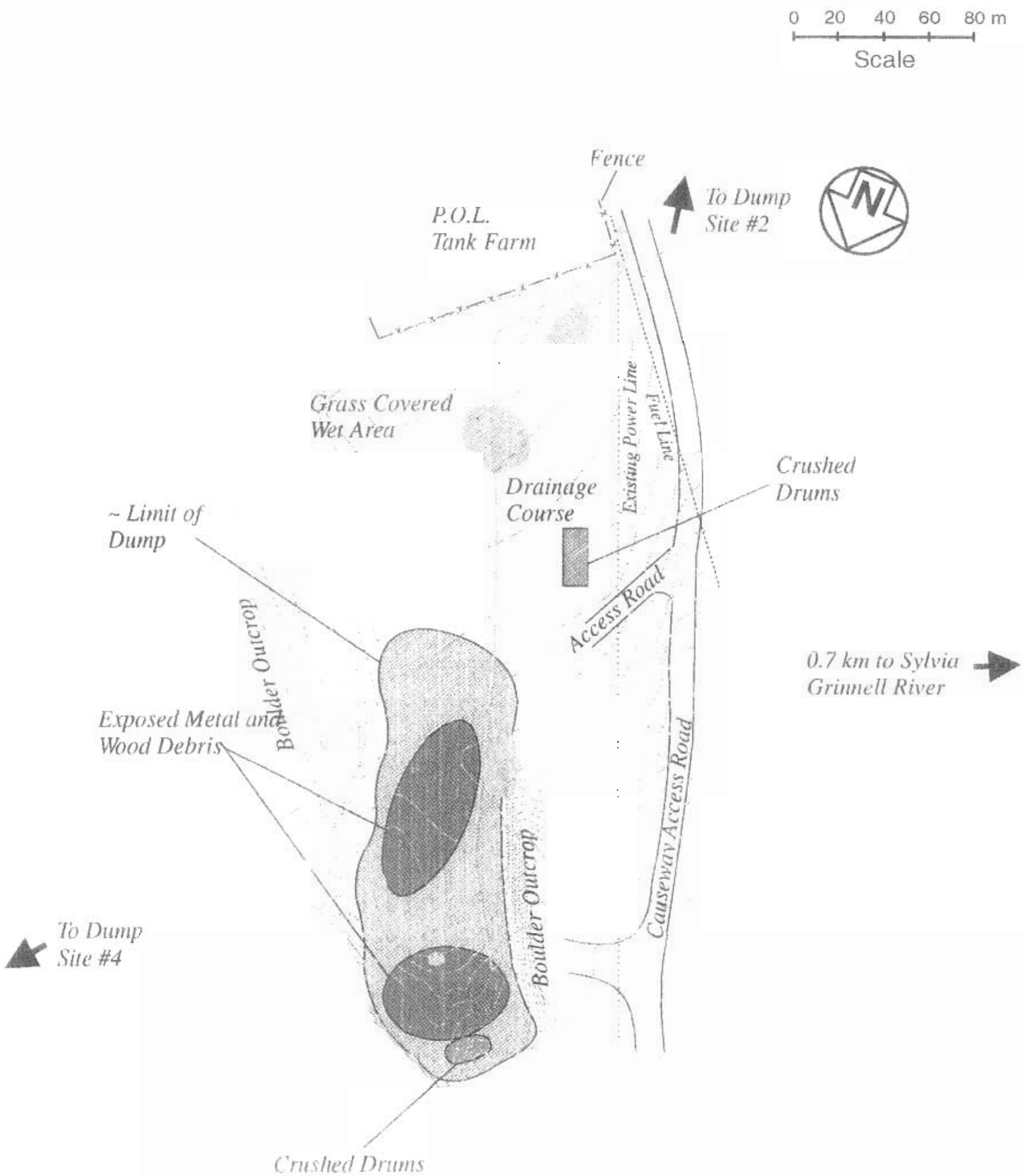
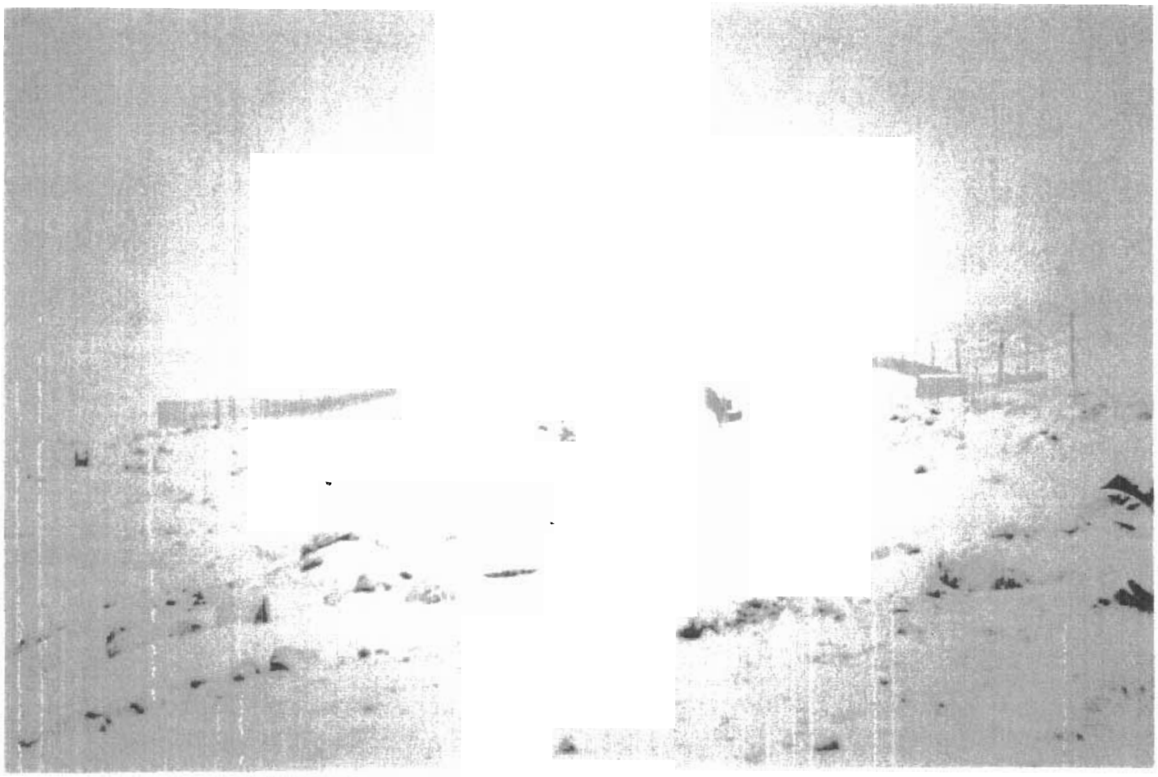
Map V-19: Dump Site #3 in August 1994 Prior to Construction of the New Municipal Landfill

