

Evaluating the Engineering and Environmental Suitability of Recycled Materials

AASHTO Designation: PP 56-06 (2008)¹



1. SCOPE

- 1.1. This practice is to provide a general evaluation framework for assessing the feasibility to use recycled materials in the highway environment.
- 1.2. This document was developed using the *Framework for Evaluating Use of Recycled Materials in the Highway Environment*.

2. GENERAL PROVISIONS

- 2.1. It is recommended that the *User Guidelines for Waste and Byproduct Materials in Pavement Construction* be referred to before using this practice, as many common recycled materials for highway uses have already been evaluated with this method and are documented in the User Guidelines.
- 2.2. AASHTO resolution PR-14-01, Use of Recycled Materials, encourages the use of recycled materials in transportation applications where engineering, economic, and environmental conditions warrant their use.

3. SUMMARY OF THE PRACTICE

- 3.1. The evaluation framework is illustrated in a flowchart format as shown in Figure 1. There are five steps in the framework and three screening stages. The framework provides for combining or skipping steps if it is clear that such action is appropriate. The framework also provides, as part of the stepwise evaluation process, the means to modify or beneficiate materials that do not meet criteria so that there is an opportunity to revise the application based on new data obtained during the evaluation process.
- 3.2. *Framework Limitations*—This document is an attempt to provide an overall comprehensive evaluation framework that decision makers can use in evaluating recycled material use in highway applications. Although much progress has been made in the development of these procedures, the complexity associated with defining evaluation procedures and criteria demands that the evaluator select the best test methods and criteria subject to local conditions and that the criteria and test methods presented be continually updated as new information is made available. The multidisciplinary engineering and environmental efforts involved in implementing the steps outlined in the framework will require that state engineering and environmental agencies forge cooperative efforts, pooling the necessary resources to undertake the evaluation effort. Only through such cooperative efforts can the complex issues that need to be addressed receive proper attention and ensure the appropriate use of recycled materials in the highway environment.

