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**OPERATIONS AND
MAINTENANCE MANUAL REV. 2
FRESH WATER DAM
NID ID# AK 00200
RED DOG MINE, ALASKA**

For

**TECK COMINCO ALASKA, INC.
URS JOB NO. 33757358
August 5, 2005**

**Original – September 19, 1989
Revision 1 – April 2000
Revision 2 – August 5, 2005**

August 5, 2005

Mr. Jim Swendseid
Teck Cominco Alaska, Inc.
Red Dog Operations
3105 Lakeshore Drive, Building A, Suite 101
Anchorage, Alaska 99517

**Operations and Maintenance Manual
Fresh Water Dam
NID ID# AK 00200
Red Dog Mine, Alaska
PO 1245255-S, Contract RD-2-06
URS Job No. 33757358**

Dear Mr. Swendseid:

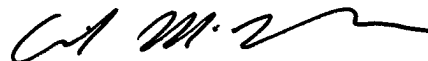
We are pleased to submit three copies of the Operations and Maintenance (O&M) Manual, Revision 2, for the Fresh Water Dam at Red Dog Mine. Revision 2 supercedes all previous versions of the manual. The dam is also known as the Water Supply Dam.

The scope of this work was authorized by Teck Cominco Alaska, Inc., in Purchase Order No. 1259053S, Contract No. RD-02-06.

We thank you for the opportunity to have been of service and we trust that the information provided will be useful in the operation of the fresh water collection and supply system. Please call if you have questions or need additional information.

Yours truly,

URS CORPORATION



Cecil M. Ulrich, P.E.
Vice President

**OPERATIONS AND MAINTENANCE MANUAL
REVISION 2**

**FRESHWATER DAM
NID ID# AK 00200**

RED DOG MINE, ALASKA

**Prepared by
URS Corporation
Century Square
1501 4th Avenue, Suite 1400
Seattle, Washington 98101-1616
Telephone: 206/438-2700**



**Prepared for
Teck Cominco Alaska Inc.
Red Dog Mine, 3105 Lakeshore Drive,
Building A, Suite 101, Anchorage, AK 99517**

August 5, 2005

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DRAWINGS

Drawing W-4 Revision 3 - Dam Plan and Profile

APPENDICES

Appendix A - Daily and Weekly/Quarterly Inspection Sheets

Appendix B - Operation and Maintenance Procedures for Thermistor Data Collection

PROJECT DATA SHEET

A. GENERAL

| | | |
|-------------------------|--|-------------------|
| Dam Name: | Red Dog Fresh Water Dam | |
| NID Number: | AK 00200 | |
| Hazard Potential Class: | Class III | |
| Purpose: | Water supply for mine, mill, offices and living quarters | |
| Year Built: | 1989 | |
| Year Modified: | Not modified | |
| Location: | N 68-04-08 W 162-52-40 | lat/long (GPS) |
| Reservoir Name: | Red Dog Fresh Water Reservoir | |
| River or Creek Name: | Bons Creek | |
| Owner: | Teck Cominco Alaska, Inc. | |
| Owner Contact: | Jim Swendseid, P.E. | |

B. DAM

| | | |
|------------------------------|--|------|
| Type: | Rockfill Embankment | |
| Core Type: | Geomembrane liner on upstream slope & in cutoff trench | |
| Crest Length: | 415 | feet |
| Crest Width: | 22 | feet |
| Crest Elevation: | 861.5 | feet |
| Crest Height (from d/s toe): | 63.0 | feet |
| Hydraulic Height: | 54.0 | feet |

C. PRIMARY SPILLWAY

| | | |
|----------------------------------|----------------|------|
| Type: | Not Applicable | |
| Location: | Not Applicable | |
| Spillway Crest Elevation: | Not Applicable | |
| Top Width: | Not Applicable | feet |
| Bottom Width: | Not Applicable | feet |
| Length: | Not Applicable | feet |
| Discharge Capacity at Dam Crest: | Not Applicable | cfs |

D. EMERGENCY SPILLWAY

| | | |
|----------------------------------|--|------|
| Type: | Open channel cut and chute to Bons Creek | |
| Location: | East abutment hillside | |
| Spillway Crest Elevation: | 852.5 | feet |
| Top Width: | 121 | feet |
| Bottom Width: | 41 | feet |
| Length: | 900 | feet |
| Discharge Capacity at Dam Crest: | 990 | cfs |

E. OUTLET WORKS

| | | |
|---------------------------|--|--------|
| Type: | Submerged pipeline and seepage gallery | |
| Location: | Sump and pump house at downstream toe of dam | |
| Inlet Invert Elevation: | 790 | feet |
| Outlet Invert Elevation: | 970 | feet |
| Diameter: | 18 | inches |
| Length: | 20,000 | feet |
| Outlet Type: | Discharge to freshwater tank in SW corner of mill area | |
| Discharge Capacity at Dam | | |
| Crest: | 1.05 | cfs |

F. RESERVOIR

| | | |
|---------------------------------|-------|-----------|
| Normal Water Surface | | |
| Elevation: | 852.5 | feet |
| Normal Storage Capacity: | 535 | acre-feet |
| Maximum Water Surface | | |
| Elevation: | 856.9 | feet |
| Maximum Storage Capacity: | 684 | acre-feet |
| Maximum Surface Area at Dam | | |
| Crest: | 47.5 | acres |
| Surface Area at Spillway Crest: | 30 | acres |

G. HYDROLOGY

| | | |
|----------------------------|-----------|-----------|
| Drainage Basin Area: | 4.57 | sq. miles |
| Average Annual Rainfall: | 17.5 | inches |
| 100 Year/24 Hour Rainfall: | 2.5 | inches |
| 100 Year Flood: | 1898 | cfs |
| Probable Maximum | | |
| Precipitation: | 5.9 | inches |
| Probable Maximum Flood: | 1438 | acre-feet |
| Flood of Record: | Not known | cfs |
| Inflow Design Flood: | 1898 | cfs |

1.0 INTRODUCTION

This Operations and Maintenance (O&M) Manual, Revision 2, provides operation and maintenance guidelines for the Red Dog fresh water dam at the Teck Cominco Alaska Inc. (TCAK) Red Dog Mine in Alaska. For clarification purposes, the fresh water dam was called the water supply dam during its design, construction, and initial operations and maintenance.

The fresh water dam is classified by Alaska Department of Natural Resources (ADNR) as a Class III (low hazard) dam as defined in Title 11 of Alaska Administrative Code (AAC) 93.157. This classification is assigned to a dam if it is determined that the failure or improper operation of the dam will result in:

- (a) limited impacts to rural or undeveloped land, rural or secondary roads, and structures;*
- (b) property losses or damage limited to the owner of the barrier; or,*
- (c) insignificant danger to public health.*

The O&M program is defined by the U.S. Bureau of Reclamation as a “*systematic means of ensuring that a dam is operated and maintained adequately for ensuring the continued safe operation of the dam and the continued productive use of the reservoir.*” This O&M Manual complies with that definition and fulfills the requirements of “Guidelines for Cooperation with the Alaska Dam Safety Program,” dated September 26, 2003.

This O&M Manual describes procedures for operating the fresh water dam under normal and extreme reservoir level and flow conditions. It also provides technical guidance and procedures for monitoring, inspection, and long-term maintenance programs. The following information is included in this manual:

- General information, including a description of the dam, its purpose and features, and identification of the parties responsible for its requirements.
- Project data sheet completed with information compiled during a Periodic Safety Inspection of the dam in October 2004.
- Schedule for routine maintenance of all aspects of the system that require attention, as well as maintenance instructions, if required
- Schedule for routine inspection and monitoring, including a site-specific visual inspection checklists and data forms.
- Description of unusual conditions that could occur and operating procedures to be performed under those conditions.

