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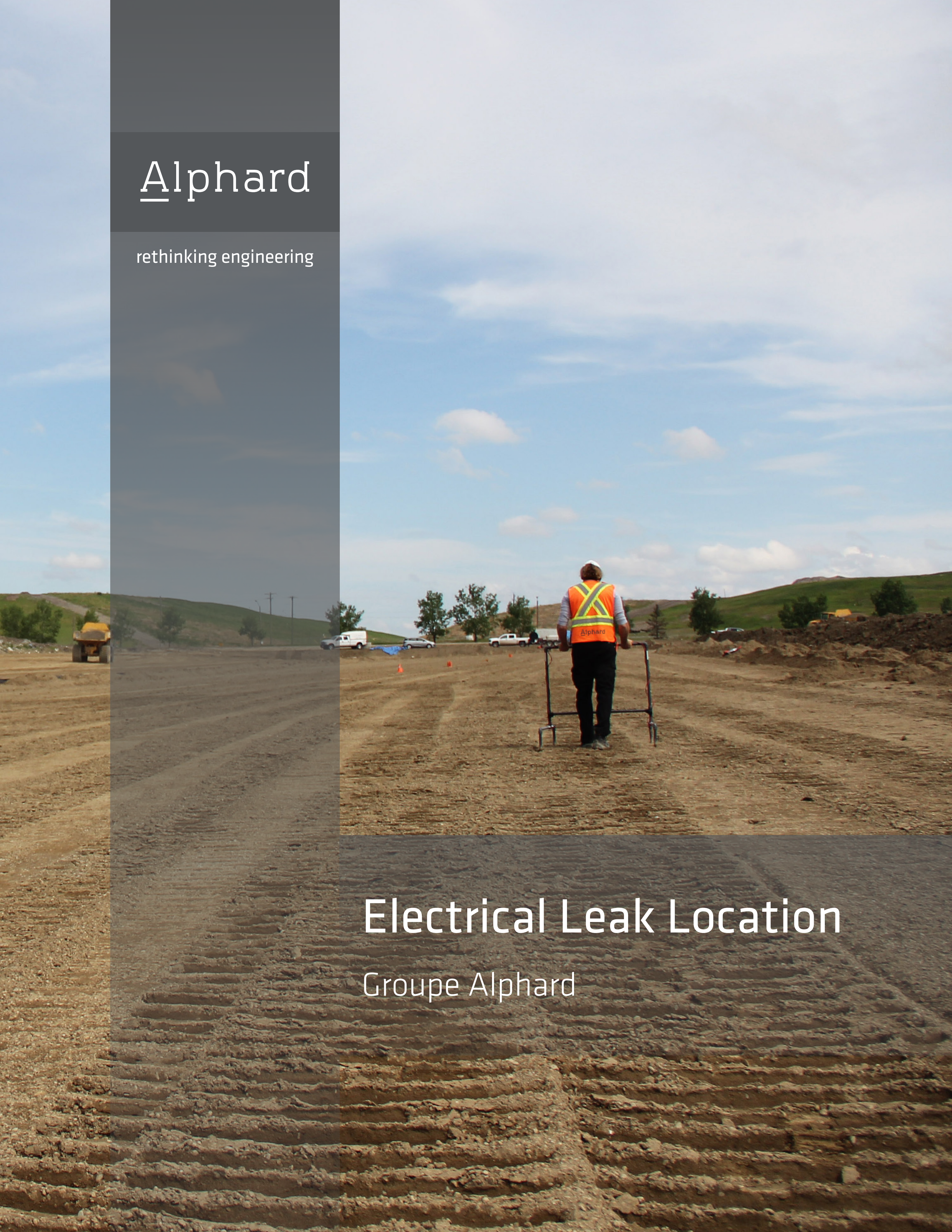

Electrical Leak Location

Groupe Alphard

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1. Electrical Leak Location

Whilst geosynthetic materials already play a key role in the majority of containment works, their use continues to grow in a variety of sectors including waste management, industrial and mining applications and contaminated soils management.

