The Resource Conservation and Recovery Act (RCRA) was enacted 21 October 1976 to govern the disposal of solid and hazardous waste in the US. The law established two programmes that could have been relevant to the disposal of waste produced as byproducts from the combustion of coal. These byproducts, often referred to as coal combustion residuals (CCRs), are produced in large quantities during the generation of electricity in coal-fired power plants.

The first programme was the hazardous waste programme. Authorised under RCRA Subtitle C, the programme established a federally enforceable system for...
controlling hazardous waste from the
time it was generated until its ultimate
disposal.

The second of these programmes
was the solid waste programme.
Authorised under RCRA Subtitle D, it
encouraged individual states to
develop comprehensive plans to
manage non-hazardous industrial solid
waste and municipal solid waste.

The RCRA compelled the
US Environmental Protection Agency
EPA) to establish rules regulating the
disposal of waste under the two
separate, but nonetheless related,
programmes. A key element of the
rules was the identification of certain
waste as hazardous. The EPA’s final
rule identifying hazardous waste
under RCRA Subtitle C was scheduled
to take effect on 19 November 1980.
The rule intended to treat CCRs as
hazardous waste, subject to the full
requirements of RCRA Subtitle C.

Before the rule became effective,
congress passed the Solid Waste
Due to what is generally known as the
Bevill Amendment, coal ash was
temporarily exempted from hazardous
waste regulation until further study
was completed. The EPA codified the

Bevill exemption in 1980 as “fly ash
waste, bottom ash waste, slag waste,
and flue gas emission control waste,
generated primarily from the
combustion of coal or other fossil
fuels”, stipulating that these were “not
hazardous waste.” This regulation was
intended to remain in effect, pending
the EPA’s determination whether
Subtitle C regulation was warranted.

At the same time, section 8002(n) of
the Act required the EPA to study coal
ash and submit a report to Congress,
evaluating the adverse effects on
human health and the environment
from the disposal and use of these
wastes by October 1982. Lastly, section
3001(b)(3)(C) required the EPA to make
a regulatory determination within six
months of completing the report to
Congress, as to whether coal ash
warranted regulation under RCRA
subtitle C or some other set of
regulations.

To date, the EPA has maintained
CCR is exempt from treatment as a
hazardous waste. The exemption was
re-affirmed in August 1993 and again
in May 2000 in reports to Congress.
While the EPA did not find a need for
Subtitle C regulation in its 2000 report,
it did declare that the Subtitle D
regulations that are currently
applicable to coal ash disposal were in
need of revision. The EPA’s final
determination in 2000 made the
following conclusions:

- Firstly that Subtitle C (hazardous
waste) regulation of coal ash was
not warranted in 2000, but under
certain conditions specified in the
determination, it could become
necessary.

- Secondly that revision of Subtitle D
regulations was immediately
required for the disposal of
coal ash in landfills and surface
impoundments.

Using geosynthetics for
coal ash storage

In the absence of regulations, some
coal-fired power plants and companies
have voluntarily chosen, over the
years, to apply the use of geosynthetic
materials to the issues of coal ash
storage. One such facility was

Figure 1. Slide slope of an empty (used) coal ash facility in Florida.

Figure 2. Floor and overview of the (empty) storage facility in Florida.
constructed in Hillsborough County near Tampa, Florida. The facility was constructed in 1981/1982 and the barrier system consisted of a 2 mm high-density polyethylene liner (HDPE), which was manufactured by Schlegel Lining Technology (SLT). This 5.25 ha. facility has operated successfully since the installation of the containment system and has a storage capacity of approximately $5.7 \times 10^8$ kg (650,000 t) of coal combustion residuals.

In 2012, the decision was made – based on the age of the lining system, the appearance of a few cracks at the tops of the slopes, the current legal and economic environment and the significant costs that would be associated with a leak or other containment failure – to replace the geomembrane with the latest materials. This upgrade offered a rare opportunity to obtain forensic samples for testing and evaluation, as well as the chance to document the performance of these materials subjected to real world aging and exposure conditions.

Samples were obtained from multiple locations within the containment structure:

- At the bottom of the structure.
- Along the side walls/slopes and at the freeboard level(s).
- From the upper sections of the side slopes, which have seen a near continuous exposure.
- From the upper anchor trenches, where the materials have only been exposed to soil and have neither had UV exposure nor exposure to the stored ash materials.

Analysis demonstrated that the materials had performed well, but failed to meet the present day materials requirements for geosynthetic barrier products. This was perhaps not surprising, as significant improvements have been made to both geosynthetic raw materials and finished products over the past 30 years.

Since CCR materials were exempted from treatment as hazardous wastes under RCRA, CCR materials have been regulated as solid wastes subject to regulation by individual states in the US. Despite the declaration by the EPA of an immediate need for revision of subtitle D regulations pertaining to CCR in 2000, no such revisions exist today. There is as yet no federal mandate in the US to regulate the disposal of CCR.

Each of the 50 states have put regulatory programmes in place as they have seen necessary. As a result, there exists substantial differences in regulation of the disposal of CCR between states. After a time, many states required that CCR disposal be done in facilities with reasonable controls, often using Subtitle D-like configurations.