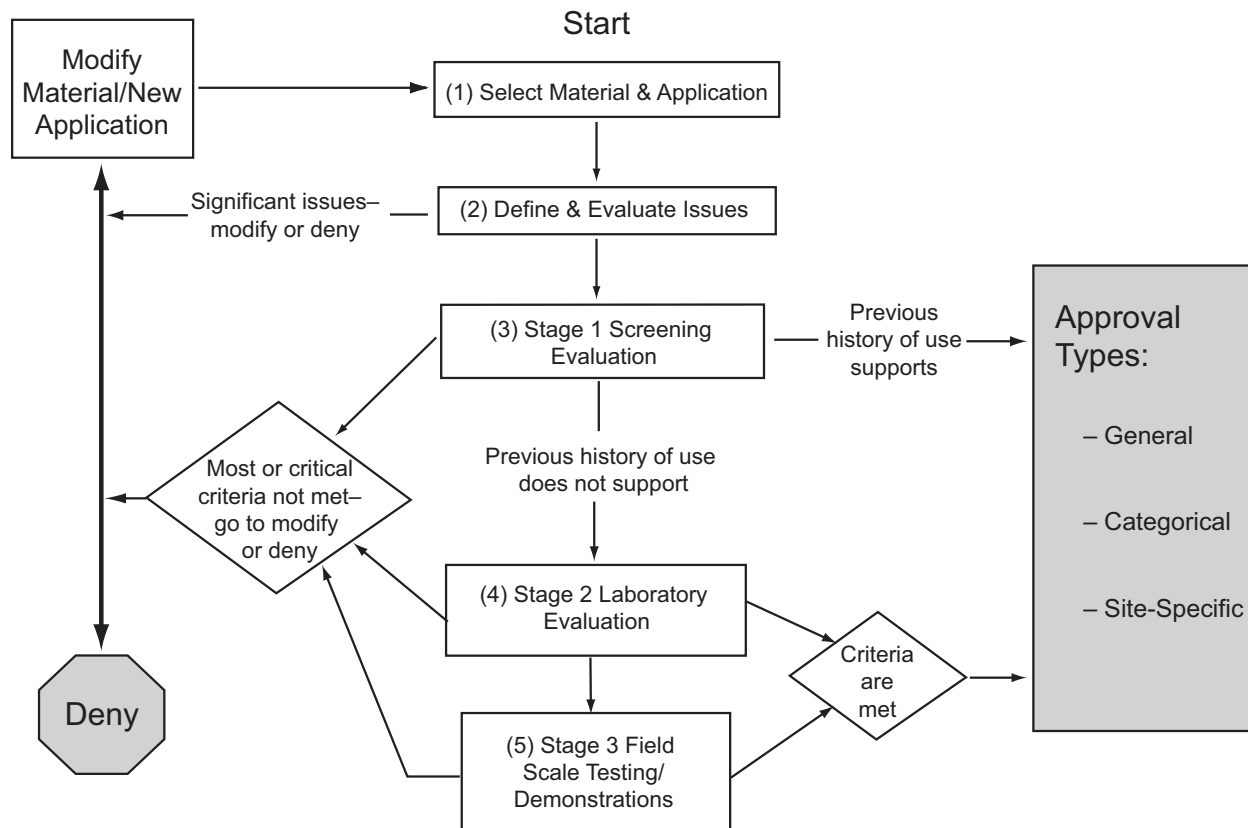


Figure 1—Evaluation Framework Flow Process

4. PROCEDURE

- 4.1. *Step 1—Select Material and Application*—The first step in the framework process is to select a material and a specific application (e.g., use blast furnace slag in embankment construction) that will be evaluated.
- 4.2. *Step 2—Define and Evaluate Issues*—The second step is to collect all relevant information that can provide input into the decision-making process. This includes, for the material and its proposed application, all related historical data; engineering and material property data; environmental, health, and safety data; implementation constraints; recycling issues; and economic issues.
- The purpose of this step is to define all issues that may warrant more detailed examination and, in particular, those issues that may be problematic insofar as approval of the material for use may be concerned. A flowchart that can be used to identify the key issues in any material-application proposal is presented in Figure 2. Recommended checklists to ensure that the proper information is collected for such an evaluation are provided in Tables 1 through 6.