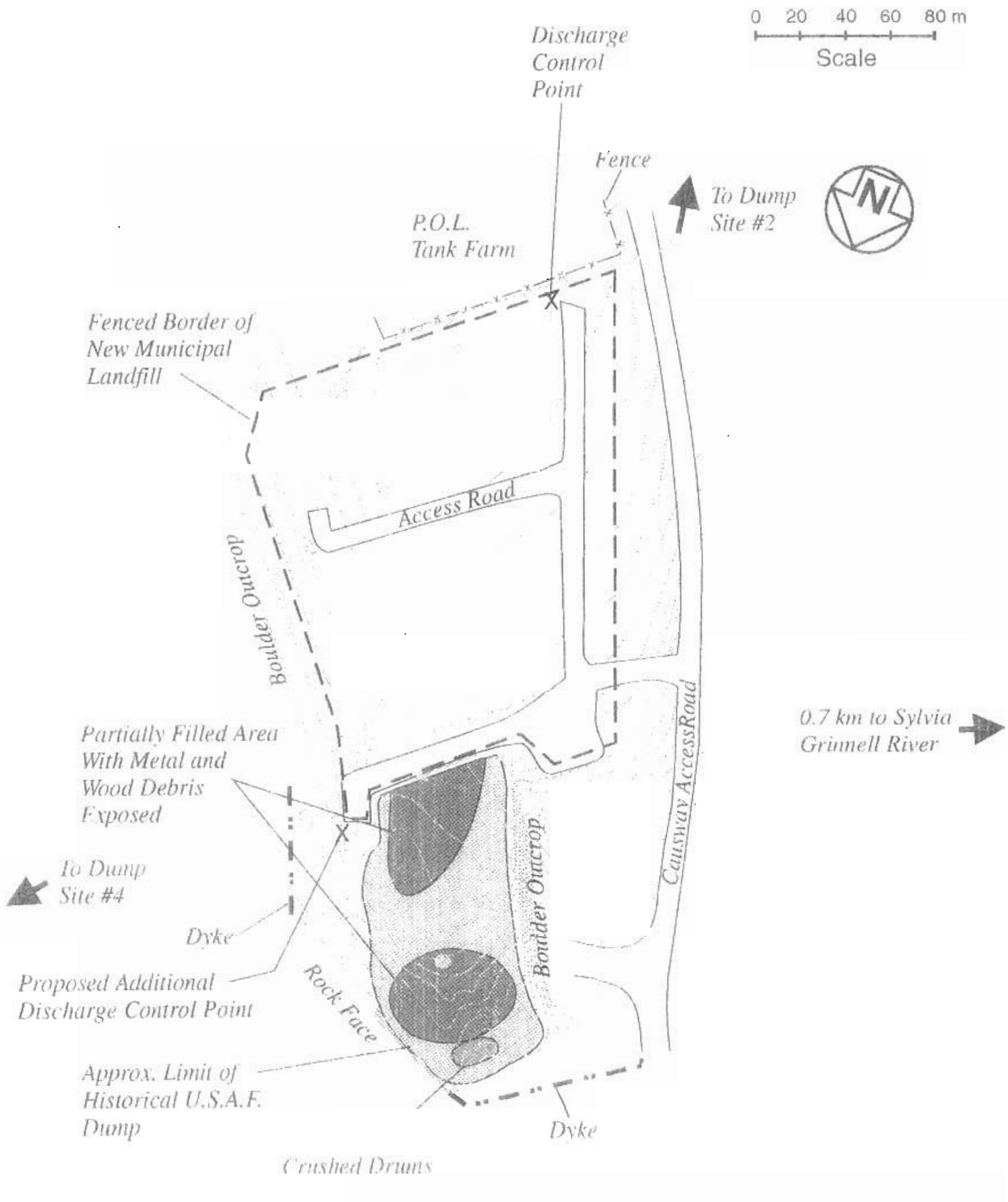


Map adapted from the Preliminary Report on Cleanup of Waste Disposal Sites Near the Town of Iqaluit, NWT
Prepared by UMA Engineering Ltd., April 1994



Photograph V-39: The New Municipal Landfill as seen from the west.

Map V-20: Dump Site #3 including the New Municipal Landfill and the Historical USAF Dump



Map adapted from the Landfill Operation and Maintenance Manual for Site #3 in West 40. Prepared by UMA Engineering Ltd., Dec. 1994

2. *Results of Previous Studies*

In their report on the state of waste disposal practices in the town of Iqaluit, the engineering firm Oliver, Mangione, McCalla and Associates (1983) made several recommendations for changes to the manner in which wastes were disposed of and for cleanup of dump sites previously used for municipal wastes. Their recommendations regarding Dump Site #3 were limited to the removal of visible debris, consolidation of affected areas and addition of cover with regrading. Their study comprised a literature review and visual inspection of the sites and did not include sampling to investigate potential contamination of the area.

In 1991 UMA Engineering Ltd. presented results of a preliminary engineering report on the same subject, indicating the presence of subsurface contamination in the north end of Dump Site #3. PCB soil concentrations exceeded DCC Tier I in three boreholes located at the northern end of the site. Concentrations of inorganic elements, in particular copper, lead and zinc were also elevated above the criteria (Tier II) in the same area. A number of Acid/Base/Neutral priority pollutants were detected in water at levels which exceeded the CCME criteria. Phenol (2.8 ppm), anthracene (10.6 ppm), benzofluoranthenes (15.3 ppm), benzo(a)pyrene (17 ppm), fluoranthene (31.5 ppm), indeno(1,2,3-c,d)pyrene (3.9 ppm), phenanthrene (26.3 ppm), pyrene (45.3 ppm) and pentachlorophenol (0.71 ppm) were all detected at levels exceeding the CCME FAL Remediation Criteria for those compounds. The level of chrysene in soil (14.9 ppm) exceeded the BCMOE Level C Remediation Criteria (10 ppm). Total petroleum hydrocarbons (TPH) values were also elevated above the GNWT R/P remediation criteria (500 ppm) at the north end of the site.

Proposals by Hardy BBT Engineering Ltd. for cleanup of Dump Site #3 are part of a subcontracted report appended to the UMA document (1991). Hardy BBT made recommendations based on the borehole data which included coverage of exposed waste with additional granular material followed by reseeding. In addition, they outlined the materials that would be suitable for incorporation into the two dykes requiring construction in the north and northeast corners of the dump, stating that "under no circumstances should silt such as that encountered [in the southeastern corner of the site] be incorporated into dyke construction".

