## Coal Combustion By-Products

<table>
<thead>
<tr>
<th>CCB Type</th>
<th>Recent Uses in Maryland</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Class F Fly Ash</strong> – Particles of unburned mineral component of coal small enough to be emitted through stack and contains &lt; 20% calcium oxide.</td>
<td>Cement Manufacture Ready-Mix Concrete Grout</td>
</tr>
<tr>
<td><strong>Class C Fly Ash</strong> – Similar to Class F fly ash, but containing &gt;20% calcium oxide.</td>
<td>None</td>
</tr>
<tr>
<td><strong>Class F Bottom Ash</strong> - Unburned mineral component of coal. Particles are larger and heavier than fly ash and fall to the bottom of the boiler. Contains &lt; 20% calcium.</td>
<td>Cement Manufacture Traction Control</td>
</tr>
<tr>
<td><strong>Boiler Slag</strong> – Particle size and composition are similar to bottom ash, but is glassy in nature because it falls to the bottom of the boiler in a molten state.</td>
<td>Shingles Abrasives</td>
</tr>
<tr>
<td><strong>Flue Gas Desulfurization Material</strong> – Product of scrubbers that remove sulfur compounds from flue gas. Also known as synthetic gypsum.</td>
<td>Wallboard Cement Manufacture Agriculture Research and Development</td>
</tr>
<tr>
<td><strong>Fluidized Bed Combustion Material</strong> – fly ash and bottom ash that result when coal is burned with limestone to absorb sulfur. Composition is similar to Class C fly ash.</td>
<td>Coal Mine Reclamation Research and Development</td>
</tr>
</tbody>
</table>

### CCBs Produced in Maryland 2015

- **FGD** 42%
- **Class F Fly Ash** 29%
- **Class C Fly Ash** 0.9%
- **Boiler Slag** 0.1%
- **FBC Material** 24%
- **Class F Bottom Ash** 4%

In 2015 a total of 1.4 million tons of CCBs were produced in Maryland.
CCB Sites in the Chesapeake Bay Watershed
Other Environmental Challenges

- **Acid Mine Drainage**
- **Abandoned Mine Tunnels**
- **Karst Geology**
Winding Ridge

Mine Opening
Winding Ridge Grout Injection and Coring

Mixing and Injection of Grout

Core samples of grout that cured inside the mine.
Kempton Man Shaft Ground Water Flow

Ground water flow prior to injection

Ground water flow after injection (little change – intensely fractured bedrock prevented sealing.)
Hoyes Run
Hoyes Run

The Hoyes Run Project was a joint project with the U.S. Department of Energy and DNR Bureau of Fisheries.
3 Success Stories
In 2015 a total of 1.4 million tons of CCBs were produced in Maryland.
Encapsulated Use, Unencapsulated Use, and Disposal in Maryland

Note:
Chart does not include recovery and use of previously landfilled CCBs.
Morgantown STAR

Star

<table>
<thead>
<tr>
<th>Constructed</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owner</td>
<td>SEFA Group</td>
</tr>
<tr>
<td>Beneficiation Method</td>
<td>Thermal</td>
</tr>
<tr>
<td>Fly Ash Source</td>
<td>Morgantown</td>
</tr>
<tr>
<td>Max LOI of Input CCR</td>
<td>6-10%</td>
</tr>
<tr>
<td>Min LOI of Output CCR</td>
<td>0.5%</td>
</tr>
<tr>
<td>Fly Ash Processed in 2016 (tons)</td>
<td>126,244</td>
</tr>
</tbody>
</table>

CCB Use versus Disposal

![Graph showing CCB use versus disposal over years](image)
Recovery of Landfilled CCBs at R. Paul Smith Plant

CCB Production vs Recovery from Former R. Paul Smith Landfill

Legend
- Coal Burning Power Plants
- Chesapeake Bay Watershed
- CCR Disposal Sites
- Potentially Recoverable
- Low Recovery Potential
- Not Recoverable
- Outside Chesapeake Bay Watershed
- Potential CCR Users
- Cement Plant

Plant shut down

CCRs Used
CCRs Produced

Quantity (Metric Tons)
0 50,000 100,000 150,000 200,000 250,000 300,000 350,000 400,000 450,000

Year