FINAL REPORT

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Development of Procedures for Utilizing Pit Proctors in the FDOT Construction Process for Construction of Pavement Base Materials

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16. Abstract

An investigation of the feasibility of establishing density proctors for mine sources providing pavement base materials to FDOT projects was conducted. Research procedure involved statistical analysis of test data from 69 mines for the period 1999 – 2004. Additionally, field densities and field laboratory proctor densities were compared to mine test values. Procedures for offering an option to utilize a previously established mine proctor in lieu of laboratory proctor testing of project delivered material was suggested. The proposed alternative would eliminate the 4 to 5 day waiting time for laboratory proctor results.

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1. INTRODUCTION

1.1 Research Background

The Florida Department of Transportation (FDOT) maintains extensive materials control databases on mined base materials. Material quality is sampled at the mine and at the project sites. However, the current construction procedure requires that the material be sampled when delivered to the project site and that a laboratory proctor be established for the delivered material. The time required to sample and perform the laboratory proctor testing can be from 3 to 4 days. This time delay frequently causes a delay in the construction process. On many projects a significant amount of base material is installed daily. A delay of several days while waiting on the proctor testing causes problems for the construction operations and can affect the timely completion of the project.

A preliminary analysis of FDOT's mine quality data indicates that many material sources produce materials with relatively consistent material properties. Variations in proctor values, for example, occur over relatively long periods of time. This suggests the possibility of pre-establishing a "Pit Proctor" to be utilized in construction for a given material source and project. Based on the results of the research, Pit Proctor may be utilized as a QA/QC tool.

1.2 Research Objective and Scope

There are several issues, which need to be considered for utilizing Pit Proctors as a QA/QC tool:

- What are the acceptable limits for proctor variability to allow a mine to participate in the Pit Proctor program?
- How should the variability be measured, over time or over quantity produced?
- Should the mine self certify its proctors?
- Can the pit delivery tickets contain the certified proctor?

- What is the probable effect of the pit proctor variability on the project site QA/QC process?
- If the Pit Proctor procedure is used, what QA/QC processes should be used given the FDOT's implementation of the CQC Program?

The object of this research is to resolve the above issues and develop a practical plan for improving the efficiency of construction in general and develop tools that help implement the existing QA/QC processes by utilizing Pit Proctors.

1.3 Overview of Research

The need for avoiding delay in the FDOT construction process for construction pavement base materials has prompted the development of procedures for utilizing Pit Proctors in this study. To learn other DOTs' experience, all state highway agencies are surveyed with regard to their approaches for utilization Pit Proctors. The survey findings from other DOTs are summarized. The research team acquired data of Pit Proctor test results taken at 69 mines supplying material to FDOT projects. Three representative mines were chosen for initial analysis. The initial statistical analysis was performed to obtain an understanding of the mine proctor test data to include variability, range and autocorrelation with time. A meeting of the research coordinating team was held to review and discuss the results of the preliminary statistical analysis. The coordinating team suggested a trail analysis comparing the maximum 95 percentile value from the previous period to the average value for the current period. The idea was to use the 95 percentile value from the previous period as the Pit Proctor value for the current period. Research team selected 11 Mines that have consistent Pit Proctor QA/QC data during study period. An in-depth statistical analysis for the selected mines was performed and the results of the analysis were summarized. Another analysis of Pit Proctor data variations based on mine locations was performed. Finally, it is needed that the analysis and comparison of project field density values to proposed Pit Proctor values for additional activities. The research team obtained project field proctor and test density data. The data was analyzed and compared project field density values with proposed Pit Proctor values.

2. LITERATURE REVIEW

The research team conducted a narrowly focused literature review on the subject of establishing pit proctors. As expected, a significant amount of publications were found on the general subject of proctors. Those specifically relevant to the project scope are summarized. Additionally, all state highway agencies in other states are surveyed with regard to their approaches for utilization Pit Proctors. The survey findings from other DOTs are also summarized to learn of their experience with the subject.

2.1 Brief Summary of Compaction

Principles of compaction are well described in *Construction Methods and Management* (Nunnally 2001). In the book, compaction is defined as “the process of increasing the density of a soil by mechanically forcing the soil particles closer together, thereby expelling air from the void spaces in the soil.” The purpose of compaction is stated to improve the engineering properties of soil such as increased bearing strength, reduced compressibility, improved volume-change characteristics, and reduced permeability. Nunnally (2001) stated that the soil’s moisture content is a very important factor that affects the degree of compaction among the following five factors: the soil’s physical and chemical properties, the soil’s moisture content, the compaction method employed, the amount of compactive effort, and the thickness of the soil layer being compacted (lift thickness). To evaluate a moisture/density relationship, Standard Proctor and Modified Proctor were developed. The compaction tests determine the dry weight per cubic foot under a specified compaction effort.

Ping et al. (2003) stated, “Since the development of the Proctor tests, there have been dramatic advances in field compaction equipment. Therefore, the Proctor tests no longer represent the maximum achievable field density.” This indicates that contractors using advanced compaction equipment in these days might meet DOT’s compaction requirements with a little bit less effort than decades ago. It means that setting a target density a little bit higher might not be a problem for contractors to meet the target.

2.2 Two Types of Proctors in Florida

The FDOT uses two types of Moisture Density Relations tests, Standard Proctor and Modified Proctor. The Standard Proctor performs in accordance with AASHTO T-99, which employs the use of a 5.5-lb. rammer dropped from a height of 12 inches (AASHTO 2003). Soil is placed in three layers in 4 inch molds and each layer is compacted by 25 blows of the rammer. The Standard method is typically used on FDOT project embankment and structure backfill materials. The Modified Proctor, FM 1-T180, is almost identical with AASHTO T-180 (FSTM 2002). It employs a 10-lb. rammer dropped from a height of 18 inches. Soil is placed in five layers in 6 inch molds and each layer is compacted by 56 blows of the rammer. The Modified method typically used on FDOT project base, subgrade and MSE wall backfill materials.

2.3 Current FDOT Testing and Acceptance Standard

FDOT Standard Specifications for Road and Bridge Construction 2004 specifies that bases must be constructed in lifts of no more than 6 inches [150 mm] unless the contractor demonstrates the ability to achieve satisfactory results with lifts of greater thicknesses. Individual courses shall not be less than 3 inches [75 mm]. If approved by the Engineer, the base may be constructed in successive courses of not more than 8 inches [200 mm] compacted thickness. Each lift must meet the following acceptance criteria as specified in FDOT specification (2004):

- Within the entire limits of the width and depth of the base, obtain a minimum density in any LOT of 98% of maximum density as determined by AASHTO FM 1-T 180, Method D.
- Compact the base of any LOT of shoulder pavement to not less than 95% of the maximum density as determined by FM 1-T 180, Method D

Acceptance is a pass fail criteria. The tests that fail are reworked and retested until the material passes. Field density is typically measured by a nuclear density device. The standard testing procedure calls for one density to be taken 500 feet of base lane per lift. Passing densities are recorded in a project density logbook.

2.4 Survey Findings from Other State Highway Agencies

The research team conducted a directed survey of other DOTs' approaches for Pit Proctor utilization and contacted them to learn their experience with pit proctors. The survey instrument used for this research project was a questionnaire to DOT engineers. A copy of the questionnaire and cover letter are included in Appendix A of this report. The questionnaire had six questions covering the following topics:

- Approach used for Pit Proctor utilization
- Tools used to implement QA/QC processes when utilizing Pit Proctors
- Required construction procedures for mined base material

Of the 51 questionnaire, a total of 27 were completed and returned. Thus, the overall rate of return was 53 percent. A summary of the survey response is also provided in Appendix A of this report. The following lists are in the summary:

- Survey questionnaire flowchart
- List of states that responded to the survey
- Approaches used by other DOTs & QA/QC process tools when utilizing Pit Proctors
- Required construction procedures for mined base material
- List of DOTs participating in the survey

Sixteen DOTs require laboratory proctor test for mine material delivered to a job site and it typically takes one to seven days to get results of the required testing. The average of 16 DOTs is about 3 days.

2.4.1 Approaches used by other DOTs

Only five states of 27 respondents are utilizing Pit Proctors for construction process of pavement base materials. Hawaii used Pit Proctors only as a check or conditional acceptance. South Carolina utilized Pit Proctors on small projects. Both states ordinarily require the laboratory proctor testing. Other states have a similar approach to utilize Pit Proctors. The findings obtained from specific states with regard to the utilization of Pit Proctor are summarized below:

- COLORADO

  "The Department investigates and obtains samples from sources. Prior to delivering the mined base materials to a project site, a Lab Proctor test should be performed per source and per project by the Department. The Department provides the test results to the contractor."

- GEORGIA

  "Material is certified at the quarry and a maximum dry density and optimum moisture is determined in the lab. This data is used on the job site to measure compaction using a nuclear gauge. Compaction of base material must be 100% of lab-derived density."

- HAWAII

  "On special occasions requested by our construction field personnel, Pit Proctor may be used as a check/conditional acceptance and the DOT informs contractor about risks that final acceptance shall be based on laboratory proctor testing."

- NORTH CAROLINA

  "Materials and Tests of NCDOT have a representative to go to the quarry and bring a sample to the central laboratory once a year or more often if there is a change in the material source. Materials and Tests perform a modified AASHTO T-180 to establish the proctor value for the given material. This value is provided to the contractor to be used as the target density to achieve the required compaction."

- SOUTH CAROLINA

  "We ordinarily require that initial compaction be delayed after material placement while the initial Proctor test is run. However, on small projects (very minor projects) we refer to the last laboratory Proctor performed by our laboratory for that source. We do not allow the use of the supplier's data for acceptance. Although we do not utilize their data in the acceptance process, we require suppliers of most mined base material to have participated in our QC program. This requires them to supply test data to us, have certified personnel, and have a QC plan."

Georgia Department of Transportation (GDOT) requires a Standard Operation Procedure to monitor the quality of coarse and fine aggregates. Particularly, to establish and maintain an acceptable quality assurance program, "The Producer will sample and test at a specified frequency for each type of material being certified. Test data will be reviewed during regular inspections by Pit & Quarry Control personnel. The certification data will be electronically transferred to the Office of Materials and Research at a frequency of not less than once per week. To insure uniformity of testing between the Department and the Producer, comparison tests will be run at least annually by the Producer and the Department for each test the Producer's technicians are certified to perform." (GDOT 2002)

2.4.2 Different compaction testing used in other DOTs

Most state highway agencies use the proctor tests to determine maximum density for base materials. However, three states use different compaction test methods. For example, the West Virginia DOT (WVDOT) uses the Test Strip Method to determine the maximum density for base course materials. The Nevada DOT (NDOT) uses the Harvard Miniature Procedure to test a pit for source requirements and requires testing of material delivered to the job site. Base materials are tested on samples taken from the project. It takes one hour to get results of the required testing with the Harvard. The Washington DOT (WSDOT) uses a WSDOT test method 606, which is a lab developed maximum density most of the time and uses proctor test occasionally. The WSDOT requires a compactive effort that provides a specified percent of the maximum possible density and determines maximum possible density from the Test Method 606, using either the max density curve process for granular materials or the proctor test for materials with significant fines. The tests are run before construction begins on the material expected to be used and rerun whenever a change in material or a significant change in compaction testing is noted. A maximum density determination is required for mined material delivered to a job site using WSDOT 606 test procedure.

3. RESEARCH METHODOLOGY

3.1 Overview

The research team acquired data of Pit Proctor test results taken at 69 mines supplying material to FDOT projects. Initial statistical analysis was performed to obtain an understanding of the mine proctor test data to include variability, range and autocorrelation with time. A meeting of the research coordinating team was held to review and discuss the results of the preliminary statistical analysis. The coordinating team suggested a trail analysis comparing the 95 percentile value from the previous period to the average value for the current period. Research team selected 11 Mines that had consistent Pit Proctor QA/QC data during study period. An in-depth statistical analysis was performed and the results were summarized.

It was also needed that the analysis and comparison of project field density values to proposed Pit Proctor values for additional activities. The research team obtained project field proctor and test density data. The data was analyzed and compared project field density values with proposed Pit Proctor values.

3.2 Mine Data Analysis

3.2.1 Mine data transposition and description

The research team acquired from the FDOT a data base of Pit Proctor results consisting of proctor values taken at 69 mines supplying material to FDOT projects for the years 1998 through 2003. Test values were reported from the mine producer as Quality Control tests and from the FDOT as Quality Assurance tests. Testing frequency varied from 1 to 8 testing dates per month. The data was originally obtained as a text file and was transposed to an Excel file for analysis.

It is appeared that the Pit Proctor data fluctuates within a certain range both in a short-term and in a long-term study period. The fluctuating range is usually between 8 to 15 lb/ft^3 even though mean densities are different from mine to mine. If extreme outliers of Pit Proctor data were ignored, it would make the distributed range narrower. It is also appeared that fifty percent of Pit Proctor data from each mine is usually located within 2 to 4 lb/ft^3 variation. To show distribution of Proctor data from each mine, Box-Whisker Plot analysis was performed. Description of Box-Whisker Plot is shown in Figure 3-1. Distribution of Pit Proctor values from selected mines, which have consistent Pit Proctor values during study period, is illustrated in Figure 3-2. A Box-Whisker Plot of raw Pit Proctor data from selected mines is illustrated in Figure 3-3. A sample of raw Pit Proctor data from Mine No. 01305 is illustrated in Figure 3-4. A six-month period Box-Whisker Plot of raw Pit Proctor data from Mine No. 01305 is illustrated in Figure 3-5.

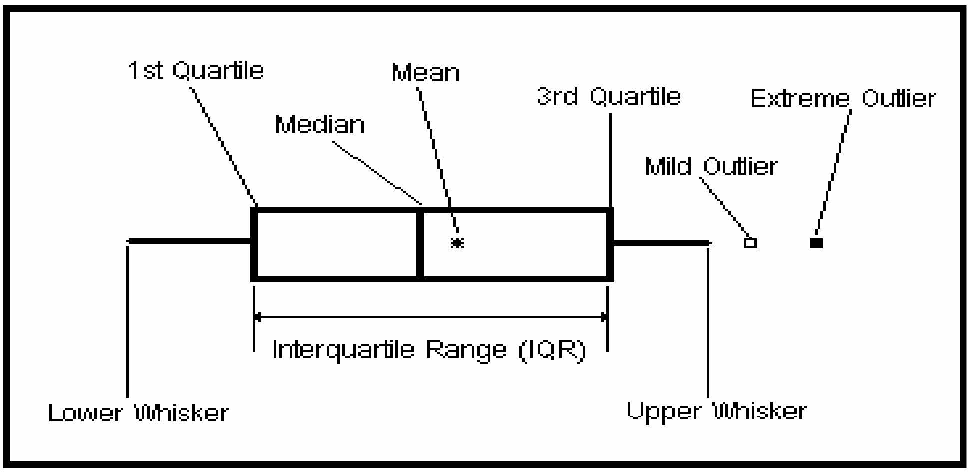

Figure 3-1. Description of Box-Whisker Plot

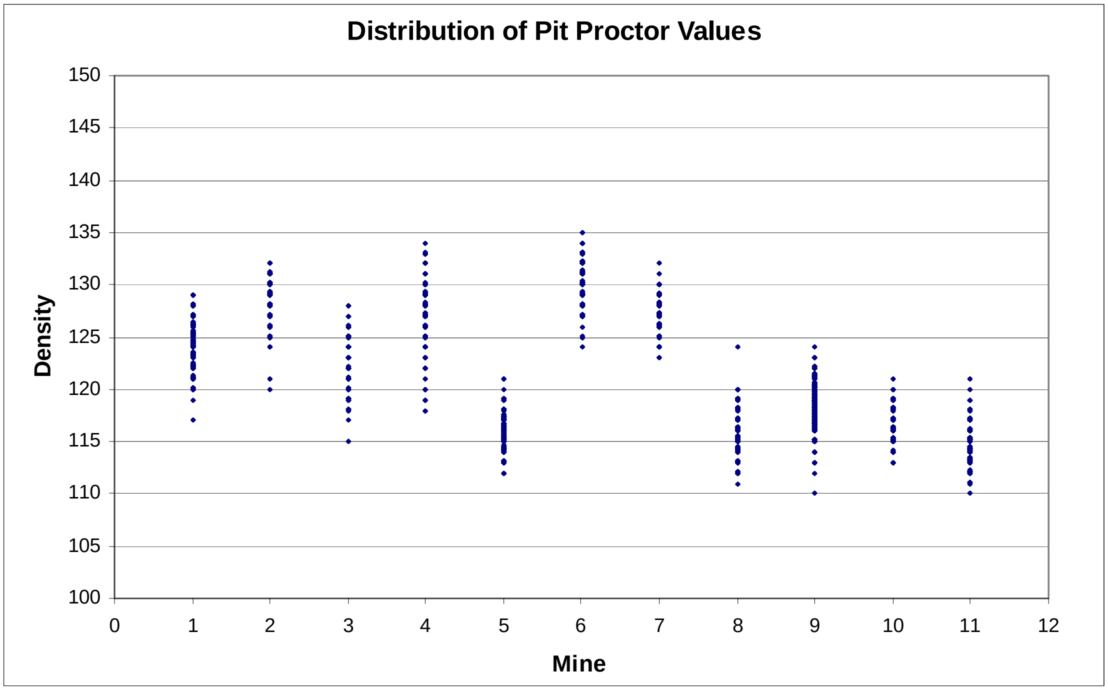

Figure 3-2. Distribution of Pit Proctor Values from Selected Mines

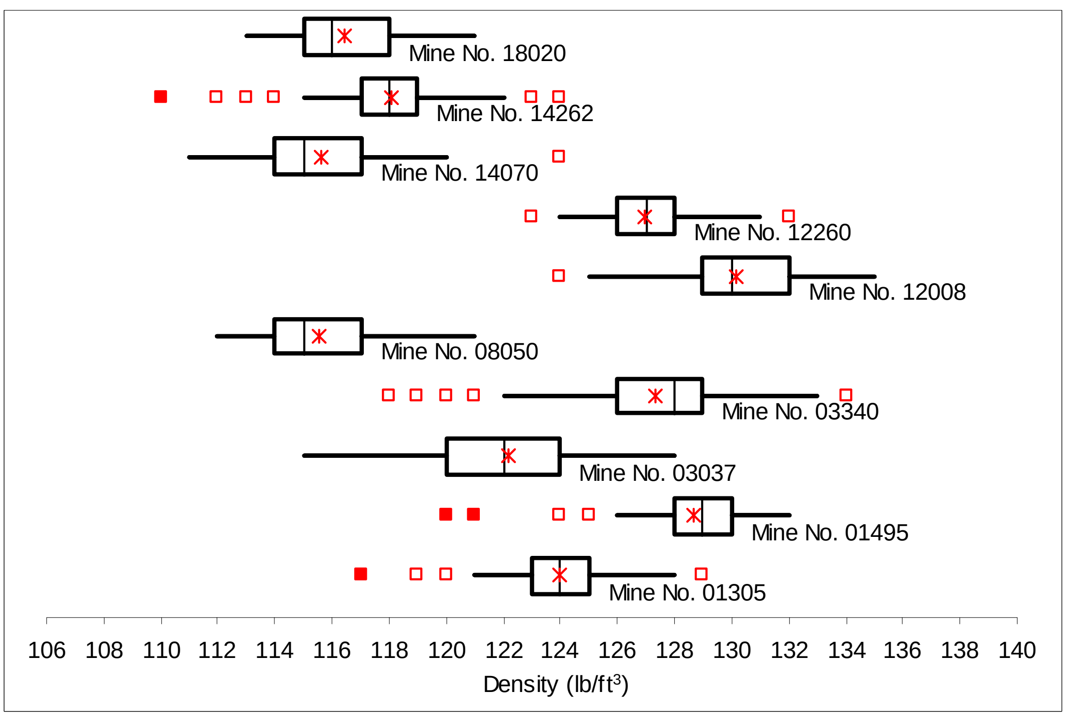

Figure 3-3. Box-Whisker Plot Comparison of Raw Pit Proctor Data from Selected Mines

