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ARMSTRONG LABORATORY

WASTEWATER CHARACTERIZATION SURVEY, THULE AIR BASE, GREENLAND

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Final Technical Report for Period 6-22 July 1992

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13. ABSTRACT *(Maximum 200 words)*
A wastewater characterization survey was conducted at Thule AB, Greenland, from 6-22 July 1992 by personnel from the Water Quality Function of Armstrong Laboratory. Extensive sampling of the outfall feeding into North Star Bay and industrial sites within the base cantonment area was performed.

Low levels of organic contamination were found in the wastewater. In addition, metals and other pollutants were found in concentrations typical of domestic wastewater, indicating little contamination from industrial activities. Daily flow averaged approximately 100,000 gallons per day (375 cubic meters per day).

The average chemical oxygen demand was found to be 130 milligrams per liter. The biochemical oxygen demand (BOD), though not determined experimentally during this survey, can be expected to fall within the range of 75-100 mg/l.

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The Armstrong Laboratory Water Quality Function team members would like to thank TSgt Wyvonia Bolds (12 SWS/SGB) for her excellent support given during this survey. Through her efforts we were able to obtain the vehicle, space, etc., needed to make this survey go smoothly. In addition, we would like to thank Mr. Niels Laurson from the Greenland Contractors Environmental Engineering Office (GC/EEG) for his help in obtaining the necessary reagents and deionized water and in acting as liaison with the GC maintenance personnel.

WASTEWATER CHARACTERIZATION SURVEY, THULE AIR BASE, GREENLAND

INTRODUCTION

A wastewater characterization survey was conducted at Thule Air Base (AB), Greenland, from 6-22 July 1992 by personnel of the Armstrong Laboratory Occupational and Environmental Health Directorate (AL/OE). This survey was performed by Capt Richard McCoy and A1C Keanue Byrd of the AL/OE Water Quality Function in response to a request from the 3d Space Support Wing Director of Bioenvironmental Engineering (3 SSW/SGPB) through the Air Force Space Command Bioenvironmental Engineer (AFSPACECOM/SGB) to characterize the wastewater in support of the design of a wastewater treatment plant at Thule AB (Appendix A).

DISCUSSION

Background

Thule AB, Greenland, is situated in northern Greenland approximately 950 miles south of the North Pole and 800 miles north of the Arctic Circle. The base is home to the 12th Space Warning Squadron (12 SWS), which provides warning of ballistic missile raids against the United States and Canada to the unified and specified commands, North American Air Defense (NORAD) Command and Joint Chiefs of Staff (JCS) Command Centers. In addition, Detachment 3, 2d Satellite Tracking Group monitors and tracks earth satellite vehicles in support of space surveillance operations. The base is also tasked with supporting United States, allied, and international military, scientific, and logistic operations conducted in northern Greenland.

At the time of this survey, the total base population was 897 and consisted of 110 active-duty American military personnel, 145 American civilians employed by several contractors, 571 Danish civilians, and 71 native Greenlanders employed by Greenland Contractors (GC).

Wastewater Sources, Collection, and Disposal

The wastewater generated at Thule AB is derived from domestic and industrial sources. Wastewater from the base cantonment area is collected in heated, insulated sewer pipes that are above ground. The wastewater flows in a northwesterly direction, beginning at Bldg 620 and traveling through the cantonment area to the outfall at the end of Campbell Road (adjacent to Delong Pier). The untreated wastewater is discharged directly into North Star Bay via an outfall pipe approximately 200 feet north of Bldg 984.

Septage generated from several sites not within the base cantonment area is trucked to Bldg 984 and dumped into the outfall pipe. These sites include the North Mountain Receiver site, Det 3, Satellite Tracking Station, and the South Mountain Receiver site. Small quantities of septage from the Ballistic

Missile Early Warning Station (BMEWS) are discharged directly from Bldgs 12 and 16 to ditches feeding into Wolstenholme Fjord. The discharge from these buildings is so low, however, that little, if any, septage actually reaches the fjord.

Industrial sources of wastewater at Thule AB include the Vehicle Maintenance complex, Civil Engineering maintenance, heating and power plants, hospital, photographic laboratories, fuels laboratory, and transient aircraft maintenance.

Sampling Strategy

A sampling strategy was developed to characterize the wastewater at Thule AB and is included in Appendix B. This sampling strategy was coordinated with Lieutenant Colonel Martin, HQ 3d Space Support Wing/SGB; TSgt Wyvonia Bolds, 12 SWS/SGB; and Mr. Niels Laurson, Greenland Contractors Environmental Engineering Office (GC/EEG), prior to the actual survey.

The sampling strategy that was developed included daily collection of 24-hour composite samples from the outfall to North Star Bay and [illegible] days of composite sampling at 6 other sites around the base cantonment area. The 6 sites selected were expected to show the contribution of industrial chemicals into the sewerage system by various shops at Thule AB. The samples collected from the sites were analyzed for common wastewater pollutant parameters such as chemical oxygen demand, volatile organic chemicals, metals, ammonia, cyanide, phenol, phosphorus, oils and greases, total petroleum hydrocarbons, and solids.

Due to limited manpower available at Armstrong Laboratory at the time of this survey, biochemical oxygen demand (BOD) analysis of the wastewater was not performed. Chemical oxygen demand (COD) analysis was performed and has been found to be an adequate surrogate for estimating the BOD of sewage that is predominantly from domestic sources.

During the survey, additional sampling was requested by Mr. Laurson. This included an additional site (Site 8) northwest of Bldg 580, Vehicle Maintenance, grab samples from a surface ponding area near Bldg 710 (Dormitory), and composite sampling of the discharge from Bldg 16 at the BMEWS site.

Figure B-1 shows the sewage system map for the west side of the base cantonment area. Figure B-2 shows the sewage system map for the east side of the base cantonment area. Figure B-3 shows the BMEWS sewage outfalls for Bldgs 12 and 16. Figures B-4 through B-7 are blown-up sections of the base sewage system maps showing the locations of the 8 sampling sites in the industrial areas on base. Table B-1 shows the preservation methods, U.S. Environmental Protection Agency (USEPA) methods, and holding times for the analyses performed during this survey.

Sample Collection and Shipping Procedures

Procedures used to collect samples during this survey are contained in the Air Force Occupational and Environmental Health Laboratory (AFOEHL) Recommended Sampling Procedures, March 1989 (1). These procedures generally follow guidelines established by the USEPA. Table B-1 summarizes the collection, preservation, and analytical methods for the parameters analyzed during this survey.

Wastewater samples collected as composites were typically collected over a 24-hour period as time-proportional composites (i.e., a daily composite of 24 samples collected at 1-hour intervals). The automated composite samplers used during this survey pump each hour's sample into a 2.5 gallon (10 l) glass jar. The jars were replaced with clean jars each day. Figures 1 and 2 show typical placement of the automatic samplers at Sites 2 and 8, respectively. Grab samples were taken for volatile organic chemicals, oils and greases, and total petroleum hydrocarbons. The wastewater pH and temperature were recorded daily at each site during sample collection.

The wastewater samples were then transported back to the workcenter (Hospital Morgue) for preservation and refrigeration until shipment to the analytical laboratory. All samples were shipped from Thule AB to Armstrong Laboratory via military airlift to McGuire AFB, New Jersey, and Federal Express to Brooks AFB, Texas. Due to some confusion experienced by McGuire AFB Transportation Management Office (TMO) personnel concerning the concurrent shipment of our wastewater samples and the shipment of hazardous waste samples in support of another project, half of our samples were shipped to Florida before arriving at Brooks AFB. This caused many of the samples collected during the last 5 days of the survey to exceed their recommended holding times.

Quality Assurance/Quality Control

A quality assurance/quality control (QA/QC) program was used during this survey. The program included collection of field equipment and reagent blank, spike, and duplicate samples. Per EPA protocols, 5% of the total number of field samples were collected for each type of QA/QC sample, as appropriate. For the preparation of QA/QC samples, distilled water was used for the organic chemical analyses and distilled, deionized water was used for the inorganic analyses. The deionized water was obtained for us by Mr. Laurson.

Field equipment blanks were collected for oils and greases, total petroleum hydrocarbons, and volatile organic chemicals by pumping distilled water through the Tygon tubing of a composite sampler into the appropriate sample container. Equipment blanks for metals, phenol, phosphorus, total organic carbon (TOC), COD, ammonia, cyanide, and solids were collected in a similar fashion using distilled water. Field equipment blanks serve as an indication of whether contaminants adhering to the inside of the Tygon tubing or the polyethylene strainer could be contaminating the samples.

Reagent blanks were collected for oils and greases, total petroleum hydrocarbons, phosphorus, TOC, solids, COD, metals, ammonia, cyanide, and phenol. These reagent blanks were collected by pouring deionized water into sample containers and preserving the samples with the appropriate preservative. Reagent blanks are collected to determine whether the preservative could be a source of sample contamination.

Spike samples were collected for cyanide, phenol, ammonia, and phosphorus. Spikes for metals analyses were to be performed during this survey; however, the ampules containing the metals solutions were broken en route to

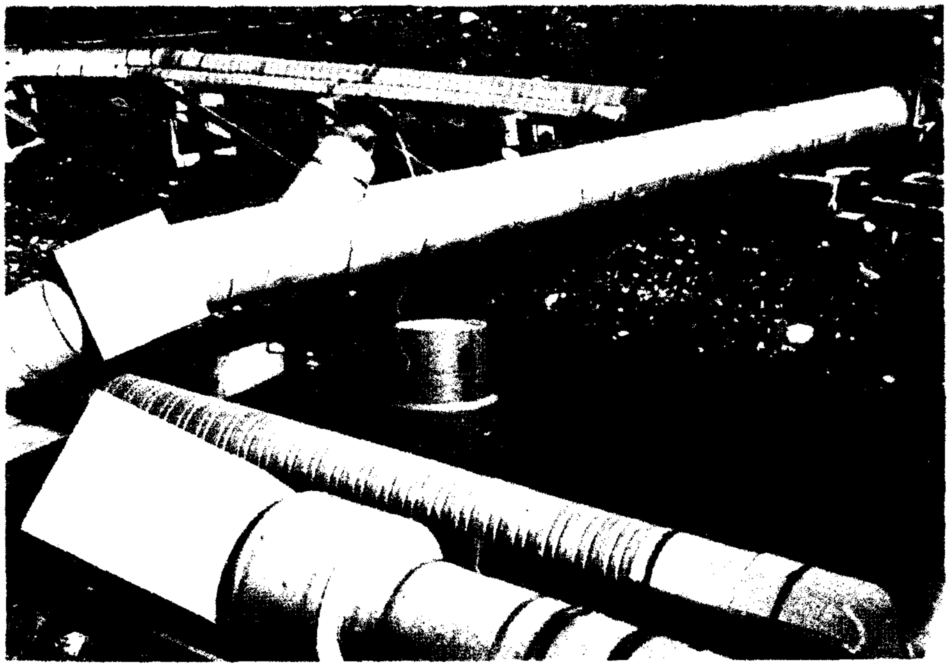

Figure 1. Automatic Sampler Operating at Site 2, Cleanout Southwest of Building 508.

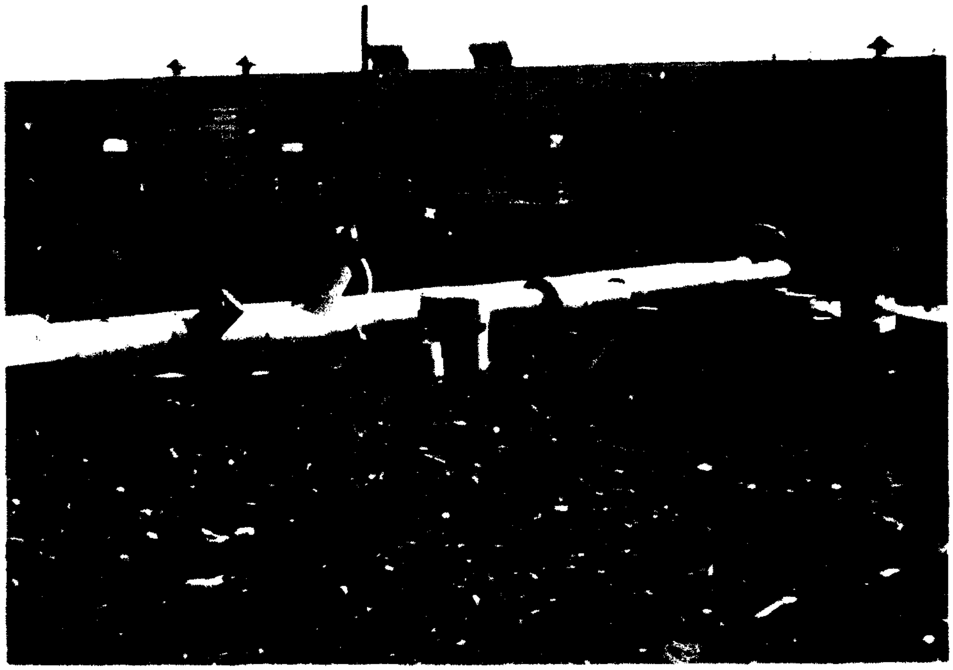

Figure 2. Automatic Sampler Operating at Site 8, Cleanout West of Motorpool.

Thule AB. Spike samples were made with 5 milliliter (ml) ampules of a commercial spike solution (Environmental Resource Associates, Arvada, Colorado) whose concentration of analytical parameters is certified. The contents of the ampules were diluted with deionized water to a final volume of 1 liter (l) using a 1-l volumetric flask. Results of the analyses were then compared to an advisory range of expected concentrations cited by the manufacturer. Results of the spike sampling indicate how closely the analytical laboratory's results approached an expected value.

Duplicate samples were collected for all analytical procedures. For composite samples, duplicates were taken from a well-stirred composite sampler collection jar. For grab samples, a clean stainless steel pitcher was used to collect the sample. The wastewater in the pitcher was well stirred before the sample was poured into the appropriate sample container.

RESULTS

General

The results discussed in this report reflect the quality of the wastewater during the period of this survey. Any changes that may have occurred to operations, shop practices, chemical usages, base population or mission, etc., will change the nature of future discharges to a wastewater treatment plant.

Flow

Flow measurements were taken at the Delong Pier outfall (Site 1) by reading a calibrated 90° V-notch weir (NB Products, New Britain, Pennsylvania). A pipe was installed by GC maintenance personnel in the trench directly downstream of a bar screen inside Bldg 984 (see Figures 3 and 4). Sandbags were positioned around the pipe to force the flow of wastewater through the pipe. This was not entirely effective in diverting the flow, and approximately 30% of the flow passed through the sandbags and around the pipe. This loss of flow was accounted for in the calculations of flow that follow. The weir was placed inside the pipe as shown in Figure 4.

Flow measurements were taken each time sampling was performed, and at 2-hour intervals from 0600 to 2200 on 10 July 1992 and from 0500 to 1700 on 17 July 1992. These flow measuring days were Wednesdays and represent midweek flows. Measurements were taken by reading the crest of the water upstream of the V-notch weir, as directed by the manufacturer's literature.

The flow measurements collected on 10 and 17 July 1992 are shown in Table 1. The shaded blocks in the table indicate the readings that were not actually taken but assumed based on the lowest flow recorded for that day. As can be seen from the table, the total estimated flow on 10 July 1992 was 87,600 gallons (331.6 cubic meters [m^3]) and on 17 July 1992 it was 105,100 gallons (397.8 m^3). Based on the installation population at the time of the survey of 897 personnel, the per capita volume of wastewater was 98 gallons per capita per day (gpcd) (370 liters per capita per day [lpcd]) on 10 July 1992, and 117 gpcd (443 lpcd) on 17 July 1992.

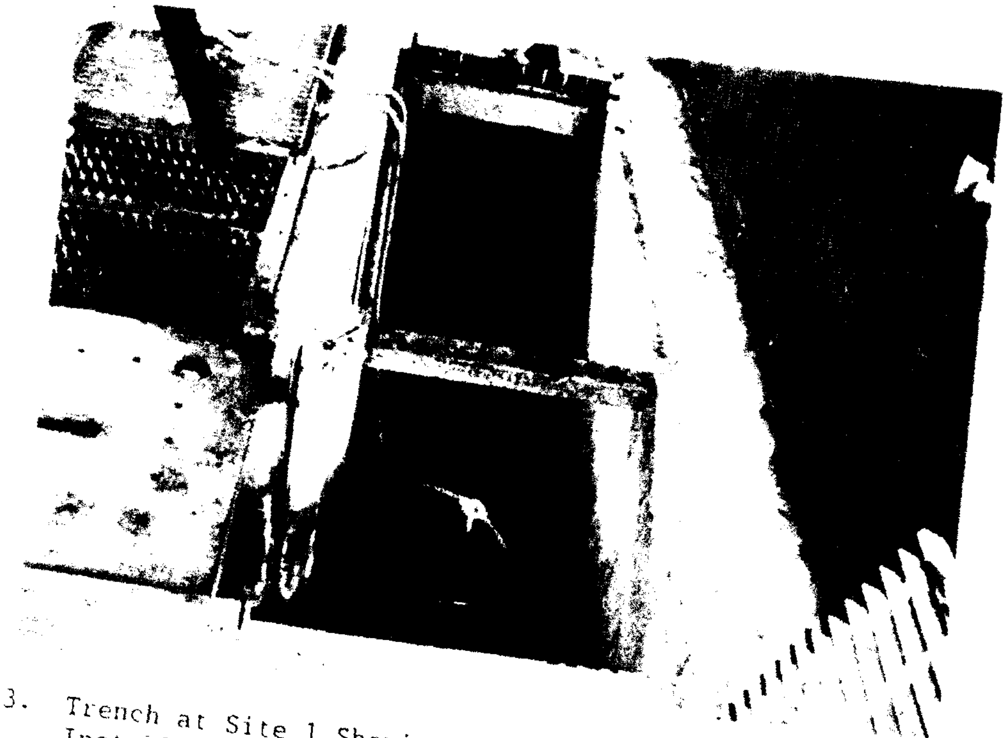

Figure 3. Trench at Site 1 Showing Channel Where Pipe was Placed for Installation of Weir.

