THE 'ROBERTSON BARRIER LINER'

A TESTABLE DOUBLE LINER SYSTEM

AUTHORS:

Dr. A MacG Robertson P.Eng., Principal	Steffen Robertson & Kirsten (Consulting Engineers)		Vancouver
Mr. W. van Woudenberg, President	Nilex Group.	Denver	Colorado
Mr. R.G. Rohrs, General Manager	Robertson Barrier Systems Inc.		Vancouver

INTRODUCTION

The need to increase the protection and preservation of groundwater has led to the search for new technology which will improve the security of containment of hazardous and polluting liquids and solids. To be effective this new containment technology must address the growing environmental concerns together with its legal responsibilities and public perceptions to provide demonstrably secure containment facilities.

Various methods of lining these containment ponds with conventional clay and or geomembrane lining systems whether they be single, multiple, or composites incorporating additional geosynthetics have been developed. Multiple liner systems, employing two or more layers of geomembrane, increase the inherent containment capability over single liner systems. A section through a portion of a typical conventional double liner system is depicted in Figure 1.

Conventional multiple liner systems provide a passive leak detection system, dependant upon the establishment of a hydrostatic head of leaking fluid within the leak detection media for flow of such leakage to the sump. Evidence of leachate in the leachate collection and return sump (LCRS) is a positive indication of a leak in the upper liner. Absence of leachate in the LCRS sump is however not a guarantee that no leaks exist, only that the rate of entry through the upper liner must be equal to or less than the rate at which leakage can occur through the lower liner. When a leak is indicated, conventional systems provide no means of accurately measuring the magnitude of the leak or the time that the leak has existed, nor whether their leak is partial loss of the leachate entering the collection media through holes in the lower liner.

The Robertson Barrier Liner (RBL) is an improved version of a multiple liner system which is particularly advantageous in applications where increased liner security is required (storage of particularly hazardous or valuable materials in sensitive areas), or where permit conditions or risk management demand the ability to demonstrate the continued integrity of the liner system.

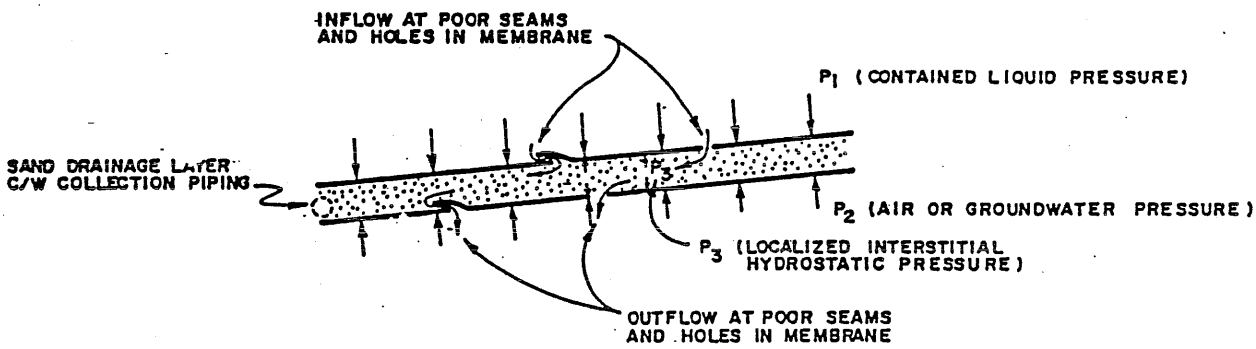

Figure 1 Conventional Double Liner System

THE ROBERTSON BARRIER LINER SYSTEM

The Robertson Barrier System is a patented double flexible liner system which permits the active testing of the liner during installation, commissioning, operation and after facility closure, to demonstrate the presence or absence of leaks in the liner. The system may be used to monitor continuously for the onset of leaks and can indicate whether the leak is stable or is escalating. It may also be used to counteract the escape of the contained fluid in the eventuality that a manageable leak may develop.

