CHAPTER 4 – SUBJECTIVE OBSERVATIONS

COMPARATIVE SUBJECTIVE INSPECTION SYSTEM

After the products were installed in September 2004, the first follow-up monitoring occurred in May 2005. The subjective observations reported in this chapter were a result of using the same system as was used for the Buenos Aires project in south-central Arizona. Under this monitoring system the project sections were observed in a predetermined order while the four evaluators visually rated them as they rode in a vehicle for 1) effectiveness against dust in dry conditions, 2) amount of wash boarding, 3) amount of raveling, 4) amount of rutting, and 5) amount of potholing.

For each of the four monitoring events, the comparative visual rating started with a different section to minimize any bias occurring if the team always used the same section as the baseline. The Monitoring Order and Mileposts Plan, shown in Appendix A, and Table 6, below, show the order in which the sections were driven and monitored at each event.

Table 6. Sections serving as baselines sequence for monitoring events.

Monitoring Event	Baseline Section	Observation Sequence
8-month	I – TerraZyme	I, II, III, IV, V, VI
11-month	III – PermaZyme	III, II, I, IV, V, VI
20-month	VI – Mag/Lig	VI, V, IV, III, II, I
23-month	IV – Soil Sement	IV, III, II, I, VI, V

At each monitoring event, the first observed section received a rating of five and served as a baseline for the other sections. The other sections were compared to the first section and rated higher (better condition) up to ten points or lower (worse condition) down to zero points. The four evaluators independently rated the sections for each parameter. Their scores were then averaged for reporting.

The benefits of this comparative visual inspection system, developed under the Buenos Aires project, were first its ability to capture subtle differences in performance of the products at one monitoring event and second that it was easy and quick to perform. Its limitation, however, was that it gave no information about the products' performance over time. No visual indications were noted.

While driving the project multiple times to carry out the comparative visual inspection the monitoring team also reviewed each section for leaching of soluble stabilizing material due to rain, impacts on roadside vegetation, application uniformity, and overall structural appearance.

SUBJECTIVE RESULTS

The results presented in Table 7 show the averaged scores from the comparative judgments of four independent evaluators. Note, in Table 7, that for each product and for each parameter of dust, washboarding, raveling, rutting, and potholing, there is an average score for each

Table 7. Subjective monitoring results.

Test Section	Product	Average Values from Subjective Monitoring															Subjective Overall Average Score (x10)
		Dust			Washboard			Raveling			Rutting			Potholing			
		8-mo. / 20-mo.	11-mo. / 23-mo.	Overall Average	8-mo. / 20-mo.	11-mo. / 23-mo.	Overall Average	8-mo. / 20-mo.	11-mo. / 23-mo.	Overall Average	8-mo. / 20-mo.	11-mo. / 23-mo.	Overall Average	8-mo. / 20-mo.	11-mo. / 23-mo.	Overall Average	
I	TerraZyme	5.0	4.8	4.8	5.0	6.0	5.5	5.0	4.0	4.8	5.0	4.8	4.8	5.0	5.0	5.0	50
		3.5	6.0		4.5	6.5		4.3	6.0		4.5	5.0		5.0	5.0		
II	Ligno-sulfonate	7.0	6.8	6.5	6.0	7.3	6.9	8.0	7.0	7.2	6.0	5.3	5.4	5.0	5.0	5.0	62
		3.3	9.0		6.3	8.3		5.5	8.3		5.5	5.0		5.0	5.0		
III	PermaZyme	6.0	5.0	5.4	5.3	5.0	4.9	6.0	5.0	5.6	4.3	5.0	4.8	4.0	5.0	4.8	51
		3.8	7.0		3.3	6.3		5.3	6.0		5.0	5.0		5.0	5.0		
IV	Soil Sement	3.3	3.0	3.5	3.5	3.5	3.6	6.3	4.5	5.1	5.3	5.0	5.1	5.0	5.0	5.0	45
		2.8	5.0		2.5	5.0		4.5	5.0		5.0	5.0		5.0	5.0		
V	DCA-2000 Caliber	4.8	4.5	5.4	6.0	6.3	6.5	6.8	4.8	5.9	6.0	5.3	5.3	5.0	5.0	5.0	56
		5.8	6.5		6.3	7.5		5.3	6.8		5.0	5.0		5.0	5.0		
VI	Mag/Lig	7.0	7.0	7.1	5.5	7.8	6.4	6.8	6.5	6.3	5.8	5.3	5.3	5.0	5.0	5.0	60
		5.0	9.3		5.0	7.5		5.0	6.8		5.0	5.0		5.0	5.0		

monitoring event. Also there is an overall average score, covering the entire monitoring period, for each product and parameter. This overall average score best shows the relative standings of the products for a particular parameter. Finally, in the far right column of Table 8, there is an overall score that represents the ranking of the products based on subjective observations. Figure 10 plots the relative product standings for each parameter and the overall subjective score for each product taking all parameters into consideration.

