6.0 CONCLUSIONS

This study provides information in response to specific provisions in the SAFETEA- LU. Consistent with the statutory direction, this report addresses the following issues:

(A) Quantify (i) the extent to which recovered mineral components are being substituted for portland cement, particularly as a result of current procurement requirements, and (ii) the energy savings and environmental benefits associated with that substitution;

(B) Identify all barriers in procurement requirements to greater realization of energy savings and environmental benefits, including barriers resulting from exceptions from current law; and

(C) (i) Identify potential mechanisms to achieve greater substitution of recovered mineral component in types of cement or concrete projects for which recovered mineral components historically have not been used or have been used only minimally; (ii) evaluate the feasibility of establishing guidelines or standards for optimized substitution rates of recovered mineral component in those cement or concrete projects; and (iii) identify any potential environmental or economic effects that may result from greater substitution of recovered mineral component in those cement or concrete projects.

With respect to the first question – the degree of beneficial use and its impact – we identify several conclusions:

- **Volumes of RMCs being substituted for portland cement.** For the four congressionally-identified RMCs, along with the additional eight RMCs identified by EPA for further evaluation, we document current production or sales, and generally capture or estimate usage rates, which are generally indicative of the extent of substitution. While data quality varies across RMCs, several materials show relatively high rates of substitution; these include RMCs, such as blast furnace slag and silica fume. Substitution rates for other high-quantity RMCs, such as coal fly ash, are lower.

- **Substitution resulting from current procurement requirements.** For all of the RMCs, complete procurement data are unavailable to estimate the total volume of RMCs used in Federal concrete projects. It follows that these information gaps preclude the Agency from establishing a causal relationship between the CPG and levels of RMC substitution in Federal concrete projects. Despite these data limitations, we have identified a number of successful efforts on the part of procuring agencies to purchase products with RMCs. The lack of a comprehensive information resource related to RMC procurement primarily results from disparate and incomplete procurement data systems, reporting burdens, and lack of reporting compliance. Improvements in procurement data

systems and reporting would allow a better understanding of the incremental effects of procurement requirements for cement and concrete projects.

- **Energy savings and environmental benefits associated with substitution.** RMC use yields positive environmental benefits through lower resource consumption. To overcome the procurement data limitations noted above, for GGBFS, coal fly ash, and silica fume, we derive estimates of their use in Federal projects by roughly apportioning total volumes to Federal and non-Federal projects (based upon the estimated proportion of total cement demand related to federally-funded projects). For the years 2004 and 2005, our life cycle analysis indicates that the use of GGBFS and coal fly ash in Federal concrete projects alone resulted in significant reductions of GHG emissions, criteria air pollutants, and energy and water use. For these two years combined, the analysis suggests reduced energy use of 31.5 billion megajoules, avoided CO2 equivalent air emissions of 3.8 million metric tons, and water savings of 2.1 billion liters. We further illustrate how these benefits may accrue over a longer time period (through 2015) given alternative use scenarios. This aspect of the analysis also links to issue C (iii) noted above.

With respect to the issues identified under parts (B) and (C), the report identified a number of barriers which impede the beneficial use of RMCs through procurement requirements. A variety of potential mechanisms exist for addressing these barriers. Specifically:

- **Procurement policies and material standards** initiatives, including an ongoing assessment and refinement of EPA's CPGs, refinement of engineering standards governing the substitution of RMCs, and development and application of green building standards.

- **Education, technical assistance, and recognition programs,** such as the Green Highways Partnership, EPA's foundry sand outreach efforts, and public/private partnerships, such as C^2P^2 encourage the beneficial use of CCPs; in addition, ongoing research and pilot projects are critical to advancing the use of RMCs.

- **Economic influences,** such as using transportation funding mechanisms to increase RMC use and providing tax credits, accelerated depreciation, tax-exempt bonds and other influences related to various components of the RMC generation and use chain.

Table 6-1 summarizes the barriers itemized in Chapter 4 and characterizes the linkages with the possible mechanisms for increasing the use of RMCs and these barriers. These linkages are complex, covering a spectrum of stronger and weaker barriers coupled with a suite of potential mechanisms of varying effectiveness given a particular context. For example, in instances where the use of an RMC is cost prohibitive (for example, where it is in short supply or requires extensive transport), it is unlikely that adjustments to the procurement guidelines or technical assistance programs would substantially affect the RMC's utilization. In contrast, these mechanisms may be more effective in instances where barriers related to perceptions of material

performance or standard operating procedures are present. As another example, EPA's efforts in C^2P^2 are primarily focused on outreach and technical assistance. However, C^2P^2 also includes research to advance coal fly ash uses; therefore, technical or economic barriers could be partly addressed by a program that is largely an education initiative. Similarly, EPA's foundry sand program includes guidance for states on creating foundry sand beneficial use programs, directly influencing procurement/contractual barriers.

With respect to barriers in procurement requirements, we have noted several concerning data reporting, material specifications and standards, contract and bidding procedures, and general program awareness. Anecdotal information indicates that these barriers may contribute, in some instances, in not using RMCs in making procurement decisions. As noted in Chapter 5, a wide range of mechanisms are applicable to these issues. Furthermore, to implement these mechanisms fully will require broad participation and effort on the part of federal, state, and private entities.

Table 6-1: Summary of Barriers and Mechanisms for Increasing Beneficial Use of RMCs

Barrier Category	Barrier	Applicable Types of Mechanisms	Example Applications of Specific Mechanisms
Economic Barriers	Transportation costs and geographic distribution RMC as minor component of producers overall revenue Poor cost-effectiveness of RMC utilization Low cost of RMC disposal	▪ Economic incentives ▪ Procurement policies and building standards ▪ Education, technical assistance, and recognition	**Economic**: Fees to increase cost of RMC disposal could increase beneficial use incentives. **Procurement**: In general, CPGs help promote demand for RMCs and increase beneficial use. However, improved data collection would allow assessment of CPG impacts and refinement of CPG. **Education**: C^2P^2 research helps identify areas with coal fly ash shortages, helping address geographic distribution barriers.
Legal, Regulatory, and Contractual Barriers	Federal air pollution regulations State and Federal solid waste regulations Bidding procedures and contractual constraints	▪ Procurement policies and building standards ▪ Education, technical assistance, and recognition	**Procurement**: Integrate green building standards into Federal, state, and local procurement policies to better focus attention on RMC-based products. **Education**: EPA's foundry sand program includes guidance on development of beneficial use programs.
Technical Barriers	Performance of products containing RMCs Acceptance of materials specifications Variation in the quality of RMC supplies	▪ Education, technical assistance, and recognition ▪ Economic incentives	**Education**: Establish baseline data and goals for RMC beneficial use rates (e.g., coal ash under EPA's C^2P^2). **Economic**: Sponsor and/or conduct research and development to minimize variation in RMC quality. **Research:** Ongoing
Safety and Health Risk Perception Barriers	Perceived risk associated with products containing RMCs	▪ Education, technical assistance, and recognition	**Education**: As a means of increasing acceptance, educate end users regarding risks associated with RMC-based products.