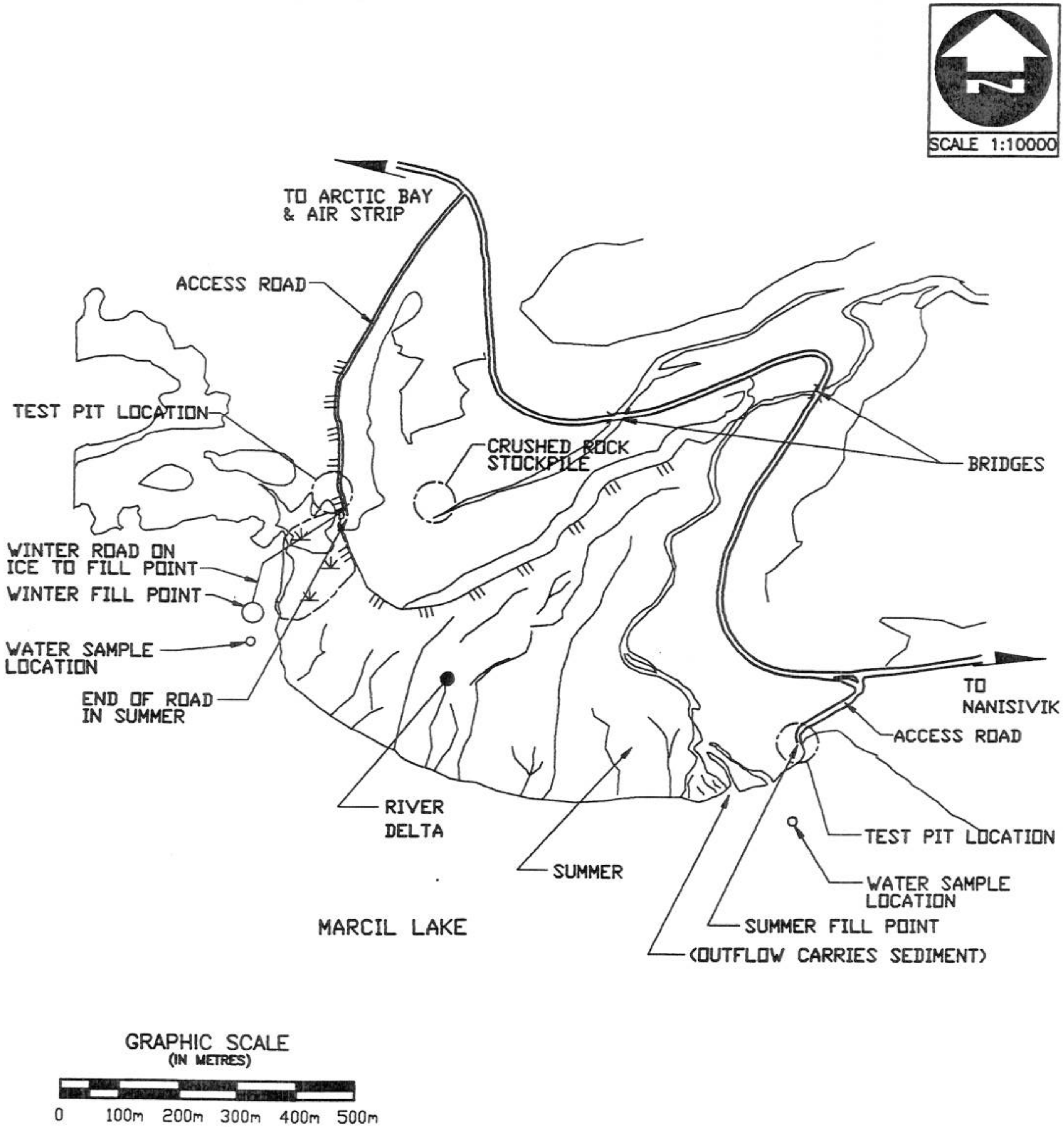