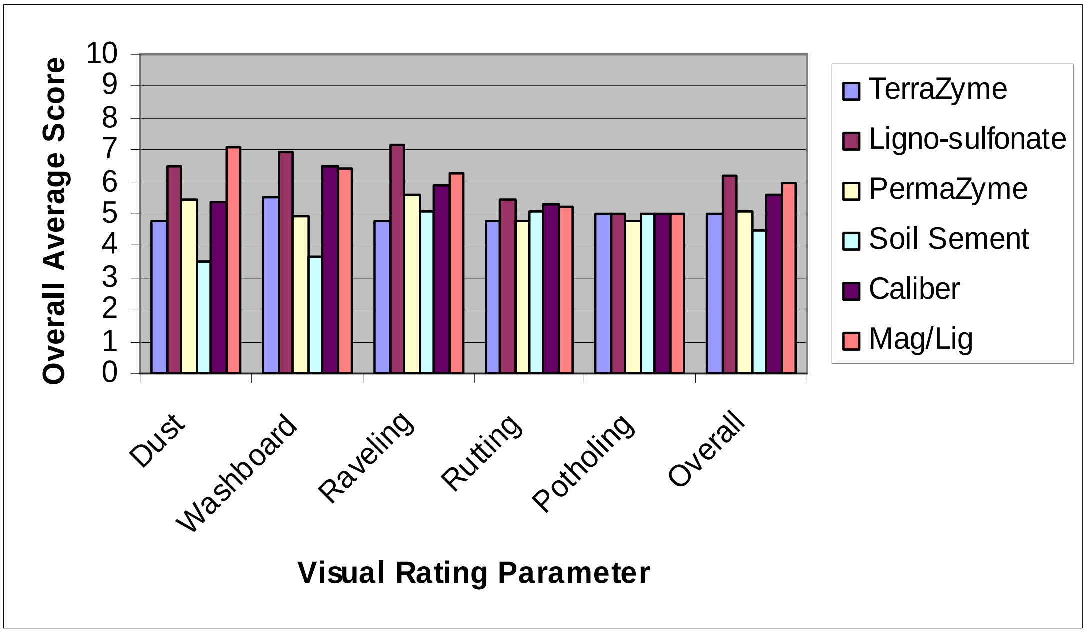

Figure 10. Plot. Relative product standings from subjective observations.

Dust Abatement

During all of the monitoring events – at 8, 11, 20, and 23 months following the September 2004 construction completion - the weather was dry. This was fortunate as it enabled the observers to distinguish the various levels of dust generation in each section.

Figure 11. Photo. Monitoring for dust.

Looking at the Figure 10 plot for dust, the products can be separated into three dust abatement groups. The columns represent for each product the overall average score it received for the entire monitoring period. In the first group, Mag/Lig and Lignosulfonate showed the least amount of airborne particles. In the second group consisting of PermaZyme, Caliber, and TerraZyme; more dust was generated relative to the first group. In the third group was Soil Sement that exhibited the most dust.

Washboarding

In looking at the washboarding overall average scores in Figure 10, the products can be separated into three groups. In the first group were Lignosulfonate, Caliber, and Mag/Lig. These products produced the least amount of washboarding. In the second group, showing more washboarding were the enzyme products - TerraZyme and PermaZyme. In the third group was Soil Sement that had the highest level of washboarding as shown in Figure 12. It should be noted again that the scores given in Table 10 for each monitoring event are not absolute scores in reference to some objective criteria, but rather ratings given in comparison to a baseline section.

Figure 12. Photo. Section IV Washboarding.

Raveling

For raveling, Table 7 and Figure 10 show overall scores ranging from 4.8 to 7.2. Lignosulfonate was the best performing product and generally showed less loose material on the road surface than any of the other sections. In fact, the Lignosulfonate surface course appeared hardened from the first monitoring event as the applied product was visible consistently throughout the section – not blotchy as in other sections. By the 20-month event, however, the product was appearing more grayed-out than it had in previous monitoring events.

