The Importance of Quality Assurance in Geosynthetic Containment Applications

Sam R. Allen

Vice President

Outline

- Definitions
- Quality Control / Quality Assurance discussion
- Consideration of some persistent questions
- Case histories
- Conclusions

Tenants of Quality

Accountability: Take ownership of our work and help others take ownership of theirs.

We all do better when we are watched.

Definitions

MQC - Manufacturer testing to monitor and control factory-made product and to ensure compliance with specified values

MQA – Inspections, verifications, audits, and evaluations of raw and final materials

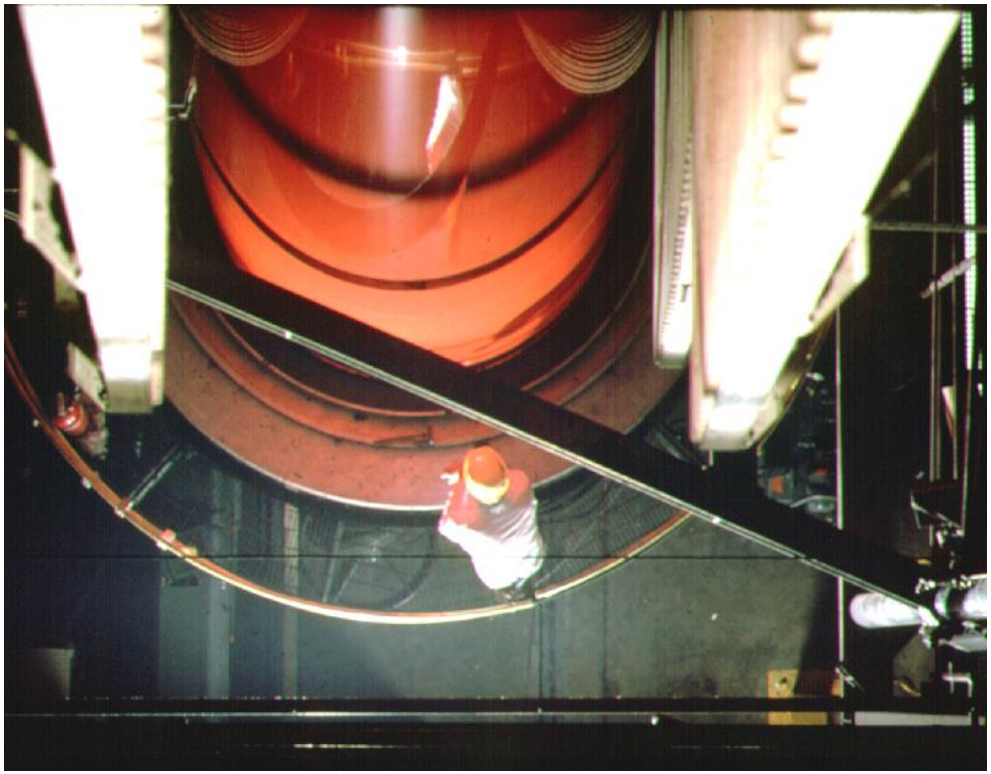
CQC – Installer or contractor activities to control the construction process and to comply with specified requirements for materials and workmanship

CQA – Activities that provide the owner and permitting agency assurance that the facility was constructed as specified.

MQC

Important for Manufacturer to control production and assure requirements

Facilitates documentation that material meets or exceeds specification



MQA

Independent

Encourages honest manufacturer's production measurements and reporting

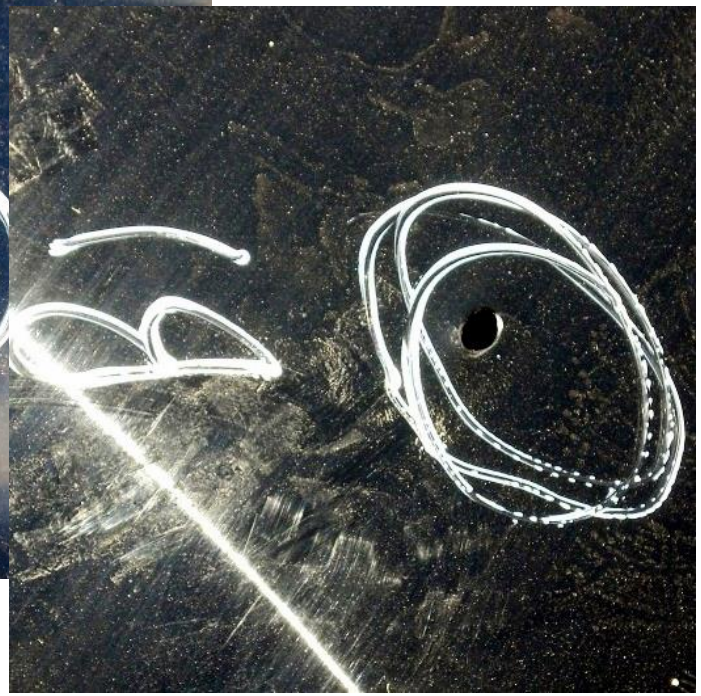
Robust MQA especially important for emerging manufacturers

MQA – do we have to?