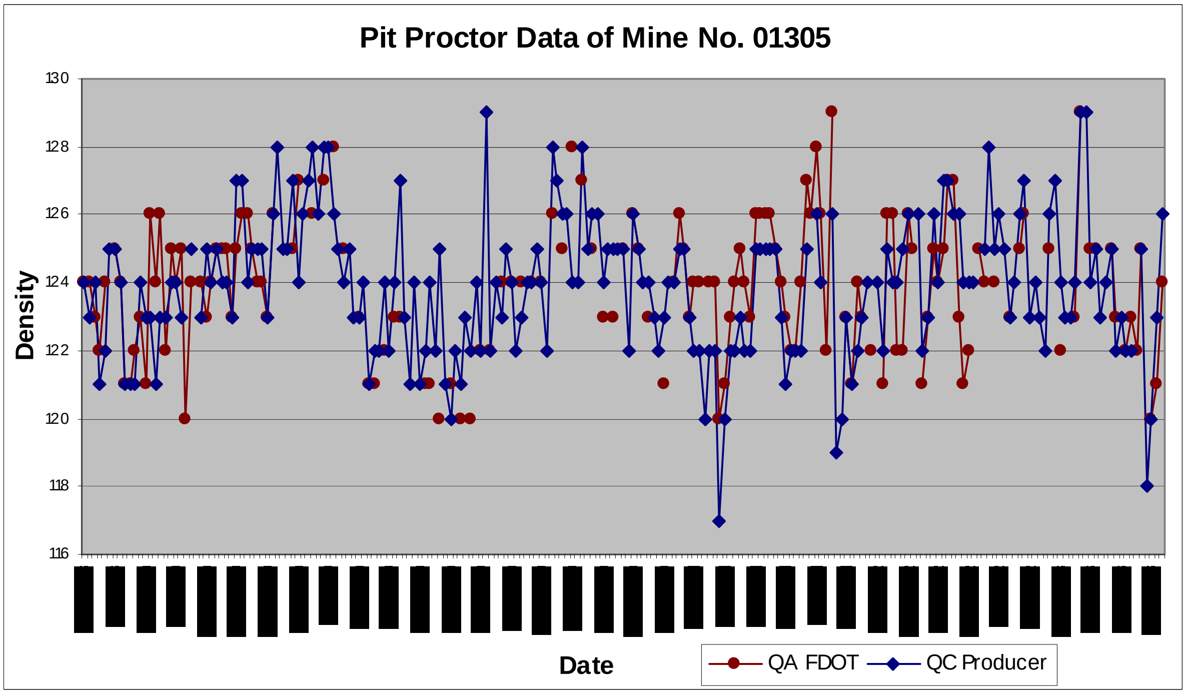

Figure 3-4. A Sample of Raw Pit Proctor Data from Mine No. 01305

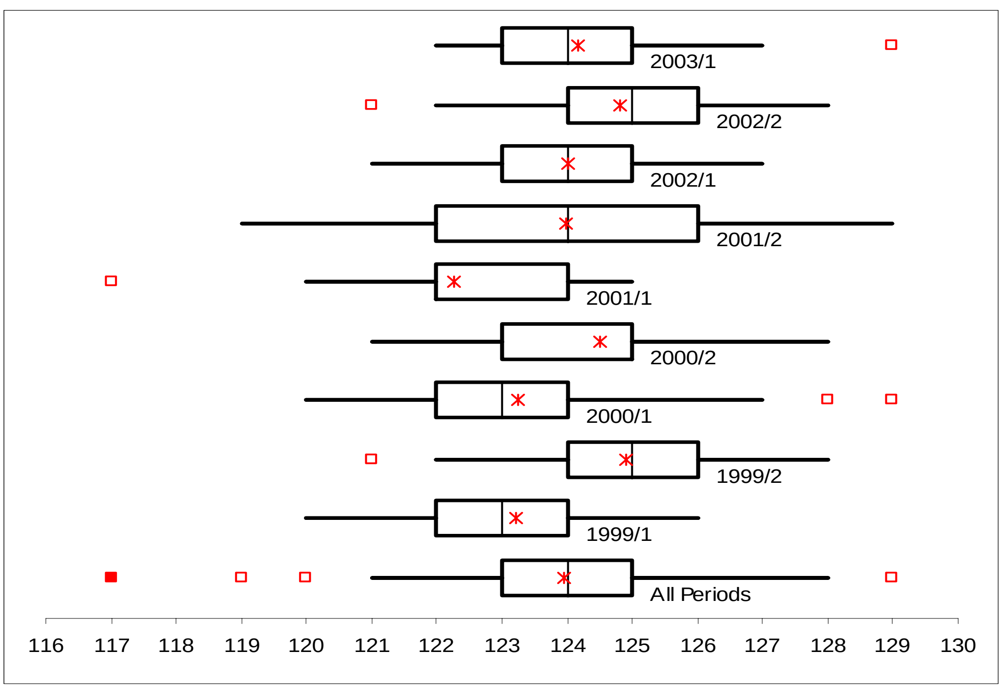

Figure 3-5. 6-Month Period Box-Whisker Plot of raw Pit Proctor data from Mine No. 01305

3.2.2 Initial statistical analysis of mine data

The objective of the initial statistical analysis was to obtain an understanding of the mine proctor test data to include variability, range and autocorrelation with time. The first analysis activities consisted of fundamental exploratory data analysis and the generation of descriptive statistics for the mine proctor data, using the maximum proctor density value. Three representative mines were chosen for initial analysis. A basic descriptive statistics of each mine was summarized in Table 3-1.

Table 3-1. Summary Statistics of Sample Data Set

Mine No.	**01305**		**01495**		**01511**	
Source	**QA**	**QC**	**QA**	**QC**	**QA**	**QC**
Sample Size	147	205	80	79	28	28
Mean	123.9	123.9	128.6	129.0	128.3	129.1
Median	124	124	129	129	128	129
Variance	3.908	4.163	3.688	4.705	5.602	7.164
Std. Dev.	1.977	2.040	1.921	2.169	2.367	2.677
Minimum	120	117	121	120	125	125
Maximum	129	129	133	134	133	133
Range	9	12	12	14	8	8
Skewness	0.0580	-0.0517	-0.9508	-1.0684	0.3463	-0.0894
Kurtosis	2.6671	3.4144	5.3649	5.8859	1.9960	1.7799

Monthly and yearly averages were plotted and examples of each were shown in Figure 3-6 and Figure 3-7, respectively. Six-point average and six-point moving average were plotted and examples of each were shown in Figure 3-8 and Figure 3-9, respectively. A frequency histogram for each mine was plotted and a sample was shown in Figure 3-10. Samples of yearly and 6-month period frequency histogram were shown in Figure 3-11 and Figure 3-12, respectively.

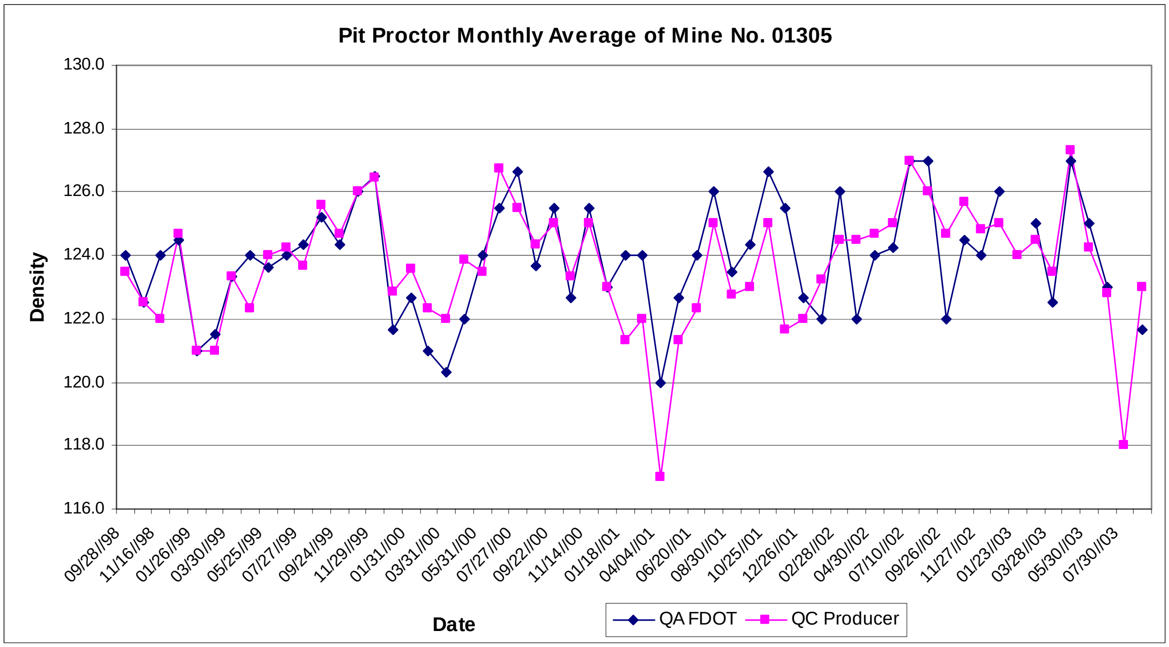

Figure 3-6. Monthly Average of Mine No. 01305

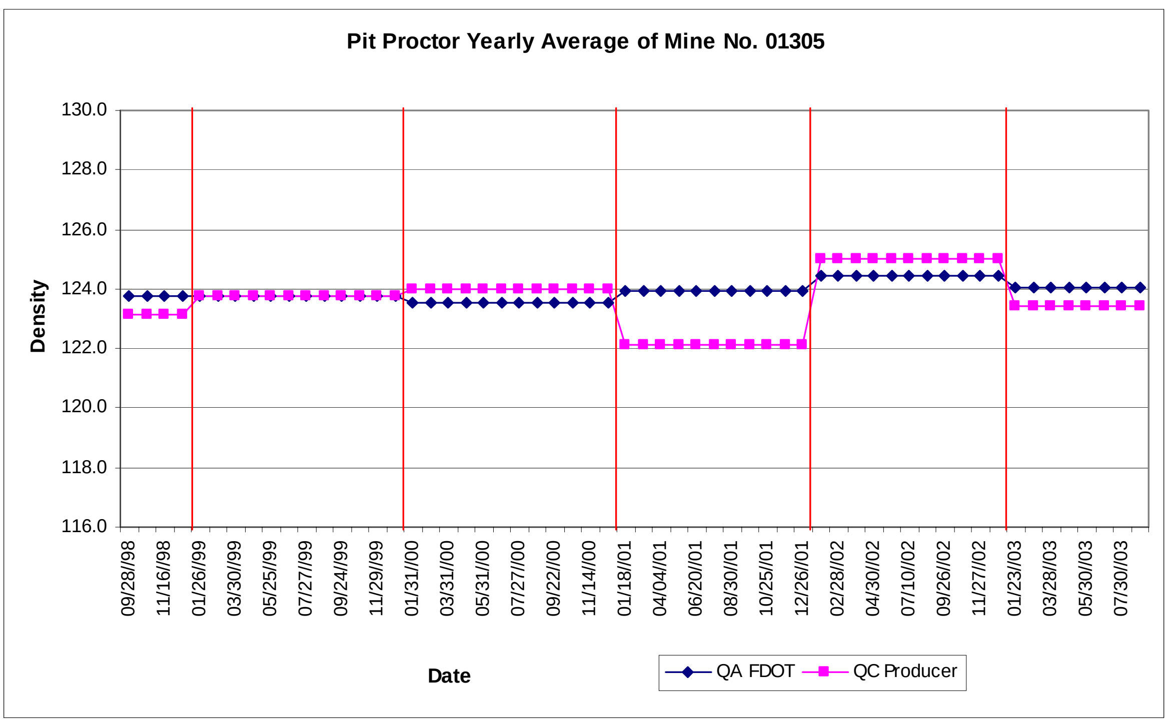

Figure 3-7. Yearly Average of Mine No. 01305

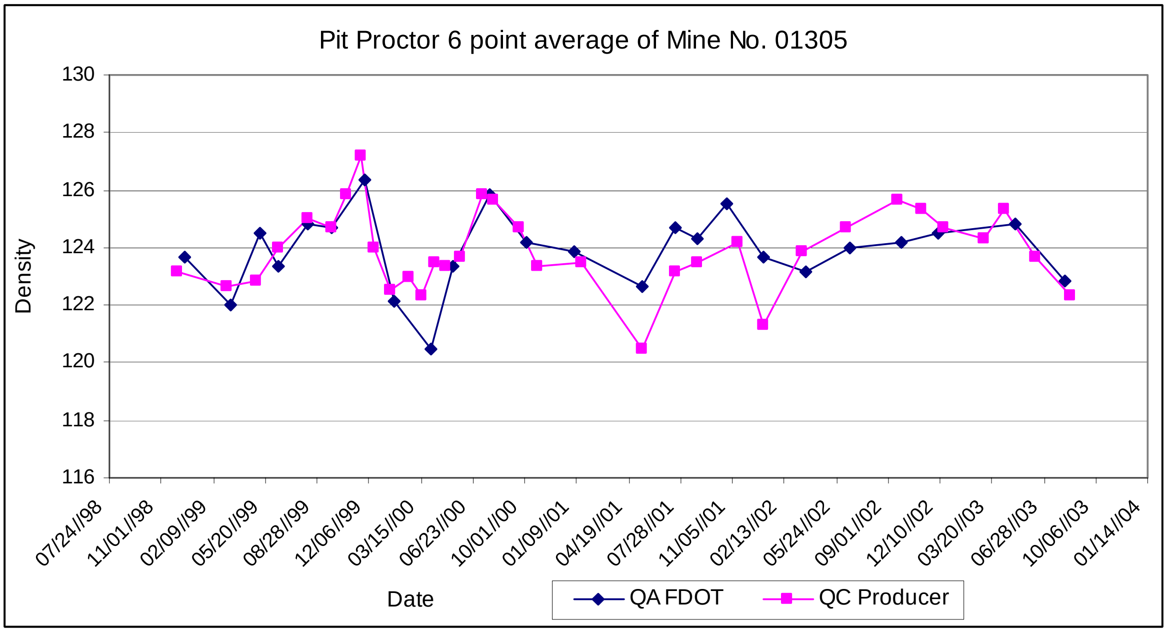

Figure 3-8. Six-point Average of Mine No. 01305

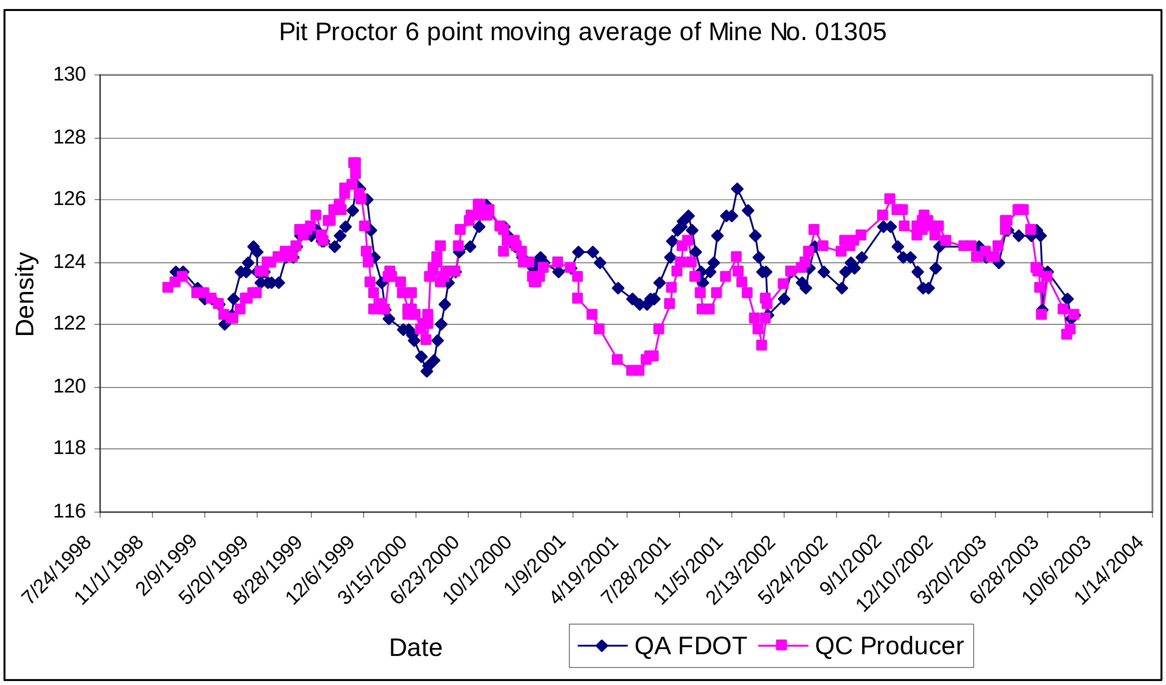

Figure 3-9. Six-point Moving Average of Mine No. 01305

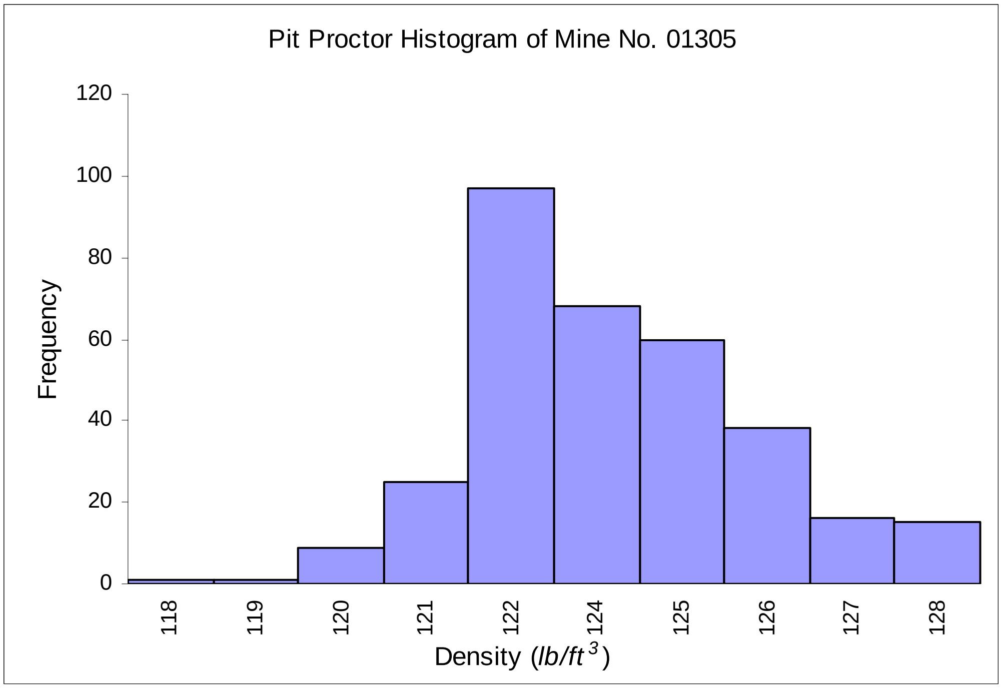

Figure 3-10. Frequency Histogram of Mine No. 01305

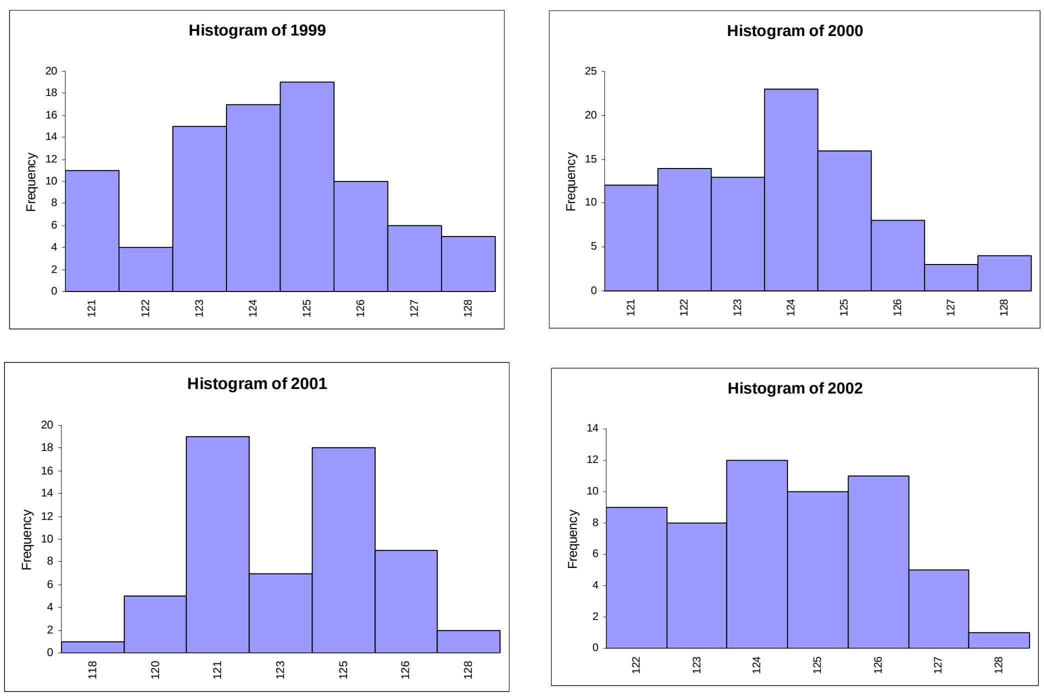

Figure 3-11. Yearly Frequency Histogram of Mine No. 01305

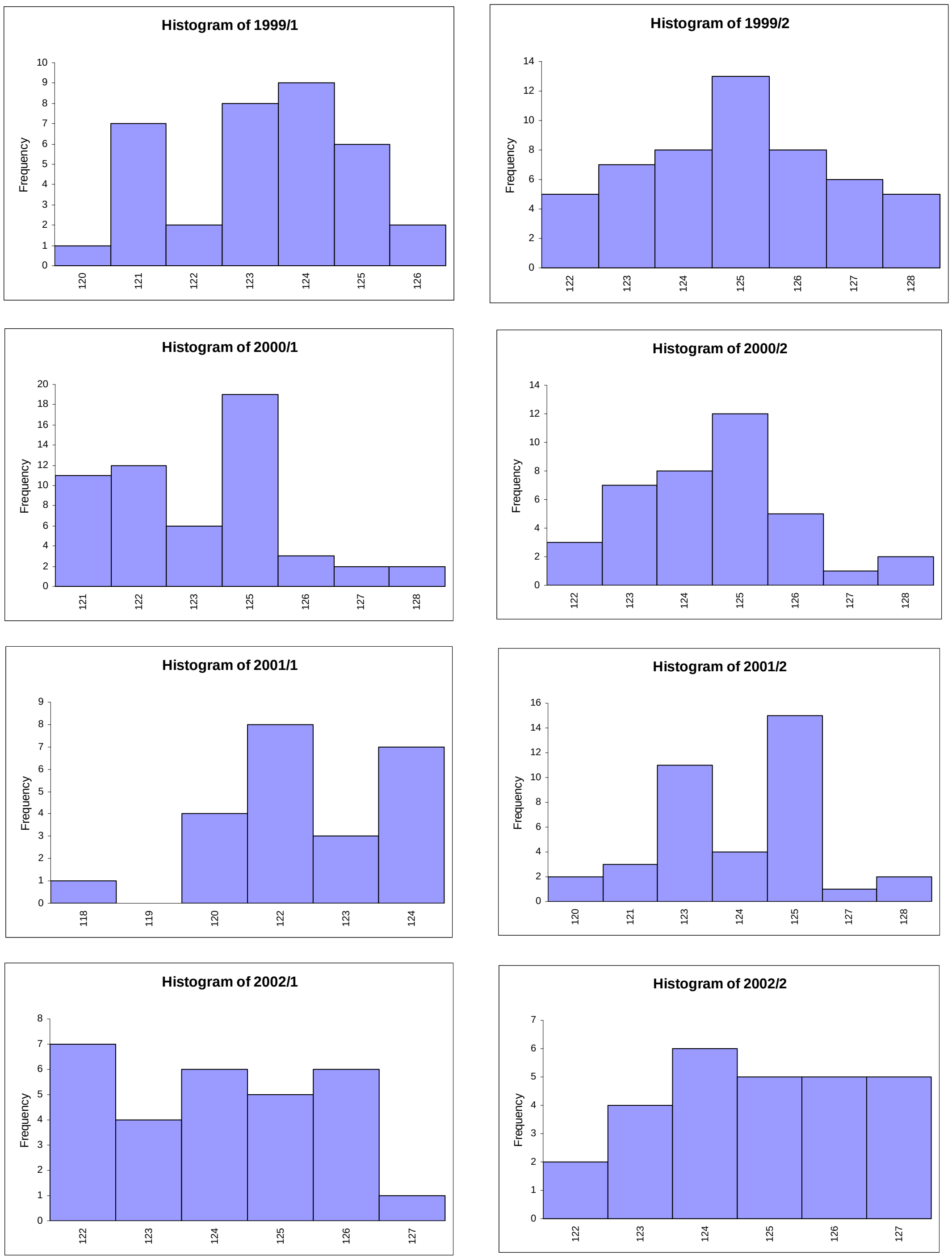

Figure 3-12. 6-month Period Frequency Histogram of Mine No. 01305

A hypothesis test was performed to determine if there was a significant difference between the means of the OC and QA tests results. Two-sample t-test was performed for each mine. The test results and significant levels were summarized in Table 3-2. The results of the analyses appeared that no statistically significant difference was found between the QC and QA test values.

