The Study Group developed a list of impact management issues that Taro is using as a basis for ongoing negotiations with the community. The community members of the Study Group were also instrumental in Taro's decision to perform a social concerns survey, which included discussions with Taro's negotiations about impact management issues.

The study comprised personal interviews with neighbours whose properties abutted Taro's property, plus drop–off surveys with people living in the community around the site. The results are compiled and analyzed in accompanying the report entitled "An Examination of the Social Environment and Community Impact Management Priorities" (Holistic Impax Group and Urban Dimensions Group, January 1995).

This study was conducted to meet the following objectives:

a) to provide information that the Study Group perceives it needs to assist in making informed decisions regarding the East Quarry Landfill proposal;
b) to ensure that the residents concerns are fully understood; and
c) to gather additional information that will assist in the design of impact management measures.

The study was conducted during a period of high visibility for the proposed landfill. Articles in the Hamilton Spectator indicated that "time was running out" to become involved in the landfill siting proposal. The municipal election had just concluded, wherein candidates canvassed door–to–door discussing the Taro East Quarry landfill proposal. An open house was scheduled and advertised in the local papers. A public opinion survey had just been completed. Yet despite these initiatives, the overall levels of concern about the proposed East Quarry landfill site do not significantly differ from those reported by Armour Environmental in the Social Impact Assessment Scoping Report (1995). Data from both the in–person survey and the drop–off survey confirm that these levels of concern have not significantly increased over time.

Taro's resulting impact management plan has three major elements as described below:

Certificates of Approval

Taro has drafted proposed Terms and Conditions to the Environmental Protection Act (EPA) Certificate of Approval for the site. These being negotiated with the Study Group and their lawyer.

The proposed Terms and Conditions to the Certificate of Approval include numerous important impact management aspects, notably:

a) Detailed requirements for inspections, monitoring, and maintenance of the site;
b) Specific requirements for contingency plans in the event of and unexpected failure;
c) Closure and port–closure requirements;
d) Details of the financial assurances;
e) Reporting requirements;
f) Establishment of a Community Liaison Committee (CLC) to monitor the operation of the landfill; and
g) Establishment of a formalized Complaints Procedure whereby impacts on the community can be identified, investigated, mitigated and reported back to the CLC.

Property Value Protection Program

The company agrees that some form of property value protection program should be established should the East Quarry be licensed for landfilling. A property value protection program is currently being discussed as part of the negotiation of a community investment program with the community members of the Study Group and their lawyer. While the details of the program have yet to be established, it is being developed along the lines of what is currently in practice in the Province. It will apply to a specified list of neighbours near the site.

Community Investment Program

The company agrees that some form of community investment program should be established should the East Quarry be licensed for landfilling. Negotiations with the community members of the Study Group and their lawyer have been underway since November 1994 and will likely be completed by the end of February 1995. Issues currently being discussed include annual payments to certain abutting neighbours, a property value protection program, a nuisance impact plan and the establishment of a community trust funded through ongoing royalty payments from the operation.

TARO EAST QUARRY ENVIRONMENTAL ASSESSMENT DESIGN AND OPERATIONS REPORT

PREPARED FOR:
TARO AGGREGATES LTD.

PREPARED BY:
GARTNER LEE LIMITED

JANUARY, 1995

GLL 94-413

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TABLE OF CONTENTS (*Cont'd*)

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APPENDICES

1.0 INTRODUCTION

1.1 BACKGROUND

This document is the design and operations report for the proposed Taro East Quarry Landfill, and is being submitted as part of Taro's applications under the Environmental Assessment Act (EAA) and the Environmental Protection Act (EPA). The East Quarry is located in the City of Stoney Creek, immediately southwest of the intersection of Highway 20 and Green Mountain Road. The East Quarry site occupies a total area of 75.3 ha, and a 59.1 ha portion of this would be occupied by the proposed landfill. The location of the East Quarry is shown on the site location map in Figure 1.

Taro currently operates a landfilling business in its adjacent West Quarry Landfill. That site accepts solid, non–hazardous industrial wastes, and will be reaching its design capacity in 1995. Taro wishes to continue its landfilling business in the East Quarry.

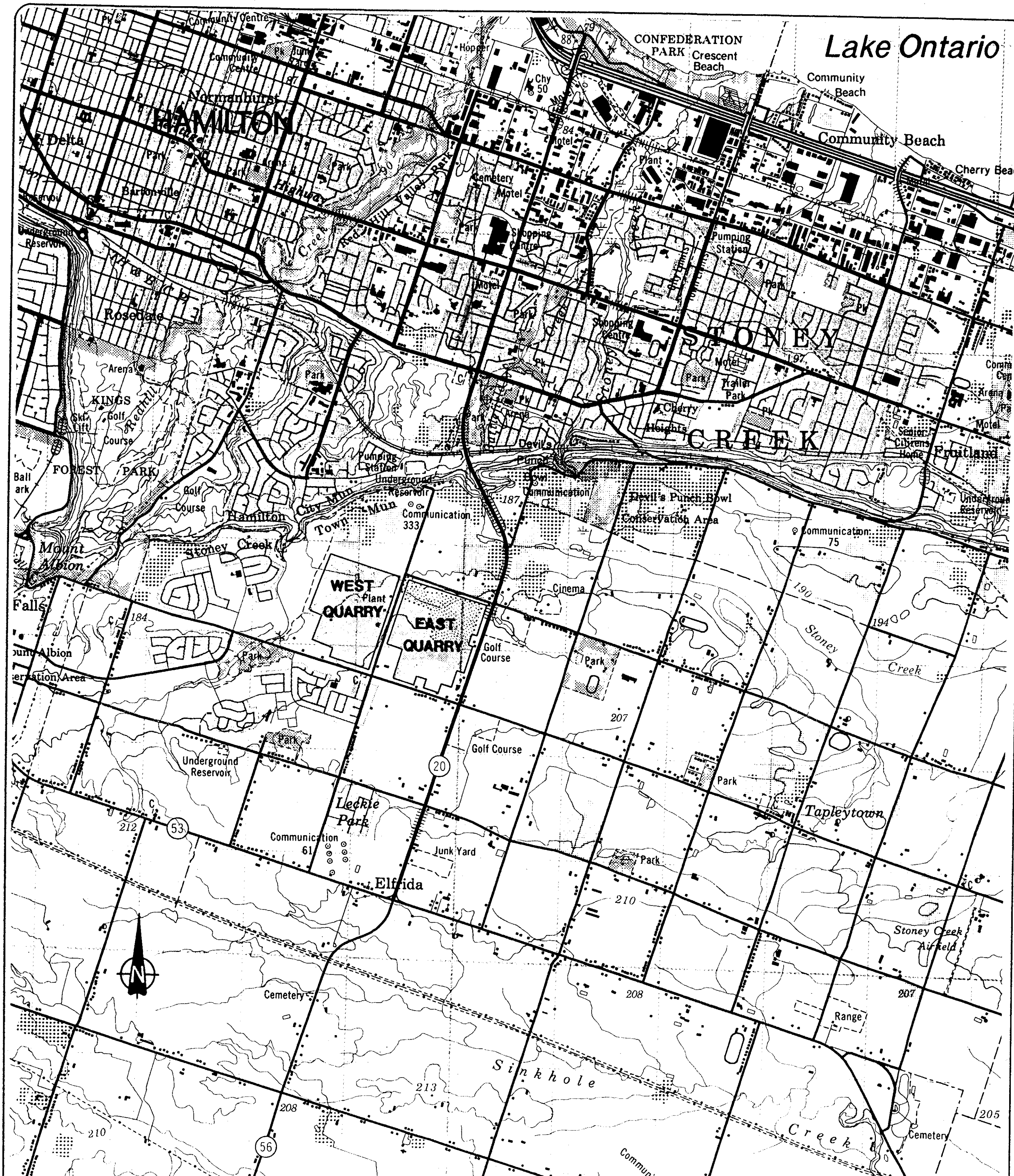
An initial set of facility characteristics assumptions for the East Quarry Landfill were developed through a process in which facility goals were determined, viable design and operating alternatives were identified, and preferred alternatives selected based on various criteria. The development of the facility characteristics assumptions is documented in Taro Aggregates Ltd., 1995 (Volume II).

The suitability of the initial design concept was then tested through the impact assessment process. It was assessed from the points of view of various disciplines, and these assessments resulted in recommendations for impact mitigation and enhancement of the concept. The recommendations developed through the impact assessment process were incorporated into the concept and resulted in the design and operating plan presented here.

The initial draft of this report was provided to various reviewers in May, 1994 as part of Taro's pre–submission consultations. The reviewers included regulatory agencies, such as the Ministry of the Environment and Energy (MOEE), as well as independent technical peer reviewers working on behalf of the community Study Group. The comments and recommendations received through the peer review process were incorporated into the Design and Operating Report presented here.

1.2 SCOPE

This document will form part of Taro's submission under the EAA and EPA for the East Quarry Landfill. It has been prepared to a preliminary level of detail, and we consider that sufficient detail is presented here to demonstrate the viability of the proposal. This design and operating report will provide the basis for final design and development of the landfill upon approval.



TARO AGGREGATES LTD.
EAST QUARRY ENVIRONMENTAL ASSESSMENT

SITE LOCATION MAP

Gartner Lee

Scale 1:50,000

Figure 1

GLL 94-413 December 1994

This document is organized as follows:

Section 1, **Introduction**, discusses the scope and organization of this report.

Section 2, **Waste Stream**, describes the characteristics and quantities of the anticipated waste stream. The contaminating lifespan of the wastes is discussed.

Section 3, **Design Basis**, discusses the overall rationale behind the design and operating strategy. Those aspects of the site physical setting that are pertinent to the development of the design and operation concept are summarized.

Section 4, **Site Design**, describes the design of the main components of the landfill site. The rationale behind the design of each component is discussed, and the service life of various components is addressed.

Section 5, **Site Operations**, describes the operational aspects of the proposed landfill and the rationale behind their development. This section addresses the overall landfill development scheme, as well as specifics of daily operations and various nuisance controls.

Section 6, **Control System Operation, Maintenance, and Performance Monitoring**, summarizes the major activities that will ensure the proper functioning of various control systems.

Section 7, **Environmental Monitoring**, discusses the ground water, surface water, and landfill gas monitoring that will be undertaken to ensure that the facility is operating as expected.

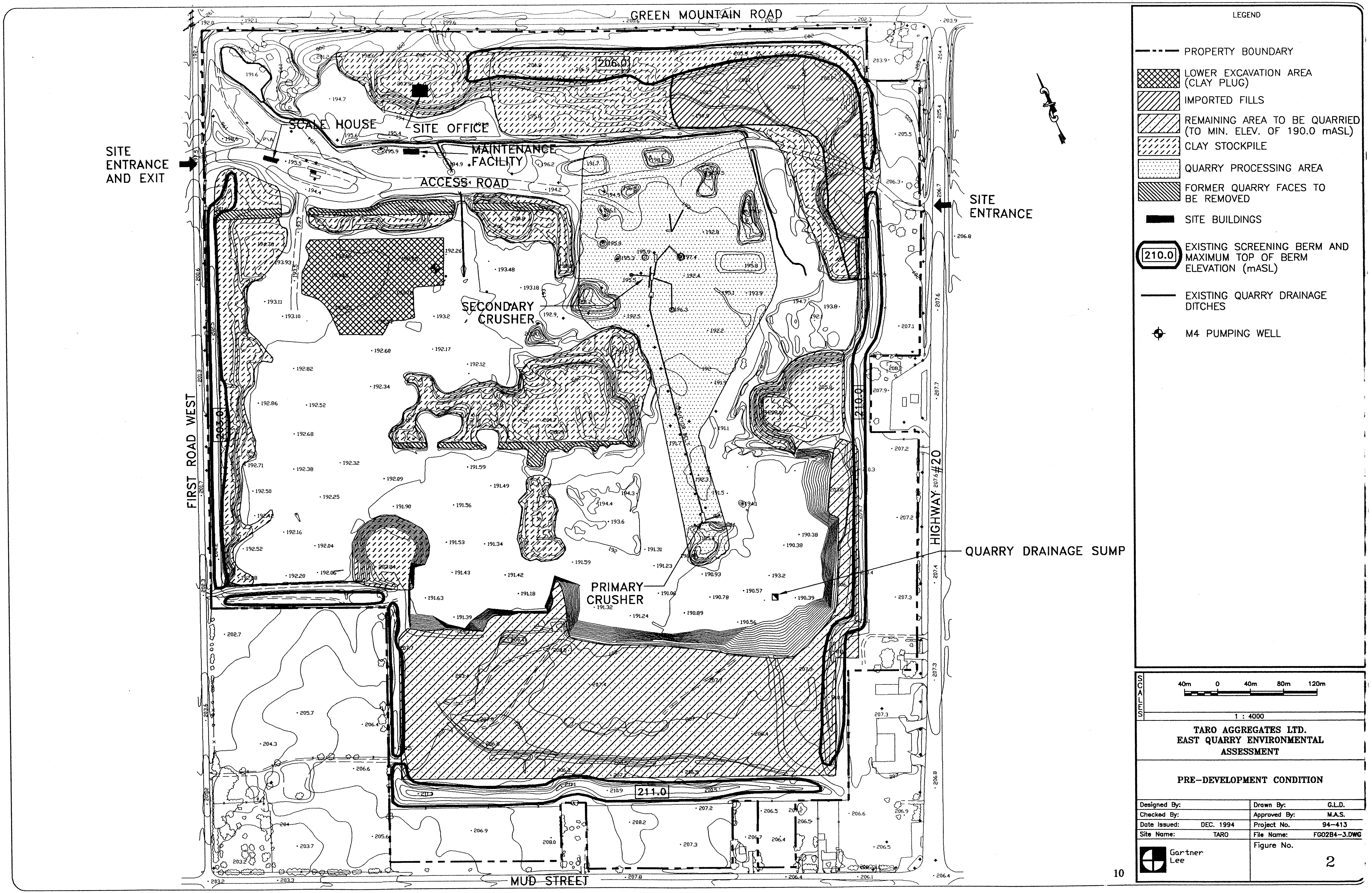
Section 8, **Reporting**, outlines the frequency and content of reporting to regulatory agencies, as well as specifics of site record keeping.

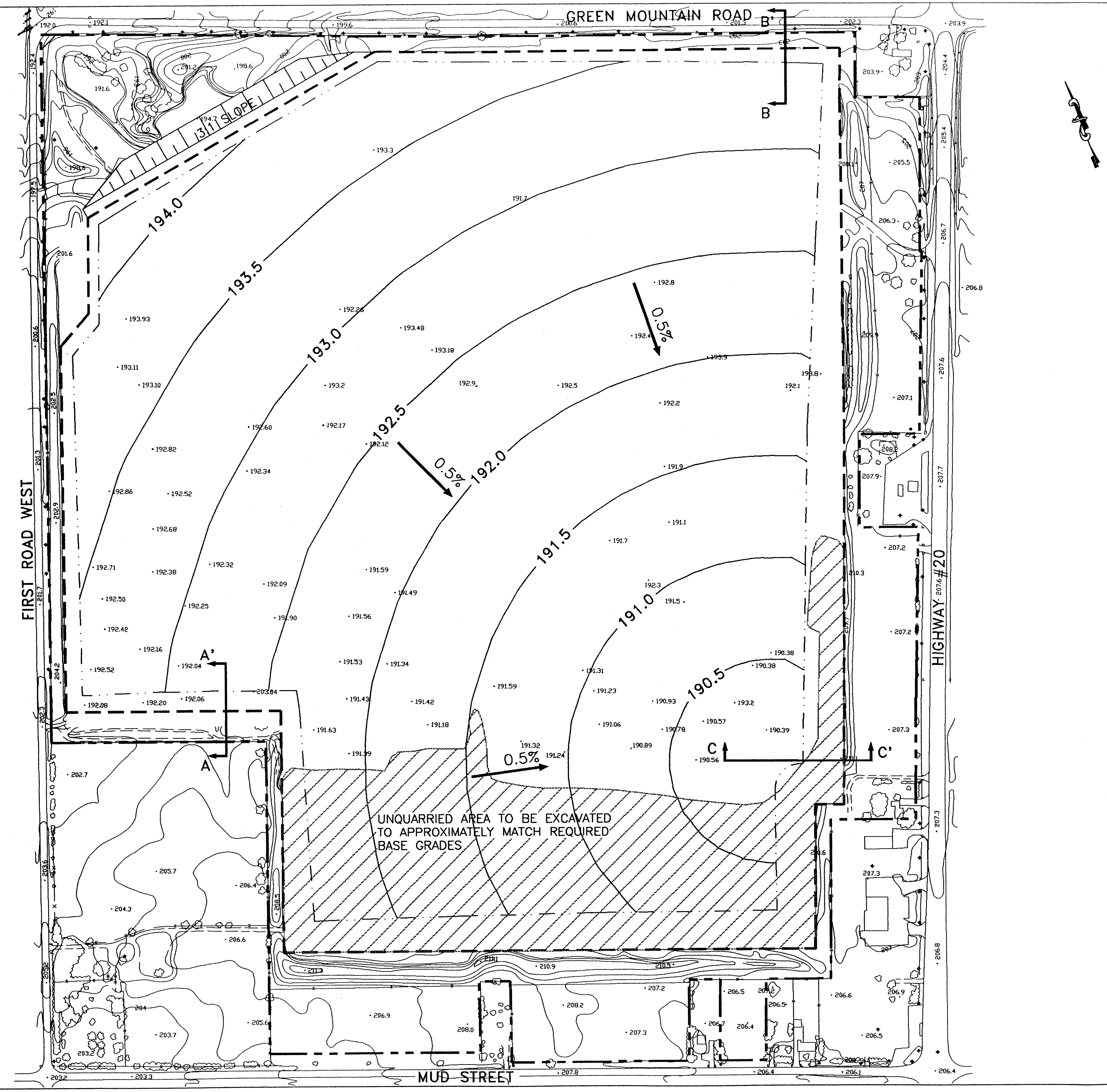
Section 9, **Contingencies**, describes the action plans that will be implemented in the event of unexpected occurrences.

Section 10, **Site Closure and End Use**, outlines the activities that will be carried out to close the site in an environmentally sound manner after completion of landfilling and end use planning.

Section 11, **Financial Assurances**, discusses the Taro's commitments to ensure that critical monitoring and contingency elements will be funded.

Section 12, **References**, presents the list of documents cited in this report.


GREEN MOUNTAIN ROAD
FIRST ROAD WEST
HIGHWAY #20
MUD STREET
SITE ENTRANCE AND EXIT
SITE ENTRANCE
SCALE HOUSE
SITE OFFICE
MAINTENANCE FACILITY
ACCESS ROAD
SECONDARY CRUSHER
PRIMARY CRUSHER
QUARRY DRAINAGE SUMP
206.0
210.0
211.0
203.0
LEGEND
PROPERTY BOUNDARY
LOWER EXCAVATION AREA (CLAY PLUG)
IMPORTED FILLS
REMAINING AREA TO BE QUARRIED (TO MIN. ELEV. OF 190.0 mASL)
CLAY STOCKPILE
QUARRY PROCESSING AREA
FORMER QUARRY FACES TO BE REMOVED
SITE BUILDINGS
EXISTING SCREENING BERM AND MAXIMUM TOP OF BERM ELEVATION (mASL)
EXISTING QUARRY DRAINAGE DITCHES
M4 PUMPING WELL
SCALES
40m 0 40m 80m 120m
1 : 4000
TARO AGGREGATES LTD.
EAST QUARRY ENVIRONMENTAL ASSESSMENT
PRE-DEVELOPMENT CONDITION
Designed By:
Checked By:
Date Issued: DEC. 1994
Site Name: TARO
Drawn By: G.L.D.
Approved By: M.A.S.
Project No. 94-413
File Name: FG02B4-3.DWG
Figure No. 2
Gartner Lee



LEGEND

- PROPERTY BOUNDARY
- 190.5 — APPROXIMATE BASE OF LINER CONTOURS (mASL)
- LIMIT OF LANDFILL
- TOE OF SLOPE
- · 191.7 EXISTING ELEVATION

NOTE:

FOR CROSS SECTIONS REFER TO DRAWINGS No.4 AND 5

No.	Description	Date	By
	Revisions		

SCALES: 40m 0 40m 80m 120m

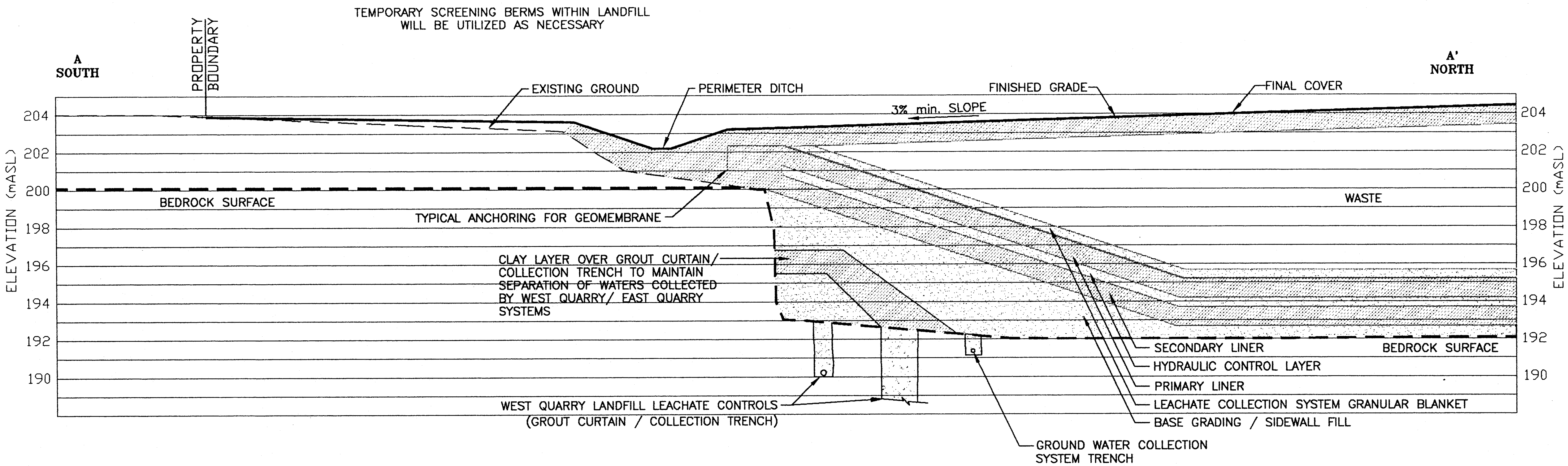
1 : 4000

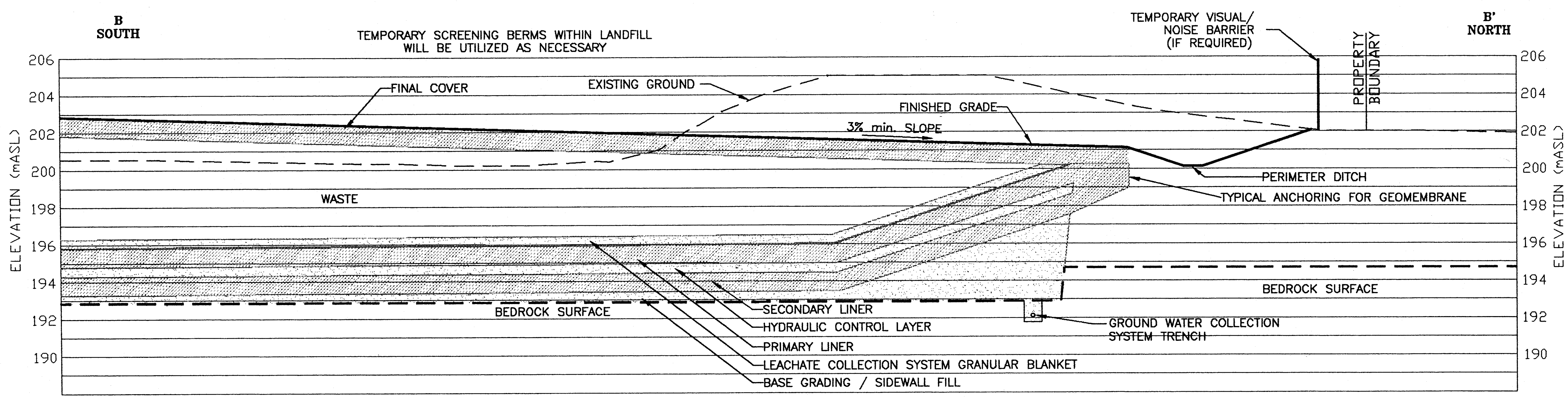
TARO AGGREGATES LTD.
EAST QUARRY ENVIRONMENTAL ASSESSMENT

BASE GRADING PLAN

Designed By:		Drawn By:	G.L.D.
Checked By:		Approved By:	M.A.S.
Date Issued:	DEC. 1994	Project No.	94-413
Site Name:	TARO	File Name:	FG03B4-3.DWG
Gartner Lee		Figure No.	3

LEGEND





NOTE:
FOR DETAILS OF SERVICING WITHIN BUFFER ZONE SEE FIGURE 11.

SCALES
2.5m 0 2.5m 5.0m 7.5m
1:250

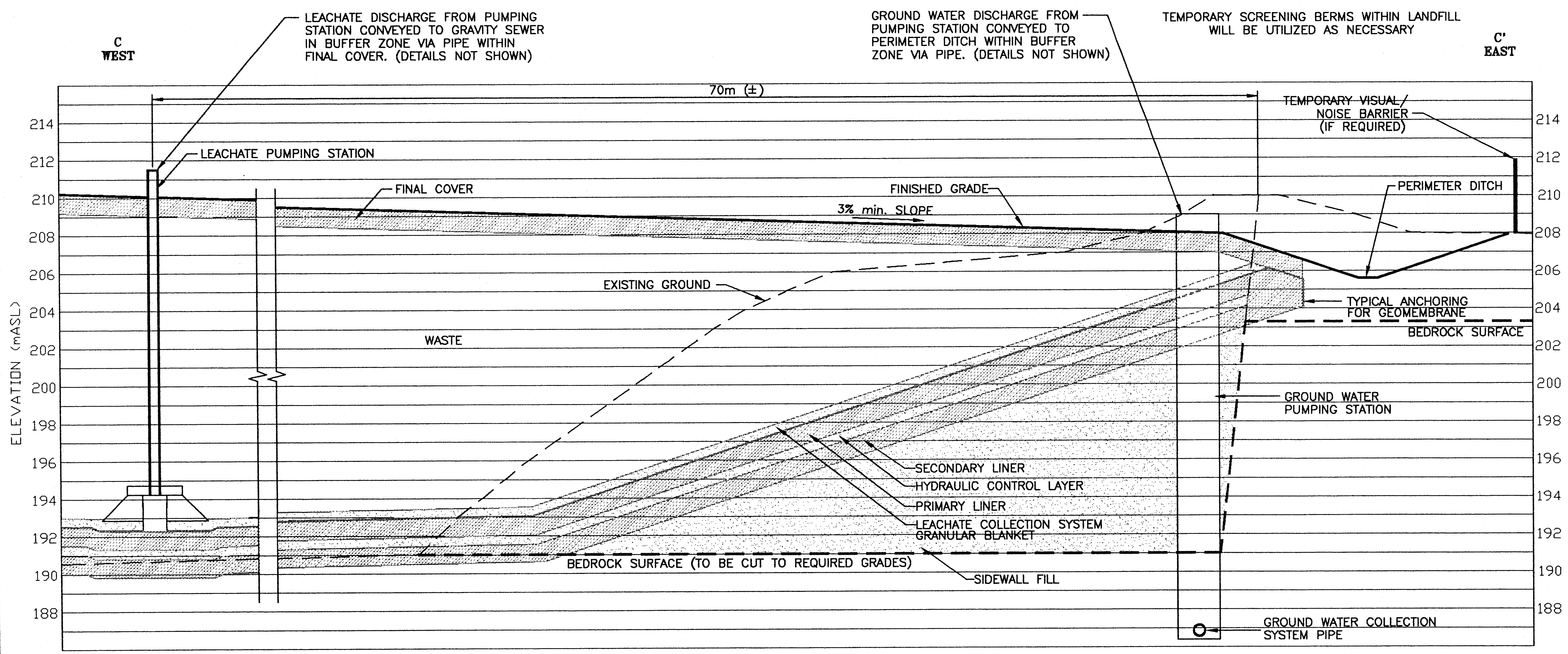
TARO AGGREGATES LTD.
EAST QUARRY ENVIRONMENTAL ASSESSMENT

TYPICAL CROSS SECTION A–A', B–B' THROUGH LANDFILL SIDEWALL

Designed By:		Drawn By:	G.L.D.
Checked By:		Approved By:	M.A.S.
Date Issued:	DEC. 1994	Project No.	94–413
Site Name:	TARO	File Name:	XS01B.DWG

Gartner Lee

Figure No. 4



LEGEND

SCALES 2.5m 0 2.5m 5.0m 7.5m
1:250

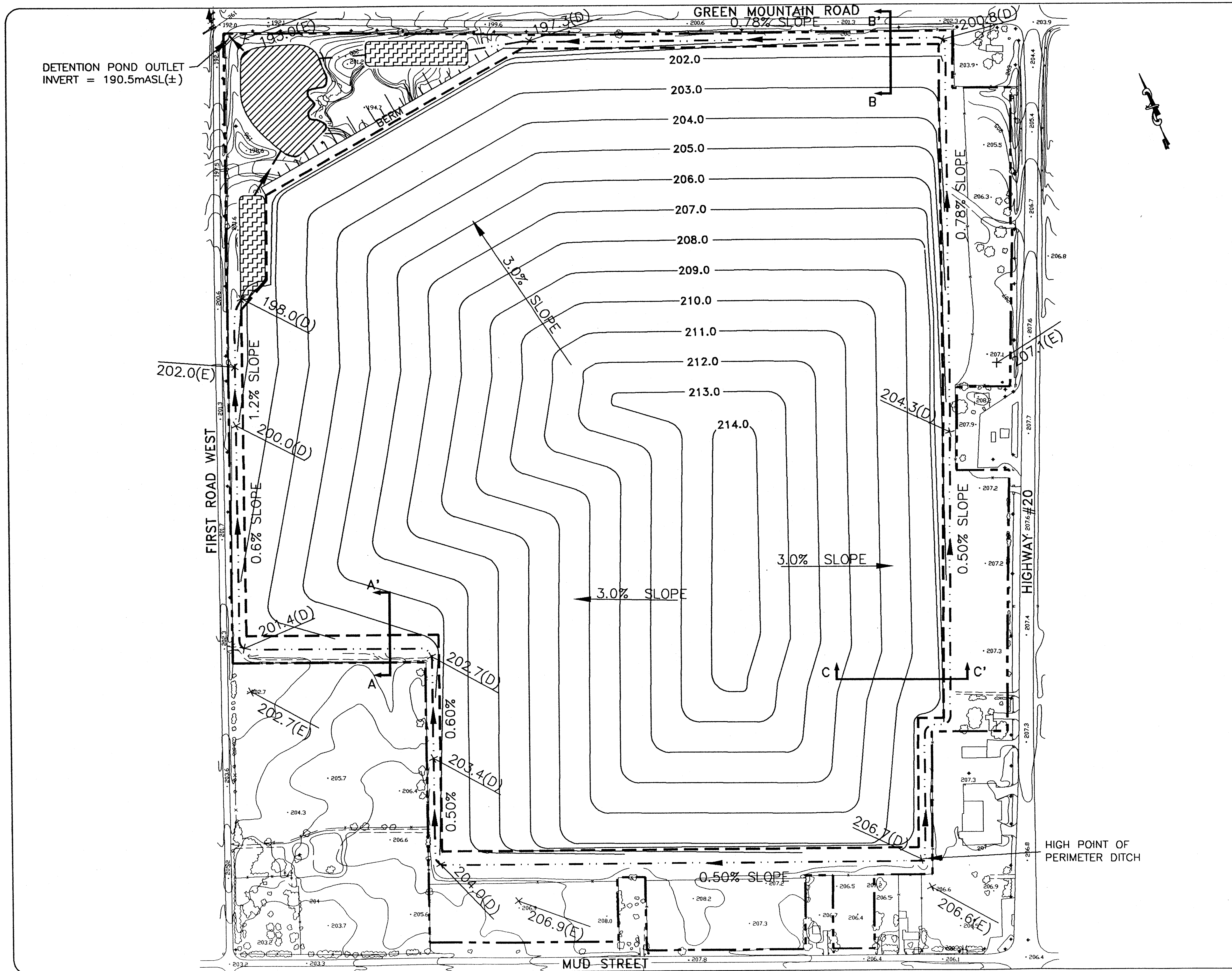
TARO AGGREGATES LTD.
EAST QUARRY ENVIRONMENTAL ASSESSMENT

TYPICAL CROSS SECTION C–C' THROUGH LANDFILL SIDEWALL

Designed By:		Drawn By:	G.L.D.
Checked By:		Approved By:	M.A.S.
Date Issued:	DEC. 1994	Project No.	94–413
Site Name:	TARO	File Name:	XS02B.DWG

Gartner Lee

Figure No. 5



LEGEND

- PROPERTY BOUNDARY
- LIMIT OF LANDFILL
- PERIMETER DRAINAGE DITCH
- 206.0 — FINAL CONTOUR (mASL, INCLUDES 1m THICK FINAL COVER)
- APPROXIMATE RUNOFF DETENTION POND LOCATION
- APPROXIMATE SEDIMENT POND LOCATION
- 206.7(D) TYPICAL PERIMETER DITCH INVERT ELEVATION
- 207.1(E) TYPICAL EXISTING GROUND ELEVATION

NOTES:

FOR CROSS SECTIONS REFER TO DRAWINGS No. 4 AND 5

TREES AND SHRUBS WILL BE PLANTED IN BUFFER ZONE BETWEEN SCREENING BERMS AND PROPERTY BOUNDARIES UPON COMMENCEMENT OF LANDFILL OPERATION. PLANTING TO REMAIN IN PLACE AFTER COMPLETION OF FINAL COVER CONSTRUCTION AND REMOVAL OF SCREENING BERMS.