Even in fully implemented MQA programs – we still have some failures – but not YOUR failures.

** YES **

Lately …..



CQC

Important for Contractor to document procedures and assure consistency in work

Provides documentation that installation meets or exceeds specifications

CQA

Independent

Importance of CQA demonstrated by numerous regulations requiring CQA as part of geomembrane installation

Track record of projects with and without presence of CQA continues to spur regulation

Even if not required by regulation, value-added CQA helps with long-term performance of systems and avoiding problems


Spreading procedure as specified?
Geomembrane protected?
Drainage aggregate within spec?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Geomembrane protected?
Drainage aggregate within spec?
CQA Tech

Role of CQA

Good CQA Firms-Assist in Project Success

- Act as eyes and ears for the owner
- Owner's or Regulator's Representative
- "Assistant Construction Manager"
- Integrated CQA

Economics create urgent need for "CQA"

Integrated CQA

Anticipate Problems

Offer suggestions for resolution

- *The CQA firm knows more about the total project than any contractor involved*

For example:

- *Assist in coordinating earthwork contractor activities in conjunction with geosynthetic contractor*

Educating Owners

Owners need to recognize…

You will not get the lowest cost project if you hire the

- low bid manufacturer, and the
- Low bid general contractor, and the
- low bid geosynthetic installer, and the
- low bid CQA firm.

The CQA firm best represents the owner's / regulator's interest and is the usually the lowest cost of the three choices

Good CQA makes a difference!

With no CQA? …..

I’ve heard of Leak Location. Can I Replace CQA with leak location?

Electrical liner integrity surveys (ELIS) only finds holes in place directly after time of construction

CQA provides holistic quality control

- Subgrade quality
- Soil density requirements
- Seam strengths
- Installation practices

