Striving for Minimal Leakage in Geomembrane Systems

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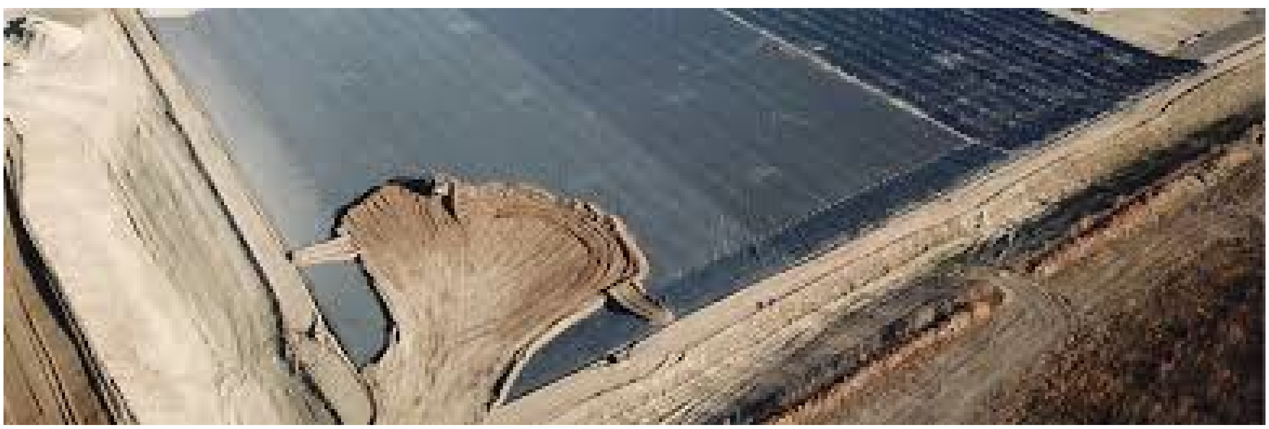
Written by: Brian Fraser & Evan Bao (IAGI Board Members)

Achieving zero leakage in geomembrane containment systems is a common aspiration among facility owners, consulting engineers, and installers. While this goal is commendable, it is exceptionally difficult to achieve and virtually impossible to guarantee due to the inherent complexity of these systems and the potential for microscopic defects. Rather than striving for an absolute zero, a more practical and effective strategy is to **target minimal, measurable leakage.** This can be accomplished through a combination of sound design, high-quality materials, expert installation, rigorous construction quality assurance (CQA), and the integration of leak detection technologies.



Design and Installation Strategies to Minimize Leakage

- **Material Selection**: Choose high-quality geomembranes with verified mechanical (tensile, tear, puncture, flexibility) and endurance (chemical, UV, thermal) properties suited to the application.
- **Composite Liners**: Use geomembranes over smooth, well-compacted clay or geosynthetic clay liners (GCL's) to improve containment and reduce leakage pathways.

- **Double Liner Systems**: Install dual geomembranes (primary and secondary) separated by a geocomposite drainage layer to enable leak detection and secondary containment via a sump and monitoring system.
- **Protection Layers**: Apply heavyweight non-woven geotextiles or soil cushions to protect geomembranes from mechanical damage during and after installation.
- **Pipe Penetrations**: In both pond and tank applications, minimize the number of pipe penetrations and where possible limit the number of penetrations and mechanical anchorage points of the liner below the waterline. This helps to reduce difficult sealing points and potential leakage risks.
- **Wrinkle Management**: Limit wrinkles and stress concentrations during installation to avoid gaps and potential stress points.

