Using Resistivity Arrays to Monitor Groundwater Impacts near Runoff Holding Ponds

Project Goal: Find a low-cost alternative to sampling wells to detect intrusion of contaminants into ground water.
Project Participants

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Precipitation runoff from feedyard pen surfaces contains mineral and organic salts. Runoff is typically held in lined ponds. If these ponds leak, contaminants can enter groundwater. Sampling wells take an infrequent snapshot. An electronic system has been developed that can perform automated monitoring and rapidly detect changes in sub-surface conductivity.
SAMPLING WELL LIMITATIONS

- Sampling wells are expensive to install.
- Analysis of water samples is expensive.
- Only 1 or 2 two samples each year.
- Snapshot of groundwater conditions.
- Likely to miss a contamination event.
- Can't demonstrate 24/7 compliance.
Two outer probes provide alternating current excitation and the two inner probes reading the resultant signal (Wenner-Alpha configuration).
16 probe array

Spacing combinations for a 16 element array
Features of the SafeSoil® Lagoon Monitor

- Daily measurement of soil resistivity to depths of 50 feet or more.
- Takes daily readings of lagoon water level and weather data (optional).
- Alarms if leak detected
- Collects and logs data, generates reports automatically.
- Reduces labor cost.
Holding pond water is a good source of nutrient laden irrigation water useful for crop production.

Removing water from the pond for irrigation can inadvertently disrupt the organic seal at the bottom.

That can result in a pathway for pond water to be discharged into the surrounding soils.

The next slide shows a dramatic visualization of this dynamic subsurface event from a leak created when water was pumped from the bottom of the pond.

The coarse textured substratum allowed for the seepage to rapidly permeate to the surrounding down-gradient area.

b). August 3, 2011

c.) Difference Map, August 3 minus previous week

Feedyard B Holding Pond
SafeSoil® System Discovers and Logs Leak (Note Orange and Red Areas)
Conclusions

- This work was undertaken to test a method of monitoring cattle feedyard holding ponds.
- The use of resistivity arrays is a sensitive, robust, stable monitoring method when data are taken frequently and continually.
- This technique can be used to establish a benchmark for determining whether any changes detected meet a pre-determined threshold that a leak has occurred.
- The resistivity array system with appropriate computer-based hardware and software has value for un-attended monitoring of agricultural liquid waste management sites.
A series of experiments are underway that include:

- Continued frequent resistivity array data collections
- Periodic water samples from monitoring wells.
- Deep soil cores to validate resistivity profiles.
- Soil temperature profile data.

Future work: Use of inversion methods to convert resistivity array data to evaluate site profile characteristics.

This information will be particularly useful for determining the best location to permanently locate an array for monitoring a holding pond and for predicting the long-term impact of holding ponds on the surrounding soil and groundwater systems.
Other Monitoring Applications

- Dairy Manure Waste Runoff.
- Power Plant Highly Mineralized Waste Water
- Gas Well Production Sites
- Mining
- Hazardous Waste and Landfill Sites
- Petroleum Handling and Spills
Typical Soil Electrical Resistivities

- bitumen spill
- control
- salty wetland formed with mining water
- reclaimed land
- mining water collector

ER, ohm m vs distance, m
Resistivity values between 96-495 Ohm-m from the surface to the depth of about 5m suggestive of clayey sand/sand lithology. There is increase in resistivity 762 to 4742 Ohm-m (red colour) between electrode positions 9 and 14 below 5m depth, suggestive of soil material that is affected by pollution.
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