The Environmental Site Assessment volume of the Avati report (1993a) presented analytical results for three soil and four water samples collected in Dump Site #3. All three soil samples were collected from the south end of the site and were analyzed for inorganic elements and TPH. None of the analytes were elevated above the applicable criteria. Water, collected from active drainages and standing pools of water around the site, contained elevated concentrations of chromium, copper and zinc, and phthalates, phenol and cresol.

The Remediation Options volume of the Avati report (1993b) outlined types of waste material and contaminants present in Dump Site #3. Using data from the Environmental Site Assessment volume and from the 1991 UMA Engineering report, this volume identified contaminants exceeding the CCME C/I Remediation criteria in soils collected from the dump. Although copper, lead, zinc and TPH levels in soils from the site exceeded the applicable criteria, concentrations of PCBs, mercury or nickel were not significantly elevated in any of the soils analyzed as outlined in this volume of the report. In fact, PCBs (from below the detection limit to 3.8 ppm) did not exceed the more stringent R/P criterion. The section outlining chemicals reported to exceed the CCME FAL Remediation Criteria for water in the Site Assessment volume included lead, iron, zinc and chromium amongst the inorganic elements. Although reported zinc levels did exceed the criterion and concentrations of chromium exceeded the lower limit of the remediation criterion, examination of the Site Assessment volume indicated that lead was not detected in any of the water samples collected, and iron did not form part of the analyses. Di-n-butylphthalate and bis(2-ethylhexyl)phthalate exceeded the criteria as reported. The inclusion of phenol and cresol in the summary of contaminants exceeding the water criteria requires some qualification. Analyses for these compounds were performed in duplicate. Cresol concentrations for the sample and its analytical duplicate were 14 ppb and undetectable, respectively with a detection limit of 1 ppb. No explanation or discussion was provided for the discrepancy, and the two results were not averaged (using half the detection limit for the undetectable). Phenol duplicates had concentrations of 1.2 ppb and below the detection limit. Values were similarly not averaged in the discussion of the results.