Geomembrane CQA Testing

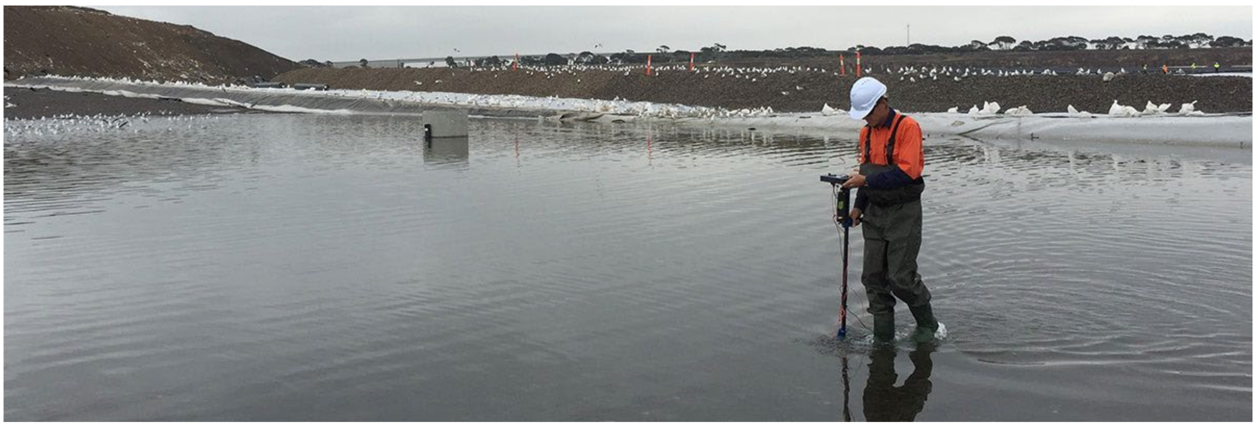
- **Pre-Service Testing**: Conduct comprehensive testing before commissioning. Techniques include:
    - **Material verification**: Checking the geomembrane material's physical, mechanical and endurance properties, including chemical resistance to ensure it meets project specifications and application requirements.
- **CQA Installation Oversight:** Subgrade construction needs to be approved as well as robust testing performed of all geomembrane seams, patches, and mechanical connections. This verification is required for all destructive and non-destructive testing performed
    - **Destructive tests** involve taking samples from the seams to measure their peel and shear strength both on site and at a certified independent lab. GRI GM19 is a recommended standard specification for testing the seam strength and related properties of thermally bonded polyolefin geomembranes.
    - **Non-destructive testing:** Non-destructive methods assess seam integrity without damaging the material. These include air lance, vacuum box, mechanical point stress and pressured air channel and spark testing. ASTM D4437-08 is the standard practice for non-destructive testing (NDT) for determining the integrity of seams used in joining flexible polymeric geomembranes
- **Liner integrity testing:** This is a crucial step to identify and locate holes or damages in the geomembrane.

- Electrical Leak Location Surveys (ELLS): These surveys are a key part of CQA, especially for identifying small holes that are difficult to see during a visual inspection of the material surface including tested welds, patches, and penetrations.

- Spark/Arc testing**:** A spark is generated at defects as an electrically charged rod or brush is moved across the surface, making even small holes visible.

- Electrical leak location methods include spark, dipole and soil testing. For more information, reference ASTM D6447-21- Standard Guide for Selection of Techniques for Electrical Leak Location of Leaks in Geomembranes.

- **Continuous Monitoring**: For critical applications, consider systems that enable ongoing leak detection using electrical current or other technologies.



Layfield Canada technician dipole testing process water mining pond in Northern Saskatchewan

Key Considerations

- **Realistic Performance Goals**: Instead of targeting absolute zero leakage, define an **allowable leakage rate** based on risk assessment and regulatory requirements.

- **Measurable Metrics**: Establish clear, quantifiable leakage thresholds to guide design and operational decisions.

- **Action and Allowable Leak Rates (ALR):**
  ALRs are regulator-defined thresholds for acceptable leakage, based on facility type and environmental risk. They set the maximum leakage a detection system can manage before corrective action is required, serving as a key compliance benchmark. ALRs should reflect application type, environmental impact, and regulatory standards.