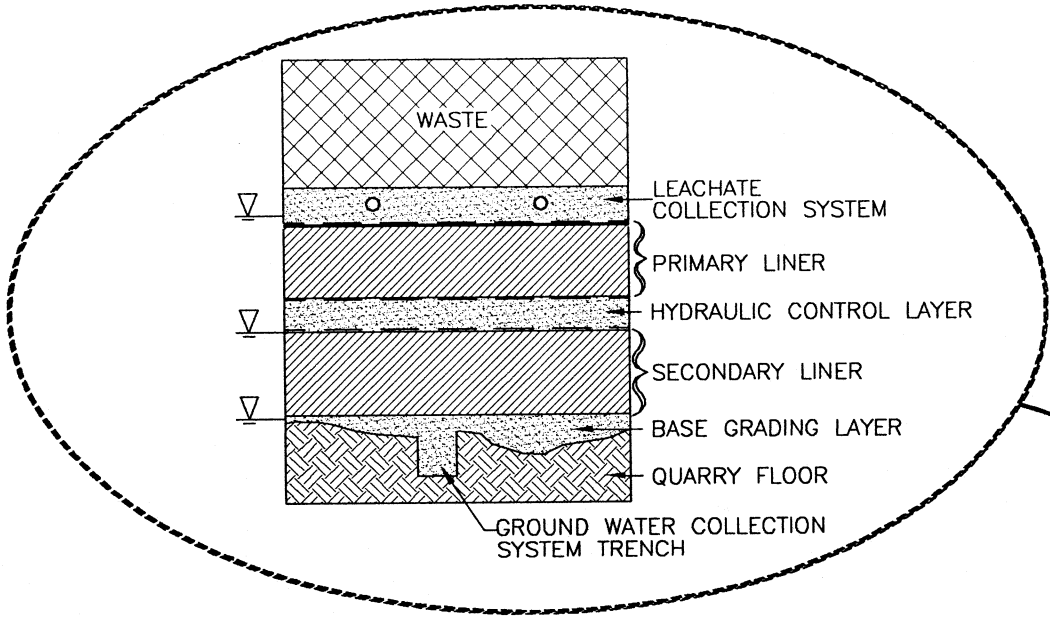
No.	Description	Date	By
	Revisions		

SCALES: 40m 0 40m 80m 120m — 1 : 4000

TARO AGGREGATES LTD.
EAST QUARRY ENVIRONMENTAL ASSESSMENT

FINAL CONTOUR PLAN

Designed By:		Drawn By:	G.L.D.
Checked By:		Approved By:	M.A.S.
Date Issued:	DEC. 1994	Project No.	94-413
Site Name:	TARO	File Name:	FG0484-3.DWG
Gartner Lee		Figure No.	6

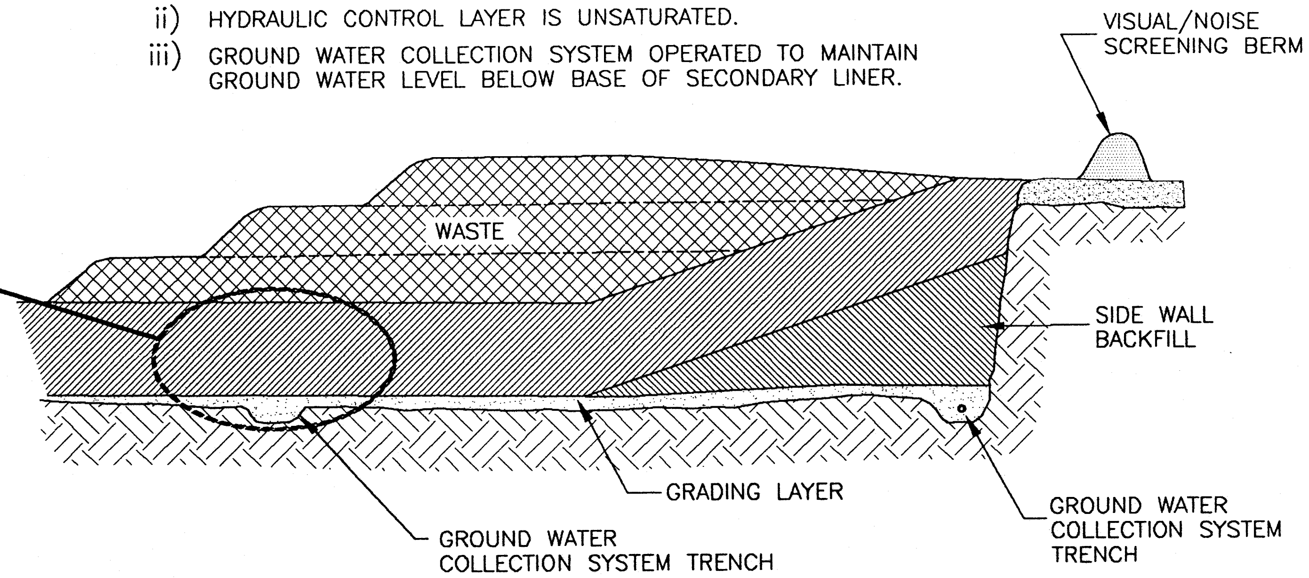


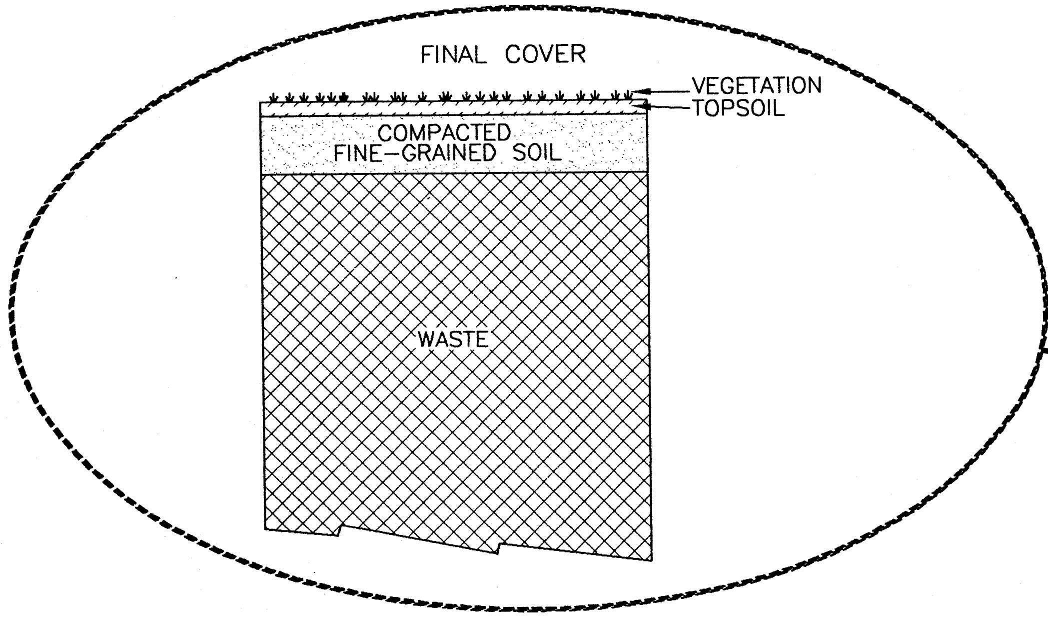
LEACHATE MANAGEMENT STRATEGY DURING LANDFILL OPERATING PERIOD

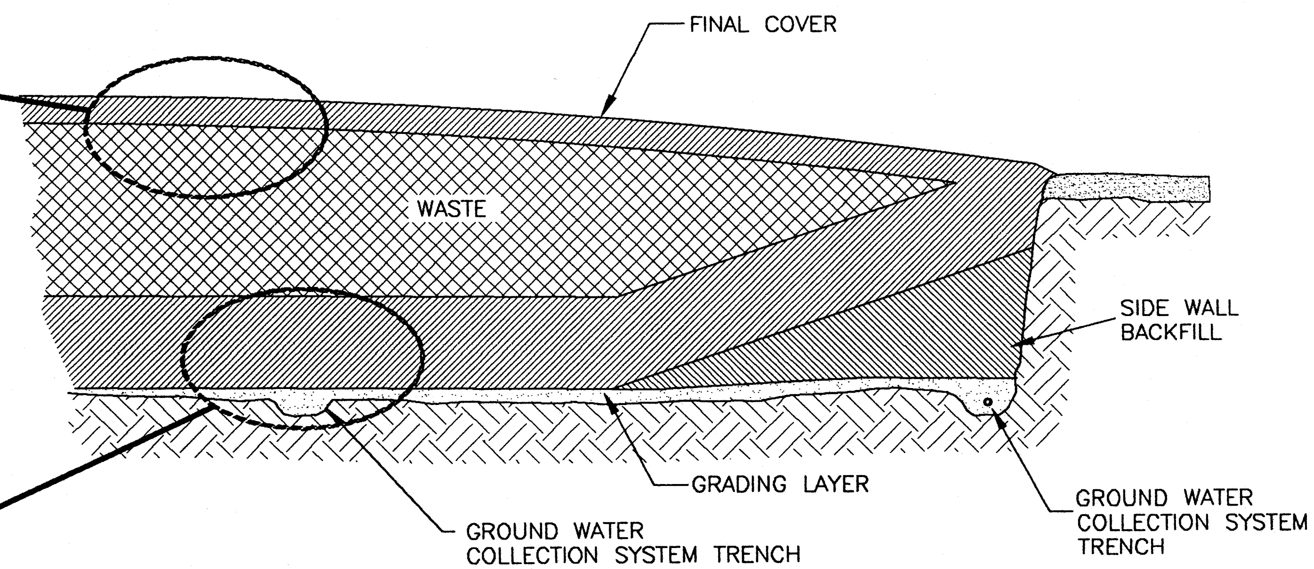
i) LEACHATE COLLECTION SYSTEM OPERATED TO MAINTAIN MINIMUM LEACHATE HEAD ON PRIMARY LINER. COLLECTED LEACHATE PUMPED TO SEWER DISCHARGE.

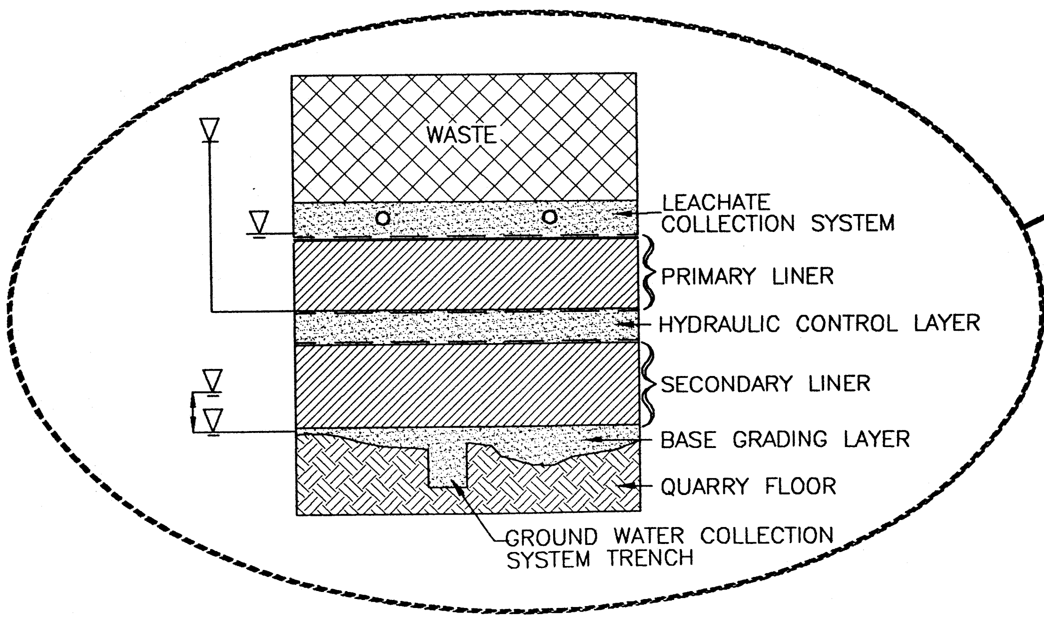
ii) HYDRAULIC CONTROL LAYER IS UNSATURATED.

iii) GROUND WATER COLLECTION SYSTEM OPERATED TO MAINTAIN GROUND WATER LEVEL BELOW BASE OF SECONDARY LINER.









LEACHATE MANAGEMENT STRATEGY AFTER LANDFILL OPERATING PERIOD

i) LEACHATE COLLECTION SYSTEM OPERATED TO MAINTAIN MINIMUM LEACHATE HEAD ON PRIMARY LINER. COLLECTED LEACHATE PUMPED TO SEWER DISCHARGE.

ii) HYDRAULIC CONTROL LAYER IS SATURATED TO MAINTAIN AN INWARD GRADIENT ACROSS PRIMARY LINER. WATER IN DRAINAGE LAYER IS PERIODICALLY REPLACED WITH CLEAN WATER.

iii) GROUND WATER LEVELS OUTSIDE LINER SYSTEM ALLOWED TO RISE TO EQUILIBRIUM LEVELS.

LEGEND

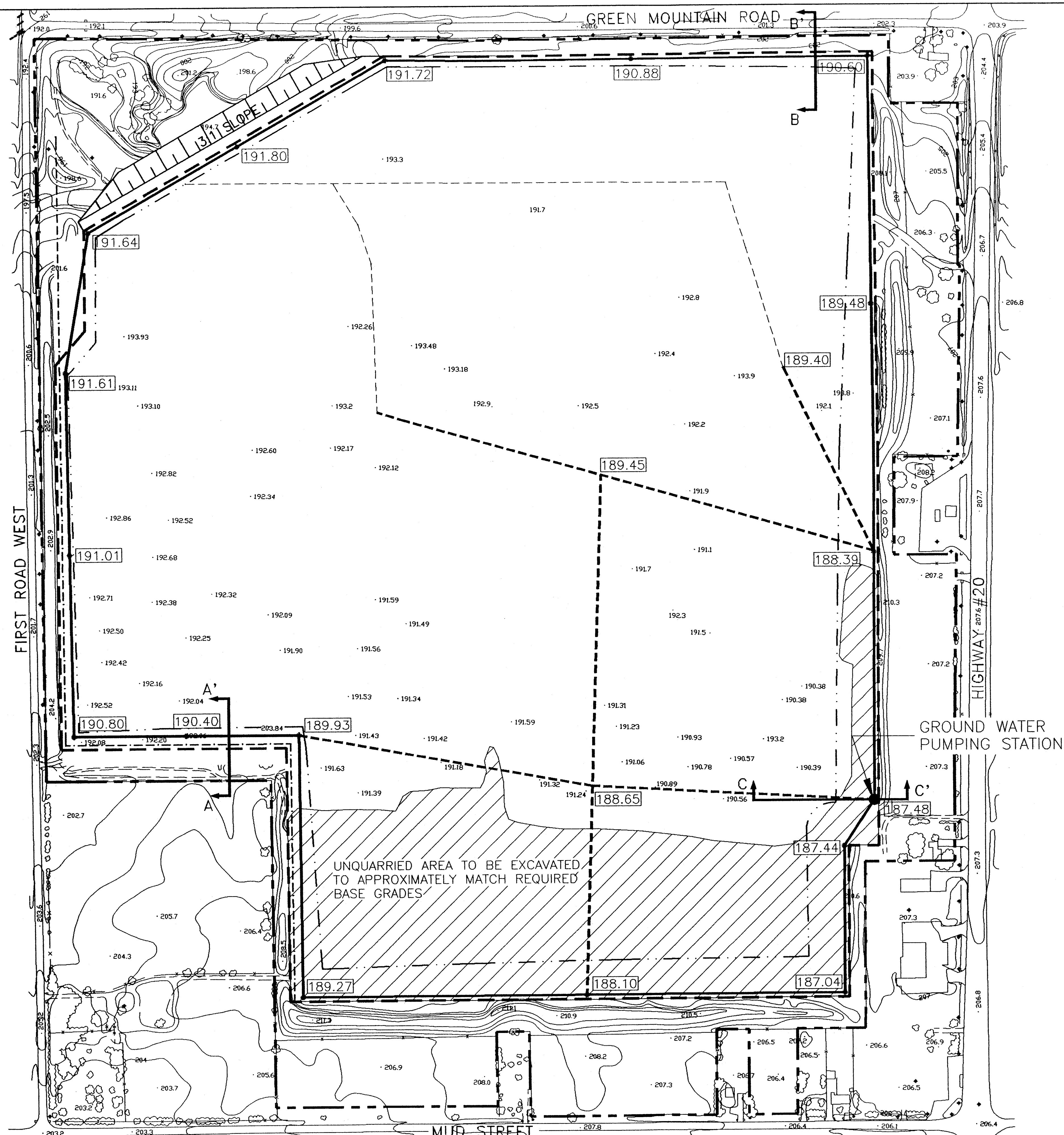
SCALES: NOT TO SCALE

Scale

TARO AGGREGATES LTD.
EAST QUARRY ENVIRONMENTAL ASSESSMENT

LEACHATE CONTROL OPERATION CONCEPT

Designed By:		Drawn By:	G.L.D.
Checked By:		Approved By:	M.A.S.
Date Issued:	DEC. 1994	Project No.	94-413
Site Name:	TARO	File Name:	FG06B1-3.DWG
Gartner Lee		Figure No.	8



LEGEND

- PROPERTY BOUNDARY
- EXISTING QUARRY DRAINAGE DITCH (TO BE INCORPORATED INTO UNDERDRAIN SYSTEM)
- PROPOSED EAST QUARRY UNDERDRAIN (GRANULAR FILLED TRENCH)
- PROPOSED EAST QUARRY PERIMETER COLLECTOR DRAIN WITH CLEAN-OUT (PERFORATED PIPE WITHIN GRANULAR FILLED TRENCH)
- LIMIT OF LANDFILL
- TOE OF SLOPE
- PROPOSED WEST QUARRY GROUT CURTAIN / COLLECTOR TRENCH
- 189.48 ELEVATION OF INVERT OF GROUND WATER COLLECTION TRENCH

NOTE:

FOR CROSS SECTIONS REFER TO DRAWINGS No.4 AND 5

No.	Description	Date	By

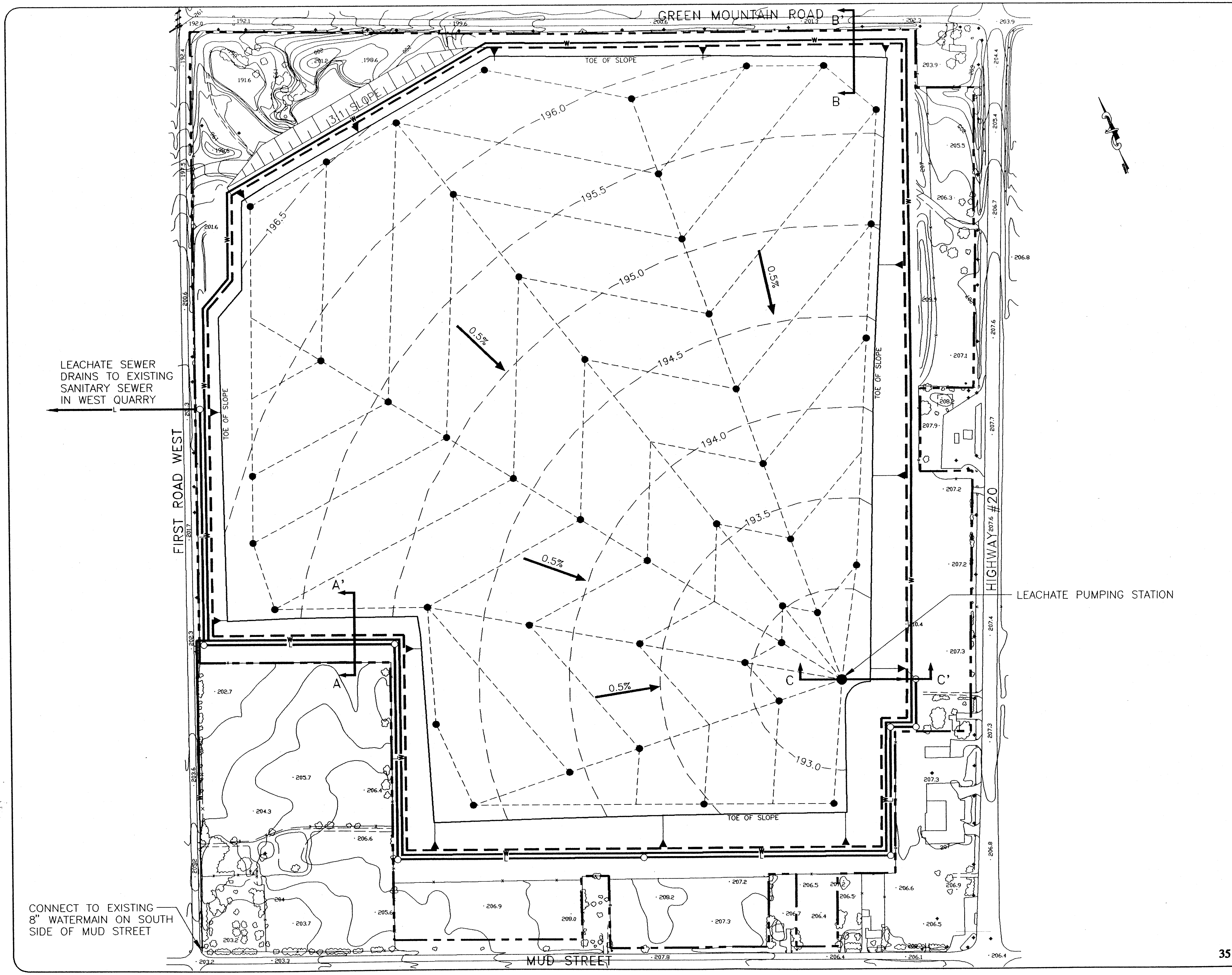
Revisions

SCALES: 40m 0 40m 80m 120m — 1 : 4000

TARO AGGREGATES LTD.
EAST QUARRY ENVIRONMENTAL ASSESSMENT

GROUND WATER COLLECTION SYSTEM LAYOUT

Designed By:		Drawn By:	G.L.D.
Checked By:		Approved By:	M.A.S.
Date Issued:	DEC. 1994	Project No.	94-413
Site Name:	TARO	File Name:	FG09B4-3.DWG
Gartner Lee		Figure No.	9



LEGEND

— — —	PROPERTY BOUNDARY
— — —	LIMIT OF LANDFILL
— —195— —	APPROXIMATE ELEVATION OF TOP OF PRIMARY LINER (mASL)
——▶	DIRECTION OF SLOPE
●	LEACHATE PIPING SYSTEM CLEANOUT
○	LEACHATE SEWER MANHOLE
—◀	HYDRAULIC CONTROL LAYER INJECTION WELLS
—▶	HYDRAULIC CONTROL LAYER EXTRACTION WELL
- - - -	PERFORATED LEACHATE COLLECTION PIPES
——L——	LEACHATE COLLECTION SEWER
——W——	WATERMAIN FOR SUPPLYING HYDRAULIC CONTROL LAYER

NOTE:

FOR CROSS SECTIONS REFER TO DRAWINGS No.4 AND 5

No.	Description	Date	By

Revisions

SCALES: 40m 0 40m 80m 120m — 1 : 4000

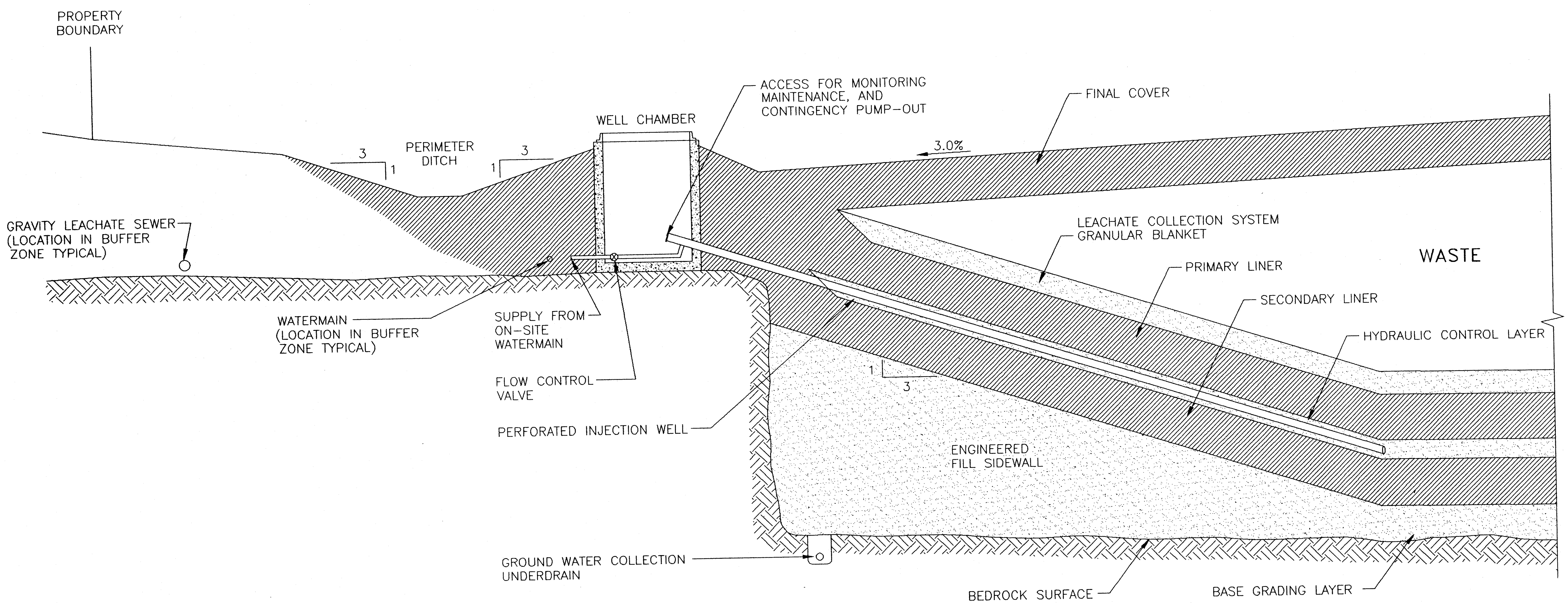
TARO AGGREGATES LTD. EAST QUARRY ENVIRONMENTAL ASSESSMENT

TOP OF PRIMARY LINER CONTOURS AND LEACHATE COLLECTION SYSTEM LAYOUT

Designed By:		Drawn By:	J.G.L.
Checked By:		Approved By:	M.A.S.
Date Issued:	DEC. 1994	Project No.	94-413
Site Name:	TARO	File Name:	FG07B4-3.DWG