Table 3-2. Two-Sample t-Test for QA/QC Effect

Mine No.	Source	t-Test Statistic	p-Value	Significant levels
01305	QA	-0.1680	0.8667	Not Significant
	QC			
01495	QA	-1.3090	0.1925	Not Significant
	QC			
01511	QA	-1.3223	0.1916	Not Significant
	QC			

3.2.3 Further statistical analysis of mine data

A meeting of the research coordinating team was held to review and discuss the results of the preliminary statistical analysis. The initial findings indicated that the average proctor values varied for most mines varied only a few pounds from month to month. The indication was that establishing a mine proctor value was feasible for most of the mines. The coordinating team suggested a trail analysis comparing the 95 percentile value from the period to the average value for the current period. The idea was to use the 95% value from the previous period as the Pit Proctor value for the current period.

The research team performed the further analysis. Data from each mine were analyzed and example plots of this analysis are shown in Figure 3-13 and Figure 3-14. The average distance from the trial Pit Proctor values and the actual values for the current periods was 2.7 lb/ft^3 as shown in Table 3-3. In most cases, the trial Pit Proctor value didn’t fall below the actual value. Some trial values fell below the actual values. However, it usually happened in the mines where QA/QC Pit Proctor data was available at only temporary period. In some instances the analysis is less precise than it could be because of the difference in the number of test data values from period to period. Establishing a minimum number of tests per period or month would improve the statistical calculation.

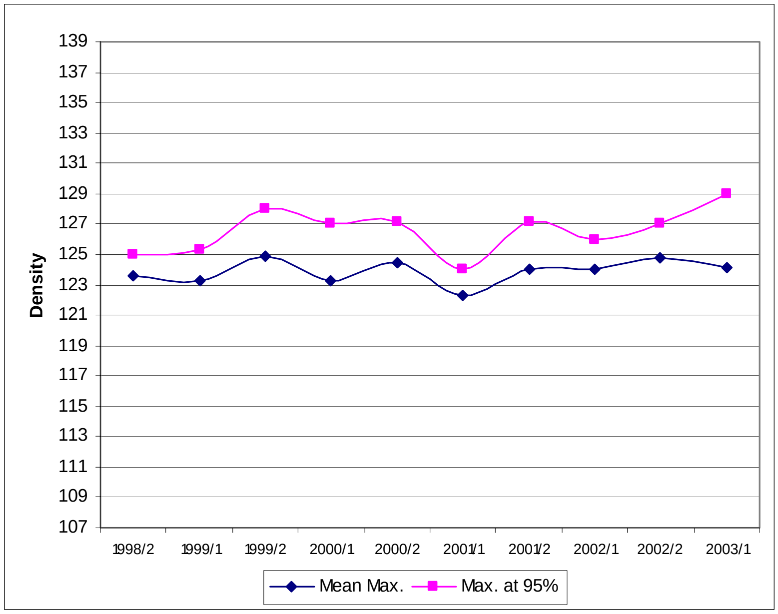

Figure 3-13. Plot of Average Maximum Proctor and Maximum 95 Percentile value of Mine No. 01305

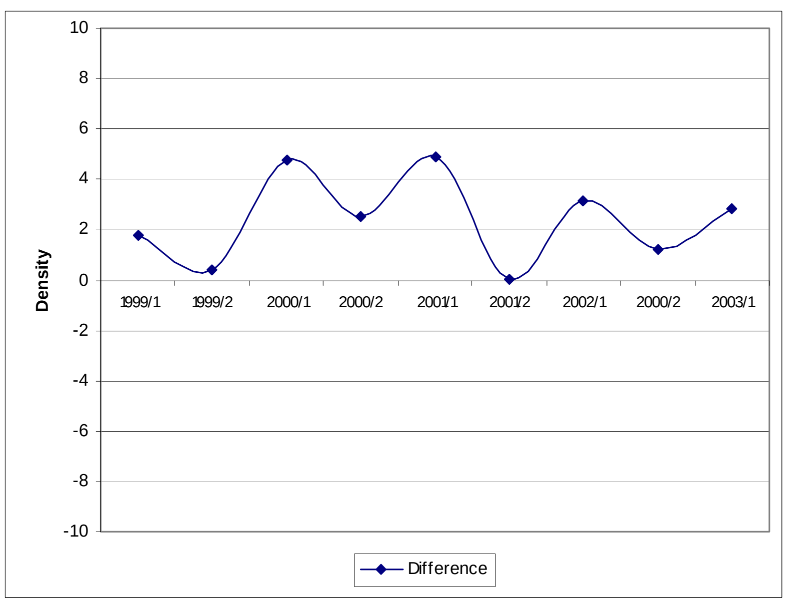

Figure 3-14. Plot of the Difference between the 95 Percentile Value from the Previous Period and the Average Value for the Current Period of Mine No. 01305

Table 3-3. Average of the Difference between Pit Target Value from Previous Period and Mean Value from Current Period

Mine No.	Average of Difference	Mine No.	Average of Difference
01305	2.4	36350	3.8
01495	2.3	36356	4.7
01511	4.6	36527	2.8
01552	-1.7	37007	3.1
02018	1.7	37112	2.7
03037	3.0	37304	3.9
03038	3.7	38036	3.0
03340	2.4	38228	4.7
03479	2.4	53271	3.5
05354	3.3	53311	2.8
08050	2.4	53357	3.9
12008	2.6	53390	3.2
12260	2.3	53543	4.6
12521	3.7	56465	4.3
13276	2.1	61391	2.4
14070	2.6	70279	1.9
14262	2.1	70483	2.1
16231	2.2	87063	1.9
17091	2.2	87089	2.0
18020	2.2	87145	1.8
18056	2.7	87223	N/A
18058	2.7	87264	2.4
18393	2.6	87339	1.9
18522	2.9	87343	2.1
26001	3.1	87428	2.3
26002	2.7	87541	1.3
26096	1.8	87542	2.1
26098	3.2	91404	2.9
26099	1.5	93366	3.7
26100	2.3	93406	3.1
33496	2.7	93497	1.8
33567	2.6	94209	1.8
34106	N/A	94414	1.7
36053	3.0	94488	1.4
36246	3.7	**Average Total**	**2.7**

3.2.4 In-depth statistical analysis of mine data

The research team performed an in-depth statistical analysis of Pit Proctor values from selected mines, which have consistent Pit Proctor values during study period. Eleven mines were selected and analyzed. Sample size of each mine varied from 87 to 625 during four-year study period.

First, a hypothesis test was performed to determine if there was a significant difference between the means of the QA and QC tests results. Two-sample t-test was performed for each mine. Summary statistics of sample mines and the t-test results were summarized in Table 3-4. The results of the analyses appeared that statistically significant differences were found between the QA and QC test values in some mines, although no statistically significant differences were found at the initial analysis of three representative mines.

Second, another hypothesis test was performed to determine if there was a significant difference between the means of the yearly QA and QC tests results. Two-sample t-test was performed for each year and each mine. Summary statistics of sample mines and the t-test results for non-significant mines based on the first hypothesis test were summarized in Table 3-5 and for significant mines in Table 3-6, respectively. The results of the analyses appeared that statistically significant differences were found between the yearly QA and QC test values in most mines. Although no statistically significant differences were found at the first t-test for QA/QC effect in four mines, some yearly QA/QC effects were found in three mines. Only one mine, Mine No. 03340, was not statistically significant in both tests.

Finally, the same analysis was performed for a biannual period basis. The test results were similar to the yearly period tests for each mine. Mine No. 03340 was not statistically significant in this test, either. In this analysis, the yearly QA/QC effect generally divided into one or two biannual QA/QC effect. For example, the means of QA and QC data in 1999 from Mine No. 01495 were statistically turned out to be different from each other. The test of the first half-year period was turned out to be statistically significant. The means of the other half-year period QA and QC data were not different from each other.

Thus, the results of in-depth statistical analysis indicate that it might be reasonable to utilize Pit Proctors based on a more reliable source than the other. However, it is not found that which data source is statistically more reliable through this analysis.

Table 3-4. Summary Statistics and Two-Sample t-Test for QA/QC Effect

Mine No.	Source	Mean	Median	Std. Dev.	Minimum	Maximum	Sample Size	t-Test Statistics	p-Value	Significant Levels
01305	QA	123.9	124	1.99	120	129	137	-0.220	0.826	Not Significant
	QC	124.0	124	2.01	117	129	193			
01495	QA	128.4	129	1.88	121	131	67	-1.575	0.118	Not Significant
	QC	128.9	129	2.14	120	132	66			
03037	QA	121.9	122	2.88	115	128	45	-1.080	0.283	Not Significant
	QC	122.5	123	2.59	118	128	42			
03340	QA	127.4	128	3.15	118	134	87	0.559	0.577	Not Significant
	QC	127.2	128	3.30	118	133	86			
08050	QA	115.9	116	1.48	112	121	151	3.488	0.001	0.01
	QC	115.3	115	1.51	112	121	179			
12008	QA	129.7	130	2.08	124	134	89	-3.258	0.001	0.01
	QC	130.6	131	1.75	126	135	88			
12260	QA	126.5	126	1.71	123	132	76	-3.655	< 0.001	0.01
	QC	127.4	127	1.50	124	131	74			
14070	QA	115.9	116	1.88	112	120	101	1.808	0.072	0.1
	QC	115.4	115	2.09	111	124	159			
14262	QA	118.4	118	1.98	114	124	176	3.467	0.001	0.01
	QC	117.8	118	1.84	110	123	449			
18020	QA	117.0	117	1.75	113	121	82	3.993	< 0.001	0.01
	QC	116.0	116	1.33	113	120	85			
18056	QA	115.2	115	2.00	110	121	111	7.359	< 0.001	0.01
	QC	113.6	114	1.12	111	116	112			

Table 3-5. Two-Sample t-Test for Yearly QA/QC Effect of Non-Significant Mines Based on the t-Test for QA/QC Effect

Mine No.	Year	Source	Mean	Std. Dev.	Sample Size	t-Test Statistics	p-Value	Significant Levels
01305	2001	QA	124.2	2.074	30	3.202	0.002	0.01
		QC	122.5	2.111	31			
	2002	QA	123.9	1.891	25	-1.831	0.074	0.1
		QC	124.8	1.521	31			
01495	1999	QA	128.3	1.776	18	-1.988	0.055	0.1
		QC	129.4	1.412	17			
	2000	QA	128.6	1.758	13	-2.051	0.053	0.1
		QC	130.0	1.549	11			
03037	2000	QA	121.5	3.230	13	-2.125	0.0445	0.05
		QC	124.0	2.646	13			

Table 3-6. Two-Sample t-Test for Yearly QA/QC Effect of Significant Mines Based on the t-Test for QA/QC Effect

Mine No.	Year	Source	Mean	Std. Dev.	Sample Size	t-Test Statistics	p-Value	Significant Levels
08050	1999	QA	116.3	1.443	44	4.722	< 0.001	0.01
		QC	114.9	1.401	44			
	2000	QA	116.3	1.288	38	2.721	0.008	0.01
		QC	115.4	1.407	38			
	2001	QA	115.8	1.424	33	2.370	0.021	0.05
		QC	115.0	1.519	40			
	2002	QA	115.0	1.596	21	-2.441	0.019	0.05
		QC	116.1	1.552	34			
12008	2000	QA	129.9	2.300	20	-2.591	0.014	0.05
		QC	131.6	1.957	20			
12260	1999	QA	126.1	1.192	22	-2.839	0.007	0.01
		QC	127.1	1.236	21			
	2000	QA	126.5	1.969	22	-3.066	0.004	0.01
		QC	128.0	1.430	22			
14070	1999	QA	115.1	1.701	20	3.915	0.000	0.01
		QC	113.4	1.222	36			
	2000	QA	116.9	1.906	18	2.833	0.008	0.01
		QC	115.2	1.667	17			
	2002	QA	115.9	1.739	27	-1.927	0.059	0.1
		QC	116.7	1.871	49			
14262	1999	QA	118.3	2.016	44	2.276	0.025	0.05
		QC	117.4	2.319	96			
	2000	QA	120.1	1.744	49	2.963	0.004	0.01
		QC	119.2	1.825	98			
	2001	QA	117.8	1.143	38	2.998	0.004	0.01
		QC	117.1	1.107	99			
	2002	QA	117.2	1.458	33	-2.896	0.006	0.01
		QC	118.1	1.317	104			
18020	2001	QA	116.7	2.004	22	2.078	0.045	0.05
		QC	115.7	1.278	21			
	2002	QA	117.2	1.875	23	2.705	0.011	0.05
		QC	116.0	0.905	23			
18056	1999	QA	115.4	1.586	24	3.364	< 0.001	0.01
		QC	114.1	1.152	25			
	2000	QA	115.6	1.932	32	5.342	< 0.001	0.01
		QC	113.4	1.216	32			
	2002	QA	116.0	1.939	22	5.856	< 0.001	0.01
		QC	113.4	0.891	23			

3.2.5 Analysis of Pit Proctor data variations based on mine locations

District engineers reported that Proctor values from mines and fields in some area were very consistent with quite small variation. To investigate this idea, the research team performed another statistical analysis of Pit Proctor values based on mine locations. County and District were used for location units. Mines were divided into Counties, where they were located in. Each County has one to ten mines. Counties which have at least three mines in were selected for this study.

Standard deviation of each mine was evaluated and used for statistical analysis. A hypothesis test was performed to determine if there was a significant difference between the means of the standard deviations from each County. Summary statistics of sample Counties were summarized in Table 3-7. Two-sample t-tests were performed for sample Counties. All possible cases were tested and 19 tests were conclusive as shown in Table 3-8. The results of the analysis indicate that statistically significant differences exist between the means of the standard deviations from each County. It is also found that mines in Counties of District 4 had relatively smaller standard deviations than in other Districts as shown in Table 3-9. Particularly, Proctor values of mines located in Miami-Dade County and St. Lucie County were consistent with the least variation.

Table 3-7. Summary Statistics of Sample Counties

County	01	03	12	18	26	36	37	53	87	93	94
	Charlotte	Collier	Lee	Sumter	Alachua	Marion	Suwannee	Jackson	Miami-Dade	Palm Beach	St. Lucie
Number of Mines	4	4	3	5	6	5	3	5	10	3	3
Mean	2.34	2.75	2.10	1.92	2.11	2.45	2.59	3.30	1.62	2.17	1.70
Std. Dev.	0.37	0.59	0.53	0.23	0.33	0.38	0.73	0.62	0.33	0.44	0.13
Variance	0.14	0.35	0.28	0.05	0.11	0.14	0.53	0.39	0.11	0.20	0.02

Table 3-8. Significant Two-Sample T-Test Results

No.	County	Mean	Std. Dev.	Number of Mines	p-value	Significance Levels
1	01-CHARLOTTE	2.34	0.37	4	0.029	0.05
	53-JACKSON	3.30	0.62	5		
2	01-CHARLOTTE	2.34	0.37	4	0.028	0.05
	87-MIAMI-DADE	1.62	0.33	10		
3	01-CHARLOTTE	2.34	0.37	4	0.048	0.05
	94-ST. LUCIE	1.70	0.13	3		
4	03-COLLIER	2.75	0.59	4	0.076	0.1
	18-SUMTER	1.92	0.23	5		
5	03-COLLIER	2.75	0.59	4	0.036	0.05
	87-MIAMI-DADE	1.62	0.33	10		
6	03-COLLIER	2.75	0.59	4	0.040	0.05
	94-ST. LUCIE	1.70	0.13	3		
7	12-LEE	2.10	0.53	3	0.045	0.05
	53-JACKSON	3.30	0.62	5		
8	18-SUMTER	1.92	0.23	5	0.038	0.05
	36-MARION	2.45	0.38	5		
9	18-SUMTER	1.92	0.23	5	0.006	0.01
	53-JACKSON	3.30	0.62	5		
10	18-SUMTER	1.92	0.23	5	0.070	0.1
	87-MIAMI-DADE	1.62	0.33	10		
11	26-ALACHUA	2.11	0.33	6	0.012	0.05
	53-JACKSON	3.30	0.62	5		
12	26-ALACHUA	2.11	0.33	6	0.015	0.05
	87-MIAMI-DADE	1.62	0.33	10		
13	26-ALACHUA	2.11	0.33	6	0.034	0.05
	94-ST. LUCIE	1.70	0.13	3		
14	36-MARION	2.45	0.38	5	0.040	0.05
	53-JACKSON	3.30	0.62	5		
15	36-MARION	2.45	0.38	5	0.004	0.01
	87-MIAMI-DADE	1.62	0.33	10		
16	36-MARION	2.45	0.38	5	0.010	0.01
	94-ST. LUCIE	1.70	0.13	3		
17	53-JACKSON	3.30	0.62	5	0.002	0.01
	87-MIAMI-DADE	1.62	0.33	10		
18	53-JACKSON	3.30	0.62	5	0.031	0.05
	93-PALM BEACH	2.17	0.44	3		
19	53-JACKSON	3.30	0.62	5	0.005	0.01
	94-ST. LUCIE	1.70	0.13	3		

Table 3-9. District Based Comparison of Two-Sample T-Test

Counties in District 4	Counties in Other Districts	p-value	Significance Levels
94-ST. LUCIE	01-CHARLOTTE	0.048	0.05
94-ST. LUCIE	03-COLLIER	0.040	0.05
94-ST. LUCIE	26-ALACHUA	0.034	0.05
94-ST. LUCIE	36-MARION	0.010	0.01
94-ST. LUCIE	53-JACKSON	0.005	0.01
93-PALM BEACH	53-JACKSON	0.031	0.05
87-MIAMI-DADE	01-CHARLOTTE	0.028	0.05
87-MIAMI-DADE	03-COLLIER	0.036	0.05
87-MIAMI-DADE	18-SUMTER	0.070	0.1
87-MIAMI-DADE	26-ALACHUA	0.015	0.05
87-MIAMI-DADE	36-MARION	0.004	0.01
87-MIAMI-DADE	53-JACKSON	0.002	0.01

3.3 Field Data Analysis

A meeting of the research coordinating team was held to review and discuss the results of the latest analysis. In the meeting, the agenda for additional activities were established. Particularly, it was needed to analyze and compare project field density values with proposed Pit Proctor values for additional activities. Researchers used the Maximum 95 percentile value of the previous 12-month period for the Pit Proctor target value in this study.

3.3.1 Field data transposition and description

The research team visited FDOT project sites and obtained project field proctor and test density data from four highway projects for comparison purposes. The data was analyzed and compared project field density values with proposed Pit Proctor values. The data were originally obtained as a paper copy and were transposed to an Excel file for analysis. Two mine sources were used for the four highway projects:

- Mine No. 36246
    - Project FIN 21025315210
    - Project FIN 21040915210
- Mine No. 93406
    - Project FIN 21049915210
    - Project FIN 21079715210

Testing frequency of Pit Proctor data was 2 or 4 testing per month. The details of Pit Proctor data are summarized in Appendix B of this report. The components of this analysis are Pit Proctor Acceptable Limits, Lab Proctor Acceptable Limits, and Nuclear density values. Brief statistics of the sources are summarized in Table 3-10.

