Operation/Maintenance and Abandonment/Restoration Plans for the Clean Up of the CAM-4, Pelly Bay DEW Line Site

Prepared for:
Nunavut Water Board

Prepared by:
UMA Engineering Ltd.

February 2002

File: 0171-095-68-08

Table of Contents **Page No.**

List of Drawings

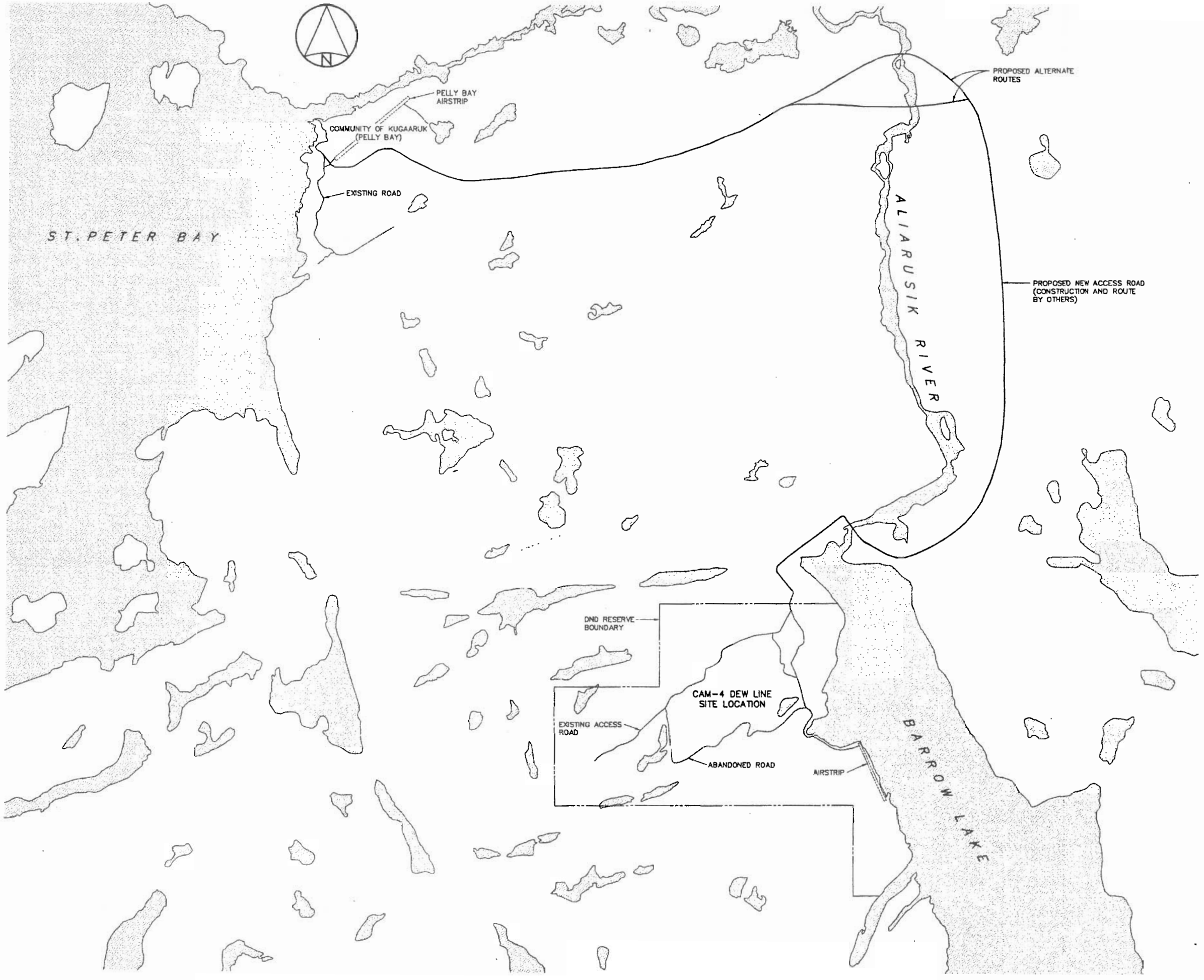
1. INTRODUCTION

The landfills at the former CAM-4, Pelly Bay DEW Line site are being specifically constructed for the disposal of demolition debris and contaminated soils from the site clean up activities. The landfills are not for the use of the Municipality for the disposal of domestic waste, although the Contractor may dispose of minimal camp wastes within these landfills. All landfills constructed at the CAM-4 site will be closed at the end of the 2002 construction season, likely in October 2002.

Please refer to Drawings 101, 102, 103 and 104 at the end of this section, which show the location of the landfill areas with reference to the Site Vicinity Plan, Overall site Plan and Project Layout.

The purpose of this report is to provide the Nunavut Water Board with additional information regarding the construction and consequent closure of these landfills. This report also provides information on the landfill performance monitoring program, which will be conducted for 25 years after construction/closure of the landfills has been completed.

All work conducted with regard to construction, operation and maintenance and closure of the landfills shall follow the Environmental Protection Plan, which is part of the formal documents with the Contractor and was included with the water use license application, and the Contingency Plan also submitted to the Water Board.



National Defence / Défense nationale

Headquarters
Quartier général

General Notes:

Legend:

BODY OF WATER

No.	DATE	REVISION	REVISION	APPR.

REGISTERED PROFESSIONAL ENGINEER S. M. STOWKOWY LICENSEE N.W.T.

THE ASSOCIATION OF PROFESSIONAL ENGINEERS, GEOLOGISTS AND GEOPHYSICISTS OF THE NORTHWEST TERRITORIES PERMIT NUMBER P 007 UMA ENGINEERING LTD.