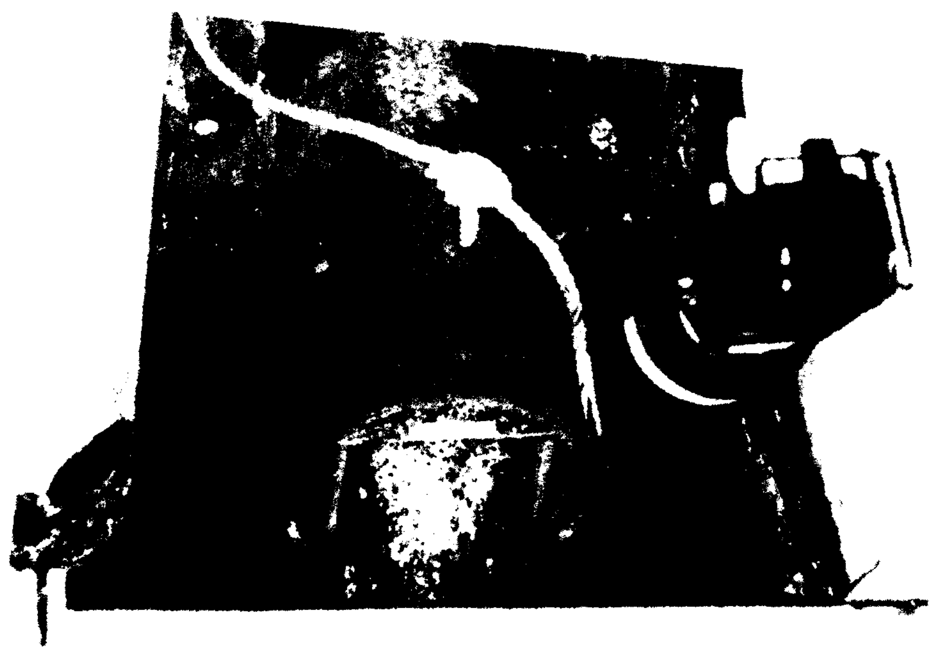

Figure 4. End of Pipe Showing Developed Flow Through Weir.

The peak instantaneous flow measurement recorded during this survey was 206,700 gallons per day (gpd [782 m^3/d]) at 0700 on 17 July 1992, while the minimum instantaneous flow measured was 60,100 gpd (227 m^3/d) measured at 2200 on 10 July 1992. Figures 5 and 6 show the diurnal patterns of wastewater flow observed during these two days of flow readings.

The flows measured during this survey are lower than the flows reported by Roy F. Weston, Inc., during their July 1984 wastewater survey (2). Weston reported a 5-day average flow of 150,200 gpd. The decrease in flow reported during this survey reflects the downsizing the base has undergone since 1984.

Table 2 shows the water consumption rates during the period of the wastewater survey. As can be seen from the table, water consumption rates on 10 and 17 July 1992 are approximately 100% higher than the wastewater flow rates for those days. Typically, municipal wastewater flow rates vary from 40-130% of water usage rates (3). The relatively high percentage rate of water consumption compared to wastewater flow indicates that a lot of the potable water used at Thule AB did not enter the sewerage system during this survey. This may be attributed to the high frequency of outdoor vehicle washing that was occurring. Potable water line leaks are not expected to have contributed much to the greater water consumption rates because the water lines are above ground and leaks are obvious to detect.

Quality Assurance/Quality Control (QA/QC) Results

Results of the QA/QC sampling are contained in Appendix C. Table C-1 shows the results of the trip blank analyses for volatile organic chemicals. As can be seen from the table, no detectable levels of volatile organics were found in the samples. However, the detection limits of the contract laboratory that performed these analyses are high, and conclusive statements about volatile organic chemical detection cannot be made.

Table C-2 shows the results of the spike sample analyses for phenol, total cyanide, ammonia, and total phosphorus. Ammonia and total phosphorus concentrations reported by Armstrong Laboratory were within the advisory range of concentrations cited by the manufacturer of the spike reagents. In addition, spike samples for phenol and cyanide collected on 18 July 1992 were within the advisory range. However, the spike concentrations reported by Armstrong Laboratory for the 16 July 1992 samples did not fall within the advisory range and indicate the laboratory had poor recoveries for these analytes on that day. This may indicate that readings reported on 16 July 1992 for phenol and total cyanide are actually higher than what is reported.

Table C-3 shows the results of the equipment and reagent blank sample analyses for metals. Equipment and reagent blanks taken on 16 and 17 July 1992 had no detectable levels of metals, and indicate that the equipment and preservatives used were not sources of sample contamination. Table C-4 shows the results of equipment and reagent blank sample analyses for other analytes. Very low levels of oil and grease were reported for the reagent blank collected on 16 July 1992 and for the equipment blank collected on 17 July 1992. In addition, a reagent blank sample analyzed for total phosphorus on 17 July 1992 had a low level of phosphorus. The equipment blank collected for solids showed some low levels of solids in the sample, which indicates the automatic sampler

Table 1. Flow Readings Taken at Deiong Pier Outfall. (All readings in gallons per day)		
Time	10 July	17 July
0500		65500
0600	92900	
0700		206700
0800	102000	
0900		191000
1000	118100	
1100		93900
1200	86900	
1300		118100
1400	118100	
1500		118100
1600	118100	
1700		205900
1800	76000	
1900		118100
2000	99000	
2100		65500
2200	60100	
2300		65500
0000	60100	
0100		65500
0200	60100	
0300		65500
0400	60100	
Avg Flow	87600	105100
Per Capita Flow (gpcd)	98	117

NOTE: Shaded blocks denote assumed flows.

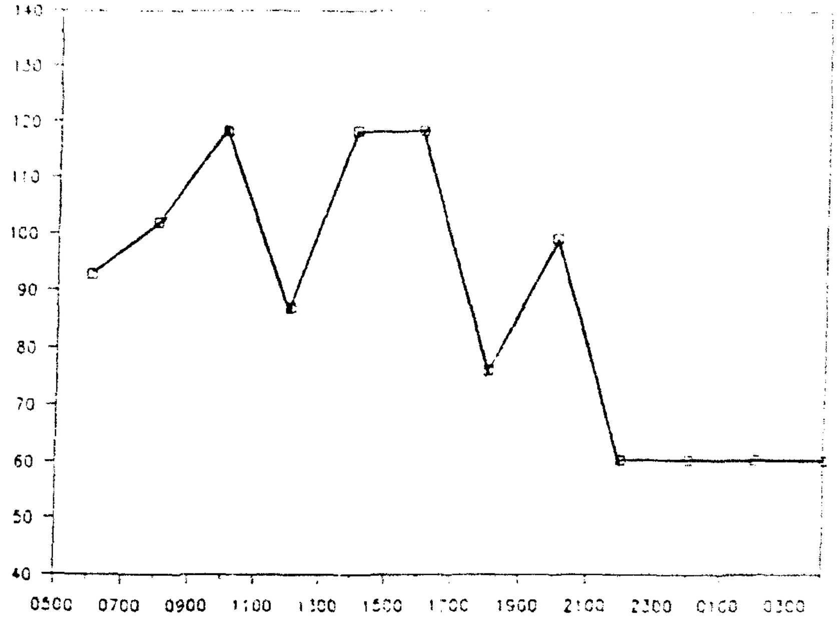

Figure 5. Wastewater Flow Readings
10 July 1992

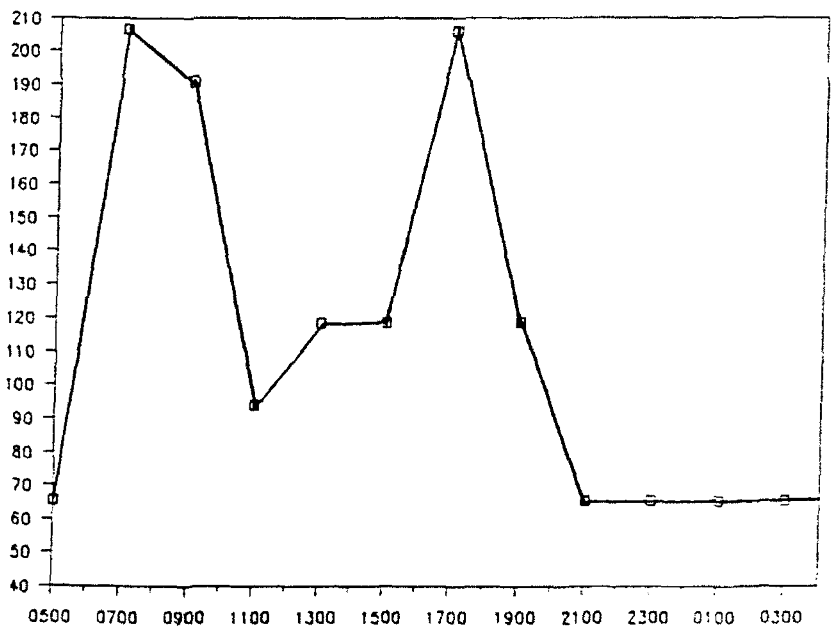

Figure 6. Wastewater Flow Readings
17 July 1992

Table 2. Water Consumption Rates During Wastewater Survey. (All readings in gallons per day)									
9 Jul	10 Jul	11 Jul	12 Jul	13 Jul	14 Jul	15 Jul	16 Jul	17 Jul	18 Jul
161162	173843	186261	147423	209246	160105	178070	197885	226155	123909

did contribute some solids to the samples, but no more than 11 mg/l total solids. Both equipment and reagent blanks analyzed for total organic carbon had low levels of organic carbon in them.

Volatile Organic Chemical Analyses Results

The results of the volatile organic chemical (VOC) sampling conducted at the 8 industrial sites are contained in Appendix D. It should be noted that all VOC samples exceeded the recommended 14-day holding time prescribed by the U.S. Environmental Protection Agency (USEPA). The holding times were exceeded because of the logistical problems of shipping the samples to Brooks AFB as stated previously. In addition, VOC samples sent to Brooks AFB at the end of the survey were transshipped to a contract laboratory due to equipment problems at Armstrong Laboratory. Biospherics, Incorporated, analyzed these samples and reported a much higher detection limit than our in-house laboratory. This higher detection limit may mask any low levels of VOCs that may have been in the water samples and makes the interpretation of sample results for samples collected during 14-18 July 1992 very difficult.

In general, the concentrations of volatile organic chemicals found in the wastewater discharged by Thule AB were found to be extremely low. Only two compounds were detected in the samples collected during this survey.

Chloroform was detected at Sites 1, 3, 5, and 6. Chloroform concentrations ranged from 0.5 micrograms per liter (µg/l) to 1.7 µg/l. Chloroform is typically found in domestic sewage in low concentrations and is usually present as a by-product of potable water disinfection.

1,4-Dichlorobenzene was found at Site 1 on the first day of sampling. The concentration was 3.2 µg/l using EPA Method 601 (3.3 µg/l using EPA Method 602). 1,4-Dichlorobenzene has also been typically found in domestic wastewater (4).

Metals Analyses Results

Results of sampling for metals is shown in Appendix E. To gauge the relative significance of the metals results, the concentrations found in the discharge from Site 1 were compared to several criteria developed by the USEPA to measure water quality. The USEPA has developed 3 types of criteria for metals in water. These include standards established by the Safe Drinking Water Act (SDWA) (5), the Water Quality Criteria for Water (6), and the National Pollution Discharge Elimination System (NPDES) Industrial Pretreatment Standards (7). It should be noted that when these standards are applied to raw wastewater, none of these criteria are currently enforceable on federal installations under current law. They are simply being applied here for the sake of comparison.

The SDWA, promulgated in 1976, authorized the USEPA to establish regulations and conduct studies concerning the safe levels of contaminants in drinking water supplies. The contaminant concentrations permitted under the SDWA represent maximum concentrations of contaminants under which it is believed that no adverse health effects will occur in the general population.

The Water Quality Criteria for Water was developed to establish water quality standards for states to adopt in their water quality programs (8). These criteria reflect the latest scientific knowledge (a) on the kind and extent of all identifiable effects on health and welfare to plankton, fish, shellfish, wildlife, plant life, shorelines, beaches, aesthetics, and recreation which may be expected from the presence of pollutants in any body of water including ground water; (b) on the concentration and dispersal of pollutants, or their by-products, through biological, chemical, or physical processes; and (c) on the effects of pollutants on biological community diversity, productivity, and stability, including information on the factors affecting rates of eutrophication and organic and inorganic sedimentation for varying types of receiving waters. These criteria are not rules and they do not have regulatory impact. Rather, these criteria present scientific data and guidance concerning the environmental effects of pollutants which can be useful to derive regulatory requirements based on considerations of water quality impacts (3). The criteria cited in this report pertain to chronic and acute exposures to marine organisms.

The NPDES Industrial Pretreatment Standards impose general prohibitions on industrial dischargers to Publicly Owned Treatment Works (POTWs) and specific prohibitions on industrial dischargers which fall into specific categories of industries (4). The industrial categories under which typical U.S. Air Force operations may fall include electroplating, metal finishing, photographic processing, and hospitals.

Table E-1 shows the criteria cited in these 3 sets of standards. The most stringent standard for each pollutant is shown in a shaded block. These are the standards that are compared to the metals results we obtained. Table E-2 shows the results of the metals analysis on the drinking water taken from a tap in the Hospital Morgue. This tap water sample was collected as a background sample. The concentration of iron in this drinking water sample exceeded the criteria level in Table E-1 and indicates that the drinking water at Thule AB is naturally corrosive and is leaching small amounts of this metal from the distribution system. The iron concentration of 690 µg/l exceeds the Safe Drinking Water Act secondary maximum contaminant level of 300 µg/l. However, secondary standards are not enforceable under the SDWA, and are established to limit contaminants which may affect the aesthetic qualities (e.g., palatability, taste, odor, etc.) and public acceptance of drinking water.

It is interesting to note the arsenic level found in the background sample was 15 µg/l. No effluent concentrations of arsenic greater than the detectable level of 10 µg/l were found; however, this may indicate the drinking water level reported in Table E-2 is erroneous. The current SDWA standard for arsenic is 50 µg/l; however, the USEPA is expected to lower that standard to 2 µg/l in 1993. In light of this new more stringent standard, resampling of the drinking water arsenic concentration seems in order to establish the true concentration of arsenic.

Table E-3 shows the results of the metals analyses for the outfall at Delong Pier. The shaded blocks show those results that were above the criteria levels listed in Table E-1. Levels of iron exceeded SDWA standards throughout the sampling period. Cadmium levels exceeded the SDWA standard on 2 days of sampling, while manganese levels exceeded the standard on 4 days of sampling. Concentrations of copper, lead, and zinc exceeded the chronic marine criteria on

7 to 10 days of sampling. Mercury exceeded the chronic marine criteria on 2 days of sampling.

Table E-4 shows the average concentration of each metal found in the discharge from Delong Pier during the 10 days of testing, along with its respective standard deviation. In addition, the mass loading of each pollutant into North Star Bay is shown. This mass loading is based on the total flow reading of 105,100 gallons recorded on 17 July 1992. Calcium, iron, magnesium, potassium, and sodium levels were the highest (by an order of magnitude over the other readings) found.

Tables E-5 through E-11 show the results of the sampling for the other 7 industrial sites. Of these 7 other sites, Site 8 appears to be discharging the most metals into the sewage system. This is expected due to the vehicle maintenance and other operations performed at the Motorpool.

Other Sampling Results

Appendix F contains the sampling results for other analyses performed during this survey. Table F-1 lists any established criteria that exist for these pollutants and the most stringent criteria level is shown in the shaded boxes.

Table F-2 shows the concentrations of other analytes discharged from the Delong Pier outfall pipe. The levels shown in shaded boxes represent concentrations above the criteria levels of Table F-1. As can be seen from the table, phosphorus levels were consistently above the chronic marine criteria level, and phenol concentrations exceeded the acute marine criteria level on 2 of the 10 days of sampling. Flow readings taken during daily sampling are also contained in Table F-2.

