Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
TX-95/2908-1F		

4. Title and Subtitle	5. Report Date
RESULTS OF THE SIX- AND TWELVE-MONTH EVALUATIONS OF THE TEXAS SUPPLEMENTAL MAINTENANCE EFFECTIVENESS RESEARCH PROGRAM (SMERP) SITES	December 1994
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
Thomas J. Freeman, P.E.	Research Report 2908-1F
9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Texas Transportation Institute The Texas A&M University System College Station, Texas 77843-3135	11. Contract or Grant No. Study No. 7-2908
12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
Texas Department of Transportation Research and Technology Transfer Office P. O. Box 5080 Austin, Texas 78763-5080	Final: October 1, 1994 to August 31, 1994
	14. Sponsoring Agency Code

15. Supplementary Notes

Research performed in cooperation with the Texas Department of Transportation.
Research Study Title: Re-Inspection of the SMERP Sites

16. Abstract

The SMERP (Supplemental Maintenance Effectiveness Research Program) study was designed to study the types of maintenance treatments typically used in Texas. Six maintenance treatments and a control section were applied at twenty test locations throughout the state. Treatments included: asphalt rubber chip seal, polymer modified emulsion chip seal, latex modified asphalt chip seal, asphalt chip seal, and a micro-surfacing treatment. Researchers re-inspected the sites approximately six and twelve months after construction. The data was entered into ASCII files and is in the same format as the output from the SHRP NIMS (National Information Management System) data base. This report presents the preliminary analysis of the change in levels of distress.

17. Key Words	18. Distribution Statement
Maintenance Effectiveness, Chip Seal, AC, Asphalt Rubber, Latex, CRS-2P, Emulsion, Slurry, Micro-Surfacing, SMERP	No restrictions. This document is available to the public through NTIS: National Technical Information Service 5285 Port Royal Road Springfield, Virginia 22161

19. Security Classif.(of this report)	20. Security Classif.(of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	108	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

RESULTS OF THE SIX- AND TWELVE- MONTH EVALUATIONS OF THE TEXAS SUPPLEMENTAL MAINTENANCE EFFECTIVENESS RESEARCH PROGRAM (SMERP) SITES

by

Thomas J. Freeman, P.E.
Engineering Research Associate,
Texas Transportation Institute

Research Report 2908-1F
Research Study Number 7-2908
Research Study Title: Results of the Six and Twelve Month Evaluation of the Texas Supplemental Maintenance Effectiveness Research Program (SMERP) Sites

Sponsored by
Texas Department of Transportation

December 1994

TEXAS TRANSPORTATION INSTITUTE
The Texas A&M University System
College Station, Texas 77843-3135

IMPLEMENTATION STATEMENT

This report describes the continued data collection for the Supplemental Maintenance Effectiveness Research Program (SMERP) test sections constructed by Keystone Services, Inc., of Bixby, Oklahoma, with International Surfacing, Inc., as a subcontractor, for the Texas Department of Transportation. The data collected and described herein can be used by the districts in Texas to document the performance of these maintenance treatments and to determine whether the maintenance treatments described in this study are performing as expected. The results of this and continued studies of the SMERP treatments could provide data for the Texas pavement management system.

DISCLAIMER

The contents of this report reflect the views of the author who is responsible for the opinions, findings, and conclusions presented herein. The contents do not necessarily reflect the official views or policies of the Texas Department of Transportation (TxDOT). This report does not constitute a standard, specification, or regulation. Additionally, this report is not intended for construction, bidding, or permit purposes. Thomas J. Freeman was the Principal Investigator for the project.

ACKNOWLEDGMENT

Special thanks is given to Elias Rmeili, Larry Buttler, James Brown, and James Sassin of TxDOT for their assistant in the development and construction of the SMERP experiment.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

SUMMARY

The Administration at the Texas Department of Transportation decided in 1990 to develop and construct test sites of various preventive maintenance treatments currently used in Texas. The primary objectives for the research are to establish the cost effectiveness of typical and promising maintenance treatments used in Texas in prolonging the life of asphalt pavements, to determine the optimum time and preventive maintenance strategies to prolong pavement life, and to demonstrate positive rates of return on preventive maintenance funds.

1. Twelve Districts participated in the study. The Districts were: Paris (1), Amarillo (4), Odessa (6), Abilene (8), Waco (9), Tyler (10), Yoakum (13), San Antonio (15), (17), Atlanta (19), Beaumont (20), and Brownwood (23).

2. Twenty sites were constructed. Each site included a total of seven 700 foot (213.4 m) sections. The sections were micro-surfacing, fog seal, a control section, and four seal coat types: asphalt rubber, latex modified, polymer modified, and conventional. Two sites did not have a fog seal or a control section.