This Revision 2 of the O&M Manual supercedes previous versions of the manual. The responsibility, location and distribution of the manual at the mine site are discussed in Section 3.0.

2.0 PROJECT DESCRIPTION

Red Dog Mine is in northwestern Alaska near the southwestern end of the DeLong Mountains of the western Brooks Range. The main components of the mine are an open pit for the extraction of metal bearing ore, a milling and concentration facility, and a tailings impoundment.

The fresh water dam is located on Bons Creek, about 3.7 miles southwest of the mine. The purpose of the dam is to impound a freshwater reservoir that provides a dependable water supply for the mine, mill, offices, and living quarters. Water is pumped from the dam area to a freshwater tank at the southwest corner of the mill area. The main components of the fresh water dam are:

- Embankment dam
- Spillway
- Pumpback system.

Plan and profile views of the fresh water dam and locations of instrumentation are shown on Drawing W-4, Revision 3. This drawing is from the original design drawings, but the topography of the dam and surrounding area has not changed since then. Details of the dam are provided in the Project Data Sheet. A summary of the dam is provided in the following sections.

2.1 EMBANKMENT DAM

The fresh water dam was built in 1989. It is a rockfill embankment across Bons Creek with a maximum height of about 63 feet and crest at an elevation of 861.5 feet (El. 861.5). The dam is aligned on two chords: across the creek, and across the west abutment. The crest is about 415 feet long and 22 feet wide. The downstream slope is inclined at 2 horizontal to 1 vertical (2:1) above El. 810 and 3:1 below El. 810. The upstream slope is inclined at 3:1. The major components are:

- A rockfill dam across the creek and continuing at an angle along the west abutment.
- A 100-mil high-density polyethylene (HDPE) liner on the upstream face of the dam.
- A cutoff trench lined with HDPE below the upstream toe of the dam.
- A HDPE/concrete cutoff wall below the cutoff trench to bedrock.
- A rockfill buttress and stability berm on the upstream face to protect the HDPE liner.
- An access road across the downstream slope from the west abutment to the toe.
- Thermistor instrumentation in and around the dam.
- Seepage from the reservoir is continuously occurring through bedrock under the dam at a rate that is higher than the fresh water demand rate. Therefore, the fresh water for TCAK use is solely obtained from the seepage and not directly from the reservoir.

2.2 SPILLWAY

The spillway is a trapezoidal channel that extends around the east abutment of the dam. The channel is 800 feet long and discharges to a 60-foot high chute that drops into a stilling basin 300 feet downstream of the dam. The spillway crest is at El. 852.5, or 8 feet below the dam crest. The major components of the spillway are:

- An unlined and ungated open channel spillway in bedrock around the east abutment.
- A steep discharge chute in bedrock at the end of the spillway downstream of the dam.
- A stilling basin in bedrock at the bottom of the discharge chute downstream of the dam.
- The spillway typically discharges water between the spring runoff surge around May to about December when the tributary streams to the reservoir become frozen.

2.3 PUMPBACK SYSTEM

The water pumpback system consists of a fresh water pumpback station at the downstream toe of the dam, and an intake pump house on the east abutment just upstream of the spillway inlet. The crest and access road on the dam slope provide vehicle access to the pumpback station. The main components of the pumpback system are:

- A french drain at the fresh water pumpback station that intercepts the seepage water
- Two continually operating submersible pumps in the french drain
- An 18-inch diameter HDPE pipeline from the pumpback station up the slope of the dam
- Two emergency pumps in the intake pump house above the east abutment of the dam
- A level gage in the ditch downstream of the pumpback station.

The two submersible pumps in the fresh water pumpback station pump seepage through the HDPE pipeline to the freshwater tank in the mill area. When the automatically operated valve at the freshwater tank is closed, the pumps circulate water back to the reservoir at the intake pump house.

The two emergency pumps in the intake structure are seldom used and are not boosters for the freshwater submersible pumps. However, the two pairs of pumps are connected in parallel

3.0 RESPONSIBILITY

3.1 RESPONSIBILITY PARTY

Overall responsibility for operating, and maintaining the freshwater dam should be assigned to a member of the mine staff, referred to as the "Responsible Party" in this O&M manual. In addition,

one or more members of the mine staff should be designated as a back-up Responsible Party for when the Responsible Party is on rotational leave from the mine.

The Responsible Party must have a basic understanding of engineering principles, operation and maintenance practices, and should be experienced in operating and maintaining dams or similar structures involving water collection and supply.

Suitable administrative controls and reporting procedures should continue to be implemented by mine management to monitor and assist the activities of the Responsible Party. Any plans of other departments at the mine that relate to the freshwater facility should be discussed with the Responsible Party so that possible impacts to the dam can be considered.

The location of the official O&M manual shall be in the office of the Responsible Party. In addition the “Responsible Party” shall distribute copies of the O&M manual to other mine staff with water supply responsibilities including alternates and inspection staff.

3.2 REGULATORY REFERENCE DOCUMENTS

The Responsible Party should have available, and be familiar with, the following documents prepared by the Dam Safety and Construction Unit, Water Resources Section, Division of Mining, Land and Water, Alaska Department of Natural Resources (ADNR):

- “Revision 1 of Guidelines for Cooperation with the Alaska Dam Safety Program”, June 30, 2005, based on revisions to Alaska dam safety regulations articulated under Article 11 of most current version of AAC 93.
- “Certificate of Approval to Operate a Dam” to Cominco Alaska Inc., for Red Dog Water Supply Dam (NID ID#AK00200).

3.3 PROJECT REFERENCE DOCUMENTS

The Responsible Party should have available, and be familiar with, the following project documents, or with any superceding updates of these documents:

- Dames & Moore, “Design Report: Proposed Water Supply Dam, Red Dog Mine Development” for Cominco Alaska Inc., July 13, 1986.
- Dames & Moore “Technical Specifications – Proposed Water Supply Dam, Red Dog Mine Development for Cominco Alaska, Inc.” Revised April 11, 1988.
- Dames & Moore, “Construction Drawings for Cominco Alaska Inc., Water Supply Dam, Red Dog Project, Alaska”, Revision 2, March 1, 1989.
- Dames & Moore “Evaluation of Performance, Water Supply Dam, Red Dog Mine Project,” August 31, 1989.
- Dames & Moore “Rock Permeability and Seepage Implications, Water Supply Dam and Cutoff Trench, Red Dog Mine Project,” May 23, 1989.

- Dames & Moore “Design Rationale for Vertical Seaming of HDPE Liner, Water Supply Dam, Red Dog Mine Project,” March 8, 1989.
- Dames & Moore “Design Rationale for Spillway Channel Chute and Stilling Basin, Water Supply Dam, Red Dog Mine Project,” March 8, 1989
- Teck Cominco Alaska, Inc., “2004 Annual Instrumentation Report, Red Dog Water Supply Dam, Red Dog Mine”, to ADNR, January 10, 2005 (and all annual reports)
- URS Corporation “Periodic Safety Inspection Report, Tailings Dam, Red Dog Mine Project,” August 5, 2005.
- Water Management Consultants, “Quality Assurance Project Plan for the Hydrologic Characterization of the Tailings Impoundment, Red Dog Project”, January 1998.