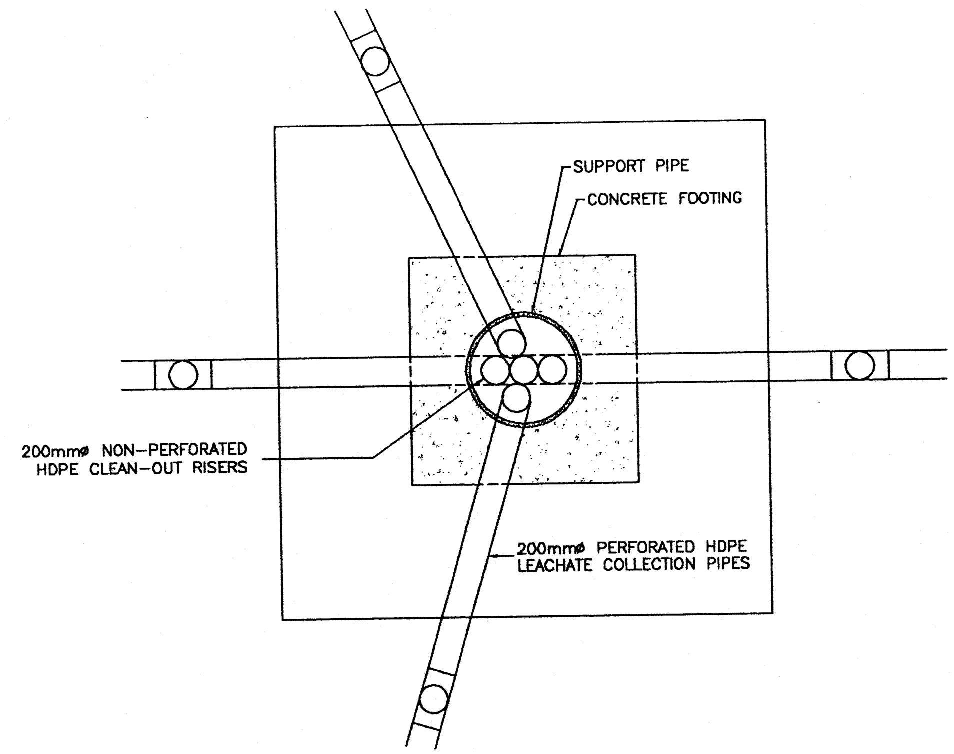
Gartner Lee

Figure No. 10

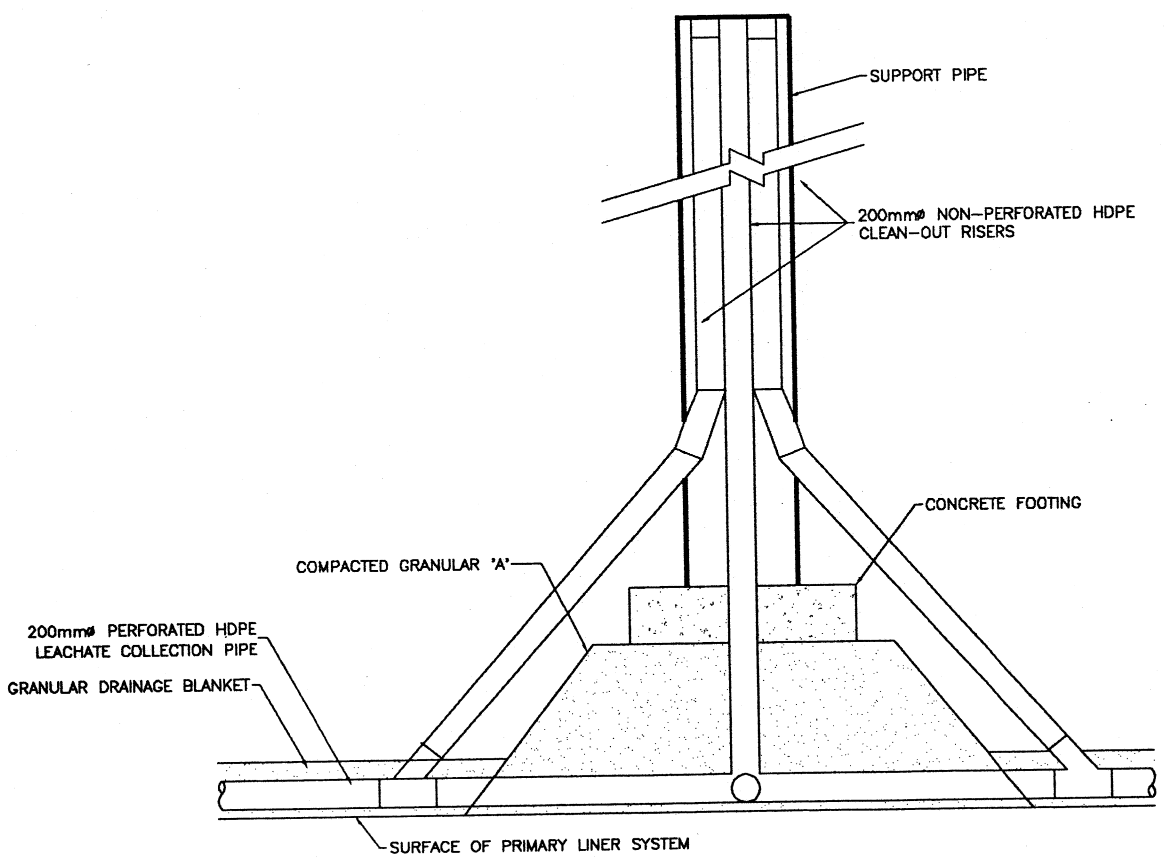


SCALES	NOT TO SCALE		
	Scale		
TARO AGGREGATES LTD. EAST QUARRY ENVIRONMENTAL ASSESSMENT			
TYPICAL CROSS SECTION THROUGH BUFFER ZONE AT INJECTION WELL			
Designed By:		Drawn By:	G.L.D.
Checked By:		Approved By:	M.A.S.
Date Issued:	DEC. 1994	Project No.	94-413
Site Name:	TARO	File Name:	FG08AINJ.DWG
Gartner Lee		Figure No.	11

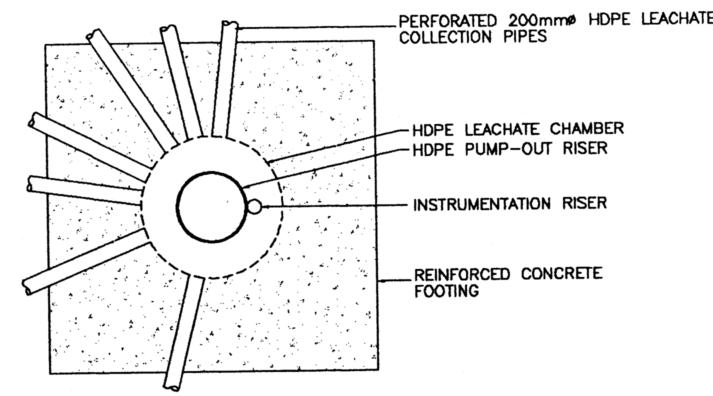
TYPICAL PLAN VIEW AT CLEAN-OUT STRUCTURE



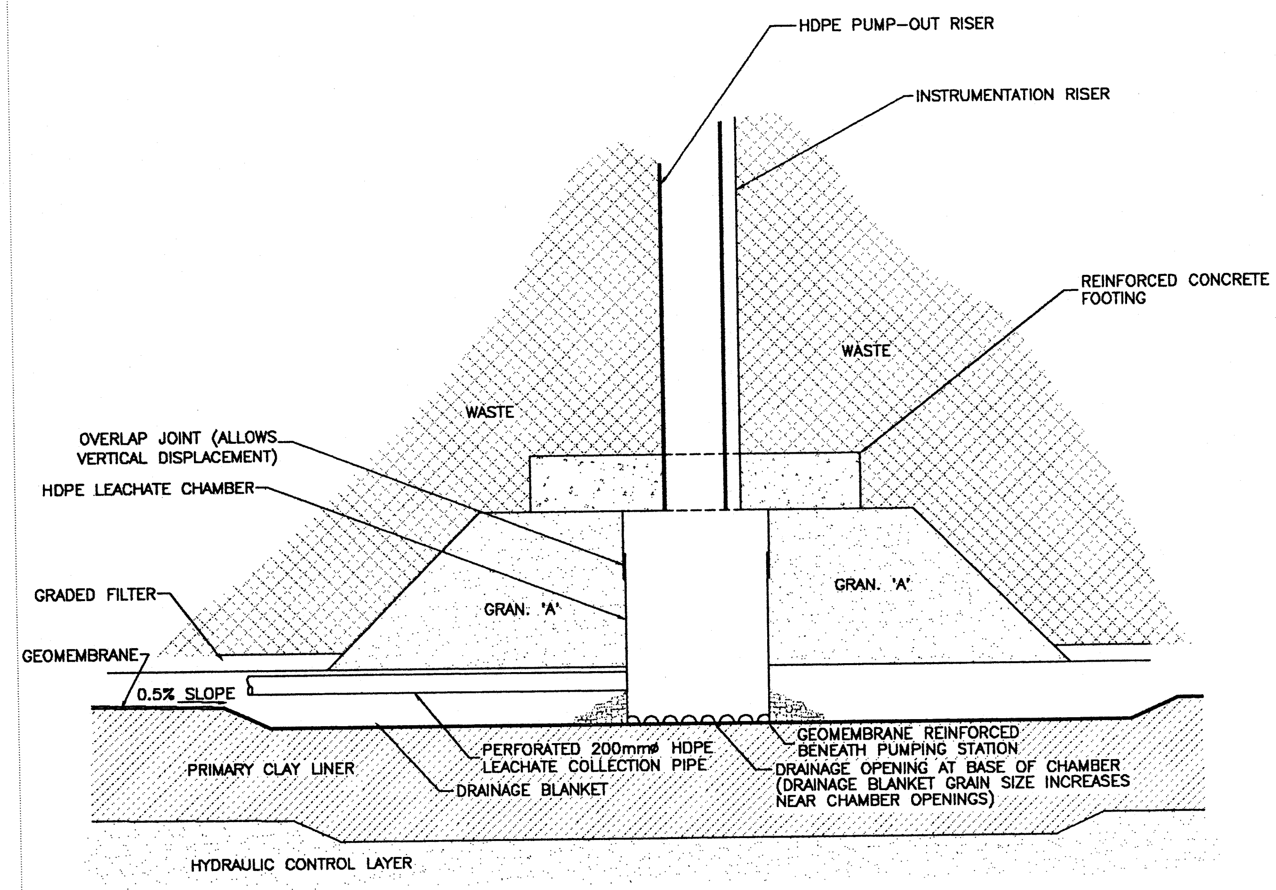
TYPICAL CROSS SECTION AT CLEAN-OUT STRUCTURE



TYPICAL PLAN VIEW AT LEACHATE PUMPING STATION



TYPICAL CROSS SECTION AT LEACHATE PUMPING STATION



LEGEND

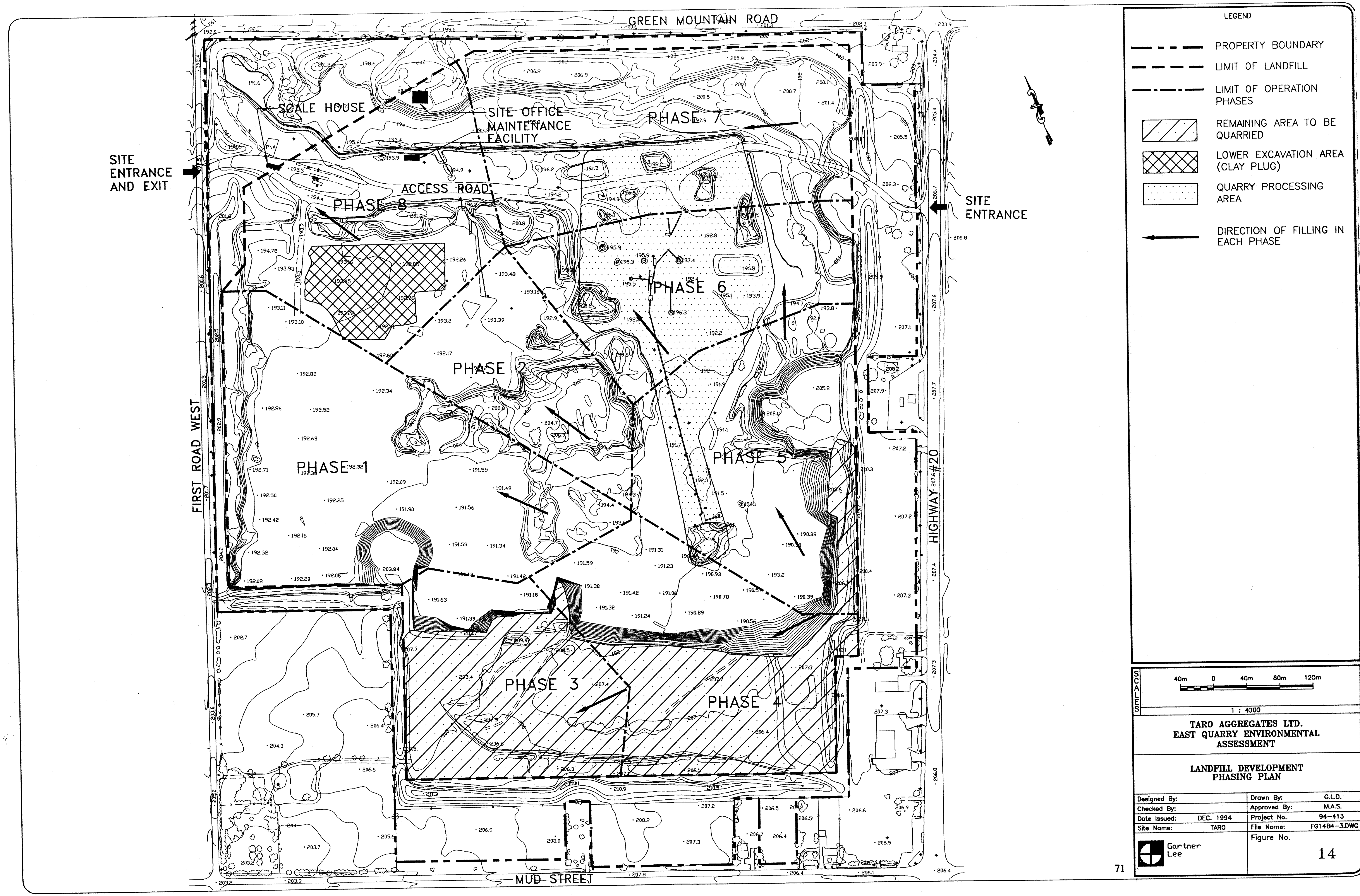
SCALES: NOT TO SCALE

Scale

TARO AGGREGATES LTD.
EAST QUARRY ENVIRONMENTAL ASSESSMENT

TYPICAL LEACHATE COLLECTION SYSTEM DETAILS

Designed By:		Drawn By:	G.L.D.
Checked By:		Approved By:	M.A.S.
Date Issued:	DEC. 1994	Project No.	94-413
Site Name:	TARO	File Name:	FG10A200.DWG
Gartner Lee		Figure No.	12


GREEN MOUNTAIN ROAD
MUD STREET
FIRST ROAD WEST
HIGHWAY #20
SITE ENTRANCE AND EXIT
SITE ENTRANCE
SCALE HOUSE
SITE OFFICE MAINTENANCE FACILITY
ACCESS ROAD
PHASE 1
PHASE 2
PHASE 3
PHASE 4
PHASE 5
PHASE 6
PHASE 7
PHASE 8
LEGEND
PROPERTY BOUNDARY
LIMIT OF LANDFILL
LIMIT OF OPERATION PHASES
REMAINING AREA TO BE QUARRIED
LOWER EXCAVATION AREA (CLAY PLUG)
QUARRY PROCESSING AREA
DIRECTION OF FILLING IN EACH PHASE
SCALES
40m 0 40m 80m 120m
1 : 4000
TARO AGGREGATES LTD.
EAST QUARRY ENVIRONMENTAL ASSESSMENT
LANDFILL DEVELOPMENT PHASING PLAN
Designed By:
Checked By:
Date Issued: DEC. 1994
Site Name: TARO
Drawn By: G.L.D.
Approved By: M.A.S.
Project No. 94-413
File Name: FG14B4-3.DWG
Figure No. 14
Gartner Lee

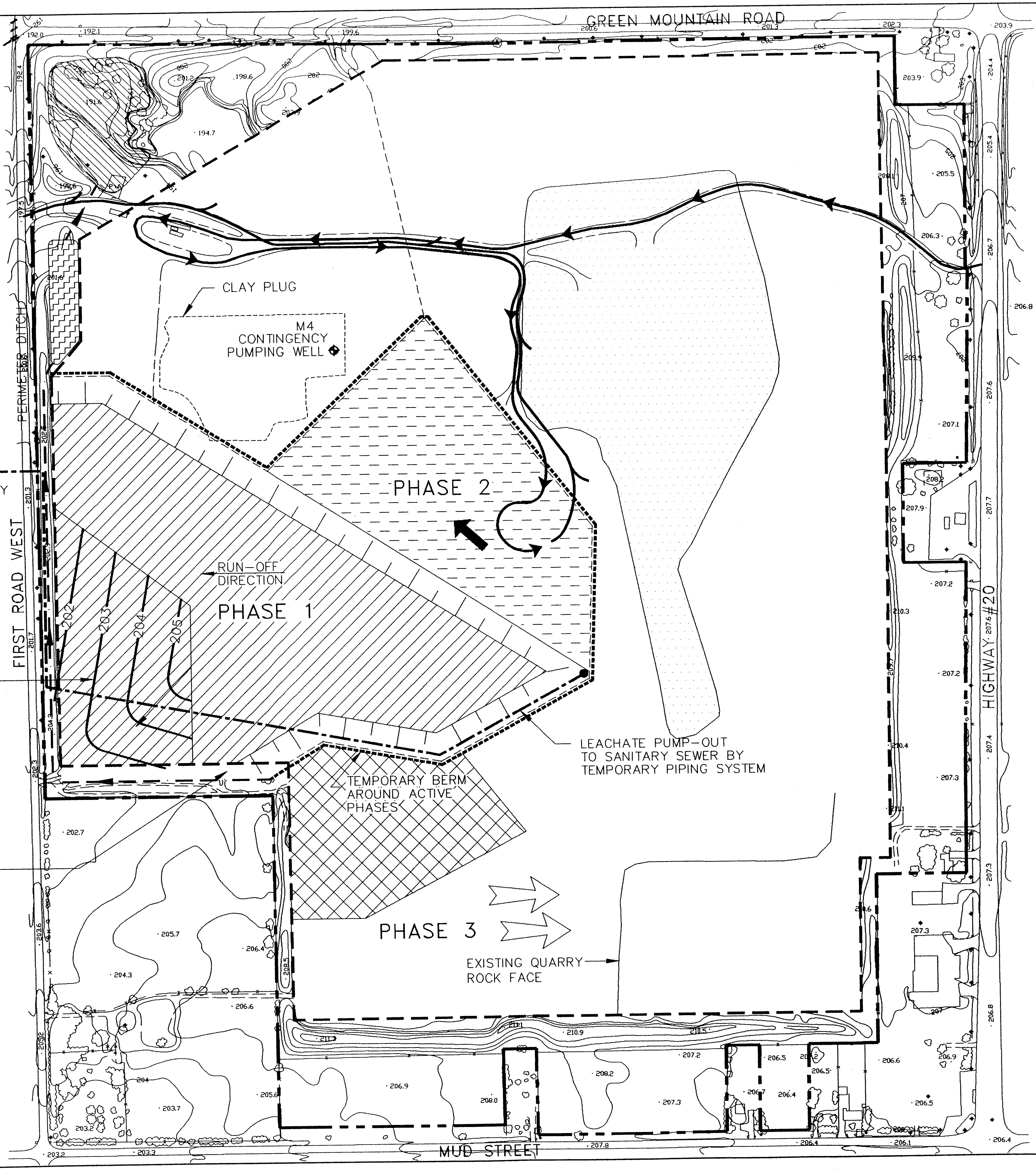
SUMMARY OF LANDFILL DEVELOPMENT TO YEAR 4:

Quarrying:
- Quarrying progressing in south east portion of site.

Landfilling and Leachate Management:
- Interim capacity of Phase 1 filled. Side slopes bordering on active phases remain to be filled.
- Active landfilling occurring in Phase 2.
- Leachate from Phases 1,2 discharged to sanitary sewer via temporary pumping station and forcemain located within Phase 1.

Final Cover and Liner Construction:
- Final cover construction progressing in Phase 1.
- West sedimentation pond and perimeter surface ditch constructed.
- Liner construction occurring in Phase 3.
- Construction utilizing on-site soil stockpiles.

Surface Water Management:
- All infiltration within active landfilled phases handled as leachate.
- Remediation of West Quarry Landfill ground water impacts proceeding; West Quarry grout curtain/collector trench and M4 well operating.
- Surface drainage from within quarry pumped to north west corner of site and discharged to sanitary sewer via existing piping.



LEGEND

- PROPERTY BOUNDARY
- LIMIT OF LANDFILL
- LIMIT OF OPERATION PHASES
- LANDFILLING DIRECTION
- QUARRYING DIRECTION
- WASTE HAULING TRUCK DIRECTION
- RETURN TRUCK DIRECTION
- PHASES WHERE INTERIM CAPACITY REACHED
- LINER CONSTRUCTION AREA
- ACTIVE FILLING AREA
- STORM WATER DETENTION POND
- STORM WATER SEDIMENT CONTROL POND
- QUARRY PROCESSING AREA
- SIDE SLOPES BETWEEN COMPLETED COVER AND ACTIVE PHASE

SCALES: 40m 0 40m 80m 120m — 1 : 4000

TARO AGGREGATES LTD.
EAST QUARRY ENVIRONMENTAL ASSESSMENT

LANDFILL DEVELOPMENT (APPROXIMATELY YEAR 4)

Designed By:		Drawn By:	G.L.D.
Checked By:		Approved By:	M.A.S.
Date Issued:	DEC. 1994	Project No.	94-413
Site Name:	TARO	File Name:	FG15A4-3.DWG
Gartner Lee		Figure No.	15

SUMMARY OF LANDFILL DEVELOPMENT TO TO YEAR 10:

Quarrying:

- Quarrying completed and quarry processing plant decommissioned.

Landfilling and Leachate Management:

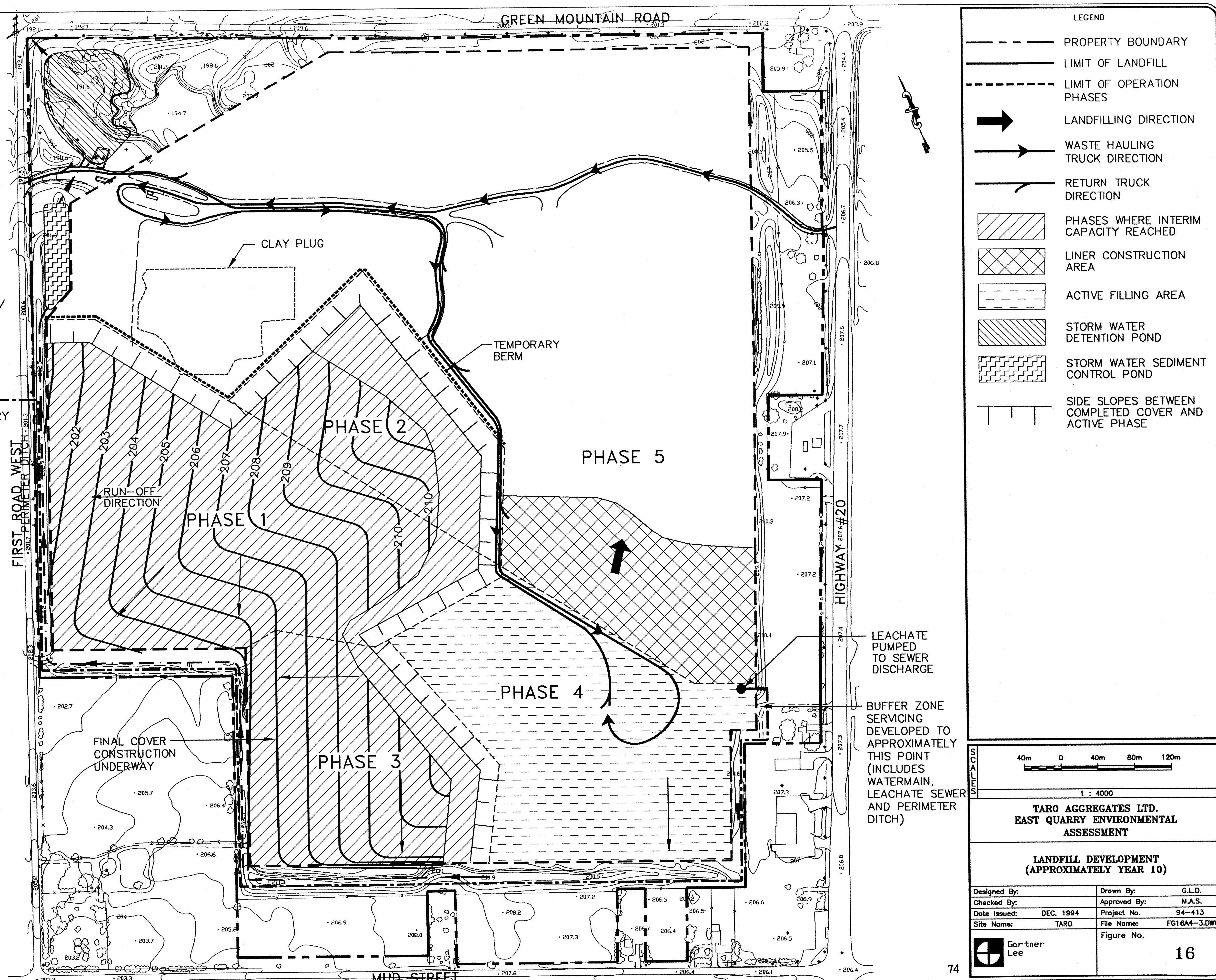
- Interim capacity of Phases 1, 2 and 3 filled. Side slopes bordering on active phases remain to be filled.
- Active landfilling occurring in Phase 4.
- Leachate from Phases 1 – 4 discharged to sanitary sewer via permanaent pumping station.

Final Cover and Liner Construction:

- Final cover construction progressing in Phase 3.
- Liner construction occurring in Phase 5.
- Supplies of on-site stockpiled soils nearly exhausted.

Surface Water Management:

- Drainage from final covered portions of Phases 1, 2 and 3 discharged to perimeter ditch/ /pond system.
- Remediation of West Quarry Landfill ground water impacts completed.
- Surface drainage from within quarry pumped to detention pond in north west corner of site and discharged off-site.



TARO AGGREGATES LTD.
EAST QUARRY ENVIRONMENTAL ASSESSMENT

LANDFILL DEVELOPMENT (APPROXIMATELY YEAR 10)

Designed By:		Drawn By:	G.L.D.
Checked By:		Approved By:	M.A.S.
Date Issued:	DEC. 1994	Project No.	94-413
Site Name:	TARO	File Name:	FG16A4-3.DWG
Gartner Lee		Figure No.	16

SUMMARY OF LANDFILL DEVELOPMENT TO YEAR 17:

Landfilling and Leachate Management:

- Interim of capacity of Phases 1 – 6 reached. Side slopes in previous phases which border onto Phases 7 and 8 remain to be filled.
- Site entrance has been relocated from Highway 20 to First Road West.
- Active landfilling occurring in eastern portion of Phase 7.
- All leachate discharged to sanitary sewer via permanaent pumping station.

Final Cover and Liner Construction:

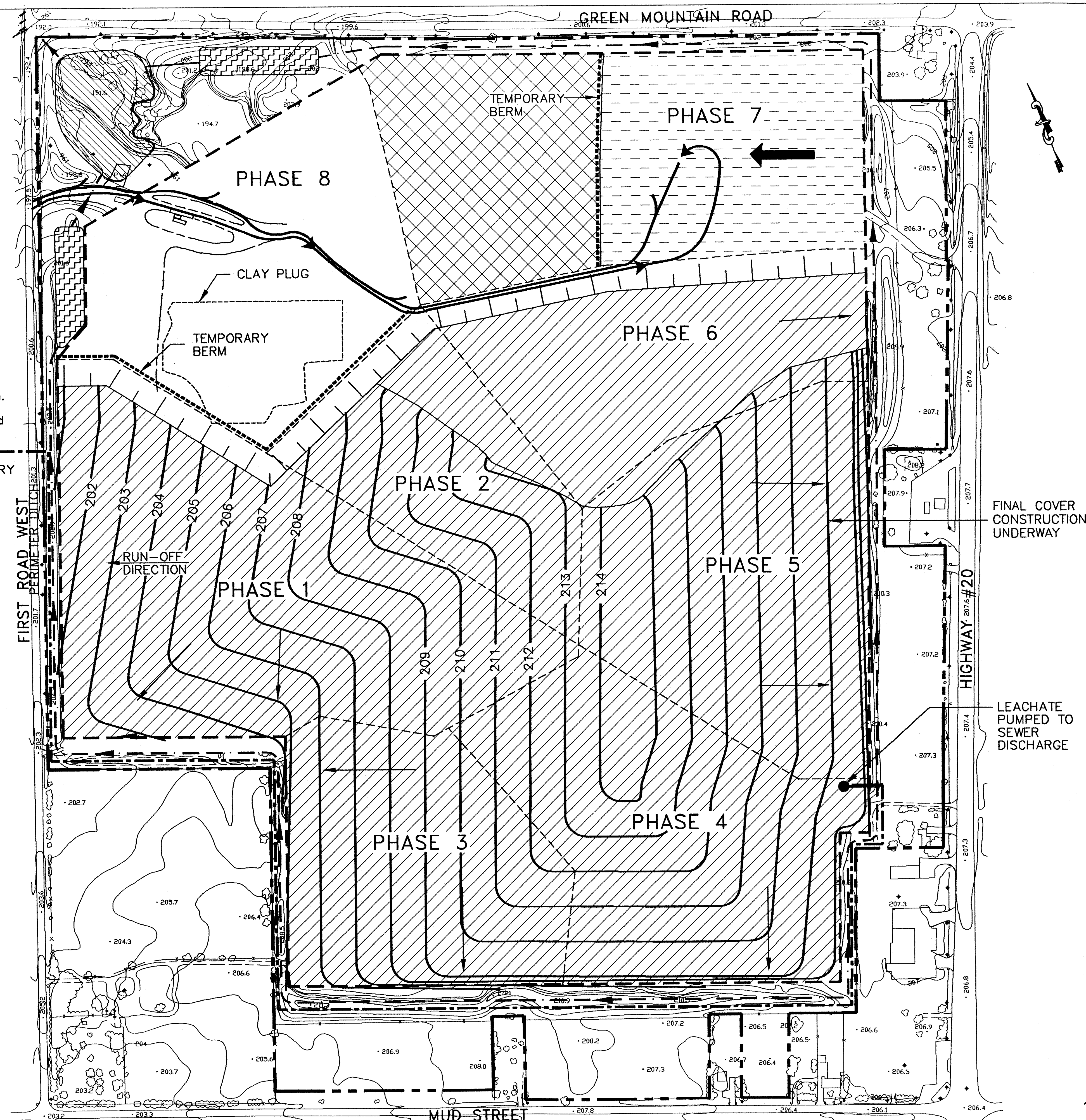
- Final cover construction progressing in Phase 5.
- Liner construction proceeding in western portion Phase 7.
- Pre-loading of clay plug in Phase 8 underway.
- All liner/cover material supplied from off-site.

Surface Water Management:

- Drainage from final covered Phases 1 –4 discharged to western portion of ditch/ pond system.
- Drainage from final covered portion of Phase 5 discharged to eastern perimeter ditch/pond system.
- Clean surface drainage from within quarry pumped to detention pond in north west corner of site and discharged off-site.