3. The contractor was Keystone Services, Inc., with International Surfacing, Inc., as a subcontractor. State forces constructed the fog seal sections. Overall, the project was completed with a TxDOT rating of "Good."

4. Construction of the test sections began April 5, 1993, and was completed July 14, 1993.

5. The sections were inspected approximately six and twelve months after construction. The sites will be re-inspected once per year until failure to accomplish the objectives.

Considerable construction data was collected in order to determine the quality of treatment. The data collected can be used by the districts in Texas to see if they should be collecting any additional data and by researchers studying the effectiveness of the SMERP treatments. Research report TX-93/1981-1F, "Development and Construction of the Texas Supplemental Maintenance Effectiveness Research Program (SMERP) Experiment," contains additional details on the construction sequence, data collection during construction, materials used, and other information pertinent to the construction of the test sites.

To date, one site (48Q19, site 17 in Panola county west of Carthage) has failed and been taken out of service. The entire roadway section is to be rehabilitated due to structural failure. The

Fog Seal and Control Section at one other site (48G08, site 7 in Taylor County southeast of Abilene) have been lost due to maintenance forces placing a chip seal on top of these sections. A contributing factor may have been that this site did not have the test section signs installed.

With only two post-construction inspections (six months and twelve months), it is too early to establish the performance of the treatments. The phenomena of development or initiation of distress will need to be separated from those sections where the quantity of an existing distress is increasing. Another complicating factor is that the six month inspection was done during the cold season. The purpose of performing this early distress survey was to gather data in case of an early failure of a treatment and to establish a baseline performance for the treatments. However, a lesson learned during the SHRP SPS-3 analysis is that there may be a seasonal factor to the results of distress surveys. If more distress surveys could be performed during various seasons, this effect of this factor could be determined.

With the preceding cautions it appears, in general, that as of approximately twelve months after construction, the treatments (except for the Fog and Control sections) have had a positive impact on reducing the occurrence of distresses. Table 1 lists the trends for each distress type and treatment. It must be noted that this information is **very preliminary** and future analysis may contradict these trends.

Table 1. Preliminary Analysis of SMERP Sites

	Alligator Cracking	Bleeding	(*) Block Cracking	Long and Trans Cracking	Long WP Cracking	(*) Ravelling
Rubber	Reduced	Increased	Reduced	Reduced	Reduced	Increased
Micro	Reduced	Reduced	Reduced	Mixed	Increased	Reduced
Emulsion	Reduced	Reduced	Reduced	Reduced	Reduced	Reduced
Latex	Reduced	Increased	Reduced	Reduced	Reduced	Mixed
AC	Mixed	Increased	Reduced	Reduced	Reduced	Mixed
Fog	Reduced	Increased	Increased	Reduced	Mixed	Increased
Control	Mixed	Increased	Increased	Reduced	Increased	Increased

(*) - Few sites affected, trends questionable.

CHAPTER 1. BACKGROUND AND OBJECTIVES

BACKGROUND

Now that most of the new road construction in the United States is complete, the major emphasis has switched to maintaining those roads. In an effort to improve the information on the performance of maintenance treatments, the Strategic Highway Research Program (SHRP) implemented research on the effectiveness of maintenance treatments. SHRP is gathering field performance data from pavement test sections spread over the various climatic regions of the United States. However, the SHRP data is not applicable to all pavement preventive maintenance treatments currently used in Texas.

The SHRP (Strategic Highway Research Program) H-101 Maintenance Effectiveness program studied the effects of selected preventive maintenance treatments (Ref. 1). Texas is in the SHRP Southern region. The SHRP Southern region has test sites throughout Texas, as far north as Tennessee, and as far east as Florida. The SHRP research required that the contractor use the same asphalt and aggregate at each site constructed within the specific SHRP region. In addition, the SHRP research studied the following maintenance treatments only: emulsified asphalt chip seal, crack seal, slurry seal, and a thin overlay. When SHRP personnel were looking for SHRP sites on which to build the Asphalt Maintenance Cost Effectiveness Study, Specific Pavement Study-3 (SPS-3), they offered to State Highway Agencies the option to build supplemental test sections adjoining the SPS-3 sections under the agreement that SHRP would monitor all test sections constructed. Interest was expressed by several Texas Districts after the SHRP offer. However, a combination of limited funding in the individual district's maintenance allocation and lack of consensus on which treatments to place resulted in a decision by the Administration to adjust the state's overall preventive maintenance program and develop a comprehensive preventive maintenance experiment.