4.0 ROUTINE OBSERVATION AND MAINTENANCE

This section describes the daily, weekly and quarterly inspections that are required for the freshwater dam and any actions and maintenance activities that are found to be necessary as a result of the inspection observations. The daily and weekly/quarterly inspection sheets are in Appendix A.

The inspections are to be performed without seasonal interruption. However, the spillway and dam toe areas are inaccessible for close examination during the winter because of snow. Therefore, special attention should be given to these areas during inspections immediately after breakup and just before the first major snowfall.

The inspections should focus on unusual behavior which includes the sudden development of springs, seeps, wet areas, whirlpools, cracking, sliding, slumping, deformation, erosion, rapid changes in reservoir level, unexpected melting of snow or ice, ice and slide blockages in the spillway, pipeline breaks, and similar events that are obvious deviations from normal conditions.

Another type of unusual behavior is a rise in the reservoir water level above the maximum design height of El. 856.9, which is 4.4 feet above the spillway crest and 4.6 feet below the dam crest.

4.1 DAILY INSPECTION

The dam, spillway and surrounding areas should be visually inspected daily for any unusual behavior. An “EMS Daily Dam & Pumping Inspection Sheet” is attached in Appendix A. This sheet is applicable for the freshwater dam, along with other mine dams and diversion facilities.

The duties of the mine staff responsible for the daily inspection are to fill out the “Daily Dam & Pumping Inspection Sheet” by completing the following:

- Document the temperature and general weather condition.

- Dames & Moore “Design Rationale for Vertical Seaming of HDPE Liner, Water Supply Dam, Red Dog Mine Project,” March 8, 1989.
- Dames & Moore “Design Rationale for Spillway Channel Chute and Stilling Basin, Water Supply Dam, Red Dog Mine Project,” March 8, 1989
- Teck Cominco Alaska, Inc., “2004 Annual Instrumentation Report, Red Dog Water Supply Dam, Red Dog Mine”, to ADNR, January 10, 2005 (and all annual reports)
- URS Corporation “Periodic Safety Inspection Report, Tailings Dam, Red Dog Mine Project,” May 27, 2005.
- Water Management Consultants, “Quality Assurance Project Plan for the Hydrologic Characterization of the Tailings Impoundment, Red Dog Project”, January 1998.

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The duties of the mine staff responsible for the daily inspection are to fill out the “Daily Dam & Pumping Inspection Sheet” by completing the following:

- Document the temperature and general weather condition.

- Visually scan the dam, spillway and the surrounding areas for unexpected behavior.
- Promptly report any unusual behavior to the Responsible Party.

In the event of an unusual behavior, the Responsible Party is to:

- Investigate and assess if the behavior is an unusual occurrence or emergency (as defined later in this O&M Manual), and take appropriate action.
- Keep a written log of the date, nature of the unexpected behavior, action taken, and other pertinent information.

When signs of an impending break-up appear each spring, the daily inspection must increase attention at the spillway for any obstructions that might block its flow, such as floating ice, rocks, slide material and other debris. Promptly remove any such materials, and increase the frequency of checking as necessary to prevent the spillway from becoming blocked.

4.2 WEEKLY INSPECTION

The dam, spillway and surrounding areas should be visually inspected weekly for any unusual behavior. This inspection is more detailed than the daily inspection, and is documented in the “Visual Freshwater Dam Inspection” sheet in Appendix A.

The duties of the mine staff responsible for the weekly inspection are to fill out the “Visual Freshwater Dam Inspection” sheet by completing the following:

- Identify the temperature range and general observations of the weather condition, wind, wave action and snow cover.
- Visually scan the freshwater dam, spillway, stilling basin and the surrounding areas for unusual behavior.
- Inspect the crest, toe, east buttress, west buttress, upstream slope and downstream slope of the dam for signs of cracks, slumps, subsidence and seepage.
- Inspect the spillway channel and chute bottom and side slopes for signs of cracks, slumps, and ice and rock blockages.
- Promptly report any unexpected behavior or unto the Responsible Party and describe in the “Other comments” section of the inspection sheet.

In the event of an unexpected behavior, the Responsible Party is to:

- Investigate and assess if the behavior is an unusual occurrence or emergency (as defined later in this O&M Manual), and take appropriate action.
- Keep a written log of the date, nature of the unexpected behavior, action taken, and other pertinent information.

4.3 QUARTERLY INSPECTION

At quarterly intervals, the Responsible Party should walk over the dam and spillway areas, and inspect all accessible parts of the system. This inspection is documented in the same “Visual Freshwater Dam Inspection” sheet in Appendix A that is used for the weekly inspections.

The spillway and dam toe areas are inaccessible for close examination during the winter because of snow. Therefore, attempts should be made to complete two of the four quarterly inspections immediately after breakup and just before the first major snowfall. If necessary, these inspections should be increased in order to thoroughly examine the entire system.

The quarterly inspection shall include checking at least the following:

- All exposed surfaces of the dam, buttress, and stability berm for evidence of deformation, vertical or horizontal displacement, cracks, sags, escarpments, settlement, subsidence, sinkholes, erosion, sliding, slumping and frost heaving
- Dam toe, downstream area and abutments for springs, seeps, boils, or unusually wet spots, recording the location, pattern, discharge and its variation with reservoir water level, turbidity, temperature, recency, and duration
- Instrument installations for signs of physical damage, malfunctioning or needed maintenance, and recent readings for signs of trends that could be related to observed conditions
- Any exposed surfaces of upstream buttress for evidence of erosion caused by waves, slumping, sliding, or erosion.
- Junction area of the dam and spillway at the east abutment for whirlpools, flow into the dam embankment, erosion, or riprap damage.
- Spillway channel for signs of side slope instability, damage, erosion, debris accumulation, or poor performance.
- Spillway chute for dislodged rocks, erosion, slope instability, new water discharge paths, or evidence of poor performance.
- Spillway stilling basin for excessive sedimentation, erosion, or evidence of poor hydraulic performance.
- Stream channel downstream from the spillway for erosion, turbidity, sedimentation, or obstructions that could interfere with the stilling basin operation.

Any deformation or cracking should be compared to previous conditions and to the behavior of other fills and dams at the mine to evaluate its significance to the performance of the system. The horizontal and vertical movements across areas of significant cracking or deformation should be monitored using surveying measurements.

For the quarterly inspections, the Responsible Party is to complete the following tasks:

- Keep a complete written record of each inspection and findings with the checklist, and locate points of interest using crest stations and offsets, or references to mapped locations.
- Attempt to find the cause and evaluate the significance of any deviations noted during the inspections.
- Schedule the necessary repairs and maintenance items identified during the inspection and ensure that they are completed.
- Obtain the help of the dam design engineer if unable to confidently assess the significance of any observations made during inspections.
- Keep a written log of repairs and maintenance, including date and time of inspection, inspector name, description of repair or item, summary of action taken, date of action, and names of persons involved.

4.4 PERIODIC SAFETY INSPECTION

The periodic safety inspection (PSI) shall be conducted on a five year interval. The PSI shall be conducted by an Alaska professional engineer (PE) and shall be approved by ADNR. The scope of the PSI is not included in this O & M report.

5.0 INSTRUMENTATION MONITORING

5.1 TYPES OF INSTRUMENTATION

Instrumentation for monitoring the freshwater dam includes:

- Thermistors for collecting temperature data
- Level gage in the stream downstream of the dam

The locations of the thermistor strings are shown on Drawing W-4. Instrumentation results should be considered along with the inspection results and other data to evaluate if problems exist, and the need for repair, maintenance, or further investigation.