Table F-3 shows the average concentrations of these analytes for the Delong Pier outfall, along with their respective standard deviations. In addition, flow data from 17 July 1992 was used to calculate the mass loading of these contaminants into North Star Bay for the sampling period. The 10-day average COD was found to be 130 mg/l. The BOD of this wastewater can be expected to be between 75-100 mg/l, which indicates a low-strength domestic wastewater. By comparison, the COD found from the 5 days of sampling by Weston in 1984 was 377 mg/l (std. dev. 65 mg/l) and the measured BOD was 180 mg/l (std. dev. 22 mg/l). All other average concentrations listed in the table are typical of domestic sewage.

Tables F-4 through F-10 show the concentrations of other analytes found at the 7 other industrial sites that were sampled. It is interesting to note that at Site 5 the COD measured on 10 July 1992 was 600 mg/l. This high reading is most likely due to the Dundas Dining Hall, which is on this line. This wastestream was probably the most significant factor in the COD reading of 385 mg/l at the Delong Pier outfall on 10 July 1992.

Results of Sampling at Other Sites

BMEWS

Figure B-3 shows the sewer system diagram for the BMEWS. It should be noted that many of the buildings at this site are closed. The discharge point from Bldg 16 is shown. Figures 7 and 8 show the discharge pipe that was sampled and a view of Wolstenholme Fjord downhill from the pipe.

Results of the sampling conducted at the discharge from Bldg 16 at the BMEWS are shown in Appendix G. Table G-1 shows the concentrations of metals in the septage. Concentrations of cadmium, copper, iron, manganese, and zinc exceeded the criteria levels listed in Table E-1. However, the quantity of septage discharged from this building is very low and the impact on the fjord is expected to be minimal.

Table G-2 shows the results of volatile organic chemical analysis for the 2 days of sampling at the Bldg 16 outfall. Toluene was the only VOC detected in the two samples taken. This indicates that low levels of VOCs may be being discharged from the BMEWS. It is expected that as the wastewater travels down the ditch to the fjord, the volatile compounds would evaporate before reaching the receiving water.

Table G-3 shows the results of other sampling performed on the BMEWS discharge. Concentrations of phosphorus, total cyanide, and phenol found on both days of sampling exceeded the criteria levels cited in Table F-1. These levels are typical of wastewater. A large amount of the phosphorus that is discharged is likely to be removed by the algae and plant life in the ditch before reaching the fjord.

Dormitory 710 Spill

Table G-4 shows the results of metals and other analyses for the sewage spill that occurred near a dormitory (Bldg 710) during this survey. The water that was sampled had collected in a depression near the dormitory. The concentrations of metals found in the water were low and only iron and manganese exceeded the criteria levels contained in Table E-1. The phosphorus concentration of 2.7 mg/l also exceeded its criteria level of 0.1 mg/l. Based on these results, the spill did not create a significant environmental impact.

Oily Discharge at Delong Pier from Detachment 3 Septage

A grab sample of surficial water near the shore of the bay at Delong Pier was collected on 17 July 1992 after septage was dumped there from Det 3. This sampling was conducted for oils and grease and total petroleum hydrocarbons because a significant grease slick was evident in the bay after the dumping. The concentration of oil and grease on the surface of the water was 248 mg/l and the total petroleum hydrocarbon level was 151.2 mg/l. Though the concentration of oil and grease was well below the criteria level of 26,000 mg/l, 61% of the oil and grease is from petroleum sources and not from cooking.

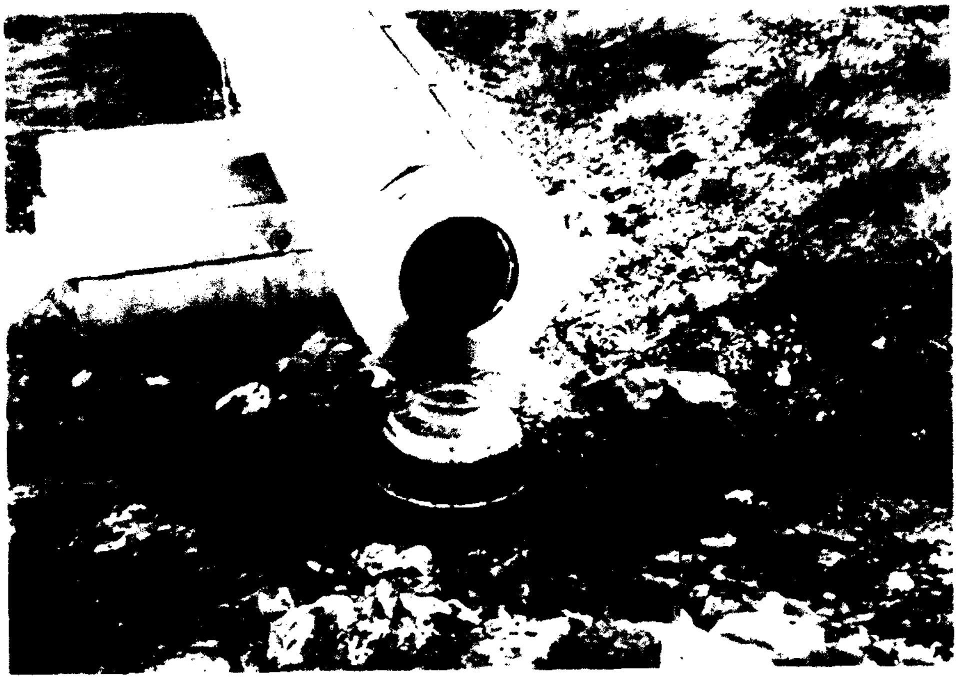

Figure 7. Discharge Sampling Point for BMEWS Building 16.

Figure 8. View of Wolstenholme Fjord from BMEWS Building 16 Discharge Point.

CONCLUSIONS AND RECOMMENDATIONS

Thule AB discharges approximately 100,000 gpd (375 m^3/d) of wastewater into North Star Bay. The peak instantaneous flow recorded during this survey was 206,700 gpd (782 m^3/d) and the minimum instantaneous flow was 60,100 gpd (227 m^3/d).

Quality assurance/quality control results were generally good and indicate no contamination due to sampling equipment or preservatives. Spike samples on 1 of 2 days of sampling showed analytical recoveries for phenol and cyanide were low.

The poor detection limits reported by the contract analytical lab for VOC samples collected after 13 July 1992 make it difficult to determine if low levels (less than 33 µg/l volatile organic halocarbons and less than 3.3 µg/l volatile organic aromatics) are being discharged. However, VOC results for 9-13 July 1992 indicate VOC concentrations in the wastewater are low, with only low levels of two disinfection by-products (chloroform and 1,4-dichlorobenzene) detected.

Iron concentrations found in the drinking water exceeded the SDWA secondary maximum contaminant level. Detectable levels of zinc and copper in the drinking water, though below current SDWA maximum contaminant levels, are indications of leaching of distribution pipe by aggressive water. Arsenic was detected at a low level (15 µg/l) in the drinking water and follow-up sampling should be performed to accurately determine the true level in the water, especially in light of the USEPA's decision to decrease the arsenic maximum contaminant level to a proposed 2 µg/l (compared to the current 50 µg/l).

Iron, copper, and zinc were found to exceed water quality criteria levels in the discharge from Delong Pier. Calcium, iron, magnesium, potassium, and sodium were found to contribute the most loading by metals into North Star Bay.

The average COD being discharged from Delong Pier was found to be 130 mg/l. The BOD can be expected to be between 75-100 mg/l. All other pollutant concentrations measured were found to be typical of domestic sewage.

Overall, the loading placed on North Star Bay by the wastewater discharged by Thule AB is low, and is not expected to be causing a significant environmental impact. Roy F. Weston, Inc., reported the same conclusion in their July 1984 study (9). Some of the major findings of the Weston study are discussed here to compare with the results of the Armstrong Laboratory survey. Chemical analyses of the North Star Bay water at the outfall pipe and at stations around the outfall revealed that nitrate nitrogen was the only monitored parameter that was higher around the outfall pipe than at the other sampling stations. Orthophosphate and lead levels were found to be higher at the control station than at the outfall and could not be explained. Results of sampling for ammonia nitrogen, total Kjeldahl nitrogen, cadmium, total chromium, copper, nickel, mercury, and oils and grease at the outfall showed that the levels for these pollutants were not significantly different (at the 95% confidence level) at the outfall pipe than at other stations in North Star Bay. A study of the sediments in North Star Bay did show higher levels of oils and grease and the presence of PCBs near the outfall. Levels of metals were evenly distributed throughout North Star Bay and did not differ significantly from what might be expected in Arctic sediments free of the inputs of sewage and industrial waste.

Though little information exists on the effects of raw sewage on Arctic marine receiving waters, a study was done on the effects of eliminating sewage discharge into an Arctic lake (10). When a sewage treatment plant was installed in Sweden, the noticeable effect of the decrease in nutrient loading on the receiving lake was a reduction in the overall algal biomass in the lake of 74% and an increase in average Secchi disk readings of 60%. In addition, the predominant algae species changed after the nutrient loading to the lake changed. Though this study was of an Arctic lake and not the Arctic Ocean, the trends that were shown may be indicative of the water quality in North Star Bay. It can be expected that the algal density in the Bay is artificially high due to the nutrient addition from the sewage. The peak can be expected to occur in the summer when the days are long (and for a period of time continuous). The high concentration of algae can be expected to deplete oxygen in the bay during the dark respiration cycle. If a wastewater treatment system is built at Thule AB, some beneficial results of wastewater treatment would be a decrease in the overall algal biomass, increased depth of light penetration into the water, and a decrease in the suspended solids.

The environmental impact on Wolstenholme Fjord from discharges from the BMEWS is not expected to be significant due to the distance the wastewater must travel to reach the fjord, and the relatively low volume of discharge from the buildings.

REFERENCES

1. Air Force Occupational and Environmental Health Laboratory (AFOEHL). AFOEHL Recommended Sampling Procedures. Brooks AFB, TX: AFOEHL: March 1989.

2. Wastewater Characterization/Surface Water Quality Survey, pages 4-1 - 4-5, Roy F. Weston, Inc., West Chester, PA, May 1985.

3. Tchobanoglous, G. and Burton, F. Wastewater Engineering: Treatment, Disposal, and Reuse, Metcalfe & Eddy, Inc., 3rd Edition, page 17. New York, NY: McGraw-Hill, Inc., 1991.

4. Pooled Emission Estimation Program (PEEP), Final Report for Publicly Owned Treatment Works (POTWs), James M. Montgomery Consulting Engineers, Inc., December 1990.

5. Code of Federal Regulations, Title 40, Parts 141-143, July 1, 1992.

6. Water Quality Criteria for Water, US EPA Office of Water Regulations and Standards, Washington, DC, May 1986.

7. Code of Federal Regulations, Title 40, Part 403, July 1, 1992.

8. Clean Water Act (33 U.S.C. 1314(a)(1)), Section 304(a)(1).

9. Wastewater Characterization/Surface Water Quality Survey, pages 4-9 - 4-15, Roy F. Weston, Inc., West Chester, PA, May 1985.

10. Holmgren, Staffan. "Phytoplankton in a Polluted Subarctic Lake Before and After Nutrient Reduction." Water Research, Vol. 19, No. 1, pp. 63-71, 1985.

APPENDIX A

REQUEST LETTER

DEPARTMENT OF THE AIR FORCE

HEADQUARTERS 3D SPACE SUPPORT WING (AFSPACECOM)
PETERSON AIR FORCE BASE, COLORADO 80914-5000

REPLY TO ATTN OF: SGPB 9 Apr 92

SUBJECT: Wastewater Characterization, Thule AB, Greenland

TO: HQ AFSPACECOM/SGB
AL/OEB
IN TURN

1. Please perform a wastewater characterization study at Thule AB, Greenland as soon as possible. We were informed that a Military Construction Program (MCP) project was inserted in the FY 94 MCP for the construction of a wastewater treatment plant at Thule. The wastewater characterization is needed in order to go ahead with the design. Attached is a copy of the sewage system plans for Thule AB. Note that the sewerage system is all insulated above ground piping. The numerous cleanouts may provide sampling points.

2. Lt Col Montgomery, Capt McCoy and I discussed this project and I indicated the need for detailed wastewater flow information. I discussed this problem with the Wing engineers. Because of the difficulty in obtaining this data, we have agreed that flow data need not be obtained. We will instead estimate flow based on drinking water production/flow.

3. Please contact me at DSN 692-7721 once you have determined a schedule for the survey. It is critical that it be completed this summer.

JOSEPH E. MARTIN, Jr., Lt Col, USAF, BSC
Director, Bioenvironmental Engineering

1 Atch
2 Cys Sewerage Plans

cc: 1 SPW/XREV

1st Ind (HQ AFSPACECOM/SGB) 8 Apr 92

TO: AL/OEB

Concur. Request your timely support on this important effort.

RONALD E. HERGENRADER, LT COL, USAF, BSC
Director, Bioenvironmental Engineering
Office of the Command Surgeon

Atch As Shown

GUARDIANS OF THE HIGH FRONTIER

APPENDIX B

SAMPLING STRATEGY

DEPARTMENT OF THE AIR FORCE
ARMSTRONG LABORATORY (AFSC)
BROOKS AIR FORCE BASE, TEXAS 78235 5000

28 MAY 1992

FROM: OEBE

SUBJ: Thule AB Wastewater Characterization Survey Sampling Strategy

TO: HQ 3D SSW/SGPB

1. A sampling strategy for the Thule AB wastewater characterization survey is at Atch 1. This strategy lists the sampling locations and the parameters to be analyzed. Weirs will be installed at the sampling sites in order to measure flows. Flow readings will be collected throughout each sampling day to give us a good representation of daily variation in the flow.

2. The parameters chosen to be sampled should be adequate for use in the design of a package wastewater treatment plant. However, if you have any changes or comments concerning this sampling strategy, please do not hesitate to call me.

3. Grab and composite samples will be collected as indicated in the notes in Atch 1. Composite samples will consist of discrete samples collected at one-hour intervals over a 24-hour period. A list of the analytes measured in metals and volatile organic screens can be found at Atch 1.

4. We have coordinated the shipment of our sampling equipment with the Traffic Management Office at McGuire AFB and with TSgt Bolds at Thule AB. At this time we do not anticipate any logistical problems with the survey.

5. If there are any questions concerning this strategy, please contact me at DSN 240-3305.

Richard P. McCoy

RICHARD P. McCOY, Capt, USAF, BSC
Consultant, Water Quality Branch

2 Atchs
1. Sampling Strategy
2. List of Analytes

cy to: 12 SWS/SGB

SAMPLING STRATEGY FOR THULE AB WASTEWATER CHARACTERIZATION SURVEY

Site #	# of Days	Pipe Size	Site Description	Analyses
1	8	10"	Last sewer cleanout before discharge to Bay	COD, Volatiles, Metals, NH3, CN, Phenol, P, O&Gs, TPH Solids
2	4	8"	Cleanout SW of B508 (Line E)	COD, Volatiles, Metals, O&Gs, TPH
3	4	9"	Cleanout W of B571 (Line F)	COD, Volatiles, Metals, O&Gs, TPH
4	4	6.5"	Cleanout NW of B436 (Line A)	COD, Volatiles, Metals, O&Gs, TPH
5	4	8"	Cleanout W of B216 (Line F)	COD, Volatile., Metals, O&Gs, TPH
6	4	8"	Cleanout N of New Food Storage (Line K)	COD, Volatiles, Metals, O&Gs, TPH
7	4	8"	Cleanout NW of B517 (Line E-1)	COD, Volatiles, Metals, O&Gs, TPH

Notes: COD = Chemical Oxygen Demand (Composite)
Volatiles = EPA Methods 601 and 602 (Grab)
NH3 = Ammonia (Composite)
CN = Cyanide (Composite)
P = Phosphorus (Composite)
O&Gs = Oils and Greases (Grab)
TPH = Total Petroleum Hydrocarbons (EPA Method 418.1) (Grab)
Solids = Total Dissolved Solids, Suspended Solids, and Volatile Suspended Solids (Grab)

Atch 1

LIST OF CONTAMINANTS MEASURED IN SCREENING TESTS

Screening Test	Contaminants Analyzed
Metals	Antimony, Arsenic, Barium, Beryllium, Boron, Cadmium, Calcium, Chromium (total), Copper, Iron, Lead, Magnesium, Manganese, Mercury, Nickel, Potassium, Selenium, Silver, Sodium, Thallium, Zinc
Volatiles (EPA 601)	Bromodichloromethane, Bromoform, Bromomethane, Carbon Tetrachloride, Chlorobenzene, Chloroethane, 2-Chloroethylvinyl Chloroform, Chloromethane, Dibromochloromethane, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, dichlorodifluoromethane, 1,1-dichloroethane, 1,2-dichloroethane, 1,1-dichloroethene, trans-1,2-dichloroethene, 1,2-dichloropropane, cis-1,3-dichloropropene, methylene chloride, 1,1,2,2-tetrachloroethane, tetrachloroethylene, 1,1,1-trichloroethane, 1,1,2-trichloroethane, trichloroethylene, trichlorofluoromethane, vinyl chloride
Volatiles (EPA 602)	Benzene, Chlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, ethylbenzene, toluene