uma

SCALE - ECHELLE 0.5 0.25 0 0.5 1 1.5km

PROJECT - PROJET

CAM-4 PELLY BAY

DEW LINE CLEAN UP

TRADE - METIER	DATE
SITING	2001-02-28

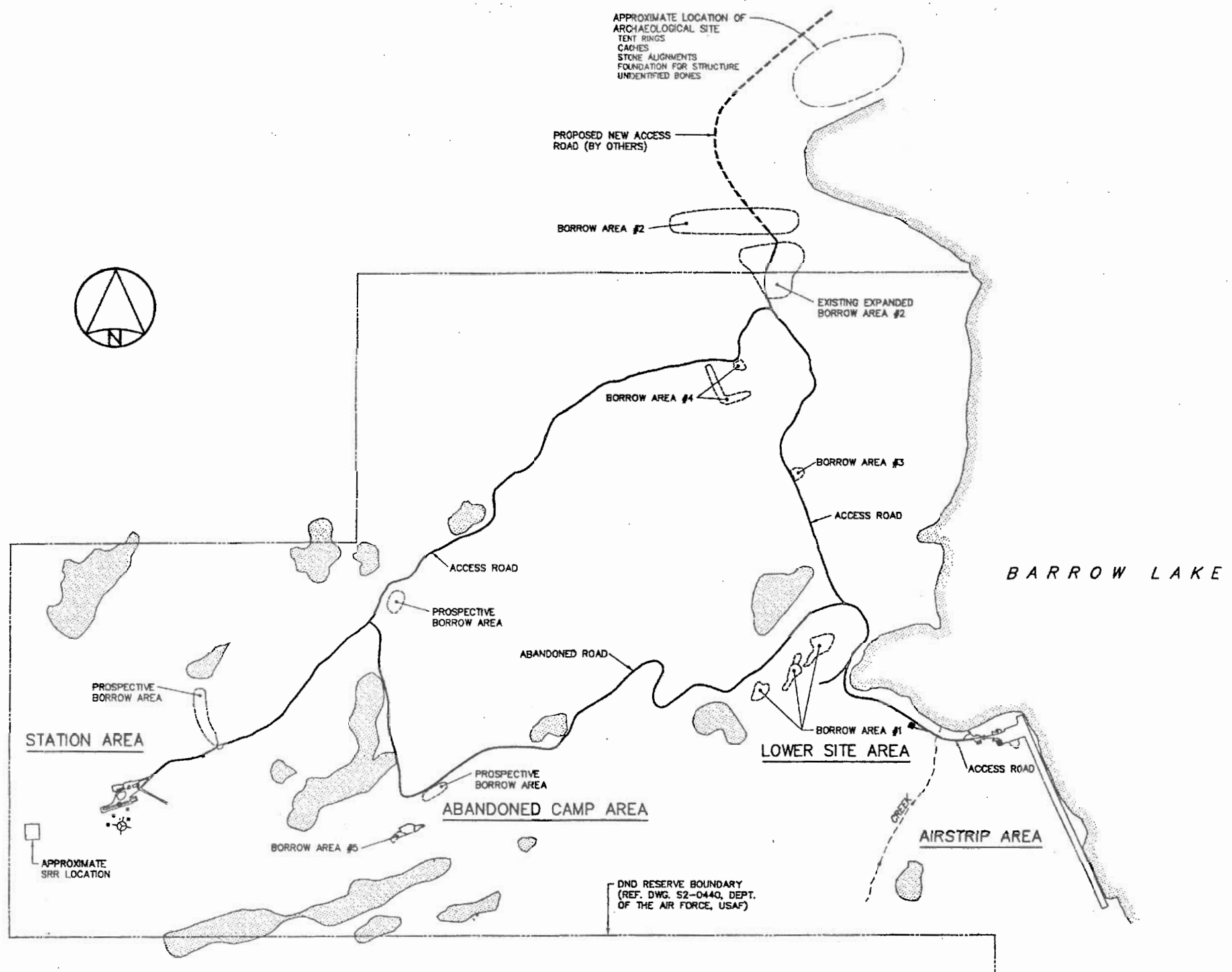
SUBJECT - SUJET

SITE VICINITY PLAN

PRODUCTION		CONCURRENCE - ASSENTIMENT	
DESIGNED ETUDIE	TMS		DES OFF AGENT CONCEPT
DRAWN DESSINE	JC		SECT HD CHEF SECT
CHECKED VERIFIE	RDH		DES MGR GEST CONCEPT
COORDINATION	TMS	REVIEWED - REVU	

DWG. NO. - DESSIN NO.
H-P44/1-9101-101

Canada



National Defence / Défense nationale

Headquarters
Quartier général

General Notes:

Legend:

BODY OF WATER

No.	DATE	REVISION	REVISION	APPR.

REGISTERED PROFESSIONAL ENGINEER S. M. STONKWOY LADEMSES N.W.T.

THE ASSOCIATION OF PROFESSIONAL ENGINEERS, GEOLOGISTS AND GEOPHYSICISTS OF THE NORTHWEST TERRITORIES
PERMIT NUMBER
P 007
UMA ENGINEERING LTD.

UMA

SCALE - ECHELLE 200 100 0 200 400 600m

PROJECT - PROJET
CAM-4 PELLY BAY

DEW LINE CLEAN UP

TRADE - METIER	DATE
SITING	2001-02-28

SUBJECT - SUJET

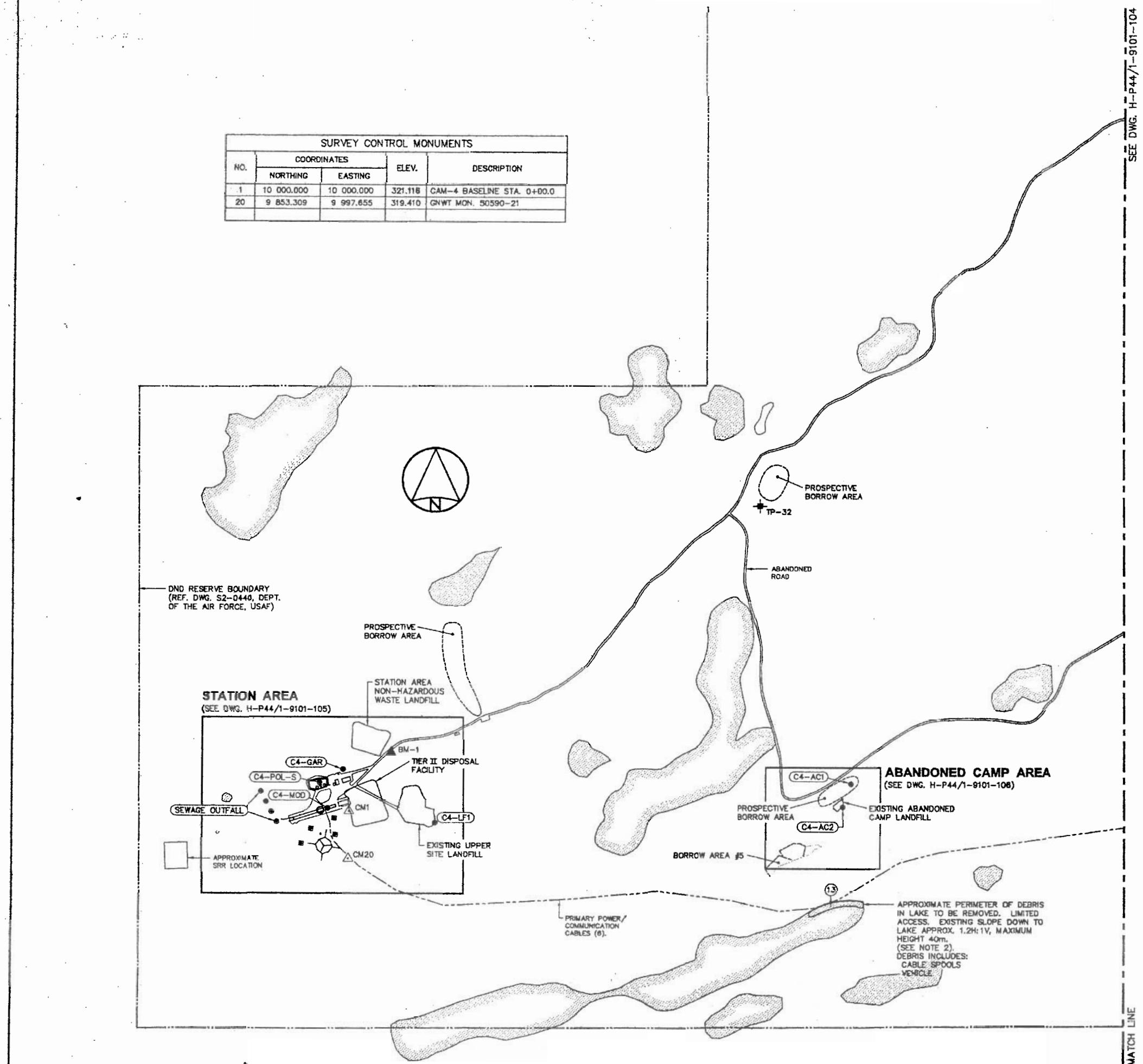
OVERALL SITE PLAN

PRODUCTION	CONCURRENCE - ASSENTIMENT	
DESIGNED / ETUDIE: TRT		DEB OFF / AGENT CONCEPT
DRAWN / DESSINE: DAE		SECT HD / CHEF SECT
CHECKED / VERIFIE: RRM		DES MGR / GEST CONCEPT
COORDINATION: SMT	REVIEWED - REVU	