In its Remediation Options volume, Avati (1993b) assigned Dump Site #3 the highest NCSCS score of all the sites investigated (84), suggesting that it represents a greater threat to the environment than the Upper Base. Avati recommended the following cleanup plan for Dump Site #3 based, in part, on the site's NCSCS score: excavation of the landfill and contaminated media followed by sorting of wastes and shipment of **all** materials off-site (industrial and hazardous wastes to be shipped south to Canadian or US disposal facilities). Two other similar options were also considered by Avati; both of these also involved excavation of the dump. Although the authors detail some of the many problems inherent in excavating a dump, they maintain that this is the best possible option for the remediation of Dump Site #3.

In its report on the cleanup of waste disposal sites around Iqaluit, UMA (1994a) concluded that Dump Site #3 is much more stable than Dump Sites #1, #4 or #5 and recommended that the extent of contamination in soils at the northern end of the site should be determined before a cleanup plan is developed. The authors suggest that, based on current data, coverage of waste areas followed by reseeding may be an adequate cleanup measure. Figure 6-3 of the UMA report shows plans for cleanup and stabilization of the dump and includes construction of dykes to prevent contaminant migration to the north or northeast, as recommended in the 1991 UMA assessment of the site. Their discussion of the 1991 results indicated that the potential for leachate generation with attendant contaminant migration to the foreshore flats south of the site also needs to be addressed.

Two additional reports by UMA (1994b, 1994c) detail the operation and maintenance of the new municipal landfill, built in Dump Site #3 in October 1994. Figure 3 of the Maintenance Plan for the site (UMA 1994c) outlines the configuration of the new landfill site and is provided in Annex A of this chapter. The design includes a leachate monitoring system and a manual for its operation and maintenance (UMA 1994b). It was suggested in the manual that runoff from the landfill should be sampled at the discharge culvert in the southwest corner of the site on a monthly basis (May through October) (UMA 1994b). The design also incorporates rerouting of drainage in the portion of Dump Site #3 not included as part of the new landfill (see Figure 3, Annex A), but does not include leachate monitoring from this area of the site.

3. Current Sampling Program

The ESG conducted its sampling program at Dump Site #3 on August 14th, 1995, before construction of the new landfill commenced. In view of the analytical results obtained from twenty boreholes drilled as part of the UMA work (1991), the current sampling program focused on drainage channels and catchment areas into which the migration of contaminants was possible. A total of seven soil samples were collected, five from the north and two from the southern end of the site (Map V-21). Two samples of vegetation were collected from two different sampling locations. Two freshwater samples were collected from pools of standing water in the northern half of the site, and a single water sample was obtained from a borehole at the southern end of the largest area of concentrated wastes. Detailed descriptions of individual sampling locations and vegetation collected and surveyed are provided in Section F, Chapter IV of the Appendices.

Map V-21: Sample Locations at Dump Site #3, Site of the New Municipal Landfill

Map adapted from the Preliminary Report on Cleanup of Waste Disposal Sites Near the Town of Iqaluit, NWT
Prepared by UMA Engineering Ltd., April 1994

4. Analytical Results

The analytical results for this and all other sites can be found in Chapter V of the Appendices. One soil sample and three water samples contained inorganic elements or PCBs in excess of the DCC (Map V-22).

i. Inorganic Elements

Six of the seven soil samples collected at Dump Site #3 were analyzed for inorganic elements. Mean levels of all elements investigated were below the DCC (Figure V-13). However, the maximum concentrations of cadmium (5.2 ppm), lead (840 ppm) and zinc (1080 ppm) exceeded the DCC Tier II for those elements.