Provides assurance for ***long-term*** performance of facility

So…….** NO **

Geomembrane Leak Statistics With and Without CQA

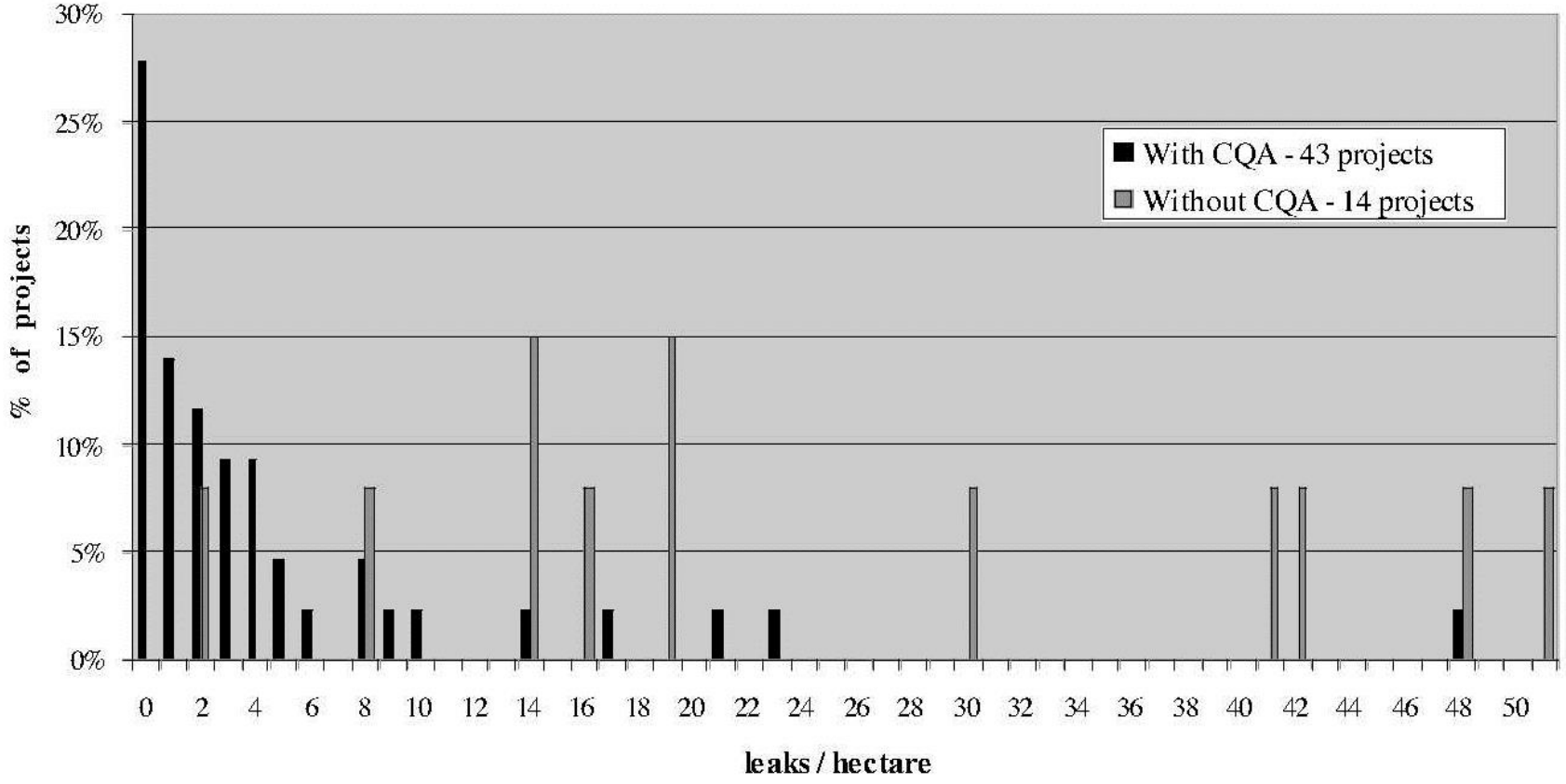


Figure 3. Leak Densities – With and Without a Rigorous CQA Program (Exposed Geomembranes).
Forget et. al., 2005

Geomembrane Leak Statistics With and Without CQA

Statistics of modern installations with extensive CQA:

- 20-25% holes due to geomembrane installation (1-5 holes/ha)
- 75-80% holes due to placement of cover material (few – 20 holes/ha)

Statistics of low quality geomembrane installation:

- 70% holes due to geomembrane installations (32 holes/ha)
- 30% holes due to placement of cover material (14 holes/ha)

Giroud and Peggs, 2002

CQA Issues

Highest role of CQA:

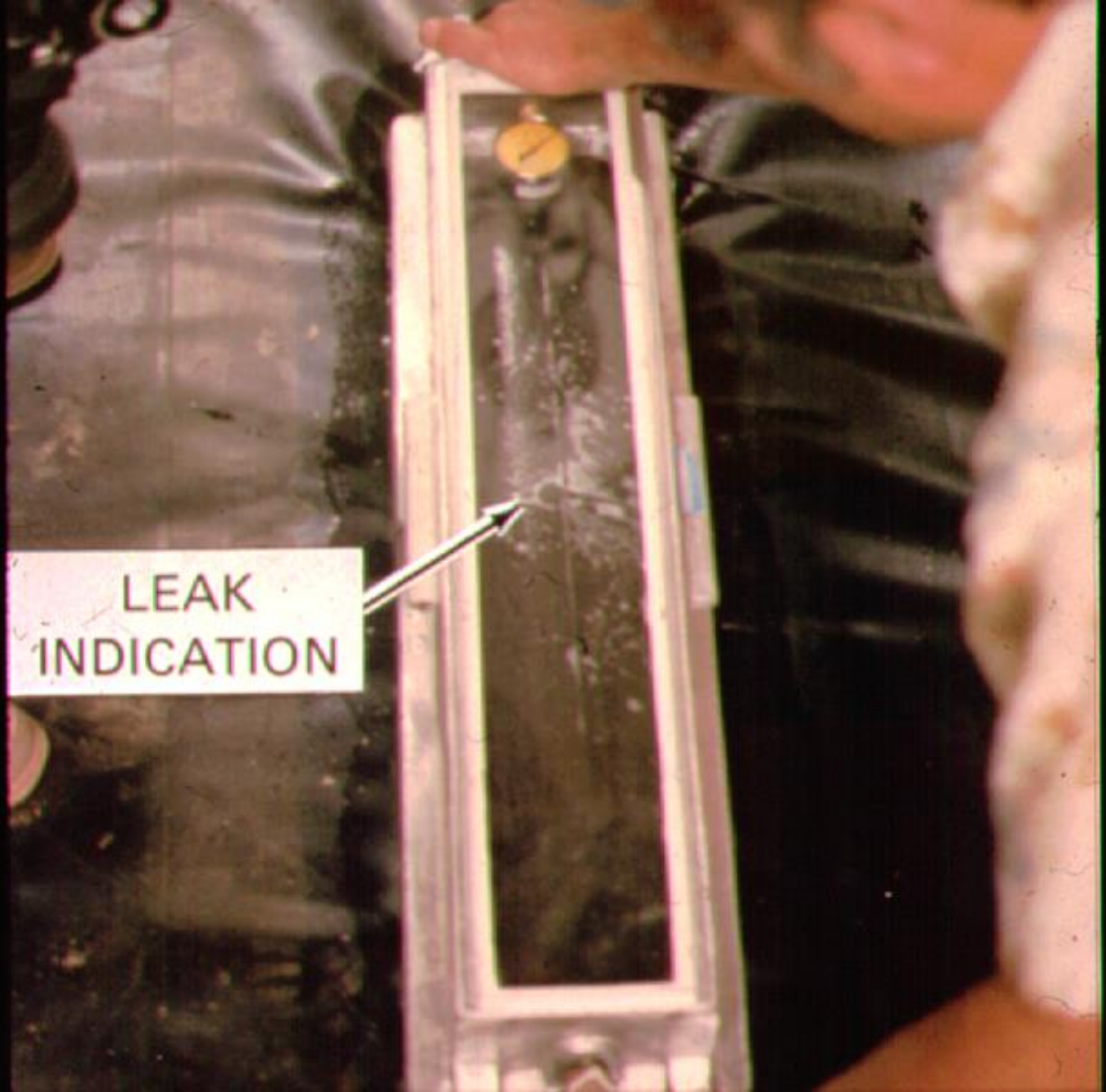
- To maintain feet on the ground
- Be “eyes and ears” of project
- Hold contractors accountable by constant presence on site