DWG. NO. - DESSIN NO.
H-P44/1-9101-102

Canada

SURVEY CONTROL MONUMENTS				
NO.	COORDINATES		ELEV.	DESCRIPTION
	NORTHING	EASTING		
1	10 000.000	10 000.000	321.118	CAM-4 BASELINE STA. 0+00.0
20	9 853.309	9 997.655	319.410	GNWT MON. 50590-21



National Defence / Défense nationale

Headquarters
Quartier général

General Notes:

1. ALL ELEVATIONS ARE REFERENCED TO MEAN SEA LEVEL (REF. DWG. AAP-2, DEPT. OF THE AIR FORCE, USAF).
2. ALL NON-HAZARDOUS DEBRIS WITHIN PLAN AREA TO BE PLACED IN STATION AREA NON-HAZARDOUS WASTE LANDFILL.
3. HORIZONTAL CONTROL REFERENCED TO SURVEY CONTROL MONUMENTS.
4. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
5. ALL SHORT RANGE RADAR (SRR) FACILITIES ARE CURRENTLY OPERATIONAL AND ARE NOT TO BE DISTURBED.
6. FOR PERMANENT SURVEY CONTROL (BENCHMARK) INSTALLATION DETAILS, SEE DWG. H-P44/1-9101-135. LOCATIONS TO BE APPROVED BY THE ENGINEER.

Legend:

- CM1 — SURVEY CONTROL MONUMENT
- CONTAMINATED AREA
- TEST PIT LOCATION (1993)
- 13 — PHOTOGRAPHIC VIEWPOINT
- BODY OF WATER
- BM-1 — PROPOSED PERMANENT BENCHMARK LOCATION (1). (SEE NOTE 6).

No.	DATE	REVISION / REVISION	APPR.

THE ASSOCIATION OF PROFESSIONAL ENGINEERS, GEOLOGISTS AND GEOPHYSICISTS OF THE NORTHWEST TERRITORIES
PERMIT NUMBER P 007
UMA ENGINEERING LTD.

REGISTERED PROFESSIONAL ENGINEER — LICENSEE — N.W.T. — S. M. STEWARDSON

UMA — SEE

SCALE - ECHELLE 100 50 0 100 200 300m

PROJECT - PROJET
CAM-4 PELLY BAY

DEW LINE CLEAN UP

TRADE - METIER	DATE
SITING	2001-02-28

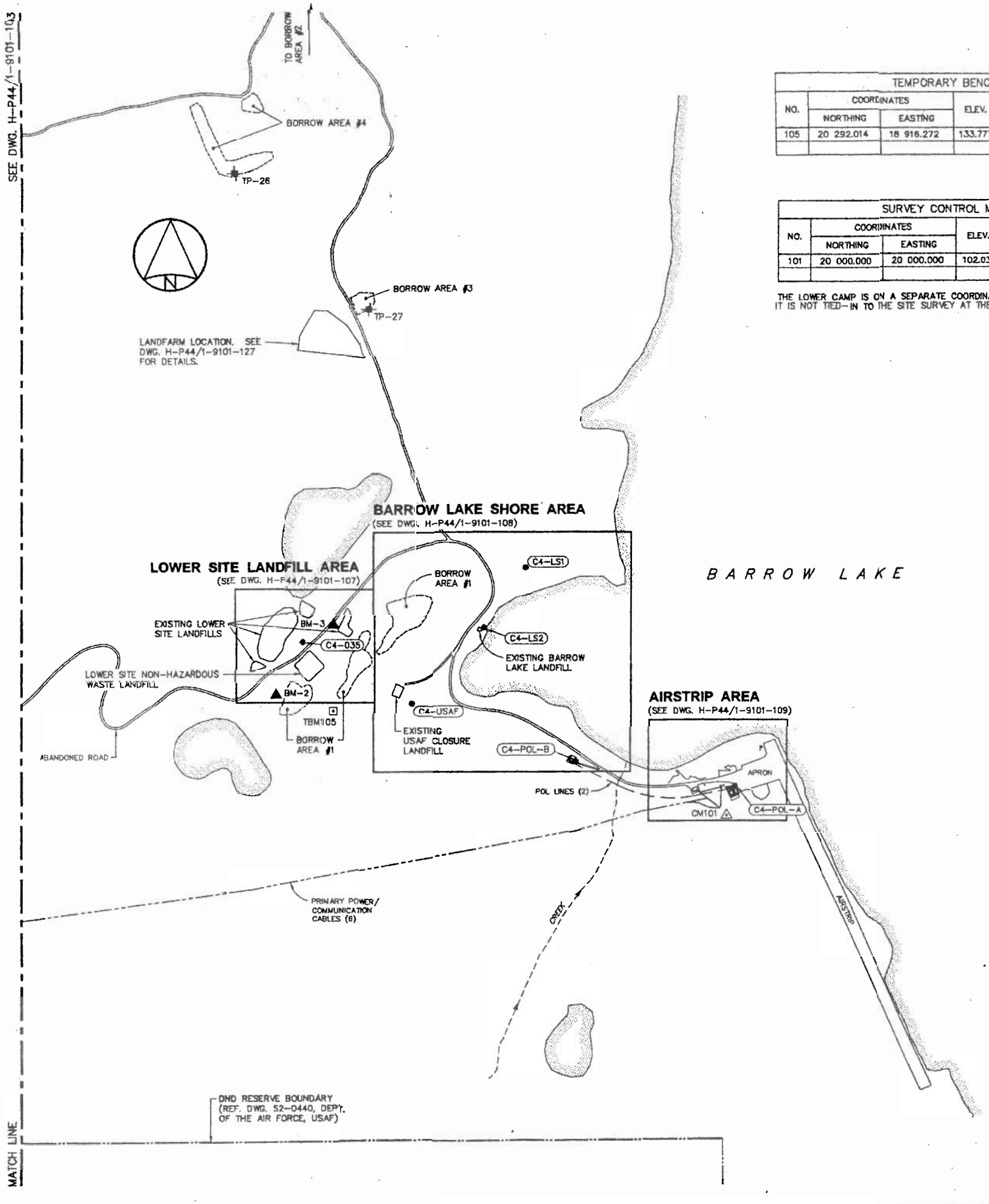
SUBJECT - SUJET

PROJECT LAYOUT SH. 1

PRODUCTION	CONCURRENCE - ASSENTIMENT	
DESIGNED / ETUDIE: TMB		DCS OFF / AGENT CONCEPT
DRAWN / DESSINE: CAE		SECT HD / CHEF SECT
CHECKED / VERIFIE: RDH		DES MGR / GEST CONCEPT
COORDINATION: SMS	REVIEWED - REVU	

DWG. NO. - DESSIN NO.
H-P44/1-9101-103

Canada



TEMPORARY BENCHMARKS				
NO.	COORDINATES		ELEV.	DESCRIPTION
	NORTHING	EASTING		
105	20 292.014	18 916.272	133.777	CUT CROSS IN ROCK

SURVEY CONTROL MONUMENTS				
NO.	COORDINATES		ELEV.	DESCRIPTION
	NORTHING	EASTING		
101	20 000.000	20 000.000	102.031	GNWT MON. 50590-23

THE LOWER CAMP IS ON A SEPARATE COORDINATE SYSTEM. IT IS NOT TIED-IN TO THE SITE SURVEY AT THE STATION AREA.

National Defence / Défense nationale

Headquarters / Quartier général

General Notes:

1. ALL ELEVATIONS ARE REFERENCED TO MEAN SEA LEVEL.
2. HORIZONTAL CONTROL REFERENCED TO SURVEY CONTROL MONUMENTS.
3. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
4. FOR PERMANENT SURVEY CONTROL (BENCHMARK) INSTALLATION DETAILS, SEE DWG. H-P44/1-9101-135. LOCATIONS TO BE APPROVED BY THE ENGINEER.