The performance of a containment site is directly affected by the presence of faults in its geomembrane layer. Potential risk factors for faults during the construction of containment works are varied, including perforation, welding errors (fusion, extrusion), tearing, cutting, vehicle damage and manufacturing faults. Groupe Alphard's range of leak location techniques ensures the integrity of containment works before they are put into operation, as well as providing effective diagnostic tools for existing containment sites.

Groupe Alphard's professionals have over 15 years experience in the field of electrical leak location. Their expertise includes performing leak location surveys on a variety of covered and exposed geomembranes, as well as developing new leak location technologies and assisting in the standardization of existing leak location techniques.

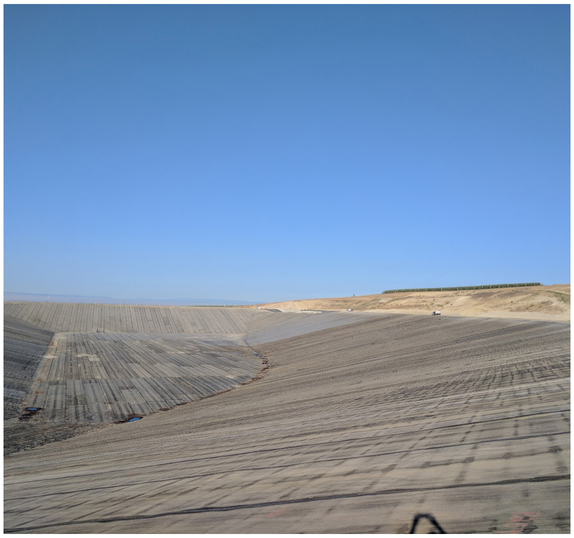
This document provides an outline of the electrical leak location methods currently offered by Groupe Alphard.

SITES AND APPLICATIONS

- Technical landfill sites
- Industrial containment works
- Mine tailings parks
- Leachate ponds
- Site closures
- Water treatment reservoirs
- Dams and dikes
- Biogas barriers
- Contaminated soils treatment platforms
- Check dams

Example of localized failure due to tension in a PEHD geomembrane, located using the dipole method.

Example of superficial damage hidden underneath a sandbag, detected through the sack during a water pudde test.



STATISTICS

- Groupe Alphard has performed electrical leak location surveys on over 2.9 million square metres of geomembrane material, covering 70 distinct projects.
- The most leaks found on a single project was 203 leaks with the water puddle method, and 396 leaks with the dipole method.
- The largest leak found to date was more than 12 m long. It was found by applying the dipole method through a natural covering layer.
- In 2014, only 21.41% of all geomembrane installed in the province of Quebec was tested using ELL methods.
- The most unusual leak found was a puncture caused by a bicycle's handlebars. The whole bicycle had to be removed from the clay subgrade before repairing the geomembrane material.
- The dipole method was successfully applied at -13 °C, the coldest leak location conditions experienced to date, requiring significant effort to heat the surrounding ground.
- The thickest covering tested was a 1.1 m thick layer of fill dirt, stones and boulders (up to 40 cm wide). Several leaks were found in the underlying geomembrane material.
- Leaks as small as 6 mm^2 were located and excavated in an evaporation pond in Chile.