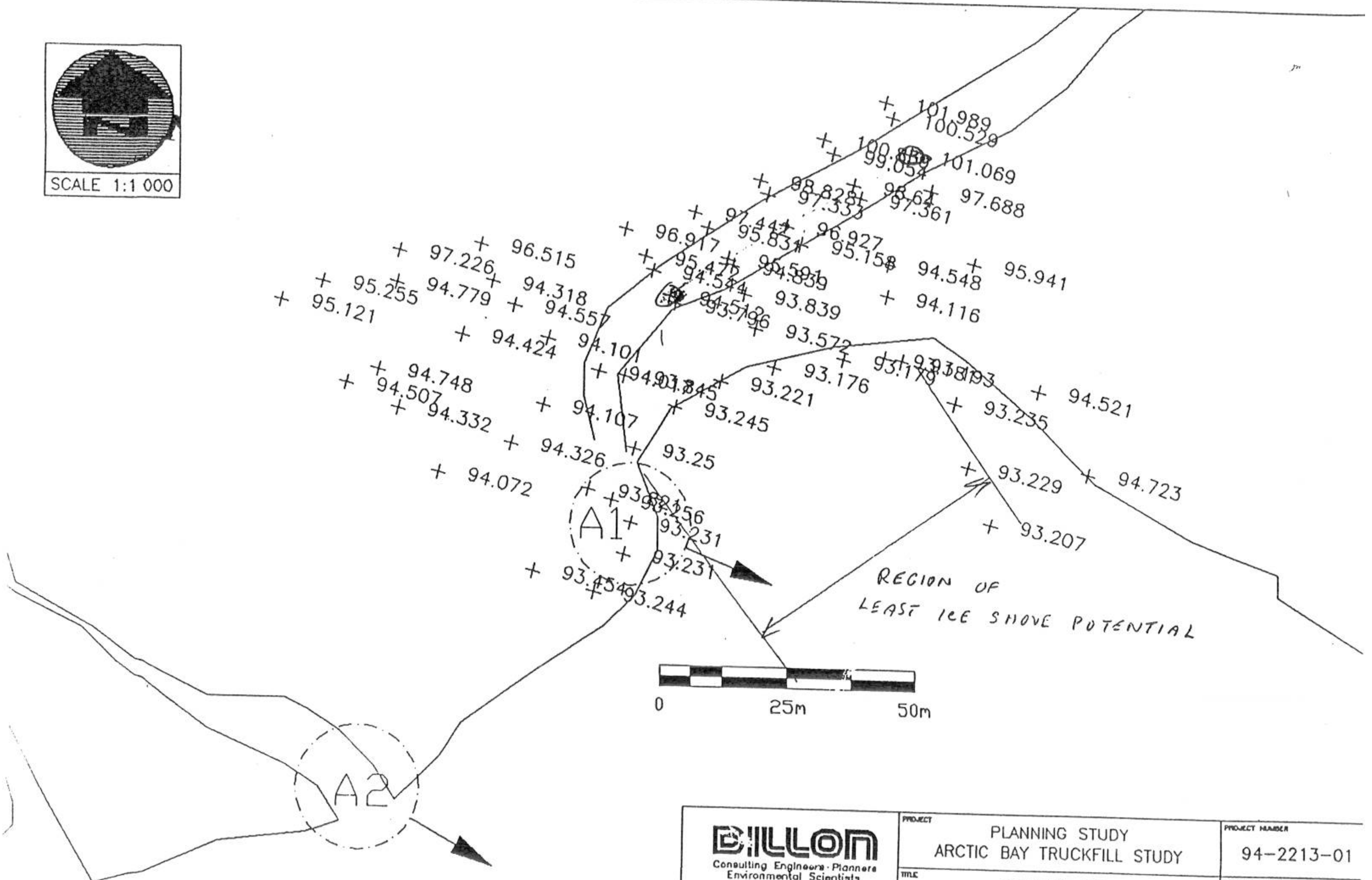
APPENDIX A