1.1.1 Thermistors

The terminal box for the thermistors is on the dam crest at the east abutment, just downstream from axis Station 5+92. Six thermistor strings (T-1, T-3, T-4, T-5, T-6 and T-7) are in current operation. All other thermistors and piezometers, shown on Drawing W-4, were either deleted, abandoned, or no longer operable. The thermistors are grouped as follows:

- T-1, T-3 and T-4 are located along the crest of the dam
- T-5 and T-6 are submerged in the reservoir within the original creek drainage
- T-7 is located at the toe of the dam in the original creek channel

The thermistor wells consist of a string of thermistors hung within a PVC well. The individual thermistors on the strings are spaced at 10-foot intervals. The thermistors are YSI 44034 equivalent and are manufactured by Dryden Instrumentation of Anchorage. These instruments measure the temperatures of the embankment and foundation to monitor the rate of thaw and indicate the presence and extent of thawed zones through which seepage could occur.

1.2.1 Level Gage

The level gage is a vertical survey rod in the ditch downstream of the dam and just below the freshwater seepage pumpback. The water in the ditch is the amount of seepage from the reservoir that is not needed for the freshwater tank.

5.2 DATA COLLECTION

1.3.1 Frequency of Data Collection

Thermistors are to be read quarterly under normal operating procedures.

- Some event may require that readings be taken more frequently than under normal operation conditions. Such readings must continue at the increased frequency until the event is over, and until either the readings have returned to the pre-event condition, or the situation has stabilized.

During each PSI of the fresh water dam, the schedule of readings should be reviewed and the reading intervals should be modified as warranted.

1.4.1 Thermistors

Thermistor data can be read either manually, or with automated data recording devices. Thermistor readings should include resistance values from each thermistor. Data from thermistors are read using either:

- The automated procedure using a HP 200 Data Collector and a T5KMUX analog to digital converter and multiplexer
- Fluke multimeter and Dryden instrumentation switchbox

Thermistor string readings should be reduced to convert resistance to temperature. The readings should be stored or filed as complete profiles for each date.

- Plot the temperature data as temperature contours with depth against date. Look for trends as to the enlargement or contraction of the thawed zone
- Plot the profiles as thermistor elevation against temperature. Look for changes in the active zone, the development of thawed zones, and long-term shifts in the ground temperature.

Standard operating procedures for data collection, inspection, calibration, and maintenance procedures for the thermistors are summarized in the Appendix B.

1.5.1 Level Gage

The amount of seepage from the fresh water reservoir that is not pumped to the freshwater tank is determined by means of visual observation of the level gage. Measurements are to be taken from the ditch bottom to the water surface. The rate at which water is pumped from the reservoir is estimated by means of water usage at the plant and domestic quarters.

6.0 UNUSUAL OCCURENCES AND EMERGENCIES

6.1 UNUSUAL OCCURRENCE PROCEDURES

Unusual occurrences are events or conditions that are not normally encountered during routine operations and which may endanger the facility. Examples include:

- Storms and floods.
- Earthquakes
- Increased seepage or changes in seepage character
- Landslides around the reservoir perimeter and dam area
- Fire or explosions
- Human interference by terrorism, vandalism, or accidents
- Incidents of potential environmental damage
- Imminent rise of reservoir level above the flood storage threshold.

The following steps are to be taken in the event of an unusual occurrence:

- Immediately report unusual occurrences to the Responsible Party and Mine Management
- Promptly make a special inspection and evaluate the significance of the occurrence
- Take protective or corrective actions as appropriate for the nature of the occurrence
- Activate emergency procedures discussed below, if necessary
- If emergency procedures are activated, inform State Dam Safety Engineer within 24 hours.

6.2 EMERGENCY PROCEDURES

Emergencies are serious situations which develop suddenly and unexpectedly, threaten the structural integrity of the dam, and demand immediate attention. Examples include:

- Impending or actual release of water caused by improper operation, accidental damage, sabotage, or general failure of the dam and its appurtenances.
- Impending flood conditions, even when the dam is not in danger of failure.
- Unusual increase in either seepage or turbidity of the seepage.
- Large or local earthquakes.

Emergencies should be handled by putting pre-existing contingency plans into operation. If emergency procedures are activated, inform the State Dam Safety Engineer and dam design engineer within 24 hours.

6.3 CONTINGENCY PLANS

Contingency plans have been developed to address the following emergency situations:

- Structural emergency of water cresting the dam due to a spillway blockage
- Structural emergency of water cresting the dam due to a spillway overflow
- Structural failure caused by other catastrophic scenarios

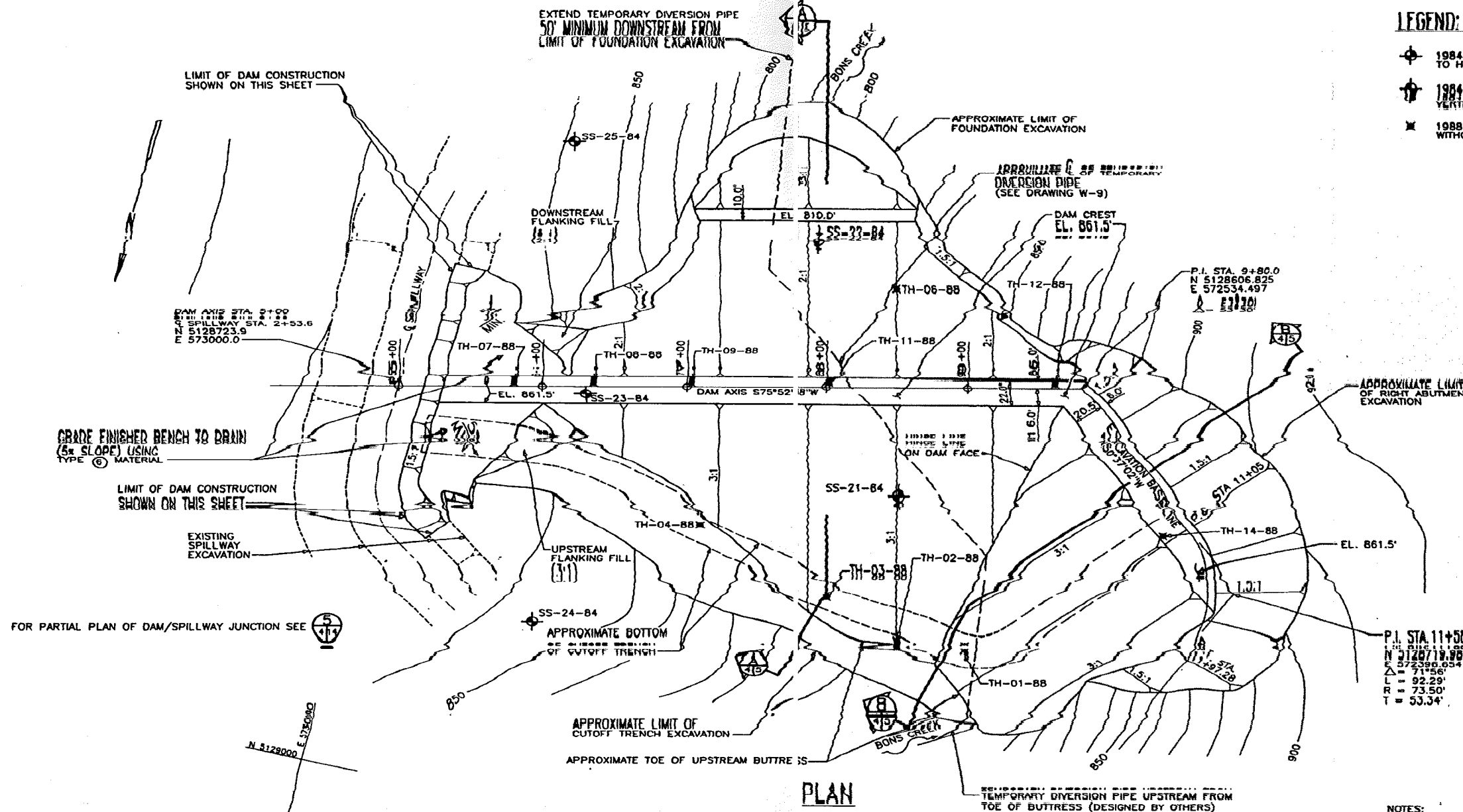
A structural emergency of water cresting the dam due to a spillway blockage could develop if the spillway becomes blocked from debris, ice, or other foreign material and causes water to be diverted away from the spillway and flow over the dam crest.