Atch 2

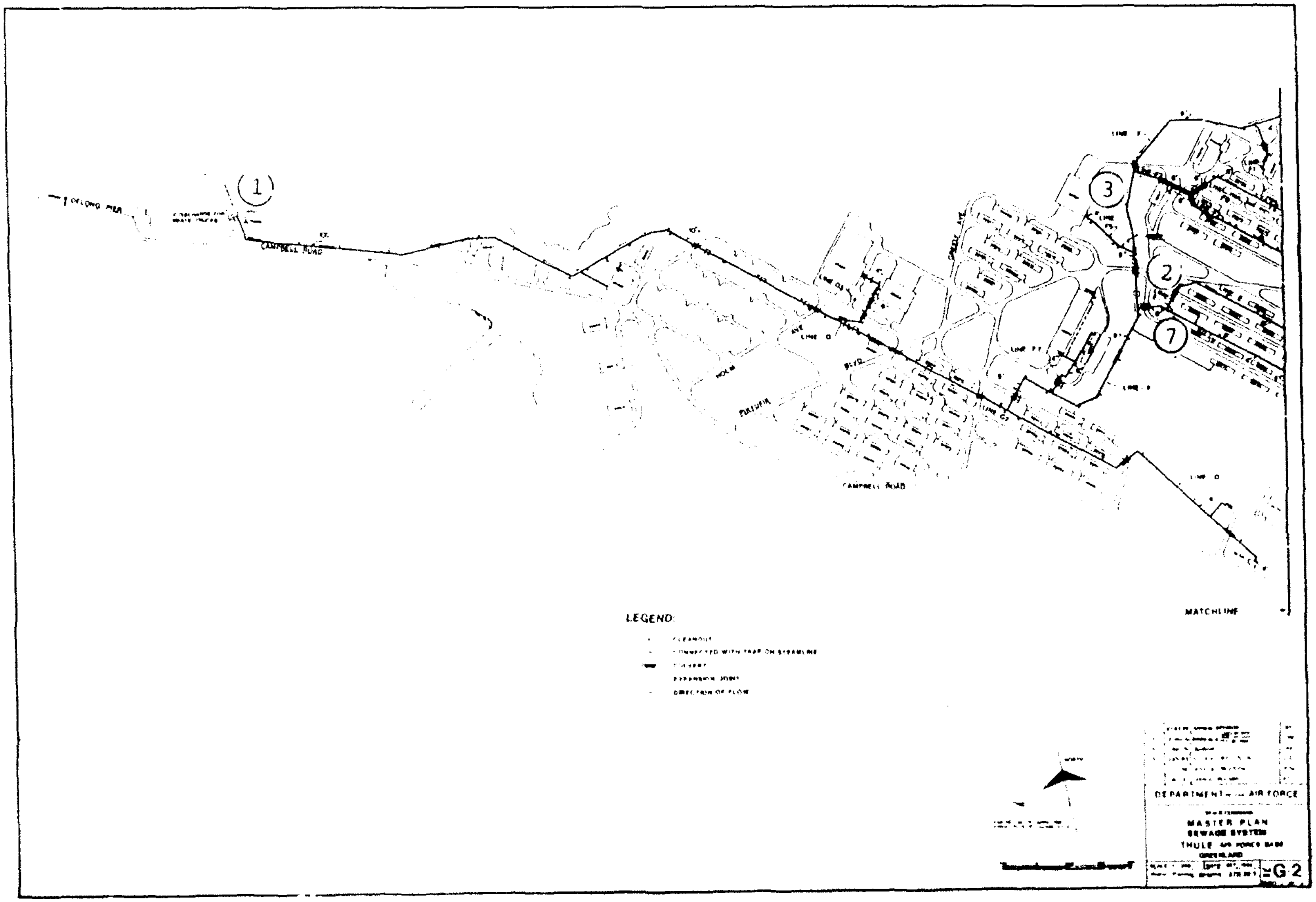

Figure B-1. Thule AB Sewage System Map Showing Sewers on West Side of Base.

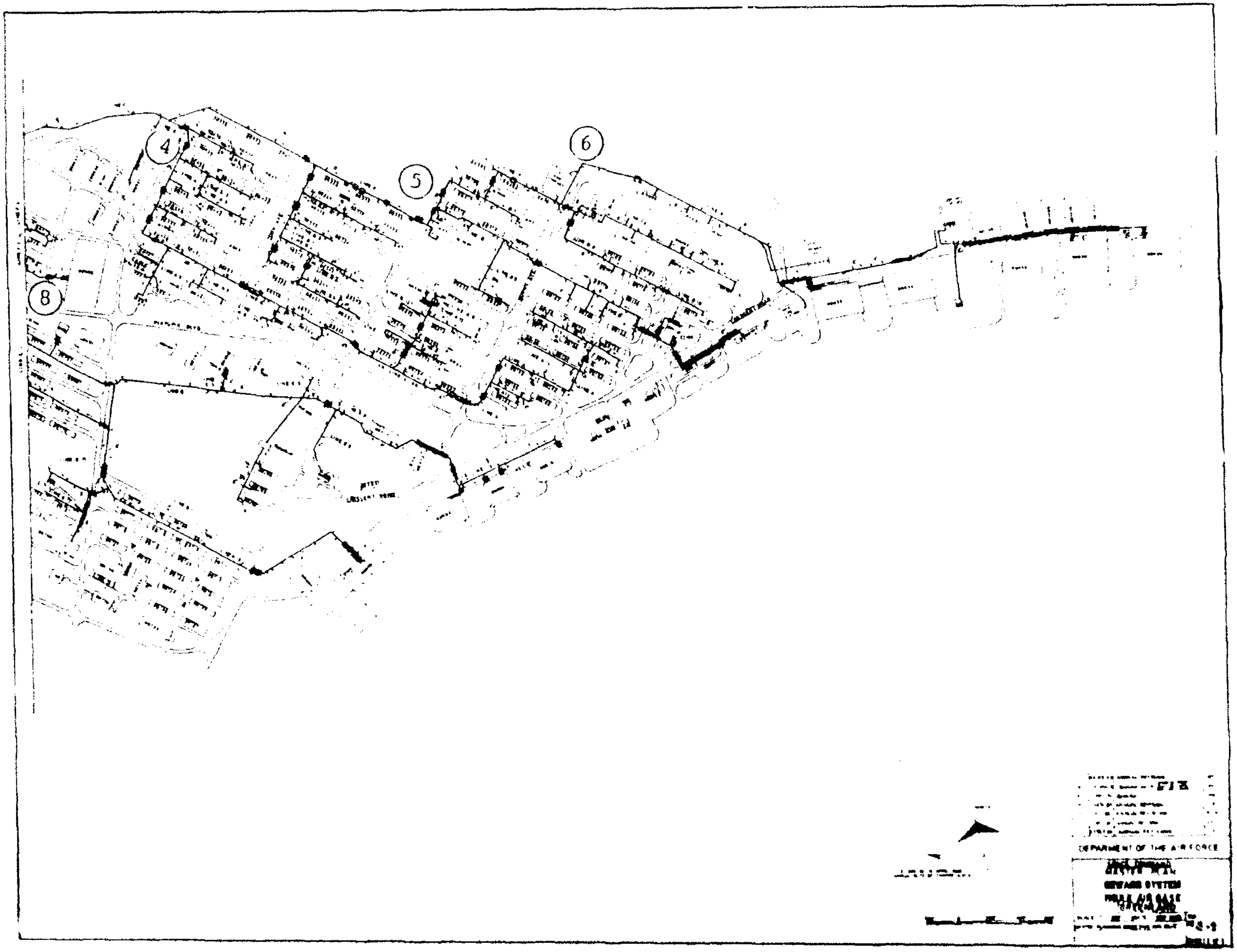

Figure B-2. Thule AB Sewage System Map Showing Sewers on East Side of Base.

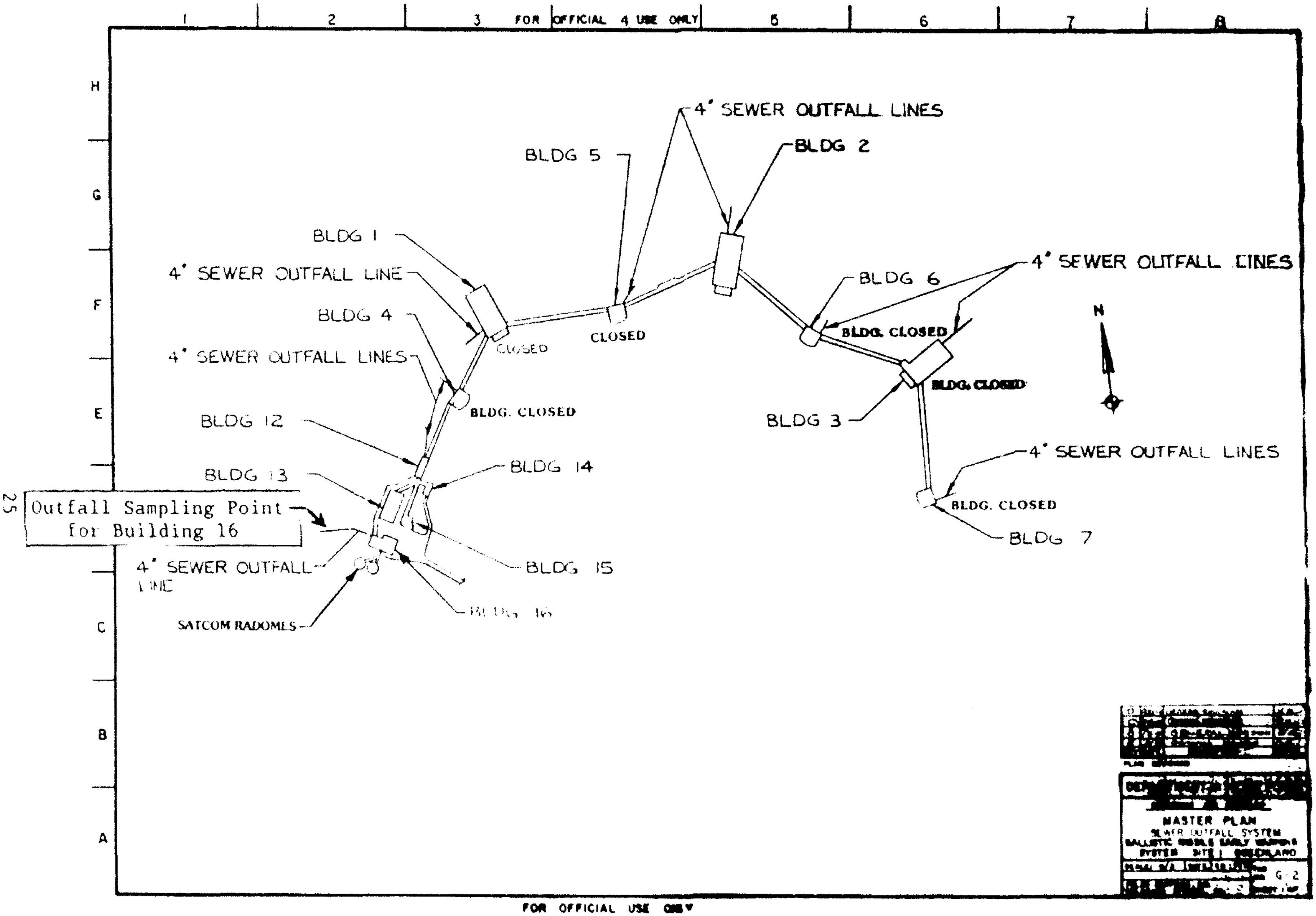

Figure B-3. Thule AB Sewage Outfall System Showing Location of BMEWS Discharge Pipe.

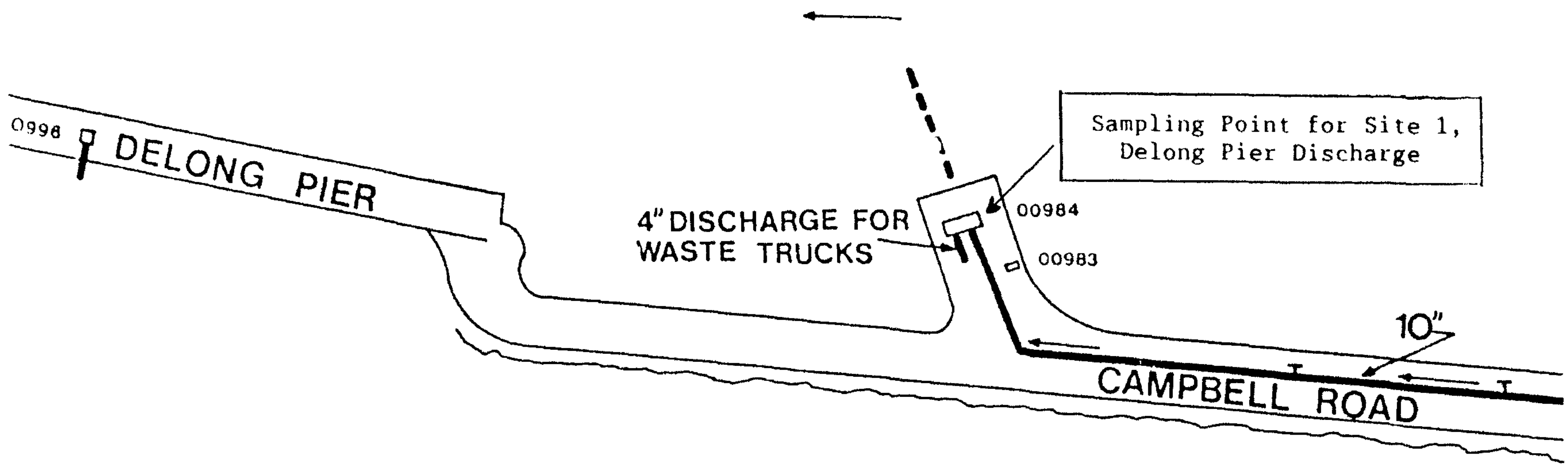

Figure B-4. Blowup of Thule AB Sewage System Map Showing Location of Site 1, Delong Pier Outfall.

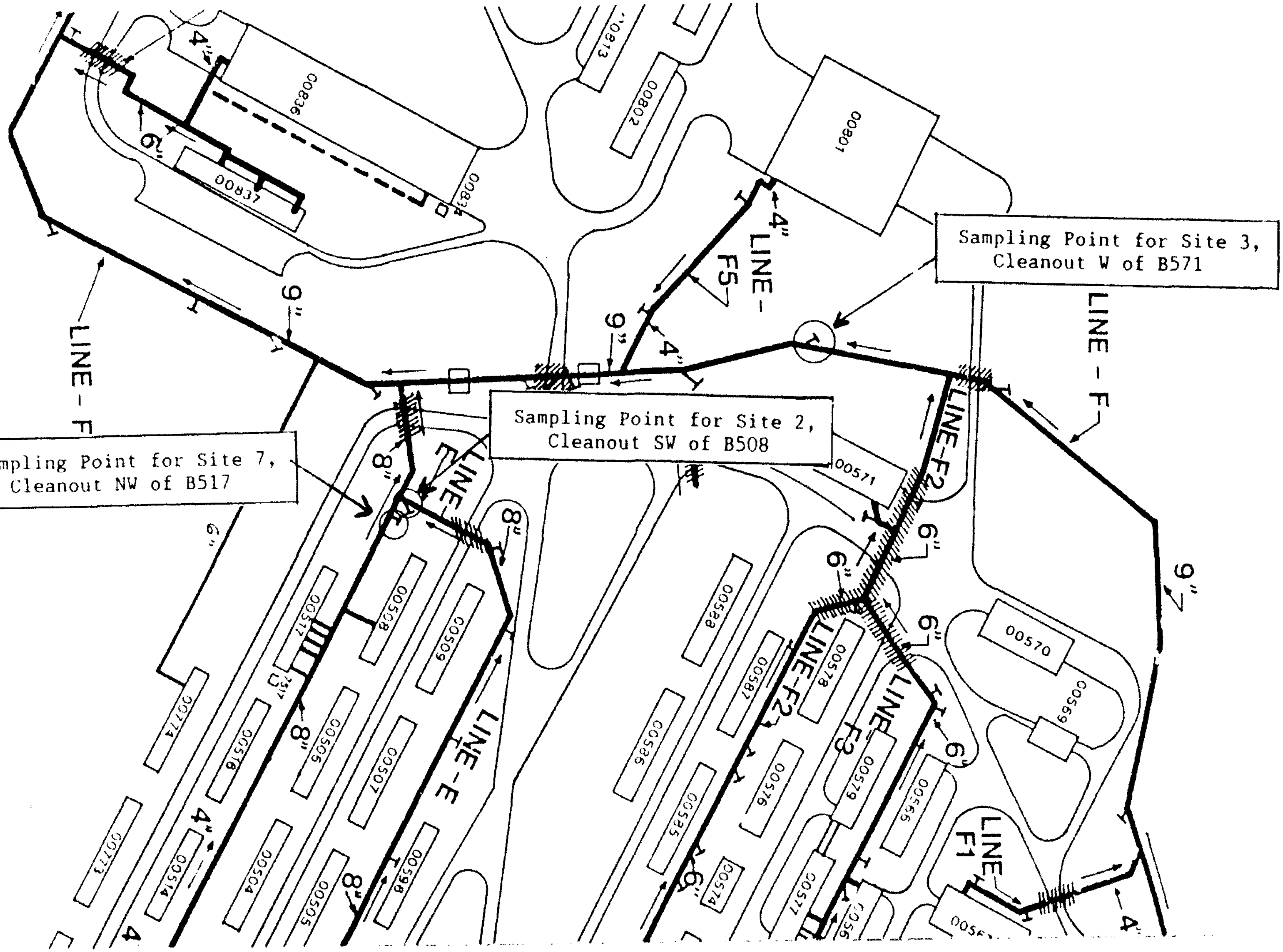

Figure B-5. Blowup of Thule AB Sewage System Map Showing Locations of Sites 2, 3, and 7.