The Texas Department of Transportation (TxDOT) spends approximately $450 million per year on its overall maintenance program and approximately $150 million per year on its Preventive Maintenance Program. The Texas Department of Transportation introduced the Texas Preventive Maintenance Research Program at the annual District SHRP Coordinators meeting in October 1990. The name of this program was later changed to SMERP (Supplemental Maintenance Effectiveness Research Program). One million dollars was allocated to the experiment to build test sections of preventive maintenance treatments of interest to Texas but not considered in the SHRP national experiment.

The SMERP study was designed to more closely study the types of maintenance treatments typically used in Texas, and it allowed the contractor to use local materials if desired. The treatments constructed in the SMERP study were asphalt rubber chip seal, polymer modified emulsion chip seal, latex modified asphalt chip seal, asphalt chip seal, and a micro-surfacing treatment. All treatments were placed on test sections that were 700 feet (213.4 m) long. Both lanes were treated and, where they existed, the shoulders were also treated. Shoulders were not treated under the SHRP SPS-3 study. A fog seal section was constructed by state forces and a control section was established on which no treatment was placed. In general, the SMERP contractor did not use local materials at each site but did use local sources of asphalt and aggregate where available.

OBJECTIVES

The goal for the SMERP Experiment is to establish the cost effectiveness of typical and promising maintenance treatments used in Texas in prolonging the life of asphalt pavements.

Factors contributing to increased maintenance effectiveness and optimum pavement life-cycle cost are maintenance planning, spending, and performance monitoring. TxDOT will be able to address these factors by using the pavement management system and the data collected from the SHRP SPS-3 and SMERP studies. By combining the data and analysis of both programs, the department will be assured optimal planning strategies in selecting preventive maintenance treatments. Once again, the primary objective is to determine optimum preventive maintenance strategies that prolong pavement life and to demonstrate positive rates of return on preventive maintenance funds.

EXPERIMENT DESIGN

It was decided that the experiment design should incorporate factors considered to be key variables in the analysis and that the basic design matrix should be similar to the one developed for the SHRP study. At that point, it was decided to fill the matrix with candidate projects that fit the following criteria.

A. Performance Regions
   West, East, South, NorthWest, and Central.

B. Pavement Condition
   Good and Fair.

C. Traffic
   Low and high.

After reviewing all of the sites submitted, the goal of filling all of the above criteria could not be met. However, the performance regions criteria were met. Not all of the pavement condition and traffic criteria were met, but the sites were typical candidates to receive preventive maintenance treatments. The final list of sites is shown in Table 2, and the geographical distribution of the sites is shown in Figure 1.

The sites where the SMERP sites were to be constructed were identified by the districts that offered to participate in the study and accepted by the TxDOT Design Division. The districts marked the beginning and end of each treatment and provided signs along the roadway to indicate each of the SMERP treatments.

Table 2. Test Sites, Locations, and Section Numbers

PROJ NO.	DIST	ROAD	COUNTY	REF MARKER FROM	REF MARKER TO	LOCATION FROM	LOCATION TO	SITE NUMBER
1	1	SH 11	Grayson	600+0.00	600+0.80	2.8 mi S. of FM 637	0.76 mi S.	48A01
2	1	SH 19	Hopkins	246+0.00	246+0.76	Sulphur Springs City Limits	0.76 mi S.	48B01
3	4	US 385	Deaf Smith	116+0.00	116+1.00	FM 1412	FM 1062	48C04
4	4	FM 1061	Potter	102+0.00	104+0.00	0.75 mi E. of FM 2381	2.0 mi E.	48D04
5	6	FM 181	Ector	326+0.00	336+0.50	Andrews County Line	Near SH 158	48E06
6	6	SH 349	Martin	288+0.00	302+1.85	Near FM 87	Dawson Co.	48F06
7	8	SH 36	Taylor	296+7.00	302+3.00	Abilene City Limits	Callahan Co.	48G08
8	8	US 84	Scurry	407+1.74	404+4.00	Snyder City Limits	US 180	48H08
9	9	FM 933	McLennan	356+1.367	358+0.161	FM 3051	0.8 mi S.	48I09
10	10	SH 135	Smith	302+1.962	304+1.752	0.26 mi NE of SH 64	0.79 mi NE	48J10
11	13	SH 35	Calhoun	602+0.00	606+0.26	Jackson Co. Line	FM 1593	48K13
12	13	SH 71	Fayette	644+0.283	648+0.310	Baylor Creek	FM 955	48L13
13	15	SH 46	Bandera	472+0.442	468+0.042	Kendall Co. Line	SH 16	48M15
14	15	FM 484	Comal	462+0.041	464+0.988	FM 32	FM 306	48N15
15	17	US 190	Milam	628+0.685	628+1.485	1.9 mi S. of US 77	0.8 mi S.	48O17
16	19	SH 49	Titus	700+1.111	700+1.774	1.1 mi W. of Morris Co.	Morris Co.	48P19
17	19	SH 315	Panola	738+0.709	738+1.37	1.4 mi W. of SH 149	0.3 mi W. of SH 149	48Q19
18	20	FM 105	Jasper	424+0.000	424+1.500	US 96	1.5 mi S.	48R20
19	23	US 67	Brown	558+0.54	558+1.47	Blanket Creek Bridge	1.0 mi N.	48S23
20	23	US 377	McCulloch	472+1.908	474+0.836	1.0 mi N. of FM 2996 S.	FM 2996	48T23

