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Design and construction of the Brooklyn landfill, Victoria

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ABSTRACT: During 1992, an inert (non putrescible) landfill was implemented for Cleanaway at their site in Brooklyn, Victoria. Involvement with this project included a hydrogeolgical assessment of the site followed by a design and construct phase and now continues in the form of ongoing consultation for landfill and water management. This paper discusses this interesting project and looks at design issues relevant to the implementation of an inert landfill.

1.INTRODUCTION

1.1 The Site

The Brooklyn Landfill site consists of a basalt quarry covering an area of about 10 Ha and has a depth of about 50m below the surrounding area. Groundwater flows into the quarry from various points on the quarry faces at an estimated rate of 1500m^3/day. Quarrying operations are expected to continue at the site for a further 6 years during which time the groundwater level within the quarry needs to be kept at or near the base level.

The overall objective of this project was to allow landfilling to proceed in one area of the quarry as quarrying continued in other areas. Victorian regulations do not prohibit leachate from an inert landfill entering the groundwater. However the regulations stipulate that no leachate from this landfill is to be pumped to the adjoining creek.

The problem then was to allow pumping of the groundwater to the creek to continue whilst ensuring that it did not become infected by the leachate developed in the landfill.

1.2 Aims of the project

Based on the clients' needs the aims of the project were:

* to assess the site geology and hydrogeology for the possible development of a landfill
* to choose the most cost effective type of landfill for the site
* to develop a water management system which would:

1) minimise leachate generation
2) seperate the clean groundwater from the leachate
3) allow continual pumping of clean groundwater to the adjoining creek
4) avoid disrupting the quarry operations
5) make available storage for leachate generated as runoff following a 1 in 100 year storm event
6) allow recirculation of collected leachate back through the landfill
7) satisfy regulatory authorities to gain an inert waste tipping license

* to commence tipping on April 1
* to minimise overall costs

2. BACKGROUND

To assist in describing this project the following comments are included:

- Leachate is produced when moisture enters refuse within a landfill, extracts contaminants into liquid phase and produces sufficient moisture to initiate liquid flow (Farquar, 1987)
- Clean groundwater in this context refers to the quality of the groundwater prior to the commencement of tipping
- Inert waste landfills allow tipping of dry inorganic materials consisting of such things as building rubble, plastic, metal, rubber and glass. Leachate generated within this type of landfill is not considered to be as harmful to the environment as that generated in a putrescible landfill.
- The efficiency of a recirculation program is dependent on the type of waste, the degree of compaction of the waste, and the frequency, thickness, and continuity of the daily cover.
- In addition to using available storage space the recirculation of leachate enhances the decomposition of waste.

3.0 SITE ASSESSSMENT

3.1 Visual assessment

The first assessment of the site involved a walk over inspection to see that the walls of the quarry were structurally sound, and whether there were any on site materials available for use in liner construction or for daily cover.

It was seen at this time that the amount of overburden on the site was minimal and would only be suitable as cover material. The quarry has near vertical sides with four benches present over its full height. The columnar jointing present in the lower of the three basalt flows presented some safety problems for construction with some high overhangs present in some areas of the site.

At the time of this first inspection we observed that the majority of the inflowing groundwater was apparent on the western side of the quarry which was adjacent to the creek. Most of the groundwater was flowing into the site near the toe of the quarry face near the base although at several locations water was flowing from upper faces.

3.2 Hydrogeological assessment

3.2.1 Field investigation

Based on the visual assessment of the site, the existing information, and the requirements of the Environment Protection Authority of Victoria for gaining a landfilling license, a drilling investigation was performed which included the installation of four groundwater monitoring bores.

The aim of the investigation was to assess the basalt rock to determine its variability and continuity for assessment of its likely hydraulic conductivity. Also of interest was the extent of the groundwater drawdown and the presence if any of secondary aquifers and perched water bodies. To assist in the evaluation of the hydraulic conductivity a measure was continually made of the amount of water that was being airlifted during drilling.