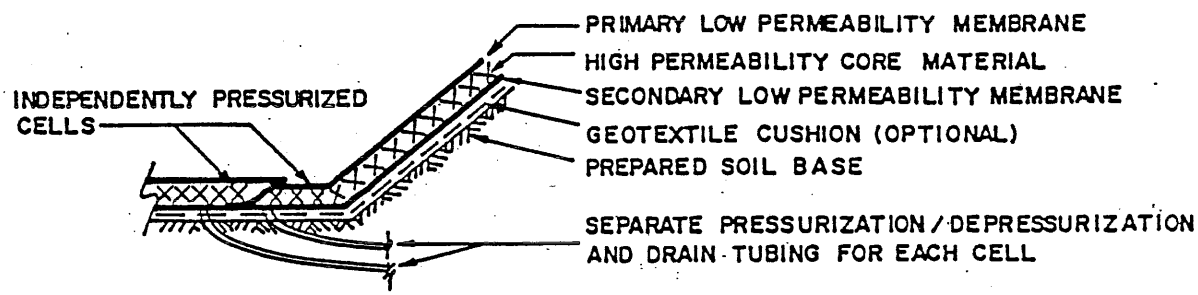

Figure 2 Section Through A Portion Of A Typical Robertson Barrier Liner System

As depicted in Figure 2 a Robertson Barrier Liner consists of a sandwich of two layers of geomembrane on either side of a permeable zone. The permeable zone is formed using a layer of geonet or by coarse texturing on the inner face of one of the membranes. The geomembranes are sealed along the outer edges of the sandwich to form a cell. Drainage tubes are connected to the outer secondary liner into the permeable zone at the lowest point to allow any fluids draining into the permeable zone to be removed. A partial vacuum is the applied to the permeable zone between the two geomembrane layers through these drainage tubes.

The partial vacuum establishes an inward hydraulic gradient through both geomembranes. The inward flow of air or fluid causes vacuum pressure loss and/or liquid accumulation within the cell and indicates the presence of leaks. This can be monitored by measuring the vacuum pressure and fluid collection. Prior to contained fluid covering any hole in the upper or lower membranes, any potential leaks will pass air which is immediately detected as a loss of vacuum. It is therefore possible to detect potential leak locations prior to their coverage by liquid or leachate. Such early detection greatly enhances the ability to repair the liner prior to commissioning, as well as providing the owner with an additional quality control measure. Figure 3 illustrates that, with the maintenance of the partial vacuum in the presence of leaks, it is possible to maintain the inward gradient across the liner and hence prevent the outward flow or 'escape' of any fluids which may have entered the permeable space through the upper membrane.