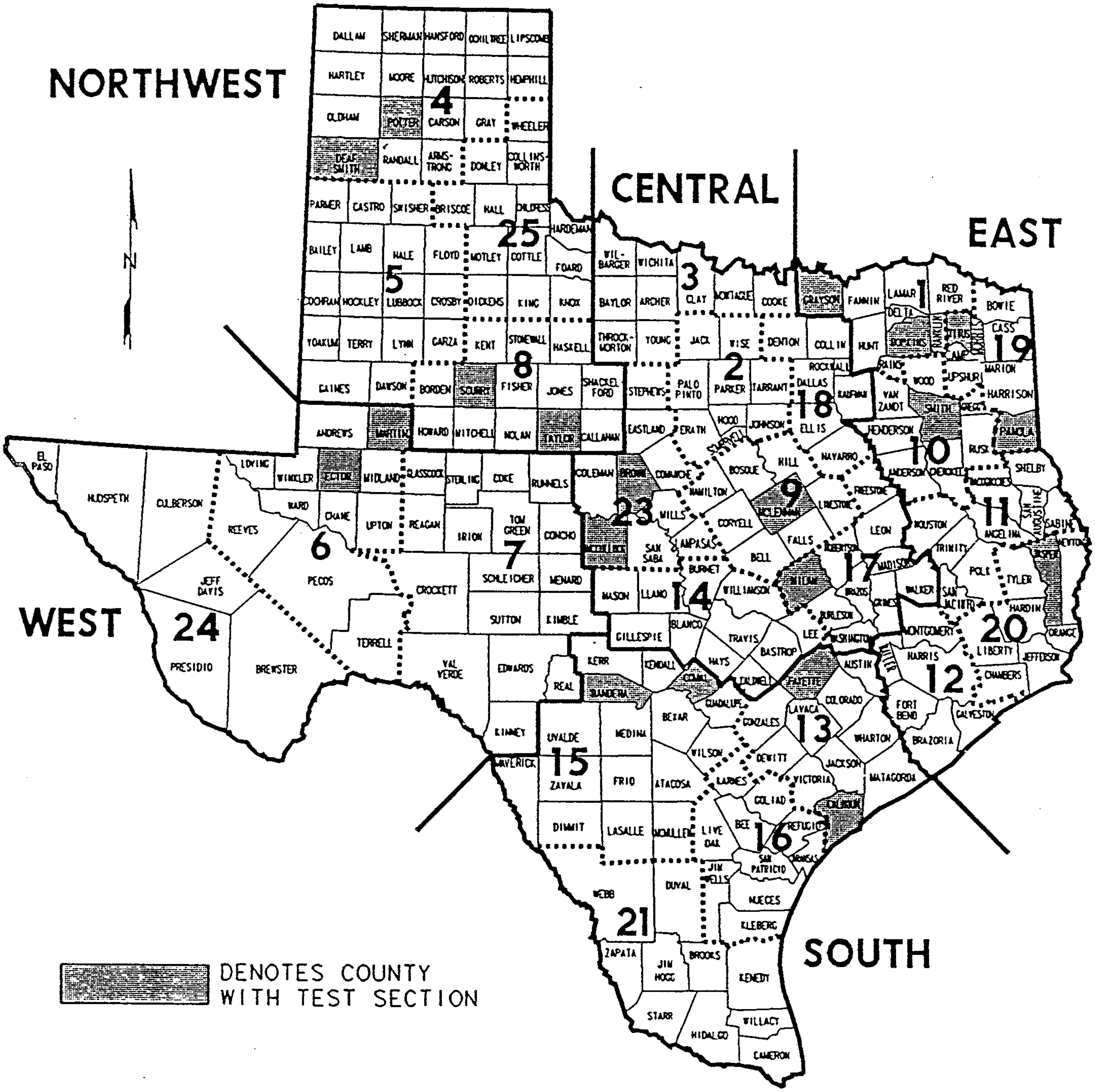


Figure 1. Locations of SMERP Sites

LAYOUT, MARKING, AND SIGNING TEST SECTIONS

Figure 2 shows the typical layout of test sections within each site. All sections are grouped together unless there is a change in pavement structure, traffic, or condition. The monitoring section will be 500 feet (152.4 m) long and only in the designated lane. However, visual distress data has been collected on all lanes, and the evaluation may include both lanes.