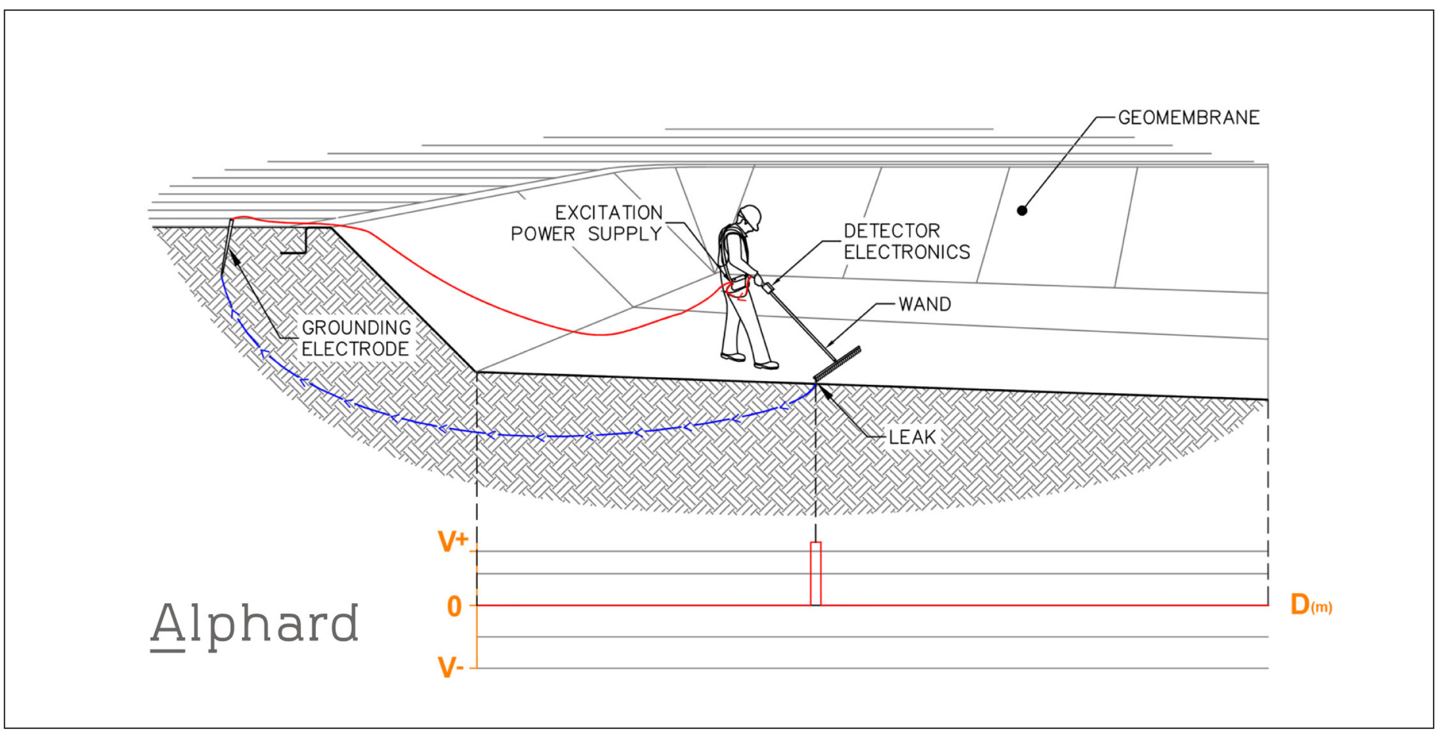
THE SPARK TEST METHOD

The spark test method (standardized under ASTM D7240 – "Standard Practice for Leak Location Using Geomembranes with an Insulating Layer in Intimate Contact with a Conductive Layer via Electrical Capacitance Technique [Conductive Geomembrane Spark Test]") allows for the detection and localization of faults sustained during the installation of conductive geomembranes.

Recent developments in the manufacturing of coextruded geomembranes have made it possible to produce geomembranes with a conductive layer alongside the traditional isolating layer. It is this conductive layer that allows the geomembrane to be surveyed using the spark test method.

To perform the survey, the geomembrane must be installed with the conductive layer face down. A portable power source is then used to charge a conductive element (such as a neoprene pad), and this charge is transferred to the conductive layer through the capacitance effect. A leak location probe is then swept over the surface of the geomembrane. When the probe passes over a leak or fault, the conductive geomembrane layer is discharged, creating a spark that allows the fault to be identified and localized.