Biggest challenges of CQA:

- Keeping head “out of the clipboard”
- Watching what is going on rather than being worried about getting behind in paperwork
- Being spread too thin (can’t be everywhere at once – must choose most crucial aspect of project for oversight sometimes)

Oversight is most important; paperwork is secondary


R18


LEAK
INDICATION

Issues with Vacuum Box Testing

Difficult to perform correctly

- Window gets soap or fogged up
- Large holes can blow out the bubbles too quickly to see

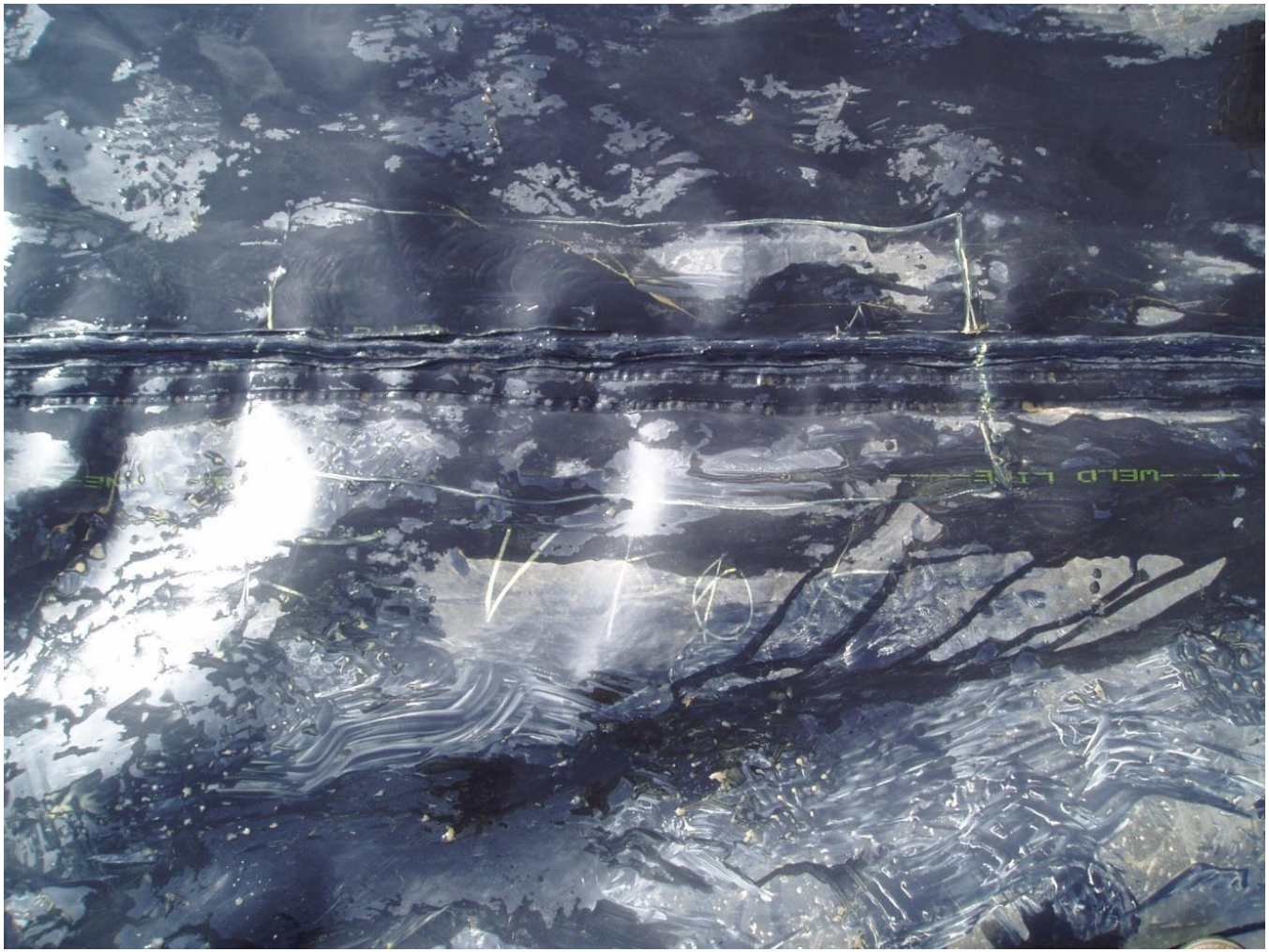
Some geometries can’t be tested or are very difficult to test

