2012 Testing

Nine samples were processed in 2012 to get clear data on the ability of the optical sorter to recover PLA from various materials streams. PLA bottles were added to each of the three samples run in June 2012 (referred to as Performance Test 1 in the Cascadia Report). Larger numbers of PLA products were added to each of the six samples that were tested in July 2012 (Performance Test 2 in the Cascadia Report).

In the Performance Test 1 series, 50 PLA bottles were added to each of three samples of mixed plastics, before the loads were run through the optical scanner. The results of these tests are provided in Table 5.

Table 5: Performance Testing Series 1

Seeded Material	**Sample**	**First Run**	**Second Run**		**Results – Seeded PLA Material (percent of Total Quantity)**
PLA Bottles	Sample 1	PLA + PET (+)	PLA + PET component	PLA (+)	24.0 percent in PLA component
		Paper (-)		PET (-)	10.0 percent in PET component
		Other (>)		Other (>)	66 percent in Other component
	Sample 2	PLA (+)	N/A		67.7 percent in PLA component
		PET (-)			11.1 percent in PET component
		Other (>)			21.2 percent in Other component
	Sample 3	HDPE (+)	Other component	PLA (+)	65.0 percent in PLA component
		PET (-)		PP (-)	18.0 percent in PET component
		Other (>)		Other (>)	16.0 percent in Other component

Each of the three samples was separated into three streams (as shown in Figure 3); one category of materials was blown upward (+), one category was blown downward (-), and one allowed to continue through unimpeded (>).

In Sample 1, PLA and PET were separated as one category, paper as a second category, and "Other" materials as the third category. We found that sheets of paper in the load interfered with the scanner's ability to properly sort materials since the paper limits the ability of the sensors to see materials that are covered, and sheets of paper interfere with the ability of the air jets to move the containers to the desired sort bin. Because of the amount of paper in this load, 66 percent (33 of 50) of the PLA bottles ended up with the Paper or "Other" materials, and only 17 of the PLA bottles ended up in the PLA + PET stream. The combined PLA + PET stream was then resorted into three streams. Over 70 percent (12 of the remaining 17) of the PLA bottles ended up in the PLA stream, almost 30 percent (5 of 17) of the PLA bottles still ended up in the PET stream, and none of the PLA ended up in the "Other" stream.

In Sample 2, PLA was sorted as one category, PET as another category, and "Other" materials as the third category. None of the three materials categories was resorted. The scanner correctly sorted 68 percent (34 of 50) of the PLA bottles into the PLA stream, 10 percent (5 of 50) of the PLA bottles were ejected into the PET; and 22 percent (11 of 50) of the PLA bottles ended up in the "Other" materials category.

In Sample 3, HDPE was sorted as one category, PET was separated as the second category, and all "Other" materials as a third category. The "Other" materials were then run through the sorter a second time to separate three streams, with positive sorts for polypropylene (PP) and PLA, and a negative sort for "Other" materials. In this sample, no PLA bottles ended up in the HDPE, 18 percent (9 of 50) of the PLA bottles ended up in the first run PET stream, and 41 PLA bottles were sorted into the "Other" stream. Then, in the resort of the "Other" stream, 80 percent (33 of 41) of the remaining PLA bottles ended up in the PLA category, and 20 percent (8 of 41) of the PLA bottles were ejected along with the "Other" materials category.

Based on observations of the operators, the poor results achieved for Samples 1-3 were caused by the two positive-one negative sort feature, where the air jets pushing some containers upward and others downward, and the irregular shape of the containers (some flattened, some round) caused some containers to bump into others, and end up in the wrong compartment. It is likely that the low recovery rate in Sample 1 also resulted from the interference from the positive sort for paper.

None of the Sample 1-3 tests were considered to have demonstrated the capabilities of the optical sorter to achieve the project goals, so changes were made to the sorting machinery and additional testing was scheduled.