Legend:

- CM101 — SURVEY CONTROL MONUMENT
- TBM105 — TEMPORARY BENCHMARK
- CONTAMINATED AREA
- TEST PIT LOCATION (1993)
- BODY OF WATER
- BM-2 — PROPOSED PERMANENT BENCHMARK LOCATION (2). (SEE NOTE 4).

No.	DATE	REVISION	REVISION	APPR.

REGISTERED PROFESSIONAL ENGINEER — M. STORKOWY — LICENSEE — N.W.T.

THE ASSOCIATION OF PROFESSIONAL ENGINEERS, GEOLOGISTS AND GEOPHYSICISTS OF THE NORTHWEST TERRITORIES — PERMIT NUMBER P 007 — UMA ENGINEERING LTD.

uma — SNC

SCALE - ECHELLE 100 50 0 100 200 300m

PROJECT - PROJET

CAM-4 PELLY BAY

DEW LINE CLEAN UP

TRADE - METIER: SITING

DATE: 2001-02-28

SUBJECT - SUJET

PROJECT LAYOUT SH. 2

PRODUCTION		CONCURRENCE - ASSENTIMENT	
DESIGNED / ETUDIE	TMS		DES OFF / AGENT CONCEPT
DRAWN / DESSINE	CAE		SCCT HD / CHEF SECT
CHECKED / VERIFIE	KBM		DES MGR / GEST CONCEPT
COORDINATION	TMS	REVIEWED - REVU	

DWG. NO. - DESSIN NO. H-P44/1-9101-104

Canada

2. PROPOSED LANDFILLS/DISPOSAL FACILITIES

2.1 Non-Hazardous Waste Landfill

There will be two Non-Hazardous Waste (NHW) Landfills constructed at the CAM-4 site, one is to be located at the Station Area at the Upper Site, and the other facility is to be located at the Lower Site area. Drawings 105 and 107 show the locations of these landfills.

The NHW landfills will be used for the disposal of demolition debris and non-hazardous site debris.

NHW landfills are designed on the premise that moisture migration into the landfill material need not be eliminated completely. The debris is generally dry material, and is not considered to generate leachate. Therefore, it is not necessary to eliminate all moisture infiltration into and out of the landfill.

The landfill is constructed by building containment berms around the perimeter of the landfill area. The containment berms are to have a maximum outside sideslope of 3 horizontal (H):1 vertical (V), and inside sideslope of 1.5H:1V. The shallower outside sideslopes are to minimize surface erosion. The berms are to be constructed in lifts 0.3 metres (m) thick and compacted to 95% of Standard Proctor density. The top of the berm should have a minimum width of 3 m for constructability.

Placement of non-hazardous material is to be in designated areas in uniform, horizontal lifts between and against the berms. The thickness of each lift shall be such that all voids within the waste can be filled with intermediate cover to reduce settlement and ground subsidence. The maximum thickness of each waste lift shall not exceed 1 m. The total maximum thickness of the landfill debris should be about 3 m. The waste is to be compacted during placement with heavy equipment.

All demolition materials and debris is to be cut to minimize displacement and lifting of landfilled materials resulting from landfill compaction operations so that the maximum depth of any one material component within the landfill does not exceed 1 m, and to satisfy the overall landfill dimension requirements.

Structural steel materials are to be cut into separate pieces prior to placement in the landfill. Large materials, including structural steel members, timbers, communication dishes, etc., are to be placed on the base of the landfill or on the base on an intermediate fill cover so that the materials lay on a compacted, flat surface. Hollow components or objects, such as tanks, are to be cut to allow nesting of materials. As a minimum, hollow components are to be cut in half, parallel to the lengthwise axis. Within the landfill, the underside of the nested materials is to be supported with intermediate cover or other debris material to minimize displacement and lifting of materials.

All metal demolition material and debris is to be segregated from other material when placed in the landfill. All asbestos material is to be segregated from other materials and consolidated in one single location within the landfill. The asbestos is to be double-bagged and hand-placed in the landfill. Daily intermediate cover of minimum 150 mm Type 6 fill is to be placed on asbestos waste. Barrels are to be crushed, cut or shredded to reduce the original barrel volume by 75%.

Intermediate cover is to be placed to a maximum loose thickness of 300 mm over each layer of non-hazardous material or as required to infill voids within the waste layer, and compact with the random action of tracked equipment. Sufficient passes are to be made with the tracked equipment to subject every point on the surface to a minimum of three separate passes.

The number of layers of 300 mm deep intermediate cover to be placed within the landfill is dependent on the total depth of waste material to be placed as presented in Table 2.1.

Table 2.1
Number of Intermediate Cover Layers Required

Total Waste Material Depth	Number of Intermediate Cover Layers
<1 metre	0
>1 metre, <2 metres	1
> 2 metres, <3 metres	2

Additional Type 6 cover material is to be placed on the final lift of debris to a level that all debris is covered with Type 6 fill prior to placement of Type 2 cover material. The additional cover material is to be placed and compacted to a minimum of 95% Maximum Dry Density, to completely infill voids within the waste layer and prior to placement of the final cover. Moisture conditioning may be required to obtain the specified density. Special care should be taken to place and compact intermediate fill cover material against exposed rock faces and areas inaccessible to tracked compaction equipment to specified requirements.

The landfill surface must be graded to avoid water ponding and minimize infiltration, which could increase seasonal thaw depth. The landfill surface, however, must be gentle to avoid erosion of the cover materials. The landfill surface grade should be greater than 2 m and not exceed approximately 8%. The fill material should be well graded so it is erosion resistant and has moderate water infiltration.

Record Drawings of the landfill construction are to be maintained by the Contractor and provided to the Owner [Defence Construction Canada (DCC)/Department of National Defence (DND)] upon completion of the project.

Following completion of the landfill closure, groundwater monitoring wells will be installed to facilitate monitoring of the landfill performance. A description of the landfill monitoring program is included in Section 3 of this report.

2.2 Tier II Disposal Facility

The Tier II Disposal Facility is to be constructed at the CAM-4 site for the disposal of Tier II contaminated soils. Please refer to Drawing 105 for the location of the Tier II Disposal Facility.

The Tier II Soil Disposal Facility will consist of a lined containment system with sufficient cover material to ensure freezeback, and to ensure that it remains in a frozen condition. The liner system will consist of a 60 millimetre high density polyethylene (HDPE) liner protected on either side by a non-woven geotextile or possibly a geocomposite clay liner. A minimum cover thickness of 2.3 m is required for the Tier II facility.

Fill material used for the frozen containment berms surrounding the landfill must be a non-saline, well-graded material that must be placed and compacted with a degree of saturation greater than 90% and have a minimum dry density of 95% of Standard Proctor Density.

The size and configuration of the frozen saturated berms are based on the thermal analysis and constructability. The berms are to be a minimum of 3 m wide at their crest, and have a maximum outside sideslope of 2H:1V, and inside sideslope of 2H:1V. The berms will have a key trench excavated up to 1.5 m to permafrost or to acceptable foundation conditions. The key trench will be 4 m wide at its base and have roughly 1H:1V sideslopes.