DRAIN TO SANITARY SEWER IN WEST QUARRY

ALL BUFFER ZONE SERVICING DEVELOPED. (INCUDES WATERMAIN, LEACHATE SEWER AND PERIMETER DITCH)



LEGEND

- PROPERTY BOUNDARY
- LIMIT OF LANDFILL
- LIMIT OF OPERATION PHASES
- LANDFILLING DIRECTION
- WASTE HAULING TRUCK DIRECTION
- RETURN TRUCK DIRECTION
- PHASES WHERE INTERIM CAPACITY REACHED
- LINER CONSTRUCTION AREA
- ACTIVE FILLING AREA
- STORM WATER DETENTION POND
- STORM WATER SEDIMENT CONTROL POND
- SIDE SLOPES BETWEEN COMPLETED COVER AND ACTIVE PHASE

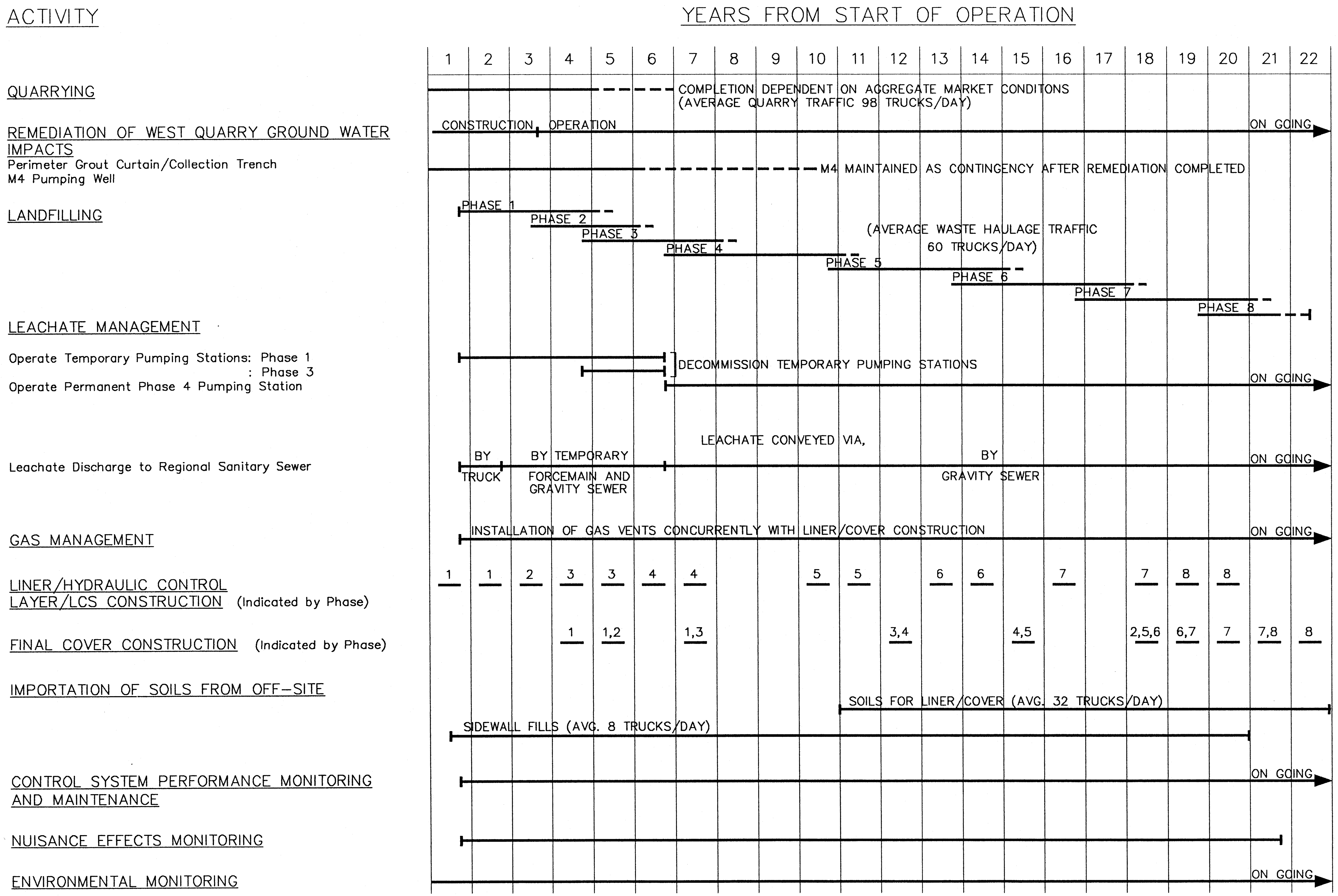
SCALES

Scale

TARO AGGREGATES LTD.
EAST QUARRY ENVIRONMENTAL ASSESSMENT

LANDFILL DEVELOPMENT (APPROXIMATELY YEAR 17)

Designed By:		Drawn By:	J.G.L.
Checked By:		Approved By:	M.A.S.
Date Issued:	DEC. 1994	Project No.	94-413
Site Name:	TARO	File Name:	FG17B4-3.DWG
Gartner Lee		Figure No.	17



NOTES
1: TIMING SHOWN FOR ACTIVITIES IS APPROXIMATE.
2: LANDFILLING PROGRESS SHOWN BASED ON RECEIPTS OF 500,000 T/YEAR. ACTUAL PROGRESS DEPENDS ON ACTUAL WASTE RECEIPTS.

LEGEND

SCALES: NOT TO SCALE

TARO AGGREGATES LTD.
EAST QUARRY ENVIRONMENTAL ASSESSMENT

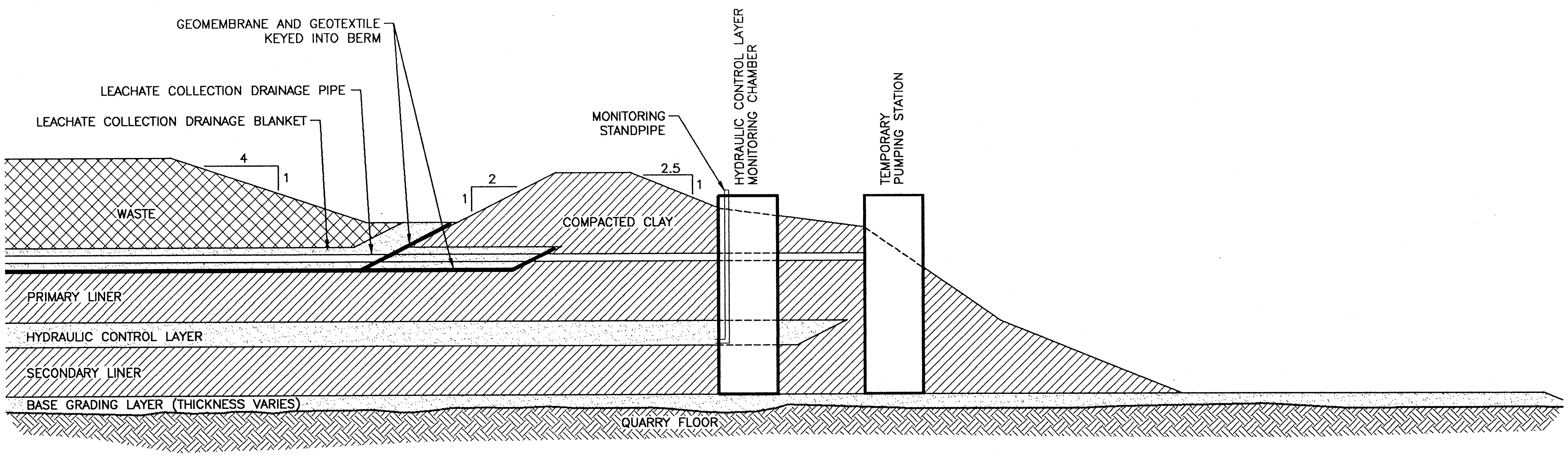
OPERATIONS SCHEDULE

Designed By:		Drawn By:	G.L.D.
Checked By:		Approved By:	M.A.S.
Date Issued:	DEC. 1994	Project No.	94-413
Site Name:	TARO	File Name:	94413F18

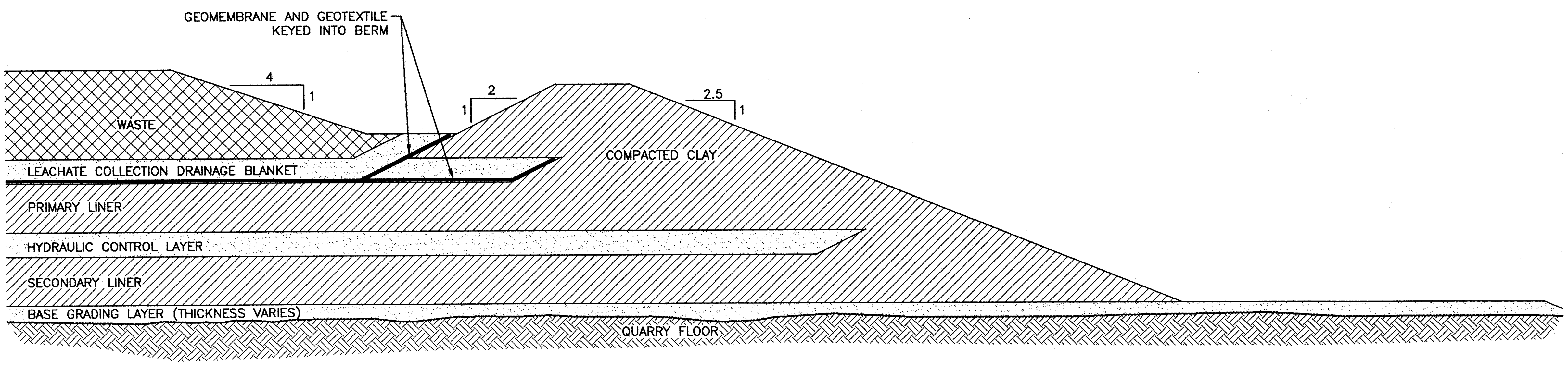
Gartner Lee

Figure No. 18

NOTE:
SEE FIGURE No. 15 FOR LOCATION OF PUMPING STATION



TYPICAL DETAIL AT TEMPORARY LEACHATE PUMPING STATION AND HYDRAULIC CONTROL LAYER MONITORING CHAMBER



TYPICAL DETAIL THROUGH TEMPORARY BERM

LEGEND

SCALES

NOT TO SCALE

Scale

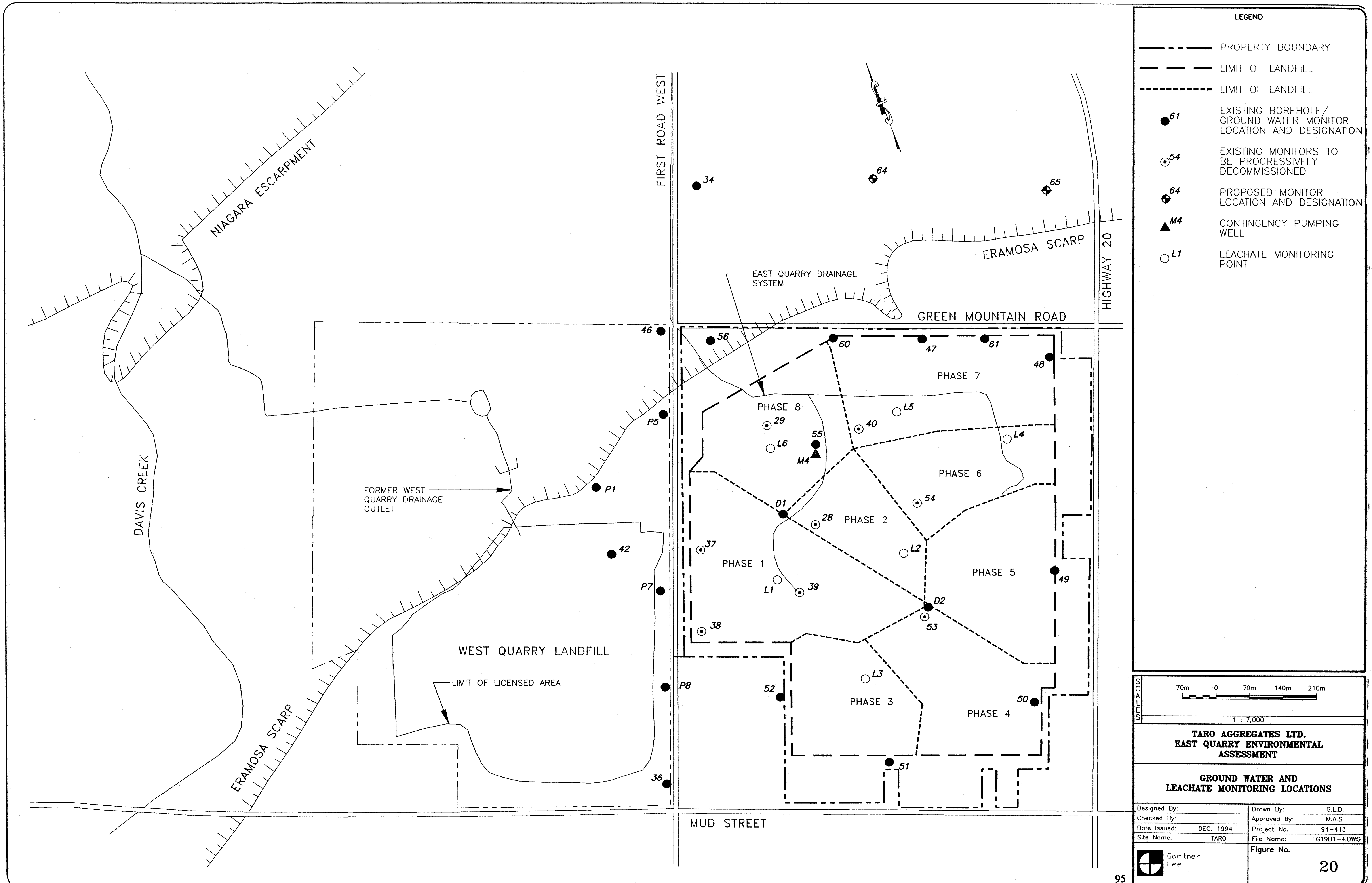
TARO AGGREGATES LTD.
EAST QUARRY ENVIRONMENTAL ASSESSMENT

TYPICAL DETAILS THROUGH TEMPORARY BERM

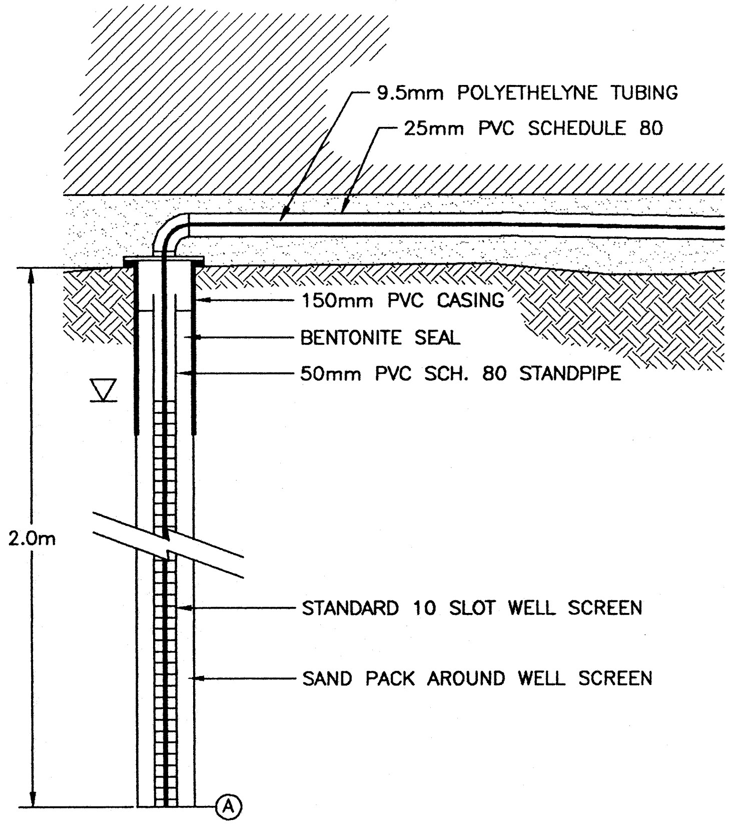
Designed By:		Drawn By:	G.L.D.
Checked By:		Approved By:	M.A.S.
Date Issued:	DEC. 1994	Project No.	94-413
Site Name:	TARO	File Name:	TEMPBERR.DWG

Gartner Lee

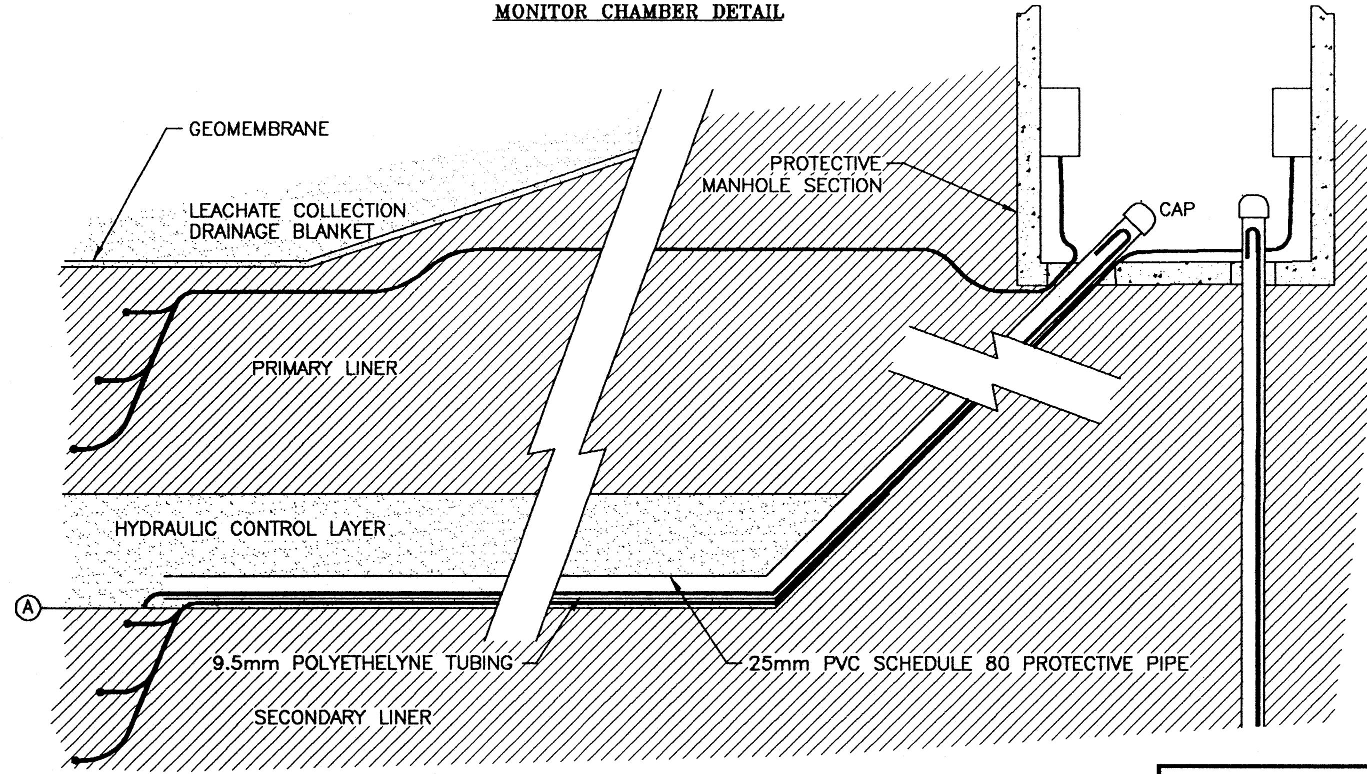
Figure No. 19


LEGEND
PROPERTY BOUNDARY
LIMIT OF LANDFILL
LIMIT OF LANDFILL
EXISTING BOREHOLE/ GROUND WATER MONITOR LOCATION AND DESIGNATION
EXISTING MONITORS TO BE PROGRESSIVELY DECOMMISSIONED
PROPOSED MONITOR LOCATION AND DESIGNATION
CONTINGENCY PUMPING WELL
LEACHATE MONITORING POINT
NIAGARA ESCARPMENT
DAVIS CREEK
ERAMOSA SCARP
FIRST ROAD WEST
GREEN MOUNTAIN ROAD
HIGHWAY 20
MUD STREET
EAST QUARRY DRAINAGE SYSTEM
FORMER WEST QUARRY DRAINAGE OUTLET
WEST QUARRY LANDFILL
LIMIT OF LICENSED AREA
PHASE 1
PHASE 2
PHASE 3
PHASE 4
PHASE 5
PHASE 6
PHASE 7
PHASE 8
SCALES
70m 0 70m 140m 210m
1 : 7,000
TARO AGGREGATES LTD.
EAST QUARRY ENVIRONMENTAL ASSESSMENT
GROUND WATER AND LEACHATE MONITORING LOCATIONS
Designed By:
Checked By:
Date Issued: DEC. 1994
Site Name: TARO
Drawn By: G.L.D.
Approved By: M.A.S.
Project No. 94-413
File Name: FG19B1-4.DWG
Figure No. 20
Gartner Lee

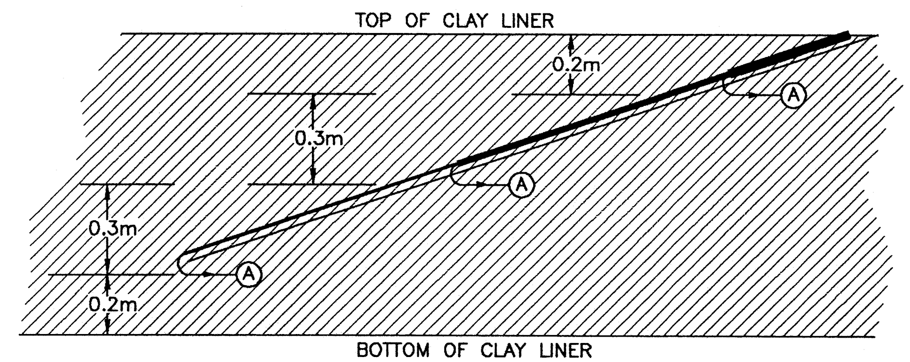
SHALLOW GROUND WATER MONITOR DETAIL



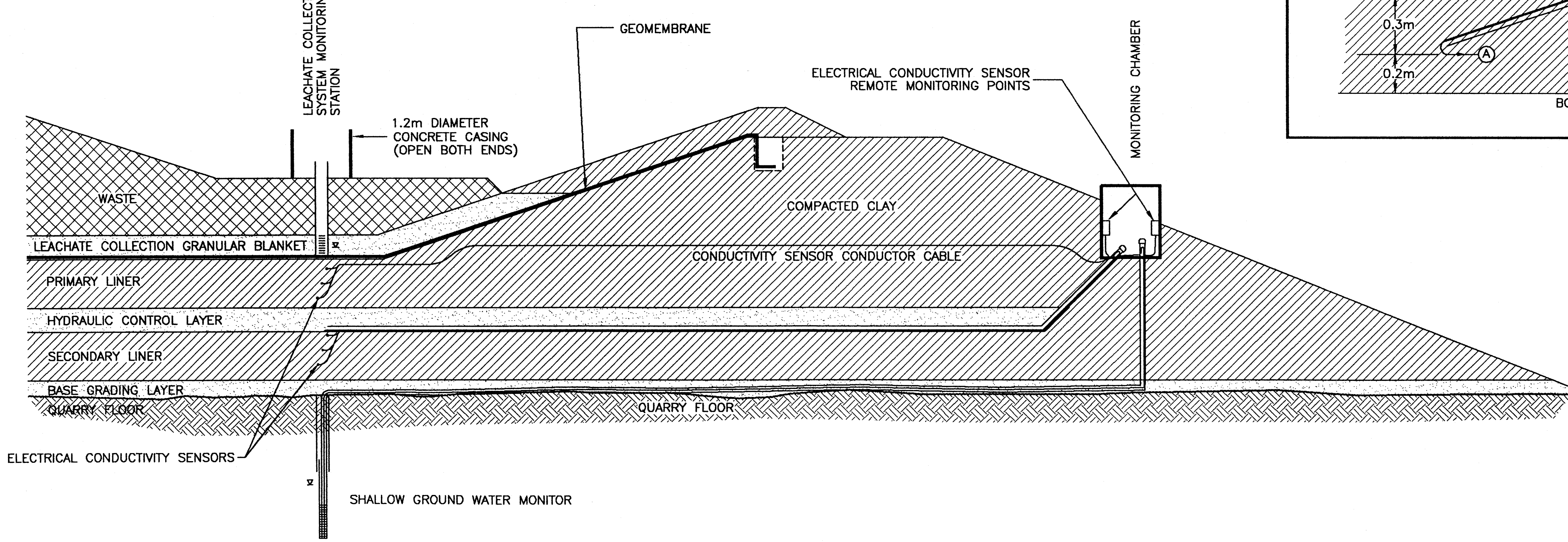
MONITOR CHAMBER DETAIL



CONDUCTIVITY SENSOR LOCATION DETAIL



TYPICAL DETAIL THROUGH DIFFUSION TEST PAD



NOTE:

(A)— SENSOR ELEVATION RECORDED IN FIELD AT TIME OF CONSTRUCTION

SCALES: NOT TO SCALE

Scale

TARO AGGREGATES LTD.
EAST QUARRY ENVIRONMENTAL ASSESSMENT

TYPICAL DETAILS THROUGH DIFFUSION TEST PAD

Designed By:		Drawn By:	G.L.D.
Checked By:		Approved By:	M.A.S.
Date Issued:	DEC. 1994	Project No.	94-413
Site Name:	TARO	File Name:	TESTPAD.DWG
Gartner Lee		Figure No.	21

Section 13, **Glossary of Terms**, presents definitions for the technical terminology used in this report.

A series of appendices are provided following the report text. Appendices A and B provide supporting information and calculations, respectively. Appendices C, D, E, and F provide responses to comments received on the May 1994 draft report.

2.0 WASTE STREAM

2.1 ACCEPTABLE WASTES

Taro proposes to use the East Quarry to landfill solid non–hazardous waste from industrial, commercial, and institutional sources in the Region of Hamilton–Wentworth, including the residue of waste brought into Hamilton for recycling and processing by Philip Environmental.

The exact character of the waste cannot be determined now, but it would be similar in many respects to the wastes now being placed in Taro's West Quarry Landfill. Examples of potential wastes include:

a) basic oxygen furnace oxides;
b) baghouse dust;
c) mixed wastes including floor dust and sweepings;
d) fuel contaminated soils from fuel retail and tank farm decommissionings;
e) contaminated soils from industrial site decommissioning;
f) waste clay;
g) waste lime;
h) solidified/stabilized industrial wastes;
i) industrial slags;
j) construction/demolition waste and rubble;
k) shredder wastes; and,
l) waste silica.

In the past the West Quarry Landfill has accepted aluminum processing wastes. These wastes will not be accepted in the East Quarry landfill due to their high chloride levels. Other wastes that will not be accepted include:

a) residential, agricultural or medical wastes;
b) liquid wastes;
c) hazardous wastes as defined by Ontario Regulation 347, or,
d) barrels, drums or other similar containers.

(1ra1220ms/94413/1294)

2.2 WASTE QUANTITIES AND PHYSICAL CHARACTERISTICS

The planning assumptions that Taro has used for waste receipts are an average of 500,000 tonnes per year for about 20 years. A landfill meeting these requirements would have a capacity of approximately 10,000,000 tonnes. Taro has also identified the need to be able to accommodate a greater waste receipt rate on a short–term basis, and has identified a peaking factor of about four. It is thus possible that peak waste receipts of up to an equivalent of 2,000,000 tonnes/year may be received on a short–term basis. Taro has developed these waste projections based on actual historical receipts at the West Quarry Landfill as well as projections regarding growth in their waste disposal market. A further discussion of Taro's disposal capacity needs is presented in Taro Aggregates Ltd., 1995 (Volume I).

The majority of wastes will be granular, soil–like materials which, when compacted, will have an overall density of between 1.6 to 2 tonnes/m^3. Therefore, 10,000,000 tonnes translates to a volume of between 5,000,000 m^3 and 6,250,000 m^3.

Waste settlement over time should be minor because of the granular nature and high density of the wastes. For example, the West Quarry landfill has been active since 1980 and the average fill thickness is about 10 m. Future settlement of wastes that have been well compacted at this site is expected to be in the order of about 150 mm.

2.3 POTENTIAL FOR WASTES TO GENERATE GAS

Based on experience at the West Quarry landfill, it is known that the waste stream is a source of combustible gas. Combustible gas can be generated through the degradation of organic components of the wastes. Combustible gas generation at the West Quarry Landfill is significantly less than that at typical municipal landfill sites. By way of comparison, the organic fraction of the West Quarry wastes is less than 5%, whereas the organic fraction at municipal sites is up to 50% or greater. The East Quarry wastes will be similar in many respects to those in the West Quarry Landfill, thus we must consider that combustible gas generation potential will be similar.

Monitoring carried out to date at the West Quarry Landfill indicates that emissions of non–methane organic compounds, or NMOCs, are insignificant. Monitoring has included recovery and analysis of soil gas samples from within the wastes, as well as ambient air quality monitoring. The NMOC assessment work is documented in detail in CJB Air Quality Management, 1995.

2.4 CONTAMINATING LIFESPAN

Leachate is formed when precipitation infiltrates into waste materials and dissolves various minerals, elements, and chemical compounds out of the waste. The East Quarry wastes are expected to produce leachate that will initially exceed various regulatory limits for surface and ground water quality and thus cannot be released to the environment without some form of treatment. The dissolution of these constituents is an ongoing process, and, eventually, a sufficient amount of these constituents will be removed from the waste so that the leachate can no longer adversely impact the environment. The "contaminating lifespan" is thus defined as the length of time that the wastes can produce leachate that is unacceptable for direct release to the environment.

The contaminating lifespan of the wastes must be considered when developing a landfill design because it defines the length of time for which leachate must be collected, handled, and disposed of in a controlled manner. The Ministry of the Environment and Energy (MOEE) requires that a proponent estimate the contaminating lifespan of the wastes to be landfilled, and demonstrate that any proposed leachate controls will function for at least this length of time.

The estimated contaminating lifespan of the East Quarry landfill is in the range of 200 to 300 years. We have thus conservatively assumed that the East Quarry leachate controls will need to function for at least 300 years. The work carried out to develop the contaminating lifespan estimate is presented in detail in Gartner Lee Limited 1995b.