July 2012 Testing

Much larger quantities of PLA were added to Samples 4-9. These six samples, (referred to as Performance Test 2 in the Cascadia Report) were run in July 2012. In Samples 4 and 5, 163 PLA bottles were added; and in Sample 6, 159 bottles were added.

In Samples 7 through 9, in addition to PLA bottles, PLA cups and clamshells were added to the materials to be sorted. In Sample 7, 120 bottles, 61 cups, 47 clamshells (total 228 pieces) were added. In Sample 8, 125 bottles, 69 cups, 55 clamshells (total 249 pieces) were added. In Sample 9, 124 bottles, 70 cups, 59 clamshells (total 253 pieces) were added.

Four of the samples were run as two-way sorts, instead of the three-way sorts, to determine whether better results could be achieved. The results of the Samples 4-9 tests are provided in Table 6.

Table 6: Performance Testing Series 2

Seeded Material	Sample	First Run	Second Run		Results – Seeded PLA Material (percent of Total Quantity)
PLA Bottles	Sample 4	PLA (-)	N/A		97.5 percent in PLA component
		Other (>)			
	Sample 5	PET (-)	Other component	PLA (+)	87.7 percent in PLA component
		Other (>)		Other (>)	8.6 percent in PET component
	Sample 6	PLA (-)	N/A		88.7 percent in PLA component
		PET (+)			2.5 percent in PET component
		Other (>)			8.8 percent in Other
PLA bottles, cups and clamshells	Sample 7	PLA (+)	N/A		99.6 percent in PLA component
		Other (>)			
	Sample 8	PET (-)	Other component	PLA (-)	87.6 percent in PLA component
		Other (>)		Other (>)	12.4 percent in PET component
	Sample 9	PLA (-)	N/A		92.5 percent in PLA component
		PET (+)			0.9 percent in PET component
		Other (>)			6.6 percent in

				Other

Sample 4 was sorted into two categories, PLA and "Other" and properly recovered 97.5 percent (159 of 163) of the PLA bottles in the sample. The other 2.5 percent (4 of 163) of the PLA bottles were sorted into the "Other" materials category.

Sample 5 was first sorted to separate PET bottles from all "Other" materials, and then the "Other" materials were sorted to separate PLA from all "Other" materials. Almost 9 percent (14 of 163) of the PLA bottles were sorted into the PET stream in the first run, while 88 percent (144 of 163) of the PLA bottles were correctly sorted into PLA stream. The remaining 3 percent (5 of 163) of the PLA bottles were sorted into the second run "Other" materials category.

Sample 6 was sorted into PLA, PET and "Other" materials. In this sample, 87.7 percent (138 of 159) of the PLA bottles were correctly sorted into PLA stream, 2.5 percent (4 of 159) of the PLA bottles were sorted into the PET stream, and the remaining 9.8 percent (17 of 159) into the "Other" materials stream.

While Sample 5 and Sample 6 both correctly recovered about the same percentage of the available PLA bottles, by sorting only for PET and "Other" in Sample 5, fewer PLA bottles ended up in the PET in Sample 6.

Sample 7 was sorted only to separate PLA bottles, cups, and clamshells from "Other" materials, and 99.6 percent of the total PLA was correctly sorted. This sample achieved the best results of all of the tests that were run.

Sample 8 was sorted to separate PET from "Other" materials in the first run, and then the "Other" materials were sorted to separate PLA from everything else. In the first run, 12.4 percent of the total PLA bottles, cups, and clamshells were sorted into the PET bottles. In the second run, the sorter correctly separated all of the remaining PLA bottles, cups, and clamshells into the PLA component stream.

Sample 9 was sorted into three categories to separate the PLA, PET and "Other" materials. In this sample, almost 1 percent of the PLA products were sorted into the PET stream; 92.5 percent of the PLA bottles, cups, and clamshells were correctly sorted into PLA stream; and the remaining 6.6 percent of the PLA was sorted into the "Other" materials.