DILLON Consulting Engineers · Planners Environmental Scientists	PROJECT TRUCKFILL STATION PLANNING STUDY ARCTIC BAY	PROJECT NUMBER 94-2213-01
DATE OCT 94	TITLE LOCATION PLAN	FIGURE NUMBER 1.1



DILLON Consulting Engineers · Planners Environmental Scientists	PROJECT: PLANNING STUDY ARCTIC BAY TRUCKFILL STUDY	PROJECT NUMBER: 94-2213-01
DATE: OCT 94	TITLE: SUMMER FILL LOCATION SITE	FIGURE NUMBER: 1.3

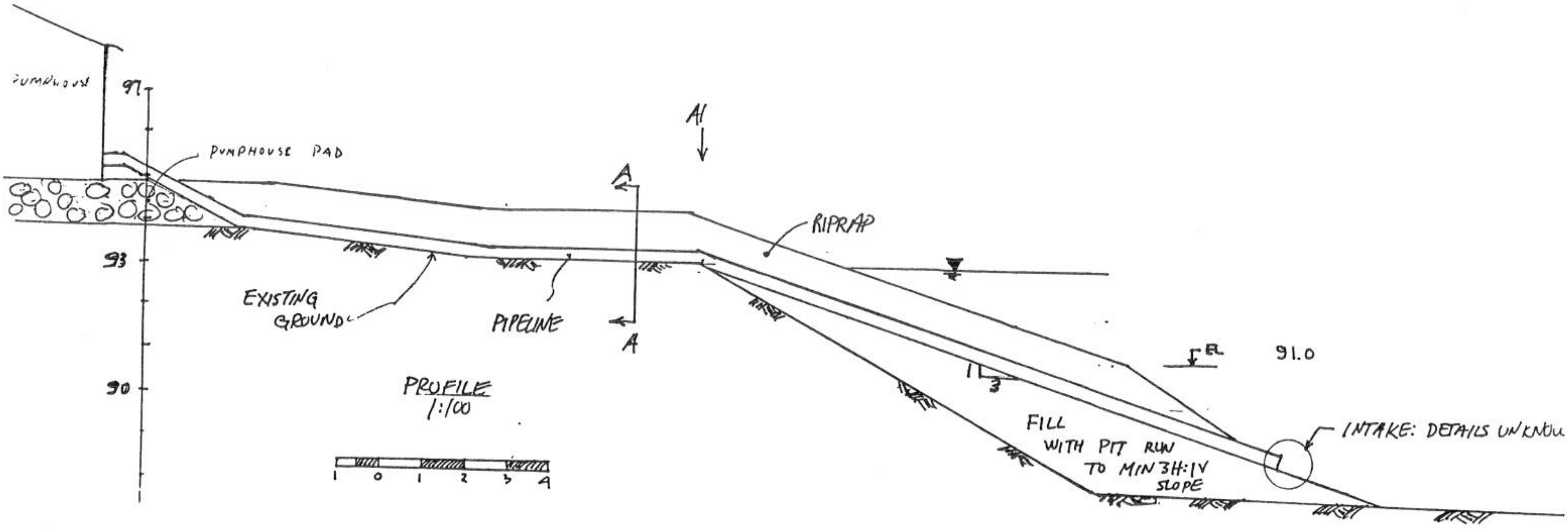
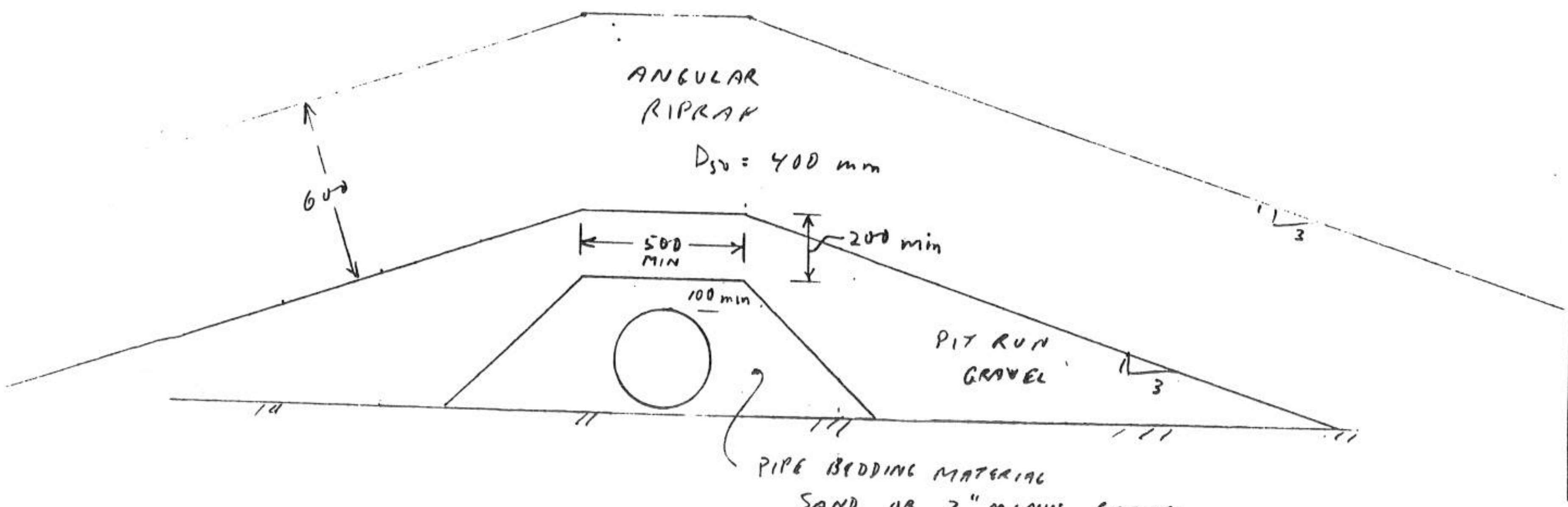