Table 3-10. Summary Statistics of Field Data Sources

Project ID	**FIN 210253**			**FIN 210409**		
Source	**Pit Target**	**Lab Target**	**Nuclear Density**	**Pit Target**	**Lab Target**	**Nuclear Density**
Mean	121.9	117.8	118.1	121.9	120.0	120.2
Std. Dev.	-	1.299	1.659	-	1.055	1.435
Minimum	-	114.8	115.4	-	117.4	117.0
Maximum	-	120.8	119.8	-	121.1	126.4
Range	-	6.0	4.4	-	3.7	9.4
Project ID	**FIN 210499**			**FIN 210797**		
Source	**Pit Target**	**Lab Target**	**Nuclear Density**	**Pit Target**	**Lab Target**	**Nuclear Density**
Mean	130.0	127.4	127.1	130.0	126.5	128.2
Std. Dev.	0.052	2.454	2.528	0.075	4.100	4.377
Minimum	129.8	122.9	120.3	129.8	117.5	118.7
Maximum	130.0	131.0	132.7	130.0	129.2	136.1
Range	0.2	8.2	12.4	0.2	11.7	17.4

3.3.2 Analysis of field data

The research team performed the analysis and comparison of project field density values to proposed Pit Proctor target values. The following results of analysis are included in Appendix B of this report:

- Details of QA/QC Pit Proctor values
- Details of Actual Lab Proctor target density and Nuclear density values
- Comparison of actual field density values to trial Pit Proctor target values
- Comparison of the difference between two target acceptable limits

The maximum 95 percentile Pit Proctor targets based on the previous 3-month, 6-month, and 12-month periods are compared with the Lab Proctor targets. Differences between the three Pit targets and Lab targets are plotted in Figure 3-15, 3-16, and 3-17 respectively. In the previous 3-month and 6-month periods, some Pit Proctor target values were smaller than the actual Lab Proctor values. However, the previous 12-month period Pit Proctor target values were greater than the Lab Proctor values. It indicates that the longer period of Pit Target will make the more conservative target value. Thus, researchers used the maximum 95-percentile value of the previous 12-month period for the Pit Proctor target value in this study.

In the field study, all nuclear density test results met the actual Lab Proctor acceptable limits. The passing rates of nuclear density values were 98% to 105% of Lab Proctor values. That is, a range of 0 to 10 lb/ft^3 was over the Lab Proctor acceptable limits. To satisfy the Department's specification on compaction, contractors made an average of 2.5 lb/ft^3 extra compaction efforts for base materials during projects. However, the Pit Proctor acceptable limits are usually greater than the actual Lab Proctor acceptable limits. Thus, the contractors are theoretically expected to make a little bit more efforts to satisfy the proposed Pit Proctor target acceptable limit instead of the Lab Proctor. In this field study, the researchers investigated the contractor's compaction efforts based on the proposed Pit Proctor target acceptable limit. Interestingly, the contractors were still making an average of 0.7 lb/ft^3 extra compaction efforts for base materials during projects. Although the average nuclear density value is greater than the proposed Pit Proctor acceptable limit, it happened that some individual nuclear density values didn't meet the

Pit Proctor acceptable limit. Summary statistics of differences between acceptable target limits and nuclear densities are summarized in Table 3-11.

The researchers compared the differences between two targets, the Pit Proctor and the Lab Proctor, based on the previous 1-month period and 12-month period. An example plot of field study results for a FDOT project is shown in Figure 3-18. Comparison of the difference between two acceptable limits was also performed. Difference between acceptable limit based on the previous12-month period maximum 95% Pit Proctor target and nuclear density is plotted in Figure 3-19. The difference between the acceptable limit based on Lab Proctor target and nuclear density is compared in Figure 3-20.

Table 3-11. Summary Statistics of Differences between Nuclear Densities and Acceptable Limits

Project ID	**FIN 210253**		**FIN 210409**	
Source	Nuclear Density vs. Pit Target Limit	Nuclear Density vs. Lab Target Limit	Nuclear Density vs. Pit Target Limit	Nuclear Density vs. Lab Target Limit
Mean	-1.68	1.71	0.76	2.61
Std. Dev.	1.299	1.462	1.435	1.482
Minimum	-4.66	-0.46	-2.47	-0.47
Maximum	1.34	5.82	6.95	8.95
Range	6.00	6.28	9.43	9.43
Project ID	**FIN 210499**		**FIN 210797**	
Source	Nuclear Density vs. Pit Target Limit	Nuclear Density vs. Lab Target Limit	Nuclear Density vs. Pit Target Limit	Nuclear Density vs. Lab Target Limit
Mean	-0.31	2.12	0.82	4.20
Std. Dev.	2.530	1.590	4.316	2.443
Minimum	-7.09	-0.58	-8.52	-0.12
Maximum	5.32	6.71	8.69	9.45
Range	12.42	7.29	17.21	9.57

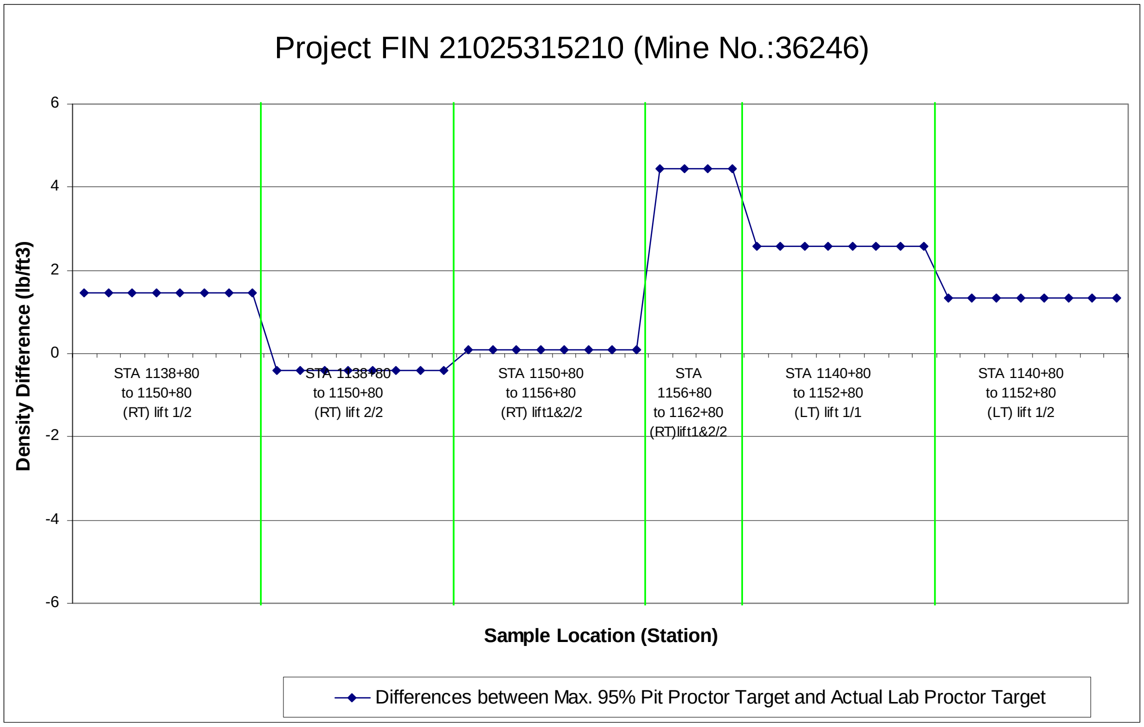

Figure 3-15. Difference between Previous 3-Month Period Pit Target and Lab Target

Figure 3-16. Difference between Previous 6-Month Period Pit Target and Lab Target

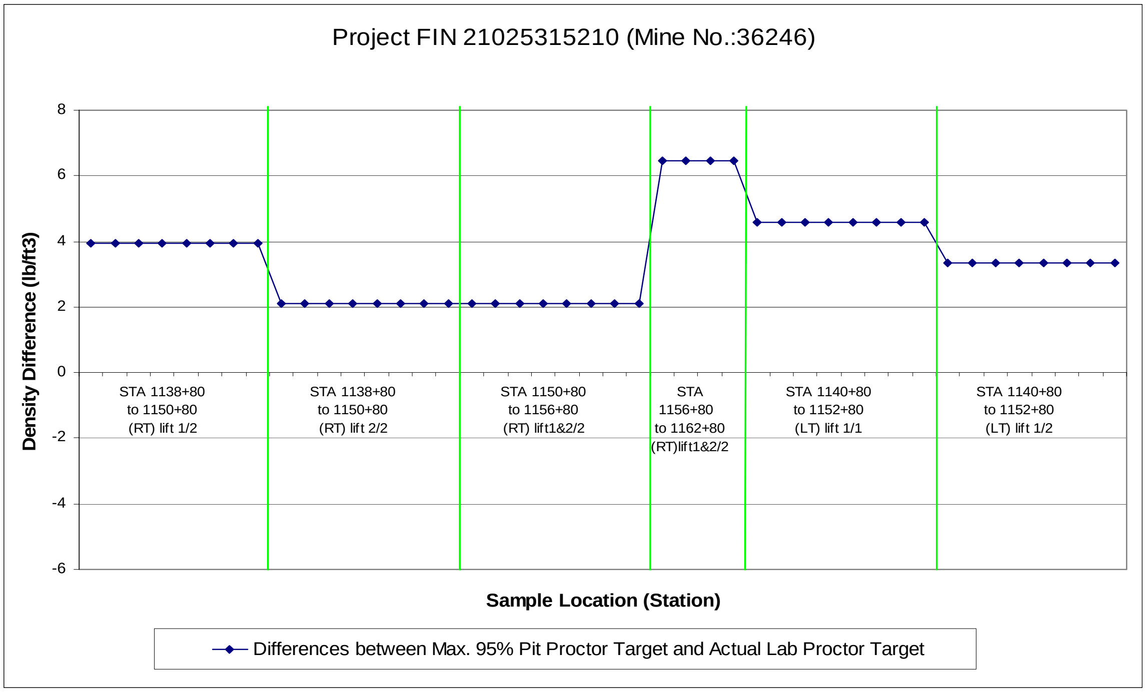

Figure 3-17. Difference between Previous 12-Month Period Pit Target and Lab Target

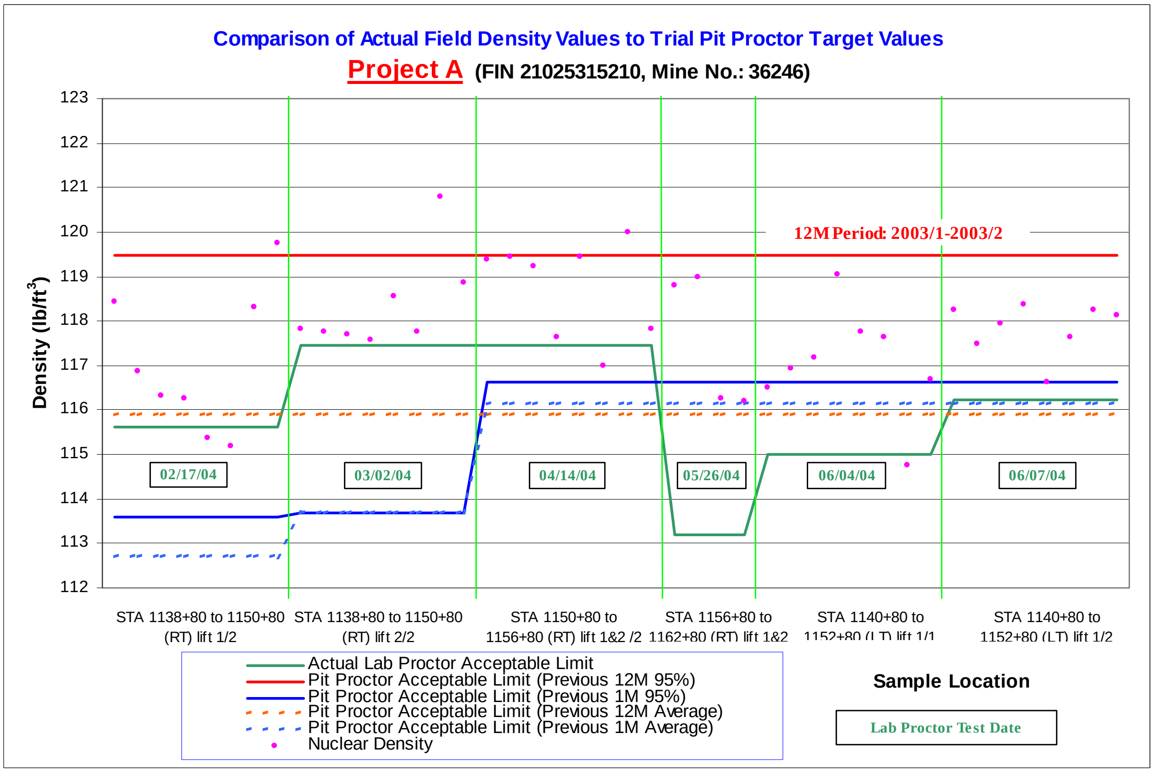

Figure 3-18. An Example Plot of Field Study Results for a FDOT Project [1]

[1] See Appendix B for additional plots of field study results

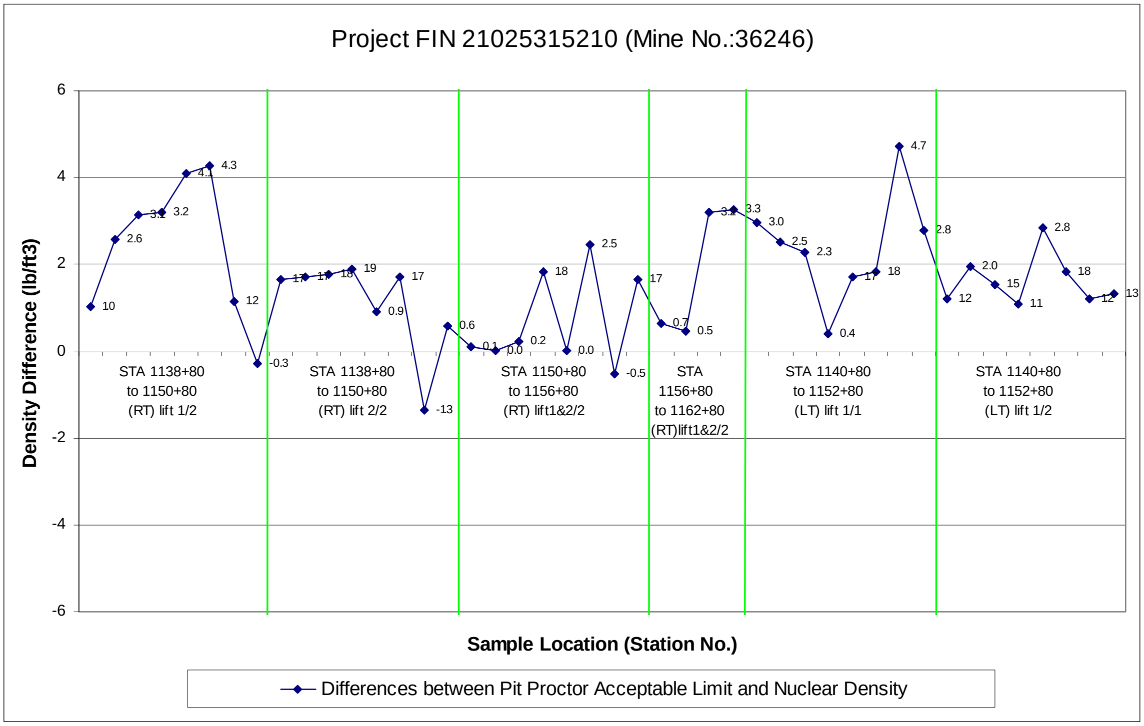

Figure 3-19. Plot of Differences between Pit Proctor Acceptable Limit and Nuclear Density

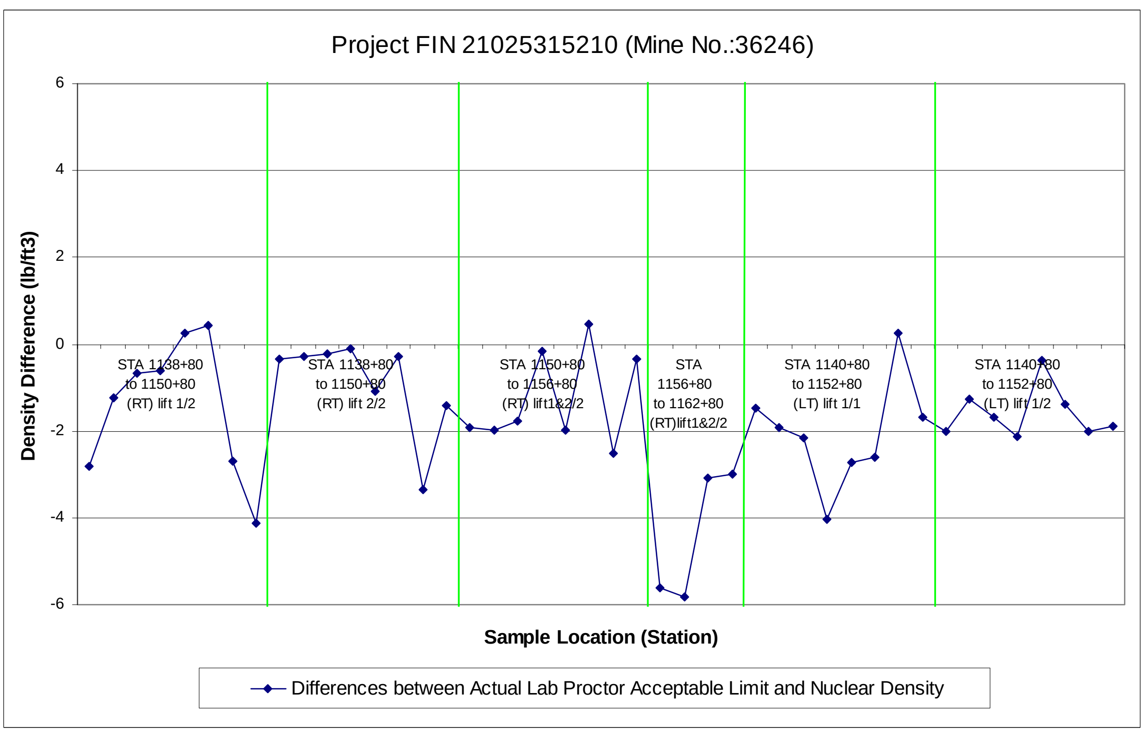

Figure 3-20. Plot of Differences between Actual Lab Proctor Acceptable Limit and Nuclear Density

4. CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

The FDOT currently collects and maintains records of proctors test taken at all mines. Sampling frequency is from 1 to 8 times per month. A review of the historical proctor test values for 69 mines indicates that typically 50% of the proctor values are within 2 – 4 lbs. of the mean. A comparison of actual project laboratory proctor values, field densities and mine proctor values was performed on four FDOT construction projects. The following possible acceptance criteria were considered and compared to the actual project values:

- 95 percentile of the previous 12 months of mine proctor test values
- 95 percentile of the previous 1 month of mine proctor test values
- Average of the previous 12 months of mine proctor test values
- Average of the previous 1 month of mine proctor test values

4.2 Recommendations

- The above results provide interesting indications of how acceptance criteria based upon a mine proctor might be developed. For instance, in this study, the 95 percentile of the previous 12 months of mine proctor test values, is consistently higher than actual lab proctor acceptable limit and could provide a possible acceptable criteria. However, in order to base the acceptance on a large population of field data, this study recommends that FDOT explore the use of pit proctors on several pilot projects in all the Districts. Project selection will be structured to include a representative distribution of mines. The additional information gained from these trials would assist the FDOT in formulating an acceptance criteria for the pit proctor.

4.3 Benefits

- Improved production efficiency and construction cost savings
- Reduced testing costs
- Reduced construction time

LIST OF REFERENCES

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5. FSTM, "Florida Method of Test for Moisture-Density Relations of Soils Using a 4.54 kg Rammer and a 457 mm Drop," Florida Sampling and Testing Method, 2002.
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APPENDIX A

Survey Summary:

- Survey Letter and Questionnaire
- Survey Questionnaire Flowchart
- The list of states that responded to the survey
- Approaches used by DOTs & QA/QC Processe Tools when utilizing Pit Proctors
- Required construction procedures for mined base material
- List of DOTs participating in the survey

Survey of State Highway Agencies

Development of Procedures for Utilizing Pit Proctors in the FDOT Construction Process for Construction of Pavement Base Materials

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Background:

The University of Florida has been asked by the Florida Department of Transportation to conduct a research study focusing on developing procedures for utilizing Pit Proctors in construction process for construction of pavement base materials.

The FDOT maintains extensive materials control databases on mined base materials. Material quality is sampled at the mine and at the project sites. However, the current construction procedure requires that the material be sampled when delivered to the project site and that a laboratory proctor be established for the delivered material. The time required to sample and perform the laboratory proctor testing can be from 3 to 4 days. This time delay frequently causes a delay in the construction process. On many projects a significant amount of base material is installed daily. A delay of several days while waiting on the proctor testing causes problems for the construction operations and can affect the timely completion of the project.

From this inquiry, we hope to learn how other transportation agencies are utilizing Pit Proctors and to develop guidelines for pre-establishing a Pit Proctor to be utilized in construction for a given material source and project.

Survey Form

1. Does your organization utilize Pit Proctors for construction process of pavement base materials?
   - □ Yes (Please complete **Questions 2-6**)
   - □ No (If your answer is no, please answer **Questions 2-3** and return the survey.

   Thank you for your time and effort)

2. What kinds of construction procedures are currently required for mined base material?

3. Does your organization require laboratory proctor testing for mined material delivered to a job site?
   - □ Yes
   - □ No

If your answer is **yes**, typically it takes   days to get results of the required testing.