- Around wrinkles
- In sump geometry (where leaks are most important)
- Side slopes

Highly operator dependent

- Lowest man on totem pole gets this job
- Needs a lot of physical pressure and visual acumen

Issues with Vacuum Box Testing



Issues with Vacuum Box Testing

Case Studies Of Failures - Kettleman Hills

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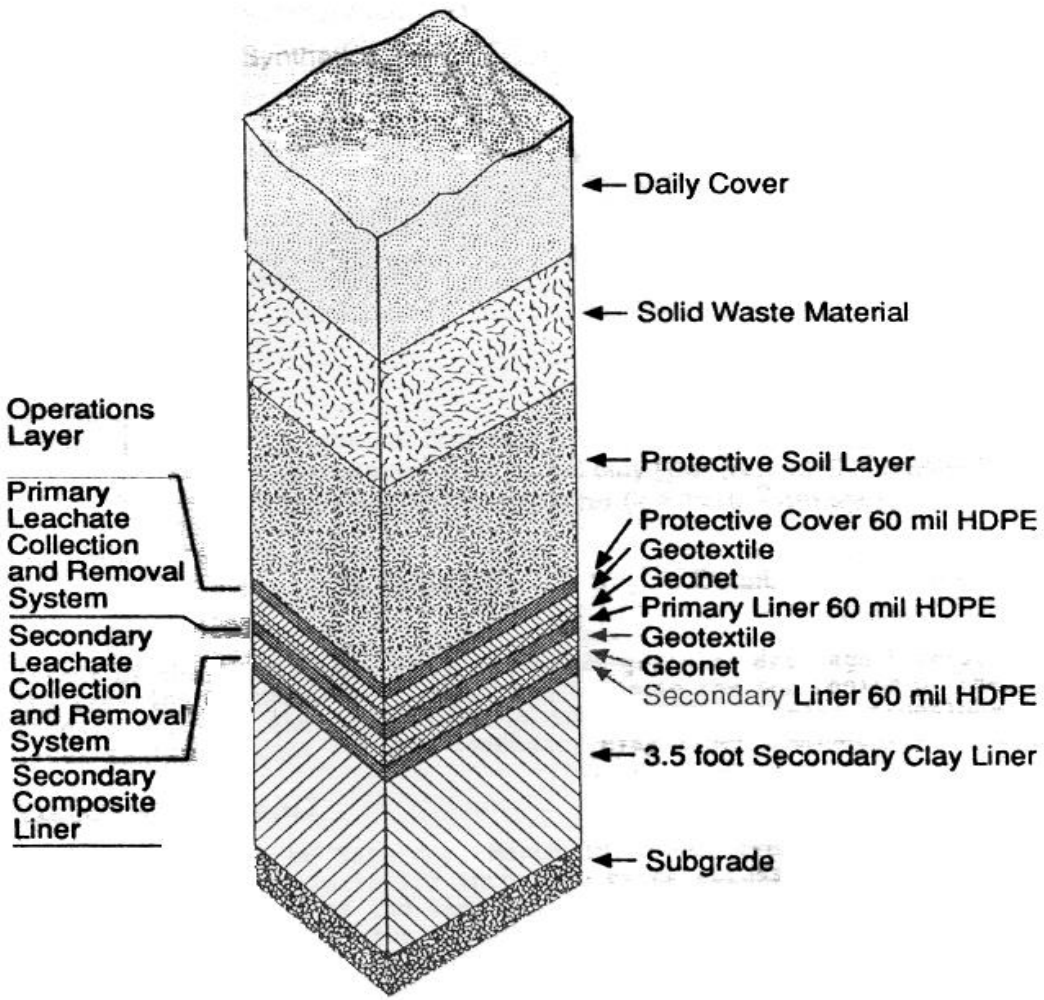
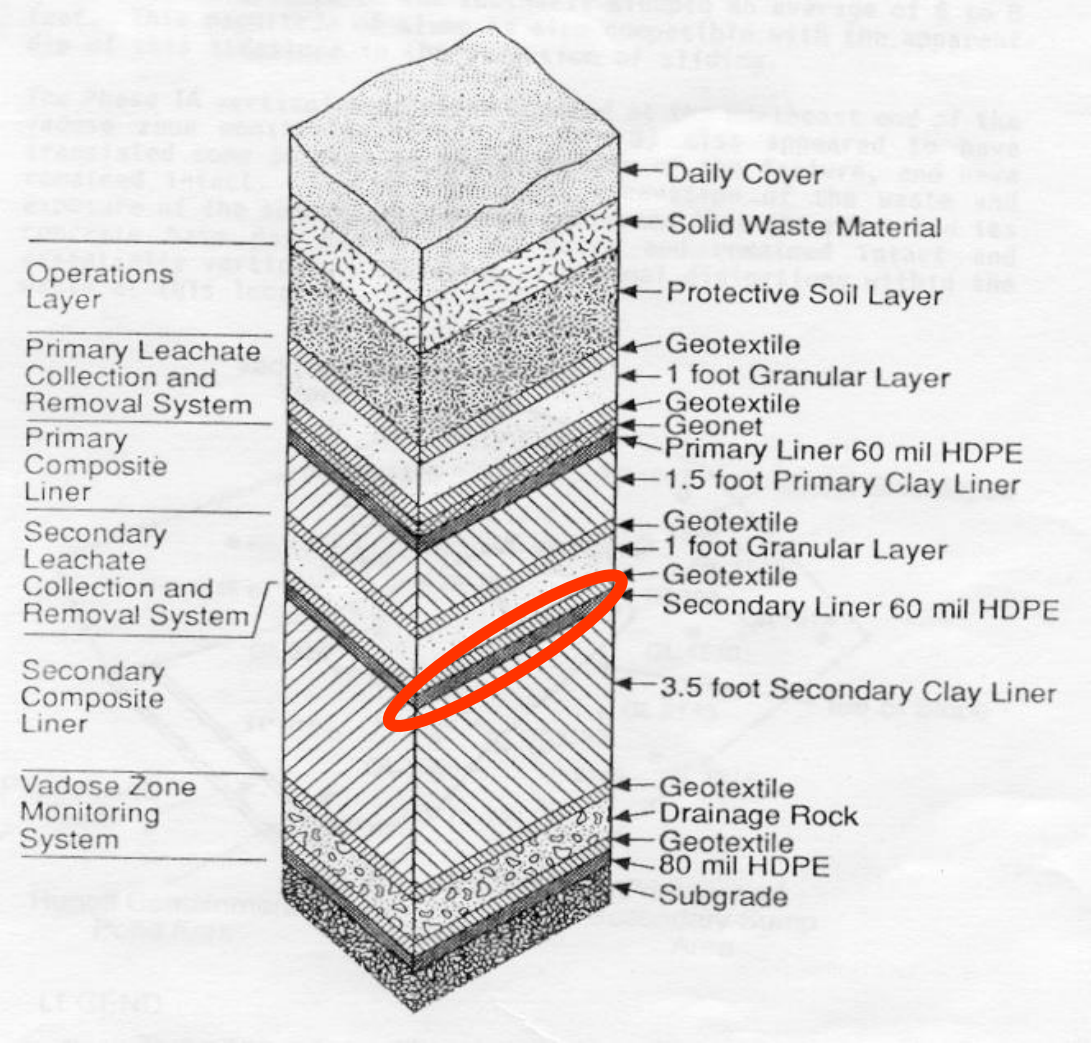
Side Slope Lining System