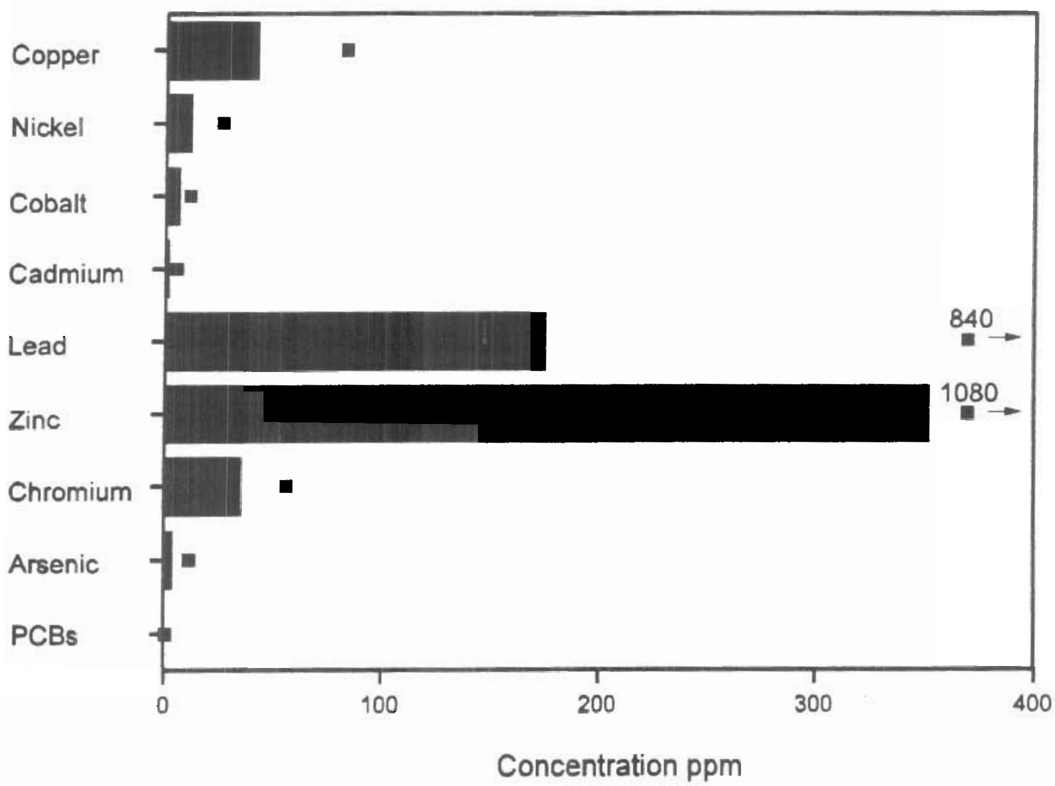


Figure V-13: Mean and Maximum Inorganic Element and PCB Concentrations in Soils Collected at Dump Site #3.

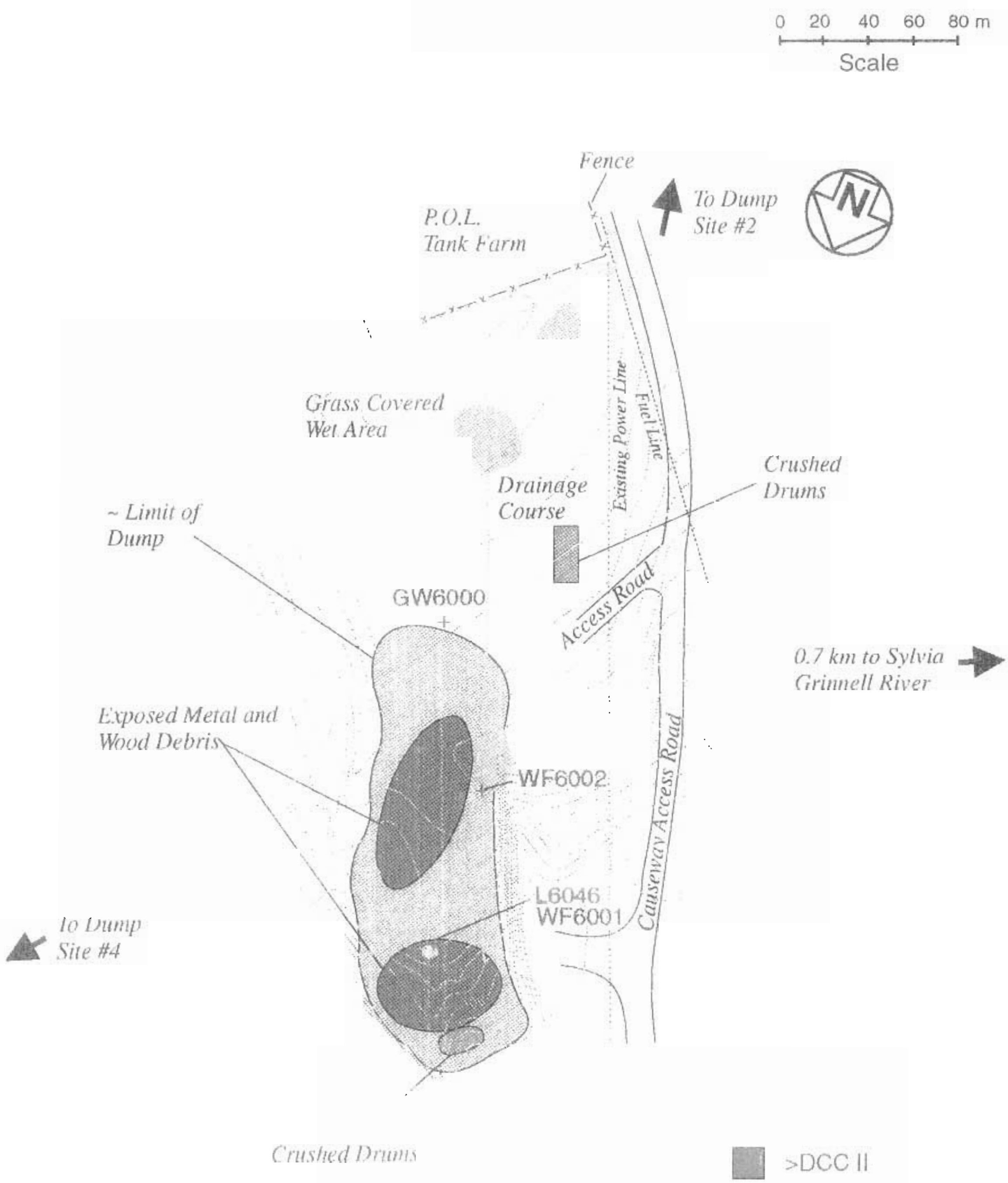
Contaminants at concentrations exceeding the DCC were found in only one sample, L6046, collected from the bottom of a small drainage catchment on the south side of the northernmost debris pile (Photograph V-40).