FIGURE 1
RIPRAP PROTECTION

RIPRAP - MAX SIZE 600 mm
MIN SIZE 200 mm



SECTION A-A
1:20

FIGURE 2

RIPRAP BERM DETAIL

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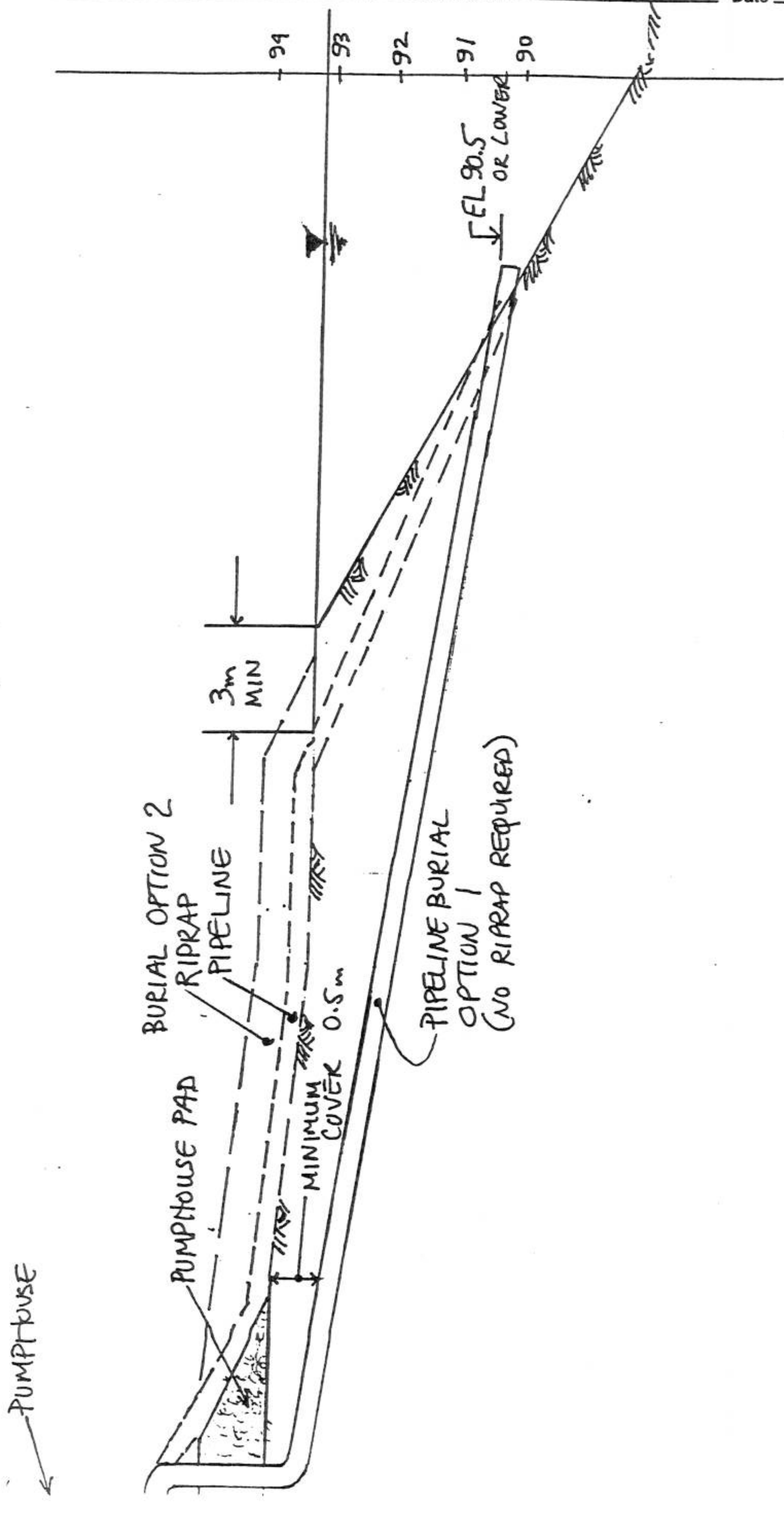

FIGURE 3
BURIAL OPTIONS

Option	Pros	Cons	Recommendations
Winter Intake Site	• If a road can be built to the high ground to the south (the ancient alluvial fan of the Marcil Creek), then the problems of the soft low-lying ground at the existing site can be overcome.	• The site is exposed to west and northwest winds, and resultant wave action and ice movement. The effects of wave and ice action are evident in the rocks and boulders piled up on the shoreline immediately south of the present winter water intake site.	Not the preferred site from a hydrotechnical standpoint. Geotechnical considerations dealing with the pump house and access road foundations would need to be overcome. Significant fill would need to be added to bring the pump house and road above the high water level of the lake. The site is prone to more significant wave and ice action than the summer site.
	• Water quality (suspended solids) may be at acceptable levels as there are no major streams entering the lake in the vicinity.	• The low-lying ground at the existing site is soft, and may be prone to inundation.	
		• Soft and low-lying ground conditions exist at the site, necessitating the importation of fill. (The winter site cannot be accessed in the summer, hence the summer fill site.)	
Summer Intake Site	• Generally firmer ground conditions appear to be available at this site, due primarily to the coarse bed material transported and deposited by Marcil Creek.	• The site is close to the mouth of Marcil Creek, which may result in water quality problems at the intake during peak runoff periods.	Recommended as the better site from a hydrotechnical standpoint, provided that water quality is acceptable. Of the local sites proposed, site A1 is preferred because of the separation from the mouth of Marcil Creek and the short distance to adequate depths.

Option	Pros	Cons	Recommendations
	• The site surveys indicate that adequate depths for the intake can be provided offshore.	• The input of coarse sediment from Marcil Creek may build up a delta which could affect the water intake, especially at site A2.	
	• The exposure of the site to wind and wave action appears to be less than for the winter site, because there is not the same accumulation of boulders along the shoreline. (the presence of the wind driven ice pile-up along the shoreline during the July 1994 site visit appears to have been a minor event, because the ice was well-candled and easily broken up, and therefore posed no significant danger to the shoreline or any structure.		
	• The site is only a short distance off the main all-weather road between Arctic Bay and Nanisivik.		