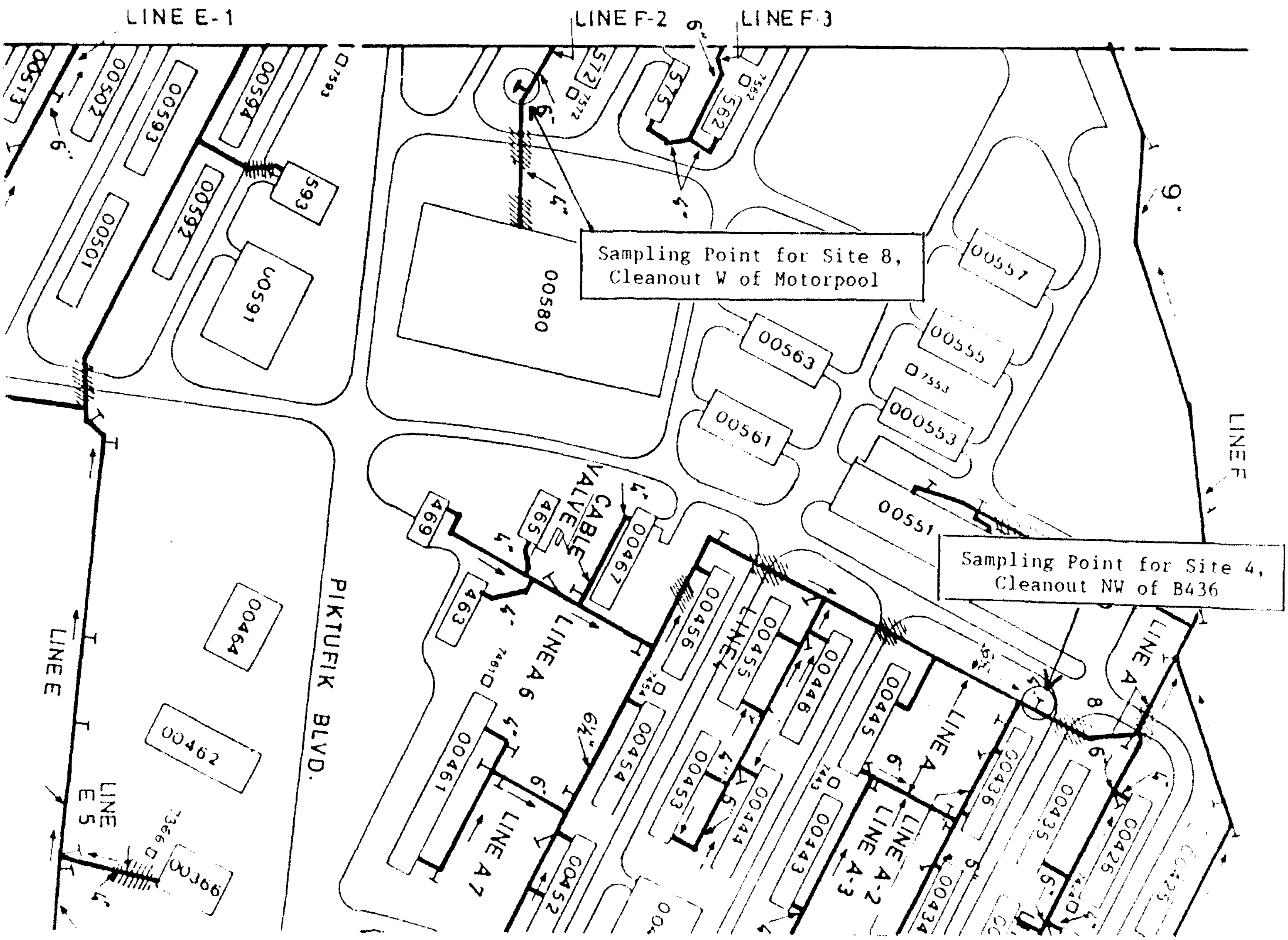

Figure B-6. Blowup of Thule AB Sewage System Map Showing Locations of Sites 4 and 8.

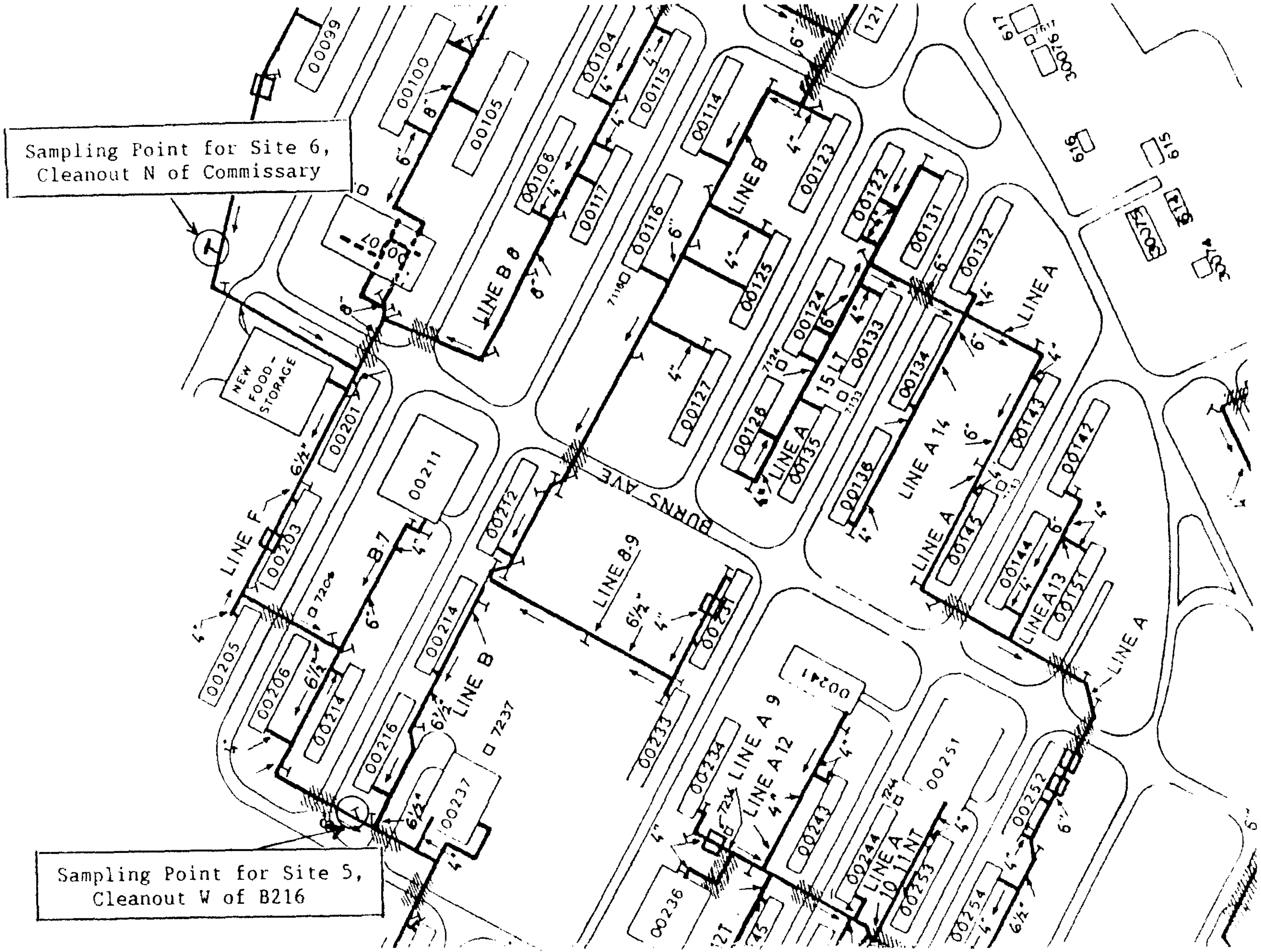

Figure B-7. Blowup of Thule AB Sewage System Map Showing Locations of Sites 5 and 6.

TABLE B-1. WASTEWATER ANALYSES AND PRESERVATION METHODS

Analysis	Preservation	EPA Method	Holding Time (days)
Purgeable Aromatics (VOAs)	4°C	602	14
Purgeable Hydrocarbons (VOHs)	4°C	601	14
Total Metals			
Arsenic	HNO_3	206.2	180
Barium	HNO_3	200.7	180
Beryllium	HNO_3	210.1	180
Boron	HNO_3	200.7	180
Cadmium	HNO_3	213.1	180
Calcium	HNO_3	215.1	180
Chromium	HNO_3	218.1	180
Chromium (VI)	HNO_3	218.1	180
Copper	HNO_3	220.1	180
Iron	HNO_3	236.1	180
Lead	HNO_3	239.1	180
Magnesium	HNO_3	242.1	180
Manganese	HNO_3	243.1	180
Mercury	HNO_3	245.1	180
Molybdenum	HNO_3	200.7	180
Nickel	HNO_3	249.1	180
Potassium	HNO_3	258.1	180
Selenium	HNO_3	270.2	180
Silver	HNO_3	272.1	180
Thallium	HNO_3	279.2	180
Zinc	HNO_3	289.1	180
Cyanide	NaOH	335.3	14
Ammonia	H_2SO_4, 4°C	350.1	28
Phenols	H_2SO_4, 4°C	420.2	28
Oils & Greases	H_2SO_4, 4°C	413.2	28
Phosphorus, Total	H_2SO_4, 4°C	365.1	28
Hydrocarbons, Total Petroleum	H_2SO_4, 4°C	418.1	28
Total Toxic Organics	4°C	624	14
Total Toxic Organics	4°C	625, 608	7

NOTES: 4°C = Chilled to 4°C
HNO_3 = Add nitric acid to pH < 2.0
H_2SO_4 = Add sulfuric acid to pH < 2.0
NaOH = Add sodium hydroxide to pH > 12.0

APPENDIX C

QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) SAMPLING RESULTS

TABLE C-1, Results of Trip Sample Analyses for Volatile Organic Chemicals

THULE AB WASTEWATER CHARACTERIZATION SURVEY

(All Concentrations in ug/l)

Volatile Organic Hydrocarbons (EPA Method 601):	16 Jul	17 Jul
Bromodichloromethane	<33	<33
Bromoform	<33	<33
Bromomethane	<33	<33
Carbon Tetrachloride	<33	<33
Chlorobenzene	<33	<33
2-Chloroethylvinyl ether	<33	<33
Chloroform	<33	<33
Chloromethane	<33	<33
Dibromochloromethane	<33	<33
1,2-Dichlorobenzene	<33	<33
1,3-Dichlorobenzene	<33	<33
1,4-Dichlorobenzene	<33	<33
Dichlorofluoromethane	<33	<33
1,1-Dichloroethane	<33	<33
1,2-Dichloroethane	<33	<33
Tetrachloroethylene	<33	<33
1,1,1-Trichloroethane	<33	<33
1,1,2-Dichloroethane	<33	<33
Tetrachloroethylene	<33	<33
Trichlorfluoromethane	<33	<33
Vinyl Chloride	<33	<33
1,1-Dichloroethane	<33	<33
trans-1,2-Dichloroethylene	<33	<33
1,2-Dichloropropane	<33	<33
cis-1,3-Dichloropropylene	<33	<33
trans-1,3-Dichloropropylene	<33	<33
Methylene Chloride	<33	<33
1,1,2,2-Tetrachloroethane	<33	<33
trans-1,3-Dichloropropane	<33	<33
Volatile Organic Aromatics (EPA Method 602):		
Benzene	<3.3	<0.33
Chlorobenzene	<3.3	<0.33
1,2-Dichlorobenzene	<3.3	<0.33
1,3-Dichlorobenzene	<3.3	<0.33
1,4-Dichlorobenzene	<3.3	<0.33
Ethylbenzene	<3.3	<0.33
Toluene	<3.3	<0.33

TABLE C-2. Results of Spike Sample Analyses for Other Analyses
THULE AB WASTEWATER CHARACTERIZATION SURVEY
6 - 21 JULY 1992

Analyte	Units	Advisory Range	16 Jul	18 Jul	18 Jul
Phenol	ug/l	260–440	**73**	300	
Cyanide (Total)	mg/l	0.21–0.37	**0.088**	0.215	
Ammonia	mg/l	5.6–7.8		7.0	7.0
Phosphorus (Total)	mg/l	10–15		11.6	11

TABLE C-3. Results of Equipment and Reagent Blank
Sample Analyses for Metals
THULE AB WASTEWATER CHARACTERIZATION SURVEY
6 - 21 JULY 1992

		Reagent Blank	Reagent Blank	Equipment Blank	Equipment Blank
		16 Jul	17 Jul	16 Jul	17 Jul
ANALYTE	UNITS:				
Antimony	ug/l	<10	<10	<10	<10
Arsenic	ug/l	<10	<10	<10	<10
Barium	ug/l	<100	<100	<100	<100
Beryllium	ug/l	<10	<10	<10	<10
Cadmium	ug/l	<5	<5	<5	<5
Calcium	mg/l	<1.0	<1.0	<1.0	<1.0
Chromium	ug/l	<50	<50	<50	<50
Copper	ug/l	<50	<50	<50	<50
Iron	ug/l	<100	<100	<100	<100
Lead	ug/l	<20	<20	<20	<20
Magnesium	mg/l	<1.0	<1.0	<1.0	<1.0
Manganese	ug/l	<50	<50	<50	<50
Mercury	ug/l	<1.0	<1.0	<1.0	<1.0
Nickel	ug/l	<50	<50	<50	<50
Potassium	mg/l	<1.0	<1.0	<1.0	<1.0
Selenium	ug/l	<10	<10	<10	<10
Silver	ug/l	<5	<5	<5	<5
Sodium	mg/l	<1.0	<1.0	<1.0	<1.0
Thallium	ug/l	<10	<10	<10	<10
Zinc	ug/l	<50	<50	<50	<50

TABLE C-4, Results of Equipment and Reagent Blank Sample Analyses for Other Analyses THULE AB WASTEWATER CHARACTERIZATION SURVEY					
		Reagent Blank 16 Jul	Reagent Blank 17 Jul	Equipment Blank 16 Jul	Equipment Blank 17 Jul
Analyte	Units				
Oil and Grease	mg/l	0.9	<0.3	<0.3	1.5
Total Petroleum Hydrocarbons	mg/l	<1.0	<1.0	<1.0	<1.0
Phenol	ug/l	<10		<10	
Cyanide (Total)	mg/l	<0.005		<0.005	
Ammonia	mg/l		<0.1	<0.1	<0.1
Phosphorus (Total)	mg/l	<0.1	0.27	<0.1	<0.1
Chemical Oxygen Demand	mg/l	<10	<10	<10	<10
Residue, Total	mg/l			11	
Residue, Filterable	mg/l			4	
Residue, Nonfilterable	mg/l			1	
Residue, Settleable	mg/l			<0.2	
Residue, Total Volatile	mg/l			3	
Total Organic Carbon	mg/l	6	BIT		5

BIT = Sample Broken in Transit

APPENDIX D

RESULTS OF VOLATILE ORGANIC ANALYSES

TABLE D-1, Results of Volatile Organic Analyses for
Site 1, Delong Pier Discharge
THULE AB WASTEWATER CHARACTERIZATION SURVEY
6 - 21 JULY 1992
(All Concentrations in ug/l)

Volatile Organic Hydrocarbons (EPA Method 601):