To alert the public to the existence of a test site, a sign was installed alongside the test section 6 feet (1.8 m) to the right of the shoulder and 200 feet (61.0 m) before the first test section. This sign reads "TEST SITE NEXT 1 MILE." Signs identifying the specific treatment type were installed near the right-of-way line at the beginning of each section. Each sign listed SMERP, the test section number, treatment type, and section number. At the one site where these signs were not installed, the fog seal and control section were chip sealed and have been removed from the experiment.

White, non-reflectorized traffic buttons were placed on the edge of the shoulder at the beginning of every section and at every 100 feet (30.5 m). If a site did not have a shoulder, buttons were not installed.

A white paint stripe (3-4 inches wide [0.076 m - 0.102 m]) was placed at the beginning and end of each treatment across the treatment lane. A white stripe (3-4 inches wide [0.076 m - 0.102 m]) was also placed at the beginning and end of the monitoring section across the treatment lane. The stripe at the end of a treatment was used for the beginning of the next treatment if the two treatments were adjacent.

White crosses were painted at the beginning and end of the monitoring section and at every 100 feet (30.5 m) within the monitoring section. The station numbers (0, 1, 2, 3, 4, and 5) were painted to the right of the crosses to aid in location for distress surveys and other data collection efforts.

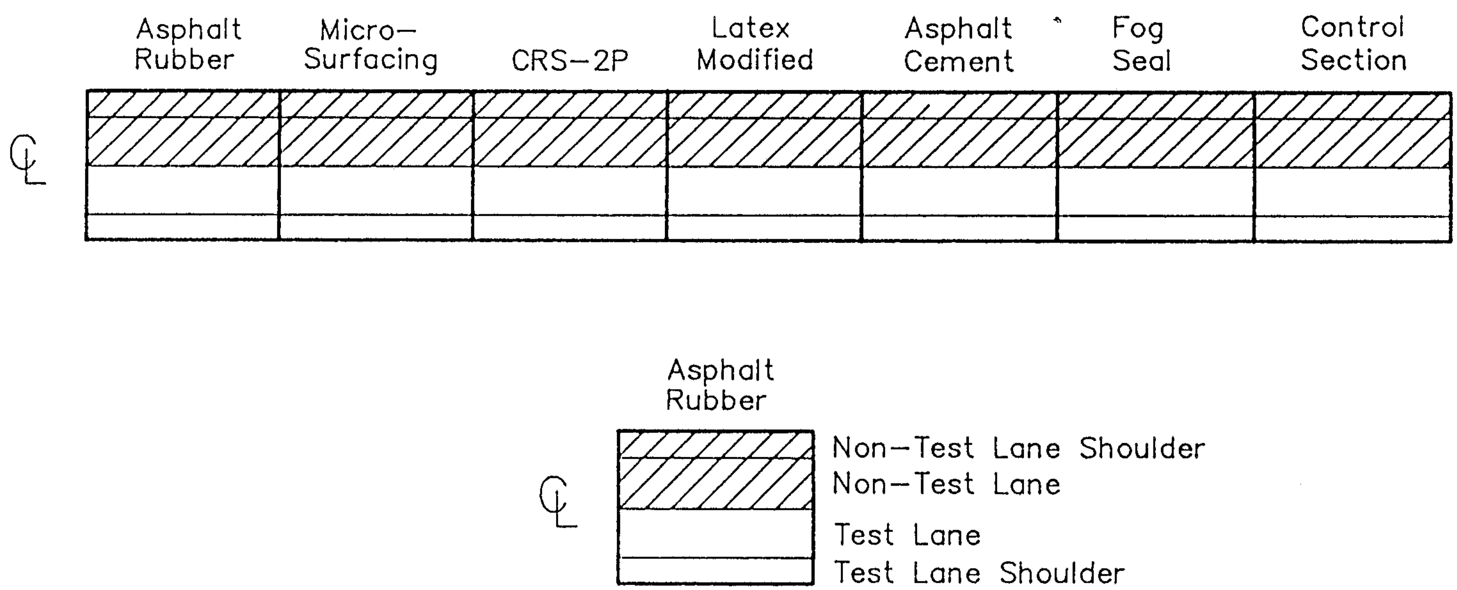


Figure 2. Typical SMERP Site Layout

The section number was painted to the right of the white stripe at the beginning of the monitoring test section (the numbers and letters were about 5 inches high [0.127 m]). The section numbering scheme of the SMERP sections is similar to the SHRP scheme. The numbering of a site consists of four parts. The first two digits (48) represent the state code for Texas. The next character is the site number expressed alphabetically (i.e., A is site 1, B is site 2, C is site 3, etc.). The next two digits signify the TxDOT district where the site is located. The final character is the site type. Table 3 lists the site types and their appropriate description.