A structural emergency of water cresting the dam due to a spillway overflow could develop if there is high precipitation and runoff from the watershed that floods Bons Creek and the spillway such that the spillway capacity is exceeded and causes water to flow over the dam crest.

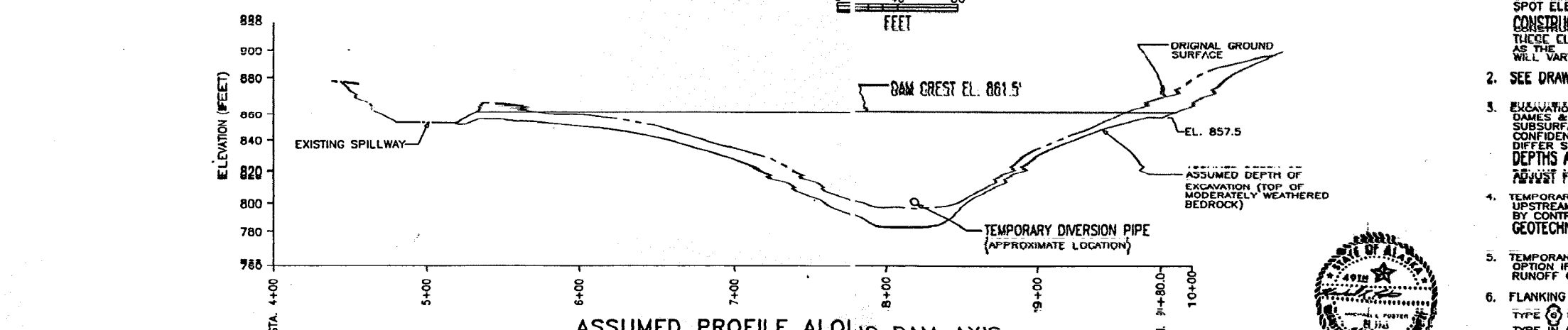
A structural failure caused by other catastrophic scenarios could develop in spite of the level of monitoring, inspection and maintenance conducted on the dam. A failure of the dam and spillway is still possible in the event of other catastrophic scenarios, such as a large earthquake or terrorist activity.

The contingency plans should be periodically reviewed and updated.

DRAWINGS



- LEGEND:**
- ⊕ 1984 DAMES & MOORE BORING CORED AT ABOUT 60° TO HORIZONTAL BY CME-55 DRILL RIG
 - ⊕ 1984 DAMES & MOORE BORING CORED VERTICALLY BY CME-55 DRILL RIG
 - ⊕ 1988 DAMES & MOORE BORING DRILLED VERTICALLY WITHOUT SAMPLING BY TAMROCK AIR TRACK DRILL



- NOTES:**
1. CONSTRUCTION LIMITS AND SLOPES ARE BASED ON SURVEYED SPOT ELEVATIONS OF EXISTING GROUND SHOWN ON DWG. S-2 SPOT ELEVATIONS SHOWN WERE PROVIDED BY GREEN CONSTRUCTION COMPANY (VARIOUS DATES IN AUGUST 1988). THESE ELEVATIONS CONFLICT WITH THE TOPOGRAPHIC MAP (AS IS) AS THE PLAN BASE. ACTUAL LIMITS AND SLOPE CATCH POINTS WILL VARY WITH FIELD LOCATIONS.
 2. SEE DRAWING W-3 FOR BORING LOGS AND ADDITIONAL NOTES.
 3. EXCAVATION DEPTHS SHOWN ON PROFILE ARE ESTIMATED FROM DAMES & MOORE INTERPRETATIONS OF LIMITED BORING DATA. SUBSURFACE CONDITIONS ARE KNOWN WITH REASONABLE CONFIDENCE ONLY AT DAMES & MOORE BORINGS AND MAY DIFFER SUBSTANTIALLY AT OTHER LOCATIONS. VARY EXCAVATION DEPTHS AS DIRECTED BY THE GEOTECHNICAL ENGINEER TO ADJUST FOR FIELD VARIATIONS.
 4. TEMPORARY DIVERSION WORKS (INCLUDING DIVERSION PIPE) UPSTREAM FROM TOE OF UPSTREAM BUTTRESS TO BE DESIGNED BY CONTRACTOR. THIS DESIGN IS SUBJECT TO REVIEW BY GEOTECHNICAL ENGINEER AND APPROVAL BY OWNER.
 5. TEMPORARY DIVERSION PIPE MAY BE DELETED AT OWNER'S OPTION IF DAM WILL BE COMPLETED PRIOR TO SURFACE RUNOFF OCCURRING IN THE DAM SITE BASIN.
 6. FLANKING FILLS ON LEFT ABUTMENT SHALL BE BUILT WITH TYPE (C) MATERIAL, OR WITH MATERIAL MATCHING THE FILL TYPE IN ADJOINING EMBANKMENT.
 7. MAP COORDINATE SYSTEM BASED ON ALASKA STATE PLANE COORDINATES, ZONE 7, TOPOGRAPHIC BASE MAP SUPPLIED BY COMINCO ALASKA INC., 1984.



| REFERENCES | | REFERENCES | | REVISIONS | | REVISIONS | | SCALE | | DATE | | COMINCO ALASKA INC. | |
|---|--|----------------------------|--|-----------|----|-----------|-------------|-------|----|------|-------------|----------------------|------|
| TITLE | | TITLE | | NO. | BY | DATE | DESCRIPTION | NO. | BY | DATE | DESCRIPTION | SCALE | DATE |
| DAM ORIGINAL GROUND CROSS-SECTION DATA BY ALLISON, MAKEHAM AND SMITH, DATED 8/1/88, 8/5/88 AND 8/8/88 PROVIDED BY GREEN CONSTRUCTION COMPANY. | | GREEN CONSTRUCTION COMPANY | | 1 | | | | 1 | | | | 1" = 40' | 1/89 |
| SPILLWAY AS-BUILT SURVEY DATA PROVIDED BY GREEN CONST. CO. | | | | 2 | | | | 2 | | | | DESIGNED BY: RNM/FWK | 1/89 |
| | | | | 3 | | | | 3 | | | | DRAWN BY: WEH | 1/89 |
| | | | | 4 | | | | 4 | | | | CHECKED BY: ELK/MLF | 1/89 |
| | | | | 5 | | | | 5 | | | | APPROVED BY: CMU | 3/89 |
| | | | | 6 | | | | 6 | | | | APPROVAL BY: | |

DAMES & MOORE

COMINCO ALASKA INC.