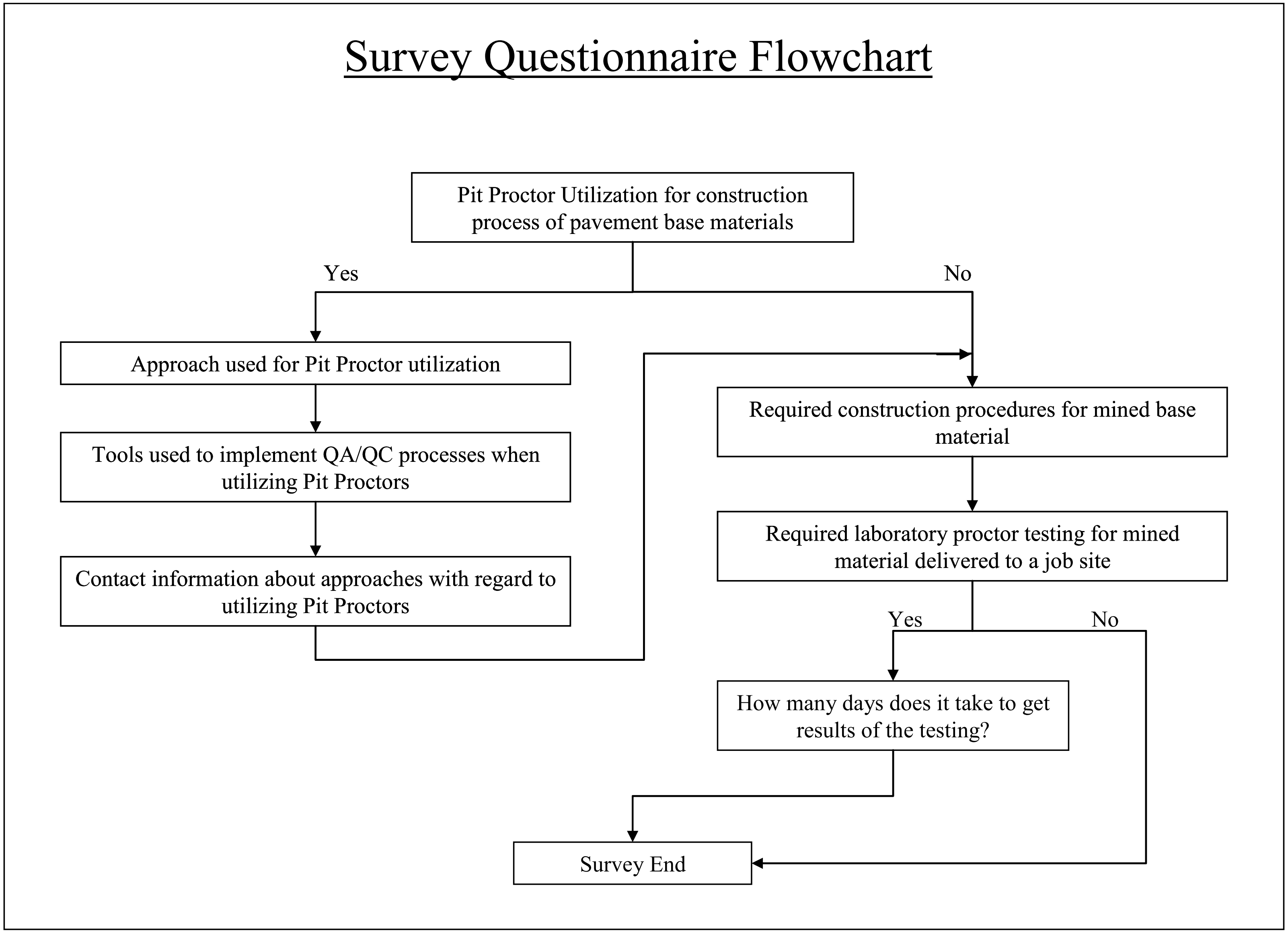
4. What approach does your organization use for utilization Pit Proctor?
   - □ Acceptable limits for proctor variability
   - □ Self-certified mine
   - □ Other approach (   )

5. What other tool does your organization use to implement QA/QC processes when utilizing Pit Proctors?

6. With whom should we speak for more information about your organization's approaches with regard to utilizing Pit Proctors?

Please EMAIL or FAX the completed survey form to:

Email: pyeon@ufl.edu / Fax (352) 392-8487
Ralph D. Ellis, Jr., Ph.D., P.E.
Department of Civil Engineering
University of Florida
Phone (352) 392-9537 ext. 1485


Survey Questionnaire Flowchart
Pit Proctor Utilization for construction process of pavement base materials
Yes
No
Approach used for Pit Proctor utilization
Tools used to implement QA/QC processes when utilizing Pit Proctors
Contact information about approaches with regard to utilizing Pit Proctors
Required construction procedures for mined base material
Required laboratory proctor testing for mined material delivered to a job site
Yes
No
How many days does it take to get results of the testing?
Survey End

Summary of Pit Proctor Utilization Survey Responses

No.	States	Utilizing Pit Proctors		Lab Proctor Testing	
		Yes	No	Yes	No
1	ALABAMA		x	3 days	
2	ALASKA		x	2-3 days	
3	ARIZONA		x	1 day	
4	COLORADO	x		2-3 days	
5	GEORGIA	x			x
6	HAWAII	x		6 days	
7	ILLINOIS		x	3-4 days	
8	INDIANA		x	5 days	
9	IOWA		x		x
10	KANSAS		x	2-3 days	
11	KENTUCKY		x		x
12	MAINE		x	2-3 days	
13	MARYLAND		x	4 days	
14	MASSACHUSETTS		x	7 days	
15	MICHIGAN		x		x
16	NEBRASKA		x		
17	NEVADA		x		x
18	NEW HAMPSHIRE		x		x
19	NEW MEXICO		x	1 day	
20	NEW YORK		x		x
21	NORTH CAROLINA	x			x
22	PENNSYLVANIA		x		
23	RHODE ISLAND		x	2 days	
24	SOUTH CAROLINA	x		3-4 days	
25	WASHINGTON		x	1 day	
26	WEST VIRGINIA		x		x
27	WISCONSIN		x	2 days	

Approaches used by DOTs & QA/QC Processe Tools when utilizing Pit Proctors

States	Approaches	Tools used to implement QA/QC Processes when utilizing Pit Proctors
COLORADO	The Department investigates and obtains samples from sources. Prior to delivering the mined base materials to a project site, a Lab Proctor test should be performed per source and per project by the Department. The Department provides the test results to the contractor.	Independent Assurance (IA) program
GEORGIA	Material is certified at the quarry and a maximum dry density and optimum moisture is determined in the lab. This data is used on the job site to measure compaction using a nuclear gauge. Compaction of base material must be 100% of lab-derived density.	Use “sand cone” procedure to calibrate nuclear gauges to lab-determined density.
HAWAII	On special occasions requested by our construction field personnel, Pit Proctor may be used as a check/conditional acceptance and the DOT informs contractor about risks that final acceptance shall be based on laboratory proctor testing.	None. Acceptance shall be based on laboratory proctor testing.
NORTH CAROLINA	Materials and Tests of NCDOT have a representative to go to the quarry and bring a sample to the central laboratory once a year or more often if there is a change in the material source. Materials and Tests perform a modified AASHTO T-180 to establish the proctor value for the given material. This value is provided to the contractor to be used as the target density to achieve the required compaction.	Requirement of meeting NCDOT gradation specs
SOUTH CAROLINA	We ordinarily require that initial compaction be delayed after material placement while the initial Proctor test is run. However, on small projects (very minor projects) we refer to the last laboratory Proctor performed by our laboratory for that source. We do not allow the use of the supplier’s data for acceptance.	Although we do not utilize their data in the acceptance process, we require suppliers of most mined base material to have participated in our QC program. This requires them to supply test data to us, have certified personnel, and have a QC plan.

Required Construction Procedures for Mined Base Material

States	Required Construction Procedures for Mined Base Material	Comments
ALABAMA	A sample is submitted to a Division Materials Lab. A PD is required whenever the material chances.	
ALASKA	Maintain surface to drain freely at all times. Place material in layers not exceeding 8 inches in depth. Compact to specified percent of maximum density.	
ARIZONA	Materials must meet the department's standard specifications, section 303 Aggregate subbases and aggregate bases.	
COLORADO	The mined base material (aggregate base course) will be inspected and tested by contractor or the state prior to deliver to a project site.	
GEORGIA	Material is certified at the quarry and a maximum dry density and optimum moisture is determined in the lab. This data is used on the job site to measure compaction using a nuclear gauge. Compaction of base material must be 100% of lab-derived density.	
HAWAII	Laboratory tests on mined base materials sampled from job site.	
ILLINOIS	Material delivered to the project site is sampled and tested for Proctor density. Aggregate base course Type A requires Proctor and we run it on the sampled material. Aggregate base course, Type B, does not require density/Proctor and it is compacted in the field “to the satisfaction of the Engineer”. Therefore, Type B is not sampled or tested.	
INDIANA	Laboratory proctors are determined for each commercial source at least once per quarter. Different projects may be assigned the same proctor during the quarter. A laboratory proctor will be determined for each project for on-site material.	
IOWA	Gradation control, quality requirements (abrasion loss, F-T loss), compaction requirement (number of passes), and moisture during compaction.	

States	Required Construction Procedures for Mined Base Material	Comments
KANSAS	The contractor must have the stockpile and design approved before he is to begin construction. He can only use material from the approved stockpile, therefore there are no construction delays.	
KENTUCKY	Materials must meet the department's standard specifications, section 302 Dense graded aggregate base and crushed stone base.	
MAINE	All such materials are required to have a proctor performed from the material delivered to the project.	
MARYLAND	At job site, Compaction control (In-place density and optimum moisture content testing, must meet 97% laboratory density, +/- 2% of optimum.) At the production site, Daily gradations & moisture testing, every 1000 tons or every 4 hours of production.	Master curve developed for a specific Job Mix Formula and quarry, good for two years if specific gravity stays +/- 0.03 and daily production gradations and moisture contents are within specification tolerances.
MASSACHUSETTS	Laboratory testing for conformance with specifications prior to use.	
MICHIGAN	We have certified sources that are based on aggregate properties such as AWI, freeze thaw, chert amounts, etc. At the project site the material must me gradation and density requirements.	
NEBRASKA	Nebraska Department of Roads does not do the testing, we require our contractors to do the pit testing and provide the results to us that prove that the pit is usable for our specifications.	
NEVADA	NDOT does not use the proctor for determining lab compaction curves. We use the Harvard Miniature Procedure. For construction procedures we test the pit for source requirements. Base materials are tested on samples taken from the processed windrow from the project.	We do require testing of material delivered to the job site but do not use the proctor test. With the Harvard we can get a result in 1 hour.
NEW HAMPSHIRE	We sample material on site and either do a proctor of the material on site at a field laboratory set up on each project, or for some materials where doing a proctor is difficult density is determined by test strip.	

States	Required Construction Procedures for Mined Base Material	Comments
NEW MEXICO	Initial materials quality must meet minimum L.A. Wear and Soundness requirements. Thereafter, aggregate gradation, moisture, and density are verified in the field to ensure that the placed material meets specifications. We have very few established pits within the State and Contractors usually establish individual pits on a project by project basis.	
NEW YORK	NYSDOT requires most Subbase Items to be stockpiled, sampled and tested for gradation, soundness and plasticity index. Approval of the material for use is contingent upon the material meeting the specification requirements for these parameters.	
NORTH CAROLINA	Achieve the required field density based on the established yearly Pit Proctor values.	
RHODE ISLAND	Sample material at job site, bring to lab for testing, results sent back to field in 2 days.	
SOUTH CAROLINA	Gradation and compaction are checked once each 2000 lane-feet and depth is checked each 500 lane-feet.	
WASHINGTON	The construction procedures are left up to the contractor, which means we don't have any "required procedures." We require a compactive effort that provides a specified percent of the maximum possible density. We determine maximum possible density from	WSDOT does not use pit proctors. We will run a one-point proctor at some of our project offices to insure the material fits the curve being used for max density. Washington uses a WSDOT test method 606, which is a lab developed max density most of the time and uses proctor test occasionally.
WEST VIRGINIA	The West Virginia Department of Transportation uses the Test Strip Method to determine the maximum density for base course materials.	Test Strip Method
WISCONSIN	For base course aggregate, we do not do proctors or densities on this material. For subbase, we generally use standard compaction for acceptance but in special cases will do proctors on fill material and control density with the nuclear guage.	If the pit proctor changes or we suspect a change a one point proctor is run by the contractor just of verify the suspected change.

List of DOTs Participating in the Survey

No.	States	Contact Information			
		Name	Title/Division	Phone	E-mail
1	ALABAMA	Becky Keith, PE	Soils Testing Engineer	334-206-2360	keithb@dot.state.al.us
2	ALASKA				
3	ARIZONA	Gregg Inman	Materials Quality Assurance Section		GInman@dot.state.az.us
4	COLORADO	C.K. Su	Materials and Geotechnical Branch	303-757-9750	Cheng.Su@dot.state.co.us
5	GEORGIA	Jerry German	Testing Management Branch	404-363-7667	Jerry.German@dot.state.ga.us
6	HAWAII	Herbert Chu		808-832-3405 ext. 232	Herbert.Chu@hawaii.gov
7	ILLINOIS	Riyad Wahab, Ph.D.	State Geotechnical Engineer/Bureau of Materials & Physical Research	217-782-7207	wahabrm@nt.dot.state.il.us
8	INDIANA	Mark A. Miller	Chief, Materials & Tests Division	317-610-7251 ext 204	MMILLER@indot.state.in.us
9	IOWA	John H. Vu	Construction Earthwork Field Engineer	515-239-1280	John.Vu@dot.state.ia.us
10	KANSAS	Rodney Montney	Engineer of Tests	785-291-3825	Rodney@ksdot.org
11	KENTUCKY	Vic Malone	Aggregate Section Supervisor	502-564-3160	vic.malone@ky.gov
12	MAINE	Mark Alley, P.E.	Maine DOT Central Lab. Manager	207-941-4526	mark.alley@maine.gov
13	MARYLAND	Bob Kochen			bkochen@sha.state.md.us
14	MASSACHUSETTS		Research and Material Engineer	617-973-8440	
15	MICHIGAN	Curtis Bleech			BleechC@michigan.gov
16	NEBRASKA	Amy Starr	Research Engineer/Material & Research	402-479-3687	astarr@dor.state.ne.us
17	NEVADA	Dean C. Weitzel		775-888-7520	dweitzel@dot.state.nv.us
18	NEW HAMPSHIRE	Alan Perkins			APerkins@dot.state.nh.us
19	NEW MEXICO	John H Tenison Jr.			John.Tenison@nmshtd.state.nm.us
20	NEW YORK	Jim Curtis	General Soils Lab. Supervisor	518-457-4735.	jcurtis@dot.state.ny.us
21	NORTH CAROLINA	Mehdi Haeri		919-329-4150	mhaeri@dot.state.nc.us
22	PENNSYLVANIA	Pat Miller	Material & Testing Lab.	717-787-2489	
23	RHODE ISLAND	Mark E. Felag, P.E.	Chief Civil Engineer/Materials	401-222-2524 ext 4130	mfelag@dot.state.ri.us
24	SOUTH CAROLINA	Andrew M Johnson	State Pavement Design Engineer	803-737-6683	JohnsonAM@dot.state.sc.us
25	WASHINGTON	Thomas E. Baker	State Materials Engineer/State Materials Laboratory	360-709-5401	bakert@wsdot.wa.gov
26	WEST VIRGINIA	Ralph Adams			RALADAMS@dot.state.wv.us
27	WISCONSIN	John Volker			john.volker@dot.state.wi.us

APPENDIX B

Analysis and comparison of project field density values to proposed Pit Proctor values:

- Table of QA/QC Pit Proctor Values (Mine/Terminal - 36246)

- **Project A**: Field Data Analysis (Project FIN 21025315210)
    - Table of Actual Target Density from Lab Proctor and Nuclear Density values
    - Comparison of Actual Field Density Values to Trial Pit Proctor Target Values

- **Project B**: Field Data Analysis (Project FIN 21040915210)
    - Table of Actual Target Density from Lab Proctor and Nuclear Density values
    - Comparison of Actual Field Density Values to Trial Pit Proctor Target Values

- Table of QA/QC Pit Proctor Values (Mine/Terminal - 93406)

- **Project C**: Field Data Analysis (Project FIN 21049915210)
    - Table of Actual Target Density from Lab Proctor and Nuclear Density values
    - Comparison of Actual Field Density Values to Trial Pit Proctor Target Values

- **Project D**: Field Data Analysis (Project FIN 21079715210)
    - Table of Actual Target Density from Lab Proctor and Nuclear Density values
    - Comparison of Actual Field Density Values to Trial Pit Proctor Target Values

Table of QA/QC Pit Proctor Values (Mine/Terminal - 36246)
(Project FIN 21025315210, Project FIN 21040915210)

6 Month Period	Date Sampled	Density (lb/ft^3)	Monthly Average (lb/ft^3)	6 Month Average (lb/ft^3)	Previous 6-Month Period Pit Target (lb/ft3)	Previous 12-Month Period Pit Target (lb/ft^3)
1	2/13/2003	122	120.3	119.1	122.0	N/A
	2/13/2003	120				
	2/13/2003	122				
	2/13/2003	117				
	3/5/2003	118	117.0			
	3/5/2003	116				
	4/9/2003	120	118.5			
	4/9/2003	117				
	5/7/2003	120	119.0			
	5/7/2003	118				
	6/16/2003	121	119.5			
	6/16/2003	118				
2	7/8/2003	118	118.5	117.4	119.0	121.9
	7/8/2003	119				
	8/5/2003	118	118.0			
	8/5/2003	118				
	9/2/2003	117	117.5			
	9/2/2003	119				
	9/29/2003	116				
	9/29/2003	118				
	11/4/2003	115	115.5			
	11/4/2003	116				
	12/1/2003	117	117.5			
	12/1/2003	118				
3	1/7/2004	114	115.0	117.6	119.5	119.0
	1/7/2004	116				
	2/23/2004	116	116.0			
	2/23/2004	116				
	3/1/2004	118	118.5			
	3/1/2004	119				
	4/7/2004	118	118.5			
	4/7/2004	119				
	5/12/2004	118	118.5			
	5/12/2004	119				
	6/7/2004	120	119.0			
	6/10/2004	118				

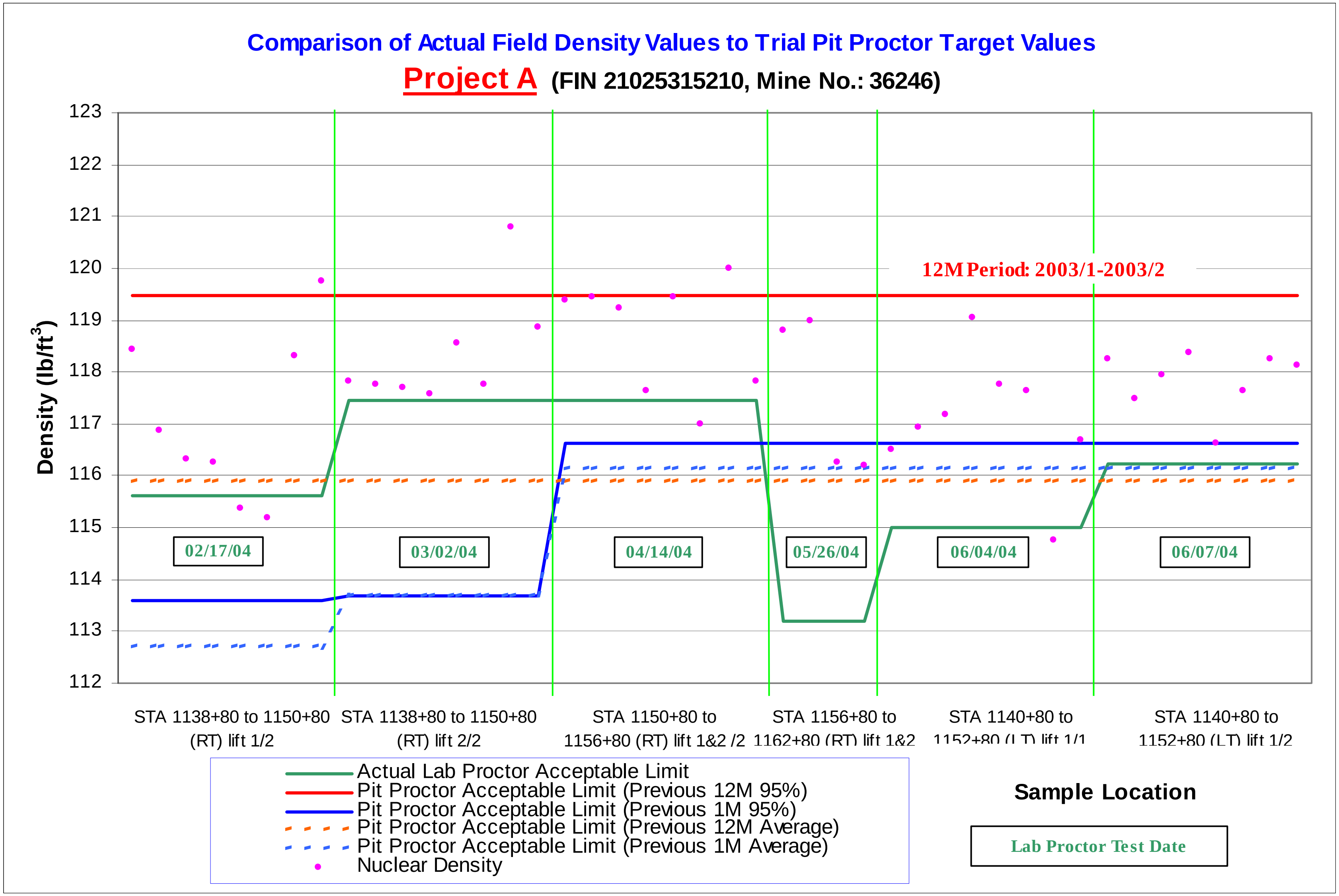
Project A: Field Data Analysis

(Project FIN 21025315210)

Table of Actual Target Density from Lab Proctor and Nuclear Density values

(Project FIN 21025315210)