	9 Jul	10 Jul	11 Jul	12 Jul	13 Jul	14 Jul	15 Jul	16 Jul	17 Jul	18 Jul
Bromodichloromethane	<4	<4	<4	<4	<4	<33	<33	<33	<33	<33
Bromoform	<7	<7	<7	<7	<7	<33	<33	<33	<33	<33
Carbon Tetrachloride	<5	<5	<5	<5	<5	<33	<33	<33	<33	<33
Chlorobenzene	<3	<3	<3	<3	<3	<33	<33	<33	<33	<33
Chloroethane	<9	<9	<9	<9	<9	<33	<33	<33	<33	<33
Chloroform	1.7	0.6	0.7	0.5	0.9	<33	<33	<33	<33	<33
Chloromethane	<8	<8	<8	<8	<8	<33	<33	<33	<33	<33
Chlorodibromomethane	<5	<5	<5	<5	<5	<33	<33	<33	<33	<33
1,2-Dichlorobenzene	<5	<5	<5	<5	<5	<33	<33	<33	<33	<33
1,3-Dichlorobenzene	<5	<5	<5	<5	<5	<33	<33	<33	<33	<33
1,4-Dichlorobenzene	3.2	<5	<5	<5	<5	<33	<33	<33	<33	<33
Dichlorodifluoromethane	<5	<5	<5	<5	<5	<33	<33	<33	<33	<33
1,1-Dichloroethane	<4	<4	<4	<4	<4	<33	<33	<33	<33	<33
1,2-Dichloroethane	<3	<3	<3	<3	<3	<33	<33	<33	<33	<33
1,1-Dichloroethene	<3	<3	<3	<3	<3	<33	<33	<33	<33	<33
Trans-1,2-Dichloroethene	<5	<5	<5	<5	<5	<33	<33	<33	<33	<33
1,2-Dichloropropane	<3	<3	<3	<3	<3	<33	<33	<33	<33	<33
Cis-1,3-Dichloropropene	<5	<5	<5	<5	<5	<33	<33	<33	<33	<33
Trans-1,3-Dichloropropene	<5	<5	<5	<5	<5	<33	<33	<33	<33	<33
Methylene Chloride	<4	<4	<4	<4	<4	<33	<33	<33	<33	<33
1,1,2,2-Tetrachloroethane	<2	<2	<2	<2	<2	<33	<33	<33	<33	<33
Tetrachloroethylene	<6	<6	<6	<6	<6	<33	<33	<33	<33	<33
1,1,1-Trichloroethane	<5	<5	<5	<5	<5	<33	<33	<33	<33	<33
1,1,2-Trichloroethane	<2	<2	<2	<2	<2	<33	<33	<33	<33	<33
Trichloroethylene	<5	<5	<5	<5	<5	<33	<33	<33	<33	<33
Trichlorofluoromethane	<4	<4	<4	<4	<4	<33	<33	<33	<33	<33
Vinyl Chloride	<2	<2	<2	<2	<2	<33	<33	<33	<33	<33
2-Chloroethylvinyl Ether	<2	<2	<2	<2	<2	<33	<33	<33	<33	<33
Bromomethane	<9	<9	<9	<9	<9	<33	<33	<33	<33	<33

Volatile Organic Aromatics (EPA Method 602):

	9 Jul	10 Jul	11 Jul	12 Jul	13 Jul	14 Jul	15 Jul	16 Jul	17 Jul	18 Jul
1,3-Dichlorobenzene	<5	<5	<5	<5	<5	<0.3	<0.3	<3.3	<0.3	<0.3
1,4-Dichlorobenzene	3.3	<5	<5	<5	<5	<0.3	<0.3	<3.3	<0.3	<0.3
Ethyl Benzene	<6	<6	<6	<6	<6	<0.3	<0.3	<3.3	<0.3	<0.3
Chlorobenzene	<3	<3	<3	<3	<3	<0.3	<0.3	<3.3	<0.3	<0.3
Toluene	<3	<3	<3	<3	<3	<0.3	<0.3	<3.3	<0.3	<0.3
Benzene	<3	<3	<3	<3	<3	<0.3	<0.3	<3.3	<0.3	<0.3
1,2-Dichlorobenzene	<5	<5	<5	<5	<5	<0.3	<0.3	<3.3	<0.3	<0.3

NOTE: All samples exceeded the 14-day holding time. Samples collected on 14 - 18 July were analyzed by Biospherics Laboratory.

TABLE D-2, Results of Volatile Organic Analyses for
Site 2, Cleanout Southwest of Bldg 508
THULE AB WASTEWATER CHARACTERIZATION SURVEY
6 - 21 JULY 1992
(All Concentrations in ug/l)

Volatile Organic Hydrocarbons (EPA Method 601):

	15 Jul	16 Jul	17 Jul	18 Jul
Bromodichloromethane	<33	<33	BIT	BIT
Bromoform	<33	<33	BIT	BIT
Carbon Tetrachloride	<33	<33	BIT	BIT
Chlorobenzene	<33	<33	BIT	BIT
Chloroethane	<33	<33	BIT	BIT
Chloroform	<33	<33	BIT	BIT
Chloromethane	<33	<33	BIT	BIT
Chlorodibromomethane	<33	<33	BIT	BIT
1,2-Dichlorobenzene	<33	<33	BIT	BIT
1,3-Dichlorobenzene	<33	<33	BIT	BIT
1,4-Dichlorobenzene	<33	<33	BIT	BIT
Dichlorodifluoromethane	<33	<33	BIT	BIT
1,1-Dichloroethane	<33	<33	BIT	BIT
1,2-Dichloroethane	<33	<33	BIT	BIT
1,1-Dichloroethene	<33	<33	BIT	BIT
Trans-1,2-Dichloroethene	<33	<33	BIT	BIT
1,2-Dichloropropane	<33	<33	BIT	BIT
Cis-1,3-Dichloropropene	<33	<33	BIT	BIT
Trans-1,3-Dichloropropene	<33	<33	BIT	BIT
Methylene Chloride	<33	<33	BIT	BIT
1,1,2,2-Tetrachloroethane	<33	<33	BIT	BIT
Tetrachloroethylene	<33	<33	BIT	BIT
1,1,1-Trichloroethane	<33	<33	BIT	BIT
1,1,2-Trichloroethane	<33	<33	BIT	BIT
Trichloroethylene	<33	<33	BIT	BIT
Trichlorofluoromethane	<33	<33	BIT	BIT
Vinyl Chloride	<33	<33	BIT	BIT
2-Chloroethylvinyl Ether	<33	<33	BIT	BIT
Bromomethane	<33	<33	BIT	BIT

Volatile Organic Aromatics (EPA Method 602):

1,3-Dichlorobenzene	<0.3	<3.3	BIT	BIT
1,4-Dichlorobenzene	<0.3	<3.3	BIT	BIT
Ethyl Benzene	<0.3	<3.3	BIT	BIT
Chlorobenzene	<0.3	<3.3	BIT	BIT
Toluene	<0.3	<3.3	BIT	BIT
Benzene	<0.3	<3.3	BIT	BIT
1,2-Dichlorobenzene	<0.3	<3.3	BIT	BIT

Samples analyzed by Biospherics Laboratory
All samples exceeded 14-day holding time.
BIT = Sample Broken in Transit.

TABLE D-3. Results of Volatile Organic Analyses for
Site 3. Cleanout West of Bldg 571
THULE AB WASTEWATER CHARACTERIZATION SURVEY
6 - 21 JULY 1992
(All Concentrations in ug/l)

Volatile Organic Hydrocarbons (EPA Method 601):	9 Jul	10 Jul	11 Jul	12 Jul
Bromodichloromethane	<4	<4	<4	<4
Bromoform	<7	<7	<7	<7
Carbon Tetrachloride	<5	<5	<5	<5
Chlorobenzene	<3	<3	<3	<3
Chloroethane	<9	<9	<9	<9
Chloroform	0.5	0.9	0.9	0.8
Chloromethane	<8	<8	<8	<8
Chlorodibromomethane	<5	<5	<5	<5
1,2-Dichlorobenzene	<5	<5	<5	<5
1,3-Dichlorobenzene	<5	<5	<5	<5
1,4-Dichlorobenzene	<5	<5	<5	<5
Dichlorodifluoromethane	<5	<5	<5	<5
1,1-Dichloroethane	<4	<4	<4	<4
1,2-Dichloroethane	<3	<3	<3	<3
1,1-Dichloroethene	<3	<3	<3	<3
Trans-1,2-Dichloroethene	<5	<5	<5	<5
1,2-Dichloropropane	<3	<3	<3	<3
Cis-1,3-Dichloropropene	<5	<5	<5	<5
Trans-1,3-Dichloropropene	<5	<5	<5	<5
Methylene Chloride	<4	<4	<4	<4
1,1,2,2-Tetrachloroethane	<2	<2	<2	<2
Tetrachloroethylene	<6	<6	<6	<6
1,1,1-Trichloroethane	<5	<5	<5	<5
1,1,2-Trichloroethane	<2	<2	<2	<2
Trichloroethylene	<5	<5	<5	<5
Trichlorofluoromethane	<4	<4	<4	<4
Vinyl Chloride	<2	<2	<2	<2
2-Chloroethylvinyl Ether	<2	<2	<2	<2
Bromomethane	<9	<9	<9	<9
Volatile Organic Aromatics (EPA Method 602):				
1,3-Dich'orobenzene	<5	<5	<5	<5
1,4-Dichlorobenzene	<5	<5	<5	<5
Ethyl Benzene	<6	<6	<6	<6
Chlorobenzene	<3	<3	<3	<3
Toluene	<3	<3	<3	<3
Benzene	<3	<3	<3	<3
1,2-Dichlorobenzene	<5	<5	<5	<5

NOTE: All samples exceeded the 14-day holding time.

TABLE D-4, Results of Volatile Organic Analyses for
Site 4, Cleanout Northwest of Bldg 436
THULE AB WASTEWATER CHARACTERIZATION SURVEY
6 - 21 JULY 1992
(All Concentrations in ug/l)

Volatile Organic Hydrocarbons (EPA Method 601):

	15 Jul	16 Jul	17 Jul	18 Jul
Bromodichloromethane	<33	<33	<33	<33
Bromoform	<33	<33	<33	<33
Carbon Tetrachloride	<33	<33	<33	<33
Chlorobenzene	<33	<33	<33	<33
Chloroethane	<33	<33	<33	<33
Chloroform	<33	<33	<33	<33
Chloromethane	<33	<33	<33	<33
Chlorodibromomethane	<33	<33	<33	<33
1,2-Dichlorobenzene	<33	<33	<33	<33
1,3-Dichlorobenzene	<33	<33	<33	<33
1,4-Dichlorobenzene	<33	<33	<33	<33
Dichlorodifluoromethane	<33	<33	<33	<33
1,1-Dichloroethane	<33	<33	<33	<33
1,2-Dichloroethane	<33	<33	<33	<33
1,1-Dichloroethene	<33	<33	<33	<33
Trans-1,2-Dichloroethene	<33	<33	<33	<33
1,2-Dichloropropane	<33	<33	<33	<33
Cis-1,3-Dichloropropene	<33	<33	<33	<33
Trans-1,3-Dichloropropene	<33	<33	<33	<33
Methylene Chloride	<33	<33	<33	<33
1,1,2,2-Tetrachloroethane	<33	<33	<33	<33
Tetrachloroethylene	<33	<33	<33	<33
1,1,1-Trichloroethane	<33	<33	<33	<33
1,1,2-Trichloroethane	<33	<33	<33	<33
Trichloroethylene	<33	<33	<33	<33
Trichlorofluoromethane	<33	<33	<33	<33
Vinyl Chloride	<33	<33	<33	<33
2-Chloroethylvinyl Ether	<33	<33	<33	<33
Bromomethane	<33	<33	<33	<33

Volatile Organic Aromatics (EPA Method 602):

	15 Jul	16 Jul	17 Jul	18 Jul
1,3-Dichlorobenzene	<3.3	<3.3	<0.3	<0.3
1,4-Dichlorobenzene	<3.3	<3.3	<0.3	<0.3
Ethyl Benzene	<3.3	<3.3	<0.3	2
Chlorobenzene	<3.3	<3.3	<0.3	<0.3
Toluene	<3.3	<3.3	<0.3	<0.3
Benzene	<3.3	<3.3	<0.3	<0.3
1,2-Dichlorobenzene	<3.3	<3.3	<0.3	<0.3

Samples analyzed by Biospherics Laboratory.
All samples exceeded 14-day holding time.

TABLE D-5, Results of Volatile Organic Analyses for
Site 5, Cleanout West of Bldg 216
THULE AB WASTEWATER CHARACTERIZATION SURVEY
6 - 21 JULY 1992
(All Concentrations in ug/l)

Volatile Organic Hydrocarbons (EPA Method 601):	9 Jul	10 Jul	11 Jul	12 Jul
Bromodichloromethane	<4	<4	<4	<4
Bromoform	<7	<7	<7	<7
Carbon Tetrachloride	<5	<5	<5	<5
Chlorobenzene	<3	<3	<3	<3
Chloroethane	<9	<9	<9	<9
Chloroform	0.5	0.8	1.1	0.8
Chloromethane	<8	<8	<8	<8
Chlorodibromomethane	<5	<5	<5	<5
1,2-Dichlorobenzene	<5	<5	<5	<5
1,3-Dichlorobenzene	<5	<5	<5	<5
1,4-Dichlorobenzene	<5	<5	<5	<5
Dichlorodifluoromethane	<5	<5	<5	<5
1,1-Dichloroethane	<4	<4	<4	<4
1,2-Dichloroethane	<3	<3	<3	<3
1,1-Dichloroethene	<3	<3	<3	<3
Trans-1,2-Dichloroethene	<5	<5	<5	<5
1,2-Dichloropropane	<3	<3	<3	<3
Cis-1,3-Dichloropropene	<5	<5	<5	<5
Trans-1,3-Dichloropropene	<5	<5	<5	<5
Methylene Chloride	<4	<4	<4	<4
1,1,2,2-Tetrachloroethane	<2	<2	<2	<2
Tetrachloroethylene	<6	<6	<6	<6
1,1,1-Trichloroethane	<5	<5	<5	<5
1,1,2-Trichloroethane	<2	<2	<2	<2
Trichloroethylene	<5	<5	<5	<5
Trichlorofluoromethane	<4	<4	<4	<4
Vinyl Chloride	<2	<2	<2	<2
2-Chloroethylvinyl Ether	<2	<2	<2	<2
Bromomethane	<9	<9	<9	<9
Volatile Organic Aromatics (EPA Method 602):				
1,3-Dichlorobenzene	<5	<5	<5	<5
1,4-Dichlorobenzene	<5	<5	<5	<5
Ethyl Benzene	<6	<6	<6	<6
Chlorobenzene	<3	<3	<3	<3
Toluene	<3	<3	<3	<3
Benzene	<3	<3	<3	<3
1,2-Dichlorobenzene	<5	<5	<5	<5

NOTE: All samcles exceeded the 14-day holding time.

TABLE D-6, Results of Volatile Organic Analyses for
Site 6, Cleanout North of Commissary
THULE AB WASTEWATER CHARACTERIZATION SURVEY
6 - 21 JULY 1992
(All Concentrations in ug/l)

Volatile Organic Hydrocarbons (EPA Method 601):	9 Jul	10 Jul	11 Jul	12 Jul
Bromodichloromethane	<4	<4	<4	<4
Bromoform	<7	<7	<7	<7
Carbon Tetrachloride	<5	<5	<5	<5
Chlorobenzene	<3	<3	<3	<3
Chloroethane	<9	<9	<9	<9
Chloroform	0.6	<3	1.2	1.1
Chloromethane	<8	<8	<8	<8
Chlorodibromomethane	<5	<5	<5	<5
1,2-Dichlorobenzene	<5	<5	<5	<5
1,3-Dichlorobenzene	<5	<5	<5	<5
1,4-Dichlorobenzene	<5	<5	<5	<5
Dichlorodifluoromethane	<5	<5	<5	<5
1,1-Dichloroethane	<4	<4	<4	<4
1,2-Dichloroethane	<3	<3	<3	<3
1,1-Dichloroethene	<3	<3	<3	<3
Trans-1,2-Dichloroethene	<5	<5	<5	<5
1,2-Dichloropropane	<3	<3	<3	<3
Cis-1,3-Dichloropropene	<5	<5	<5	<5
Trans-1,3-Dichloropropene	<5	<5	<5	<5
Methylene Chloride	<4	<4	<4	<4
1,1,2,2-Tetrachloroethane	<2	<2	<2	<2
Tetrachloroethylene	<6	<6	<6	<6
1,1,1-Trichloroethane	<5	<5	<5	<5
1,1,2-Trichloroethane	<2	<2	<2	<2
Trichloroethylene	<5	<5	<5	<5
Trichlorofluoromethane	<4	<4	<4	<4
Vinyl Chloride	<2	<2	<2	<2
2-Chloroethylvinyl Ether	<2	<2	<2	<2
Bromomethane	<9	<9	<9	<9
Volatile Organic Aromatics (EPA Method 602):				
1,3-Dichlorobenzene	<5	<5	<5	<5
1,4-Dichlorobenzene	<5	<5	<5	<5
Ethyl Benzene	<6	<6	<6	<6
Chlorobenzene	<3	<3	<3	<3
Toluene	<3	<3	<3	<3
Benzene	<3	<3	<3	<3
1,2-Dichlorobenzene	<5	<5	<5	<5

NOTE: All samples exceeded the 14-day holding time.