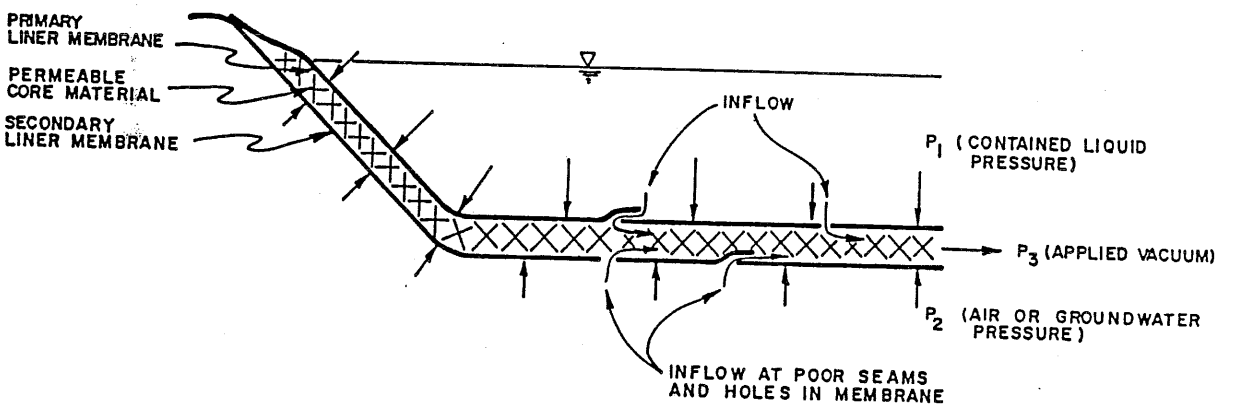

Figure 3 RBL Under-Pressure System

With an RBL the leak detection is active, providing the facility for positive testing, detection and monitoring of leaks if, or as and when they occur. The RBL allows testing of the entire liner system (not just the seams) during construction, on completion of construction and throughout the operating life of the liner system. Since it has the ability to detect potential leaks prior to leachate or fluid covering, it provides the opportunity to effect repairs prior to the occurrence of leakage. It allows the detection of the onset of leaks, as soon as they occur (not when the leachate arrives at the LCRS) and the ongoing monitoring of the leak to determine if the liner system is deteriorating.

CELLULAR LAYOUT DESIGN

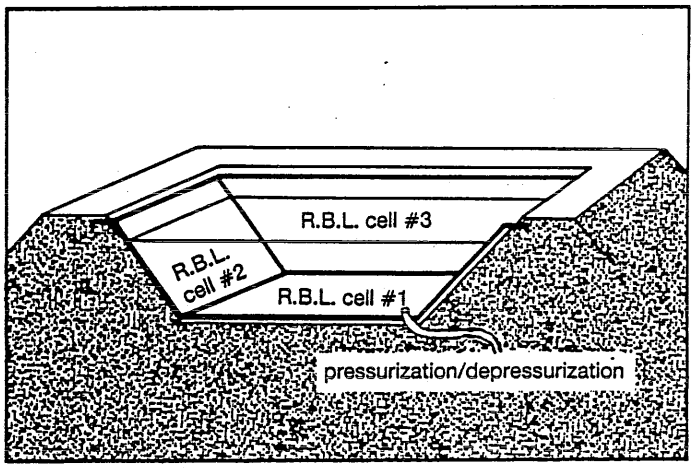

Figure 4 Cell Layout of a Typical RBL Liner System

Most RBL liner systems consist of one or more zones or cells (see Figure 4). The total liner area is divided into suitably sized cells. During liner installation, each cell is tested upon completion. Leaks are located and repaired before the liner is covered and then the entire liner is tested prior to handing it over to the client to demonstrate it is leak free and that it has not been damaged during subsequent covering or additional construction. In order to ensure that the entire surface area of the pond basin is covered with a testable double liner the seams are overlapped in shingle fashion, as shown in Figure 5.

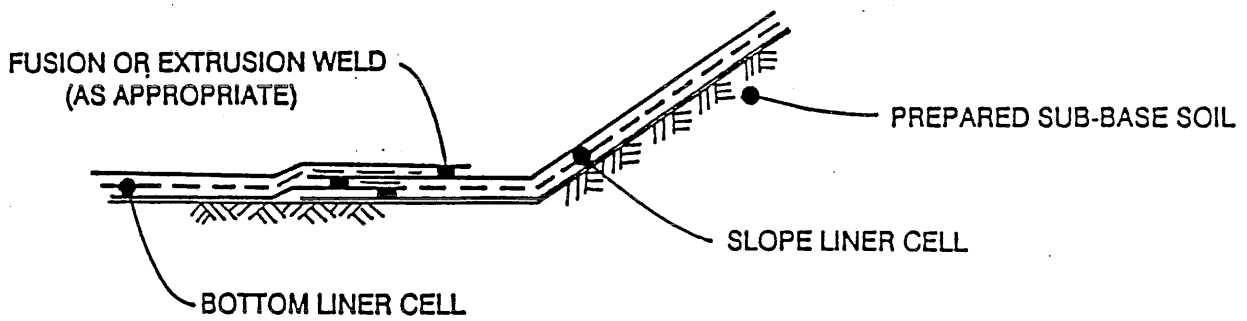

Figure 5 Method Of Overlay At The Seams

Leaks may, and often do, develop after a facility has been brought into operation. The RBL, because of its zoned nature and the fact that each cell can be isolated and tested individually, facilitates the locating of a leak and thus reduces the cost of remedial work. Also, by maintaining vacuum in the leaking cell, the facility operator can counteract small leaks and may be able to retain the lined facility in service. This way, the operator can schedule a convenient time that is least disruptive to effect repairs to the damaged liner. In some special cases, repairs can be made within the liner cells, without taking the liner out of service.