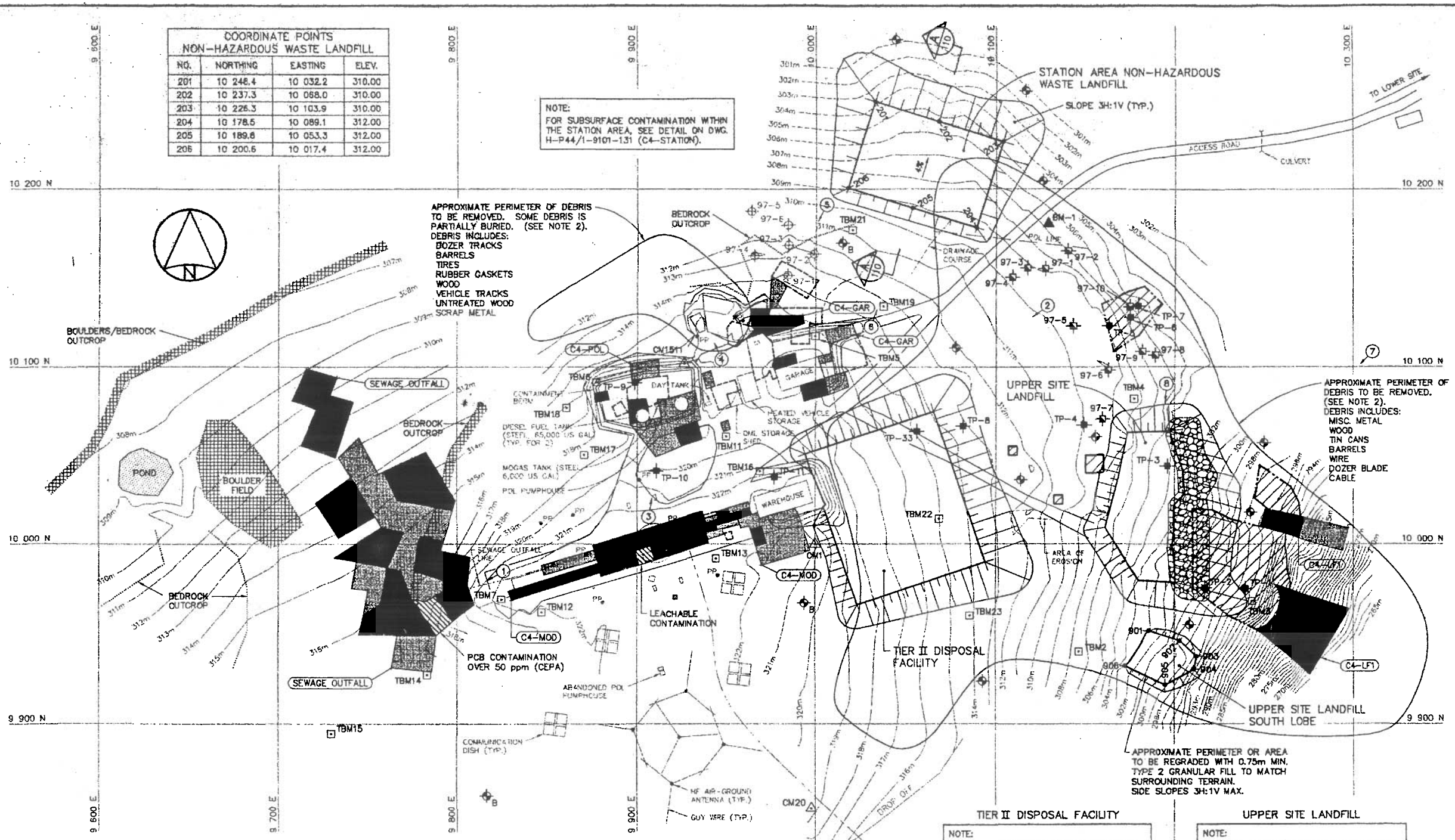
Tier II contaminated soil is to be placed in the landfill in lifts not exceeding 200 mm in loose thickness. The soil is to be compacted with the random action of tracked equipment. Type 6 granular fill is to be placed as intermediate fill to a maximum loose thickness of 200 mm over each layer of highly organic Tier II contaminated soil. The final cover of the landfill is to be constructed to specified thicknesses and grades, including the installation of geomembrane lining systems.

Record Drawings of the landfill construction are to be maintained by the Contractor and provided to the Owner (DCC/DND) upon completion of the project.

Following completion of the landfill closure, groundwater monitoring wells will be installed to facilitate monitoring of the landfill performance. A description of the landfill monitoring plan is in Section 3 of this report.

COORDINATE POINTS NON-HAZARDOUS WASTE LANDFILL			
NO.	NORTHING	EASTING	ELEV.
201	10 248.4	10 032.2	310.00
202	10 237.3	10 068.0	310.00
203	10 226.3	10 103.9	310.00
204	10 178.5	10 089.1	312.00
205	10 189.6	10 053.3	312.00
206	10 200.6	10 017.4	312.00

NOTE:
FOR SUBSURFACE CONTAMINATION WITHIN THE STATION AREA, SEE DETAIL ON DWG. H-P44/1-9101-131 (C4-STATION).



TIER II DISPOSAL FACILITY

NOTE:
SEE DWG. H-P44/1-9101-111 FOR TRENCH EXCAVATION AND INSTRUMENTATION PLANS, INCLUDING FINAL GRADE COORDINATE POINTS FOR THE TIER II DISPOSAL FACILITY.

UPPER SITE LANDFILL

NOTE:
SEE DWG. H-P44/1-9101-116 FOR TRENCH EXCAVATION AND INSTRUMENTATION PLANS, INCLUDING FINAL GRADE COORDINATE POINTS FOR THE UPPER SITE LANDFILL.

UPPER SITE LANDFILL - EXCAVATION

NOTE:
SEE DWG. H-P44/1-9101-115 FOR DETAILED PLAN AND SECTIONS OF THE PRIMARY LANDFILL EXCAVATION FOR THE UPPER SITE LANDFILL.

CONTAMINATED SOIL				
AREA NO.	APPROX. AREA (m^2)	ESTIMATED IN PLACE VOLUME (m^3)	REFERENCE POINT NORTHING	REFERENCE POINT EASTING
TIER I				
C4-LF1	327	33	10 003.4	10 269.3
C4-GAR	486	158	10 118.6	10 022.3
C4-MOD	1058	423	9 988.3	9 970.1
C4-POL-S	850	255	10 101.9	9 895.9
SEWAGE OUTFALL	2596	779	9 930.8	9 763.3
TIER II				
C4-LF1	1588	159	10 003.4	10 269.3
C4-GAR	542	227	10 129.3	9 992.7
C4-MOD	1841	512	9 988.1	9 830.1
C4-POL-S	293	107	10 059.2	9 936.8
SEWAGE OUTFALL	4586	1502	10 093.9	9 732.9
SEWAGE OUTFALL	240	96	LOCATED BENEATH CEPA	
HYDROCARBON - TYPE B				
C4-GAR	1583	782	10 118.6	10 022.3
C4-MOD	34	17	10 003.2	9 954.2
C4-POL-S	334	167	10 087.7	9 894.1
C4-STATION	6002	SEE NOTE 7	10 036.4	9 862.9
HAZARDOUS				
C4-MOD	77	38	9 988.3	9 901.3
SEWAGE OUTFALL	240	72	9 948.4	9 788.2

FOR CONTAMINATED SOIL DETAILS SEE DWGS. H-P44/1-9101-128 TO 133.