One of the two plant samples collected was analyzed for inorganic contaminants. Concentrations of inorganic elements in L6044P (*Salix arctica*) were not significantly elevated above mean background plant levels.

All three water samples were analyzed for inorganic elements. Zinc was detected in two of the samples. WF6001, a sample of standing water collected from a drainage catchment on the south side of the northernmost debris pile, contained levels of zinc (0.14 ppm) which were 4.6 times greater than the CCME FAL Remediation criterion (0.03 ppm). Zinc concentrations in the soil sample collected from the bottom of the same drainage catchment (L6046) were significantly higher than the DCC Tier II for that element (see above). Zinc was also detected in the water sample collected on the west side of the southernmost debris pile (WF6002) but did not exceed any criteria for zinc in water. The ground water sample (GW6000) collected from UMA (1991) borehole #13 situated at the south end of the southernmost debris pile contained levels of copper (0.012 ppm) which exceeded the CCME FAL Remediation criterion (maximum 0.004 ppm) for that element (Photograph V-41).

Cadmium, lead and zinc are leaching from Dump Site #3, as evidenced in soil from the bottom of a drainage catchment at the north end of the site. Elevated concentrations of zinc were present in water collected from the same drainage catchment and from a borehole which suggests that the migration of inorganic contaminants may be occurring within the site. Vegetation in Dump Site #3 did not contain elevated concentrations of inorganic elements, indicating that impact has been minimal.

Map V-22: Samples Exceeding the Cleanup Criteria, Dump Site #3



Map adapted from the Preliminary Report on Cleanup of Waste Disposal Sites Near the Town of Iqaluit, NWT.
Prepared by UMA Engineering Ltd., April 1994

ii. Polychlorinated Biphenyls (PCBs)

All seven soil samples collected were analyzed for PCBs. Mean PCB levels in soils (0.33 ppm) from the dump were 330 times greater than mean background soil concentrations (0.001 ppm), but did not exceed the DCC (Figure V-13). Five of the seven samples analyzed contained PCBs at levels significantly elevated above background.

Both plant samples collected at Dump Site #3 were analyzed for PCBs. No PCBs were detected in L6043P. Aroclor 1260 was detected (but unquantifiable) at very low levels in L6044P. Neither of the other two Aroclors was detected in this sample.

Two of the three water samples collected were analyzed for PCBs. Water collected from the pool on the west side of the southernmost debris pile (WF6002) contained levels of PCBs (0.0086 ppb) 8.6 times greater than the CCME FAL Remediation Criteria (0.001 ppb, Photograph V-42). Water from this pool drained south to a flat marshy area dominated by sedges, and then into the ditch next to the causeway access road. Ultimately the water from this area enters Frobisher Bay via Dump Site #2. The levels of PCBs in water collected from UMA (1991) borehole #13 (GW6000) were below the limit of detection.

Soils in Dump Site #3 contain concentrations of PCBs elevated above background levels, but not in excess of the DCC. The presence of PCBs in a water sample from the site suggests that these contaminants may be transported off-site and towards the marine environment. Vegetation in Dump Site #3 was unaffected by elevated concentrations of PCBs in soils.

iii. Other Organic Contaminants

One soil sample (L6047) from Dump Site #3 was analyzed for pesticides. The total concentration of pesticides (0.29 ppm) did not exceed the BC (2 ppm), Québec (2 ppm) or Netherlands (3 ppm) Level B remediation criteria. Eleven of the 22 pesticide analytes were detected, but none of the pesticides were present at concentrations which exceeded the Netherlands criteria for individual chlorinated or non-chlorinated pesticides.

One soil sample from Dump Site #3 was analyzed for the ABN suite of chemicals. Eight of the 54 analytes in the ABN suite were detected in soil sample L6046. Of the eight compounds detected, two were present at levels exceeding the relevant criteria. The level of phenol detected (1.0 ppm) was equivalent to the CCME R/P Remediation Criterion for soils, while benzofluoranthenes (1.3 ppm) were present at levels exceeding the BCMOE Level B criterion (1.0 ppm). Chrysene (0.9 ppm) was detected at a concentration which approached the BCMOE Level B remediation criterion. Pyrene (1.2 ppm), benz(a)anthracene (0.5 ppm), benzo(a)pyrene (0.7 ppm), indeno(1,2,3-cd)pyrene (0.6 ppm) and benzo(ghi)perylene (0.6 ppm) were all detected, but did not exceed the applicable criteria.