3.2.2 Computer modelling

a) Groundwater

A simple two-dimensional finite element model was used to simulate the groundwater flow on the western side of the quarry adjacent to the creek. The model was then run with the inclusion of a line of interception wells to reduce the amount of water moving from the creek to the quarry.

The modelling showed that the proposed line of wells would only reduce the inflow by about 50 to 60 % when placed at 15 to 20 m spacing. Due to the large costs associated with this installation and the relatively minor success expected from this system, this alternative was not pursued.

b) Landfill

Based on a concept design of the landfill layout a computer program called HELP (Hydrologic Evaluation of Landfill Projects) was used to model the main components of water movement through the landfill. The program was developed by the US Environment Protection Agency and uses daily meteorological data and the landfill design to simulate water movements including change in water storage at various depths in the profile, evapotranspiration, lateral drainage and vertical percolation through the landfill. In running this program the amount of groundwater entering the landfill was assumed to be negligible based on the construction of a toe drain and liner as described in the following sections

This program predicted minimal percolation of leachate to the base of the refuse due the expected high evapotranspiration rate and the high storage capacity for this type of refuse. A seperate analysis determined that storage for 1500m^3 of leachate was required for runoff from a 1 in 100 year storm event or one or more wet months.

4. DESIGN & SPECIFICATION

Following the hydrological assessment and the acceptance of a concept design we proceeded to formalise the design and prepare a specification for inclusion as part of the tender documents for construction.

Due to the uniqueness if the site and the problem at hand the design was developed using a practical approach based on experience and assumptions of the likely behaviour of the proposed system. It was expected that design changes were going to be made as construction progressed. However, the objective in preparing the specification was to provide a simple, straightforward document that would limit conflict between the superintendent and the contractor caused by ambiguities.

The design included construction of a toe drain and liner (Figure1) along a length of 300m. To complete the boundary of the landfill base a clay bund wall was to be constructed. The contractor was responsible for ensuring that the continal pumping was not interrupted and that the quarrying operations were not disrupted.

All clay and ballast rock used in the construction was to be imported to the site. This included about 6000m^3 of clay 1000m^3 of

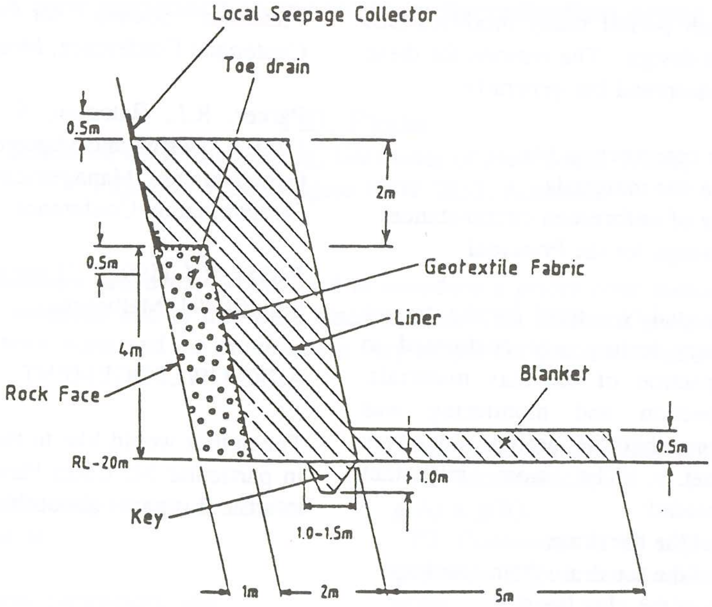

Figure 1, Toe drain and clay liner cross section

rock. The design also included ' local seepage collectors ' (Figure 2) which included a HDPE liner and directed free groundwater from the quarry faces down to the toe drain thereby minimsing interaction with the refuse or leachate.

The tender documents were distributed to three contractors that we believed were capable of performing the work to our satisfactioin in the short time made available by the Principal (Cleanaway). Following withdrawal of one of the contractors we received two submissions and chose the cheaper of the two.

