energy Efficiency Projects:** The ECMs that were identified in the 2008 energy report are being implemented in a phased approach, as funding becomes available. Those ECMs that have not been implemented by the time phase III occurs should be implemented if they have not been overcome by events.

ix. **Metering Projects:** The addition of power meters will principally occur during the installation of the new power plant. The BTU meters would be added during the extension and rework of the waste heat system. Any meters not installed during these earlier phases should be installed by the end of Phase III.

x. **Alternate Energy Projects:** If NREL is able to identify cost effective wind generation, the turbines should be installed during this phase while heavy equipment is still available on station, since a crane will be needed.

xi. **Multi-purpose Room Addition:** This project is not a priority, but is an amenity that would be appreciated and used by the community as a morale booster. It is included in Phase III to recognize that the primary function of the Station is to conduct science, but quality of life on Station is also a consideration.

References:

1. *Evaluation of Wastewater Treatment Options for Palmer Station*, by AECOM, 3101 Wilson Boulevard, 4th floor, Arlington, Virginia 22201

2. *Palmer Station Facilities Assessment*, prepared by RPSC, December 2008.

3. *Resupply and Science Support of Palmer Station and the Antarctica Peninsula Region,* Prepared by Martin, Ottaway, van Hemmen & Dolan, Inc., April 26, 2010

4. *Contaminated Fuel Analysis Lab Results,* DLA Energy Alaska, Fort Richardson, Alaska, Prepared by Steven Kelly, Lab Technician

5. *Fuel System Inspection Report, Appendix Q to Palmer Energy Study,* Scott Taube, RPSC, December 2008.

6. *Palmer Harbor Rock Removal Project: After Action Report,* John Wright, August 20, 1999.

7. *Palmer Dream Session,* No author shown, November, 2007

8. *Use of Commercial Wastewater Treatment Systems Designed for Marine Vessels Application Review for Use at Palmer Station*, by Art Jung, AECOM, 3101 Wilson Blvd, Suite 400, Arlington,