WATER SUPPLY DAM - DAM PLAN AND PROFILE

JOB NO. 05438-102-035

DRAWING NO. W-4

REV. 3

APPENDIX A

DAILY AND WEEKLY/QUARTERLY INSPECTION SHEETS

EMS Daily Dam & Pumping Inspection Sheet

Visual Freshwater Dam Inspection

EMS DAILY DAM & PUMPING INSPECTION SHEET

Date: _____ **Name:** _____

Temperature
General Weather
Condition _____

Overburden Diversion System

| | | | | | | | | |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Check condition of all pumps & piping as well as roads | Operating | | Lines Intact | | Berms Intact | | Spills | |
| | Yes | No | Yes | No | Yes | No | Yes | No |
| | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Comment _____

RedDogCreekPumpback & Dam

| | | | | | | |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Surfaces checked for; cracks, leaks and slumps | Crest | Toe | East Buttress | West Buttress | Downstream Slope | Upstream Slope |
| | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Auxiliary pump operating | Yes | No | Water Level (high/low) | | Number of Pumps Avail. | |
| | <input type="checkbox"/> | <input type="checkbox"/> | | | Grunfos Bibo | |
| | | | | | | |

Comment _____

Tailings Dam

| | | | | | | |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Surfaces checked for; cracks, leaks and slumps | Crest | Toe | East Buttress | West Buttress | Downstream Slope | Upstream Slope |
| | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Comment _____

Seepage Dam

| | | | | | | | |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Surfaces checked for; cracks, leaks and slumps | Crest | Toe | East Buttress | West Buttress | Downstream Slope | Upstream Slope | Water level (high/low) |
| | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Comment _____

Freshwater Dam

| | | | | | | |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Surfaces checked for; cracks, leaks and slumps | Crest | Toe | East Buttress | West Buttress | Downstream Slope | Upstream Slope |
| | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Comment _____

**Cominco Alaska Incorporated - Red Dog Mine
Engineering Department
Visual Freshwater Dam Inspection**

Quarterly Inspection Date: _____ Mine Shifter: _____
 Weekly Inspection Time: _____ Engineering: _____

Temperature: 81 to above 21 to 40 -21 to -40
 61 to 80 1 to 20 -41 to -60
 41 to 60 -1 to -20 -61 to below

Circle observations:

Condition: (Clear, Scattered Clouds, Overcast, Rain, Snow)
 Winds: (none, light, medium, high) and (NE, NW, SE, SW)
 Wave Action: (none, light, medium, high)

 Condition of snow cover: (none, uniform, unexpected areas of melting, normal melting)
 Visibility due to snow cover: (good, moderate, poor)
 Pond water level: (no change, rising, dropping) and (open, partially frozen, fully frozen)
 Pumpback system: (running, not running, unknown)

Freshwater dam: circle "yes" or "no" to the existing conditions:

| | Crest | Toe | W. Buttress | Upstream Slope | Downstream Slope |
|-----------------------------------|----------|---|---|----------------|---|
| Poor visibility due to snow cover | yes / no | yes / no | yes / no | yes / no | yes / no |
| Cracks | yes / no | yes / no | yes / no | yes / no | yes / no |
| Slumps | yes / no | yes / no | yes / no | yes / no | yes / no |
| Seepage | | yes / no | yes / no | | yes / no |
| Changes in seepage | | (circle one) no change increased flow decreased flow | (circle one) no change increased flow decreased flow | | (circle one) no change increased flow decreased flow |

Other comments: _____

Stage Reading at Toe:

Spillway: "X" or circle the existing conditions:

Condition: (clean, erosion, debris)
 Water flow: (none, low, medium, high)
 Ice buildup: (open, low, medium, frozen)

Other comments: _____

MARK LOCATIONS ON MAP (REVERSE SIDE OF PAGE).

Report unexpected behavior promptly to the Mine Supt., Sr. Mine Engineer and Mine Ops. Coordinator.

APPENDIX B

**STANDARD OPERATING AND MAINTENANCE PROCEDURES
FOR THERMISTOR DATA COLLECTION**

Standard Operating Procedure for Obtaining Thermistor String Readings

- Equipment:
- 1 "Thermistor Well Data" form
 - 1 Pencil
 - 1 Fluke multimeter with leads (Fluke model 23, Series II)
 - 1 Dryden Instrumentation Switchbox
 - 1 #2126 Master padlock key
- Procedure:
- Drive to well.
 - Unlock and remove the protective cap.
 - Pull excess thermistor cable from well casing.
 - Remove dust cover from the 50 pin male plug on cable end.
 - Connect the leads to the multimeter by pushing the black lead into the port labeled "com" and the red lead into the port labeled " Ω " (ohms).
 - Connect the red and black leads from the multimeter to the red and black terminal posts on the switchbox.
 - Turn on multimeter by turning the main selector switch to " Ω " DC.
 - Meter should read 0.00.
 - Push toggle switch on switchbox to "Test" position.
 - Record the reading displayed on the multimeter on the Thermistor Well Data form. The reading should be very close to the number stamped on the faceplate of the Dryden switchbox (16325 Ω). (Because the multimeter is an auto-ranging type it may read 16.32 or 16.33 K Ω). If the multimeter does not display something close to this reading then the multimeter is too cold. (See operating range for the multimeter in the owner's manual). Warm the multimeter and try again. You may wish to change the battery in the multimeter.
 - Turn right toggle to "read" position.
 - Turn left toggle to "1 - 12" position.
 - Turn selector switch to "1" position and read and record the reading on the "Thermistor Well Data" form.
 - Repeat process for switch positions 2 - 12.
 - Turn toggle switch to "13 - 24" position.
 - Continue to read and record data for positions 13 through 24.
 - Take another reading in the test position and record. Again, this reading should be similar to the reading stamped on the faceplate of the switch box.
 - Make sure the well number, date, time, outside air temperature and the name of the operator are on the form.
 - Turn off the multimeter and disconnect leads.
 - Install dust cover on the 50 pin connector plug.
 - Carefully coil the excess cable back into the well casing.
 - Lock the protective cap back into place.

PROCEDURE FOR READING AND DOWNLOADING THERMISTOR DATA FROM THE JUNIPER PRO 2000 DATA COLLECTOR

Start Up

1. Turn on data collector, the screen should show "D:\THERMS>_", if not, get to it. If the screen is already inside the T24 Program, check the Reading Thermistor Data section below to evaluate which screen you are in.
2. At this point type "date" and enter, then type the current date in mm-dd-yy format and enter. If you want to check that the new date is correct, type "date" again and enter, but this time only hit the enter key when asked for the date.
3. If the temperature is less than 32°F (0°C) turn on the heater. Type "setup" and go to KEYBOARD/DISPLAY and enter. Scroll down to HEATER and hit the F1 key to toggle the heater on, then press esc twice to get out of SETUP. The temperature is checked every 5 minutes, so if the unit goes above 32°F for a few minutes, the heater will have to be turned on again. Alternatively, you can get out of T24 when the screen starts acting up, turn the heater on, and then start T24 again, but using Append on the data file (see File Opening below).
4. Type T24 and enter. If the screen ends up being black, type X, for eXit, and try again.