L6046 was also analyzed specifically for PAHs. Although many of the PAHs are included in the ABN suite of analyses, the specificity of the targeted analyses increase the accuracy of the reported results. In this case, the PAH results from the targeted analyses were consistently greater than those from the ABN suite of analyses. In the following discussion reported concentrations of compounds for which a surrogate standard was used are corrected for percent recovery. Poor recovery of surrogate standards was reported for naphthalene d-8 (18%), 2-methylnapthalene d-10 (22%), acenaphthene d-10 (48%), chrysene d-12 (51%) and dibenz(ah)anthracene d-14 (59%). As determined from the ABN analyses of the same soil sample, benzofluoranthenes (1.9 ppm) were detected at concentrations in excess of the BCMOE Level B criterion. Chrysene results from the PAH analyses after correction for recovery (2.4 ppm) were appreciably greater than for the ABN suite (0.9 ppm). As determined in the PAH analyses, therefore, chrysene levels in soil sample L6046 are significantly elevated above the BCMOE Level B Remediation Criterion. Alkylated PAH data exhibited a signature common to petroleum products and reflected the impact of wastes contained within the dump site on the area.

Concentrations of PAHs in soil from Dump Site #3 exceeded the BCMOE criteria and the CCME R/P Remediation Criteria. Soil from the same location also contained elevated concentrations of inorganic elements.

5. Cleanup Recommendations

Results of the current assessment are consistent with previous studies that reported water and soils in Dump Site #3 to contain elevated levels of inorganic and organic contaminants (UMA 1991, Avati 1993a,b,c). Results for water samples collected under the current study, from drainage catchments and a borehole, indicate that zinc, copper and PCBs are present in leachate generated within the site. Results of the Avati study (1993a) suggest that cresol may be present in leachate originating within Dump Site #3, as well. Soils, also collected from the bottom of drainage catchments, contained pesticides and elevated levels of cadmium, lead, zinc, PAHs and phenol. Cadmium, lead and zinc were present in soils at one location (L6046) at levels exceeding DCC Tier II. Under the DLCU Protocol, soils containing inorganic elements in excess of the DCC Tier II level must removed from contact with the Arctic ecosystem.

The elevated levels of inorganic and organic contaminants in water and soils collected in the dump are not unusual given the nature of past land use in this area, nor is their presence in conflict with future use of part of the site as a municipal landfill. **However, the potential migration of contaminants into Frobisher Bay poses a considerable risk to the marine environment and constitutes a potential violation of Section 36 of the Fisheries Act.** Migration of contaminants to the north or northeast of Dump Site #3, in drainage channels previously making their course there, has been mitigated through the construction of dykes across these openings. Eastern and western migration of contaminants is prevented by the large bedrock outcrops present in those regions. However, drainage to the south remains open. **Therefore, taking into consideration evidence suggesting that contaminants present in the soils are migrating from the site via leachate, and the fact that drainage from the site ultimately enters Frobisher Bay to the south, any cleanup plans for this site should**

attempt to prevent water infiltration of the contaminated area and incorporate monitoring of leachate before discharge from the site.

Contrary to recommendations included in the Avati report (1993b), the DEW Line Cleanup Protocol directs that landfills not be removed unless they are "in unstable, high erosion areas". These conditions do not apply to Dump Site #3. More conservative measures to reduce the infiltration of the buried wastes by water would prevent contaminant migration while avoiding the potentially hazardous and costly removal of buried wastes. **As outlined in the DLCU Protocol "landfills that are located in stable areas which are not subject to erosion, but are identified as potential sources of contaminated leachate must be fully contained to prevent leachate migration".** "Containment" of the contaminated area can be achieved with the addition of sufficient granular material to cause the level of permafrost to rise above that of the buried wastes, effectively locking the contaminants into the soil. Prevention of water infiltration can be achieved through grading of the new surface and may be aided by the placement of a synthetic membrane or amended soils over the regraded area (UMA 1991). Following capping, leachate monitoring on a long-term basis should constitute part of the cleanup plan. Drainage from the area which has been channeled to run along the eastern border of the new landfill requires monitoring **for those contaminants determined to be present within the historical dump site** in a manner similar to that for leachate generated within the landfill (UMA 1994b). The construction of an additional discharge control point just outside the northeastern corner of the landfill, in which drainage from the old dump would collect and could therefore be monitored, may satisfy this requirement (see Map V-20).