Sample Location	FDOT Lab Proctor Report			Quality Control: Earthwork Density Report					
	Date Tested	Target Density (Kg/m^3)	Target Density (lb/ft^3)	Lot No.	Date Tested	Wet Density (Kg/m^3)	Dry Density (Kg/m^3)	Nuclear Density (lb/ft^3)	% Max. Density
STA 1138+80 to 1150+80 (RT) lift 1/2	2004-02-17	1890	117.9	1	2004-03-03	2125	1898	118.4	100.4
				2	2004-03-03	2135	1873	116.9	99.1
				5	2004-04-28	2035	1864	116.3	98.6
				6	2004-04-28	2012	1863	116.3	98.6
				9	2004-04-29	2060	1849	115.4	97.8
				10	2004-04-29	2001	1846	115.2	97.7
				13	2004-05-04	2123	1896	118.3	100.3
				14	2004-05-04	2117	1919	119.7	101.5
STA 1138+80 to 1150+80 (RT) lift 2/2	2004-03-02	1920	119.8	3	2004-04-26	2048	1888	117.8	98.3
				4	2004-04-26	2076	1887	117.7	98.3
				7	2004-04-29	2082	1886	117.7	98.2
				8	2004-04-29	2093	1884	117.6	98.1
				11	2004-05-04	2080	1900	118.6	99.0
				12	2004-05-04	2104	1887	117.7	98.3
				17	2004-05-11	2108	1936	120.8	100.8
				18	2004-05-11	2124	1905	118.9	99.2
STA 1150+80 to 1156+80 (RT) lift 1&2 /2	2004-04-14	1920	119.8	15	2004-05-04	2127	1913	119.4	99.6
				16	2004-05-04	2121	1914	119.4	99.7
				19	2004-05-11	2119	1911	119.2	99.5
				20	2004-05-11	2143	1885	117.6	98.2
				21	2004-06-02	2117	1914	119.4	99.7
				22	2004-06-02	2063	1875	117.0	97.7
				25	2004-06-10	2109	1923	120.0	100.2
				26	2004-06-10	2073	1888	117.8	98.3
STA 1156+80 to 1162+80 (RT) lift 1&2 /2	2004-05-26	1850	115.4	23	2004-06-02	2117	1904	118.8	102.9
				24	2004-06-02	2103	1907	119.0	103.1
				27	2004-06-10	2064	1863	116.3	100.7
				28	2004-06-10	2076	1862	116.2	100.6
STA 1140+80 to 1152+80 (LT) lift 1/1	2004-06-04	1880	117.3	29	2004-06-24	2127	1867	116.5	99.3
				30	2004-06-24	2101	1874	116.9	99.7
				31	2004-06-24	2117	1878	117.2	99.9
				32	2004-06-24	2095	1908	119.1	101.5
				33	2004-06-25	2097	1887	117.7	100.4
				34	2004-06-25	2079	1885	117.6	100.3
				41	2004-07-31	2051	1839	114.8	97.8
				42	2004-07-31	2079	1870	116.7	99.5
STA 1140+80 to 1152+80 (LT) lift 1/2	2004-06-07	1900	118.6	35	2004-06-25	2119	1895	118.2	99.7
				36	2004-06-25	2132	1883	117.5	99.1
				43	2004-08-02	2085	1890	117.9	99.5
				44	2004-08-02	2089	1897	118.4	99.8
				45	2004-08-02	2073	1869	116.6	98.4
				46	2004-08-02	2102	1885	117.6	99.2
				47	2004-08-02	2117	1895	118.2	99.7
				48	2004-08-02	2124	1893	118.1	99.6


Comparison of Actual Field Density Values to Trial Pit Proctor Target Values
Project A (FIN 21025315210, Mine No.: 36246)
Density (lb/ft^3)
123
122
121
120
119
118
117
116
115
114
113
112
12M Period: 2003/1-2003/2
02/17/04
03/02/04
04/14/04
05/26/04
06/04/04
06/07/04
STA 1138+80 to 1150+80 (RT) lift 1/2
STA 1138+80 to 1150+80 (RT) lift 2/2
STA 1150+80 to 1156+80 (RT) lift 1&2 /2
STA 1156+80 to 1162+80 (RT) lift 1&2
STA 1140+80 to 1152+80 (LT) lift 1/1
STA 1140+80 to 1152+80 (LT) lift 1/2
Actual Lab Proctor Acceptable Limit
Pit Proctor Acceptable Limit (Previous 12M 95%)
Pit Proctor Acceptable Limit (Previous 1M 95%)
Pit Proctor Acceptable Limit (Previous 12M Average)
Pit Proctor Acceptable Limit (Previous 1M Average)
Nuclear Density
Sample Location
Lab Proctor Test Date

Project B: Field Data Analysis

(Project FIN 21040915210)

Table of Actual Target Density from Lab Proctor and Nuclear Density values
(Project FIN 21040915210)

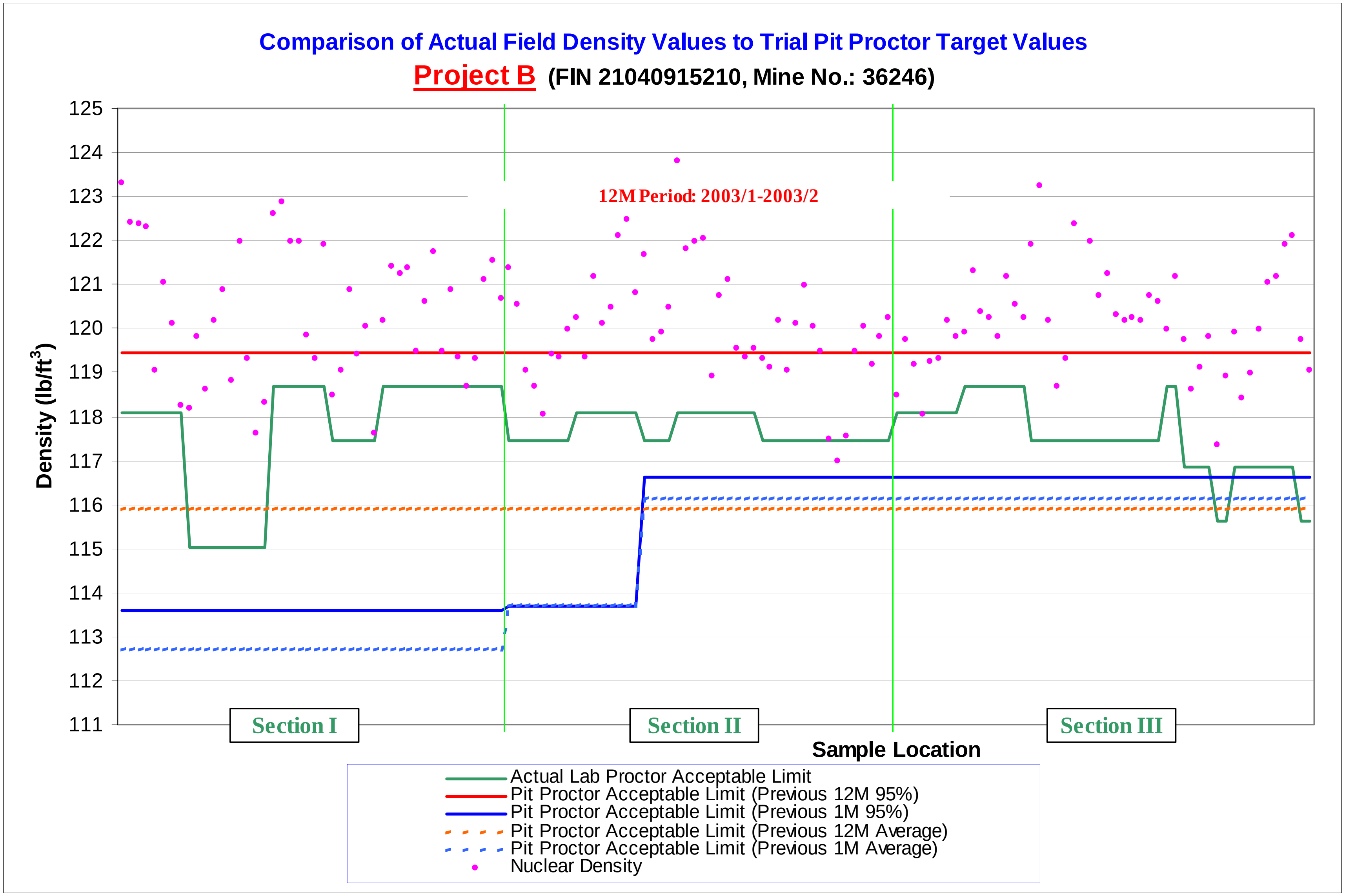
Sample Location	FDOT Lab Proctor Report			Quality Control: Earthwork Density Report				
	Date Tested	Target Density (Kg/m^3)	Target Density (lb/ft^3)	Lot No.	Date Tested	Dry Density (Kg/m^3)	Nuclear Density (lb/ft^3)	% Max. Density
STA 211+00 to 223+00 (RT) lift 1/2	2/15/2004	1930	120.5	1	2/16/2004	1975	123.3	102.3
				2	2/16/2004	1961	122.4	101.6
				3	2/16/2004	1960	122.4	101.6
				4	2/16/2004	1959	122.3	101.5
				5	2/17/2004	1907	119.1	98.8
				6	2/18/2004	1939	121.0	100.5
				7	2/18/2004	1924	120.1	99.7
				116	6/15/2004	1894	118.2	98.1
STA 150+00 to 162+00 (RT) lift 1/2	2/21/2004	1880	117.4	8	2/19/2004	1893	118.2	100.7
				9	2/19/2004	1919	119.8	102.1
				10	2/19/2004	1900	118.6	101.1
				11	2/19/2004	1925	120.2	102.4
				12	3/1/2004	1936	120.9	103.0
				28	3/8/2004	1903	118.8	101.2
				29	3/8/2004	1954	122.0	103.9
				30	3/9/2004	1911	119.3	101.6
				31	3/9/2004	1884	117.6	100.2
				62	4/2/2004	1895	118.3	100.8
STA 211+00 to 223+00 (RT) lift 2/2	2/24/2004	1940	121.1	13	3/1/2004	1964	122.6	101.2
				14	3/1/2004	1968	122.9	101.4
				15	3/1/2004	1954	122.0	100.7
				16	3/1/2004	1954	122.0	100.7
				17	3/1/2004	1920	119.9	99.0
				18	3/1/2004	1911	119.3	98.5
				126	6/17/2004	1953	121.9	100.7
STA 223+00 to 235+00 (RT) lift 1/2	2/25/2004	1920	119.9	24	3/6/2004	1898	118.5	98.9
				25	3/6/2004	1907	119.1	99.3
				26	3/6/2004	1936	120.9	100.8
				27	3/6/2004	1913	119.4	99.6
				34	3/15/2004	1923	120.0	100.2
				35	3/17/2004	1884	117.6	98.1
STA 150+00 to 162+00 (RT) lift 2/2	2/25/2004	1940	121.1	20	3/4/2004	1925	120.2	99.2
				21	3/4/2004	1945	121.4	100.3
				22	3/4/2004	1942	121.2	100.1
				23	3/4/2004	1944	121.4	100.2
				38	3/15/2004	1914	119.5	98.7
				37	3/17/2004	1932	120.6	99.6
				43	3/30/2004	1950	121.7	100.5
				44	3/30/2004	1914	119.5	98.7
				117	6/15/2004	1936	120.9	99.8
STA 223+00 to 235+00 (RT) lift 2/2	2/25/2004	1940	121.1	36	3/17/2004	1912	119.4	98.6
				39	3/17/2004	1901	118.7	98.0
				69	4/15/2004	1911	119.3	98.5
				70	4/15/2004	1940	121.1	100.0
				71	4/15/2004	1947	121.5	100.4
				72	4/15/2004	1933	120.7	99.6

Table of Actual Target Density from Lab Proctor and Nuclear Density values
(Project FIN 21040915210)

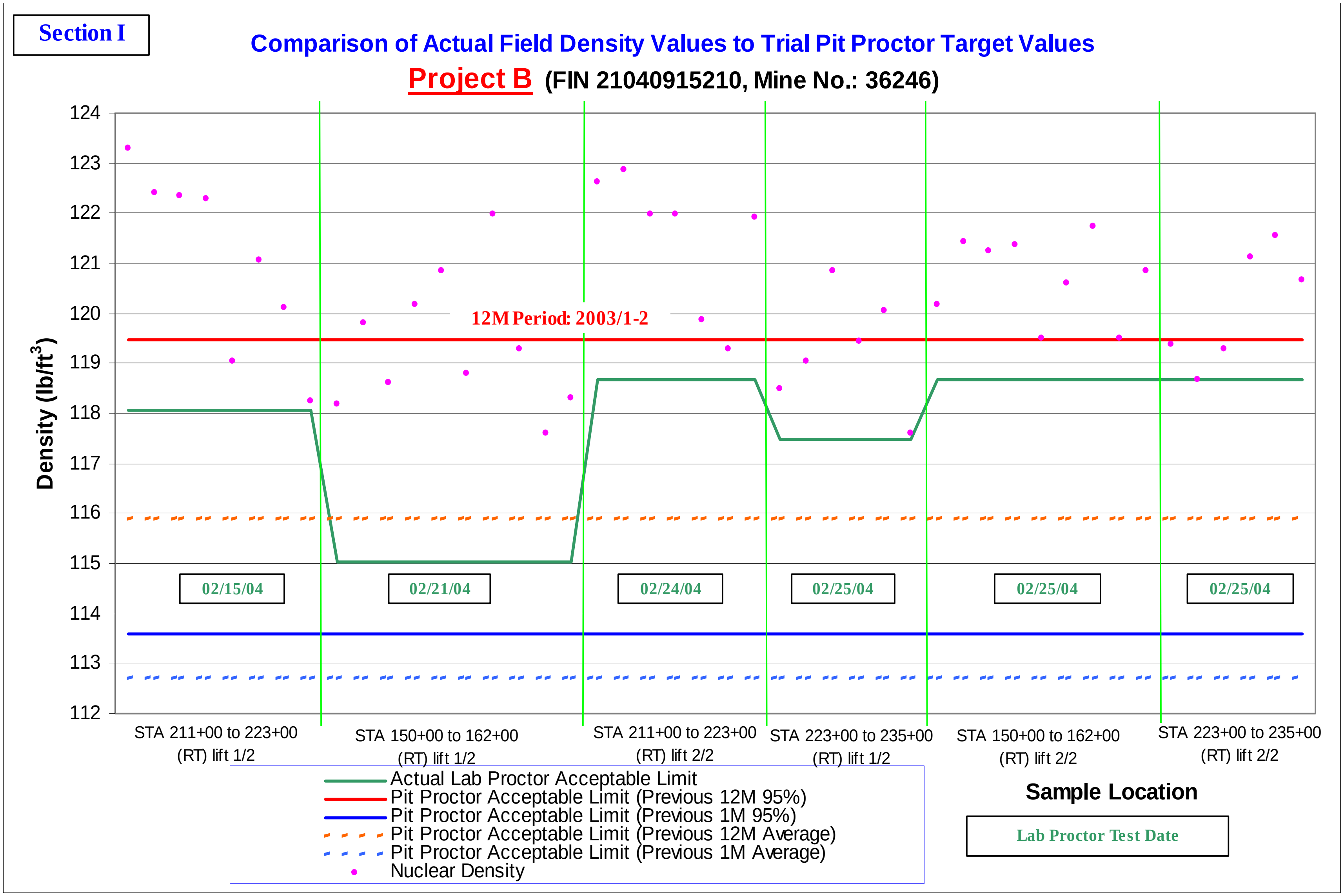
Sample Location	FDOT Lab Proctor Report			Quality Control: Earthwork Density Report				
	Date Tested	Target Density (Kg/m^3)	Target Density (lb/ft^3)	Lot No.	Date Tested	Dry Density (Kg/m^3)	Nuclear Density (lb/ft^3)	% Max. Density
STA 162+00 to 174+00 (RT) lift 1/2	3/10/2004	1920	119.9	32	3/15/2004	1944	121.4	101.3
				33	3/15/2004	1931	120.5	100.6
				40	3/16/2004	1907	119.1	99.3
				41	3/16/2004	1901	118.7	99.0
				42	3/18/2004	1891	118.1	98.5
				63	4/14/2004	1913	119.4	99.6
				64	4/14/2004	1912	119.4	99.6
				65	4/14/2004	1922	120.0	100.1
STA 162+00 to 174+00 (RT) lift 2/2	3/19/2004	1930	120.5	45	3/30/2004	1926	120.2	99.8
				46	3/30/2004	1912	119.4	99.1
				47	3/30/2004	1941	121.2	100.6
				48	3/30/2004	1924	120.1	99.7
				49	3/30/2004	1930	120.5	100.0
				88	5/11/2004	1956	122.1	101.3
				89	5/11/2004	1962	122.5	101.7
				90	5/11/2004	1935	120.8	100.3
STA 232+50 to 242+50 (LT) lift 1/2	4/3/2004	1920	119.9	51	4/1/2004	1949	121.7	101.5
				52	4/1/2004	1918	119.7	99.9
				53	4/1/2004	1921	119.9	100.1
				54	4/1/2004	1930	120.5	100.5
STA 232+50 to 242+50 (LT) lift 2/2	4/9/2004	1930	120.5	55	4/5/2004	1983	123.8	102.7
				56	4/5/2004	1951	121.8	101.1
				57	4/5/2004	1954	122.0	101.2
				58	4/5/2004	1955	122.0	101.3
STA 235+00 to 241+00 (RT) lift 1&2 /2	4/9/2004	1930	120.5	73	4/16/2004	1905	118.9	98.7
				74	4/16/2004	1934	120.7	100.2
				75	4/16/2004	1940	121.1	100.5
				77	4/17/2004	1915	119.5	99.2
				78	4/17/2004	1912	119.4	99.1
				79	4/17/2004	1915	119.5	99.2
STA 174+00 to 180+00 (RT) lift 1&2 /2	4/9/2004	1920	119.9	66	4/14/2004	1911	119.3	99.5
				67	4/14/2004	1908	119.1	99.4
				68	4/14/2004	1925	120.2	100.3
				85	5/11/2004	1907	119.1	99.3
				86	5/11/2004	1924	120.1	100.2
				87	5/11/2004	1938	121.0	100.9
				91	5/17/2004	1923	120.0	100.2
				95	5/26/2004	1914	119.5	99.7
STA 180+00 to 192+00 (RT) lift 1/2	4/19/2004	1920	119.9	82	5/10/2004	1882	117.5	98.0
				83	5/10/2004	1874	117.0	97.6
				84	5/10/2004	1883	117.6	98.1
				92	5/17/2004	1914	119.5	99.7
				93	5/18/2004	1923	120.0	100.2
				94	5/18/2004	1909	119.2	99.4
				101	5/26/2004	1919	119.8	99.9
				102	5/27/2004	1926	120.2	100.3
STA 180+00 to 192+00 (RT) lift 2/2	4/21/2004	1930	120.5	97	5/20/2004	1898	118.5	98.3
				96	5/26/2004	1918	119.7	99.4
				98	5/26/2004	1909	119.2	98.9
				99	5/26/2004	1891	118.1	98.0
				100	5/26/2004	1910	119.2	99.0
				118	6/15/2004	1911	119.3	99.0
				119	6/15/2004	1925	120.2	99.7
				127	6/17/2004	1919	119.8	99.4

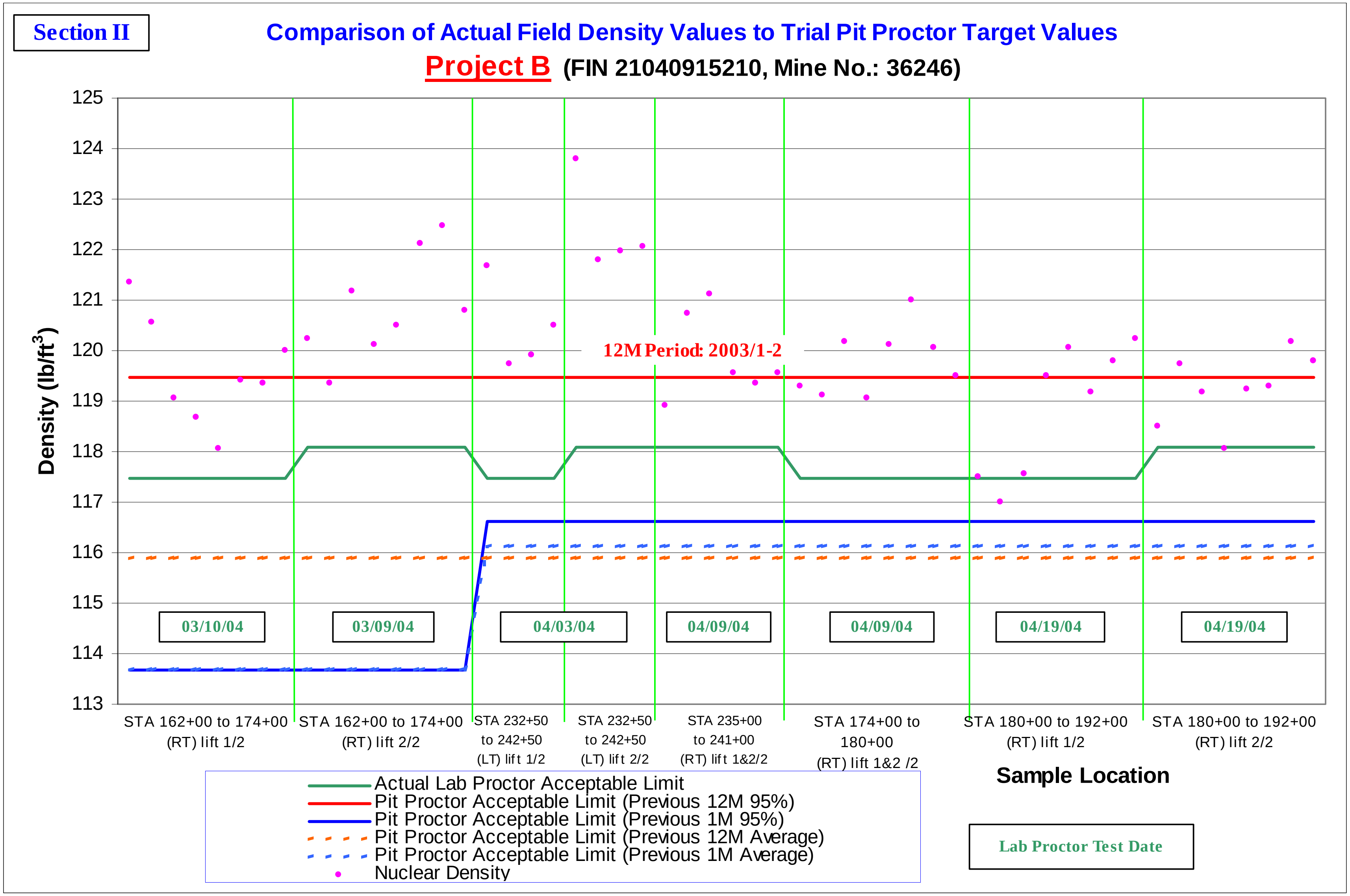
Table of Actual Target Density from Lab Proctor and Nuclear Density values
(Project FIN 21040915210)