TEMPORARY BENCHMARKS				
NO.	COORDINATES NORTHING	COORDINATES EASTING	ELEV.	DESCRIPTION
2	9 939.841	10 148.674	307.530	13mm DIA. REBAR
3	9 967.808	10 243.154	295.833	REBAR
4	10 081.880	10 177.784	308.712	13mm DIA. REBAR
5	10 117.578	9 999.749	318.515	13mm DIA. REBAR
6	10 091.274	9 877.160	319.002	13mm DIA. REBAR
7	9 968.619	9 824.533	322.485	13mm DIA. REBAR
11	10 060.773	9 950.176	319.443	SPIKE
12	9 981.191	9 846.682	321.680	50mm x 50mm WOODEN STAKE
13	9 991.824	9 944.470	322.811	50mm x 50mm WOODEN STAKE
14	9 926.940	9 783.182	317.078	50mm x 50mm WOODEN STAKE
15	9 894.539	9 729.469	315.643	50mm x 50mm WOODEN STAKE
16	10 041.136	9 969.113	321.393	SPIKE
17	10 050.143	9 870.515	318.608	50mm x 50mm WOODEN STAKE
18	10 078.750	9 860.896	316.926	50mm x 50mm WOODEN STAKE
19	10 134.323	10 036.965	313.428	
21	10 177.412	10 019.938	311.096	
22	10 014.140	10 068.484	315.374	
23	9 959.507	10 085.386	314.493	

SURVEY CONTROL MONUMENTS				
NO.	COORDINATES NORTHING	COORDINATES EASTING	ELEV.	DESCRIPTION
1	10 000.000	10 000.000	321.116	CAM-4 BASELINE STA. 0+00.0
20	9 853.309	9 997.655	319.410	GNWT MON. 50590-21
1511	10 102.015	9 926.103	319.138	CAM-4 BASELINE STA. 4+13.4

COORDINATE POINTS UPPER SITE LANDFILL - SOUTH LOBE		
NO.	NORTHING	EASTING
901	9 951.1	10 186.1
902	9 945.6	10 202.9
903	9 937.2	10 211.9
904	9 929.8	10 210.7
905	9 921.4	10 195.0
906	9 932.0	10 172.6

National Defence / Défense nationale

Headquarters
Quartier général

General Notes:

1. ALL ELEVATIONS ARE REFERENCED TO MEAN SEA LEVEL.
2. ALL NON-HAZARDOUS DEBRIS WITHIN PLAN AREA TO BE PLACED IN STATION AREA NON-HAZARDOUS WASTE LANDFILL.
3. HORIZONTAL CONTROL REFERENCED TO SURVEY CONTROL MONUMENTS.
4. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
5. FOR MONITORING WELL INSTALLATION DETAILS, SEE DWG. H-P44/1-9101-135. EXACT LOCATIONS TO BE FIELD DETERMINED BY THE ENGINEER.
6. FOR THERMISTOR/PIEZOMETER INSTALLATION LOCATIONS, SEE DWGS. H-P44/1-9101-111 AND 116.
7. HYDROCARBON CONTAMINATION AT DEPTH TO BE REMEDIATED THROUGH IN-SITU LANDFARMING.

Legend:

- CM1 SURVEY CONTROL MONUMENT
- TBM5 TEMPORARY BENCHMARK
- TIER I CONTAMINATED SOIL
- TIER II CONTAMINATED SOIL
- HYDROCARBON - TYPE B CONTAMINATED SOIL
- HAZARDOUS CONTAMINATED SOIL
- TEST PIT LOCATION (1993)
- TEST PIT LOCATION (1997)
- 201 COORDINATE POINT
- 1 PHOTOGRAPHIC VIEWPOINT
- EXISTING MONITORING WELL LOCATION
- PROPOSED MONITORING WELL LOCATION (10)
- B PROPOSED BACKGROUND MONITORING WELL LOCATION (3)
- LANDFILL EXCAVATION AREA
- BM-1 PROPOSED PERMANENT BENCHMARK LOCATION (1)

No.	DATE	REVISION	REVISION	APPR.

ASSOCIATION OF PROFESSIONAL ENGINEERS, GEOLOGISTS AND GEOPHYSICISTS OF THE NORTHWEST TERRITORIES
PERMIT NUMBER P 087
UMA ENGINEERING LTD.

S. M. STOWKOWY
LICENSEE
N.W.T.

umq

SCALE - ECHELLE 20 10 0 20 40 60m

PROJECT - PROJET
CAM-4 PELLY BAY

DEW LINE CLEAN UP

TRADE - METIER: SITING
DATE: 2001-02-28

SUBJECT - SUJET
STATION AREA
SITE PLAN

PRODUCTION		CONCURRENCE - ASSENTIMENT	
DESIGNED ETUDIE	TMS		DES OFF AGENT CONCEPT
DRAWN DESSINE	CAE		SECT HD CHEF SECT
CHECKED VERIFIE	RKM		DES MGR GEST CONCEPT
COORDINATION	TMS	REVIEWED - REVU	

DWG. NO. - DESSIN NO.
H-P44/1-9101-105

Canada

COORDINATE POINTS EAST AND SOUTH LOBE REGRADING		
NO.	NORTHING	EASTING
701	20 573.4	18 957.8
702	20 561.8	18 963.5
703	20 544.0	18 958.2
704	20 533.5	18 953.3
705	20 524.4	18 955.0
706	20 514.7	18 965.8
707	20 504.7	18 981.0
708	20 502.4	18 958.0
709	20 517.3	18 931.8
710	20 416.4	18 729.0
711	20 403.9	18 695.9
712	20 417.8	18 699.0
713	20 421.8	18 702.5
714	20 431.5	18 731.1

COORDINATE POINTS NON-HAZARDOUS WASTE LANDFILL			
NO.	NORTHING	EASTING	ELEV.
251	20 418.1	18 820.5	140.43
252	20 432.1	18 835.5	140.43
253	20 446.1	18 850.5	140.43
254	20 416.1	18 878.5	141.25
255	20 402.1	18 863.5	141.25
256	20 388.1	18 848.5	141.25

LOWER SITE LANDFILL – NORTH LOBE

NOTE:
SEE DWG. H-P44/1-9101-121 FOR DETAILED PLAN AND SECTION OF THE LOWER SITE LANDFILL – NORTH LOBE.

LOWER SITE LANDFILL
NORTH LOBE

LOWER SITE LANDFILL

LOWER SITE LANDFILL
EAST LOBE

LOWER SITE LANDFILL
SOUTH LOBE

LOWER SITE NON-HAZARDOUS WASTE LANDFILL

NOTE:
SEE DWG. H-P44/1-9101-122 FOR TRENCH EXCAVATION AND INSTRUMENTATION PLANS, INCLUDING FINAL GRADE COORDINATE POINTS FOR THE LOWER SITE LANDFILL.

EXCAVATE RIDGE TO ALLOW DRAINAGE ALONG TOE OF LANDFILL AND TO PREVENT PONDING. PLACE 0.75m MIN. TYPE 1 GRANULAR FILL ON THE LANDFILL TOE IN THIS AREA.

PLACE 0.75m MIN. TYPE 1 GRANULAR FILL ON SIDE SLOPES. (2H:1V MAX.)

APPROXIMATE PERIMETER OF AREA TO BE REGRADED WITH 0.5m MIN. TYPE 2 GRANULAR FILL SIDE SLOPES 3H:1V MAX.

APPROXIMATE PERIMETER OF SCATTERED DEBRIS TO BE REMOVED. (SEE NOTE 2.)
DEBRIS INCLUDES:
TIN CANS
GLASS
WIRE ROPE
BARRELS

APPROXIMATE PERIMETER OF AREA TO BE REGRADED WITH 0.75m MIN. TYPE 2 GRANULAR FILL TO MATCH SURROUNDING TERRAIN. SIDE SLOPES 3H:1V MAX.

SLOPE 3H:1V (TYP.)