Geonet
Primary Liner 60 mil HDPE
Geotextile

Base Lining System



Secondary Liner 60 mil HDPE

3 foot Secondary Clay Liner

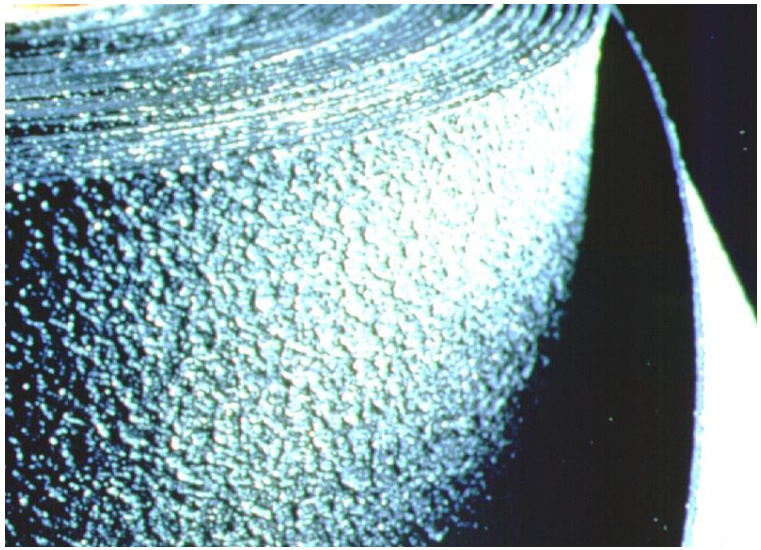
Lessons Learned

Failures are (really) expensive

($40 Million USD)