Figure 13. Photo. Raveling.

The overall scores for the other products formed no clear groups but rather stepped down in the order of Mag/Lig, Caliber, PermaZyme, and Soil Sement to the lowest ranked performer for raveling – Terrazyme. By the end of the monitoring period, the middle ranked sections typically had loose aggregate spread fairly uniformly over the entire roadbed, and defined wheel paths were just beginning to show. PermaZyme and Caliber appeared tighter than Soil Sement, and this was consistent throughout their lengths. In the TerraZyme section, no product, blotchy or otherwise, was evident except at the kiosk parking area where there had been little or no traffic use. Elsewhere, clear wheel paths were evident as raveled material was pushed to either side. It should be noted that the TerraZyme section has many curves, and near these curves, not only was there more raveling but also more rutting and washboarding. In general, wherever there was product clearly showing in a test section, there was also significantly less loose material.

Rutting

The overall average scores for rutting only varied from 4.8 to 5.4, but still could be grouped logically into two groups. In the group with the higher scores, that is, less observed rutting, were Lignosulfonate, Caliber, Mag/Lig, and Soil Sement. In the group with the lower scores were the two enzyme products – TerraZyme and PermaZyme.

The team did not consider worn tracks in the roadway as ruts if the condition appeared to be linked to raveling. At the beginning of monitoring, the team thought there could be greater potential for more pronounced rutting on a 3.7-m (12-ft) wide road than on a 5.5-m (18-ft) one because the traffic would be concentrated into one path. The sections stabilized with the Soil Sement and Caliber products, were only 3.7 m (12 ft) wide. The team did observe that on the 3.7-m (12-ft) wide sections there were two wheel paths, whereas on the 5.5-m (18-ft) wide sections there were at least three. But overall, there was very little rutting in any of the sections. The Figure 10 plot reflects this because the rutting columns representing the overall average score for each product are all close to the same height. One exception was the Permazyme Section III where rutting was apparent on a steep hill as shown in Figure 14. This rutting appeared in May of 2005 after heavy winter snows and a quick spring thaw. Most likely, it was caused by one vehicle being in the area when conditions were extremely wet and having a hard time getting up the hill. The rutting on this hill appeared to repair itself over time; it was not noticeable at the 23-month monitoring event.

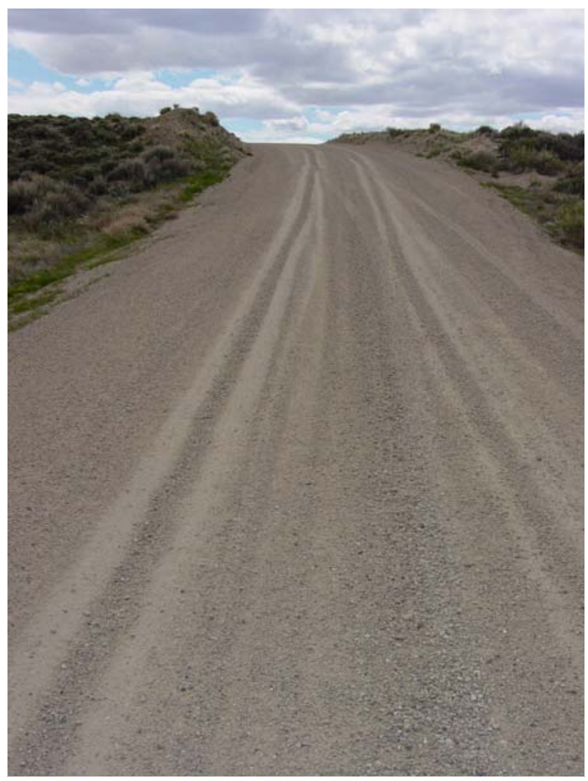

Figure 14. Photo. May 2005 ruts in PermaZyme Section III.

Potholing

Potholing was included in the evaluation based on CFLHD's prior experience with surface applications of dust abatement products, such as magnesium chloride, that tend to produce a thin hardened surface layer that can break up, or pothole, in areas of lesser compaction. Conceptually therefore, since in this project the roadway was stabilized to a depth of 125 mm (5 in), the extent of potholes that normally develop under thin surface applications was not expected to occur. The evaluation team, however, was not certain whether this full-depth stabilized roadway would form potholes or not, so they monitored it for potholes.