Should chronic leaching of contaminants from either the new landfill or the historical dump site be detected, it may become necessary to establish further drainage control measures. Construction of a ponding area outside and southwest of the landfill would slow the rate of drainage and hence permit settling of particulate matter. Drainage could be rerouted through a new culvert which would pass under the causeway access road immediately across from the southern limit of the new landfill and north of the existing culvert. A ponding area could then be constructed on the flat area located well above Dump Site #2 and the limit of high tide. Additional control of contaminant migration could be achieved with the installation of organic absorbent booms outside the ponding area. Should a settling pond not be incorporated into the amended landfill design, booms could be placed outside the culvert which currently acts as part of the landfill's discharge control. Sedges planted along the drainage ditch connecting Dump Sites #3 and #2 would also reduce particulate transport and bind inorganic elements through their uptake.

With construction of the new landfill, buried wastes located where the north end of the landfill is now situated were excavated and deposited in the area immediately outside the north end of the new landfill. Any exposed debris which may contain hazardous materials, in this and other areas of the dump, should also be removed and handled as outlined in the DLCU Protocol, before covering the area. Non-hazardous exposed debris should removed to an engineered landfill at the North 40 (refer to Implementation section, Chapter II), before covering the area with additional fill. In addition, it should be confirmed that materials from the southern end of the site were not incorporated into the newly constructed dykes at the north end and northeast corner of the site (Hardy BBT in UMA 1991).

Photograph V-40: L6046 and WF6001 containing elevated levels of zinc, phenol and PAHs and zinc, respectively, were collected in this drainage catchment.

Photograph V-41: Ground water sample GW6000 was collected from UMA borehole pipe #13, pictured here, and contained elevated concentrations of copper

Photograph V-42: Water sample WF6002, collected from the drainage catchment pictured here, contained elevated levels of PCBs.

G. Dump Site #4: Municipal Dump

1. General

Dump Site #4 is situated on the top of a steep slope overlooking Koojesse Inlet, 1.2 km south of the town of Iqaluit, and immediately north of Dump Site #3 (Map V-1). Prior to 1979 the site was used as a bagged sewage disposal area - hence the local nickname, "Honey Bag Hill".

Use of the site by USAF prior to local use is suggested by the presence of wastes typical of their operations, but these materials may have been scavenged and deposited here following the departure of the military. Disposal of household waste increased in 1979 following the closure of the Apex (Dump Site #5) and summer camp (Dump Site #2) dumps. Burning has been used at Dump Site #4 to control its size and to reduce its attraction to scavenger birds. In spite of this the site is now filled beyond capacity and is slated for closure in the spring of 1995, once the new interim landfill at Dump Site #3 becomes operational.

The access to Dump Site #4 is a dirt drive off the causeway road which runs to the south from town. Most of the debris in the 1.2 hectare dump is concentrated in an area at the top of the dump, and consists primarily of burned and compacted wastes. A second area on the north-facing slope overlooking the inlet is scattered with larger non-combustible materials (Photograph V-43). The east end of the slope contains mostly municipal waste and the west end, predominantly US military-type wastes. At the top of the dump there is a pit where organic materials are burned on a continuous basis. A ridge of granitic bedrock directly south of the actively worked area prevents both drainage and the deposition of wastes there. Vegetation was not evident in the actively worked areas. Debris at the top of the dump consists of typical small to medium sized domestic waste products such as plastics, paper, cardboard, scrap metal, wood and tin cans. Larger items including washing machines, vehicle parts and barrels, along with some wind blown paper and plastic, litter the face of the slope and extend beyond the limit of high tide. Vegetative cover of the slope face is extensive and comprises early successional species including grasses, chickweeds, mountain sorrel, broad-leaved willow-herb and poppies. Drainage from the dump runs directly down the slope-face and into Koojesse Inlet. At the time of the ESG field investigation, drainage from Dump Site #3 entered Dump Site #4 at its eastern edge and continued to the inlet. A dyke to prevent further drainage into the inlet from Dump Site #3 was built in October 1994.

In addition to the domestic waste products mentioned above, hazardous wastes have been disposed of at Dump Site #4. Soils contaminated by fuel spills of between 50 and 2600 L have been taken to this site for incineration followed by incorporation into the dump (PWC 1992). The presence of materials such as barrels, batteries, paint cans and fuel cylinders provide evidence of further incorporation of hazardous wastes into the dump.

2. Results of Previous Studies

In 1983 the engineering firm of Oliver, Mangione, McCalla & Associates, Ltd. (OMM) evaluated the state of solid waste disposal in the town of Iqaluit. Its recommendations, which were based on visual inspection of the site but did not incorporate any chemical analyses, were for cleanup and stabilization of the steep face of the slope with concomitant regrading of the top area.

Much of the literature available concerning previous studies of the municipal dump (Dump Site #4) was reviewed in 1992 by Public Works Canada (PWC). The review summarizes the history of waste disposal in Dump Site #4 and problems with its operation needing to be addressed including a requirement for leachate control. The previously made recommendation that the site be closed as soon as possible is reiterated.

The water license agreement associated with operation of the site requires that the municipal office monitor on an ongoing basis leachate originating in Dump Site #4. Leachate samples are collected from the same location (Station 87-4) each June during spring runoff if sufficient volume is present to allow a sample to be collected. Reports