Different equipment can be used depending on the area to be surveyed. Small hand-held detectors are used in confined areas, whilst large detectors are generally used on expansive open areas. Leaks of less than 1 mm^2 can be localized using the spark test method.



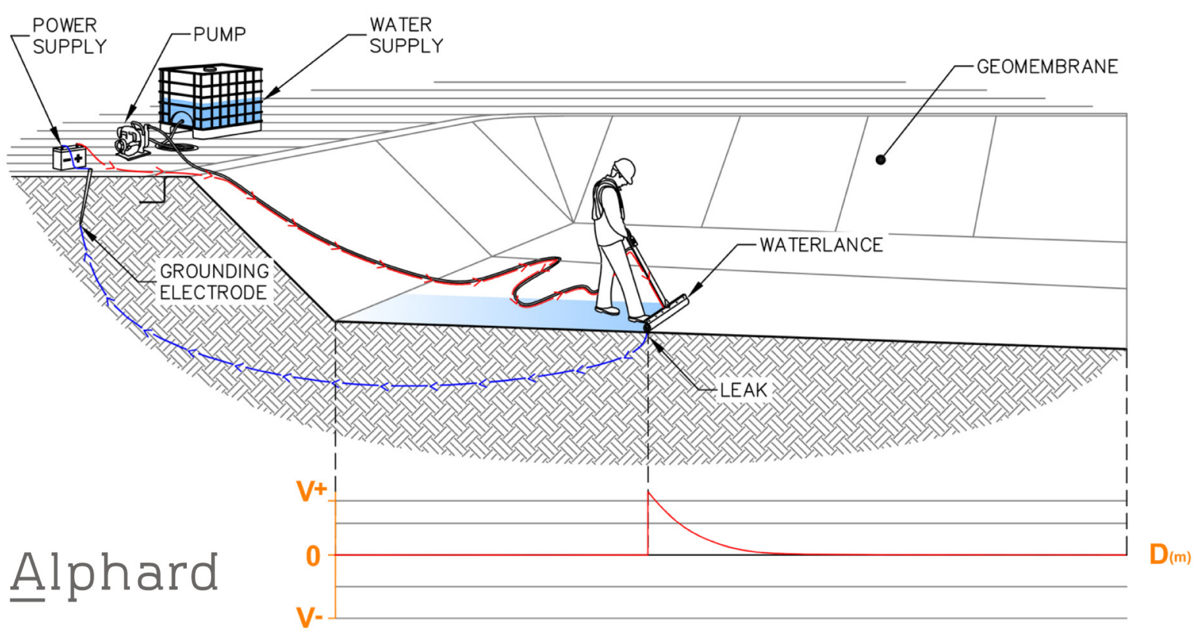
THE WATER PUDDLE METHOD

The water puddle method (standardized under ASTM D7002 – "Standard Practice for Leak Location on Exposed Geomembranes Using Water Puddle Method") allows for the detection of faults sustained during the installation of geomembrane materials.

The water puddle method applies geoelectrical techniques which harness the insulating properties of geomembrane materials to detect leaks and faults (see figure below).

To perform the survey, a DC voltage is applied to a metal sprinkler carried by the technician. A grounding electrode is then placed outside of the test site, creating a difference in electrical potential between the water distributed by the sprinkler and the underside of the geomembrane.

Once the technician reaches a fault sufficiently large to flow through, the water creates an electrical bridge between the positive voltage and the grounding electrode. An audible signal is then produced to inform the technician that a leak has been found. The water puddle method detects leaks smaller than 1 mm^2 whilst allowing for 100% of the test surface to surveyed, providing a leakproof guarantee across the entire geomembrane surface.