The work carried out to develop this estimate can be summarized as follows:

a) A basic assumption was made that the East Quarry Landfill wastes would, with the exception of high chloride aluminum processing wastes, be similar to the waste stream described in Section 2.1.

b) Waste haulage records for the West Quarry Landfill were reviewed to determine the relative proportions of various waste types in the landfill. These proportions were adjusted to reflect the exclusion of the high chloride aluminum processing wastes.

c) The projected composition of the East Quarry Landfill leachate was estimated by taking known West Quarry leachate composition and adjusting this, using the PHREEQE geochemical model, to reflect the exclusion of the high chloride aluminum processing wastes. The adjusted leachate composition was compared to water quality guidelines and natural water quality to determine the critical contaminants.

d) Selected West Quarry Landfill wastes were analyzed to determine the mass of critical contaminants in each. This plus the expected landfill volume was used to determine the total mass of each critical contaminant in the proposed East Quarry Landfill.

e) A water budget was developed for the East Quarry Landfill. This together with the adjusted leachate concentrations, was used to determine leaching rates. This leaching rate was used to determine how long it would take to leach out the total mass of the critical contaminants.

The service life of the proposed leachate controls and MOEE policies in this regard are discussed in more detail in Section 4.3.4.

3.0 DESIGN BASIS

3.1 GENERAL DESIGN CONSIDERATIONS

The design and operating plan for the proposed East Quarry Landfill is based on the following broad objectives:

a) The landfill site should provide a total waste capacity of approximately 10,000,000 tonnes. Based on a minimum achievable waste density of 1.6 tonnes/m^3, the waste volume is at least 6,250,000 m^3.

b) The operation of the site should accommodate average waste receipts of 500,000 tonnes/year over the landfill operating life. Taro expects that waste receipts could vary from time to time on a short–term basis during the operating life to up to an equivalent of 2,000,000 tonnes/year, and the operation should thus accommodate these peak receipts.

c) The landfill must incorporate control systems and be operated in such a manner that public health and safety and the natural environment are protected.

d) The landfill must be designed and operated in accordance with applicable government regulations and policies. Applicable policies will be identified in this document where they apply to specific parts of the design.

e) The design should accommodate the continuation of the quarrying operation, and utilize existing facilities where possible.

These broad objectives were focused into more specific criteria when considering the various components of the design and the specific aspects of the site setting. These criteria are discussed in more detail in Sections 4 and 5.

3.2 SITE SETTING AND EXISTING OPERATIONS

3.2.1 Geology and Hydrogeology

The East Quarry is situated on the edge of the Eramosa Scarp overlooking the Niagara Escarpment to the north. Bedrock beneath the site consists of the following members of the Lockport Formation, progressing to depth:

a) the Eramosa Dolostone;
b) the Vinemount Shale;
c) the Goat Island Dolostone;
d) the Gasport and Decew Dolostones; and,
e) the Rochester Shale.

These units dip at about 0.5% to the southeast. Extensive drilling work has been carried out which has confirmed that the geology is very uniform throughout the site.

The Eramosa Dolostone is being extracted by the quarrying operation. The upper surface of the underlying Vinemount Shale generally comprises the quarry floor although small thickness of the Eramosa have not been quarried in some areas. Both of these units are truncated to the north by the Eramosa scarp.

The Eramosa Dolostone, the Vinemount Shale, and the Goat Island Dolostone contain bedding planes, fracture zones and other geologic variations which define natural ground water flow pathways. The following flow zones exist beneath the East Quarry, progressing to depth:

a) the Vinemount Flow Zone, which exists immediately beneath the floor of the quarry within the Vinemount Shale;
b) the Upper Flow Zone, Mid Flow Zone, and Lower Flow Zone, which exist within the Goat Island Dolostone.

The Gasport and Decew Dolostones, and the Rochester Shale have low hydraulic conductivities relative to the overlying units and thus form a lower boundary to downward ground water movement.

Shallow ground water flow occurs radially inward to the site from all directions near the base of the quarry walls. Dewatering is necessary in the southern part of the quarry to prevent accumulation of water within the quarry. Ground water flow also occurs vertically downward beneath the quarry floor to several deeper ground water systems.

A detailed discussion of site geologic conditions may be found in Gartner Lee Limited, 1994a,b. A compilation of the physical data collected during various site investigations is presented in Gartner Lee Limited, 1993.

3.2.2 Surface Drainage Patterns

The lands now occupied by the East Quarry originally drained to the northwest as the headwaters of Davis and Battlefield Creeks. The construction of Green Mountain Road prior to 1920 appears to have resulted in all site flows being drained to Davis Creek. Davis Creek is a tributary of Redhill Creek.

Drainage from the East Quarry has historically been discharged to the northwest of the site, to a roadside ditch on the west side of First Road West. This ditch drains to the north and falls over the Niagara Escarpment to ultimately join Davis Creek.

Further details of the surface water system are discussed in Section 7.2, in relation to surface water monitoring. Detailed information regarding the surface water system is presented in O'Neill Environmental, 1995.

3.2.3 Existing Quarrying Operations and Facilities

3.2.3.1 Site Entrance and Exit

The existing site entrance is in the northeastern corner of the site off of Highway 20. The site exit is in the northwest of the site off of First Road West. These features are shown on Figure 2. A sweeping program is currently in effect to control the tracking of mud onto First Road West. The traffic study carried out as part of the environmental assessment indicated that the existing entrances and exits are suitable for continued use for both the quarry and landfill traffic. This work is documented in RGP Transtech Inc., 1995.

The Province of Ontario has recently announced a proposal to construct a four–lane arterial roadway (formerly termed the Red Hill Creek Expressway) west of the East Quarry and this proposal is presently being reviewed by the Region. Should this proposal be carried further the traffic analysis for the landfill will be re–evaluated to determine the impact that this roadway could have on traffic around the site.

We believe that any changes to the design regarding traffic access to the site can be incorporated at a future stage, should this be necessary.

3.2.3.2 Quarrying Operation

The southern portion of the site remains to be quarried. The remaining life of the quarry operation is estimated to be seven to eight years, and thus quarrying will be completed by about the year 2001.

The quarry weigh scales and equipment maintenance facilities are located in the northwestern portion of the site. The quarry processing plant is located in the east–central portion of the East Quarry.

The locations of these features is shown in Figure 2.

3.2.3.3 Quarry Drainage System

The East Quarry excavation is drained via a ditch system excavated within the floor of the quarry. The main parts of this ditch exist along the east and north perimeters of the quarry, and these drain by gravity to the northwest corner of the site. Pumping is used to convey water from the deeper parts of the quarry in the south of the site to the ditch systems.

Quarry drainage is typically discharged off–site at the northwest corner to a roadside ditch along the west side of First Road West. At present, however, quarry drainage is discharged to the Regional sanitary sewer due to the seepage into the quarry of leachate–impacted ground water from the West Quarry Landfill. The quarry drainage system is shown in Figure 2. Effects from the West Quarry Landfill are discussed further in Section 3.2.4.

3.2.3.4 Lower Excavation and Clay Plug

In the mid–1980s, part of the excavation in the East Quarry was advanced into the Goat Island Dolostone below the Vinemount Shale. The excavation has since been backfilled with waste rock, to the base of the Vinemount Shale. The uppermost 3 m of the excavation was then filled with a compacted clay plug, constructed from on–site stockpiles of overburden soils. The purpose of the plug was to limit the downward migration of water under future landfill conditions. The extent of the lower excavation is shown in Figure 2. The properties of the on–site soils are discussed in Section 3.2.3.5.

The clay plug was constructed in essentially the same manner as a clay liner, where material gradation, moisture content, and applied compactive energy were carefully controlled. A considerable degree of geotechnical testing was carried out on the plug after its construction. It was found, for example, that an in–situ hydraulic conductivity of 10^{-10} m/s was achieved. The performance achieved from the clay plug is significant because it can be considered a large test pad that demonstrates the potential of on–site soils for use in landfill liner construction. The testing results are summarized in Appendix A of this report.

We have identified that potential exists for differential settlement of the clay plug relative to the quarry floor under the load imposed by landfilling over this area. A combined thickness of about 15 metres of liner system and waste fill would be placed over this location. Under these loads, consolidation settlement varying from 30 to 190 mm could occur within the clay plug. The supporting calculations for this estimate are provided in Appendix B of this report.

We consider that this amount of settlement could potentially damage the liner system or leachate collection system. This will be prevented by pre–loading the clay plug prior to landfill construction, so that future settlement potential is minimized. The issues related to pre–loading of the clay plug are discussed in Section 4.3.3.5.

3.2.3.5 Overburden Soil Stockpiles

The overburden soils that exist within the East Quarry are part of the glacio–lacustrine and silt/clay till deposits that cover the majority of the Niagara Region above the Niagara Escarpment. These exist in stockpiles, in the quarry's perimeter screening berms, and as in–situ soils that will be stripped prior to future quarrying. We estimate that about 1,070,000 m^3 of overburden soils exist on–site, in the locations shown in Figure 2.

The soils at the East Quarry are suitable for liner and cover construction as indicated by considerable testing carried out on both samples recovered from stockpiles as well as from the clay plug within the lower excavation. Testing has included the following:

a) visual inspection of soils through drilling and test pitting;

b) grain size analyses;
c) atterberg limits;
d) moisture content–density relationships;
e) consolidation testing;
f) triaxial compression testing;
g) permeability testing;
h) mineralogical analyses; and,
i) clay/leachate compatibility testing.

Liner construction aspects are discussed in greater detail in Sections 4.3.3.2 and 5.2.3. A summary of the results of the soils testing program is provided in Appendix A of this report.

The available soils generally consist of brown to grey silty clay to clayey silt particle sizes, containing gravel and occasional boulders. The predominant clay mineral is illite, with lesser amounts of smectitie and vermiculite. They are relatively inactive and thus do not exhibit significant shrinkage/swelling properties.

The overburden soils have been used to successfully construct various earthworks within the East Quarry. One application was the clay plug that was constructed within the lower excavation in the East Quarry.

Taro expects to use about 150,000 m^3 from the on–site stockpiles to construct the West Quarry Landfill final cover. This will occur during landfilling in the East Quarry and would leave about 920,000 m^3 of soil for use at the East Quarry. The remaining volume should be reduced by about 10% to account for bulking, resulting in a source of about 830,000 m3 for future 'in–place' earthworks. We also consider that about 5% of the material may be unsuitable for direct use in liner or cover because of mixing with waste rock. This would leave about 790,000 m^3 available for 'in–place' cover or liner, with the remaining 40,000 m^3 being suitable for other earthworks such as sidewall backfill.

The total amount of fine–grained soils required for liner and cover construction is about 1,770,000 m^3. Therefore the existing on–site stockpiles will need to be supplemented with additional soils brought from off–site. The soils present in Taro's East Quarry are similar to much of the overburden soils present within the Niagara region, since most of these materials are derived from the same geologic source. We are aware of at least two borrow areas within the Niagara region that are currently being used to provide landfill liner and cover material. These are the Vineland Quarry, in Vineland, Ontario, which provides borrow for the Grimsby Landfill, and the Niagara Waste Systems Landfill in Thorold, Ontario, which utilizes on–site materials for landfill construction.

Fine–grained soils will need to be imported to the East Quarry at about the mid–point in the site's operating period, and we believe it is reasonable to consider that a suitable source will be available at that time. It is difficult to specify the exact source presently, since the actual timing of the need for imported fill will vary depending upon the actual rate at which the East Quarry site is built and filled, and because the economic viability of various sources will vary with time. We are confident, however, that, due to the abundance of suitable fills available within the region presently, a viable source will be available to Taro in the future. Taro is committed to ensuring that all needed approvals will be in place prior to the need to import fills from an off–site borrow source. We also note that the future need to import landfill construction materials has been accounted for in the impact assessment for the East Quarry Landfill application.

Soils that are imported from off–site in the future will be thoroughly tested prior to use to ensure their suitability for liner and cover construction. Future testing will be similar to the work carried out to date. This will include, as a minimum, basic geotechnical testing such as in–situ moisture content, grain size analyses, moisture content–density relationships, as well as hydraulic conductivity and soil/leachate compatibility.

3.2.3.6 Potential for Quarry Floor Heave

We recognize that the removal of rock and overburden, such as in a quarrying operation, results in the lowering of vertical stresses within a rock mass. Under certain circumstances, where relatively high residual horizontal stresses exist within a rock formation, the removal of vertical stress through quarrying can cause heave of a quarry floor.

We have considered the potential for stress release within the quarry floor. We believe that potential for this is very small, given the following factors:

i) The Eramosa Scarp exists immediately to the north of the East Quarry. This is an erosional feature which truncates the Eramosa Dolostone (the unit presently being quarried) and the underlying Vinemount Shale (the unit which forms the quarry floor). The presence of the Scarp implies that residual horizontal stresses within the Eramosa Dolostone or the Vinemount Shale will have dissipated in the vicinity of the Scarp.

ii) The quarry excavations have been open for over 40 years, and no signs of stress release are evident within the quarry.

iii) A series of trenches have been cut into the Vinemount Shale to assist with quarry dewatering. Additional trenches will be cut into the quarry floor as part of the construction of the East Quarry Landfill's ground water collection system and the West Quarry Landfill's grout curtain/collection trench. These trenches would have the effect of releasing any remaining residual stresses; if they exist, within the rock.

3.2.4 West Quarry Landfill

The East Quarry is located immediately adjacent to the West Quarry Landfill, which is scheduled for closure by 1996.

Leachate from the West Quarry Landfill has migrated eastward through ground water flow zones. This has created a plume of impacted ground water in bedrock flow zones beneath the western portion of the East Quarry. Some of these waters are collected by the system of drainage trenches that exists within the floor of the quarry.

These impacts are being controlled by a number of measures, of which the following affect the East Quarry:

a) storm drainage collected within the East Quarry is not discharged off–site but is discharged to a Regional sanitary sewer;
b) impacted waters are being recovered by a pumping well (designated as M4) within the East Quarry;
c) further quarrying within the East Quarry will be limited to a minimum elevation of 190.0 mASL, to lessen the need for East Quarry dewatering which tends to draw the plume eastward;
d) a grout curtain and collector trench will be constructed through the floor of the East Quarry adjacent to the quarry's western wall, to intercept eastward migrating ground water flowing from the West Quarry.

The M4 pumping well and the grout curtain/collector trench noted in items b) and d) above are also discussed in Section 4.3.3.1. For further information on these aspects of the site setting the reader is directed to Gartner Lee Limited, 1994a,b, and 1995a.

3.2.5 Possible Realignment of Surrounding Roadways

We understand that a proposals to realign a section of First Road West as well as Green Mountain Road have been put before the City of Stoney Creek for consideration. These proposals can be summarized as follows:

i) First Road West would be curved eastward and then southward again to join Mud Street approximately one hundred metres east of the location of the current intersection. This realignment would situate a part of the new roadway over wastes in the south western portion of the landfill.

ii) Green Mountain Road would be curved southward and then eastward again to join Highway 20 approximately one hundred metres south of the present intersection. This realignment would situate a part of the new roadway over wastes in the north eastern portion of the landfill.

We understand that the City of Stoney Creek may not reach a decision on these proposals for several years, therefore we do not consider it appropriate to consider these realignments in the design of the East Quarry Landfill presently. We note, however, that the future construction of a roadway over the waste fills is feasible, and consider that design changes can be made as required to the affected landfill components. This could involve, for example, some excavation and recompaction of the wastes beneath the road alignment, re–engineering of the final cover, and special considerations for the road foundation.

4.0 SITE DESIGN

4.1 BASE GRADING PLAN

The objective in developing the base grading plan was to create a sloping base that would allow the overlying leachate collection system to operate by gravity, while minimizing the amount of grading fill required.

The extent of the landfill will be generally defined by the maximum extent of the quarry excavation, which will vary between 15 m to 30 metres from the East Quarry property boundary. Taro intends to negotiate access agreements to a 30 m buffer around the entire perimeter of the fill area, in compliance with MOEE policy on buffer zones (MOEE, 1993). A more detailed discussion of buffer zones is presented in Section 4.6.1.

The existing quarry floor generally slopes down to the southeast at 0.5%. The southern portion of the site has not yet been quarried, and will be excavated to a minimum elevation of about 190.0 mASL. We consider that if the grading plan followed the existing slope of the quarry floor, adequate gravity flow in the overlying leachate collection layer would be maintained with a minimal requirement for grading fill.

The existing quarry walls are comprised of vertical rock faces. Compacted fill will be placed to form 3 horizontal to 1 vertical side slopes prior to construction of the overlying liner system. These are considered to be the steepest slopes that would permit construction of the liner system using conventional and proven methods.

A topographic low exists in the northwest corner of the site where the Eramosa Scarp is present. A compacted earth berm will be built across this area against which the side slopes will be constructed. This will be constructed late in the site operating period, when landfilling progresses to this area.

The base grading plan is shown in Figure 3. The grades shown reflect the surface upon which the liner system will be constructed. Typical cross-sections through the landfill, which show the base grading fill and sidewalls in various parts of the site are presented in Figures 4 and 5.

Some cutting and filling on the quarry floor will be required to produce the base grades shown. At this time we consider that the fill will consist of Granular 'A' material that will be produced within the East Quarry, although this choice will be reviewed from time to time during construction of the landfill on the basis of availability and production cost. It may be possible, for example, to use other types of processed waste rock from within the quarry. The key performance requirements will be that it must be sufficiently fine–grained so that when placed and compacted it forms a suitable platform for construction of the overlying liner system, but must have a minimum of clay and silt sized particles. The lack of significant fine particles is necessary since the base grading layer is intended to be hydraulically connected with the underlying ground water collection system. We consider that the shale cut from the floor during grading is unsuitable for fill due to its potential to break down and release fines over time. This shale can be used, however, in the construction of the landfill sideslopes, as discussed below.

The fill required to form the side slopes will consist of compacted materials ranging from fine–grained soils to granular materials. The key performance requirement will be that the fill can be practically compacted to the appropriate density to limit future settlement. The absence of fines is not as critical in these fills as it is in the base grading layer because they will not be hydraulically connected to the ground water collection system beneath the base of the landfill. Initially materials available on–site will be used for sidewall construction. These will include waste rock from the quarry operation, shale generated from the base grading operations, or stockpiled overburden soils that are mixed with waste rock and thus undesirable for direct use in liner or cover construction. It is anticipated that, in the future, some importation of materials for sidewall construction will be required. The required volumes of base grading cut and fill, and sidewall fill are discussed in Section 5.1.

4.2 FINAL CONTOURS

The final contour plan was developed to meet a number of constraints, considered in the following order of importance:

a) achieving the site volume;
b) provision for adequate surface water runoff from the completed site;
c) allowing for surface water control ponds to minimize peak flow and sediment load impacts on surrounding surface water courses; and,
d) attempting to minimize the overall height of the completed landfill.

At the time of preparation of this document no specific end use had been selected. Once an end use is chosen, the final contour plan can be revised, where possible, to accommodate the end use.

The final contour plan is presented in Figure 6. The contours shown represent the surface of the vegetated final cover. The final contours define a landform with a maximum elevation of about 214 mASL. The highest area of the contours will be in the south east portion of the site, in the approximate area where the pre–quarry topography was highest. The highest point of the completed landfill will be about seven to eight metres higher than the existing grades south of the site along Mud Street.

The surface of the final contours generally slopes at about 3%. We recognize that the MOEE suggests a minimum slope of 5% for a landfill surface (MOEE, 1993). We consider that a minimum slope of 3% is acceptable because the wastes are expected to settle minimally over time and thus the slopes will not significantly decrease in the future and positive drainage will be maintained. This expectation is based on experience at the adjacent West Quarry Landfill, as follows:

a) The wastes are expected to be primarily soil–like and granular in nature, and the water table within the wastes will typically be near the base of the wastes. Potential for consolidation settlement is thus minimal, and most settlement will likely be immediate, elastic settlement resulting from landfilling–related loading.

b) Standard penetration test values (STP 'N' values) measured during drilling through the waste at the West Quarry vary between about 5 to greater than 50, with most values between about 10 and 30. The West Quarry wastes were typically placed by end dumping and spreading with a bulldozer, with little other compactive effort applied. The proposed East Quarry operation will utilize a vibratory compactor on the wastes, and therefore we expect that the wastes will be as dense, if not denser, than at the West Quarry.

The final contours incorporate a perimeter ditch that will channel runoff to a system of sedimentation and detention ponds located in the northwest corner of the site. Storm water will discharge from these ponds to the road side ditch on the west side of First Road West.

The base grading and final contour plans presented in Figures 3 and 6 result in a waste capacity of about 6,320,000 m^3, which meets the volume requirements discussed in Section 3.1.

4.3 LEACHATE AND GROUND WATER CONTROLS

The discussion of leachate control for the proposed landfill has been organized into four main parts, as follows:

a) leachate management objectives;
b) an overview of the proposed control system and operating strategy;
c) design and construction aspects of each component of the system; and,
d) consideration of the service life of each main component.

These are discussed below in Sections 4.3.1 through 4.3.4.

4.3.1 Leachate Management Objectives

The overall objectives for leachate management are to protect public health and safety and the natural environment. These objectives translate into the need to comply with MOEE Policy No. 15–08: Incorporation of the Reasonable Use Concept into the Groundwater Management Activities of the Ministry of the Environment and Energy. The essence of this policy is that a proponent may not cause a degradation in ground water quality off–site such that a neighbour's "reasonable use" of ground water is impaired. The policy defines a way of calculating the degree of ground water impact that is permitted and takes into account both existing ground water uses and background water quality.

The natural ground water quality in some of the flow systems beneath the East Quarry is poor and, in some cases, naturally exceeds the limits defined in the Ontario Drinking Water Objectives (Gartner Lee Limited 1994a, and 1995a). We have reviewed the Reasonable Use Policy as it applies to this setting and conclude that the policy would permit no additional degradation of ground water quality. This has been adopted as the specific objective for leachate control.

The East Quarry's hydrogeologic setting provides little natural containment and little capability to attenuate leachate contaminants. Thus engineered systems are required to contain leachate within the proposed landfill. The MOEE will evaluate the design of any engineered leachate controls according to MOEE Policy No. 14–15: Engineered Facilities at Landfills that Receive Municipal and/or Non Hazardous Wastes. The policy states that "An engineered facility must function for as long as necessary for the protection of the environment." The policy defines "protection of the environment" as compliance with the above noted Policy 15–08 (the "Reasonable Use" policy).

According to MOEE Policy No. 14–15 a proponent must demonstrate that the proposed control systems will function as long as needed by carrying out the following:

a) defining the contaminating lifespan of the wastes;
b) defining the service life of the required engineered controls; and,
c) specifying the necessary maintenance to ensure that the service life exceeds the contaminating lifespan, and providing evidence that the maintenance can and will be carried out.

As discussed in Section 2.4, the contaminating lifespan of the wastes has been estimated to be in the range of 200 to 300 years. Although we recognize that it is difficult to accurately predict contaminating lifespan, for design purposes we consider that leachate must be controlled within the site for at least 300 years. Given the service life that is needed together with the lack of a physical setting that can naturally contain leachate, our design philosophy was to develop a system of engineered controls that uses the best available technology, incorporates a degree of redundancy, and is readily maintainable using conventional and proven methods. The design of the leachate controls is discussed in Section 4.3.3. Consideration of the service life of the leachate controls is discussed in Section 4.3.4. Maintenance and performance monitoring requirements are discussed in Section 6.

4.3.2 Overview of Leachate Control System and Operating Strategy

In considering the type of controls needed, we recognize that leachate can move through a liner system by two processes: advection and diffusion. Advection is the movement of leachate constituents together with the bulk movement of ground water. Diffusion is the process by which leachate constituents move from higher concentrations to lower concentrations independent of the flow of water. Both processes must be controlled to prevent the movement of contaminants from the landfill. We believe that control of both advection and diffusion requires the use of low permeability liners (termed engineered containment) as well as providing a means to create an inward flow of water into the landfill site (termed 'hydraulic containment', or a 'hydraulic trap').

We considered both single and double liner configurations. A double liner system was chosen because this configuration could be operated as a hydraulic trap that could control both advective and diffusive contaminant migration out of the landfill. In the East Quarry setting, this degree of control could not be provided with a single liner system.

The following are proposed as the main leachate controls:

a) A double liner system that will be built over a layer of granular grading fill placed on the quarry floor. The double liner system will incorporate the following:

   i) a composite primary liner consisting of a high density polyethylene membrane directly underlain by a 1.0 m thick compacted clay liner;
   ii) a hydraulic control layer consisting of a 0.5 m thick layer of clear crushed stone; and,
   iii) a secondary liner consisting of a 1.0 m thick layer of compacted clay.

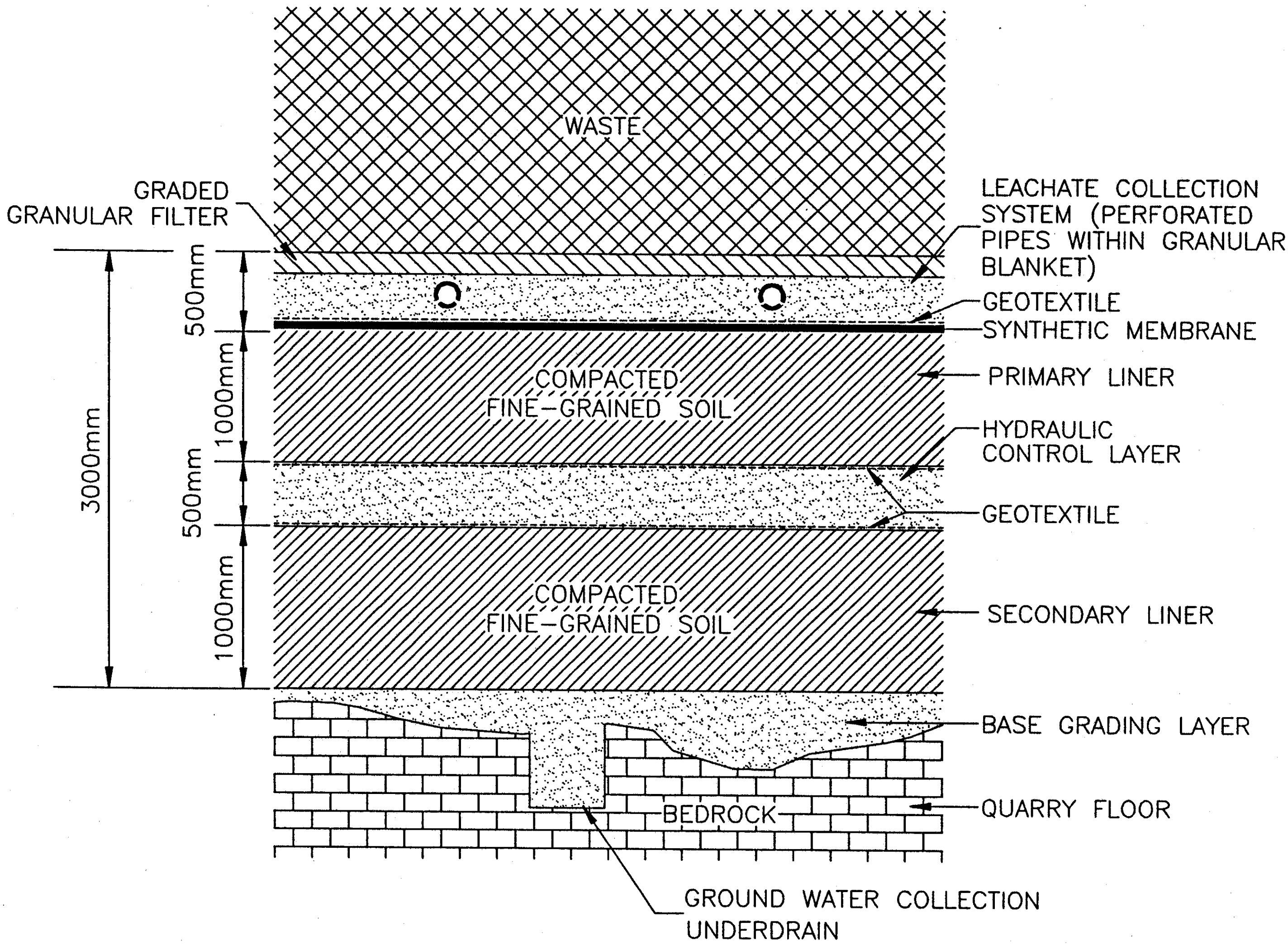
b) A leachate collection system installed on top of the primary liner across the landfill base and sideslopes. This system will consist of a 0.5 m thick layer of crushed stone which incorporates a network of perforated pipes.

A typical cross–section through these components is shown in Figure 7.

Two other landfill components will also contribute to the control of leachate, as follows:

a) A ground water collection system will be installed beneath the secondary liner. This will consist of a system of trenches filled with clear crushed stone beneath the base of the landfill and around the perimeter of the landfill. The perimeter trenches will also incorporate perforated pipes. This system will be hydraulically connected to the base grading fill placed beneath the secondary liner.

b) A final cover constructed over the surface of the completed landfill. This will consist of a 0.85 m thick layer of compacted clay overlain by a vegetated topsoil layer 0.15 m thick.



NOT TO SCALE

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FG05ALIN.DWG

TARO AGGREGATES LTD.
EAST QUARRY ENVIRONMENTAL ASSESSMENT

TYPICAL CROSS SECTION THROUGH BASE LINER SYSTEM

Figure 7

GLL 94-413 DEC. 1994

These controls will be operated in a two stage system that accounts for both advective and diffusive contaminant movement through the liner.

The leachate collection system above the primary liner will be operated both during and after the landfill operating period to remove leachate from the landfill. We estimate that the long-term leachate generation rate will be about 4.2 L/s, which has been calculated based on the following:

a) The average annual precipitation in the vicinity of the East Quarry is 890 mm/year. This can be partitioned into about 552 mm/year evapotranspiration, and a surplus of about 338 mm/year.

b) We anticipate that the final cover, in a weathered condition, can redirect about 33% of the surplus as runoff. This would allow about 67% of the surplus, or about 226 mm/year, to infiltrate. This expectation is based on typical performance expectations for fine-grained soil covers in southern Ontario.

c) An infiltration of 226 mm/year taken over a total landfill footprint of 59.1 Ha corresponds to a volume of 4.2 L/s.

The leachate collection system will drain by gravity and convey leachate to the low point of the landfill base in the south east corner of the site. Collected leachate will be pumped from the landfill and discharged to the Regional sanitary sewer system.

For the operating period of the landfill the composite primary liner will serve as the main barrier to leachate migration. The composite liner is fully expected to prevent any advective contaminant movement through the liner during this period. It is also expected that no significant diffusive contaminant movement will have occurred through the primary liner to this point in time. Any contaminants that unexpectedly migrate through the primary liner can be collected through the hydraulic control layer. Redundancy exists because a second liner exists beneath the hydraulic control layer.

After completion of the landfill operating period (e.g., after 20 years) hydraulic containment will be commenced. The hydraulic control layer will be saturated with clean water and the head in this layer increased to above that of the leachate head in the landfill. This will create an inward flow of clean water across the primary liner and will prevent the movement of contaminants from the wastes by advection. Hydraulic containment is not practical until the entire liner system has been constructed and a sufficient thickness of waste placed across the entire site to minimize liner uplift potential. This will occur just prior to site closure.