Table 3. Site Numbering Description

Example: 48A01H

H -	Asphalt Rubber Test Lane	R -	Asphalt Rubber Non-Test Lane
M -	Micro-Surfacing Test Lane	I -	Micro-Surfacing Non-Test Lane
E -	CRS-2P Test Lane	U -	CRS-2P Non-Test Lane
L -	Latex Modified Test Lane	T -	Latex Modified Non-Test Lane
C -	Straight AC Test Lane	O -	Straight AC Non-Test Lane
F -	Fog Seal Test Lane	G -	Fog Seal Non-Test Lane
X -	Control Section Test Lane	N -	Control Section Non-Test Lane

PRE-CONSTRUCTION CONDITION SURVEYS

Prior to construction of the SMERP treatments, a manual condition survey and an automated distress survey using the Automated Road Analyzer (ARAN) (video image analysis) were conducted. The ARAN data has not yet been analyzed, but provides an excellent historical video log of the pavement prior to construction. In the initial survey, only the test lane was surveyed. Future manual distress surveys will be conducted on both lanes of the test sections. The manual survey was conducted in accordance with the procedures set up for a SHRP LTPP distress survey (Ref 3.). In addition to measuring the number and quantity of each distress at each severity level, a crack map showing the location of each distress was also produced. An example of a completed form is shown in Figure 3.

The distress data from the manual surveys were summarized and entered into a spreadsheet. The data were also placed in an ASCII file in a format that is compatible with the output from the SHRP LTPP database.