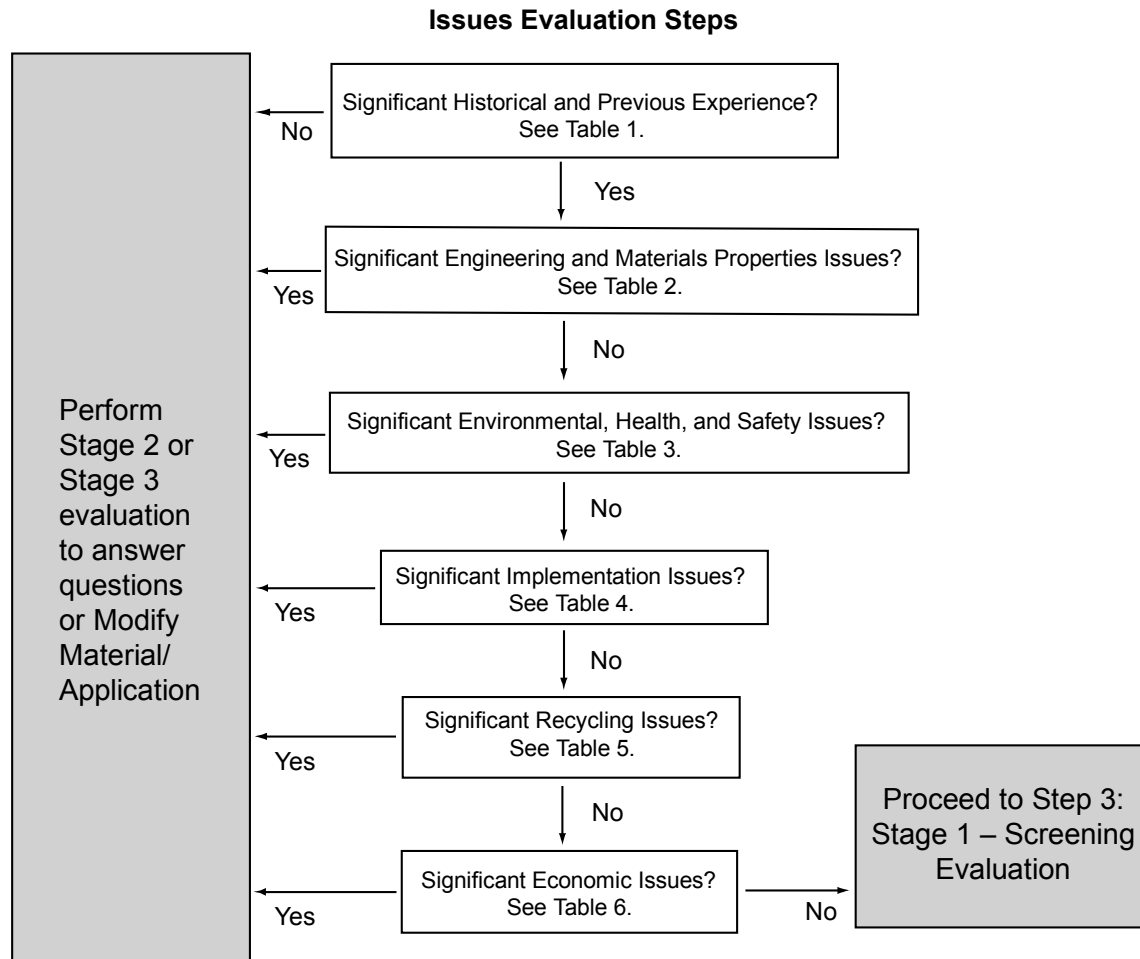


Figure 2—Issues Flowchart

Table 1—History and Previous Experience Questions

General Area	General Questions ^a		
History	1. Has the recycled material been used anywhere? If so, identify uses.	Y	N
	2. Is information available about the source of the recycled material? If so, collect it.	Y	N
	3. Has this recycled material been previously used for transportation applications? If so, identify applications.	Y	N
	4. Has this recycled material been used in geographically diverse locations? If so, identify locations.	Y	N
	5. Has this recycled material been used previously in a similar application? If so, identify location.	Y	N
	6. Has this recycled material been used in other agencies? If so, identify these agencies.	Y	N
	7. Have other agencies approved for this use? If so, identify these agencies.	Y	N
Previous Experience	1. Is information available about important prior experiences (previous use, prior objections, and similarity with other materials)? If so, collect the information.	Y	N
	2. Are there experts available to discuss prior experiences? This can include regulators, scientists, practitioners, waste generators, and associations. If so, contact the experts.	Y	N
	3. Is there any published literature about prior experiences? If so, obtain the information.	Y	N

^a Y = Yes, N = No

Table 2—Engineering and Material Properties Questions

General Area	General Questions ^a		
Engineering	1. Is information available about the engineering properties of the recycled material? This could include information about gradation, bulk density, durability, and compaction data. If so, collect the pertinent information.	Y	N
	2. Is the recycled material appropriately characterized with respect to time-dependent engineering properties? This could include time-dependent variation in gradation, bulk density, durability, and compaction. If so, collect the pertinent information.	Y	N
	3. For the proposed application, are there appropriate engineering criteria for the product? This could include durability, grain size, and compaction requirements. If so, collect the pertinent criteria.	Y	N
	4. Is engineering information available about important prior experiences (previous use, prior performance criteria, and similarity with other materials)? If so, assemble the pertinent information.	Y	N
Material Properties	1. Is information available about the material properties of the recycled material? This could include information about loss on ignition, mineralogy, and pozzolanic activity of the waste material. If so, summarize the data.	Y	N
	2. Is the recycled material appropriately characterized with respect to time-dependent materials properties? If so, summarize the data.	Y	N
	3. For the proposed application, are there appropriate material properties criteria for the product? If so, identify the criteria.	Y	N

^a Y = Yes, N = No

Table 3—Environmental, Health, and Safety (EHS) Properties Questions

General Area	General Questions ^a		
Environmental	1. Is information available about the environmental properties of the recycled material? This could include information about total elemental composition, total available elemental composition, and volatile and semi-volatile organics composition data. If so, collect the pertinent information.	Y	N
	2. Is the recycled material appropriately characterized with respect to time-dependent environmental properties? This could include time-dependent variation in total elemental composition, total available elemental composition, and volatile and semi-volatile organic composition. If so, collect the pertinent information.	Y	N
	3. For the proposed application, are there appropriate environmental criteria for the product? This could include leaching data, total content data, particle size, etc. If so, collect the pertinent criteria.	Y	N
	4. Is environmental information available about important prior experiences (previous use, prior performance criteria, and similarity with other materials)? If so, assemble the pertinent information.	Y	N
	5. Have there been any environmental assessments undertaken relative to the use of the proposed material? If so, summarize the information.	Y	N
Public Health	1. Are there any Materials Safety Data Sheets (MSDS) for the recycled materials? If so, collect the sheets.	Y	N
	2. Have there been health risk assessments (HRA) undertaken relative to the proposed use of the material? If so, summarize the information.	Y	N
Safety	1. Have there been prior Occupational Safety and Health Administration (OSHA) issues for generation, processing, storage, and use in previous efforts? If so, summarize the information.	Y	N

^a Y = Yes, N = No

Table 4—Implementation Issue Questions

General Area	General Questions ^a			
Implementation	1. Are there any apparent political constraints? If so, describe them.	Y	N	U
	2. Are there any apparent regulatory constraints? If so, describe them.	Y	N	U
	3. Are there any apparent public acceptability constraints? If so, describe them.	Y	N	U

^a Y = Yes, N = No, U = Unknown

Table 5—Recycling Issue Questions

General Area	General Questions ^a		
Recycling	1. Are there likely recycling or life-cycle issues? If so, identify them.	Y	N U
	2. Has the recycled material or its application been reused within other areas of the highway environment? If so, identify them.	Y	N U

^a Y = Yes, N = No, U = Unknown

Table 6—Economic Issue Question

General Area	General Question ^a	Y	N	U
Economic	1. Are there any apparent economic constraints? If so, identify them.			