APPENDIX B

GEOTECHNICAL REPORT CLYDE RIVER

AGRA
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December 21, 1994

File No. YX00388

M. M. Dillon Limited
201-5102 51 Street
Yellowknife, N.W.T.
X1A 1S7

Attention: Mr. Gary Strong, P.Eng.
Manager

Dear Sir:

Re: Report on Geotechnical Conditions
Water Supply Improvements, Clyde River, N.W.T.
MMD Reference 94-2214, MMD-GNWT Ref. SC320524

This letter summarizes the results of a geotechnical investigation undertaken by AGRA Earth & Environmental Limited (AGRA E&E) at the site of the proposed Water Supply Improvements and Truckfill Station in Clyde River, N.W.T.

1.0 TERMS OF REFERENCE

The Terms of Reference for the investigation, as outlined in AGRA E&E's proposal to M. M. Dillon of June 7, 1994 were to include:

- review available geotechnical information and examine aerial photographs;
- conduct a field investigation consisting of test pits (with locally contracted equipment) in order to identify the soil and bedrock conditions at the proposed truckfill sites and turn around areas;
- provide recommendations for the design and construction of the foundation for the pumphouse/truckfill station, water intake line, and armour rock/rip rap, and any site improvements, if required; and,

- provide comments as to the availability of suitable granular sources in the community.

2.0 PROJECT BACKGROUND

The hamlet of Clyde River receives its potable water from a lake which is approximately 1.6 kilometres northwest of the community. The lake has been chosen to fulfill the potable water supply needs of the community for the next 20 years. As such, a single, all-weather truckfill/pumphouse facility is required.

The truckfill station is understood to comprise the following:

- a pumphouse building of wooden construction with dimensions that are approximately 3.5m x 7.5m; it will be heated to +10°C;
- 300mm nominal diameter HDPE intake pipe will extend from the pumphouse to a depth in the order of 2 metres (design ice thickness); and,
- the intake line will be equipped with a heat trace line to reduce the potential for freezing; it will also be covered with 50mm of rigid foam insulation.

3.0 FIELD INVESTIGATION

The field investigation was conducted under the direct supervision of Mr. James Anklewich, P.Eng., of AGRA E&E's Yellowknife Office. Mr. Gary Strong, P.Eng., of M. M. Dillon's (MMD) Yellowknife Office was also present during the field investigation. The field program, which was conducted on July 26, 1994, included a visual reconnaissance of the site, excavation of test pits in the vicinity of the proposed pumphouse/truckfill station, and inspections of potential granular borrow sources.

The field program also included assisting MMD during the topographic and bathometric surveys, the results of which are reported by M. M. Dillon separately.

4.0 SITE CONDITIONS

4.1 PHYSICAL FEATURES

The subject lake is located in a natural depression with an elevation difference between lake level and the surrounding ridges being in the order of 7 to 10 metres. A second lake, which is located some 100 metres to the east, is approximately 6 metres higher in elevation and as such, drains into the subject lake. Based on the results of the topographic survey (reported by M. M. Dillon), the total area of the water shed affecting the subject lake is in the order of 50 hectares.

At the time of the field reconnaissance, the subject lake was clear of ice; however, the second lake still had a considerable amount of ice on the surface. A multibead thermoprobe was lowered into the water of the subject lake during the bathometric survey in order to establish the water temperature and confirm the presence of a thermocline. The thermoprobe data showed that the water was at a temperature of approximately +5°C (+/- 0.5°C) over the entire depth.

A nominal 3 metre wide and 75 metre long access road lies adjacent to portions of the south and east sides of the lake. The alignment of the road at this location is in an approximately north-south direction. At the approach to the lake, the top of the road is about 5.5 metres above the lake and gently slopes down to the location of the proposed new truckfill location, where the road surface is approximately 1 metre above the lake. The west bank of this access road (adjacent to the lake) has a slope angle of approximately 2.5H:1V. Although the bank appeared to be relatively stable at present, small cracks were observed in the road surface and were oriented parallel to the alignment of the road at a location where the top of the road is about 3 to 4 metres above the lake level. These cracks are indicative of movements of the active layer beneath the slope toward the water's edge (shoreline). These slope instabilities are likely attributed to saturated conditions of the active layer during prolonged rainfall whereby the unfrozen soil moves downwards over top of the frozen soil towards the shoreline.

At the most easterly edge of the lake, a 400mm diameter CMP culvert provides (outflow) drainage from the lake to the lower elevations to the east. Both inverts of the culvert, particularly the eastern invert, were noted to be damaged as a result of repeated vehicle traffic since minimal soil cover was observed on the culvert crowns. At the time of the site reconnaissance, the flow rate through the culvert was such that little to no sediment was being transported; however, several erosion scours were observed within 50 metres of the downstream invert of the culvert. These scours suggest that relatively high flow rates have occurred in the past, perhaps during peak runoff at spring thaw, or during prolonged rainfall.