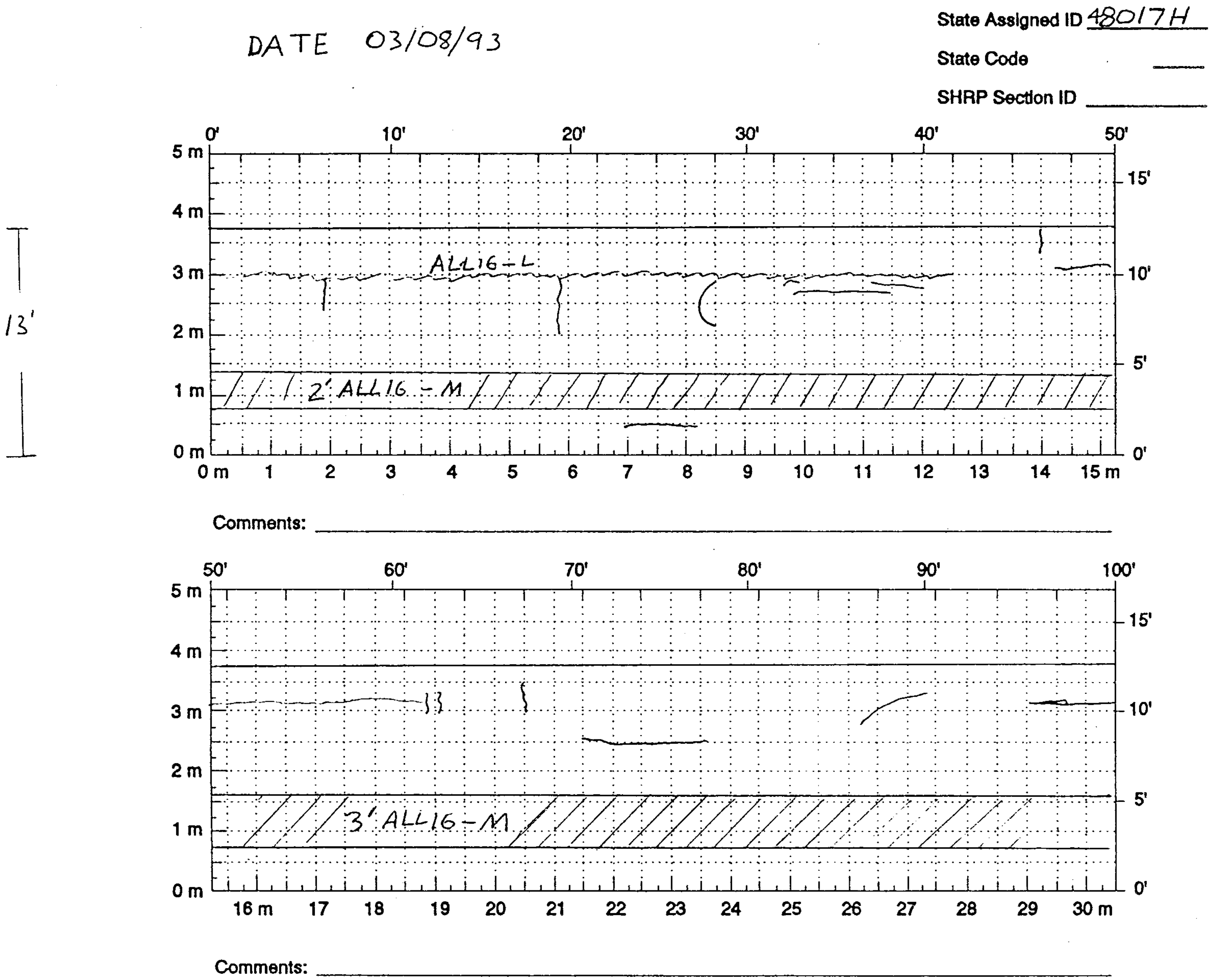


Figure 3. Completed SHRP LTPP Condition Survey Form

CHAPTER 2. CONSTRUCTION AND POST CONSTRUCTION DISTRESS SURVEYS

CONSTRUCTION

Twelve Districts participated in the study. The Districts were: Paris (1), Amarillo (4), Odessa (6), Abilene (8), Waco (9), Tyler (10), Yoakum (13), San Antonio (15), Atlanta (19), Beaumont (20), and Brownwood (23). A total of twenty sites were constructed. Each site included a total of seven 700 foot (213.4 m) sections. The sections were micro-surfacing, fog seal, a control section, and four seal coat types asphalt rubber, latex modified, polymer modified, and conventional. Two sites did not have a fog seal or a control section.

After preparation of the plans, specifications, and special provisions, bid documents were distributed to interested parties. Upon receipt and opening of the bids, Keystone Services, Bixby, Oklahoma, was selected as the prime contractor to perform the work.

Construction of the SMERP project started April 5, 1993, and was completed July 14, 1993. The contractor was Keystone Services, Inc. (KS), and the subcontractor was International Surfacing, Inc. (ISI). KS constructed the micro-surfacing and three chip seals sections: polymer modified, latex modified, and conventional. ISI constructed the asphalt rubber chip seal section. Overall, the project was completed with a TxDOT rating of "Good." The fog seal sections were constructed by the local districts. No treatment was applied to the control section. This treatment will explain the "do nothing" approach.

Construction began on SH 35, Yoakum District, and began moving north because of rainy weather. The contractor constructed all five test sections within each site before moving to the next site. The contractor provided all materials and equipment to construct all sections and provided traffic control throughout construction.

Prior to beginning construction at each site, the contractor would meet with the design division personnel and the local district to review all construction details. After the meeting, the construction of the site was turned over to the local inspector and the site was constructed according to the normal construction procedures of the local District.

The contractor would always begin work on the non-test lane and shoulder. The traffic was then switched to the treated lane and the test lane and shoulder were then treated. The reason behind treating the non-test lane first was to make sure everything was working properly by the time the test section was constructed. It usually took two days to construct the five treatments on both lanes and shoulders within a site. Usually three sections were treated the first day and the other two sections were treated the next day. Sometimes the contractor was able to construct four treatments the first day.

The following are the average target rates for the individual materials. The actual rate used for the sites in that district was provided by the local district. Target rates were modified in the field as necessary to ensure a high quality treatment.

TARGET APPLICATION RATES

Asphalt Rubber	1.8 - 2.7 l/m^2	(.40 - .60 Gal/SY)
Polymer Modified Emulsion	1.4 - 1.8 l/m^2	(.30 - .40 Gal/SY)
Asphalt Cement With Latex	1.4 - 1.8 l/m^2	(.30 - .40 Gal/SY)
Straight Asphalt Cement	1.4 - 1.8 l/m^2	(.30 - .40 Gal/SY)
Combined Micro-Surfacing	13.6 Kg/m^2	(25 Lbs/SY)
Lightweight Grade 4	6.5 Kg/m^2	(12 Lbs/SY)
Precoat Grade 4	11.4 - 12.5 Kg/m^2	(21 - 23 Lbs/SY)
Precoat Grade 3	12.5 - 16.3 Kg/m^2	(23 - 30 Lbs/SY)

After completing the Asphalt Rubber chip seal test section, construction of the chip seal with viscosity graded asphalt cement binder (Asphalt Cement) was begun. The previously described sequence of operations was followed for the Asphalt Cement chip seal section. The next treatment completed was the chip seal with polymer modified cationic rapid set emulsified asphalt cement (CRS-2P) chip seal test section. After completing both sides of the CRS-2P emulsified asphalt chip seal, construction was usually halted until the next day. Prior to leaving the site, all chip seal sections except for the CRS-2P emulsified asphalt chip seal section were swept to remove loose rock. The emulsion test section was usually swept the next day.