Diffusion of contaminants is expected to occur across the primary liner despite the inward flow of clean water. Contaminants that enter the hydraulic control layer by diffusion will be removed through the periodic replacement of the water within the layer. The secondary liner continues to provide redundancy by serving as a second barrier to contaminant migration.

The ground water collection system and final cover also play a role in controlling leachate both during and after the operating period of the landfill. The ground water collection system will be necessary to keep the quarry floor dry to permit liner construction. It also serves as one of the contingencies for collecting leachate that may have unexpectedly migrated through the double liner system. The final cover will be developed progressively during the operating period. It will promote runoff and evapotranspiration of precipitation and minimize infiltration into the wastes. This minimizes the production of leachate.

The leachate control concepts for the East Quarry Landfill are shown in Figure 8.

Hydraulic traps have been implemented at many landfill sites in North America. Most hydraulic traps are described as 'engineered' or 'artificial' because they require some degree of effort on the part of the landfill operator to function properly. The most common form of 'engineered' trap is one in which the inward flow of water is maintained by routinely pumping leachate out of the site to keep the leachate level below a relatively high natural ground water level. This type of trap is currently being operated at the Halton Landfill in Milton, Ontario, and the concept has also been recently approved for use at the Lasco Landfill site in Whitby, Ontario. One feature of this hydraulic trap configuration is that it generally relies on both engineered features and natural ground water levels to function properly.

The hydraulic trap proposed for the Taro East Quarry landfill is an enhancement of the basic concept described above. It is needed at the East Quarry because the natural ground water level is at or below the base of the quarry, and would therefore be below the future base of the landfill. As with the most engineered hydraulic traps, leachate will be routinely pumped from within the landfill. In addition, clean water will be pumped into the hydraulic control layer between the two liners. This water level will be maintained above the leachate level within the waste, causing an inward flow of clean water across the primary liner. The inward flow of water will prevent advective contaminant migration, and the periodic replacement of the water within the hydraulic control layer will remove contaminant that will migrate through the primary liner by diffusion. A positive feature of this hydraulic trap configuration is that it's effectiveness cannot be diminished by fluctuations in natural ground water levels, since both the leachate level and the water level outside the waste are within the control of the landfill operator.

The design of the hydraulic trap at the Halton landfill, noted previously, can also be operated in the same configuration as the proposed East Quarry landfill. The Halton site design incorporates a layer of crushed stone beneath the primary liner. Should natural ground water levels unexpectedly fall, the crushed stone layer can be saturated to create an inward flow of clean water across the primary liner (Proctor and Redfern, 1991).

The technology required to operate the East Quarry landfill's hydraulic trap is relatively simple. The main requirements will be a series of perforated pipes installed within the hydraulic control layer on the base side slopes, connection of these pipes to the municipal water supply, and submersible pumps. These will allow the addition and removal of water from this layer.

The significant positive features of the proposed hydraulic containment strategy can be summarized as follows:

a) Hydraulic containment is created by pumping water into the hydraulic control layer. Its operation is controlled by the site operator and does not depend on ground water conditions outside the liner system. If unexpected leachate mounding should occur the head in the hydraulic control layer can be raised to maintain flow across the primary liner.

b) The periodic replacement of water in the hydraulic control layer water will remove contaminants that have migrated through the primary liner by diffusion. This prevents the accumulation of contaminants above the secondary liner.

4.3.3 Leachate Control System Components

4.3.3.1 Ground Water Collection System

Design Description

The main function of the ground water collection system is to dewater the quarry to permit base liner construction under dry conditions. Its secondary function is to serve as a contingency leachate collection system, to collect any unexpected leakage through the liner system.

The system will consist of a series of trenches excavated into the quarry floor both around the perimeter and beneath the landfill, and backfilled with crushed stone. The portion of the trench system around the perimeter of the site will also contain a perforated pipe that can be accessed via cleanouts that extend to surface. The pipe and cleanouts provide a level of redundancy to the system, and also permit monitoring of ground water quality at the perimeter of the landfill.

The trenches will be of sufficient depth to intersect the shallowest flow zone within the bedrock beneath the shale quarry floor, termed the Vinemount Flow Zone. This zone dips to the south east at about 0.5%, and thus the trench system will also slope to the south east. The layout of the ground water collection system is shown in Figure 9.

The crushed stone backfill in the trenches will consist of 19 mm diameter crushed stone that will likely be produced in the East Quarry. The trench backfill will be in contact with the granular 'A' grading fill beneath the liner system. This will allow the trenches to collect unexpected leakage from the overlying liner. The perimeter trench will be located close to the limits of the existing quarry excavation. This will allow the maintenance cleanouts to avoid passing through the liner system on the landfill side slopes.

A pumping station will be located at the low point of the liner system in the south east of the landfill. This station will likely consist of a conventional concrete wet well with dual submersible pumps. The pumping cycle will be controlled by a system of float controls within the lift station, and an alarm system will be incorporated to indicate a rise in water level due to, for example, a pump malfunction. The location of the station is shown in Figure 9 and in cross section on Figure 5.

Further details of the trench system, piping and cleanouts, and pumping station will be developed at the time of final design.

Operating Considerations

During the landfill operating period any surface or ground water that collects in the trenches will pumped out to dewater the quarry floor. The pumping station will be operated to maintain the ground water level at the level of the lowest point of the base of the secondary liner, at 190 mASL. The quality of the water being collected will be monitored and the water discharged either to the surface water system, or to the sanitary sewer, as required.

The trench system will be constructed progressively as the landfill develops. Until the time that the permanent pumping station is constructed water will be pumped out at temporary sumps at the low point of the trench system.

Presently dewatering is carried out within the quarry through a network of drainage trenches and sumps which extend into the Vinemount Flow Zone. This system drains the existing quarry adequately, and therefore we fully expect that the proposed ground water collection system can continue to serve this function.

Once landfilling has been completed ground water with in the collection system will be allowed to return to natural levels. Flow in the Vinemount Flow Zone naturally occurs to the north west, and heads in this zone beneath the landfill are expected to return to between about 191 and 192 mASL.

In the event of the need to recover ground water from the system due to unexpected leakage through the liner, then ground water will again be pumped from the system. Under pumping conditions, the head at the station will be lowered to a minimum of 190 mASL. The pumping head will not be lowered to below this level because this will tend to draw leachate impacted ground waters from the West Quarry Landfill toward the East Quarry.

We note that the location of the pumping station is not at the low point of the trench system, which is in the south east corner of the site. This location was chosen to best serve the system's primary function of keeping water levels below the base of the liner system, and because the main leachate pumping station and the extraction well for the hydraulic control layer are located in the same area. It is beneficial from a servicing and maintenance point of view to have such major components physically near one another.

This location will not preclude the system operating properly as a leachate collection contingency, since the base of the trench is below the minimum pumping level of 190 mASL. As shown on Figure 9, a cleanout structure will be provided at the low point of the trench system to allow removal of any sediment that may collect at this point.

We note that the hydrogeologic impact assessment work identified that the ground water collection system was necessary in preventing further effects associated with the plume of impacted ground water beneath the floor of the East Quarry (Gartner Lee Limited, 1995a). As such, the ground water collection system will complement the existing M4 pumping well and the proposed grout curtain/collection trench that were noted in Section 3.2.4. The locations of the M4 well and the proposed grout curtain/collection trench are shown in Figures 2 and 9, respectively. A typical cross–section through the landfill sidewall that shows the relationship of the grout curtain/collection trench to the East Quarry Landfill's ground water collection system is shown in Figure 4.

The relationship between these features can be summarized as follows:

a) The grout curtain and ground water collection trench will be installed along the western perimeter of the East Quarry to prevent the flow of impacted ground waters originating from the West Quarry Landfill. The grout curtain will be installed through the Vinemount Flow Zone and the Upper Flow Zone, and will prevent impacted ground water from flowing further eastward through these zones. A collection trench will be installed immediately west, or upgradient of the grout curtain. This will collect ground water from the Vinemount Flow Zone and thus minimize head build–up on the grout curtain. The location of these controls in the East Quarry was chosen to overcome the difficulties of installing such a system through a large thickness of waste or rock within the West Quarry.

b) Once installed, the grout curtain/collection trench will prevent further impacts from the West Quarry Landfill. These controls will not, however, remediate the existing plume of impacted water beneath the floor of the East Quarry. The currently operating M4 pumping well is successfully recovering this plume. We expect that the complete remediation of the plume will take between five and ten years.

c) The plume of contaminated ground water will still be present at the time that construction of the East Quarry landfill liner commences. It is important to prevent the contact of this plume with the overlying liner soils. If the secondary liner soils were to contact the plume then contaminants could migrate upwards into the liner by diffusion. This is undesirable because the liner could then itself become a source of contaminants after the plume has been remediated, and also because this will complicate liner performance monitoring. The ground water collection system beneath the liner is thus needed to prevent contact of the impacted waters and liner soils.

4.3.3.2 Double Liner System

The base liner system will serve as the main barrier to leachate migration and will be constructed on the base and on the 3H to 1V side slopes of the landfill. It will consist of a synthetic/compacted soil primary liner and a compacted soil secondary liner. A hydraulic control layer, consisting of a 0.5 m thick layer of crushed stone, will separate the primary and secondary liners. A typical cross section through the liner system is shown in Figure 7. This configuration can be operated to provide both engineered containment and hydraulic containment, as discussed in Section 4.3.2.

The liner system will be constructed over the base grading layer, which will result in the primary liner grades shown in Figure 10. Cross sections through the landfill side slopes at various locations which show the liner system are presented in Figures 4 and 5.

<u>Soil Component</u>

The soil component of both the primary and secondary liners will be a 1 m layer of compacted fine–grained soil. These will be constructed from the stockpiled soils that exist on–site, as well as from fine–grained soils imported from off–site. As discussed in Section 3.2.3.5, extensive testing has been carried out on existing soil stockpiles to verify their suitability for liner construction. Similarly, appropriate testing will be carried out on any imported soils to ensure their suitability for liner construction as well.

The design hydraulic conductivity for the compacted soil portion of both primary and secondary liners is $2x10^{-10}$ m/s. The need for this hydraulic conductivity was rationalized in the hydrogeologic impact assessment, documented in Gartner Lee Limited 1995a. Our testing indicates that this value can be achieved with the on–site soils when compacted to about 98% of standard proctor density at moisture contents varying from 1% to 3% wet of optimum moisture content. A summary of the testing that has been carried out on the existing soils is presented in Appendix A of this report.

Synthetic Membrane Component

A high–density polyethylene membrane will be installed immediately overlying the primary soil liner. The membrane will be 80 mil thick (e.g., about 2 mm). A layer of geotextile will be placed over the membrane to provide physical protection from the overlying granular layer of the leachate collection system. Based on the current state of technology using synthetic/clay liners, we expect that the composite liner can be constructed to have an overall hydraulic conductivity of about 10^{-12} m/s.

We selected high density polyethylene as the membrane material because it is widely regarded as being the most chemically resistant material in landfill liner applications. A discussion of our longevity expectations for the synthetic membrane are presented in Section 4.3.4.

Calculations related to the expected rates of leachate migration through the proposed composite liner system have been carried out as part of the hydrogeologic impact assessment. These are documented in Gartner Lee Limited, 1995a.

4.3.3.3 Hydraulic Control Layer

Design Description

The hydraulic control layer provides several important leachate control functions both during and after the operating period of the landfill. During the operating period it will function as a contingency collection layer for leachate that has unexpectedly migrated through the primary liner. Upon completion of landfilling, the layer will be saturated with clean water, and the head within the layer maintained above the leachate head within the landfill in order to provide hydraulic containment. The water within this layer will be periodically replaced with clean water to remove any contaminants that may have migrated through the primary liner by diffusion.

The hydraulic control layer will consist of a 0.5 m thick layer of 19 mm diameter crushed stone between the primary and secondary liners on the landfill base and side slopes. The stone is expected to be produced in the East Quarry. We have carried out hydraulic conductivity testing of samples of this material produced in the East Quarry and have found it to have a hydraulic conductivity of about 0.14 m/s. These testing results are summarized in Appendix A.

Layers of geotextile will be placed at the interface of the hydraulic control layer and the soil liners. The geotextile will provide physical separation between the dissimilar materials during construction, and will limit the migration of fine particles from the liners into the coarse stone.

The removal and addition of liquid to and from the hydraulic control layer will occur through a series of fourteen perforated HDPE wells incorporated within the layer on the landfill side slopes. These pipes will extend from ground surface down to the base of the sideslopes. The wells will be accessed through manhole chambers located at ground surface around the perimeter of the site. The locations of these wells are shown in Figure 10, and a typical cross section through the landfill sideslope at the location of one of the wells is shown in Figure 11.

Thirteen of the fourteen locations will routinely serve as injection wells, through which water can be added to the hydraulic control layer. An on–site water main will be constructed around the perimeter of the fill area, with connections to each of the injection wells. The water main will be fed from the City of Stoney Creek municipal supply. A valve will be incorporated at each connection to the water main to allow flows to each well to be regulated independently.

One of the fourteen locations, located near the south east corner of the site at the low point of the landfill base, will serve as the routine removal well. Water will be removed from the hydraulic control layer at this location by a submersible pump lowered into the well. The removed water will be discharged either to the Regional sanitary sewer system, or off–site to the surface water system, depending upon water quality. The location of the removal well is shown in Figure 10.

The design of the well head at each of the injection wells will be such that these can also serve as removal wells on a contingency basis. Similarly, the dedicated removal well can also serve as an injection well, with clean water supplied to this location via temporary piping installed when needed. All of the wells will be accessible for maintenance, such as flushing, from surface.

Operating Considerations

The hydraulic control layer will be operated in two distinct manners, corresponding to the periods during and after the 20 year landfill operating period.

During the landfill operating period, this layer will be unsaturated and will be monitored for the presence of liquid. Any significant quantity of liquid that unexpectedly migrates into this layer will flow by gravity to the south east, following the dip of the liner system.

Monitoring and liquid removal will be possible through the extraction well at the low point of the hydraulic control layer, located in the south east of the site. Before the liner system is constructed to this point, temporary monitoring chambers will be provided along the south or east perimeters of the liner system. Landfill phasing is discussed in greater detail in Sections 5.1 and 5.2.

After the operating period, the hydraulic control layer will be saturated with clean water from the municipal supply. The wells around the perimeter of the site will be used to monitor and regulate heads within the layer. The wells will also be used to add to and remove water from the layer periodically in order to remove contaminants that have migrated across the primary liner by diffusion.

We have carried out computer modelling to determine the required rate of water replacement as well as routine operating conditions within this layer after saturation. A discussion of this modelling is presented in the hydrogeologic impact assessment report (Gartner Lee Limited, 1995a). A summary of the operating conditions is presented as follows:

a) The layer will be saturated after completion of landfilling, and the head within the layer will be maintained above the leachate head within the landfill. We expect that under normal conditions the maximum leachate head will not be greater than several centimetres above the surface of the primary liner. The landfill base is sloped with about a 4 m elevation difference between the highest and lowest points of the liner system. Therefore the head within the hydraulic control layer, as measured at the base of the primary liner, will vary from between about 1 m and 5 m.

b) Head within the layer will be maintained at a static level until the concentration of contaminants in the layer builds up to a pre–determined trigger level. Water will be removed by pumping out of the removal well, concurrently with the addition of clean water via the injection wells. The overall head conditions within the layer will be maintained such that there is always an inward gradient across the primary liner. Water replacement will occur periodically, at a frequency that will be determined through monitoring of the quality of water within the layer. Because the migration of contaminants by diffusion into this layer will occur relatively slowly, we anticipate that the water replacement will occur as one event per year. We believe that the overall average rate of water replacement, if calculated on a continuous basis, would need to be in the order of less than 1 L/s. As such, if the replacement occurs once per year over a period of one month, the generated flow would be about 12 L/s. The strategy for determining when to replace the water is discussed in Section 6.

c) Consideration has been given to the flow patterns within the layer during the addition and removal of water. The thirteen injection wells will be utilized on an alternating basis during the water replacement operations, with about half of the wells used at any given time. This will ensure that no 'stagnant' pockets of water exist within the layer.

4.3.3.4 Leachate Collection System

The function of the leachate collection system is to collect and remove leachate from the wastes and thus maintain a minimal leachate head on the liner system. We have estimated that the leachate generation rate after the final cover is completely constructed will be about 4.2 L/s. The leachate flows during the operating period will vary somewhat because the site will be filled and covered progressively.

The leachate collection system will be constructed immediately overlying the primary liner on the landfill base and side slopes. It will consist of a 0.3 m thick drainage blanket consisting of coarse crushed stone overlain by a 0.2 m thick granular filter layer. A network of perforated pipes will be incorporated in the drainage blanket. Leachate will flow by gravity along the 0.5% slope of the landfill base to the low point in the south east corner of the site. Leachate will be pumped out of the landfill from this point into a gravity sewer, which will discharge to the Regional sanitary sewer. The layout of the system is shown in Figure 10.

The design of each component of the leachate collection system is discussed below.

Granular Drainage Blanket

The granular drainage blanket will serve as the main drainage medium for leachate. This will consist of a 0.3 m thick layer of 19 mm diameter crushed stone that will be produced within the East Quarry. We have tested samples of this material and have found a hydraulic conductivity value of about 0.14 m/s, and a porosity of about 0.41. The hydraulic conductivity of this material is such that, under normal conditions, the expected leachate flows would be carried within the granular blanket below the perforated piping system.

A graded granular filter will be placed over the granular blanket, to prevent the migration of fine particles from the waste into the blanket. At this time we anticipate that the filter will be about 0.2 m thick, and will consist of granular 'A'.

The calculations that support our performance expectations are presented in the hydrogeologic impact assessment report (Gartner Lee Limited, 1995a). The results of the hydraulic conductivity testing undertaken are summarized in Appendix A of this report.

Perforated Piping System

A network of perforated pipes will be incorporated within the crushed stone drainage blanket. The piping system will add a level of redundancy to the leachate collection system, in the event that the granular drainage blanket became unexpectedly and significantly blocked.

The system will consist of a series of pipes that will extend radially outward from the low point of the landfill. A 'herringbone' pattern of lateral pipes will be placed between the radial pipes. All of the piping will be accessible for regular maintenance through cleanout pipes that will be extended to the finished grade of the landfill. Figure 10 shows the layout of the piping system.

The leachate collection piping will consist of HDPE pipes with an internal diameter of about 200 mm. This size is significantly greater than that required to convey the expected leachate flows, but is necessary to facilitate maintenance operations. HDPE was chosen since it is widely recognized as being very resistant to chemical degradation.

The pipes will require several centimetres of structural bedding, and we expect that the normal leachate level will be below the invert of the piping system. The pipe bedding material may cause a slight increase in leachate heads beneath the pipes because it may have a finer grain size distribution that the majority of the granular blanket. The bedding material will be chosen at the time of final design.

The spacing of the perforated pipes that are oriented lateral to the flow direction of leachate will be 75 m. This determination is based on calculations to estimate the height of mounding that could occur as a function of pipe spacing in the event that hydraulic conductivity of the granular blanket were to decrease. For this calculation we assumed that the granular blanket became completely incapable of conveying flow below the inverts of the pipes, and that the hydraulic conductivity of the granular between adjacent pipes decreased by a factor of about 14. A 75 m spacing between pipes would allow development of a mound height of only 0.03 m. These calculations are presented in the hydrogeologic impact assessment (Gartner Lee Limited 1995a).

Piping System Cleanouts

Each section of piping will be accessible for maintenance via a cleanouts from surface. These will consist of vertical extensions of the leachate collection system piping to grade and will allow insertion of cleaning and video inspection equipment. The cleanouts will be supported by a structural pipe composed of either HDPE or steel, and a concrete footing that will be founded on a granular pad placed on the liner system. A typical cross-section and plan view of a cleanout is presented in Figure 12.

The cleanouts will be located at junctions in the leachate collection system piping, and will be located so that no part of the piping system is greater than about 150 m from a cleanout. This distance was chosen based on the maximum length of pipe that we believe can be reliably accessed using proven sewer maintenance technology. The locations of the cleanouts are shown in Figure 10.

During our design work we considered various configurations of cleanout structures, including conventional concrete manholes. In the case of the East Quarry liner design a conventional manhole could not be adequately supported on the liner system due to bearing capacity considerations and would need to be founded on the quarry floor. A commonly recognized disadvantage with this configuration is that leakage can occur at the point where the manhole passes through the liner. One of the advantages of such relatively large structures is that maintenance personnel can actually enter the structure and decend to the level of the leachate piping. We believe, however, that this activity is undesirable from a worker health and safety point of view, and consider that minimal maintenance work can be performed within the manhole in any event. As such, we believe that the benefit of access is far outweighed by the benefit of reducing the number of intentional perforations through the liner system.

We have carried out calculations to determine the expected loading and the resulting consolidation settlement that will occur within the liner system due to these cleanouts. These calculations are presented in Appendix B of this report.

<u>Leachate Pumping Station and Gravity Sewer</u>

Leachate will flow by gravity within the granular blanket to the low point of the system at the south east corner of the site. A leachate pumping station will be located at this low point. The pumping station will be founded on the surface of the liner system, and as such, no perforation of the liner system will be present. Leachate will be pumped from the landfill from this location and discharged to a gravity sewer, which will ultimately be connected to the Regional sanitary sewer system. Leachate disposal considerations are discussed further in Section 4.3.3.6. A typical cross-section and plan view through the leachate pumping station is provided in Figure 12.

During our design work several pumping station configurations were considered, including conventional designs where a relatively large structure that permitted access by maintenance personnel would be founded on the quarry floor. As with our rationale for the leachate cleanouts discussed previously, we believe that the benefit of access is far outweighed by the benefit of eliminating intentional perforations through the liner system.

The details of the pumping station design will be finalized at the time of final design. A summary of the general features of the design may be summarized as follows:

a) A shallow depression will be formed in the liner surface in the south east corner of the site to act as a sump. A leachate collection chamber will be located within the sump. The liner thickness will not be decreased due to this depression.

b) The leachate collection pipes will be connected to the leachate collection chamber, and the base of the chamber will also be perforated. The perforations will be relatively large–sized openings (i.e., in the order of 100 to 150 mm diameter), and the grain–size of the granular blanket in the immediate vicinity of the chamber will be increased to prevent entrapment of solids carried within the leachate. This configuration will allow leachate to flow into the chamber either from the piping system or directly from the drainage blanket, and will result in the collection of leachate while maintaining a minimal head build–up on the liner system. The depth and size of the sump, and the size of the leachate collection chamber will be refined during final design. At this time we anticipate that the sump will be in the order of 0.3 m deep, and that the chamber will consist of about a 1.5 m diameter HDPE manhole.

c) Two vertical risers will extend from the leachate collection chamber to the landfill surface. The risers will be supported on a concrete footing that will be founded on a pad of compacted granular 'A'. The larger riser will permit the installation and removal of submersible pumps into the leachate chamber from surface. The smaller diameter riser will be used primarily for monitoring and instrumentation. We consider that the separation of these functions will eliminate problems associated with fouling of pump discharge hoses and control lines within a single riser. The size of the risers will be determined at the time of final design, but at this time we anticipate that they will consist of HDPE pipes with internal diameters of about 0.6 m and 0.2 m, respectively.

d) The pumping station will be constructed when the landfilling progresses to the south east corner of the site. This is anticipated to occur in about Year 6 or 7 of the operating period. Until that time leachate will be removed from the site by means of a temporary pumping station and forcemain. The staging of landfill development and the associated temporary works are discussed in Sections 5.1 and 5.2 of this report.

e) Removed leachate will be discharged into a gravity sewer, which will convey leachate to the Regional sanitary sewer system. At this time we anticipate that the gravity sewer will be routed to the existing Regional sanitary sewer connection north of the West Quarry Landfill. This alignment is shown in Figure 10. It is possible that ongoing municipal development in the area may result in the Regional sanitary sewer system being expanded. Should the Regional sewer system be extended to near the south east corner of the site prior to the construction of the pumping station, Taro may consider a different sewer alignment.

f) The gravity sewer will be constructed from butt–fused HDPE piping, and will be located near surface within the landfill's buffer zone. Maintenance and inspection access will be possible through manholes. The sewer will be sized to accommodate routine leachate flows from the landfill, and the water periodically removed from the hydraulic control layer. It will also be sufficiently large to accommodate water pumped from the West Quarry grout curtain/collection trench system, and contingency flows from the East Quarry Landfill's ground water collection system. The detailed alignment and sizing of the sewer will be confirmed at the time of final design.

We have carried out calculations to determine the expected loading and the resulting consolidation settlement that will occur within the liner system due to the pumping station. These calculations are presented in Appendix B of this report.

4.3.3.5 Pre–Loading of Clay Plug

The clay plug is estimated to experience in the range of 30 to 190 mm of consolidation settlement due to the loads imposed by landfilling over this area. The calculations that support this estimate are documented in Appendix B.

We consider that settlements in the upper part of this range could affect the performance of the liner system, given that the quarry floor beyond the clay plug will not settle. To reduce settlement potential, and thus problems associated with differential settlement, the clay plug will be pre–loaded prior to the construction of liner system.

Placement of about 6 m of fill over the plug for a period of at least one year would reduce the maximum settlement potential to about 75 mm. Although we have not assessed in detail the actual allowable settlements, we consider that this provides a reasonable planning guide for pre–loading requirements.

The differential settlement issue and special considerations for liner design over this area will be considered in greater detail at the time of final design.

4.3.3.6 Leachate Disposal

At this time it is expected that the proposed waste stream will produce leachate that will meet the limits set in the Region's sewer use by–laws or that can be dealt with through negotiated over–strength agreements with the Region. This expectation is supported by the leachate characterization work carried out as part of the contaminating lifespan estimation (Gartner Lee Limited, 1995b).

As such, collected leachate will be discharged to a Regional sanitary sewer system and the leachate will undergo treatment at a Regional sewage treatment plant prior to discharge to the environment. Should this not be possible a pre–treatment system can be retrofitted to produce effluent suitable for discharge to the sewer.

4.3.3.7 Final Cover

The final cover has several functions:

a) It will serve as a physical barrier between the wastes and the environment, and will prevent human and animal contact with the wastes.

b) It will minimize the amount of infiltration into the wastes. We anticipate that the cover will be capable of reducing infiltration by about 33% from pre–cover conditions. The long–term leachate generation rate for the East Quarry Landfill is expected to be about 4.2 L/s.

The final cover will consist of a 0.85 m thick barrier layer of compacted fine–grained soil placed over the waste material, overlain by a 0.15 m thick vegetated topsoil layer. A typical cross section through the final cover is shown in Figure 13.

The cover will be constructed from on–site stockpiles as well as being imported from off–site. As noted in Section 3.2.3.5 the on–site soils are expected to be suitable for final cover construction. At this time we understand that no significant topsoil stockpiles exist on–site. As such, we expect that all of this material will need to be imported from off–site.

4.3.4 <u>Consideration of Service Life of Leachate Control System</u>

4.3.4.1 Overview

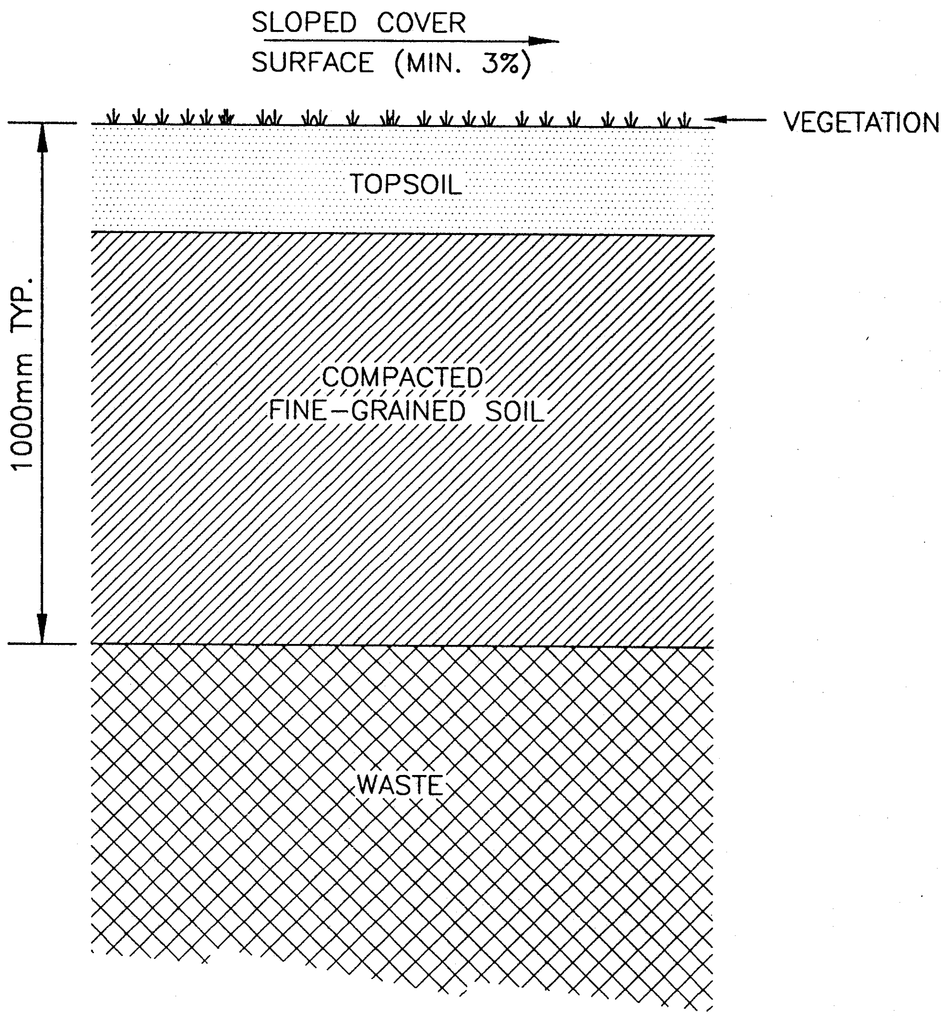
We recognize that certain engineered elements of the leachate control system have a finite lifespan, which cannot be accurately estimated in a landfill setting. In accordance with MOEE Policy No. 14–15: <u>Engineered Facilities at Landfills that Receive Municipal and Non Hazardous Wastes</u>, the concept for the leachate controls have been developed such that components can either be replaced or maintained, or alternatively, redundancy has been provided where maintenance isn't practical. We expect that the system, as a whole, is capable of controlling leachate for at least the entire contaminating lifespan which is estimated to be up to 300 years.

Table 1 summarizes the rationale behind our expectation of the service life of the system. Table 1 also describes the function and estimated service life of each leachate control component, identifies the potential failure modes that we consider are realistic, and indicates how these failure modes have been addressed in the design.

The following Sections 4.3.4.2 through 4.3.4.5 provide a detailed discussion of our rationale for service life expectations for each leachate control element, and also present the contingencies that will exist. This discussion is organized as follows:

a) Section 4.3.4.2 – the final cover;
b) Section 4.3.4.3 – the leachate collection system;
c) Section 4.3.4.4 – the liner system, including the hydraulic control layer; and,
d) Section 4.3.4.5 – the ground water collection system.