4.2 SUBSURFACE CONDITIONS

A total of three test pits were excavated in the vicinity of the access road and truckfill location using a rubber-tired loader provided by the Hamlet of Clyde River. The test pits locations are shown on the attached Site Plan. The test pits were advanced to a depth of approximately 1 metre below existing grade whereupon frozen ground was encountered. Seepage from the active layer immediately above the permafrost table was observed in all of the test pits. The test pits were terminated at this depth and backfilled immediately.

The soils encountered at the test pit locations generally consisted of a fine to coarse grained, loose, brown sand overlying a brown, frozen silt. Thin beds of low plastic, brown silt were noted within the sand as well. Based on our experience elsewhere in the community, the deposit of silt observed at the 1 metre depth is expected to be ice rich and potentially unstable if allowed to thaw.

5.0 GRANULAR RESOURCES

AGRA Earth & Environmental previously reported on the availability of suitable granular materials in the community of Clyde River. The information was summarized in our June 11, 1993 letter to M. M. Dillon Ltd.

Based on a review of recent aerial photographs and available geotechnical data, several potential borrow deposits in the community were identified. All of the potential borrow sources identified, which are located in the vicinity of the existing airstrip, were reported to be poorly graded gravelly sands with a variable fines content (material passing 0.075mm/#200 sieve screen). These information is summarized in a letter to M. M. Dillon Ltd., dated June 11, 1993.

Sieve analyses were conducted on samples of granular materials, which were obtained by MMD field personnel and delivered to our Yellowknife laboratory. The results of these tests confirm that the samples are poorly graded, gravelly sands with a fines content varying from 10 percent to 22 percent. These results were reported in a letter dated July 26, 1993. The June 11, 1993 and July 26, 1993 letters are appended.

Other potential granular borrow sources exist in the immediate vicinity of the proposed truckfill station; however, the quantity remaining in these sources is not confirmed, nor has the quality of the material been identified. Moreover, it is uncertain whether the hamlet prefers to use the sources located near the airstrip or those located near the truckfill station. Regardless of which granular borrow source is chosen, samples of the materials should be shipped to our laboratories prior to construction in order to determine the specific construction criteria (standard Proctor density, grain size distribution).

6.0 RECOMMENDATIONS

6.1 PUMPHOUSE FOUNDATION

Based on AGRA E&E's past experience, it is envisaged that the pumphouse for the truckfill station will consist of an insulated building of wood construction that is mounted on skids and supported on a compacted granular pad. Such a foundation is considered to be feasible for the present truckfill site. It is not likely that other foundation types, such as piles (adfreeze or bedrock grouted) or spread footings would be necessary or economical.

It is likely that the new pumphouse building would be located in the immediate vicinity of the existing truckfill location. In such a case, the granular pad should be placed directly on the existing surface. The granular pad should be a minimum of 1 metre thick such that the summer depth of thaw is maintained within the granular pad and not the native soils.

Backfill for pad construction should be a well graded gravel that is free of organics and compressible material. Ideally, the backfill should contain less than 5% fines (particles passing the 0.075mm/#200 screen) to reduce the potential for frost heave. The maximum particle size is dependent on the compactive equipment available for construction; however, in the absence of a specified value, a maximum size of 75mm is recommended.

As the existing truckfill location and approach pad have been in use for several years, the surficial soils at this location are expected to be relatively dense due to the daily vehicular traffic; however, there may still exist localized "soft" spots, or zones of weaker material. As such, preparation of the existing surface should include proof-rolling with heavily loaded trucks. Where appreciable deflections are observed beneath the truck tires, the soils at this location should be subexcavated for a depth of at least 300mm and recompacted to a minimum of 95 percent of standard Proctor density.

All fill for the granular pad should be placed in lifts not exceeding 200 mm in loose thickness and should be compacted to not less than 95% of standard Proctor density. The compacted fill pad should be placed a minimum of 2 metres beyond the perimeter of the building. The bearing capacity of a well compacted pad may be taken as 150 kPa.

Long term settlement of the fill structure, if constructed according to the above guidelines, may be expected to be in the order of 1 to 2 percent of the fill thickness. However, if the granular pad is saturated prior to freezing, some heave can be expected during freezeback. For the minimum fill thickness specified above, potential heave in the order of 30mm to 40mm can be expected. Monitoring of the construction of the granular pad would verify that high quality construction is maintained and would reduce the potential for differential settlement.

6.2 WATER INTAKE LINE AND EROSION PROTECTION

At the time of the field reconnaissance, strong southerly winds were noted. During the spring breakup, such winds could cause any large blocks of loose ice on the lake to be deposited onshore and could infringe on the pumphouse building. Hence, consideration should be given to selecting the final locations for the pumphouse intake facility.

The need for a protective berm is envisaged near the shoreline for the water intake line. It is anticipated that sufficient quantities of the larger diameter rocks (boulders) which are required for the armour rock are available in a neighboring borrow source in the near proximity of the proposed pumphouse location. Recommendations with respect to the extent of erosion protection and rip rap size can be provided on request, when the design profile details have been established.