TABLE D-7, Results of Volatile Organic Analyses for
Site 7, Cleanout Northwest of Bldg 517
THULE AB WASTEWATER CHARACTERIZATION SURVEY
6 - 21 JULY 1992
(All Concentrations in ug/l)

Volatile Organic Hydrocarbons (EPA Method 601):

	15 Jul	16 Jul	17 Jul	18 Jul
Bromodichloromethane	<33	<33	<33	<33
Bromoform	<33	<33	<33	<33
Carbon Tetrachloride	<33	<33	<33	<33
Chlorobenzene	<33	<33	<33	<33
Chloroethane	<33	<33	<33	<33
Chloroform	<33	<33	<33	<33
Chloromethane	<33	<33	<33	<33
Chlorodibromomethane	<33	<33	<33	<33
1,2-Dichlorobenzene	<33	<33	<33	<33
1,3-Dichlorobenzene	<33	<33	<33	<33
1,4-Dichlorobenzene	<33	<33	<33	<33
Dichlorodifluoromethane	<33	<33	<33	<33
1,1-Dichloroethane	<33	<33	<33	<33
1,2-Dichloroethane	<33	<33	<33	<33
1,1-Dichloroethene	<33	<33	<33	<33
Trans-1,2-Dichloroethene	<33	<33	<33	<33
1,2-Dichloropropane	<33	<33	<33	<33
Cis-1,3-Dichloropropene	<33	<33	<33	<33
Trans-1,3-Dichloropropene	<33	<33	<33	<33
Methylene Chloride	<33	<33	<33	<33
1,1,2,2-Tetrachloroethane	<33	<33	<33	<33
Tetrachloroethylene	<33	<33	<33	<33
1,1,1-Trichloroethane	<33	<33	<33	<33
1,1,2-Trichloroethane	<33	<33	<33	<33
Trichloroethylene	<33	<33	<33	<33
Trichlorofluoromethane	<33	<33	<33	<33
Vinyl Chloride	<33	<33	<33	<33
2-Chloroethylvinyl Ether	<33	<33	<33	<33
Bromomethane	<33	<33	<33	<33

Volatile Organic Aromatics (EPA Method 602):

1,3-Dichlorobenzene	<3.3	<3.3	<0.3	<0.3
1,4-Dichlorobenzene	<3.3	<3.3	<0.3	<0.3
Ethyl Benzene	<3.3	<3.3	<0.3	<0.3
Chlorobenzene	<3.3	<3.3	<0.3	<0.3
Toluene	<3.3	<3.3	<0.3	<0.3
Benzene	<3.3	<3.3	<0.3	<0.3
1,2-Dichlorobenzene	<3.3	<3.3	<0.3	<0.3

Samples analyzed by Biospherics Laboratory.
All samples exceeded 14-day holding time.

TABLE D-8, Results of Volatile Organic Analyses for
Site 8, Cleanout West of Motorpool
THULE AB WASTEWATER CHARACTERIZATION SURVEY
6 - 21 JULY 1992
(All Concentrations in ug/l)

Volatile Organic Hydrocarbons (EPA Method 601):

	16 Jul	17 Jul	18 Jul
Bromodichloromethane	<33	<33	<33
Bromoform	<33	<33	<33
Carbon Tetrachloride	<33	<33	<33
Chlorobenzene	<33	<33	<33
Chloroethane	<33	<33	<33
Chloroform	<33	<33	<33
Chloromethane	<33	<33	<33
Chlorodibromomethane	<33	<33	<33
1,2-Dichlorobenzene	<33	<33	<33
1,3-Dichlorobenzene	<33	<33	<33
1,4-Dichlorobenzene	<33	<33	<33
Dichlorodifluoromethane	<33	<33	<33
1,1-Dichloroethane	<33	<33	<33
1,2-Dichloroethane	<33	<33	<33
1,1-Dichloroethene	<33	<33	<33
Trans-1,2-Dichloroethene	<33	<33	<33
1,2-Dichloropropane	<33	<33	<33
Cis-1,3-Dichloropropene	<33	<33	<33
Trans-1,3-Dichloropropene	<33	<33	<33
Methylene Chloride	<33	<33	<33
1,1,2,2-Tetrachloroethane	<33	<33	<33
Tetrachloroethylene	<33	<33	<33
1,1,1-Trichloroethane	<33	<33	<33
1,1,2-Trichloroethane	<33	<33	<33
Trichloroethylene	<33	<33	<33
Trichlorofluoromethane	<33	<33	<33
Vinyl Chloride	<33	<33	<33
2-Chloroethylvinyl Ether	<33	<33	<33
Bromomethane	<33	<33	<33

Volatile Organic Aromatics (EPA Method 602):

1,3-Dichlorobenzene	<3.3	<0.3	<0.3
1,4-Dichlorobenzene	<3.3	<0.3	<0.3
Ethyl Benzene	<3.3	<0.3	<0.3
Chlorobenzene	<3.3	<0.3	<0.3
Toluene	<3.3	<0.3	<0.3
Benzene	<3.3	<0.3	<0.3
1,2-Dichlorobenzene	<3.3	<0.3	<0.3

Samples analyzed by Biospherics Laboratory.
All samples exceeded 14-day holding time.

APPENDIX E

RESULTS OF METALS ANALYSES

TABLE E-1, Water Quality Standards for Metals THULE AB WASTEWATER CHARACTERIZATION SURVEY 6 - 21 JULY 1992					
		Water Quality Criteria			
		Acute	Chronic	SDWA	Pretreatment
ANALYTE	UNITS:	Marine	Marine	Standards	Standards
Antimony	ug/l				
Arsenic	ug/l	69	36	50	
Barium	ug/l			1000	
Beryllium	ug/l				
Cadmium	ug/l	43	9.3	5	70
Calcium	mg/l				
Chromium	ug/l	10300		100	1710
Copper	ug/l	2.9	2.9	1300	2070
Iron	ug/l			300	
Lead	ug/l	140	5.6	15	400
Magnesium	mg/l				
Manganese	ug/l			50	
Mercury	ug/l	2.1	0.025	2	
Nickel	ug/l	75	8.3	100	2380
Potassium	mg/l				
Selenium	ug/l	410	54	50	
Silver	ug/l	2.3		50	240
Sodium	mg/l				
Thallium	ug/l	2130		1	
Zinc	ug/l	95	86	5000	1480

TABLE E-2, Results of Metals Analyses for
Background Drinking Water, Hospital Morgue
THULE AB WASTEWATER CHARACTERIZATION SURVEY
6 - 21 JULY 1992

ANALYTE	UNITS:	18 Jul
Antimony	ug/l	<10
Arsenic	ug/l	15
Barium	ug/l	<100
Beryllium	ug/l	<10
Cadmium	ug/l	<5
Calcium	mg/l	5
Chromium	ug/l	<50
Copper	ug/l	56
Iron	ug/l	690
Lead	ug/l	<20
Magnesium	mg/l	3
Manganese	ug/l	<50
Mercury	ug/l	<1.0
Nickel	ug/l	<50
Potassium	mg/l	1
Selenium	ug/l	10
Silver	ug/l	<5
Sodium	mg/l	5
Thallium	ug/l	<10
Zinc	ug/l	730

TABLE E-3, Results of Metals Analyses for
Site 1, Delong Pier Discharge
THULE AB WASTEWATER CHARACTERIZATION SURVEY
6 - 21 JULY 1992

ANALYTE	UNITS:	9 Jul	10 Jul	11 Jul	12 Jul	13 Jul	14 Jul	15 Jul	16 Jul	17 Jul	18 Jul
Antimony	ug/l	<10	<10	<10	<10	<10	12	<10	<10	<10	11
Arsenic	ug/l	<10	<10	<10	<10	<10	<10	<10	<10	<10	18
Barium	ug/l	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Beryllium	ug/l	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Cadmium	ug/l	**16**	1.4	1.1	<1.0	<1.0	**5.5**	<1.0	<1.0	<5	<5
Calcium	mg/l	14	20	18	10	10	20	30	25	<1.0	56
Chromium	ug/l	<50	<50	<50	<50	<50	<50	<10	<50	<50	<50
Copper	ug/l	**57**	<50	**58**	**75**	**52**	<50	**53**	**56**	**62**	**110**
Iron	ug/l	**1000**	**980**	**1000**	**610**	**820**	**1100**	**2700**	**1800**	**2400**	**4100**
Lead	ug/l	<20	<20	**28**	**31**	<20	**24**	**70**	**30**	**60**	**60**
Magnesium	mg/l	9	9	9	7	8	10	20	10	<1.0	20
Manganese	ug/l	<50	<50	<50	<50	<50	50	**82**	**59**	**660**	**140**
Mercury	ug/l	<1.0	<1.0	<1.0	<1.0	<1	**2**	<1	**1.5**	<1.0	<1.0
Nickel	ug/l	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Potassium	mg/l	7	11	8	7	8	10	10	8	<1.0	10
Selenium	ug/l	<10	<10	<10	11	<10	46	12	12	<10	43
Silver	ug/l	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Sodium	mg/l	30	40	44	55	40	280	50	50	<1.0	100
Thallium	ug/l	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Zinc	ug/l	**170**	**150**	**160**	**110**	**140**	**140**	**150**	**140**	**190**	**340**

TABLE E-4, Mass Loading of Metals Into North Star Bay THULE AB WASTEWATER CHARACTERIZATION SURVEY 6 - 21 JULY 1992					
		Average	Standard	Loading	
ANALYTE	UNITS:	Conc.	Dev.	(kg/d)	(lbs/day)
Antimony	ug/l	6.3	2.8	0.003	0.006
Arsenic	ug/l	6.3	4.1	0.003	0.006
Barium	ug/l	50	0	0.020	0.044
Beryllium	ug/l	5	0	0.002	0.004
Cadmium	ug/l	3.1	4.8	0.001	0.003
Calcium	mg/l	20.4	15.1	8.10	17.85
Chromium	ug/l	23.0	6.3	0.009	0.020
Copper	ug/l	57.3	24.1	0.023	0.050
Iron	ug/l	1651	1108	0.66	1.45
Lead	ug/l	33.3	22.4	0.013	0.029
Magnesium	mg/l	10.25	5.8	4.08	8.99
Manganese	ug/l	111.6	196.2	0.044	0.098
Mercury	ug/l	0.75	0.54	0.000	0.001
Nickel	ug/l	25	0	0.010	0.022
Potassium	mg/l	7.95	2.97	3.16	6.97
Selenium	ug/l	14.9	15.9	0.006	0.013
Silver	ug/l	2.5	0.0	0.001	0.002
Sodium	mg/l	68.95	78.10	27.43	60.48
Thallium	ug/l	5	0	0.002	0.004
Zinc	ug/l	169.0	63.7	0.067	0.148

TABLE E-5, Results of Metals Analyses for
Site 2, Cleanout Southwest of Bldg 508
THULE AB WASTEWATER CHARACTERIZATION SURVEY
6 - 21 JULY 1992

ANALYTE	UNITS:	16 Jul	17 Jul	18 Jul
Antimony	ug/l	<10	<10	<10
Arsenic	ug/l	<10	<10	<10
Barium	ug/l	<100	<100	<100
Beryllium	ug/l	<10	<10	<10
Cadmium	ug/l	<1.0	<1.0	<5
Calcium	mg/l	10	10	10
Chromium	ug/l	<50	<50	<50
Copper	ug/l	83	57	62
Iron	ug/l	3800	2900	2500
Lead	ug/l	700	514	<20
Magnesium	mg/l	10	7	10
Manganese	ug/l	<50	<50	<50
Mercury	ug/l	1.3	<1.0	<1.0
Nickel	ug/l	<50	<50	<50
Potassium	mg/l	10	6	5
Selenium	ug/l	<10	<10	<10
Silver	ug/l	<5	<5	<5
Sodium	mg/l	20	20	20
Thallium	ug/l	<10	<10	<10
Zinc	ug/l	280	180	190

TABLE E-6, Results of Metals Analyses for Site 3, Cleanout West of Bldg 571 THULE AB WASTEWATER CHARACTERIZATION SURVEY 6 - 21 JULY 1992						
ANALYTE	UNITS:	9 Jul	10 Jul	11 Jul	12 Jul	13 Jul
Antimony	ug/l	<10	<10	<10	12	<10
Arsenic	ug/l	<10	<10	<10	<10	<10
Barium	ug/l	<100	<100	<100	<100	<100
Beryllium	ug/l	<10	<10	<10	<10	<10
Cadmium	ug/l	4.3	2.2	1.2	<1.0	<5
Calcium	mg/l	14	25	16	30	10
Chromium	ug/l	<50	<50	<50	<50	<50
Copper	ug/l	<50	<50	<50	<50	62
Iron	ug/l	690	610	620	510	2500
Lead	ug/l	<20	<20	<20	<20	<20
Magnesium	mg/l	9	8	9	20	10
Manganese	ug/l	<50	<50	<50	<50	<50
Mercury	ug/l	<1.0	<1.0	<1.0	<1.0	<1.0
Nickel	ug/l	<50	<50	<50	<50	<50
Potassium	mg/l	7	8	8	10	5
Selenium	ug/l	<10	<10	<10	53	<10
Silver	ug/l	<5	<5	<5	<5	<5
Sodium	mg/l	42	40	41	260	20
Thallium	ug/l	<10	<10	<10	12	<10
Zinc	ug/l	110	130	120	110	190

TABLE E-7, Results of Metals Analyses for
Site 4, Cleanout Northwest of Bldg 436
THULE AB WASTEWATER CHARACTERIZATION SURVEY
6 - 21 JULY 1992

ANALYTE	UNITS:	16 Jul	17 Jul	18 Jul	19 Jul
Antimony	ug/l	<10	<10	<10	<10
Arsenic	ug/l	<10	<10	<10	12
Barium	ug/l	<100	<100	<100	<100
Beryllium	ug/l	<10	<10	<10	<10
Cadmium	ug/l	<1.0	<1.0	<5	<5
Calcium	mg/l	10	10	30	10
Chromium	ug/l	<50	<50	<50	<50
Copper	ug/l	57	61	<50	55
Iron	ug/l	710	780	820	570
Lead	ug/l	<20	<20	<20	<20
Magnesium	mg/l	10	7	10	10
Manganese	ug/l	<50	<50	<50	<50
Mercury	ug/l	<1.0	<1.0	<1.0	<1.0
Nickel	ug/l	<50	<50	<50	<50
Potassium	mg/l	10	10	10	10
Selenium	ug/l	<10	<10	<10	23
Silver	ug/l	<5	<5	<5	<5
Sodium	mg/l	40	40	50	60
Thallium	ug/l	<10	<10	<10	<10
Zinc	ug/l	97	120	88	86

TABLE E-8, Results of Metals Analyses for Site 5, Cleanout West of Bldg 216 THULE AB WASTEWATER CHARACTERIZATION SURVEY 6 - 21 JULY 1992					
ANALYTE	UNITS:	9 Jul	10 Jul	11 Jul	12 Jul
Antimony	ug/l	<10	<10	<10	39
Arsenic	ug/l	<10	<10	<10	<10
Barium	ug/l	<100	<100	<100	<100
Beryllium	ug/l	<10	<10	<10	<10
Cadmium	ug/l	1.4	<1.0	<1.0	3.6
Calcium	mg/l	80	55	32	50
Chromium	ug/l	<50	<50	<50	<50
Copper	ug/l	<50	80	104	94
Iron	ug/l	1300	1700	1700	1400
Lead	ug/l	<20	41	41	<20
Magnesium	mg/l	30	11	11	20
Manganese	ug/l	<50	60	51	<50
Mercury	ug/l	<1.0	<1.0	<1.0	<1.0
Nickel	ug/l	<50	<50	<50	<50
Potassium	mg/l	12	14	10	20
Selenium	ug/l	32	13	17	182
Silver	ug/l	<5	<5	<5	<5
Sodium	mg/l	130	52	70	530
Thallium	ug/l	<10	<10	<10	28
Zinc	ug/l	290	360	250	350

TABLE E-9, Results of Metals Analyses for
Site 6, Cleanout North of Commissary
THULE AB WASTEWATER CHARACTERIZATION SURVEY
6 - 21 JULY 1992

ANALYTE	UNITS:	9 Jul	10 Jul	11 Jul	12 Jul
Antimony	ug/l	15	<10	<10	22
Arsenic	ug/l	<10	<10	<10	<10
Barium	ug/l	110	<100	<100	<100
Beryllium	ug/l	<10	<10	<10	<10
Cadmium	ug/l	2.5	1.4	4	<1.0
Calcium	mg/l	80	37	39	20
Chromium	ug/l	<50	<50	<50	<50
Copper	ug/l	75	82	78	<50
Iron	ug/l	2300	1900	560	350
Lead	ug/l	<20	<20	20	<20
Magnesium	mg/l	30	10	8	20
Manganese	ug/l	74	55	<50	<50
Mercury	ug/l	<1.0	<1.0	<1.0	<1.0
Nickel	ug/l	<50	<50	<50	<50
Potassium	mg/l	5	7	8	4
Selenium	ug/l	58	<10	<10	81
Silver	ug/l	<5	<5	<5	<5
Sodium	mg/l	300	34	33	160
Thallium	ug/l	<10	<10	<10	21
Zinc	ug/l	330	410	140	160