Contingency measures are dealt with as a separate issue in Section 9 of this report.



NOT TO SCALE

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TARO AGGREGATES LTD.
EAST QUARRY ENVIRONMENTAL ASSESSMENT

TYPICAL CROSS-SECTION
THROUGH FINAL COVER

Figure 13

GLL 94-413 DEC. 1994

TABLE 1: RATIONALE FOR EXPECTED SERVICE LIFE OF ENGINEERED LEACHATE CONTROLS

COMPONENT	PRIMARY FUNCTION AND REQUIRED SERVICE LIFE	FAILURE MODES CONSIDERED	PERFORMANCE EXPECTATION AND RATIONALE
FINAL COVER	– Minimize leachate production by reducing infiltration into wastes. – Required for about 300 years.	Increase of cover hydraulic conductivity through deterioration from weathering (freeze/thaw effects, dessication, surface erosion).	**EXPECTATION :** Infiltration limiting properties of cover can be maintained in excess of 300 years. **RATIONALE:** – deterioration expected and accounted for in cover design; cover accessible for maintenance as needed.
LEACHATE COLLECTION SYSTEM GRANULAR BLANKET	– Collects leachate to maintain minimal head on liner system. – Required for about 300 years.	Blockage of granular blanket due to siltation, bio–fouling, or chemical precipitation.	**EXPECTATION :** Granular blanket will be capable of conveying flow for at least 300 years. **RATIONALE:** – siltation can be controlled because graded filter will be incorporated into upper part of blanket. – bio–fouling only possible within waste or graded filter where small pore spaces exist; bio–fouling in lower part of blanket will not be significant because of large pore spaces and minimal organic content of waste. – precipitation will not occur because waste/granular blanket is a closed geochemical system and because of large pore spaces within blanket. – precipitation only considered possible at pumping station where geochemical conditions change; pumping station accessible for routine maintenance. – localized blockages will not be significant due to continuous nature of granular blanket on base and side slopes. – redundancies exist: – collection through perforated pipes – pumping from cleanout risers
LEACHATE COLLECTION PIPING SYSTEM	– Provides redundancy for leachate collection. – 300 year service life desirable but not essential.	Blockage of piping system due to siltation, bio–fouling, or chemical precipitation.	**EXPECTATION :** Service life unquantifiable but expected to be many decades. **RATIONALE:** – blockage will not occur because pipes can be cleaned. – design facilitiates cleaning through close clean–out spacing and access from ground surface. – prevention of blockage desirable but not essential.
		Collapse of piping system due to landfill–imposed stresses or chemical deterioration.	**EXPECTATION :** Service life unquantifiable but expected to be many decades. **RATIONALE:** – stresses are readily calculated; piping system will be designed with sufficient safety factor so that collapse does not occur. – prevention of collapse desirable but not essential. – HDPE known to be chemically resistant.

TABLE 1: RATIONALE FOR EXPECTED SERVICE LIFE OF ENGINEERED LEACHATE CONTROLS

COMPONENT	PRIMARY FUNCTION AND REQUIRED SERVICE LIFE	FAILURE MODES CONSIDERED	PERFORMANCE EXPECTATION AND RATIONALE
LEACHATE PUMPING STATION	– Removes leachate from landfill. – Required for about 300 years.	Failure of leachate pumps.	**EXPECTATION :** Leachate pump–out capability will be provided for at least 300 years. **RATIONALE:** – pumps will be rated for service in landfill environment; pumps readily removed for maintenance or replacement.
		Blockage of pumping station due to siltation, bio–fouling, or precipitation.	**EXPECTATION :** Pumping station can be maintained indefinitely. **RATIONALE:** – pumping station can be maintained via access riser. – entire station can be replaced by installing new large–diameter pump–out well.
		Structural deterioration of pumping station.	**EXPECTATION:** Structural integrity can be maintained. **RATIONALE:** – risers can be re–lined from surface. – HDPE known to be chemically resistant. – entire station can be replaced by installing new large–diameter pump–out well.
LEACHATE GRAVITY SEWER	– Conveys collected leachate to Regional sanitary sewer. – Required for about 300 years.	Leakage from sewer.	**EXPECTATION :** Leachate will be conveyed to sewer discharge for at least 300 years. **RATIONALE:** – forcemain will be situated at shallow depth and thus will always be accessible for maintenance.
PRIMARY LINER SYSTEM	– Provides engineered leachate containment prior to hydraulic containment (during 20 year operating period). – Engineered containment only required for about 20 years.	Increase in hydraulic conductivity from deterioration of HDPE membrane due to contact with leachate.	**EXPECTATION :** Membrane will retain its low permeability properties for well in excess of 20 years. **RATIONALE:** – unexpected based on current knowledge of durability of HDPE and expected leachate; processes that are known to cause HDPE deterioration do not exist within landfill.

TABLE 1: RATIONALE FOR EXPECTED SERVICE LIFE OF ENGINEERED LEACHATE CONTROLS

COMPONENT	PRIMARY FUNCTION AND REQUIRED SERVICE LIFE	FAILURE MODES CONSIDERED	PERFORMANCE EXPECTATION AND RATIONALE
		Increase in hydraulic conductivity from deterioration of clay liner due to contact with leachate.	**EXPECTATION :** Clay liner will retain its low permeability properties for well in excess of 20 years (see SECONDARY CLAY LINER, below). **RATIONALE:** – unexpected to occur; mineralogical analyses carried out indicate that clay performance not affected by expected leachate.
HYDRAULIC CONTROL LAYER	– Provides contingency leachate collection capability in the event of leachate migration through primary liner prior to hydraulic containment. – Capability needed for about 20 years.	Blockage of drainage layer due to siltation, bio–fouling, or chemical precipitation.	**EXPECTATION :** Leachate collection ability will be provided for period prior to hydraulic containment. **RATIONALE:** – blockage will not occur because no significant water layer during this period. – large pore spaces in layer will preclude any significant blockage.
	– Conveys water to create hydraulic containment starting in about Year 20. – Hydraulic containment needed for 300 years.	Blockage of drainage layer due to siltation, bio–fouling, or chemical precipitation.	**EXPECTATION :** Capability to provide hydraulic containment will exist for at least 300 years. **RATIONALE:** – siltation will not occur because: –source water for hydraulic containment will likely be municipal water which has low sediment content; –flow direction will be out of layer thus fines will not be transported into layer; –geotextiles used to limit siltation potential. – bio–fouling unexpected because source water will have very low organic content. – precipitation will not occur because municipal source water will have insufficient dissolved constituents for significant precipitation to occur. – large pore spaces in layer will preclude any significant blockage. – any precipitation that does occur would be near extraction well, where all components accessible for maintenance.

TABLE 1: RATIONALE FOR EXPECTED SERVICE LIFE OF ENGINEERED LEACHATE CONTROLS

COMPONENT	PRIMARY FUNCTION AND REQUIRED SERVICE LIFE	FAILURE MODES CONSIDERED	PERFORMANCE EXPECTATION AND RATIONALE
INJECTION/EXTRACTION WELLS WITHIN HYDRAULIC CONTROL LAYER	– Add/remove water from layer. – Capability needed for about 300 years.	Deterioration/collapse of well pipes.	**EXPECTATION:** Can add/remove water from layer for 300 years. **RATIONALE:** – wells composed of HDPE, and no significant presence of contaminants expected. – collapse of one/several wells not critical because each of the 14 wells can be used for injection or extraction. – if all wells deteriorated, could always add water to layer at any point around perimeter of landfill, from ground surface. – water level in layer can be managed to allow removal of water at any point around perimeter of landfill from near ground surface.
SECONDARY CLAY LINER	– Prevents water loss out of inter–liner drainage layer during hydraulic containment: needed for about 300 years. – Provides contingency barrier for leachate migration for about 300 years.	Increase in hydraulic conductivity from deterioration of clay liner due to contact with leachate.	**EXPECTATION :** Clay liner will retain its low permeability properties for excess of 300 years. **RATIONALE:** – no contact of secondary liner with significant leachate concentrations is expected because primary liner will provide containment until hydraulic containment commenced. – hydraulic conductivity increase unexpected because mineralogical analyses indicate that clay performance not affected by expected leachate.
GROUND WATER COLLECTION SYSTEM	– Dewaters quarry to permit liner construction during operating period. – Provides contingency leachate collection capability in event of liner for about 300 years.	Blockage of system due to siltation, bio–fouling, or chemical precipitation.	**EXPECTATION :** System will be capable of conveying ground water for at least 300 years. **RATIONALE:** – siltation unlikely because collected water originates from bedrock flow systems. – bio–fouling unexpected because system conveys ground water with low organic content. – precipitation considered only possible at pumping station where geochemical conditions change due to pumping out of water; pumping station accessible for routine maintenance. – piping in perimeter portion of system as well as pumping station accessible for cleaning.
		Failure of ground water pumps.	**EXPECTATION :** Ground water pumping capability will exist for at least 300 years. **RATIONALE:** – pumps accessible for service or replacement. – ground water collection well can be drilled near low point of system for pumping.

4.3.4.2 Final Cover

The purpose of the compacted soil final cover is to minimize leachate production by limiting infiltration into the wastes. The cover will also serve as a physical barrier between the wastes and the environment. It must serve these functions for the entire contaminating lifespan. The failure modes considered include degradation due to weathering, desiccation, and freeze/thaw effects, surface erosion, and activities of burrowing animals.

Soil covers will deteriorate due to weathering, and we have taken into account what cover performance can be expected after this occurs. This has been factored into our leachate generation estimates.

Nevertheless, because the cover is on top of the landfill it is fully accessible and can be maintained indefinitely through repair and reconstruction. Cover condition can be assessed through visual inspections, and through monitoring of the quantities of leachate that are collected by the leachate collection system. Cover maintenance would typically consist of excavation, recompaction, and reseeding of cover soils. This operation can be carried on indefinitely, and can cover as large or as small an area of the cover, as required.

We consider that, due to the accessibility of the final cover for maintenance, no additional contingencies are warranted.

4.3.4.3 Leachate Collection System

The leachate collection system will consist of a crushed stone drainage blanket overlying the primary liner. A network of perforated pipes will be installed within the blanket. Leachate will flow downward from the wastes into the granular blanket, which will convey it to the low point in the base of the landfill. A pumping station at this location will pump leachate into a gravity sewer, which will connect to the Regional sanitary sewer system. The system, as a whole, will need to function for the entire contaminating lifespan. We have considered a number of failure modes for each component of the system, as discussed below.

Granular Blanket

The main drainage function will be achieved by the granular blanket. The permeability of this layer is such that all expected leachate flows would be carried within the bottom few centimetres of the blanket. Failure modes considered include blockage of the granular blanket due to siltation, bio–fouling, or precipitation.

Siltation is the gradual clogging of a drainage layer due to fine particles being carried in from the waste with the movement of leachate. There are several techniques typically used in landfills for preventing this, including the use of synthetic filter fabrics, or varying the gradation of the upper part of the drainage blanket to act as a graded filter. Both methods are expected to prevent the movement of fine particles into the lower part of the granular layer. At this stage of design we consider that a graded granular filter is preferable because this is a proven siltation control technique that utilizes natural geologic materials.

Bio-fouling is the blockage of drainage systems that can occur due to the growth of organic matter. This is created by microorganisms which feed on the organic fraction of the waste, and this is typically a serious problem at municipal landfills where the organic fraction is often 50%. By way of comparison, the Taro waste stream is expected to have an organic fraction of less than 5%, and therefore the degree of fouling will be much less. Some evidence that minimal biological growth is expected with the proposed waste stream is present in the adjacent West Quarry Landfill. Leachate is drained from that site by means of a pipe drain within the floor of the former quarry. No unaccountable decreases of leachate flows, along with any significant leachate mounding, have been observed to occur over the fourteen years that the site has existed.

Chemical precipitation is the process where certain minerals, dissolved in the leachate, may solidify within the drainage blanket. Chemical precipitation typically only occurs where there is a significant change in chemical conditions. This is not expected to occur because the chemical conditions between the drainage blanket and the waste will not be different. For example, both waste and granular material will be mostly unsaturated, will contain similar soil gases, and will have low levels of oxygen. Therefore the Reduction-Oxidation Potential will be the same, as will the pH. The only place where chemical precipitation is likely to occur is at the leachate pumping station where the leachate will come in contact with oxygen, and will undergo pressure changes due to pumping activity. The pumping station has been designed for regular maintenance to prevent any problems.

Notwithstanding these performance expectations, the East Quarry's leachate collection system can, nevertheless, accommodate some blockage. The drainage blanket proposed here has a large porosity, and particulate matter will, to a large degree, pass through it. If any material collects at all, it would be in the fine grained wastes where pore sizes are much smaller. Should localized perching of water be created, it would be in the waste and the drainage blanket would remain open. The blanket would continue to receive the leakage from above, with no additional head imposed on the liner. As well, localized blockages of the drainage blanket due to the above mechanisms are considered to be inconsequential since the drainage blanket will be present throughout the base and side-slopes of the site.

Several redundancies have been built into the design to permit continued leachate collection in the eventuality that the granular blanket were to perform poorly. The first redundancy in this regard is to continue collecting leachate via the perforated piping system. The piping system will be maintained, and should clogging of the piping system begin to occur, then the frequency of pipe cleaning will be increased as necessary. In the event that leachate can no longer be effectively removed from the piping system, then the vertical cleanout risers provide additional locations from which leachate could be pumped out from the waste.

Notwithstanding the noted redundancies, leachate could also be removed on a contingency basis by pumping from purge wells installed within the waste at required locations within the landfill. We recognize that the operation of purge wells in municipal waste can be problematic primarily due to the variable nature of municipal garbage. Because the intended waste stream will consist primarily of soil–like materials, we consider that the problems typically associated with purge wells within landfills will not exist. Purge wells would be installed from the landfill surface and thus could be maintained or replaced as necessary.

Perforated Piping System

The perforated piping system is a design redundancy because leachate will be conveyed within the lowest few centimetres of the granular blanket, below the invert level of the pipes. The piping system will therefore only be necessary if the granular blanket became unexpectedly considerably blocked. The failure modes considered include blockage due to siltation, bio–fouling, or precipitation, and the physical deterioration of the piping due to structural failure or chemical degradation.

The piping system will itself be readily accessible for cleaning and video inspection through surface cleanouts, and thus with routine maintenance, blockage should not occur. All piping will be composed of high density polyethylene, which is known to be very resistant to chemical deterioration in landfill settings. A review of current literature that supports this expectation is presented below in Section 4.3.4.4. Although no proof exists that the pipes will be physically intact for the entire contaminating lifespan, we also have no expectation for short term deterioration or collapse of the piping. We also consider that any uncertainties associated with the longevity of the piping system are inconsequential since the system itself is a redundancy.

Leachate Pumping Station and Gravity Sewer

The other main components of the leachate collection system are the pumping station and the leachate sewer. These components will need to function for the entire contaminating lifespan. The failure modes considered with respect to the pumping station were as follows:

a) failure of the pumps;
b) blockage of the leachate collection chamber due to sedimentation, precipitation, or bio–fouling; and,
c) structural collapse of the leachate collection chamber or access riser.

The pumping station pumps will be rated for service in a landfill environment, and can be removed for routine servicing or replacement. Pump maintenance and replacement can be carried out indefinitely.

The interior of the leachate collection chamber can be flushed and any accumulated sediment removed from surface via the large diameter riser. As well, the openings at the base of the collection chamber will be relatively large–sized openings (i.e., in the order of 100 to 150 mm diameter) that are not expected to clog. We believe that any blockage or precipitation that occurs around the perforations can be removed through a combination of acidification and flushing of the chamber.

At this time we anticipate that the collection chamber and riser will be composed of HDPE, and are thus expected to experience minimal deterioration with time. If these elements were to begin to fail structurally, a new structural lining can be inserted into the riser from the landfill surface, which would prevent further collapse. In the event that the leachate pumping station, as a whole, were to unexpectedly be completely inoperable, the station could be abandoned and a new large–diameter well could be installed from the landfill surface.

The leachate sewer will be constructed using butt–fused HDPE piping and therefore leakage is not expected. The sewer will be located near surface and will therefore be accessible for inspection and repair as necessary.

A number of additional contingencies inherently exist in the landfill design to deal with the unexpected overall poor performance of the leachate collection system. Poor performance would be indicated by an increase in leachate head on the primary liner, which would result in an increased rate of contaminant migration through the liner. It is useful to consider these contingencies during two time frames: during the operating period, when the hydraulic control layer remains unsaturated, and after closure of the landfill when the hydraulic control layer is saturated and the hydraulic trap is operating.

During the operating period, the following contingencies exist:

a) leakage through the primary liner can be detected and collected via the hydraulic control layer;
b) leakage collection can be enhanced through the controlled flushing of the hydraulic control layer with clean water;

c) any further leakage will be impeded by the presence of the secondary liner;

d) leakage through the secondary liner can be collected through the ground water collection system;

e) ground water impacts that occur below the ground water collection system can be controlled by pumping from recovery wells within the Vinemount Flow Zone;

f) ground water impacts in deeper ground water systems can be controlled by wells installed within the appropriate zones.

It is important to recognize that the practicality of these ground water control contingencies has been proven through Taro's work in controlling ground water impacts from the West Quarry Landfill. Impacted ground water is successfully being collected by recovery wells located in various flow zones beneath the landfill.

After the operating period the hydraulic control layer will be used for the operation of the hydraulic trap. During this period the following contingencies will exist:

a) the hydraulic trap will prevent advective flow through the primary liner;

b) the head within the hydraulic control layer will be increased, as necessary, to match any increases in leachate head on the primary liner;

c) contaminants that migrate through the primary liner by diffusion will be removed from the system through the periodic circulation and replacement of the water in the hydraulic control layer;

d) beyond the hydraulic trap, the same contingencies noted previously still exist, as follows:

    i) leakage out of the landfill will be impeded by the secondary liner;

    ii) if leakage were to occur beyond the secondary liner it may be collected via the ground water collection system, or, if necessary, via recovery wells in deeper ground water systems.

4.3.4.4 Liner System and Hydraulic Control Layer

<u>Primary Liner</u>

The primary liner will consist of a 1.0 m thick high-density polyethylene/compacted clay composite. The main function of the primary liner is to contain leachate prior to the operation of the hydraulic trap, which is a period of about 20 years. Following this period, the hydraulic trap will serve to be the main control for preventing leachate migration out of the landfill. After the hydraulic trap is established the low permeability properties of the primary liner will assist in operating the hydraulic trap efficiently, but these will not be critical to controlling contaminants. The failure mode considered was the increase of liner hydraulic conductivity due to contact with leachate.

The high-density polyethylene (HDPE) component is fully expected to maintain its low-permeability properties for at least 20 years. This expectation is fully supported by experience reported in the technical literature. During the course of design work we carried out a literature review and a summary of some of the papers reviewed is presented as follows:

Ojeshina, Jett, and Krecic, 1984. <u>An Assessment of HDPE Liner Durability: A Report on Selected Installations</u>.
This paper reports three case studies where liner samples were recovered from various installations and tested. Tests for various physical properties were carried out and compared to pre-installation liner properties. One of the case studies included testing of a liner from a process waste evaporation pond that had been in use for two years. This case study concluded that a service life in excess of 20 years could be expected.

Dudzik and Tisinger, 1990. <u>An Evaluation of Chemical Compatibility Test Results of High Density Polyethylene Geomembrane Exposed to Industrial Waste Leachate.</u>
This paper reports on test results of an HDPE geomembrane that was exposed to leachate generated from an existing industrial waste landfill for up to one year. Liner samples were exposed to the leachate both under laboratory conditions (as per United States Environmental Protection Agency (EPA) Method 9090) and in a leachate collection sump at the site. Test results indicated that, for a number of various liner properties, no significant liner degradation was evident. The study also concluded that the EPA Method 9090 could reasonably approximate field conditions within the landfill examined.

Tisinger and Giroud, 1993. <u>The Durability of HDPE Geomembranes</u>.
This paper presents an overview discussion of the processes which can cause HDPE to deteriorate, and summarizes the current state of knowledge regarding the durability of HDPE materials. The following views are presented:

a) that processes that can cause HDPE to deteriorate generally do not exist in landfill sites;
b) that HDPE materials, including geomembranes, can perform satisfactorily for decades if they are protected from mechanical damage;
c) that a U.S. EPA ad hoc committee on the durability of polymeric landfill lining materials has concluded that these materials should maintain their integrity in waste disposal facility environments in "terms of hundreds of years".

We therefore fully expect that the synthetic component of the primary liner will last for at least 20 years, and have no reason to suspect that it wouldn't last for a significantly longer period of time.

We fully expect that the clay component of the primary liner will maintain its low permeability properties for far longer than 20 years. Clay liners have been used in landfill sites for several decades, and the liner will be constructed using proven methods and quality control procedures. Preliminary testing on the liner materials available in the East Quarry indicate that they are mineralogically stable, and we thus expect that no significant change will occur in the clay liner material due to contact with leachate. This will be further confirmed with actual clay/leachate compatibility testing, presently under way.

Numerous contingencies exist to control any leachate that unexpectedly migrates through the primary liner during the operating period. These were noted previously in Section 4.3.4.3, and can be briefly summarized as follows:

a) leakage can be detected and collected via the hydraulic control layer;
b) any further leakage will be limited by the presence of the secondary liner;
c) leakage through the secondary liner can be collected through the ground water collection system and recovery wells installed in deeper flow systems.

The hydraulic trap will be established at the end of the operating period, and this will serve as the main control to contaminant migration from the landfill for the duration of the contaminating lifespan. Should contaminants migrate in unexpected quantities through the primary liner after the trap is established, then contingencies described previously may be implemented. These may briefly be repeated as:

a) the presence of the secondary liner;
b) collection of impacted water from the ground water collection system; and,
c) collection of impacted water from deeper flow systems.

Hydraulic Control Layer

This will consist of a layer of crushed stone between the primary and secondary liners. A series of perforated pipes will extend down the side slopes of the landfill within this layer, to allow addition and removal of water to and from this layer. These pipes will be accessible from manholes located at ground surface. Pumps and the associated equipment needed to add and remove water will be installed via these manholes.

The primary function of this layer is to provide a means of creating the hydraulic trap after completion of the landfill operating period. Hydraulic containment will be necessary from this time for the entire contaminating lifespan. Prior to the establishment of hydraulic containment, this layer serves as a contingency leachate collection layer, as discussed previously, for a period of about 20 years.

The failure modes considered were the blockage of the layer through siltation, bio–fouling, or precipitation after it has been saturated, the deterioration of the injection/extraction wells, and the failure of the pump.

Siltation is not expected since the source for the water in this layer will be from the municipal supply and thus have no significant sediment content. As well, the flow direction will be out of this layer and upwards across the primary liner or downward across the secondary liner, transporting any fines that do exist out of the layer, not inwards. As a precaution, layers of geotextile will be installed between this layer and the overlying primary and underlying secondary liner to limit potential for migration of fines into the layer. Similarly, bio–fouling is not expected since the water contained in this layer will have a very low organic content.

Precipitation is not expected to occur within the layer itself since the municipal source water is expected to have low quantities of dissolved constituents. If any precipitation were to occur, it would be where geo–chemical conditions change, such as at the extraction well where water is pumped out. This well will be accessible for maintenance as necessary.

Furthermore, localized blockages, should they ever occur, would not significantly impede flow of clean water through this layer since it will be present as a continuous blanket across the entire base and on the side–slopes of the site. As such, we consider that the complete blockage of this layer, to the point that no inward gradient at all can be provided, is unrealistic.

The unexpected deterioration or collapse of some of the fourteen perforated injection/extraction well pipes was considered. This is unexpected since the pipes will consist of HDPE which is chemically resistant. We also consider that the deterioration of one or several of the injection wells would cause a loss of flexibility in flushing this layer, although this would not prevent the hydraulic trap from functioning. As well, clean water could always be added at any point along the edge of the hydraulic control layer around the perimeter of the landfill.

Should the pipe that is used as the extraction well collapse, a submersible pump could be installed in one of the injection wells and this could be operated as an extraction well. In the unlikely event that water could not be pumped out of any of the other wells, two additional actions could be taken. A new extraction well could be installed from surface, to a limited depth down the sideslope. A second contingency would be to operate the hydraulic control layer under a higher head, so that the head level were present near the surface of the layer around the perimeter of the site. In this event, the removal of water could be carried out from near surface.

Notwithstanding the performance expectations of this system, contingency measures exist to address the reduced effectiveness of this layer. The following contingencies exist:

a) dependence on the effectiveness of this layer can be reduced by reducing the leachate head on the liner through by the various methods discussed in Section 4.3.4.3;
b) leakage out of the landfill will be impeded by the secondary liner;
c) if leakage were to occur beyond the secondary liner it may be collected via the ground water collection system;
d) impacted water could be collected by recovery wells in deeper ground water systems.

Secondary Liner

The secondary liner will consist of a 1.0 m thick layer of compacted clay. The primary function of the secondary liner is to complement the hydraulic control layer during operation of the hydraulic trap. The low permeability properties of the liner will limit water loss out of the inter–liner drainage layer, and thus allow the trap to operate efficiently. This function is required for the entire period of the contaminating lifespan. This liner also functions as a contingency barrier for leachate migration, as discussed previously. The failure mode considered was an increase in hydraulic conductivity due to contact with leachate.

As discussed previously, clay liners have been used in landfill sites for several decades, and the liner will be constructed using proven methods and quality control procedures. Clay mineralogy testing carried out to date indicates that the liner material will not be adversely affected through contact with leachate. We fully expect that the liner will maintain its low permeability for the duration of the contaminating lifespan, and have no reason to suspect that it would not maintain these properties for a much longer period.

We also note that maintaining a very low permeability within this liner is beneficial, but not essential to the proper operation of the hydraulic trap. For example, any localized zones of higher permeability would simply necessitate the routine addition of more water to the inter–liner layer.

4.3.4.5 Ground Water Collection System

The ground water collection system will consist of a series of trenches beneath the base and around the perimeter of the landfill. The trenches will be filled with crushed stone, and will drain down to a low point in the south east corner of the site. The perimeter trenches will contain a perforated pipe that can be accessed through cleanouts. The trenches will be hydraulically continuous with the granular grading fill upon which the liner system will be built. Water collected at the low point will be pumped out via a pumping station, and would be discharged to the surface water system off–site, or to the Regional sanitary sewer system, as determined by water quality.

The primary function of the ground water collection system is to dewater the quarry base during the 20 year operating life to permit liner construction under dry conditions. This system also serves as a contingency leachate collection system, as noted previously.

The failure modes considered were:

a) blockage of the system due to siltation, bio–fouling, or precipitation;
b) failure of the ground water pumps; and,
c) deterioration of the ground water pumping station.

Siltation and bio–fouling are unexpected because the system will convey ground water that has low particulate and organic content, respectively. Precipitation is considered possible only where geo–chemical conditions change, such as at the pumping station. The pumping station can be accessed for maintenance as necessary. A redundancy exists around the perimeters of the landfill because the perimeter trenches contain a piping system that can be accessed for cleaning via cleanout structures.

Failure of the ground water pumps is not considered realistic because the pumps can be removed for maintenance or replacement as necessary. The structural failure of the pumping station is not expected since the station will be designed as a conventional wet well structure, and will not be in routine contact with leachate. In the event that the structural failure of the pumping station chamber itself occurred, a well could be drilled from surface in the immediate vicinity of the pumping station for continued pumping.

Should this system become inoperable during the operating period, contingency dewatering can be achieved on an as–needed basis from temporary sumps located in the base of the quarry. Although this would be less efficient than using the ground water collection system, temporary sumps have been used effectively during routine quarry operations. Should the system become inoperable after the 20 year operating period, contingency collection of leachate impacted waters is still possible through collection via recovery wells in deeper flow systems.

4.4 STORM WATER CONTROLS

The overall goal of the landfill's storm water management program is to return clean runoff to the drainage system around the site to maintain baseline flow conditions. For design purposes, baseline conditions are defined as those prior to the development of the quarrying operation in the East Quarry. As such, clean runoff will be drained to the road–side ditch on the west side of First Road West and northwards towards the Niagara escarpment.

The specific objectives for managing storm runoff are as follows:

a) to prevent peak storm flows from impacting flow quantities off–site downstream; and,
b) to ensure that water discharging off–site complies with the MOEE's Provincial Water Quality Objectives.

The main drainage works will consist of a storm water ditch around the perimeter of the waste area and a system of sedimentation and detention ponds located in the northwest corner of the site. These are shown in Figure 6. These drainage works will be developed progressively during the site's operating period, and will have a capacity to handle up to a 1:100 year storm flow.

The perimeter ditch will collect storm water running off of the vegetated final cover, and will be progressively constructed together with the cover as landfilling progresses. The high point of the ditch will be at the southeast corner of the site. The ditch grade will generally be about 0.5%, but will be considerably greater near the northwest corner where the ditch invert elevation must drop to match the topographic low in this area of the site. Various sediment and erosion control structures, such as rock check dams and drop structures, will be incorporated into the ditch where appropriate. The details of these structures will be developed at the time of final design.

Storm water will be conveyed by the perimeter ditch to two sedimentation ponds which will allow the deposition of a significant portion of the suspended sediment load. Both sedimentation ponds will outlet to a single detention pond, which will ultimately discharge runoff off–site at the northwest corner of the site. The detention pond will control future peak flows to baseline conditions to ensure that downstream flooding and erosion potential is not increased. The pond system will also allow for sampling water quality prior to off–site discharge. If a concern is identified, off–site discharge will be stopped and the water will be conveyed to the Regional sanitary sewer system for treatment. The ditches, sedimentation ponds and detention pond have been designed to operate without backing up flow into one another.

The detention pond will have an active storage volume of about 7,600 m^3. This detention area will serve to reduce peak flows to the roadside ditch to pre–quarry levels for the 1:2 year to 1:100 year storm frequency.

The sedimentation ponds will be based on a minimum volume of 125 m^3/ha of exposed surface area. This is a standard volume required by the Ministry of Natural Resources and would be subject to refinement during detailed design based on cover soil type and the maximum area exposed at a given time. Ultimately, each sedimentation pond will have an active volume of about 2900 m^3 which will accommodate the runoff generated from a short duration 25 mm rainfall over the completed site.

All storm drainage collected within the active landfill area during the site operating period will be handled as leachate and discharged to the sanitary sewer via the leachate collection system. All clean storm drainage collected from within the remainder of the quarry will be conveyed to the detention pond and discharged off–site. Routine storm water management activities during and after the landfill operating period are discussed in more detail in Section 5.8.

The hydrogeologic assessment concluded that the presence of engineered leachate controls in the landfill would result in a reduction of infiltration as compared to conditions both during and prior to the quarrying (Gartner Lee Limited 1995a). This is considered detrimental to ground water quantities in the area and may also result in a degradation of background ground water quality. It was thus recommended that measures be taken to allow some clean storm runoff to infiltrate into the ground while allowing excess runoff to discharge off–site to road side ditches.