The operator is able to perform periodic or continuous checks to determine if the liner remains leak free. Such testing may be continued after the facility closure to demonstrate the long term effectiveness of the liner system. Independent checks and verification of liner integrity by Regulatory Authorities are possible.

Minor leaks can be controlled indefinitely by merely pumping the fluid that has collected in the vacuum and drainage collection system back into the containment basin at regular intervals. By measuring the quantity that has leaked out of the liner, one can to some extent determine the magnitude of the damage or hole. Recent simulated leak tests at an installation resulted in the flow rates per hole size in a liner as indicated in Figure 6. The chemical content of the liquid in the cell will be typical of the contained liquid or ground water, or a mixture of the two, and will indicate whether the upper or lower liner, or both, are leaking and by how much.

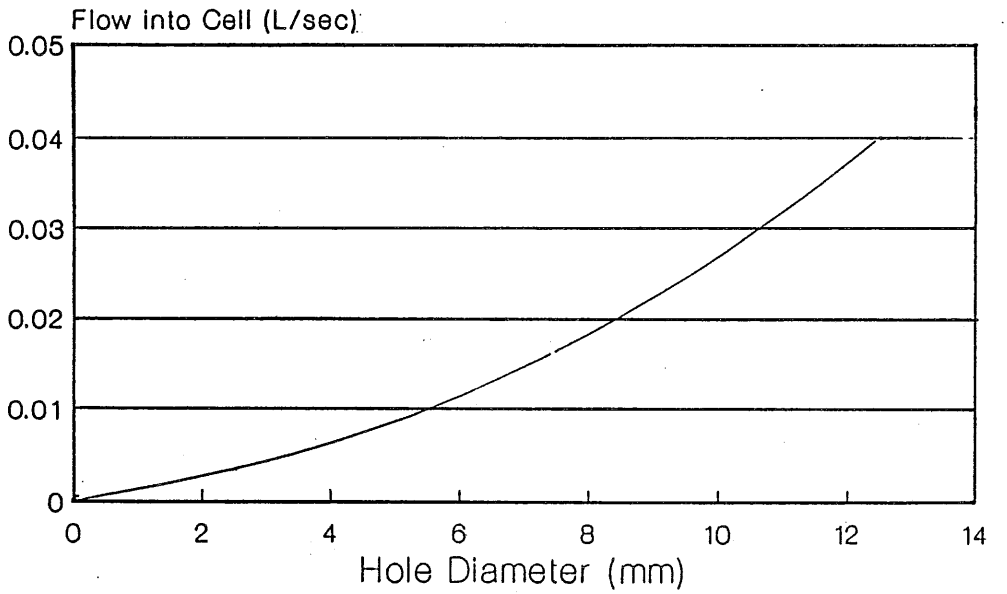

Figure 6 Flow vs Hole Diameter For A Typical Simulated Leak

INSTALLATION

The RBL system should be installed by, appropriately licenced, experienced and fully-trained installation contractors, assisted by Robertson Barrier Systems Corp (RBSC) staff. Installation should be to designs approved by RBSC. The RBL utilizes only known and proven geomembrane materials, as well as established seaming technology. Normal QA / QC for high security liner systems including seam peel and vacuum box testing should be undertaken. The RBL advantage is derived from the cellular way in which the way the system is assembled, and the ability to immediately and thereafter repeatedly test the quality of the installation by simply applying the vacuum apparatus.

TEST EQUIPMENT

Each cell is connected to the central vacuum test equipment by means of plastic tubing. These lead into a set of vacuum chambers / liquid traps set one above the other. Each cell can be isolated by

means of a valve and cell pressure is monitored by a pressure gauge. A vacuum pump is situated above the liquid traps to enable a partial vacuum to be drawn onto the whole liner system. When the required vacuum, usually about 2 to 4 psi, has been drawn onto the whole system, the valves to each cell can be closed and the pressure gauges observed for any pressure loss. Pressure deterioration in a cell indicates a leak. The vacuum pump can be operated manually or automatically by means of a pressure switch which will maintain the vacuum at predetermined levels.