As shown in the Figure 10 plot, potholing was not an issue except for in the PermaZyme section. This section was downgraded in the 8-month monitoring event because one pothole was discovered in the section. A total of only three potholes were evident on the entire project – the second appeared in the TerraZyme section at the 13-month event and the third also in the TerraZyme section at the 20-month event. Though the team rated the PermaZyme section lower at the 8-month event, it was later decided that a total of only one or two potholes in a half-mile of roadway had to be due to something other than poor performance of a stabilizer product such as uncompacted material left in a hole by a removed rock or a gopher hole.

SUBJECTIVE INSPECTION SUMMARY

The overall average scores for each product covering all the parameters are shown in the extreme right column of Table 7 and plotted in Figure 10 as the right-most set of bars. These numbers, for each product, are the average of the scores it received for dust, washboarding, raveling, rutting, and potholing. Thus from subjective observations, three groups of product performance are evident. In the first group performing best, second and third, were the Lignosulfonate, Mag/Lig, and Caliber sections. The two enzyme products, TerraZyme and PermaZyme, were in the second group, and the third group consisted of the Soil Sement product that had the lowest overall average.

OTHER OBSERVATIONS

Whereas the subjective observation method was used to evaluate the five parameters of dust, washboarding, raveling, rutting and potholing, other observations in the areas of environmental effects, application uniformity, and design geometrics and structural appearance were also made and are briefly summarized below.

Observed Environmental Effects

At the first monitoring event in May 2005, no leaching off the road into the ditch was observed in any of the sections nor were impact to roadside vegetation seen in any of the sections. Neither was there any leaching impacts observed during subsequent events. By August 2005, Halogeton, a noxious weed that takes root in disturbed areas, was growing vigorously along the roadway and in the ditch. The team observed in the final monitoring event in August 2006, that vegetation had also come up in areas where there was very little traffic such as the middle of the road, pullouts, and parking areas. Most places, even those sections without treatment, along the entire project had Halogeten growing along the edges of the roadway. Curiously, some areas had none or only a little with stunted growth, and this variability in growth was not correlated to any one product. Since the Refuge had not done any control spraying, the extremely long dry period preceding the last monitoring event may have stunted this noxious weed.

Application Uniformity

Since the roadway, which varied from 3.7 to 5.5 m (12 to 18 ft) wide, was reconditioned using a 3-m (10-ft) wide CMI 650 pulverizer, the team expected to see areas of concentrated treatment where the two passes overlapped. At the 8-month event, this effect was observed only in the Lignosulfonate section as shown in Figure 15. The overlapping was quite pronounced at this first monitoring event but diminished over time. The Mag/Lig section had a blotchy appearance in the wheel paths rather than in the center as was seen in the Lignosulfonate section.

By the 11-month event in August 2005, no product was visible in the TerraZyme, PermaZyme, or Soil Sement sections. The Lignosulfonate section was showing a lot of product in the wheel paths. The Caliber section showed product in a few areas, and the Mag/Lig section showed product at the beginning of its length.

Figure 15. Photo. Lignosulfonate Section II product still showing two years after application.

In the 20-month event of May 2006, pullout areas with kiosks were showing a lot more residual product than the roadways. These areas may have had a heavier application (shot then spread with a grader) than the main roads which had products applied using the pulverizer. Another theory was that in parking areas, there was little traffic whereas on the road, where traffic breaks down the aggregate, any product on the surface was also broken down. Below the surface of the road it was expected that residual product was still present. During sampling for the Silt Load Test, covered in Chapter 6, all loose material in a 0.3 by 0.9-m (1 by 3-ft) swath was swept up off the road, and underneath residual product could still be seen in all the sections.

As of the last 23-month monitoring event in August 2006, the Lignosulfonate Section II still had some product showing as blotches throughout its length. A small amount of the Caliber product in Section V could also be seen at its end near the cattle guard that marks the Refuge boundary.

Design Geometrics and Structural Appearance

The design geometrics of the sections appeared to an have influence on performance of some of the products. The TerraZyme Section I had more curves which may have affected the amount of raveling and possibly washboarding that occurred over the two-year study period. During the first monitoring event, ruts approximately 18 m (60 ft) long were observed on a fairly steep hill in the PermaZyme Section III. It is possible that a heavy vehicle went up the hill in saturated conditions and may have spun its wheels to get to the top. No ruts were apparent in the remainder of this section or in the Caliber Section V that has a gradual hill climbing up away from the river. This same section, however, suffered erosion damage from rapid melting of winter snows as discussed earlier in this report.