The re–infiltration of surface run–off into the ground water system can be achieved in several ways. First, the base of the main retention pond can be excavated down to bedrock. This will allow some infiltration of standing water, although this will likely reduce with time as fine soil particles in the water fill fractures and other flow paths in the bedrock base. A second method would be to install vertical riser pipes into the bedrock base of the pond. The top of the risers would be located such that only the clearest portion of the stored water (i.e. the supernatant) could enter the pipe, while the majority of suspended solids would settle out below the top of the pipe.

These issues will be considered in more detail at the time of final design.

For a more detailed discussion of surface water issues and the related impact assessment recommendations, the reader is directed to O'Neill Environmental, 1995 and Gartner Lee Limited, 1995a.

4.5 GAS CONTROLS

The objective for gas control within the proposed landfill is to prevent the subsurface off–site migration of combustible gases. The presence of gases containing non–methane organic compounds (NMOCs) is not expected, and thus it is considered that landfill gases may be passively vented to atmosphere. As noted in Section 2.3, monitoring for gases containing NMOCs has been carried out at the West Quarry Landfill, and results indicate that NMOCs are present in only trace levels within the wastes, and that no significant emissions are detected through ambient air monitoring around this site. Further information regarding air quality issues is presented in CJB Air Quality Management, 1995.

The synthetic/soil composite primary liner on the base and side slopes of the landfill will limit subsurface gas migration off–site. The presence of the liner will encourage the venting of any gases from the wastes to the atmosphere.

It is expected that the construction of the final cover will restrict gas venting to the atmosphere, and thus a means of allowing gas to escape from the unsaturated portion of the granular blanket following cover construction is necessary. Venting will be encouraged by installing perforated pipes within the leachate collection granular blanket on the side slopes of the landfill. These pipes will be connected to non–perforated risers that will extend through the final cover and will be open to the atmosphere. This system will allow the free venting of gases via the unsaturated portion of the granular blanket. Should additional gas venting be necessary, wind–powered ventilators can be added to the vertical risers, or, in an extreme case, a shallow header can be installed to allow the connection of the venting pipes to an active extraction system.

At this time we consider that the perforated venting pipes will be installed on about 50 metre spacings along the perimeter of the landfill, and will extend down to the base of the landfill sideslope. The design of the gas controls will be considered in more detail at the time of final design.

If needed, additional venting pipes will be installed through the final cover in the central portion of the site. This decision will be made after construction of the final cover over the wastes and will be based on the routine combustible gas monitoring.

4.6 FACILITY LAYOUT

4.6.1 Site Buffer Zone

Current MOEE landfilling guidelines indicate that a minimum buffer zone of 30 m should be maintained between the edge of the wastes and the property boundary (MOEE, 1993). This is required to provide space around the perimeter of the fill area for general site access and operations, monitoring, implementation of remedial measures, and as physical separation from adjacent land uses. Given the non–hazardous, non–putrescible nature of the wastes and the fact that engineered leachate and gas control systems will be present in the site, we consider that a 30 m buffer is appropriate.

As noted in Section 4.1, the extent of the landfill will generally be defined by the maximum extent of the quarry excavation. As such, the perimeter of the fill will be situated from approximately 15 m to 110 m from Taro's property boundaries. In accordance with the MOEE guideline, Taro intends to negotiate access agreements to those lands which Taro does not presently own within 30 m of the perimeter of fill. The location of the perimeter of the fill with respect to the property boundaries is shown in Figure 3.

We note that additional physical separation of much of the site operations from adjacent land uses will exist since operational facilities such as the scales and the equipment maintenance facilities are located within the quarry. As such, the zone between the edge of the quarry and the property boundary will typically only be occupied by the existing screening berms, for the routing of the permanent perimeter ditch and various subsurface pipelines, and for access to cleanout and monitoring locations.

The buffer zones that will exist can be summarized as follows:

To the South

Taro's lands typically extend to between 30 m to 110 m south of the proposed perimeter of fill, thus no negotiated access is necessary for the majority of this perimeter. The western portion of the southern perimeter (e.g., near the intersection of First Road West and Mud Street) borders onto privately owned lands for a distance of about 240 m, where the edge of fill would be 15 m from the property line.

Negotiations will be held with the owner of these lands regarding access permission.

To the West

The proposed perimeter of fill is about 15 m from the property line, which borders onto the road allowance for First Road West. Negotiations will be held with the City of Stoney Creek to obtain access.

To the North

The proposed perimeter of fill is about 15 m from the property line, which borders onto the road allowance for Green Mountain Road. Negotiations will be held with the City of Stoney Creek to obtain access.

To the East

Taro's lands typically extend between 70 to 80 m east of the proposed perimeter of fill, thus no negotiated access is necessary for the majority of this perimeter. The edge of fill will, however, be situated about 15 m from the property line in three areas of the east perimeter, where the property line borders onto privately owned lands. Taro will negotiate access agreements for these areas.

4.6.2 Site Entrances/Exits

Site access will continue as per the present practice with trucks entering the site from the Highway 20 entrance. Trucks will continue to leave the site from the exit onto First Road West. These are shown on Figure 2.

Late in the landfill operating period, when landfilling and final cover construction proceeds to the north east corner of the site, the First Road West access will be used as both the truck entrance and exit. The progression of landfill development is discussed in Section 5.1.

As noted in Section 3.2.3.1, the re–evaluation of the traffic analysis for the proposed site will review the merits of relocating the site entrance and exit to Highway 20.

4.6.3 Existing East Quarry Facilities

The locations of the quarry processing plant, the quarry weigh scales, and the equipment maintenance buildings are shown in Figure 2.

The weigh scales and maintenance facility presently service the West Quarry landfill, and are capable of servicing the proposed East Quarry landfill operation. We consider that no benefit would be gained by moving these facilities and thus they will be maintained in their present location for the majority of the landfill operating period.

The scales will need to be removed near the end of the operating life since they are within the last portion of the site to be landfilled. For the filling that occurs after removal of these scales, temporary scales will be installed near the First Road West site access.

4.6.4 Truck Wash Facility

A truck wash facility will be operated to clean trucks of excess soil and waste materials prior to allowing trucks to leave the site. This facility will help reduce dust emissions from the site as well as reduce tracking of dirt onto roads surrounding the site.

At this time we anticipate that the truck wash will be a semi–portable unit that can be relocated moved as traffic patterns on site change with the progression of landfilling. It will likely be located in the north west corner of the site, near the site scales.

The design and location of the wash unit will be finalized at the time of final design.

4.6.5 Screening Berms

Presently grassed earth berms exist around the perimeter of the East Quarry site as shown in Figure 2. These berms are between 2 m to 6 m high and effectively screen the view and noise of site operations. These berms will be maintained throughout the life of the landfill operation. Some of the existing berms are located on top of soil stockpiles that exist against the quarry faces. These stockpiles will be removed in preparation for liner construction, which will necessitate relocating some of the berms. In such cases temporary berms or other temporary screening measures will be re–established in the appropriate locations. Cross–sections through the perimeter of the quarry that show the existing berms are presented in Figures 4 and 5.

Concurrently with landfilling development, some additional vegetation including trees will be planted near the berms. The growth of this vegetation will result in the height of the visual screen increasing throughout the operating period. This will serve to minimize the visual impact of the landfill once filling progresses above the level of surrounding lands. The earth berms and vegetative screens will be left in place for as long as practical until the final cover has been constructed in the adjacent portion of the landfill.

4.6.6 Fencing

The East Quarry site is presently fenced with a post and wire fence about 1.5 m high located outside the earth berms. We consider that this fence is suitable to sufficiently control site access, and will thus be maintained.

The entrances and exits to the East Quarry are presently controlled with gates that are locked when the site is closed. Security personnel are on–site 24 hours per day. These practices will be maintained throughout the operating life of the landfill.

4.6.7 Signs

Upon commencement of landfilling appropriate signs will be erected at site entrances and exits, and at selected locations around the site perimeter.

4.6.8 Weather Monitoring Station

Taro has recently constructed an on–site weather monitoring station which provides the following data:

a) wind speed and direction;
b) temperature; and,
c) barometric pressure.

The weather station is situated at the north west corner of the site, adjacent to Taro's site office. The station will be modified prior to commencement of landfilling to allow collection of precipitation data.

This information will assist in managing the day to day operations of the site (e.g., to control dust and odour emission) as well as assisting with the interpretation of monitoring results.

5.0 SITE OPERATIONS

5.1 SEQUENCE OF LANDFILL DEVELOPMENT

Wastes will be placed according to the cell method, which will result in waste depth being increased preferentially over the expansion of the footprint of the wastes. This will allow the progressive development of the final cover, resulting in a gradual decrease of both site–generated dust and leachate production over the operating period.

The general sequence in which the site will be filled is shown in Figure 14. According to this plan, the filling operation will begin with Phase 1 in the west central portion of the site. The filling will progress through subsequent phases in a generally counter–clockwise direction, with the filling completing at Phase 8 in the northwest corner of the site.

This landfilling sequence accommodates the completion of the existing quarry operation, and generally precludes the need to relocate existing facilities such as the site entrance/exit, the weigh scales, and the quarry processing plant. It will also result in the landfill being built over the compacted clay fill in the former lower excavation late in the landfill's operating period. This will allow preloading of the clay plug prior to construction of the liner system over it, thus minimizing the potential for future settlement in this area.

Landfill traffic will enter the site off of Highway 20 and exit onto First Road West for the majority of the operating period, as per existing practice. Once filling progresses into Phases 7 and 8, the Highway 20 entrance will be closed because of the presence of the landfill operation in this area. At this time, traffic will both enter and leave the site from First Road West.

Construction of control systems will proceed progressively as required by the progress of landfilling. For example, the construction of the liner, the leachate collection system, and the ground water collection system will proceed so that a minimum of about one year filling capacity is available at all times. This capacity is required to accommodate fluctuations in the progress of liner system construction, as well as short–term fluctuations in waste receipts. The final cover will be constructed progressively as final grades are achieved in each phase.

The ground water collection system, the base liner and hydraulic control layer, and the leachate collection systems will be constructed in a step–wise fashion. Construction of these systems will typically occur over one or two seasons within each phase, as dictated by weather conditions and the physical constraints of the site. For example, liner or cover construction would only occur during non–freezing months when proper quality control can be achieved. Care will be taken during the stepwise construction to ensure that the successive phases of the control systems are properly joined to the previous phases. Once all phases have been filled all control systems will be continuous across the entire site.

Some temporary works, such as berms and temporary pumping stations, will be necessary to allow the control systems to function properly prior to their complete construction. These temporary works are discussed in Section 5.2.

A blasting impact assessment has been carried out in relation to the landfill proposal. This recommends that a minimum separation of 60 m be maintained between any landfill components and quarry blasting activity (VME Associates Limited, 1995). We anticipate that it will be possible to maintain a significantly greater separation than 60 m during the course of landfill development.

The phase boundaries have been chosen to coincide conveniently with the layout of the leachate collection piping and cleanouts, which will facilitate leachate collection within each phase. As well, landfilling within each phase will generally occur from the low point to the high point of the phase. This will result in leachate generated within the phase always flowing toward the portion of the leachate collection system that has been constructed.

The direction in which filling in each phase will proceed is shown with arrows in Figure 14. Major site activities at various times during the operating period are shown in Figures 15, 16, and 17. These correspond to filling occurring about Years 4, 10, and 17 of the operating period.

All nuisance control measures will be in place, as appropriate, from the commencement of landfilling in Phase 1. As such the truck wash station will be fully operational and the First Road West street sweeping program will be in effect to control dust impacts. All nuisance and environmental monitoring programs will also be commenced, together with the appropriate maintenance programs.

An overall landfill development schedule is presented in Figure 18, which shows the relationship between the various activities that will occur during the operating period.

Table 2 summarizes information related to the phased landfill development. Table 2 presents the waste capacity and area of each phase, the approximate period for which phases are active, and the average on–site waste haulage distance for each phase.

Table 3 provides information related to landfill construction, such as the amount of cut and fill required to achieve the base grades, and the quantities of earthworks required for each phase.

TABLE 2: LANDFILL WASTE CAPACITIES AND AVERAGE ON–SITE WASTE HAULAGE DISTANCES

Phase #	Surface Area (ha)	Waste Capacity (1) (m^3)	Portion of Operating Period for which Phase is Active (years) (2)	Waste Haulage Distance (on–site round trip, m)
1	11.0	980,000	1 – 4	2,200
2	4.4	650,000	3 – 5	2,200
3	5.8	650,000	4 – 7	3,300
4	7.7	1,140,000	6 – 10	3,400
5	7.8	1,160,000	10 – 14	3,300
6	6.0	800,000	13 – 17	2,600
7	9.2	440,000	16 – 20	1,100
8	7.2	500,000	19 – 21	600
Totals	**59.1**	**6,320,000**		

Notes:
(1) *Refers to actual waste capacity as defined by physical geometry of phase. Volumes are approximate and have been rounded off to nearest 10,000 m^3.*
(2) *Assumed that some operating overlap is necessary between successive phases. Assumes filling starts part way through Year 1, and finishes part way through Year 21, for a net life of 20 years.*

TABLE 3: LANDFILL CONSTRUCTION MATERIALS VOLUMES (1)

Phase #	Surface Area (ha)	Base Grading Requirements		Sidewall Fill Requirements (m^3)	Soil Requirements (5) (m^3)	Leachate Collection System/Hydraulic Control Layer Requirements (6)
		Cut (2) (m^3)	Fill (m^3)			
1	11.0	0	70,000	30,000	330,000	110,000
2	4.4	10,000	10,000	0	130,000	40,000
3	5.8	0	0 (3)	90,000	170,000	60,000
4	7.7	0	0 (3)	120,000	230,000	80,000
5	7.8	20,000	0	90,000	230,000	80,000
6	6.0	10,000	0	20,000	180,000	60,000
7	9.2	0	40,000	20,000	280,000	90,000
8	7.2	0	60,000	80,000 (4)	220,000	70,000
Totals	**59.1**	**40,000**	**180,000**	**450,000**	**1,770,000**	**590,000**

Notes:
(1) *All volumes are 'in–place'. Volumes are approximate and have been rounded off to nearest 10,000 m^3.*
(2) *Consists of material generated from cutting shale from quarry floor. Does not include remaining quarrying in Phases 3, 4.*
(3) *Assumes bedrock in unquarried portion of Phases 3, 4 will be quarried to approximately required base grades.*
(4) *Includes fill required to construct berm across topographic low in north west corner of site.*
(5) *Soils required for liner and cover construction. Consists of 1.0 m thickness of fine–grained soil for each liner, and 1.0 m thickness for final cover (0.85 m fine–grained soil and 0.15 m topsoil).*
(6) *Consists of 0.3 m thickness for drainage blanket, 0.2 m thickness for granular filter, and 0.5 m thickness for hydraulic control layer.*

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5.2 LANDFILL CONSTRUCTION CONSIDERATIONS

5.2.1 Site Preparation

Site preparation prior to the first phase of liner construction and landfilling will include installation of the truck wash facility and upgrading of site signage. Existing site facilities such as the entrance and exit, scales, maintenance buildings will continue to be utilized for the landfill operations..

Preparation work prior to construction of control systems for each phase will generally include:

a) cleanup of fine–grained sediments on the quarry floor;
b) removal of rock rubble and overburden stockpiles;
c) cutting down of high points on the quarry floor and placing and compacting grading fill according the specified base grading plan; and,
d) constructing the appropriate sections of the base side slopes.

5.2.2 Ground Water Collection System

The ground water trenches for will be constructed prior to the liner system in a given phase. The trenches will typically be constructed along the southern and eastern boundaries of the phase being developed. Any water that enters the trenches flow along dip of the Vinemount Flow Zone, which is 0.5% to the south east, and would thus be collected in the trenches.

Prior to the time that permanent ground water pumping station is constructed in Phase 4, any water within the trenches will be pumped out from temporary sumps.

5.2.3 Base Liner

The base liner will be constructed in a step–wise fashion in the sequence shown in Figure 14. The edge of the liner at each phase boundary will be terminated with temporary berms which will prevent leachate movement off of the lined area. The berms will be sized to contain up to a 1:100 year rainfall event within the lined area.

As the liner system is extended into the next phase, the temporary berms will be removed and reconstructed at the edge of the new phase. A sufficient amount of the berm material will be removed to ensure that an unweathered portion of the liner is exposed before the liner system is extended into the next phase. Figure 19 presents typical details of the temporary berms.

A liner test pad will be built prior to the commencement of large scale liner construction in each phase. The test pad will consist of about a 10 m by 20 m area in which a 1 m thickness of clay liner will be constructed. It will be built by the contractor who has been awarded the contract for liner in that phase, using the equipment and methods intended for use in the large scale construction. The in-situ density and moisture content of the liner soils will be measured, and undisturbed samples will be recovered from the test pad for hydraulic conductivity testing in the laboratory. The test pad will serve a number of important functions:

a) it will demonstrate that the clay liner performance specifications are practically achievable;
b) it will identify potential problems with the contractor's methods or equipment;
c) it will allow determination of a relationship between number of compactor passes, moisture content, and compaction density;
d) it will help determine the degree of soil processing that may be necessary prior to placement, and whether or not moisture content adjustment is necessary;
e) it will allow the contractor and inspection staff to gain a preliminary indication of the overall handling properties of the soil; and,
f) it will reduce the amount of testing that may otherwise be required during actual liner construction.

5.2.4 Hydraulic Control Layer

The hydraulic control layer will be constructed progressively with the liner system in each phase. This layer will be used to monitor for unexpected leakage through the primary liner during the landfill operating period.

Any leakage collected in this layer will migrate downslope towards the southeast. As such, temporary monitoring chambers will be constructed through the temporary berms at the downgradient edge of Phases 1 and 3. As landfilling progresses, further monitoring can be carried out through the appropriate injection/extraction wells as they are constructed. A typical detail for a monitoring chamber is presented in Figure 19.

5.2.5 Leachate Collection System

The progressive construction and operation of the leachate collection system can be summarized as follows:

a) Until the permanent leachate pumping station is constructed in Phase 4, leachate generated within Phases 1, 2, and 3 will be collected at temporary leachate pumping stations located at the low points in Phases 1 and 3. These will consist of a concrete manhole structure to which the leachate collection system piping will be connected.

b) The temporary berms around the perimeter of the phases will prevent leachate from migrating beyond the phase boundaries.

c) Leachate will be pumped into a temporary forcemain, which will convey flow to the western perimeter of the site where it will discharge into a gravity sewer located within the landfill buffer zone. The sewer will convey leachate to the existing connection to the Regional sanitary sewer system in the West Quarry Landfill.

d) The permanent leachate pumping station will be constructed concurrently with the liner system in Phase 4. At this time the gravity sewer will be extended along the southern and eastern perimeter of the site to service the permanent pumping station. Once Phase 4 is operational, the temporary leachate sumps in Phases 1 and 3 will be decommissioned, along with the temporary forcemain.

e) The leachate collection system will be extended as Phases 5 through 8 are constructed, with all leachate being pumped out via the permanent pumping station, and conveyed by gravity flow to the Regional sewer connection at the West Quarry Landfill.

5.2.6 Waste Placement

Immediately following construction and completion of quality assurance testing of the control systems within a given phase, a layer of waste at least 0.5 m thick will be spread over the completed liner. This layer, together with the leachate collection system granular blanket will provide both physical protection from the vehicle traffic within the phase as well as protection against liner desiccation and freeze/thaw effects.

No compactive effort, other than that achieved with the tracking of the bulldozer spreading the wastes will be applied to the initial lifts of waste. This will ensure that the leachate collection system piping is not damaged.

The waste surface will be brought as close as possible to the final grades within each phase prior to commencing operations in a successive phase. Waste slopes of 4 horizontal to 1 vertical will be maintained at the edges of active phases that border onto future phases.

5.2.7 Final Cover and Surface Drainage Works

The final cover will be constructed and vegetated progressively as allowed by the progress of landfilling. The perimeter surface water ditch and sedimentation and detention ponds will be constructed progressively together with the final cover. Construction will be timed so that the sedimentation and retention ponds are in place prior to the need to discharge clean runoff from the final cover.

The perimeter screening berms will be removed gradually as the final cover and surface drainage works are constructed.

5.3 TRAFFIC VOLUMES

5.3.1 Traffic from Waste Haulage

The average expected waste receipts are 500,000 tonnes/year over an approximate 20 year site life. It is considered that peak waste receipts equivalent to 2,000,000 tonnes/year may occur on a short–term basis from time to time.

These scenarios result in an average of 60 waste trucks per day for receipts of 500,000 tonnes/year, and 240 waste trucks per day for receipts of 2,000,000 tonnes/year. These estimates are based on the assumption that the characteristics of the waste haulage operation will be similar to that carried out at the West Quarry Landfill. We have assumed that trucks will carry an average load of 32 tonnes, and will operate 5 days per week for about 52 weeks per year.

5.3.2 Traffic from Landfill Construction Material Haulage

5.3.2.1 Base Grading Layer and Sidewall Fill

The required volumes of base grading and sidewall fill are summarized in Table 3.

A total of about 180,000 m^3 of base grading fill will be required. We anticipate that this material will be produced within the East Quarry, and thus no off–site traffic will be generated.

A total of about 450,000 m^3 of fill will be required to form the 3 horizontal to 1 vertical side slopes prior to liner construction. We anticipate that some of this material will be supplied from existing on–site sources, such as soils mixed with waste rock (about 40,000 m^3), and shale that is cut from the quarry floor (about 40,000 m^3) and subsequently crushed to an appropriate gradation. Other materials, such as off–spec aggregates may be available for this use, although these quantities cannot be estimated presently. We therefore conservatively assume that about 370,000 m^3 of sidewall fill will need to be imported.

We consider that sidewall fill would be trucked to the site at a steady rate over the 20 year operating life. This will result in an average rate of 8 trucks per day, assuming a truck capacity of 10 m^3, and haulage occurring five days per week for about 52 weeks per year. The actual daily requirements will vary because of differing soil requirements for various phases of landfilling.

5.3.2.2 Soils for Liner and Cover Material

The liner and cover soil requirements for each phase are summarized in Table 3. On–site stockpiles of fine–grained soil are sufficient to construct about 790,000 m^3 of 'in–place' liner or final cover. We estimate that these reserves will be used up by about Year 11 of the landfill operation, at which time soil will be imported from off–site sources.

The total quantity of soil that must be imported once existing stockpiles are used up is about 980,000 m^3. This will consist mainly of fine–grained soils and a small proportion of topsoil. This requirement will result in an average rate of 32 trucks per day, assuming a truck capacity of 10 m^3, and haulage occurring five days per week for about 52 weeks per year. The actual daily requirements will vary because of differing soil requirements for various phases of landfilling.

5.3.2.3 Materials for Leachate Collection System and Hydraulic Control Layer

The volumes of drainage materials required for the leachate collection system and the hydraulic control layer for each phase are summarized in Table 3. The total volume required is about 590,000 m^3.

We anticipate that all of these materials will be produced in the East Quarry, and thus no off–site traffic will be generated.

5.3.3 Traffic Related to Other Taro Activities

The landfilling operation will occur concurrently with the existing quarrying and West Quarry asphalt plant operations for approximately six to seven years. A significant portion of all East Quarry traffic that will occur during this period is directly related to the these non–landfill operations.

Average quarry haulage traffic has been estimated to be 98 trucks/day, with a peak of 261 trucks/day. Asphalt plant traffic has been estimated as an average of 30 trucks/day (including product and raw material trucks, with a corresponding peak of about 90 trucks/day. More detailed information regarding existing Taro traffic is presented in RGP Transtech Inc., 1995.

5.4 HOURS OF OPERATION

Hours of operation will typically be from 7:00 a.m. to 5:00 p.m., Monday to Friday for the receipt of waste. The site will typically be closed weekends and all statutory holidays. Equipment maintenance activities can occur at any time.

Under special circumstances liner construction may occur six days per week. This is anticipated under rare conditions when, for example, construction has been delayed due to inclement weather or other scheduling problems. Liner and cover construction work will likely proceed at steady pace throughout the non–freezing period of the year (April to October).

5.5 SITE STAFFING

Taro currently employs 27 staff. This consists of the following:

- East Quarry Operations: 9
- West Quarry Landfill:.. 4
- Asphalt Plant:... 2
- Management/administrative:... 12

It is anticipated that once the East Quarry landfill operation commences, 4 additional landfill–operations staff will be required.

5.6 SITE EQUIPMENT

The equipment roster for the East Quarry landfill operation will consist of the following:

a) one D–8 bulldozer and a vibratory sheepsfoot compactor at the landfill working face;
b) various earthmoving equipment for managing stock–piled soils and quarry materials; and
c) various service vehicles.

Taro already owns the majority of this equipment, with the exception of the waste compactor. This will be acquired prior to commencement of landfilling operations in the East Quarry.

5.7 DAILY OPERATIONS

5.7.1 Waste Control

Incoming wastes will be subjected to a thorough screening process. This can be summarized as follows:

a) waste streams will be required to meet all of the conditions specified on the site Certificate of Approval;
b) waste stream testing will be carried out at the generator's site by qualified technicians;
c) waste loads entering the site will be accompanied by a waybill from the generator to ensure that the waste stream has valid approval; and,
d) wastes will be visually inspected by qualified site staff as they are unloaded.

5.7.2 Waste Placement

Waste will be dumped from trucks, spread in about 1 m thick lifts with a bulldozer, and compacted with a vibratory sheepsfoot compactor. One D–8 bulldozer and one vibratory compactor will operate full–time at the working face.

The surface of a newly–constructed area of liner will be covered as soon as possible with a thickness of 0.5 m of waste. Together with the underlying granular blanket, this will prevent liner damage from freezing and thawing effects, drying, and equipment traffic.

5.8 STORM WATER MANAGEMENT

The goal of the storm water management program will be to minimize the contact of clean runoff with the wastes, to segregate clean and contaminated runoff, and to handle each appropriately. Storm water management practices at various times during the operating period are shown in Figures 15, 16, and 17. These correspond to landfilling operations in about Years 4, 10 and 17 of the operating period.

Runoff originating within the lined surface of the active landfill area will be collected by the leachate collection system and discharged to the sanitary sewer for treatment. This runoff will be prevented from flowing out of the active landfilling area by the temporary berms that will be constructed around the perimeter of each phase as it is developed.

The perimeter ditch and the sedimentation/detention pond system will be constructed progressively as required to handle clean drainage from those parts of the landfill where the final cover has been constructed. The western–most of the two sedimentation ponds, and the detention pond will be constructed at the commencement of landfill activities, in preparation for runoff from the completed portions of the final cover in Phase 1. The perimeter ditch will be constructed as needed progressing in a counter–clockwise direction around the site. During Phases 2, 3 and 4 construction will be proceeding upgrade to the high point of the system which is located in the south east corner of the site. Storm water collected up to this point will drain by gravity to the pond system, as shown in Figure 16.

As landfilling progresses beyond Phase 4, ditch construction will proceed downgrade along the eastern perimeter of the site. Runoff collected in this portion of the ditch will be pumped back up to the high point of the ditch and be allowed to flow by gravity along the south and west perimeters to the pond system.

Once landfilling progresses into Phase 7, the remaining part of the ditch along the north perimeter of the site can be practically constructed. The eastern sedimentation pond would also be built at this time once the east and north perimeter ditch is completed. From this time onward all runoff collected along the eastern and northern site perimeters will drain by gravity to the eastern sedimentation pond. This is shown in Figures 16 and 17.

Surface runoff from the portion of the quarry that is not occupied by the landfill will be conveyed to the sedimentation and detention pond system by sump and pump methods, similar to the practices in place now. It was noted in Section 3.2.3.3 that the East Quarry drainage system is presently collecting ground water impacted by leachate from the adjacent West Quarry Landfill. Resultantly, East Quarry storm drainage is not presently discharged off–site but is discharged to the Regional sanitary sewer. We expect that these impacts will be remediated between five to ten years from the present through a series of ground water controls being implemented as part of the closure of the West Quarry Landfill. Until that time, all East Quarry surface drainage will be collected in the sedimentation and detention ponds and discharged to the sanitary sewer. Once the West Quarry plume has been remediated, East Quarry drainage will be tested regularly and handled as clean runoff where appropriate.

5.9 DUST AND MUD CONTROL

Potential exists for dust to be generated from the movement and handling of wastes and soils, and from wind erosion of unvegetated surfaces. Potential exists for dust and mud to be carried onto off–site roads by trucks leaving the site.

The dust impact assessment carried out for this environmental assessment recommended that measures be implemented to control dust emissions. This assessment noted, however, that the predominant source of dust from the East Quarry site was the present quarrying operation. By comparison the existing West Quarry landfill operation was found to result in low dust emissions. The dust impact assessment is documented in CJB Air Quality Management, 1995.

A number of measures will be taken to ensure that dust emissions and tracking of mud are minimized. The proposed cell method of landfill development will provide flexibility to relocate the working face according to daily wind conditions. When possible, on windy days the working face will be operated within the quarry excavation below the level of the surrounding lands. The existing meteorological station will allow measurement of wind conditions, and this information will be used to plan filling areas on a day to day basis.

Effort will also be made to stage earthmoving activities such as liner and cover construction such that working areas are as small as practical.

If dust emissions consistently occur from specific parts of the waste, these areas will be sprayed with water or temporarily covered with either tarpaulins or wastes that do not produce dust.

A regular program of watering haulage roads will be undertaken to control dust emissions. These roads will be kept on the floor of the quarry for as long as possible. The present practice of using a street–sweeper on the off–site roads on a regular basis would be continued. A truck–wash station will be constructed on–site to remove accumulated dirt from trucks.

5.10 ODOUR CONTROL

It is expected that the proposed waste stream will not routinely generate significant odours. We recognize, however, that some of the wastes at the West Quarry Landfill which are similar to the expected waste stream have occasionally generated ammonia or hydrocarbon odours. These are not routine occurrences and have typically occurred only during the actual dumping and spreading of certain waste loads. The odour concerns typically associated with municipal landfills will not exist with the proposed waste stream.

Odour control, when needed, will be achieved by varying the location of the active landfill face and by covering with non–odourous wastes.

Operations will be staged to minimize the spreading of odourous wastes over large areas. In a similar fashion to the proposed dust control program, daily weather conditions will be used to locate the working face on a day to day basis. The intent will be to avoid placing these materials under low–wind, high temperature conditions, when there is little mixing of air.

5.11 NOISE CONTROL

Sources of noise from the landfill operation include the operation of waste trucks, the bulldozer and compactor used in filling operations, and construction equipment for the landfill's control systems.

The noise impact assessment carried out for this environmental assessment concluded that noise from the landfilling operation will produce a minimal increase in noise beyond the background noise from traffic unrelated to the landfill. It is thus considered that standard landfill noise control practices will be adequate. The following noise control measures will be practiced:

a) All equipment will be maintained to ensure that undue noise is not created (for example mufflers will be maintained in proper working order).

b) Construction activities will be limited to site hours of operation.

c) The existing vegetated earth berms (which vary in height between about 2 m to 6 m) will be maintained around the site until the final cover is developed in