File Opening

1. Type O to open a file for data collection.
2. Type in the name of the file with the following naming convention, "TM followed by the reading date", for example TM102497 for readings on October 24, 1997, and hit enter. At this point, if you are resuming after having turned the heater on, you will get a new screen; type A for append, then enter.
3. You should be back at the options screen. At the top of the screen a very light colored message will appear giving the data file name, for example "Writing D:\THERMS\TM1024". This message is your check to know that the data collector is ready to read thermistors.

Reading Thermistor Data

1. Type R, for Read, to go to the Red Dog thermistor list
2. Connect the data collector to a thermistor.
3. Scroll down the list using the PGUP and PGDN keys until the thermistor you want to read is highlighted. Thermistor names are listed in the first column, locations in the second column.
4. Once on the thermistor name, hit the enter key to read the thermistor.
5. After 4 seconds the thermistor data will come up on the screen. Typing O will Ok the reading, typing R will Reread the thermistor, and typing C will Cancel the reading.
6. Repeat steps 2 to 6 until all the thermistors you want to read have been read.
7. When you have finished reading thermistors for the day, you will be at the Red Dog thermistor list that step 1 refers to. Hit esc to exit reading mode.

Closing Down the Data Collector

1. Hit O and you will be given the option to close the data file.
2. Hit enter if you wish to close the file and ESC if you want to continue reading thermistors.
3. If you are finished with reading thermistors, type X, for eXit, and you will return to D:\THERMS>_

(OVER)

Transferring the Data

1. Connect the PRO2000 data collector's COM1 port to the PC's COM 2 port. (Make certain you plug it in to the correct port, it is the plug used for the HP48, not the one for the GPS.)

On the PC

2. Start PCS by clicking the "Juniper Transfer" icon in the "Mine survey_engineering" menu, or by doing the following:

Open a DOS window (located under Programs).

Type "CD C:\THERMS\PCSIDE", hit enter.

Type "SET OMNIDIR=C:\THERMS\PCSIDE", hit enter.

Type "PCS", hit enter.

3. Hit F5 to enter the data transfer setup menu.
4. Select "COM 2" by hitting F1.

On the PRO 2000 hand held

5. Type "C:", enter, "CD \DOS", enter, and then "PS" and enter.
6. Select Drive "D:" from the list by hitting enter, using the arrow keys to find "D:", and hitting enter again. When selected, you should end up in "D:\THERMS".
7. Scroll to the file you want to transfer and hit the INS key to select the file.
8. Type F5 to get into data transfer mode.
9. Hit F4, 'RECEIVE', on the survey computer immediately before hitting F5, 'SEND', on the PRO 2000.
10. Repeat steps 7. to 9. selecting and transferring files from the PRO 2000.
11. Once finished, to exit from each program hit esc, then Y for Yes, and enter.
12. Transfer the downloaded data files in "C:\THERMS\PCSIDE", on the PC, to "Y:\Minetech\Inter\Monitor\Thermis\RawData" on the server computer.
13. When you are certain all the data files in the PRO 2000 have been transferred to the RawData directory on the Y: drive, delete them from the PRO 2000 by typing "DEL *.RDG" in the "D:\THERMS" directory.

Updating the Excel thermistor files

1. Start the Update Macro by clicking the "UpdateThermsXLS" icon in the "Mine survey_engineering" menu.
2. Type in the name of the thermistor rawdata file to be dumped, and enter.

Helpful Notes

1. To check battery status type "setup" and go to SYSTEM INFORMATION; if voltage is greater than 5.9V, charge should be OK. If the unit ever beeps during use, immediately save all data, get out of the T24 program, turn the unit off, and bring it inside to charge overnight before dumping the data to the PC.
2. If the data collector sits for a while without being used, it will shut off. To resume, hit the ON/OFF key and it will turn on at the same screen displayed when it shut off.
3. To change screen contrast up use the 'RED' & '+' keys and down use the 'RED' & '-' keys.
4. To turn on backlighting use the 'RED' & 'BS' keys.

Thermistor Well Data Form

Well No: _____

Air Temperature: _____

Date: _____

Observer: _____

Time: _____

Initial Test Reading: _____

| Thermistor# | Reading |
|-------------|---------|
| 1 | _____ |
| 2 | _____ |
| 3 | _____ |
| 4 | _____ |
| 5 | _____ |
| 6 | _____ |
| 7 | _____ |
| 8 | _____ |
| 9 | _____ |
| 10 | _____ |
| 11 | _____ |
| 12 | _____ |
| 13 | _____ |
| 14 | _____ |
| 15 | _____ |
| 16 | _____ |
| 17 | _____ |
| 18 | _____ |
| 19 | _____ |
| 20 | _____ |
| 21 | _____ |
| 22 | _____ |
| 23 | _____ |
| 24 | _____ |

Final Test Reading: _____

**STANDARD OPERATING PROCEDURE
FOR OBTAINING THERMISTOR READINGS WITH THE
T5KMUX SYSTEM
AUTOMATED THERMISTOR STRING READER**

T5KMUX SYSTEM
AUTOMATED THERMISTOR STRING READER

prepared by
James Dryden & Marie Dryden
of
Dryden Instrumentation
for
Cominco Alaska

September 16, 1997

Introduction

The purpose of this system is to provide a method of automating the labor intensive reading of thermistors installed in strings. The system provides a handheld package that will record the ohmic values of the all the thermistors points on a string in a few seconds. These values are recorded on a handheld PC or laptop for later archiving on desktop platforms.

The system consists of the following :

- Juniper Systems Pro2000 handheld computer (DOS PC-AT compatible)
- including CA-2009 serial Pro2000 to PC cable, and PW-110T charger
- Dryden Instrumentation T5KMUX analog to digital converter and multiplexor
- Program diskette with T24.exe, MSTRTHRM.TXT, T24.cfg files

This documentation and the programs have been prepared for use with the Pro2000 because of it's field ruggedness but the T24 program and the T5KMUX unit should work on any PC DOS platform. You should be able to easily operate the program on a desktop for testing in the office or on a laptop in the field if conditions allow it.

Setup

The Pro2000 unit delivered with the system has 2M of memory. This has been allocated to 1M of operating RAM for running programs and 1M on the D: drive. As we have been using it, the D: is the active drive for all thermistor data and programs. The A:, B:, and C: drives are reserved for system usage. The E: drive would be the PCMCIA card if installed.

The user should read the first part of the Pro2000 manual to gain familiarity with it's operation, it can't all be covered here. We have tried to provide a few tips at the back of this document for the things that we kept having to look up. The user needs to understand the full screen vs small display and how panning works - see page 2-11 in the Pro2000 manual.

We have set some of the Pro2000 operating parameters to facilitate use with the T24 program. These can be reached from the DOS prompt by executing PS (PolyShell utility program provided with the Pro2000). The TAB provides a menu of utility programs. The SETUP utility can be used to alter the Pro2000 operating parameters. We have set the following but you may find you want to alter these or others according to your preferences :

| |
|---|
| Configuration : Ram Disk 2 is your D: drive, CPU speed 100% |
| Power/Com Ports : Power Key Susp/Res so it doesn't reboot on power on |
| Auto-Suspend 10 min. to turn off power automatically after 10 minutes of inactivity |
| Serial Ports On |
| Keyboard/Display : Keyboard Internal |
| Display Internal |
| Contrast 30 |
| Backlight On |
| Key Click On |
| Video Grayscale |
| Auto-Pan Disabled |
| Heater Off |

If not there, the programs and supporting files need to be transferred to the Pro2000 D:\THERMS sub-directory. A sample set of these were included on the delivery disk and they were all preloaded onto the Pro2000. If they need to be transferred, use PS on the Pro2000 and PCS on the desktop to transfer these files to the Pro2000 - details are in the Pro2000 manual page 5-12.