The Florida site did not use a Subtitle D compliant design for the original construction, instead focusing on the geomembrane as the primary containment component. This differs from the Subtitle D design in that the current technology uses a composite liner system as the primary barrier. The composite system includes both a geomembrane as the primary contact and containment layer, but adds a geosynthetic clay liner or clay layer to provide additional barrier properties. Over decades and literally thousands of sites and installations, it has been determined that a composite liner performs as a better barrier than either a clay or geomembrane component alone.

A later EPA study spanning between January 1994 – December 2004 concluded the following:

- Wet surface impoundments were being replaced by dry landfills.
- New facilities had undergone a permit process.
- The percentage of composite liners in ash landfills increased from 10% to 50%.
- The percentage of composite liners in surface impoundments increased from 2% to 50%.
- 91% of new facilities were installed with groundwater monitoring.

Thus, over the ten-year period ending in 2004, new CCR disposal facilities were constructed with composite liners about half of the time.

**Cause to reconsider regulations**

In December 2008, the retaining wall of a surface impoundment failed in Tennessee, thereby precipitating a major environmental disaster and triggering a large-scale, expensive clean-up. By June of 2010, the EPA
proposed the regulation of CCRs under the RCRA. Two alternative proposals were put forward. Under both alternatives, the EPA proposed to establish dam safety requirements to address the structural integrity of surface impoundments to prevent catastrophic releases, such as that seen in Tennessee.

Under the first proposal, the EPA would reverse its August 1993 and May 2000 exemptions regarding CCRs and list these residuals as special wastes subject to regulation under Subtitle C of the RCRA, when they are destined for disposal in landfills or surface impoundments.

Under the second proposal, the EPA would leave the exemption for CCR in place and regulate disposal of such materials under Subtitle D of the RCRA by issuing national minimum criteria.

Since the issuance of the proposed rules, the EPA has been in assessment mode. In an effort to provide some direction, Congress has proposed and debated new laws for the disposition of CCR. The House of Representatives has passed several versions of a new law, but none of these versions has ultimately been enacted. Frustration in the environmental community grew steadily with the passage of considerable time since the 2000 report to Congress and the subsequent proposal of new rules in 2009.

In April 2012, The US District Court for the District of Columbia agreed to hear a legal complaint against the EPA brought by a host of environmental groups (Appalachian Voices, et al) alleging that the EPA failed to perform certain non-discretionary duties with respect to the disposal of CCR. The action made three specific complaints:

- Failure to review and revise as needed the Bevill Amendment to the RCRA excluding CCR from treatment as a hazardous waste.
- Failure to review and revise as needed portions of the Federal Code of Regulations dealing with protection of groundwaters, protection of surface waters and protection of air related to the disposal of CCR.

The court made its decision in the case in late October 2013. The court found in favour of the EPA in claims 1 and 3, and found in favour of Appalachian Voices in claim 2. In its ruling, the court determined that, although coal ash is exempt from regulation under Subtitle C, coal ash remains a solid waste subject to regulation under Subtitle D. The court found that the administrator of the EPA does have a non-discretionary duty that may be enforced pursuant to the RCRA’s citizen suit provision to review and, if necessary, revise regulations every three years.

With the ruling, the court ordered the EPA to “advise the court within sixty days of this court’s decision (29 October 2013) of when it proposes to complete its review and revision of its Subtitle D regulations concerning coal ash. The plaintiffs may then file a response to EPA’s proposal.” The due date for the EPA’s plan was recently extended to 29 January 2014.

Implications for the future

Nearly all parties engaged in the CCR disposal debate agree regulation is required. The debate centres on the type, the extent of regulation – Subtitle D or Subtitle C under RCRA – and additional implementation details. Much like the original implementation of RCRA, there is considerable discussion and importance as to how these new regulations are applied to existing and even closed facilities. Closure requirements, techniques and scope are a critical part of the engineering and economic calculations and are very likely to vary on a state-by-state basis.

The recent court ruling acknowledges the Bevill Amendment as part of the current law – a law specifying the process by which the EPA may determine that coal ash is a hazardous waste. The court also found that the EPA need not review and revise the Bevill Amendment on a specified time period: “It is clear that the Bevill Amendment removes the regulation of coal ash as a hazardous waste from the RCRA’s general regulatory scheme by creating a different process for regulating coal ash as hazardous waste. Assuming that the Bevill Amendment does not create a one-time process, the statute unequivocally provides that the EPA cannot regulate coal ash under Subtitle C until after it determines that regulation is warranted and promulgates regulations accordingly.”

The new rules would establish a national standard for the disposal of CCR for the first time. A federal standard for the regulation of CCR would compel states to establish consistent disposal practices. The federal standard would likely mandate the transition from wet CCR handling to dry CCR handling.

Surface impoundments would likely be closed and capped over an implementation period. Caps for legacy surface impoundments can be expected to use geosynthetics in large quantities.

New landfill cells for the disposal of CCR would be consistently constructed to Subtitle D practices. Almost all landfills would be constructed with composite liners over the implementation period. Strict construction practices for Subtitle D CCR landfills would drive the replacement of old-practice earthen materials with new-practice geosynthetic clays and geocomposite drainage materials. In the less-likely event that the EPA rules require Subtitle C practices for new landfills, two additional complete layers of geosynthetic materials will be necessary. Each new landfill cell would require an additional geomembrane over the entire area. In addition, each new landfill would require a further geocomposite over the entire area to perform a leak detection function for the landfill.

Geosynthetic systems exist to address both the applications of coal ash storage and the capping and closure of existing coal ash storage sites. Several suppliers have developed materials specific to this application.