6.3 STABILITY OF ROAD EMBANKMENT

As noted in Section 4.1 above, small cracks were observed in the surface of the road adjacent to the lake and were oriented parallel to the alignment of the road. These cracks are likely due to slope instabilities caused by displacement of the soil in the active layer downslope. The concern is that this portion of the road could continue to move and become increasingly unstable. Saturated soil conditions resulting from extended rainfall events, combined with strong winds and wave action on the toe of the slope, could result in undermining the road embankment and failure of a portion of the access road. Periodic regrading of the road and slope will be required as future instabilities and slope movements occur.

Consideration could be given to improving the stability conditions of this slope. The most feasible mitigating measure includes placing large diameter rocks (cobble and boulder sizes) along the shoreline, particularly at the toe of the road embankment. These large diameter rocks would effectively act as a toe berm and serve to provide restraint against any potential slope movements. Additionally, a suitable geotextile (filter fabric) could be placed between the existing soils on the slope and the overlying rip rap so that the potential for migration and washing of the soils from wave action is reduced.

6.0 CLOSURE

We trust the foregoing is sufficient for your present purposes. Should any questions arise, please contact the undersigned at your convenience.

Yours truly,

AGRA Earth and Environmental Limited

REGISTERED PROFESSIONAL ENGINEER
J. L. ANKLEWICH
N.W.T.

THE ASSOCIATION OF PROFESSIONAL ENGINEERS, GEOLOGISTS and GEOPHYSICISTS OF THE NORTHWEST TERRITORIES
PERMIT NUMBER
P 047
AGRA Earth & Environmental Limited

James L. Anklewich
Manager, Yellowknife Office

Reviewed by:

Marv J. Cherniawski, P.Eng.(Alberta)
Senior Project Engineer

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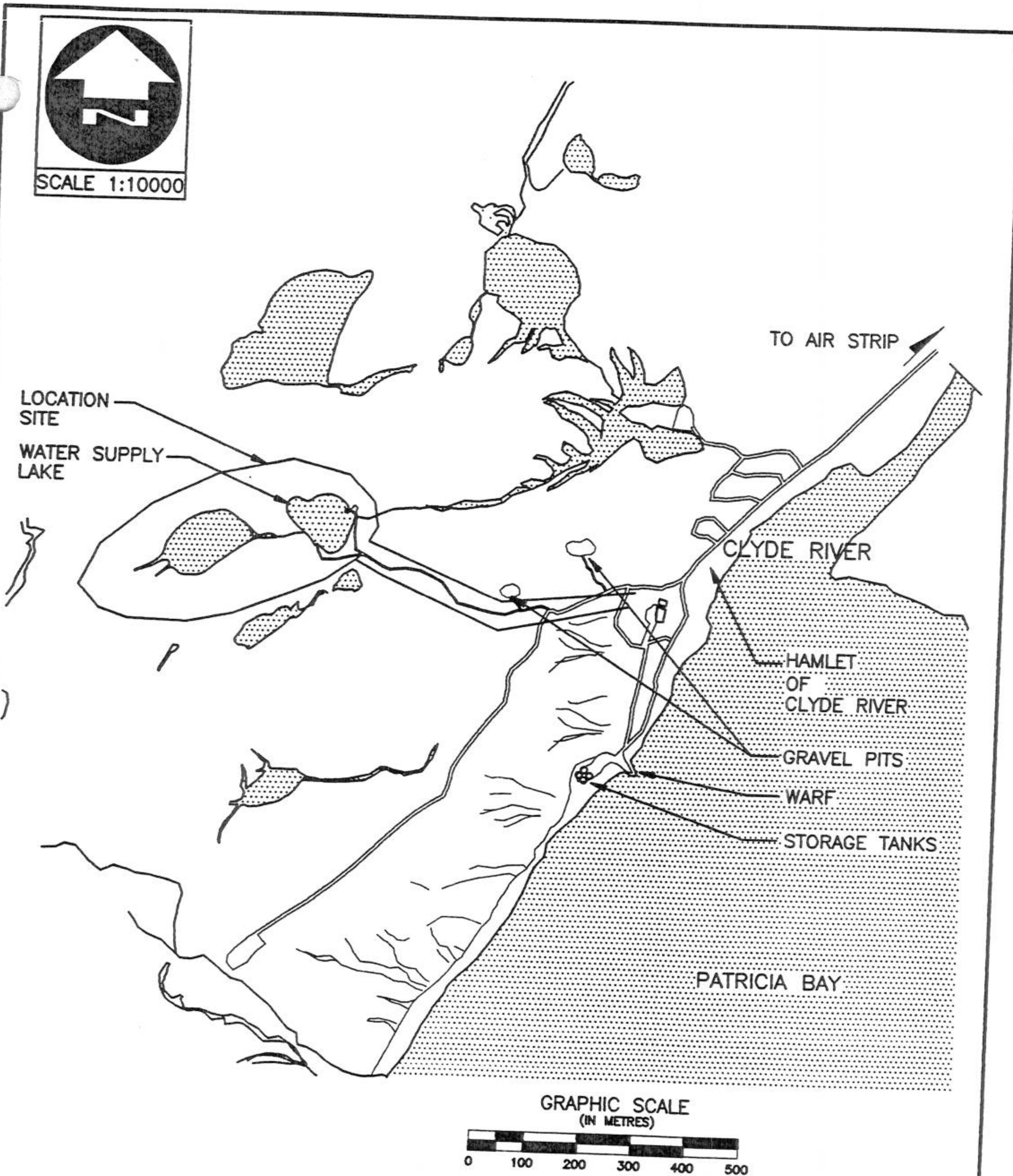