  - *A useful reference is GSI GRI White Paper #15: Survey of U.S. State Regulations on Allowable Leakage Rates in Liquid Impoundments and Wastewater Ponds.*

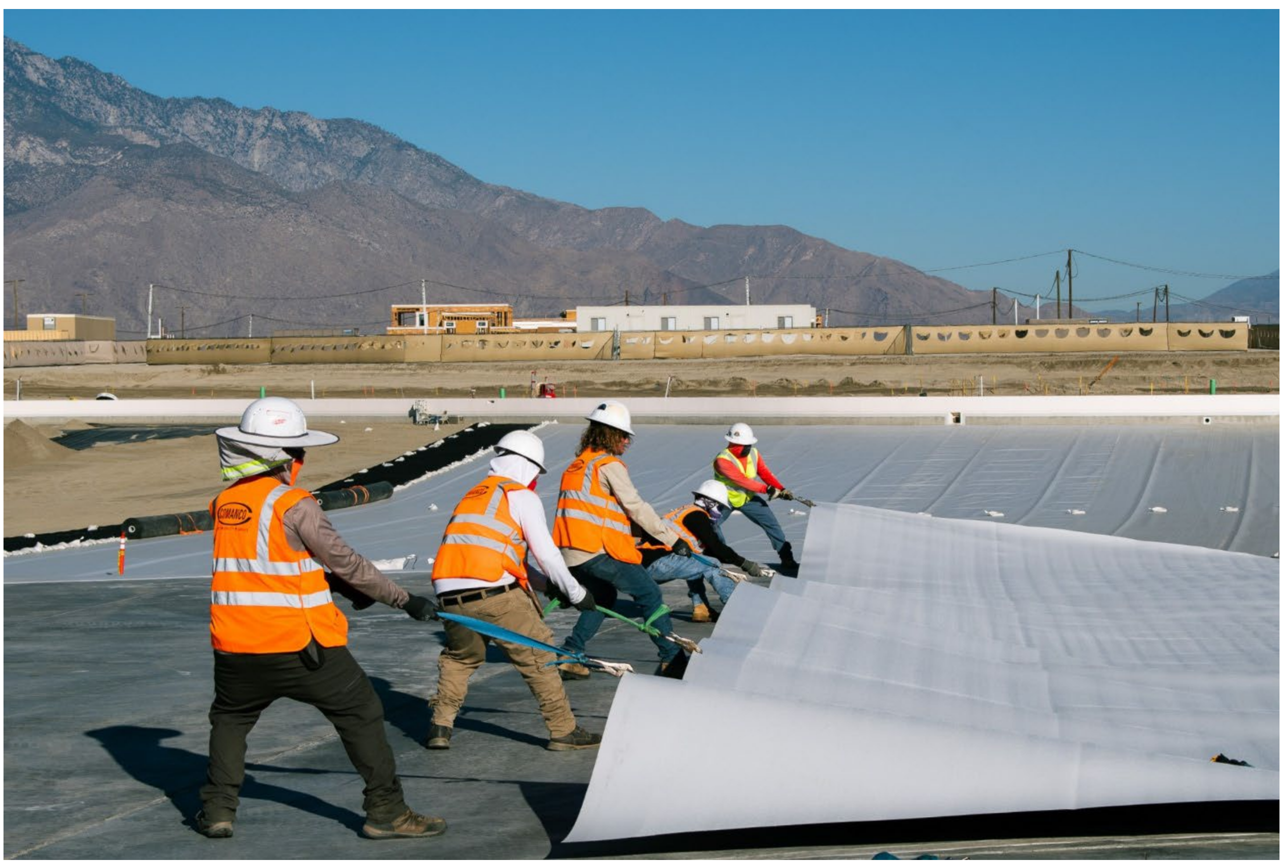
- **Installer Expertise**: Installation errors are a common source of leakage. Ensure technicians are trained and certified—such as through the **IAGI Certified Welding**

Technician (CWT) program. Verify credentials and resumes of all installation technicians to ensure proper experience and certification.

- **Service Life Management**: Recognize that leakage potential increases over time due to various environmental and operational factors. For exposed liners, implement regular inspection and maintenance protocols. A good source of information is the **Flexible Geomembrane Institute (FGI) - Operation and Maintenance Guideline for Geosynthetic Lined Water Reservoirs**.

Conclusion

Zero leakage is an ideal goal, but containment systems must be designed for **minimal, acceptable leakage**. Achieving this requires multi-layered geomembranes, skilled installation, and robust quality assurance, including leak detection and monitoring. The International Association of Geosynthetic Installers **(IAGI)** recommends a comprehensive approach to minimizing geomembrane leakage involving an integrated strategy addressing the **design, construction, and post-installation phases**.



Comanco crew deploying geomembrane sheet for a mining project in USA