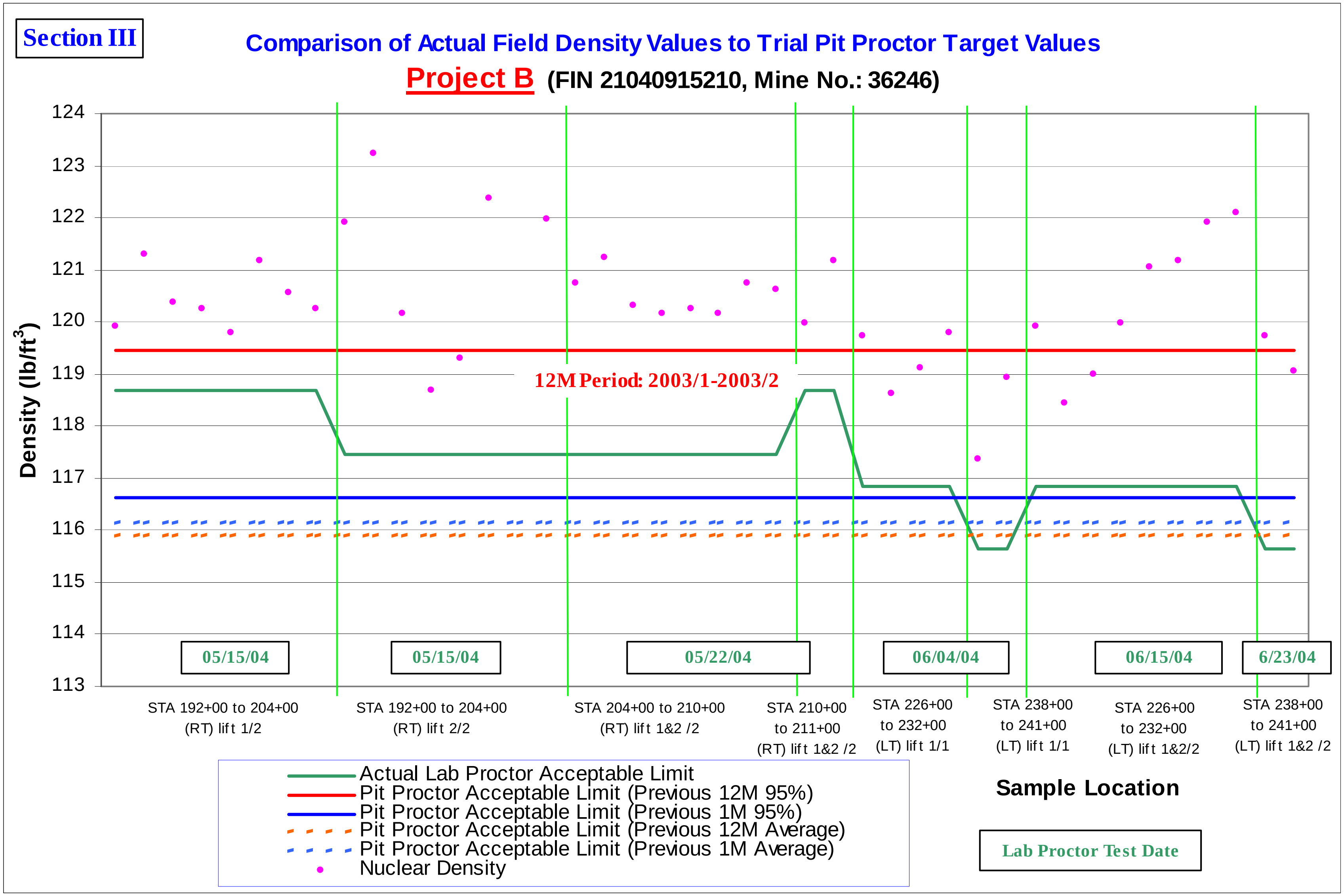
Sample Location	FDOT Lab Proctor Report			Quality Control: Earthwork Density Report				
	Date Tested	Target Density (Kg/m^3)	Target Density (lb/ft^3)	Lot No.	Date Tested	Dry Density (Kg/m^3)	Nuclear Density (lb/ft^3)	% Max. Density
STA 192+00 to 204+00 (RT) lift 1/2	5/15/2004	1940	121.1	103	5/27/2004	1921	119.9	99.0
				104	6/14/2004	1943	121.3	100.2
				105	6/14/2004	1928	120.4	99.4
				108	6/15/2004	1926	120.2	99.3
				109	6/15/2004	1919	119.8	98.9
				110	6/15/2004	1941	121.2	100.1
				111	6/15/2004	1931	120.5	99.5
				112	6/15/2004	1926	120.2	99.3
STA 192+00 to 204+00 (RT) lift 2/2	5/15/2004	1920	119.9	120	6/17/2004	1953	121.9	101.7
				128	6/21/2004	1974	123.2	102.8
				129	6/21/2004	1925	120.2	100.3
				130	6/21/2004	1901	118.7	99.0
				131	6/21/2004	1911	119.3	99.5
				132	6/21/2004	1960	122.4	102.1
				153	7/15/2004	2025	126.4	105.5
				154	7/15/2004	1954	122.0	101.8
STA 204+00 to 210+00 (RT) lift 1&2 /2	5/22/2004	1920	119.9	106	6/14/2004	1934	120.7	100.7
				107	6/14/2004	1942	121.2	101.1
				113	6/15/2004	1927	120.3	100.4
				114	6/15/2004	1925	120.2	100.3
				121	6/17/2004	1926	120.2	100.3
				122	6/17/2004	1925	120.2	100.3
				123	6/17/2004	1934	120.7	100.7
				124	6/17/2004	1932	120.6	100.6
STA 210+00 to 211+00 (RT) lift 1&2 /2	5/22/2004	1940	121.1	115	6/15/2004	1922	120.0	99.1
				125	6/17/2004	1941	121.2	100.1
STA 226+00 to 232+00 (LT) lift 1/1	6/14/2004	1910	119.2	133	6/23/2004	1918	119.7	100.4
				134	6/23/2004	1900	118.6	99.5
				135	6/23/2004	1908	119.1	99.9
				136	6/23/2004	1919	119.8	100.5
STA 238+00 to 241+00 (LT) lift 1/1	6/14/2004	1890	118.0	137	6/23/2004	1880	117.4	99.5
				138	6/23/2004	1905	118.9	100.8
STA 226+00 to 232+00 (LT) lift 1&2/2	6/15/2004	1910	119.2	139	6/23/2004	1921	119.9	100.6
				140	6/23/2004	1897	118.4	99.3
				141	6/24/2004	1906	119.0	99.8
				142	6/24/2004	1922	120.0	100.6
				149	7/13/2004	1939	121.0	101.5
				150	7/13/2004	1941	121.2	101.6
				151	7/13/2004	1953	121.9	102.3
				152	7/13/2004	1956	122.1	102.4
STA 238+00 to 241+00 (LT) lift 1&2 /2	6/23/2004	1890	118.0	143	6/24/2004	1918	119.7	101.5
				144	6/24/2004	1907	119.1	100.9



Comparison of Actual Field Density Values to Trial Pit Proctor Target Values
Project B (FIN 21040915210, Mine No.: 36246)
12M Period: 2003/1-2003/2
Density (lb/ft^3)
125
124
123
122
121
120
119
118
117
116
115
114
113
112
111
Section I
Section II
Section III
Sample Location
Actual Lab Proctor Acceptable Limit
Pit Proctor Acceptable Limit (Previous 12M 95%)
Pit Proctor Acceptable Limit (Previous 1M 95%)
Pit Proctor Acceptable Limit (Previous 12M Average)
Pit Proctor Acceptable Limit (Previous 1M Average)
Nuclear Density


Section I
Comparison of Actual Field Density Values to Trial Pit Proctor Target Values
Project B (FIN 21040915210, Mine No.: 36246)
Density (lb/ft³)
124
123
122
121
120
119
118
117
116
115
114
113
112
12M Period: 2003/1-2
02/15/04
02/21/04
02/24/04
02/25/04
02/25/04
02/25/04
STA 211+00 to 223+00 (RT) lift 1/2
STA 150+00 to 162+00 (RT) lift 1/2
STA 211+00 to 223+00 (RT) lift 2/2
STA 223+00 to 235+00 (RT) lift 1/2
STA 150+00 to 162+00 (RT) lift 2/2
STA 223+00 to 235+00 (RT) lift 2/2
Actual Lab Proctor Acceptable Limit
Pit Proctor Acceptable Limit (Previous 12M 95%)
Pit Proctor Acceptable Limit (Previous 1M 95%)
Pit Proctor Acceptable Limit (Previous 12M Average)
Pit Proctor Acceptable Limit (Previous 1M Average)
Nuclear Density
Sample Location
Lab Proctor Test Date


Section II
Comparison of Actual Field Density Values to Trial Pit Proctor Target Values
Project B (FIN 21040915210, Mine No.: 36246)
Density (lb/ft3)
125
124
123
122
121
120
119
118
117
116
115
114
113
12M Period: 2003/1-2
03/10/04
03/09/04
04/03/04
04/09/04
04/09/04
04/19/04
04/19/04
STA 162+00 to 174+00 (RT) lift 1/2
STA 162+00 to 174+00 (RT) lift 2/2
STA 232+50 to 242+50 (LT) lift 1/2
STA 232+50 to 242+50 (LT) lift 2/2
STA 235+00 to 241+00 (RT) lift 1&2/2
STA 174+00 to 180+00 (RT) lift 1&2 /2
STA 180+00 to 192+00 (RT) lift 1/2
STA 180+00 to 192+00 (RT) lift 2/2
Sample Location
Actual Lab Proctor Acceptable Limit
Pit Proctor Acceptable Limit (Previous 12M 95%)
Pit Proctor Acceptable Limit (Previous 1M 95%)
Pit Proctor Acceptable Limit (Previous 12M Average)
Pit Proctor Acceptable Limit (Previous 1M Average)
Nuclear Density
Lab Proctor Test Date



Section III
Comparison of Actual Field Density Values to Trial Pit Proctor Target Values
Project B (FIN 21040915210, Mine No.: 36246)
124
123
122
121
120
119
118
117
116
115
114
113
Density (lb/ft^3)
12M Period: 2003/1-2003/2
05/15/04
05/15/04
05/22/04
06/04/04
06/15/04
6/23/04
STA 192+00 to 204+00 (RT) lift 1/2
STA 192+00 to 204+00 (RT) lift 2/2
STA 204+00 to 210+00 (RT) lift 1&2 /2
STA 210+00 to 211+00 (RT) lift 1&2 /2
STA 226+00 to 232+00 (LT) lift 1/1
STA 238+00 to 241+00 (LT) lift 1/1
STA 226+00 to 232+00 (LT) lift 1&2/2
STA 238+00 to 241+00 (LT) lift 1&2 /2
Actual Lab Proctor Acceptable Limit
Pit Proctor Acceptable Limit (Previous 12M 95%)
Pit Proctor Acceptable Limit (Previous 1M 95%)
Pit Proctor Acceptable Limit (Previous 12M Average)
Pit Proctor Acceptable Limit (Previous 1M Average)
Nuclear Density
Sample Location
Lab Proctor Test Date

Table of QA/QC Pit Proctor Values (Mine/Terminal - 93406)
(Project FIN 21049915210, Project FIN 21079715210)

6 Month Period	Date Sampled	Density (lb/ft3)	6 Month Average (lb/ft3)	Previous 6-Month Period Pit Target (lb/ft3)	Previous 12-Month Period Pit Target (lb/ft3)
1	6/7/2002	124	126.1	129.7	N/A
	6/7/2002	124			
	7/5/2002	126			
	7/5/2002	126			
	8/2/2002	129			
	8/2/2002	131			
	9/13/2002	128			
	9/13/2002	124			
	10/4/2002	129			
	10/4/2002	126			
	11/1/2002	124			
	11/1/2002	123			
	12/6/2002	127			
	12/6/2002	125			
2	1/9/2003	127	125.7	129.0	129.8
	1/9/2003	127			
	2/7/2003	124			
	3/7/2003	124			
	3/13/2003	126			
	4/4/2003	124			
	4/4/2003	122			
	5/2/2003	128			
	5/2/2003	124			
	6/13/2003	130			
	6/13/2003	127			
3	7/11/2003	130	127.6	130.0	130.0
	7/11/2003	129			
	8/8/2003	128			
	8/8/2003	124			
	9/5/2003	129			
	9/5/2003	129			
	10/3/2003	130			
	10/3/2003	129			
	11/14/2003	126			
	11/14/2003	126			
	12/5/2003	125			
	12/5/2003	126			

Table of QA/QC Pit Proctor Values (Mine/Terminal - 93406)
(Project FIN 21049915210, Project FIN 21079715210)

6 Month Period	Date Sampled	Density (lb/ft3)	6 Month Average (lb/ft3)	Previous 6-Month Period Pit Target (lb/ft3)	Previous 12-Month Period Pit Target (lb/ft3)
4	1/9/2004	124	125.3	129.7	129.7
	1/9/2004	122			
	2/6/2004	129			
	2/6/2004	127			
	2/10/2004	122			
	2/27/2004	126			
	3/5/2004	127			
	3/5/2004	125			
	4/2/2004	125			
	4/2/2004	121			
	5/7/2004	131			
	5/7/2004	127			
	6/4/2004	125			
	6/4/2004	123			
5	7/7/2004	131	129.9	132	131.7
	7/7/2004	127			
	8/6/2004	130			
	8/6/2004	127			
	9/17/2004	131			
	9/17/2004	129			
	10/1/2004	128			
	10/1/2004	130			
	10/7/2004	129			
	10/22/2004	132			
	11/5/2004	131			
	11/5/2004	130			
	12/10/2004	132			
	12/23/2004	131			

Project C: Field Data Analysis

(Project FIN 21049915210)

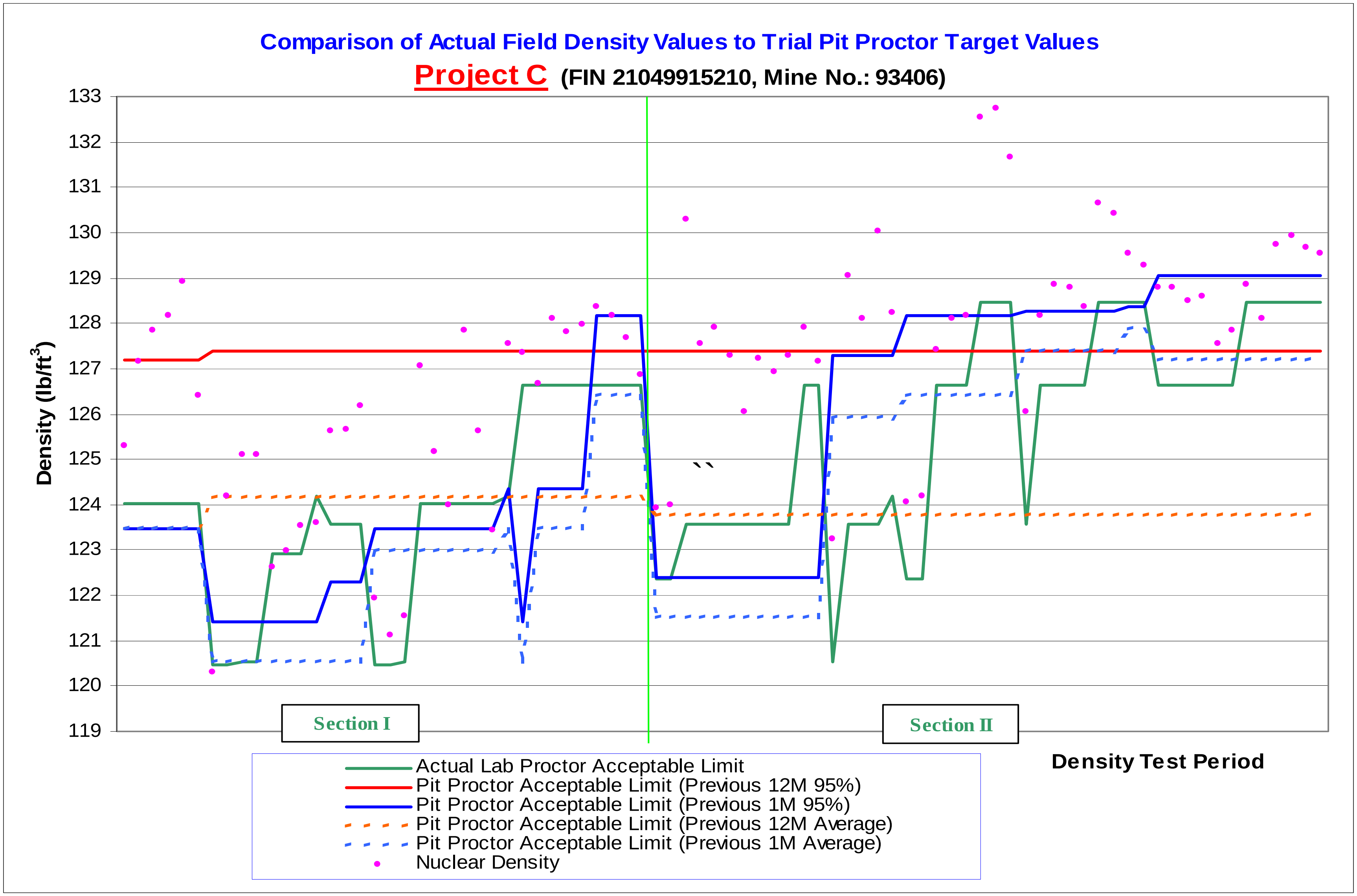
Table of Actual Target Density from Lab Proctor and Nuclear Density values
(Project FIN 21049915210)

FDOT Lab Proctor Report			Quality Control: Earthwork Density Report						
Test No.	Target Density (Kg/m^3)	Target Density (lb/ft^3)	Period Tested	Lot No.	Lift	station No.	Dry Value (Kg/m^3)	Nuclear Density (lb/ft^3)	Passing %
1	2027	126.5	2003/2	1	1/2	207+00	2008	125.3	99
2	2027	126.5	2003/2	2	1/2	207+75	2038	127.2	101
3	2027	126.5	2003/2	3	1/2	208+50	2049	127.9	101
4	2027	126.5	2003/2	4	1/2	212+25	2054	128.2	101
5	2027	126.5	2003/2	5	1/2	212+75	2066	128.9	102
6	2027	126.5	2003/2	6	1/2	214+00	2026	126.4	100
7	1969	122.9	2004/1	13	1/2	104+50	1954	121.9	99
8	1969	122.9	2004/1	15	1/2	105+00	1941	121.1	99
9	1969	122.9	2004/1	17	1/2	116+75	1928	120.3	98
10	1969	122.9	2004/1	22	1/2	101+20	1990	124.2	101
11	1970	122.9	2004/1	14	1/2	105+60	1948	121.6	99
12	1970	122.9	2004/1	21	1/2	99+50	2005	125.1	102
13	1970	122.9	2004/1	23	1/2	102+30	2005	125.1	102
14	2009	125.4	2004/1	18	1/2	118+50	1965	122.6	98
15	2009	125.4	2004/1	19	1/2	120+05	1971	123.0	98
16	2009	125.4	2004/1	20	1/2	120+80	1980	123.6	99
17	2020	126.0	2004/1	29	1/2	93+25	2013	125.6	100
18	2020	126.0	2004/1	30	1/2	94+70	2014	125.7	100
19	2020	126.0	2004/1	31	1/2	96+00	2022	126.2	100
20	2027	126.5	2004/1	7	2/2	206+30	2036	127.0	100
21	2027	126.5	2004/1	8	2/2	207+05	2006	125.2	99
22	2027	126.5	2004/1	9	2/2	209+60	1987	124.0	98
23	2027	126.5	2004/1	10	2/2	211+50	2049	127.9	101
24	2027	126.5	2004/1	11	2/2	212+65	2013	125.6	99
25	2027	126.5	2004/1	12	2/2	213+00	1978	123.4	98
26	2030	126.7	2004/1	16	1/2	115+60	1981	123.6	98
27	2030	126.7	2004/1	24	2/2	115+35	2044	127.5	101
28	2070	129.2	2004/1	32	1/2	122+25	2057	128.4	99
29	2070	129.2	2004/1	33	1/2	123+65	2054	128.2	99
30	2070	129.2	2004/1	34	1/2	125+25	2046	127.7	99
31	2070	129.2	2004/1	35	1/2	126+20	2033	126.9	98
32	2070	129.2	2004/1	25	2/2	117+05	2030	126.7	98
33	2070	129.2	2004/1	26	2/2	118+25	2053	128.1	99
34	2070	129.2	2004/1	27	2/2	119+75	2048	127.8	99
35	2070	129.2	2004/1	28	2/2	121+00	2051	128.0	99
36	1970	122.9	2004/2	61	2/2	214+75	1975	123.2	100
37	2000	124.8	2004/2	41	2/2	105+35	1986	123.9	99
38	2000	124.8	2004/2	42	2/2	104+25	1987	124.0	99
39	2000	124.8	2004/2	49	2/2	102+70	1988	124.1	99
40	2000	124.8	2004/2	50	2/2	100+75	1990	124.2	100
41	2020	126.0	2004/2	36	1/2	127+25	2088	130.3	103
42	2020	126.0	2004/2	46	1/2	114+85	2039	127.2	101
43	2020	126.0	2004/2	47	1/2	111+75	2034	126.9	101
44	2020	126.0	2004/2	48	1/2	113+00	2040	127.3	101
45	2020	126.0	2004/2	37	2/2	122+50	2044	127.5	101
46	2020	126.0	2004/2	38	2/2	123+95	2050	127.9	101