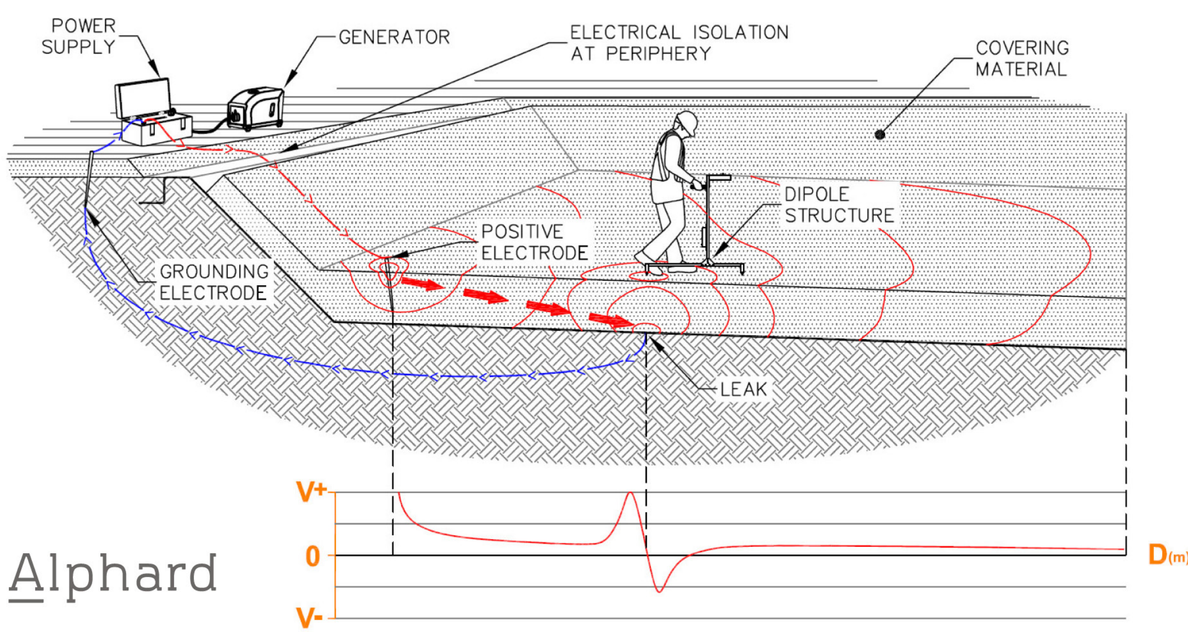
THE DIPOLE METHOD

The dipole method of leak localization (standardized under ASTM D7007 – "Standard Practices for Electrical Methods for Locating Leaks in Geomembranes Covered with Water or Earth Materials") allows for the detection of leaks and faults sustained during the installation of covering materials.

The dipole method applies geoelectrical techniques which harness the insulating properties of geomembrane materials to detect leaks and faults (see figure below).

A voltage of around 550 V (DC) is passed directly into the covering materials whilst a grounding electrode is placed outside the limits of the geomembrane. If a fault or leak is present, the electrical charge will pass through the defect to reach the grounding electrode, generating a distinct electrical signature that can be identified and localized by a qualified technician.

The dipole method allows for the detection of faults around 6 mm in diameter through covering materials up to 1 m thick.



2. Our Electrical Leak Location Projects

Groupe Alphard's leak location professionals have over 15 years of experience in the domain, during which they have developed a diverse portfolio of public and private clients.

The following list provides an overview of our major leak location projects:

- Zink mine water storage pond, Portugal (Lundin Mining): 12,900 m^2 water puddle method (2019)
- Industrial waste disposal cell, Alberta (Clean Harbors): 14,200 m^2 dipole method (2019)
- Domestic waste landfill stage 1A, British Columbia (Belkorp Environmental Services Inc.): 63,900 m^2 water puddle and dipole (2019)
- Pulp mill landfill extension, British Columbia (Harmac): 32,000 m^2 dipole (2018)
- Sewage Lagoon in Sucker River, Saskatchewan (Pinehouse Business North): 4,500 m^2 dipole (2018)