UNDEVELOPED BORROW AREA #1

BORROW AREA #1

ABANDONED ROAD

EXISTING DRAINAGE COURSE

TBM110 TBM150 TBM154 TBM29 TBM104 TBM103 TBM28

TP-18 TP-19 TP-20 TP-21 TP-22 TP-23 TP-24 TP-34

97-14 97-15 97-16

BM-3 BM-2

C4-035

TEMPORARY BENCHMARKS				
NO.	COORDINATES NORTHING	COORDINATES EASTING	ELEV.	DESCRIPTION
28	20 553.034	18 913.510	134.742	
29	20 449.339	18 814.476	136.940	
103	20 577.853	18 982.703	133.782	CUT CROSS IN ROCK
104	20 313.985	18 757.653	142.703	CUT CROSS IN ROCK
110	20 530.892	18 649.779	132.062	SPIKE
154	20 493.242	18 815.308	134.703	SPIKE
160	20 530.204	18 774.741	129.097	

CONTAMINATED SOIL				
AREA NO.	APPROX. AREA (m^2)	ESTIMATED IN PLACE VOLUME (m^3)	REFERENCE POINT NORTHING	REFERENCE POINT EASTING
TIER I				
C4-035	727	218	20 489.8	18 852.1

FOR CONTAMINATED SOIL DETAILS SEE DWGS. H-P44/1-9101-128 TO 133.

National Défense Defence nationale

Headquarters
Quarter général

General Notes:

1. ALL ELEVATIONS ARE REFERENCED TO MEAN SEA LEVEL.
2. ALL NON-HAZARDOUS DEBRIS WITHIN PLAN AREA TO BE PLACED IN LOWER SITE NON-HAZARDOUS WASTE LANDFILL.
3. HORIZONTAL CONTROL REFERENCED TO SURVEY CONTROL MONUMENTS.
4. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
5. FOR MONITORING WELL INSTALLATION DETAILS, SEE DWG. H-P44/1-9101-135. EXACT LOCATIONS TO BE FIELD DETERMINED BY THE ENGINEER.
6. FOR THERMISTOR/PIEZOMETER INSTALLATION LOCATIONS, SEE DWG. H-P44/1-9101-122.

Legend:

- TBM151 TEMPORARY BENCHMARK
- TIER I CONTAMINATED SOIL
- TEST PIT LOCATION (1993)
- TEST PIT LOCATION (1997)
- COORDINATE POINT
- (14) PHOTOGRAPHIC VIEWPOINT
- BODY OF WATER
- PROPOSED MONITORING WELL LOCATION (8)
- PROPOSED BACKGROUND MONITORING WELL LOCATION (1)
- BM-2 PROPOSED PERMANENT BENCHMARK LOCATION (2)
- LANDFILL EXCAVATION AREA

No.	DATE	REVISION	REVISION	APPR.

REGISTERED PROFESSIONAL ENGINEERS N.W.T. S. M. STOMKOWY LICENSEE

THE ASSOCIATION OF PROFESSIONAL ENGINEERS, GEOLOGISTS AND GEOPHYSICISTS OF THE NORTHWEST TERRITORIES PERMIT NUMBER P 007 UMA ENGINEERING LTD.

SCALE – ECHELLE 10 5 0 10 20 30m

PROJECT – PROJET
CAM-4 PELLY BAY

DEW LINE CLEAN UP

TRADE – METIER SITING | DATE 2001-02-28

SUBJECT – SUJET

LOWER SITE LANDFILL AREA
SITE PLAN

PRODUCTION		CONCURRENCE – ASSENTIMENT	
DESIGNED ETUDIE	TRT		DES OFF AGENT CONCEPT
DRAWN DESSINE	DAE		SECT HD CHEF SECT
CHECKED VERIFIE	RRM		DES MGR DIRECT CONCEPT
COORDINATION	SMS	REVIEWED – REVU	

DWG. NO. – DESSIN NO.
H-P44/1-9101-107

Canada

3. LANDFILL MONITORING PROGRAM

All landfills and disposal facilities are to be monitored to assess the performance of the facilities and to mitigate potential impacts to neighbouring lands.

For Non-Hazardous Waste Landfills, the landfill monitoring requirements include:

- Visual Monitoring;
- Active Layer Groundwater Sampling; and,
- Soil Sampling.

For Tier II Disposal Facilities, the landfill monitoring requirements include:

- Visual monitoring;
- Active layer Groundwater Sampling;
- Soil Sampling; and,
- Thermal Monitoring.

The following sections describe the various requirements of the landfill monitoring program.

3.1 Landfill Monitoring Requirements

The specific components of the landfill monitoring program are based on the type of landfill, and the remediation or closure design. For any specific landfill, these components may include:

Visual Monitoring: the physical integrity of the landfill will be inspected and reported using hand drawn sketches. Documentation will include:

- Evidence of settlement, ponding, frost action, erosion, and lateral movement.

- Sloughing of berms, thermal contraction cracks, etc.

Photographic records will be provided from ground and air, to document the general condition of the landfill and to substantiate all recorded observations. The location of all photographic viewpoints will be referenced to existing monuments.

Soil and Active Layer Water Monitoring: the soil and active layer water monitoring program will consist of baseline/background assessment, as well as contaminant evaluation. Background conditions represent soil and water quality from an area not impacted by the landfill. Background (naturally occurring) values will be obtained from samples collected from areas that have not been directly influenced by activities at the DEW Line site, but are indicative of the pre-vailing geochemistry. These samples are taken hydraulically upgradient and at some distance from the landfill. Baseline conditions refer to existing soil and water quality at the landfill area, prior to any remediation and/or construction work being carried out. These samples are generally collected from areas both up and downgradient of the landfill.

Soil and active layer water samples (where required) will be collected prior to construction/closure of a landfill, to represent background as well as baseline conditions. The results of subsequent landfill monitoring events will be compared to these baseline and background values to evaluate any potential changes in environmental conditions.

In general, one monitoring well will be installed upgradient and two to three wells will be installed downgradient of the landfill during the construction phase. Using water elevation data from a minimum of three wells allows assessment of the hydraulic gradient and flow velocities. Review of analytical data from water samples collected from wells up and downgradient allows evaluation of potential impacts associated with the landfill. Soil samples will be collected from the toe of the landfill, generally from the same locations as the monitoring wells. Contamination in soil samples at the toe of the landfill reflects chronic input from water that may have infiltrated the landfill, and is an important indicator of contaminated leachate.

Soil samples will be transported to an accredited laboratory for the following analyses:

- Polychlorinated biphenyls (PCBs);
- Total petroleum hydrocarbons (TPH); and,
- Inorganic elements including: arsenic, cadmium, chromium, cobalt, copper, lead, nickel, and zinc.

Prior to collection of samples from a monitoring well, the well will be purged and allowed to reach equilibrium. Physical measurements shall be collected prior to and after purging and shall be referenced to the top of the monitoring well pipe. Parameters include:

- Water elevation;
- Total depth of water;
- Presence of hydrocarbons; and,
- Hydrocarbon layer thickness (if appropriate).

Following withdrawal of a water sample, other physical measurements to be recorded include:

- Colour;
- Odour;
- pH;
- Conductivity; and,
- Temperature.

The water sample will be filtered, as required for specific analyses, and transferred into appropriate containers for transport to a laboratory for analysis. Parameters for analysis include:

- Inorganic elements: arsenic, cadmium, chromium, cobalt, copper, lead, nickel, and zinc (total and dissolved concentrations);

- PCBs; and,
- TPH.

If the landfill is in close proximity and hydraulically upgradient of a drinking water source, the water samples will be analyzed for the following parameters, in addition to the compounds and elements listed above:

- Inorganic elements with low detection limits (ppb); and,
- Major ions, hardness, and total dissolved solids.

The supplementary analyses provide additional information on the potential impacts related to the landfill, but do not necessarily provide an assessment of the potability of the water source. In the latter case, the results of the analysis of these drinking water samples will be compared to the most current version of Canadian and/or Territorial standards for drinking water for the parameters analyzed, in addition to comparison with background and baseline data.