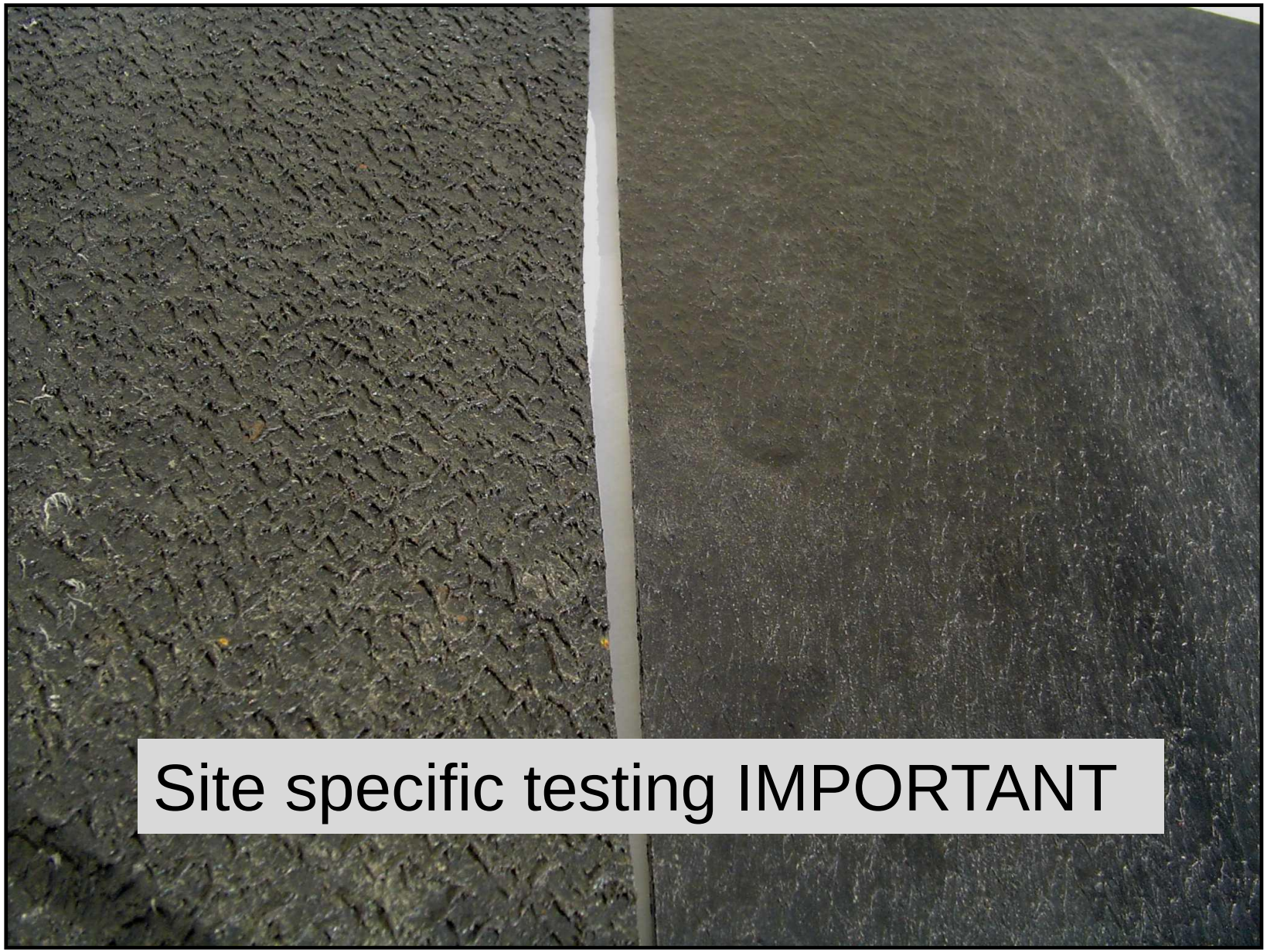
Shear strength testing is NECESSARY

- Interfaces are weak (textured GM development)
- Site-specific soils
- Site specific products
- Site-specific conditions



Stability analyses are NECESSARY

- Static and Seismic
- Interim Grades and Final Grades
- Peak and Residual Strengths


Site specific testing IMPORTANT

Puncture Damage

Puncture damage too common

Rarely get noticed unless ELIS performed

Lack of puncture testing of project-specific materials to blame

Some punctures likely to occur during operating life of facility with full depth of fill

Puncture Case History

- Specifications required “rounded” drainage gravel
- No project-specific puncture testing
- ELIS located 12 leaks in 2.2 hectares (5.5 acres), all due to puncture from drainage gravel, which was more “angular” than “rounded”
- How many punctures were caused after more overburden pressure?