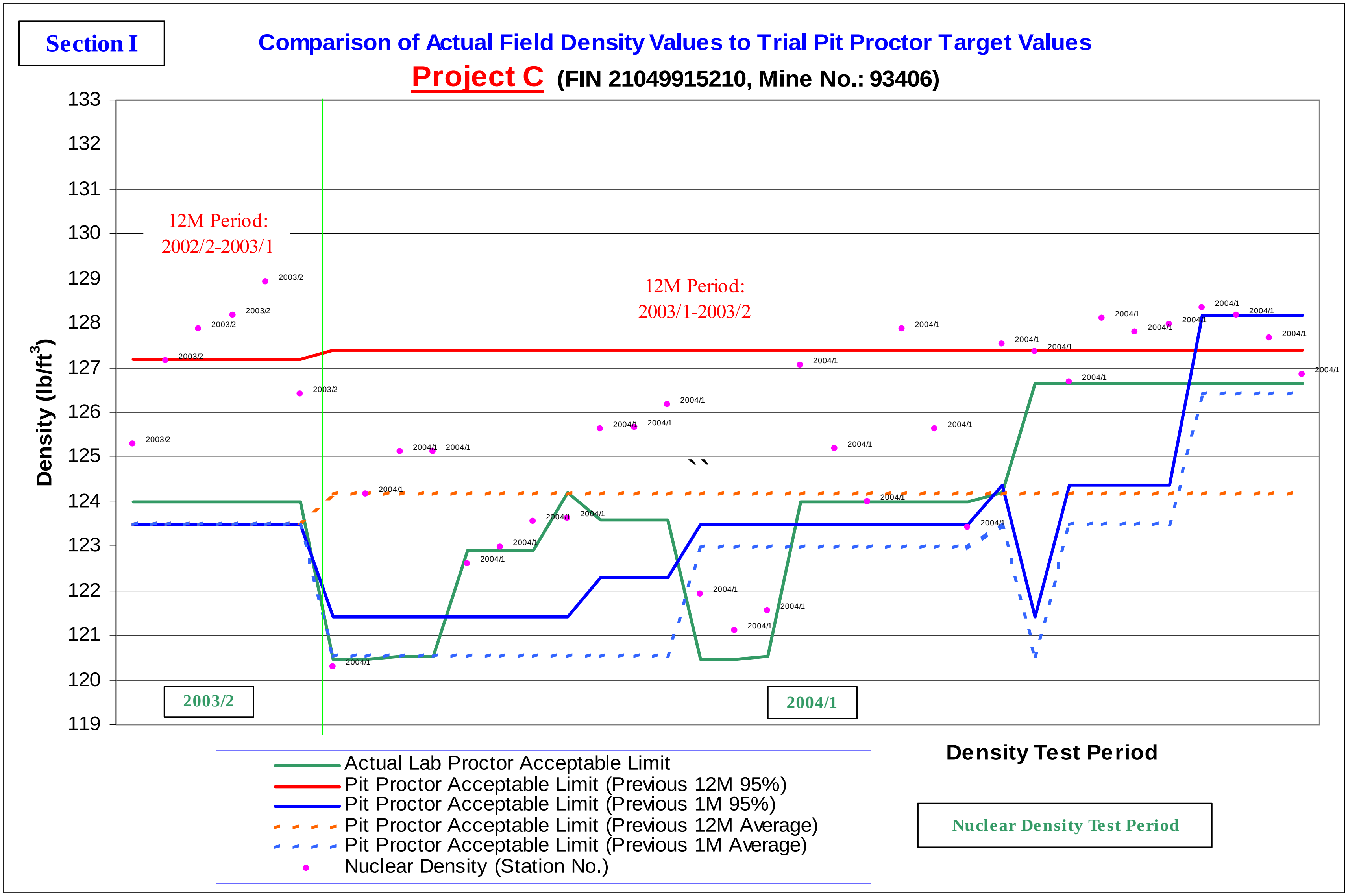
Table of Actual Target Density from Lab Proctor and Nuclear Density values

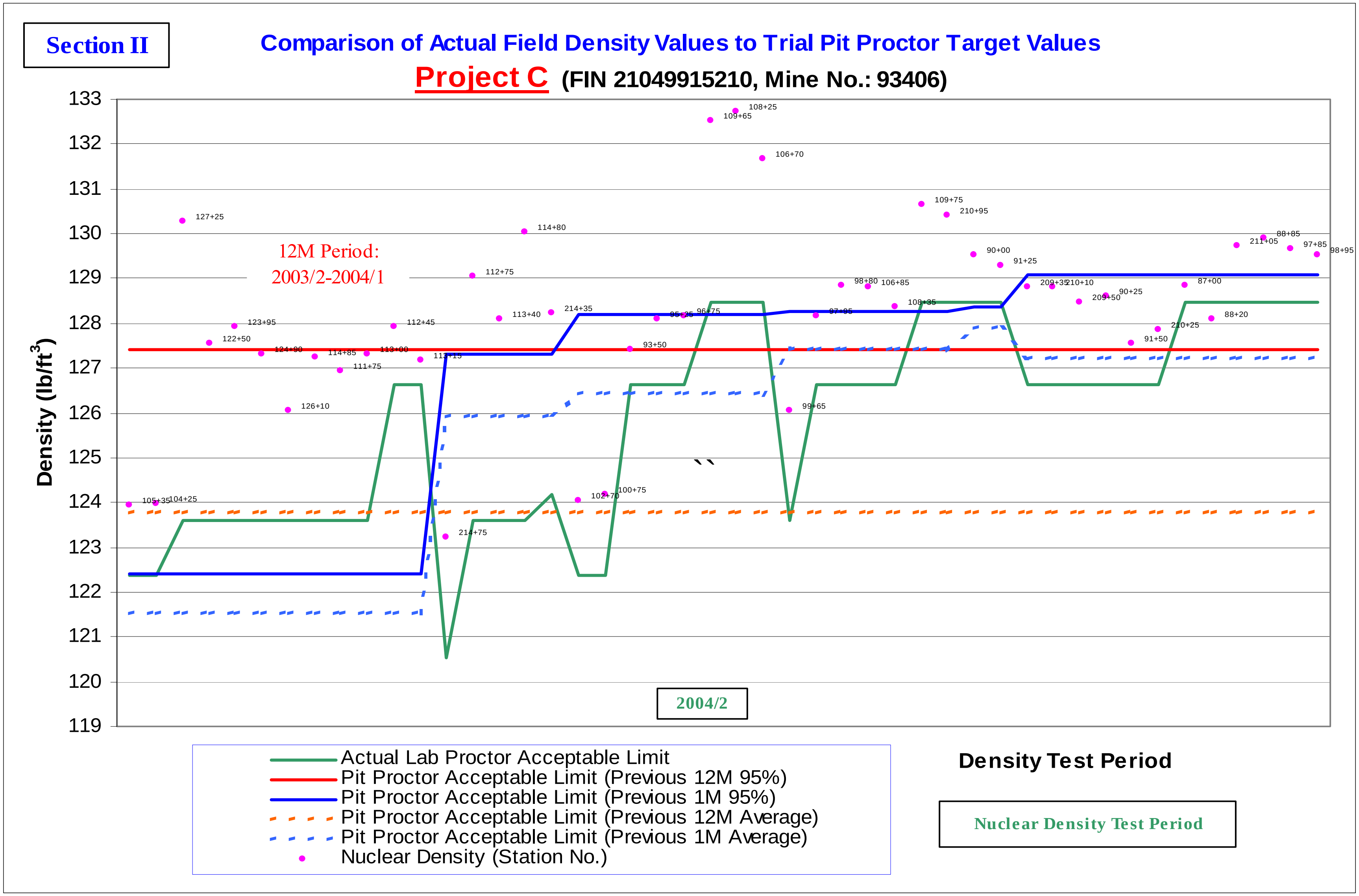
(Project FIN 21049915210)

FDOT Lab Proctor Report			Quality Control: Earthwork Density Report						
Test No.	Target Density (Kg/m^3)	Target Density (lb/ft^3)	Period Tested	Lot No.	Lift	station No.	Dry Value (Kg/m^3)	Nuclear Density (lb/ft^3)	Passing %
47	2020	126.0	2004/2	39	2/2	124+90	2040	127.3	101
48	2020	126.0	2004/2	40	2/2	126+10	2020	126.0	100
49	2020	126.0	2004/2	57	2/2	112+75	2068	129.0	102
50	2020	126.0	2004/2	58	2/2	113+40	2053	128.1	102
51	2020	126.0	2004/2	59	2/2	114+80	2084	130.0	103
52	2020	126.0	2004/2	66	2/2	99+65	2020	126.0	100
53	2030	126.7	2004/2	60	1/2	214+35	2055	128.2	101
54	2070	129.2	2004/2	44	1/2	112+45	2050	127.9	99
55	2070	129.2	2004/2	45	1/2	113+15	2038	127.2	98
56	2070	129.2	2004/2	64	1/2	97+95	2054	128.2	99
57	2070	129.2	2004/2	65	1/2	98+80	2065	128.9	100
58	2070	129.2	2004/2	69	1/2	209+35	2064	128.8	100
59	2070	129.2	2004/2	71	1/2	209+50	2059	128.5	99
60	2070	129.2	2004/2	73	1/2	90+25	2061	128.6	100
61	2070	129.2	2004/2	74	1/2	91+50	2044	127.5	99
62	2070	129.2	2004/2	43	2/2	127+15	2041	127.4	99
63	2070	129.2	2004/2	51	2/2	93+50	2042	127.4	99
64	2070	129.2	2004/2	52	2/2	95+25	2053	128.1	99
65	2070	129.2	2004/2	53	2/2	96+75	2054	128.2	99
66	2070	129.2	2004/2	67	2/2	106+85	2064	128.8	100
67	2070	129.2	2004/2	68	2/2	108+35	2057	128.4	99
68	2070	129.2	2004/2	70	2/2	210+10	2064	128.8	100
69	2070	129.2	2004/2	72	2/2	210+25	2049	127.9	99
70	2100	131.0	2004/2	54	1/2	109+65	2124	132.5	101
71	2100	131.0	2004/2	55	1/2	108+25	2127	132.7	101
72	2100	131.0	2004/2	56	1/2	106+70	2110	131.7	100
73	2100	131.0	2004/2	63	1/2	210+95	2090	130.4	100
74	2100	131.0	2004/2	75	1/2	87+00	2065	128.9	98
75	2100	131.0	2004/2	76	1/2	88+20	2053	128.1	98
76	2100	131.0	2004/2	80	1/2	88+85	2082	129.9	99
77	2100	131.0	2004/2	62	2/2	109+75	2094	130.7	100
78	2100	131.0	2004/2	77	2/2	211+05	2079	129.7	99
79	2100	131.0	2004/2	78	2/2	97+85	2078	129.7	99
80	2100	131.0	2004/2	79	2/2	98+95	2076	129.5	99
81	2100	131.0	2004/2	81	2/2	90+00	2076	129.5	99
82	2100	131.0	2004/2	82	2/2	91+25	2072	129.3	99



Comparison of Actual Field Density Values to Trial Pit Proctor Target Values
Project C (FIN 21049915210, Mine No.: 93406)
Density (lb/ft^3)
133
132
131
130
129
128
127
126
125
124
123
122
121
120
119
Section I
Section II
Density Test Period
Actual Lab Proctor Acceptable Limit
Pit Proctor Acceptable Limit (Previous 12M 95%)
Pit Proctor Acceptable Limit (Previous 1M 95%)
Pit Proctor Acceptable Limit (Previous 12M Average)
Pit Proctor Acceptable Limit (Previous 1M Average)
Nuclear Density


Section I
Comparison of Actual Field Density Values to Trial Pit Proctor Target Values
Project C (FIN 21049915210, Mine No.: 93406)
12M Period: 2002/2-2003/1
12M Period: 2003/1-2003/2
Density (lb/ft3)
2003/2
2004/1
Density Test Period
Nuclear Density Test Period
Actual Lab Proctor Acceptable Limit
Pit Proctor Acceptable Limit (Previous 12M 95%)
Pit Proctor Acceptable Limit (Previous 1M 95%)
Pit Proctor Acceptable Limit (Previous 12M Average)
Pit Proctor Acceptable Limit (Previous 1M Average)
Nuclear Density (Station No.)



Section II
Comparison of Actual Field Density Values to Trial Pit Proctor Target Values
Project C (FIN 21049915210, Mine No.: 93406)
Density (lb/ft^3)
12M Period:
2003/2-2004/1
2004/2
Density Test Period
Nuclear Density Test Period
Actual Lab Proctor Acceptable Limit
Pit Proctor Acceptable Limit (Previous 12M 95%)
Pit Proctor Acceptable Limit (Previous 1M 95%)
Pit Proctor Acceptable Limit (Previous 12M Average)
Pit Proctor Acceptable Limit (Previous 1M Average)
Nuclear Density (Station No.)

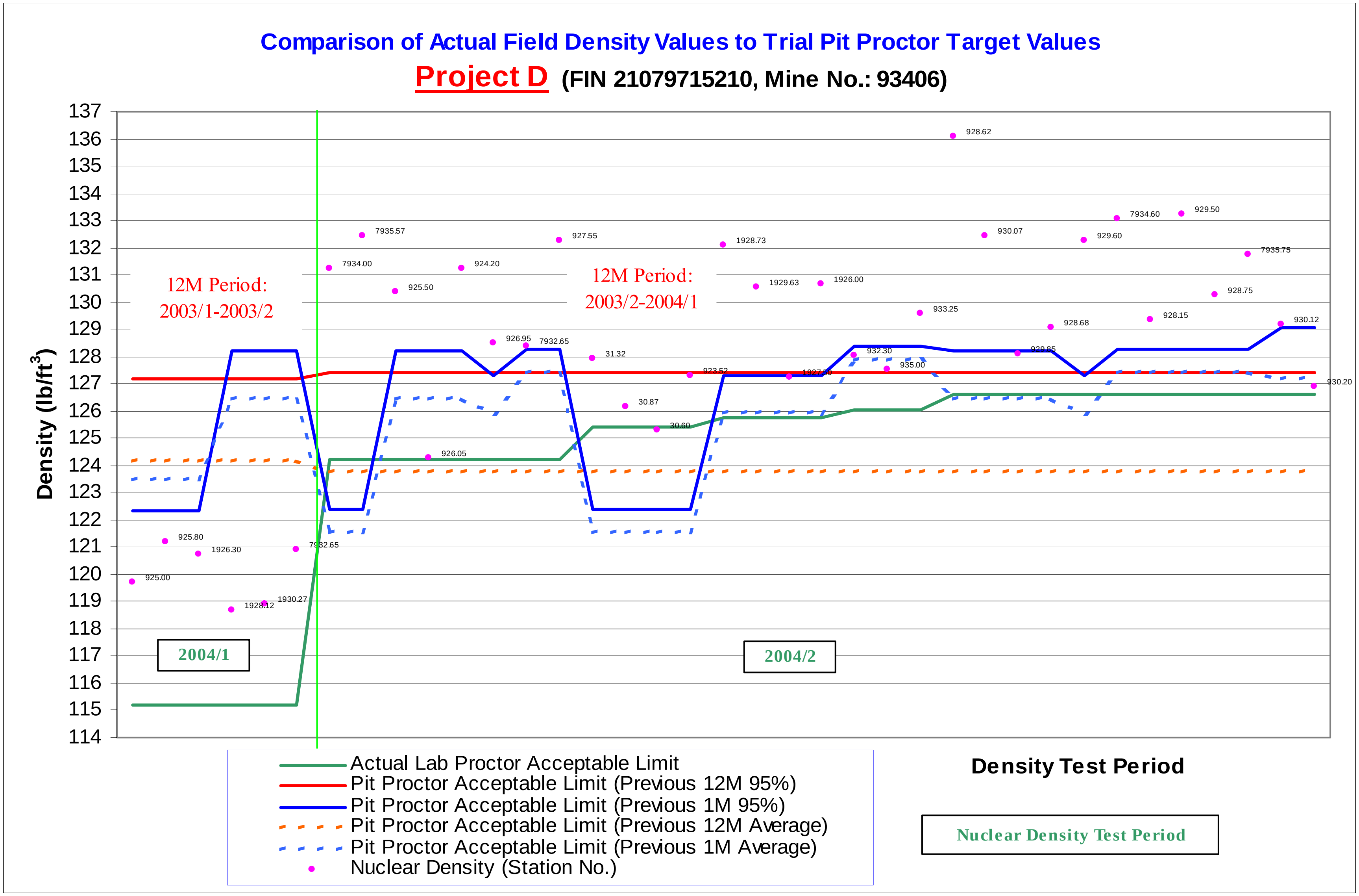
Project D: Field Data Analysis

(Project FIN 21079715210)

Table of Actual Target Density from Lab Proctor and Nuclear Density values

(Project FIN 21079715210)

FDOT Lab Proctor Report			Quality Control: Earthwork Density Report						
Test No.	Target Density (Kg/m^3)	Target Density (lb/ft^3)	Period Tested	Lot No.	Lift	station No.	Dry Value (Kg/m^3)	Nuclear Density (lb/ft^3)	Passing %
1	1883	117.5	2004/1	1	1/2	925+00	1918	119.7	102
2	1883	117.5	2004/1	2	1/2	925+80	1942	121.2	103
3	1883	117.5	2004/1	4	1/2	1926+30	1935	120.7	103
4	1883	117.5	2004/2	8	1/2	1928+12	1902	118.7	101
5	1883	117.5	2004/2	9	1/2	1930+27	1906	118.9	101
6	1883	117.5	2004/2	10	1/2	7932+65	1938	120.9	103
7	2030	126.7	2004/2	16	1/2	7934+00	2103	131.2	104
8	2030	126.7	2004/2	17	1/2	7935+57	2122	132.4	105
9	2030	126.7	2004/2	24	2/2	925+50	2089	130.4	103
10	2030	126.7	2004/2	25	2/2	926+05	1992	124.3	98
11	2030	126.7	2004/2	30	2/2	926+95	2059	128.5	101
12	2030	126.7	2004/2	33	2/2	7932+65	2057	128.4	101
13	2030	126.7	2004/2	38	2/2	927+55	2120	132.3	104
14	2030	126.7	2004/2	23	2/3	924+20	2103	131.2	104
15	2050	127.9	2004/2	11	1/3	31+32	2050	127.9	100
16	2050	127.9	2004/2	18	1/3	923+52	2040	127.3	100
17	2050	127.9	2004/2	12	2/3	30+87	2022	126.2	99
18	2050	127.9	2004/2	13	3/3	30+60	2008	125.3	98
19	2056	128.3	2004/2	26	2/2	1928+73	2117	132.1	103
20	2056	128.3	2004/2	27	2/2	1929+63	2092	130.5	102
21	2056	128.3	2004/2	28	2/2	1927+50	2039	127.2	99
22	2056	128.3	2004/2	29	2/2	1926+00	2094	130.7	102
23	2060	128.5	2004/2	47	1/2	935+00	2044	127.5	99
24	2060	128.5	2004/2	48	1/2	932+30	2052	128.0	100
25	2060	128.5	2004/2	49	1/2	933+25	2077	129.6	101
26	2070	129.2	2004/2	46	1/1	930+12	2070	129.2	100
27	2070	129.2	2004/2	19	1/2	928+62	2181	136.1	105
28	2070	129.2	2004/2	21	1/2	929+85	2053	128.1	99
29	2070	129.2	2004/2	22	1/2	928+68	2068	129.0	100
30	2070	129.2	2004/2	31	1/2	929+60	2120	132.3	102
31	2070	129.2	2004/2	37	1/2	928+15	2073	129.4	100
32	2070	129.2	2004/2	45	1/2	930+20	2034	126.9	98
33	2070	129.2	2004/2	20	2/2	930+07	2122	132.4	103
34	2070	129.2	2004/2	34	2/2	7934+60	2132	133.0	103
35	2070	129.2	2004/2	35	2/2	929+50	2135	133.2	103
36	2070	129.2	2004/2	36	2/2	928+75	2088	130.3	101
37	2070	129.2	2004/2	39	2/2	7935+75	2111	131.7	102


Comparison of Actual Field Density Values to Trial Pit Proctor Target Values
Project D (FIN 21079715210, Mine No.: 93406)
Density (lb/ft3)
12M Period: 2003/1-2003/2
12M Period: 2003/2-2004/1
2004/1
2004/2
Actual Lab Proctor Acceptable Limit
Pit Proctor Acceptable Limit (Previous 12M 95%)
Pit Proctor Acceptable Limit (Previous 1M 95%)
Pit Proctor Acceptable Limit (Previous 12M Average)
Pit Proctor Acceptable Limit (Previous 1M Average)
Nuclear Density (Station No.)
Density Test Period
Nuclear Density Test Period