- Water treatment ponds in VanKleek, Ontario: 57,500 m^2 water puddle (2018)
- Permanent mining cap in Val d'Or, Quebec (Teck Ressources Ltd): 122,800 m^2 water puddle and dipole (2018)
- Rainwater storage reservoir, Washington: 171,000 m^2 water puddle method (2017)
- Radioactive waste landfill site, Port Hope, Ontario: 92,000 m^2 dipole method (2017)
- Technical landfill extension, Calgary (Shepard Landfill): 30,132 m^2 dipole method (2017)
- Grenade launcher firing range, Valcartier military base, Quebec: 4,658 m^2 water puddle method (2017)
- Capping of toxic waste sites, Blainville (Stablex): 25,269 m^2 dipole method (2017)
- Comox Valley landfill site – Cell 1, British Columbia: 78,750 m^2, water puddle method; 46,700 m^2, dipole method (2016-2017)
- Extension of technical landfill site, Calgary (East Calgary Landfill): 64,940 m^2 dipole method (2016-2017)
- Oil basin secondary containment layer, Suncor Montréal: 7,100 m^2 dipole method (2016)
- Pulp & paper plant landfill site, Skookumchuck, British Columbia: 13,600 m^2 dipole method (2016)
- Industrial landfill capping – Cell B, Contrecoeur (ArcelorMittal): 29,545 m^2 water puddle method; 28,675 m^2, dipole method (2016)
- Espanola facility, Domtar Corp., Ontario: 5,475 m^2 dipole method (2015)
- Water retention basin, Eastmain: 34,000 m^2 water puddle method (2015)
- Decontamination of soil cells 1-4, Mascouche (Signaterre): 79,352 m^2 water puddle method; 60,523 m^2, dipole method (2015)
- Drainage and purification of sludge treatment pols, Fort McMurray, Alberta, District Sunrise (Husky Energy) North Blowdown: 325 m^2 water puddle method, 60 m^2 dipole method (2015)

- Contaminated soils landfill cell, Phase 2, L'Épiphanie: 26,282 m^2 water puddle method; 22,129 $m^2$2 dipole method (2015)
- Spyhill dump, Stage 3 (municipal dump), City of Calgary dump (AECOM): 55,625 m^2 dipole method (2015)
- Petroleum waste dump, Grande Prairie (Newalta Golde Creek dump): 5,984 m^2 water jet, 42,146 m^2 dipole method (2015)
- Construction reservoir, Saskatchewan (K+S Potash Canada): 7,000 m^2 dipole method (2014)
- Geotubes platform, Opinaca (Eleonor Mine): 3,200 m^2 water puddle method, 3,200 m^2 dipole method (2015)
- Closure of Barvue Mine, Barraute (Quebec): 250,000 m^2 water puddle, 253,000 m^2 dipole method (2014)
- East Calgary Landfill, Construction site 7, phase 8 (part 2), Calgary: 9,500 m^2 dipole method (2014)
- Selenium pool, British Columbia (TECK Line Creek Mine): 8,000 m^2 dipole method (2014)
- Chemical treatment tank, Saskatchewan (K+S Potash Canada): 11,500 m^2 dipole method (2014)
- Grenade launcher firing range, Valcartier military base, Quebec: 9,000 m^2 water puddle method, 9,000 m^2 dipole method (2014)
- Permanent covering of mine residues and tailings (Northwestern Territories): Tundra Mines, 132,500 m^2 water puddle method (2014)
- Additional cell of existing contaminated soils landfill, L'Épiphanie (Biogénie): 24,000 m^2 water puddle method, 43,200 m^2 dipole method (2013)
- Contaminated soils landfill, L'Épiphanie (Biogénie): 78,000 m^2 water puddle method, 43,200 m^2 dipole method (2012)
- Waste water treatment reservoir, Murdochville (Xtrata): 17,000 m^2 water puddle method (2012)
- Service demonstration on mining residues (Northwestern Territories), Tundra Mines, 3,800 m^2 dipole method (2012)

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