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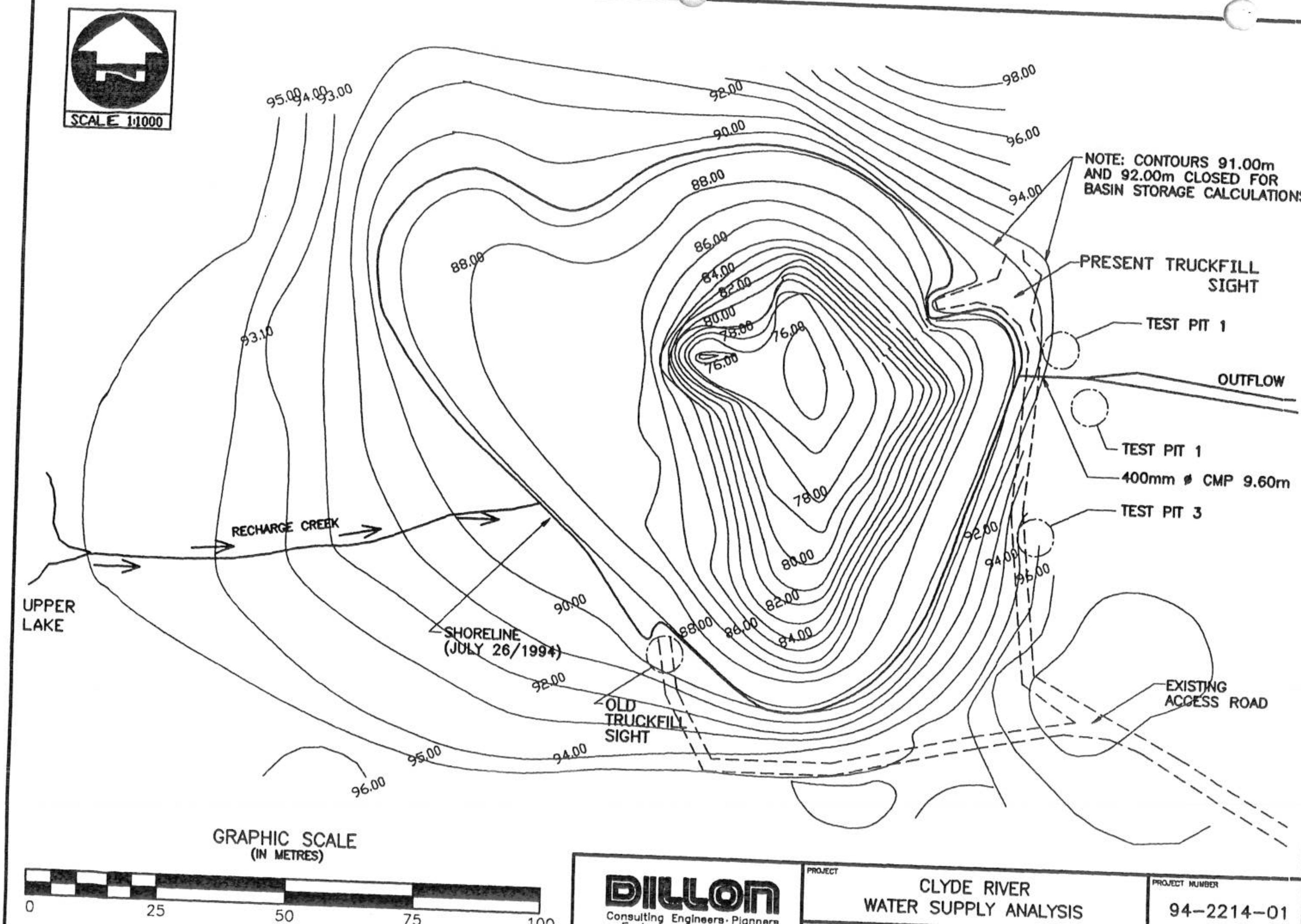
Environmental Scientists

PROJECT: PLANNING STUDY		PROJECT NUMBER: 94–2214–01
DATE: AUG 94	TITLE: CLYDE RIVER TRUCKFILL STATION	FIGURE NUMBER: 1.2



DILLON Consulting Engineers · Planners Environmental Scientists	PROJECT CLYDE RIVER WATER SUPPLY ANALYSIS	PROJECT NUMBER 94-2214-01
DATE AUG 94	TITLE WATER SUPPLY LAKE ELEVATIONS & CONTOURS	FIGURE NUMBER 1.1