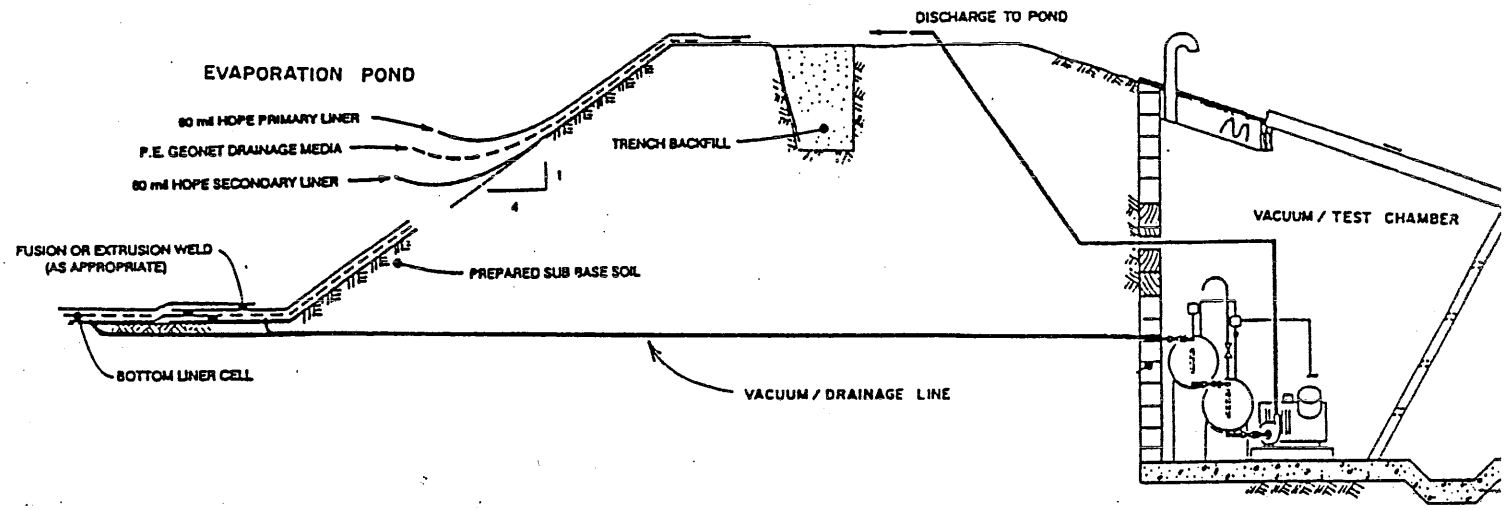

Figure 7 A Typical Test Chamber Layout

When a leak occurs, liquid is drawn into the cell and into the liquid trap. Valves allow this trap to be isolated from the system which is then be emptied by a small pump provided for this purpose. The pumped fluid may be discharged back into the lined pond or elsewhere.

APPLICATIONS

Some typical applications for Robertson Barrier Liner Systems are :

- Ponds and Surface Impoundments
- Landfills
- Tanks and Vaults
- Surface Storage tanks
- Underground Storage Tanks
- Leach Pads
- Tailings Ponds
- Floating Covers

Figure 8 illustrates some of the more common applications.