^a Y = Yes, N = No, U = Unknown

- 4.3. *Step 3—Stage 1 Screening Evaluation*—The third step in the process is a Stage 1 screen. The purpose of a Stage 1 screen is to determine whether the data collected in Step 2 are sufficient to approve (or reject) the proposed application without additional study. A Stage 1 approval means that the evaluator has a high degree of certainty that there is sufficient information to justify acceptance of the proposed material and application. This typically involves demonstrating that the proposed material is sufficiently similar to reference materials that have been used successfully to warrant approval. A Stage 1 screen should include an assessment of all existing data pertaining to engineering data; environmental, health, and safety data; recycling issues; implementation concerns; political issues; and economic issues to ensure that the data are sufficient to permit a responsible decision. Recommended screening checklists with evaluation criteria are presented in Tables 7 through 11.

Table 7—Stage 1 Engineering Screening Checklist

Parameter	Test Method	Evaluation Criteria ^a			
Material Source	Determine whether the proposed material is generated from similar source materials and the same process or operation as the reference material.	1. Will the quality of feedstock materials to be used in the production or generation of the proposed material be sufficiently similar to that used to produce or generate the reference material so that the engineering properties of the proposed material will not be significantly impacted and will still be comparable to the reference material?	Y	N	U
		2. Will the operating conditions associated with the production or generation of the proposed material be sufficiently similar to those of the reference material so that the engineering properties of the proposed material will not be significantly impacted and will still be comparable to the reference material?	Y	N	U
		3. Will the post-production operations (e.g., material processing, handling, and storage) associated with the production or generation of the proposed material be sufficiently similar to the reference material so that the engineering properties of the proposed material will not be significantly impacted and will still be comparable to the reference material?	Y	N	U
Engineering Properties	Assess whether there are sufficient data to compare the engineering properties of the proposed material and the reference material, and whether the respective properties are sufficiently similar to approve the proposed material for use.	1. Are appropriate engineering property data available for both the proposed and the reference materials, and are the data reliable?	Y	N	U
		2. Can it be determined that the proposed and the reference materials have statistically similar engineering properties that are in conformance with the specifications of the proposed application, and are they comparable?	Y	N	U
Field Performance	Determine whether the reported historical data for the reference material provided give reasonable assurance that the proposed material will provide satisfactory performance in the intended application.	1. Is there a sufficient and reliable historical performance record available?	Y	N	U
		2. Are there experienced personnel available with whom to review the results of the historical performance data, and have the above-referenced contacts provided positive feedback regarding the application?	Y	N	U
		3. Are the historical performance data of the material sufficient to warrant a Stage 1 approval?	Y	N	U

^a Y = Yes, N = No, U = Unknown

Table 8—Stage 1 Environmental, Health, and Safety Screening Checklist

Parameter	Test Method	Evaluation Criteria ^a			
Material Source	Determine whether the proposed material is generated from similar source materials and the same process or operation as the reference material.	1. Will the quality of feedstock materials to be used in the production or generation of the proposed material be sufficiently similar to that used to produce or generate the reference material so that the environmental properties of the proposed material will not be significantly impacted and will still be comparable to the reference material? 2. Will the operating conditions associated with the production or generation of the proposed material be sufficiently similar to those of the reference material so that the environmental properties of the proposed material will not be significantly impacted and will still be comparable to the reference material? 3. Will the post-production operations (e.g., material processing, handling, and storage) associated with the production or generation of the proposed material be sufficiently similar to the reference material so that the environmental properties of the proposed material will not be significantly impacted and will still be comparable to the reference material?	Y	N	U
Environmental Properties	Assess whether there are sufficient data to compare the environmental properties of the proposed material and the reference material, and whether the respective properties are sufficiently similar to approve the proposed material for use.	1. Are appropriate environmental property data available for both the proposed and the reference materials, and are the data reliable? 2. Can it be determined that the proposed and the reference materials have statistically similar environmental properties that are in conformance with the specifications of the proposed application, and are they comparable?	Y	N	U
Field Performance	Determine whether the reported historical data provided give reasonable assurance that the proposed material will provide satisfactory performance in the intended application.	1. Is there a sufficient and reliable historical performance record available? 2. Are there personal contacts (regulators or scientists with experience) available with whom to review the results of the historical performance data, and have the above-referenced contacts provided positive feedback regarding the application? 3. Were there any specific problems or difficulties reported, and were the reported problems satisfactorily addressed in previous investigations to warrant a Stage 1 approval?	Y	N	U

^a Y = Yes, N = No, U = Unknown