5. CONSTRUCTION

Construction extended over a 4 month period although the program was scheduled so that tipping could commence prior to the completion of the total works. This was achieved with tipping commencing on schedule on April 1.

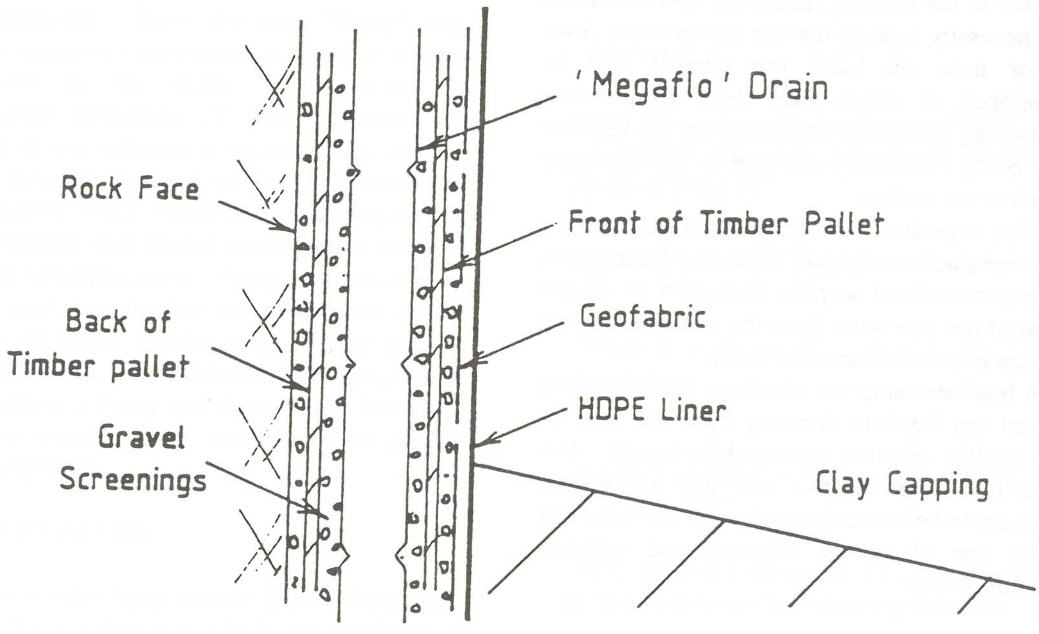

Figure 2, Local seepage collector cross section

Over the 4 month period many modifications were made to the design. The reasons for these changes were widespread but generally:

* created a safer construction site
* made use of on site materials
* took advantage of unforeseen circumstances
* gained cost savings for the Principal

As part of the quality control for the project some field density testing was performed to assess the compaction of the clay materials. Full time inspection and monitoring was adopted to ensure that all design objectives were being met. The more important requirements included:

- the continuity of the toe drain
- the protection of the toe drain from blockage
- the compaction of the clay liner
- the construction of the local seepage collector
- the minimisation of groundwater / leachate interaction

Throughout construction surveyors were engaged to compute the constructed quantities for payment of the works completed.
Following the completion of the work, quantities were eventually agreed to and a completion report was prepared.

6. CONCLUSIONS

The Brooklyn Landfill was developed to accept inert refuse in accordance with all regulations.

Due to the ongoing quarrying operations and the necessity to keep the the groundwater level at or near the base, the landfill will be developed in stages with clean groundwater remaining essentially seperate from the leachate and being continually pumped to the adjoining creek at the surface.

This seperation has been made possible by the construction of a toe drain and liner which incorporates local seepage collectors to collect most of the free water from the quarry faces and directs it to the clean water sump.

A leachate sump has also been constructed to accept the leachate draining from the base of the landfill and that produced as runoff. The landfill is operated in a way that allows this leachate to be recirculated through the refuse to make use of storage capacity and enhance decomposition

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