Puncture Case History

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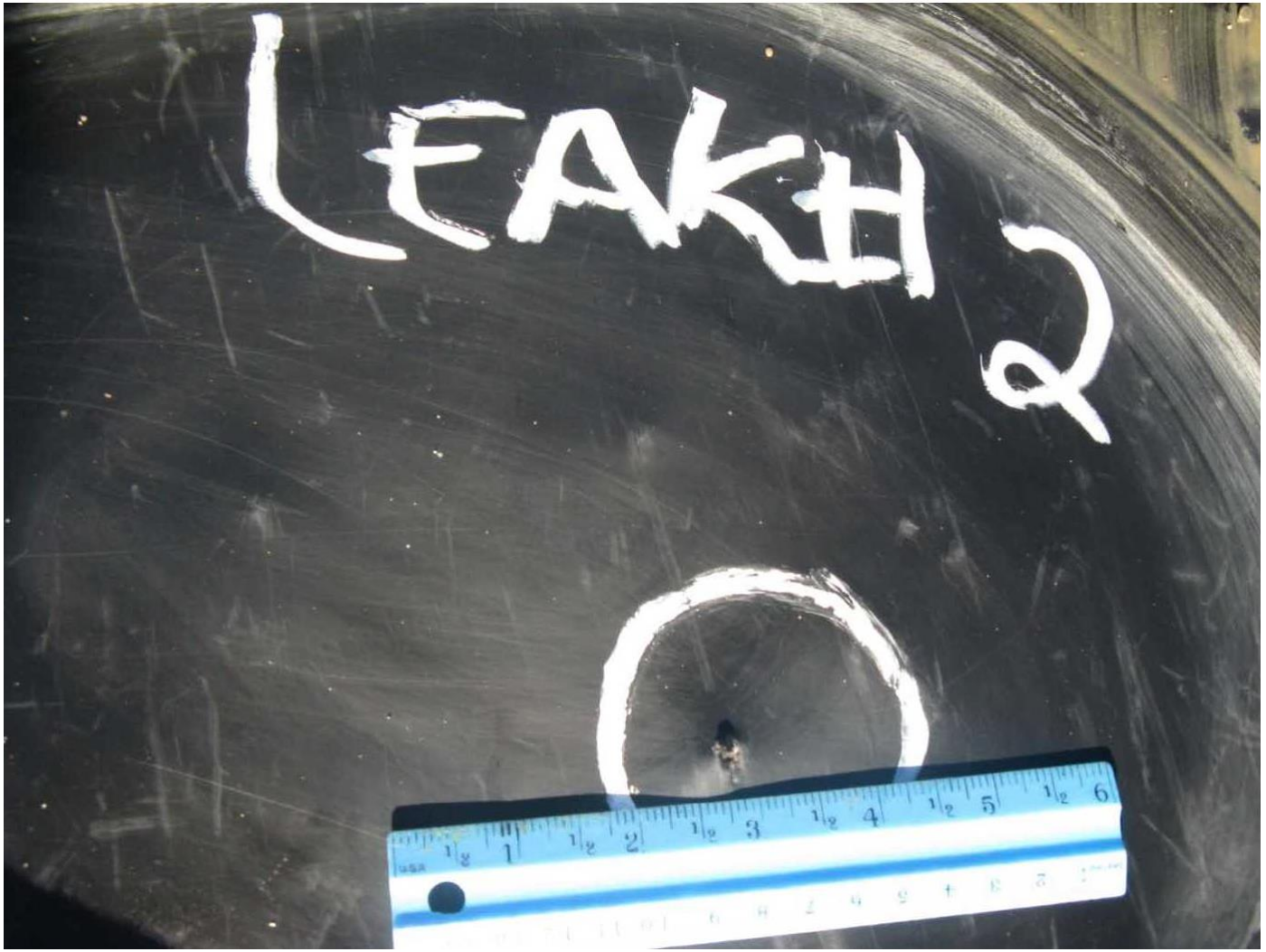

Puncture Case History

SIGNIFICANT DAMAGE FOUND BY LIS

Tear found under waste before major waste movement


OLEUM

WHY CARE ABOUT LEAKAGE?

Environmental Damage

- Relatively cheap to prevent
- Very costly to mitigate
- May never return to original condition

Financial

- Future litigation
- Mine sites; solution loss

Liability

- Public image
- Disrupts operations

Containment system stability

- Leakage can create saturated conditions

LITIGATION - Example

Groundwater Contamination in Hinkley, CA

- **PG&E cooling tower water stored in unlined ponds**
- **Chromium-6 in groundwater causing cancer and autoimmune disease**
- **Leakage occurred between 1952 and 1966**

$333M settlement in 1996

$295M settlement in 2006

$20M settlement in 2008

$700M in cleanup costs

Three years ago, contaminant plume 2 ½ miles long, currently may be 7 miles long, spreading at 2 feet per day

LITIGATION - Example

Ponds built per current regulations at the time they were constructed

That did not release them from future litigation caused by contamination

Performing leak location as part of construction very cheap insurance against future litigation

RESULTS OF BECK STUDY, 2012

Abigail Beck, P.E.
Director of ELIS Services

RESULTS OF BECK STUDY

- **For landfill expansions using modern construction methods and a rigorous CQA program:**
  - **Landfill cells without a liner integrity survey have an average leakage rate of 13.3 gpad and a 22.2% chance of exceeding 20 gpad (~200 lphd; suggested allowable leakage rate for landfills)**
  - **Landfill cells that have performed a dipole method survey have an average leakage rate of 7.6 gpad and have a 7.1% chance of exceeding 20 gpad**
  - **Landfill cells that have performed both bare geomembrane and dipole method surveys have an average leakage rate of 1.2 gpad and have a 0.00001% chance of exceeding 20 gpad**

What does all this mean?

Watch each other, doubt, measure, verify …….

- Manufacturing (Design support testing and MQA)
- Construction, and (CQA)
- Geomembrane and cover soil installation (CQA)

all need oversight in order to achieve optimum project performance.

The quality approach works!

References

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References

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