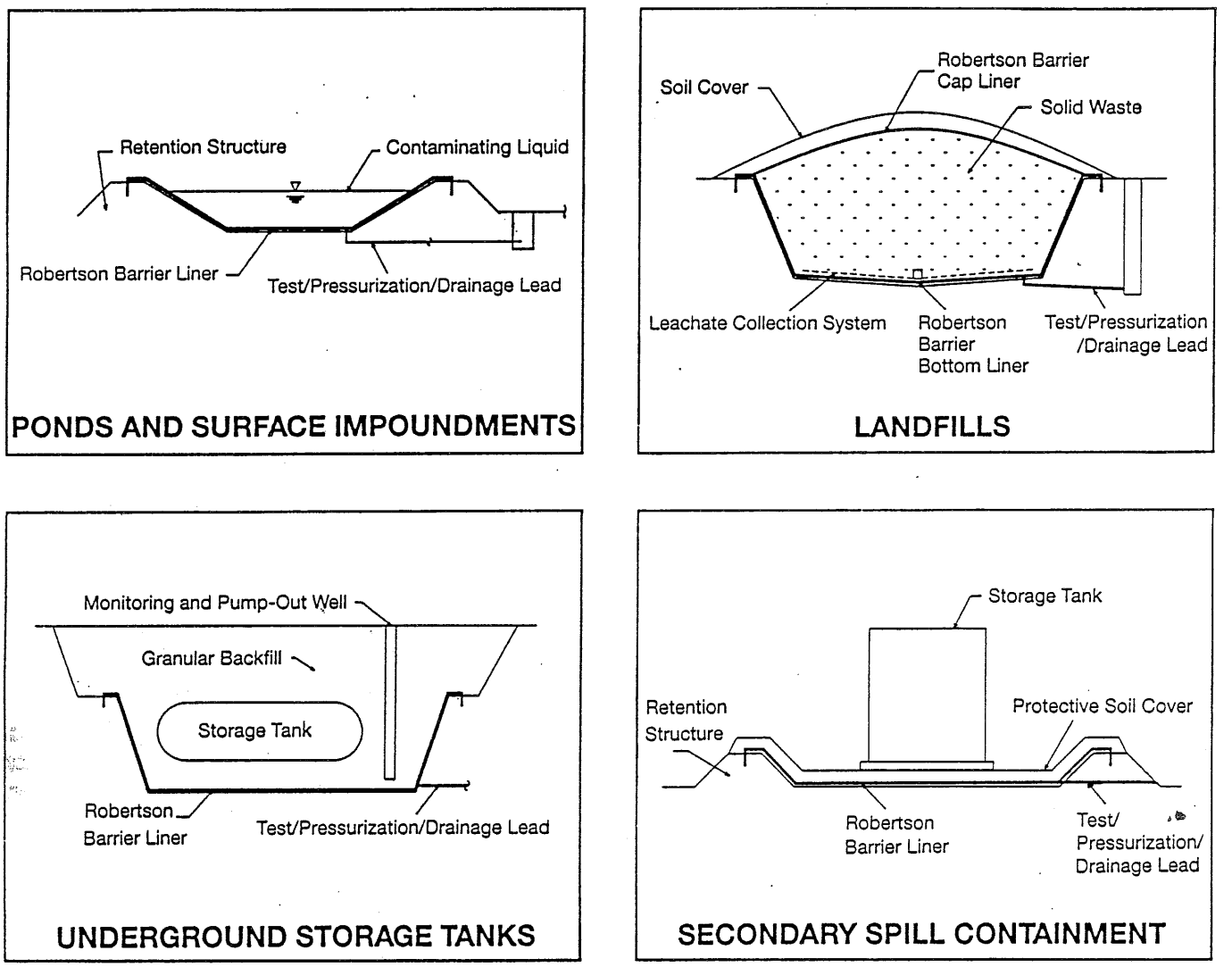

Figure 8 Typical RBL Applications

CONCLUSION

The Robertson Barrier Liner has a number of unique advantages that enable it to provide unprecedented security for the containment of environmentally hazardous or valuable materials. The system uses only known and proven materials, existing installation expertise and equipment, and has proven to be economically attractive.

- TESTING A RBL permits both continuous and intermittent testing for leaks. In addition, it is testable both during and after installation, and during operation of the containment facility when the liner is covered.

- DETECTION OF POTENTIAL LEAKS PRIOR TO OCCURRENCE

  A RBL can be tested to establish if there is a potential for leaks prior to the introduction of fluids. This reduces the risk of unexpected leaks and consequential pollution damage.

- CONTROL A RBL permits control of identified small leakage, thereby preventing contaminants entering the environment space. In this way the system provides unprecedented security both in the short and the long term.