T24.EXE Application program to collect data from TSKMUX hardware
T24.CFG Little text file to tell T24.exe what video and com port to use
MSTRTHRM.TXT Text file listing thermistor string numbers, locations, and number of nodes

A testing version of the last two files are provided on the delivery diskette. Both of those files are small text files that can be created with a text editor such as notepad under Windows95. Their formats are as follows :

T24.cfg One line of text in the file
 Char 1-5 must be COM=1, COM=2, COM=3, or COM=4 giving the TSKMUX port
 Char 6-9 must be MONO, BW80, or DFLT. DFLT recommended. Anything else gives you
 DFLT. The MONO option locks up the Pro2000.
Example line : COM=2DFLT

Mstrtherm.txt One line for each thermistor string to be defined. The order will be the order that the selections appear in the pick list on Pro2000. The program checks that all thermistor strings have between 1 and 24 points and terminates the loading of the list if an invalid record is found. Each line is formatted as follows:

| | | |
|-----------------|---|-----------------|
| Char 1-8 | String ID | |
| Char 9 | Space | |
| Char 10-29 | Location Description | |
| Char 30-34 | space | |
| Char 35-36 | Number of nodes (thermistors on the string) | |
| Char 38-50 | Excel spreadsheet name | |
| Example Group : | | |
| MW95-T1 | MAIN WASTE DUMP | 7 dpmwthrm.xls |
| MW95-T2 | MATN WASTE DUMP | 7 dpmwthrm.xls |
| T96-15 | RED DOG CREEK | 24 196th10.xls |
| T96-16 | RED DOG CREEK | 24 196th10.xls |
| T96-17 | RED DOG CREEK | 24 196th10.xls |
| T-8 | TAILINGS DAM | 17 tdamthrm.xls |
| T-15 | TAILINGS DAM | 13 tdamthrm.xls |

If these files have been loaded, turn on the Pro2000, set the default dir to D:\THERMS and execute the T24 program from the DOS prompt. We set the PC Configuration options in T24 to Default video and used Com2 for the TSKMUX connection. Changing the PC Configuration options requires exiting back to DOS and restarting the program.

For training purposes, it helps tremendously to run the T24 program on a full screen desktop before using it on the Pro2000.

Data Collection

The field process of collecting data amounts to executing T24 on the Pro2000, selecting a data collection file, and then proceeding to read each thermistor. As each thermistor is read, the results will be written to the output file. I would assume that the operator would select the output file while still in the office and then turn off the Pro2000 until they get to the first location. At each thermistor string, the operator would connect the thermistor string, select the String ID, view the output file for problems, press an enter to record the values, and turn off the Pro2000 until they get to the next string.

Hopefully, operation of the T24 program is obvious. Try it on a desktop with a full screen - it is a lot easier to understand.

Here are the basics

- Menu selections are made by pressing highlighted character (like x for exit), or by moving highlight bar to the selection and pressing enter, or by clicking with a mouse.
- X or Alt-X at the main menu will get you out of the program.
- Esc will get you out of most any window.
- Alt-M will get you the main menu (Read Thermistor, Open...) if you have lost it.
- Select the Thermistor string from the pick list with a space or Enter.
- Tab is used to move between fields in a window. On Pro2000 you will need to do some panning sometimes to find yourself (hold RED key while pressing red arrows plus an extra key to find panning mode). Read about panning in Pro2000 operator manual.
- The red LED in the TSKMUX turns on during the time the program is querying it.

Transfer Data to DeskTop PC

The output files created by T24 have a default extension of *.rdg. These files will be transferred to the PC using the PolyShell utilities. See the Pro2000 Operators Manual

Here are two lines of example output file with a ruler line on top:
.....|.....1.....|.....2.....|.....3.....|.....4.....|.....5.....|.....6.....|.....
dpmwthrm.xls MW95-T1 7 09/14/97 19:04 Err 0 132225 132225 132225
132225 132225 132225 132225
tdamthrm.xls T-15 13 09/14/97 19:04 Err 0 15.205 11.509 132274
132274 132274 132274 132274 132274 132274 132274 132274
132274

The values above (132225 or 132274 k ohms) were generated by T5KMUX sn002 when there was no thermistor connected to the T5KMUX. In a real case, the value files would be things like 16.325, 100.32, or -15.16 which would always fill the seven characters where you see the 132274. The 16.325 is in k ohms and is the table resistance value for a YSI44007 thermistor at 0°C.

The error code at character 45 above means the following :

0=All ok as far as program is concerned

1=The program saw no signal from the analog to digital converter within 25msec after it was told to do a conversion. T5KMUX probably not connected to PC.

2=The internal control values used by the analog to digital converter appear out of range. Readings might be good nevertheless.

3=At least one value was outside of the 1k TO 20k check range. Sometimes this is just because nothing is connected or the thermistor has failed. In the case of a negative value, the program is telling you that the value drifted more than 5 counts in the two readings taken about 2 seconds apart. This could be caused by moisture intrusion into the thermistor potting or cable or might indicate the presence of electrical noise. The typical symptom of moisture intrusion is when measured with an ohmmeter, you see it just keep moving in one direction approaching some value slower and slower the longer you hold the meter on the point.

Miscellaneous

PRO2000 Operating tips

- Battery life would be 10-16 hours on a full charge at room temperature. Using the heater and the backlight will cut that in half. Since the required on-time to read 25 thermistor strings is probably less than an hour, a battery charge may last a couple weeks.
- Battery status execute PS, tab {utilities}, 3 {setup}, system information
- Toggle backlight RED Backspace
- Pressing insert key after panning with red arrows locks the pan
- Contrast on the screen is adjusted with the Red + or Red - (I guess it is really Red Blue +)
- PolyLink file transfers need Windows95 MSDOS window sensitivity set low
- Executing PCS (PC side PolyShell utility program) needs the MSDOS environment parameter Omnidir=.....\PCSIDE (the directory where you stored the pcside PCS utilities). Use the dDOS SET command like SET OMNIDIR=C:\PRO2000\PCSIDE.
- To run a transfer from the desktop PC to the Pro2000 or visa versa, you need to run PS on the Pro2000 and PCS on the PC. Mark files on sender with the Insert key. Use F5 Xfer to invoke PolyLink program. Set Com port with F1. Default baud rate should work best. Except for marking the files, you do all this on both computers then when ready you press F5 Send on the sender and F4 Receive on the other one. You have a 30 second window for them to find each other trying to negotiate a connection before it times out and you start over.

TSKMUX Specifications and Notes :

- Internal 9V Battery operating life :
Quiescent power 10 μ amp max. On power 15ma max.
This implies that one 9V battery can be used for a year with 1000 thermistor readings per month
- Accuracy : Design goal was 0.15% accuracy
Testing from +25°C to -10° with values of 15k and 10k ohms showed accuracy of ± 20 ohms.
The digital resolution of the analog conversion is about 10-15 ohms in this range.
In this range, the 20 ohms is equivalent to about 0.003°C. Component tolerance and temperature changes to -30°C would imply expected accuracy of 100 Ω ($\sim 0.1^\circ\text{C}$).