Thermal Monitoring: geothermal analyses were carried out as part of the design to predict the length of time required for permafrost aggradation through landfills requiring leachate containment, as well as DCC Tier II soil disposal facilities. These analyses also provide information on the long and short term thermal regime in the ground, and the depth of the active layer in the cover material.

A thermal monitoring system provides measurement of subsurface ground temperatures, which allows comparison to and verification of the predicted ground temperatures. The thermal monitoring system consists of installation of thermistor strings, with 'thermistor beads' at selected intervals to provide ground temperature profiles at various locations within the landfill. The thermistor strings are attached to automated data-loggers that allow for remote collection. In general, a minimum of three thermistors will be installed at each landfill where permafrost aggradation through the landfill contents is an integral part of the design.

3.2 Landfill Monitoring Frequency

The landfill post-construction monitoring program consists of three phases:

3.2.1 Phase I: Monitoring of Conditions to Confirm that Equilibrium is Achieved

At Tier II Disposal Facilities, monitoring will take place on an annual basis, for an estimated period of five years following construction. The five-year term was selected on the basis that ground-temperature thermal regimes at these specific landfills will require three to five years to reach equilibrium.

At Non-Hazardous Waste Landfills, the Phase I monitoring may be carried out over a reduced frequency in the first, third and fifth years following construction.

An evaluation of all Phase I data will be carried out at the end of five years to confirm that thermal and chemical equilibrium had been achieved, and that no stability issues had been identified. The Phase I monitoring program may be extended, if required, to provide sufficient data to establish equilibrium conditions.

3.2.2 Phase II: Verification of Equilibrium Conditions Established during Phase I

The monitoring frequency in Phase II will be downgraded from Phase I, and is anticipated to be carried out according to the following schedule: year 7, year 10, year 15 and year 25. Year 25 would mark the end of the Phase II monitoring.

3.2.3 Phase III: Monitoring for Long Term Issues such as Liner Integrity, Permafrost Stability, and Significant Storm Events

At the end of the Phase II program, 25 years after construction, a re-evaluation of the landfill monitoring program will be carried out prior to initiating any Phase III program. The scope of the

Phase III monitoring program has not been included, but is anticipated to be based on a 10 year monitoring interval.

3.3 Interpretation of Landfill Monitoring Results

To effectively assess follow-up action requirements, it is necessary that monitoring results (thermal, chemical and visual) be interpreted in concert with one another. An increase in chemical concentrations, for instance, from one year to the next does not necessarily trigger remedial action if there is no other evidence of landfill instability.

Should potential problems be identified during the landfill monitoring program, the frequency and scope of the monitoring program will be increased. Following verification of the cause and extent of the problem, the scope of any remedial action will be reviewed, and implemented, as appropriate.

In all cases, mitigation requirements are dependent on the severity of the deficiency, and are to be assessed by a professional geotechnical engineer with northern engineering design and construction experience. In addition, it is recommended that the assessment and implementation of resulting remediation requirements be carried out in a staged approach to ensure that the proposed solutions address the specific requirements in a logical and cost effective manner.

3.3.1 Visual Monitoring

If the results of the visual inspection program indicate evidence of significant settlement, erosion, ponding, or frost jacking, it may be necessary to implement one or more of the following mitigative measures:

- Increase the frequency of the visual monitoring program;
- Place erosion protection material such as rip-rap, vegetation mats, etc.;

- Re-compact existing debris material and existing granular material;
- Place additional granular fill;
- Mitigate the cause of erosion or settlement by regrading, as required, to promote positive drainage away from the deficient landfill area.

It should be noted that settlement of the landfill surface may NOT necessarily result in failure of the landfill. However, settlement (typically differential settlement) that results in ponding and infiltration of surface water could lead to erosion and frost jacking problems.

If the visual monitoring program results indicate evidence of sloughing of landfill perimeter berms and thermal contraction cracks, it may be necessary to implement one or more of the following mitigative measures:

- Flatten granular berm slopes.
- Compact existing granular slopes.
- Place and compact additional granular fill material.
- Collect soil and water samples to monitor contaminant migration.

3.3.2 Soil and Groundwater Monitoring

The results of the soil and groundwater monitoring program will be compared against baseline data established prior to the initial landfill development or remediation program. Results of the analysis of soil and groundwater samples that show decreasing trends of contamination at the perimeter of existing landfills typically indicate that the implemented landfill remediation has been effective.

Conversely, if monitoring results indicate increasing levels of contamination, it may be necessary to implement one or all of the following:

- Increase the frequency of the monitoring program.

- Carry out a review and evaluation of the nature and extent of the contamination, including the incorporation of the results of the visual monitoring program. The major objective of this evaluation will be to determine if it is the result of ineffective design, material (i.e. liner) failure, improper compaction, selection and use of inadequate granular material, poor grading, etc. This evaluation may require intrusive investigation into and around the landfill.

- Depending on the results of the above, it may be necessary to remove and replace liner material, reconstruct containment berms, etc.

- Assess the requirement to excavate and dispose of the contaminated soil. This would include the delineation of the vertical and horizontal extent of the contamination.

- Excavate and dispose of contaminated soil, as required.

The requirement for the specific scope and extent of remediation, as outlined above, should also incorporate an evaluation of the potential environmental impacts of the contamination.

3.3.3 Thermal Monitoring

The results of the thermal monitoring program will be compared against the parameters for freezeback that were incorporated into the geothermal design of the landfills. It is important that the overall assessment of these results consider the results of both the visual and soil/groundwater monitoring programs. If the thermal monitoring results indicate ground temperatures that are significantly higher than predicted during the geothermal analysis carried out as part of the design, it may be necessary to implement one or more of the following:

- Increase the frequency of the recording and assessment of results from the thermal monitors.

- Establish, based on the results of the soil and groundwater monitoring programs, if groundwater, and/or soil contaminant levels beyond the perimeter of the landfill have increased. Assess the environmental impacts to determine the appropriate remediation requirements.

- If it is established that a slower than expected freezeback period has resulted in the migration of contamination beyond the landfill and depending on the results of the above environmental impact assessment, it may be necessary to implement one or more of the following:
  - Determine if the rate of freezeback progress is continuing, or if freezeback within the landfill has terminated.
  - Excavate and dispose of contaminated soil, as required.
  - Place additional granular cover material or other insulating material (Styrofoam insulation, vegetation) over the landfill to provide an increased insulation barrier over the landfill.
  - Reconstruct and/or re-saturate the perimeter berms of the landfill.

3.4 Review of Monitoring Results

An Environmental Working Group (EWG) has been established to provide technical support to the DEW Line Cleanup Steering Committee. This working group is comprised of qualified engineers and/or environmental scientists with expertise in environmental remediation and clean up in northern climates. The EWG has two designated representatives from each of the Parties, Owner and Nunavut Tunngavik Incorporated (NTI).

During the monitoring program, the EWG will review the results of the monitoring program in accordance with the methodology as described in the previous section. The results of the review and any recommendations regarding changes to the monitoring plan and/or remediation requirements will be reported to the Steering Committee.

The requirement for Phase III monitoring will be evaluated at the end of the 25 years (end of Phase II). Monitoring may be terminated if the performance of the landfill was satisfactory over the monitoring period, from an environmental, geotechnical and thermal perspective, as appropriate. The assessment of satisfactory performance will be carried out jointly by the NTI and DND.

At the termination of the monitoring period, a decision on the disposition of the above ground installations of monitoring wells and thermistors, and associated marker posts, should be made. The decommissioning of monitoring installations shall be carried out in a manner such that, if required, they may be re-activated. Electronic equipment shall be returned to DND for re-use or disposal as appropriate, and other non-hazardous materials shall be removed from site and disposed of in an appropriate landfill area.