TABLE E-10, Results of Metals Analyses for
Site 7, Cleanout Northwest of Bldg 517
THULE AB WASTEWATER CHARACTERIZATION SURVEY
6 - 21 JULY 1992

ANALYTE	UNITS:	16 Jul	17 Jul	18 Jul	19 Jul
Antimony	ug/l	<10	<10	<10	<10
Arsenic	ug/l	<10	<10	<10	<10
Barium	ug/l	<100	<100	<100	<100
Beryllium	ug/l	<10	<10	<10	<10
Cadmium	ug/l	<1.0	35	<5	<5
Calcium	mg/l	10	10	10	10
Chromium	ug/l	<50	<50	<50	68
Copper	ug/l	68	71	81	81
Iron	ug/l	4100	2000	5000	3700
Lead	ug/l	<5	<20	<20	<20
Magnesium	mg/l	10	7	10	10
Manganese	ug/l	49	<50	54	<50
Mercury	ug/l	1.4	<1.0	1.9	1.9
Nickel	ug/l	<50	<50	<50	<50
Potassium	mg/l	50	7	10	10
Selenium	ug/l	<10	<10	<10	3
Silver	ug/l	<5	<5	<5	<5
Sodium	mg/l	14	20	20	20
Thallium	ug/l	<10	<10	<10	<10
Zinc	ug/l	440	160	460	310

TABLE E-11, Results of Metals Analyses for
Site 8, Cleanout West of Motorpool
THULE AB WASTEWATER CHARACTERIZATION SURVEY
6 - 21 JULY 1992

ANALYTE	UNITS:	16 Jul	17 Jul	18 Jul
Antimony	ug/l	16	<10	45
Arsenic	ug/l	33	12	80
Barium	ug/l	200	<100	520
Beryllium	ug/l	<10	<10	<10
Cadmium	ug/l	22	8	48
Calcium	mg/l	115	40	450
Chromium	ug/l	<50	<50	<50
Copper	ug/l	200	87	450
Iron	ug/l	16000	2700	46000
Lead	ug/l	590	NP	1425
Magnesium	mg/l	50	15	130
Manganese	ug/l	350	76	820
Mercury	ug/l	<1.0	<1.0	<1.0
Nickel	ug/l	<50	<50	54
Potassium	mg/l	8	10	13
Selenium	ug/l	27	15	55
Silver	ug/l	<5	<5	<5
Sodium	mg/l	65	10	10
Thallium	ug/l	<10	<10	12
Zinc	ug/l	610	160	770

NP = Test Not Performed

APPENDIX F

RESULTS OF OTHER ANALYSES

TABLE F-1, Standards for Other Pollutants
THULE AB WASTEWATER CHARACTERIZATION SURVEY
6 - 21 JULY 1992

		Water Quality Criteria			
		Acute	Chronic	SDWA	Pretreatment
ANALYTE	UNITS:	Marine	Marine	Standards	Standards
Oils and Grease	mg/l				26,000
Total Petroleum Hydrocarbons	mg/l				
Chemical Oxygen Demand	mg/l				
Total Organic Carbon	mg/l				
Ammonia	mg/l				
Phosphorus	ug/l		0.1		
Cyanide (Total)	mg/l	0.001	0.001	200	650
Phenol	mg/l	5.8		300	
Residue (Filterable)	mg/l				
Residue (Nonfilterable)	mg/l				31,000
pH			6.5-8.5		
Temperature	deg C				60

TABLE F-2, Results of Other Analyses for
Site 1, Delong Pier Discharge
THULE AB WASTEWATER CHARACTERIZATION SURVEY
6 - 21 JULY 1992

Analyte	Units	9 Jul	10 Jul	11 Jul	12 Jul	13 Jul	14 Jul	15 Jul	16 Jul	17 Jul	18 Jul
Oil and Grease	mg/l	31.2	28	41.6	23.2	88.8	19.9	41.4	33.6	48.9	100.8
Total Petroleum Hydrocarbons	mg/l	5	4.4	3.8	16	10.1	3	8	6.1	12.9	31.7
Chemical Oxygen Demand	mg/l	265	385	80	212	68	43	<10	70	91	78
Total Organic Carbon	mg/l	62	29	31	36	46	16	25	26	30	33
Ammonia	mg/l	7.6		13.6	15.6	14.8	<0.1	15		12.6	12.6
Phosphorus	mg/l	5	4.2	4.8	4.9	2.8	3.9	5.8	5.8	4.7	TNP
Cyanide (Total)	mg/l	<0.005	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Phenol	ug/l	<10	<10	10	<10	10	<10	<10	<10	<10	<10
Boron	ug/l	1000	650	450	450	400	700	550	2200	550	550
Residue, Total	mg/l	315	336	344	353	279	888	394	393	435	758
Residue, Filterable	mg/l	204	236	222	260	216	465	228	226	65	255
Residue, Nonfilterable	mg/l	68	85	128	144	44	60	156	124	132	348
Residue, Settleable	ml/l	1.3	2.3	2.8	0 8	0.3	0.8	1.1	0.7	2.3	3.1
Residue, Total Volatile	mg/l	169	144	151	141	91	102	103	121	161	222
Time of Sampling	hours	0950	0830	0830	0848	0900	0855	0912	0800	0830	0830
pH		6.2	6.3	6.2	6.1	6.0	6.0	6.4	6.2	6.2	6.3
Temperature	deg C	20	20	15	18	18	19	21	20	18	20
Instantaneous Flow Reading	gpd	111400	102000	99000	99000	118100	118100	205800	166400	206700	152600

TNP = Test Not Performed.

TABLE F-3, Mass Loading of Other Pollutants Into North Star Bay THULE AB WASTEWATER CHARACTERIZATION SURVEY 6 - 21 JULY 1992					
		Average	Standard	Loading	
Analyte	Units	Conc.	Dev.	(kg/d)	(lbs/d)
Oil and Grease	mg/l	45.7	27.4	18.2	40.1
Total Petroleum Hydrocarbons	mg/l	10.1	8.7	4.02	8.86
Chemical Oxygen Demand	mg/l	129.7	118.9	51.59	113.8
Total Organic Carbon	mg/l	33.4	12.7	13.29	29.3
Ammonia	mg/l	11.5	5.1	4.59	10.12
Phosphorus	mg/l	4.6	0.9	1.84	4.06
Cyanide (Total)	mg/l	0.0025	0	0.001	0.0022
Phenol	ug/l	6	2.1	0.0024	0.0053
Boron	ug/l	750	537	0.298	0.658
Residue, Total	mg/l	449.5	204	178.8	394.3
Residue, Filterable	mg/l	237.7	96.8	94.6	208.5
Residue, Nonfilterable	mg/l	128.9	86	51.3	113.1
Residue, Settleable	ml/l	1.55	1	616.6	162.9
Residue, Total Volatile	mg/l	140.5	39	55.9	123.2

NOTE: Loadings for Settleable Residue are in l/d and gal/d, respectively.

TABLE F-4, Results of Other Analyses for Site 2, Cleanout Southwest of Bldg 508 THULE AB WASTEWATER CHARACTERIZATION SURVEY 6 - 21 JULY 1992					
Analyte	Units	15 Jul	16 Jul	17 Jul	18 Jul
Oil and Grease	mg/l	19.9	NST	NST	NST
Total Petroleum Hydrocarbons	mg/l	7.4	NST	NST	NST
Chemical Oxygen Demand	mg/l	31	33	55	NST
Total Organic Carbon	mg/l	15	16	23	NST
pH		6.0	6.0	6.0	6.1
Temperature	deg C	10	10	11	10

NST = No Sample Taken.

TABLE F-5, Results of Other Analyses for Site 3, Cleanout West of Bldg 571 THULE AB WASTEWATER CHARACTERIZATION SURVEY 6 - 21 JULY 1992					
Analyte	Units	9 Jul	10 Jul	11 Jul	12 Jul
Oil and Grease	mg/l	136	37.6	46.4	47.2
Total Petroleum Hydrocarbons	mg/l	89.6	4.7	3.2	32
Chemical Oxygen Demand	mg/l	83	210	1400	150
Total Organic Carbon	mg/l	32	69	67	56
pH		6.0	6.1	6.2	6.3
Temperature	deg C	11	20	18	19

TABLE F-6, Results of Other Analyses for Site 4, Cleanout Northwest of Bldg 436 THULE AB WASTEWATER CHARACTERIZATION SURVEY 6 - 21 JULY 1992					
Analyte	Units	15 Jul	16 Jul	17 Jul	18 Jul
Oil and Grease	mg/l	87.2	NST	NST	66.4
Total Petroleum Hydrocarbons	mg/l	12.8	NST	NST	9.6
Chemical Oxygen Demand	mg/l	225	130	130	480
Total Organic Carbon	mg/l	39	39	53	132
Ammonia	mg/l	NST	NST	NST	11
Chemical Oxygen Demand	mg/l	NST	NST	NST	280
Total Organic Carbon	mg/l	NST	NST	NST	64
pH		6.2	6.2	6.2	6.2
Temperature	deg C	14	15	9	9

NST = No Sample Taken.

TABLE F-7, Results of Other Analyses for Site 5, Cleanout West of Bldg 216 THULE AB WASTEWATER CHARACTERIZATION SURVEY 6 - 21 JULY 1992					
Analyte	Units	9 Jul	10 Jul	11 Jul	12 Jul
Oil and Grease	mg/l	80	98.4	60.8	94.4
Total Petroleum Hydrocarbons	mg/l	39.2	14.4	44.8	67
Chemical Oxygen Demand	mg/l	215	600	13	270
Total Organic Carbon	mg/l	50	124	106	74
pH		6.1	6.4	6.0	6.2
Temperature	deg C	18	18	18	19

TABLE F-8, Results of Other Analyses for Site 6, Cleanout North of Commissary THULE AB WASTEWATER CHARACTERIZATION SURVEY 6 - 21 JULY 1992					
Analyte	Units	9 Jul	10 Jul	11 Jul	12 Jul
Oil and Grease	mg/l	36.8	44.8	23.2	47.2
Total Petroleum Hydrocarbons	mg/l	7.2	44	8	24
Chemical Oxygen Demand	mg/l	195	68	195	130
Total Organic Carbon	mg/l	50	318	143	41
pH		6.0	6.0	6.0	6.1
Temperature	deg C	10	10	10	15

TABLE F-9, Results of Other Analyses for Site 7, Cleanout Northwest of Bldg 436 THULE AB WASTEWATER CHARACTERIZATION SURVEY 6 - 21 JULY 1992					
Analyte	Units	15 Jul	16 Jul	17 Jul	18 Jul
Oil and Grease	mg/l	16.8	NST	NST	37.1
Total Petroleum Hydrocarbons	mg/l	6.7	NST	NST	7
Chemical Oxygen Demand	mg/l	128	91	78	205
Total Organic Carbon	mg/l	21	24	34	41
pH		6.1	6.0	6.0	6.0
Temperature	deg C	20	10	10	10

NST = No Sample Taken.

TABLE F-10, Results of Other Analyses for Site 8, Cleanout West of Motorpool THULE AB WASTEWATER CHARACTERIZATION SURVEY 6 - 21 JULY 1992				
Analyte	Units	16 Jul	17 Jul	18 Jul
Oil and Grease	mg/l	1776	NST	24.5
Total Petroleum Hydrocarbons	mg/l	518.4	NST	19.9
Chemical Oxygen Demand	mg/l	100	133	720
Total Organic Carbon	mg/l	33	50	16
pH		6.7	6.0	6.0
Temperature	deg C	10	15	10

NST = No Sample Taken.

APPENDIX G

RESULTS OF SAMPLING AT OTHER SITES

TABLE G-1, Results of Metals Analyses for BMEWS
THULE AB WASTEWATER CHARACTERIZATION SURVEY
6 - 21 JULY 1992

ANALYTE	UNITS:	19 Jul	20 Jul
Antimony	ug/l	12	<10
Arsenic	ug/l	<10	10
Barium	ug/l	<100	<100
Beryllium	ug/l	<10	<10
Cadmium	ug/l	<1.0	**39**
Calcium	mg/l	20	20
Chromium	ug/l	<50	<50
Copper	ug/l	**150**	**160**
Iron	ug/l	**960**	**1200**
Lead	ug/l	<20	<20
Magnesium	mg/l	10	10
Manganese	ug/l	**77**	**69**
Mercury	ug/l	<1.0	<1.0
Nickel	ug/l	<50	<50
Potassium	mg/l	50	40
Selenium	ug/l	50	33
Silver	ug/l	<5	<5
Sodium	mg/l	70	70
Thallium	ug/l	<10	<10
Zinc	ug/l	**140**	**140**

TABLE G-2, Results of Volatile Organic Analyses for BMEWS THULE AB WASTEWATER CHARACTERIZATION SURVEY 6 - 21 JULY 1992 (All Concentrations in ug/l)		
Volatile Organic Hydrocarbons (EPA Method 601):		
	19 Jul	20 Jul
Bromodichloromethane	<33	<33
Bromoform	<33	<33
Carbon Tetrachloride	<33	<33
Chlorobenzene	<33	<33
Chloroethane	<33	<33
Chloroform	<33	<33
Chloromethane	<33	<33
Chlorodibromomethane	<33	<33
1,2-Dichlorobenzene	<33	<33
1,3-Dichlorobenzene	<33	<33
1,4-Dichlorobenzene	<33	<33
Dichlorodifluoromethane	<33	<33
1,1-Dichloroethane	<33	<33
1,2-Dichloroethane	<33	<33
1,1-Dichloroethene	<33	<33
Trans-1,2-Dichloroethene	<33	<33
1,2-Dichloropropane	<33	<33
Cis-1,3-Dichloropropene	<33	<33
Trans-1,3-Dichloropropene	<33	<33
Methylene Chloride	<33	<33
1,1,2,2-Tetrachloroethane	<33	<33
Tetrachloroethylene	<33	<33
1,1,1-Trichloroethane	<33	<33
1,1,2-Trichloroethane	<33	<33
Trichloroethylene	<33	<33
Trichlorofluoromethane	<33	<33
Vinyl Chloride	<33	<33
2-Chloroethylvinyl Ether	<33	<33
Bromomethane	<33	<33
Volatile Organic Aromatics (EPA Method 602):		
1,3-Dichlorobenzene	<0.3	<0.3
1,4-Dichlorobenzene	<0.3	<0.3
Ethyl Benzene	<0.3	<0.3
Chlorobenzene	<0.3	<0.3
Toluene	**22**	<0.3
Benzene	<0.3	<0.3
1,2-Dichlorobenzene	<0.3	<0.3

Samples analyzed by Biospherics Laboratory.
All samples exceeded 14-day holding time.

TABLE G-3, Results of Other Analyses for BMEWS THULE AB WASTEWATER CHARACTERIZATION SURVEY 6 - 21 JULY 1992			
Analyte	Units	19 Jul	20 Jul
Oil and Grease	mg/l	42.2	16.3
Total Petroleum Hydrocarbons	mg/l	18.2	6.2
Chemical Oxygen Demand	mg/l	170	148
Total Organic Carbon	mg/l	58	58
Ammonia	mg/l	108	100
Phosphorus	mg/l	14.6	11.6
Cyanide (Total)	mg/l	0.01	0.008
Phenol	ug/l	125	35
Boron	ug/l	1400	1100
Residue, Total	mg/l	541	432
Residue, Filterable	mg/l	180	300
Residue, Nonfilterable	mg/l	35	20
Residue, Settleable	ml/l	2	<0.2
Residue, Total Volatile	mg/l	220	133

TABLE G-4, Results of Analyses for Dorm 710 Spill THULE AB WASTEWATER CHARACTERIZATION SURVEY 6 - 21 JULY 1992		
ANALYTE	UNITS:	20 Jul
Antimony	ug/l	<10
Arsenic	ug/l	<10
Barium	ug/l	<100
Beryllium	ug/l	<10
Cadmium	ug/l	<5
Calcium	mg/l	60
Chromium	ug/l	<50
Copper	ug/l	<50
Iron	ug/l	1000
Lead	ug/l	<20
Magnesium	mg/l	20
Manganese	ug/l	210
Mercury	ug/l	<1.0
Nickel	ug/l	<50
Potassium	mg/l	10
Selenium	ug/l	18
Silver	ug/l	<5
Sodium	mg/l	40
Thallium	ug/l	<10
Zinc	ug/l	65
Oil and Grease	mg/l	BIT
Total Petroleum Hydrocarbons	mg/l	BIT
Chemical Oxygen Demand	mg/l	65
Total Organic Carbon	mg/l	28
Ammonia	mg/l	8.8
Phosphorus	mg/l	2.7
Cyanide (Total)	mg/l	<0.005
Phenol	ug/l	<10
Boron	ug/l	700

BIT = Sample Broken in Transit

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