Operation the next day typically began with the above construction sequence being performed on the chip seal with the Latex Modified asphalt cement binder (Latex Modified). After completing the Latex Modified chip seal, the Micro-Surfacing treatment was begun.

POST-CONSTRUCTION CONDITION SURVEYS

Two post-construction distress surveys have now been performed. These were conducted manually in accordance with the procedures set up for a SHRP LTPP distress survey (Ref 3.). In addition to measuring the number and quantity of each distress at each severity level, a crack map showing the location of each distress was also produced. An example of a completed form was shown in Figure 3. These surveys were conducted approximately six months and twelve months after construction. In addition to the distress surveys, a video tape recording of the condition of each site was made by either walking through the section or by video taping from a car being driven down the lane or shoulder on higher traffic or reduced visibility sites.

The distress data from the manual surveys were summarized and entered into a spreadsheet. The data were also placed in an ASCII file in a format that is compatible with the output from the SHRP LTPP database.

OUTPUT FILE FORMATS

The data collected were entered into a Quattro Pro^{R} spreadsheet for the purpose of properly formatting the data. The data is contained in ASCII files formatted into the SHRP LTPP SPS-3 compatible format. Data could not be entered directly into the SHRP LTPP data base because neither TTI nor TxDOT has access to the SHRP LTPP data base. Therefore, the format used to output data from the SHRP National Information Management System (NIMS) into ASCII files was selected (Ref. 3). The data can then be easily combined with the SPS-3 data for analysis.

The data files follow the data sheets quite closely and since the data sheets include a longer description of the data item, it is advisable to have both the data sheets and this file format available during analysis.

CHAPTER 3. RESULTS AND FUTURE WORK

PRELIMINARY RESULTS

Although it is too early to determine the effectiveness of each of the treatments, the general trends of the data and an analysis of the construction process can be accomplished. Some early results regarding the application process were shown in the research report TX-93/1981-1F "Development and Construction of the Texas Supplemental Maintenance Effectiveness Research Program (SMERP) Experiment." Actual application rates were shown and compared to the target rates for the treatments. In general, with the exception of the Asphalt Rubber, the percent difference between proposed application and actual application rates were quite small. The previous report discussed possible complications in the application of the asphalt rubber.

With only two post-construction inspections (six months and twelve months), it is too early to establish the performance of the treatments. The phenomena of development or initiation of distress will need to be separated from those sections where the quantity of an existing distress is increasing. Another complicating factor is that the six month inspection was done during the cold season. The purpose of performing this early distress survey was to gather data in case of an early failure of a treatment and to establish a baseline performance for the treatments. However, a lesson learned during the SHRP SPS-3 analysis is that there may be a seasonal factor to the results of distress surveys. If more distress surveys could be performed during various seasons, this effect of this factor could be determined.

With the preceding cautions it appears, in general, that as of approximately twelve months after construction, the treatments (except for the Fog and Control sections) have had a positive impact on reducing the occurrence of distresses. Table 4 lists the trends for each distress type and treatment. Figures 4 - 15 illustrate the number of sites and average area, or length, of distress measured during the pre-construction, six month, and twelve month survey that was used to develop Table 4.

It must be noted that this information presented here is very preliminary and future analysis may contradict these trends. No attempt has been made to include the severity of the distress in the analysis. While the analysis of progression of distress from low to high is very important, there is not yet enough data to support this type of analysis.

The distresses from the SHRP distress manual have been combined to produce the following six distress types: alligator (or fatigue) cracking, bleeding (or flushing), block cracking, longitudinal and transverse cracking (many SHRP distresses combined), longitudinal cracking in the wheelpaths, and ravelling. Other distresses did not occur often enough to warrant inclusion. These included edge cracking, patching, reflection cracking, shoving, potholes, polished aggregate, lane-to-shoulder-dropoff, and water bleeding and pumping. Rutting is included in another file and is not expected to have a short term impact.

Table 4. Preliminary Analysis of SMERP Sites

	Alligator Cracking	Bleeding	(*) Block Cracking	Long and Trans Cracking	Long WP Cracking	(*) Ravelling
Rubber	Reduced	Increased	Reduced	Reduced	Reduced	Increased
Micro	Reduced	Reduced	Reduced	Mixed	Increased	Reduced
Emulsion	Reduced	Reduced	Reduced	Reduced	Reduced	Reduced
Latex	Reduced	Increased	Reduced	Reduced	Reduced	Mixed
AC	Mixed	Increased	Reduced	Reduced	Reduced	Mixed
Fog	Reduced	Increased	Increased	Reduced	Mixed	Increased
Control	Mixed	Increased	Increased	Reduced	Increased	Increased

(*) - Few sites affected, trends questionable.

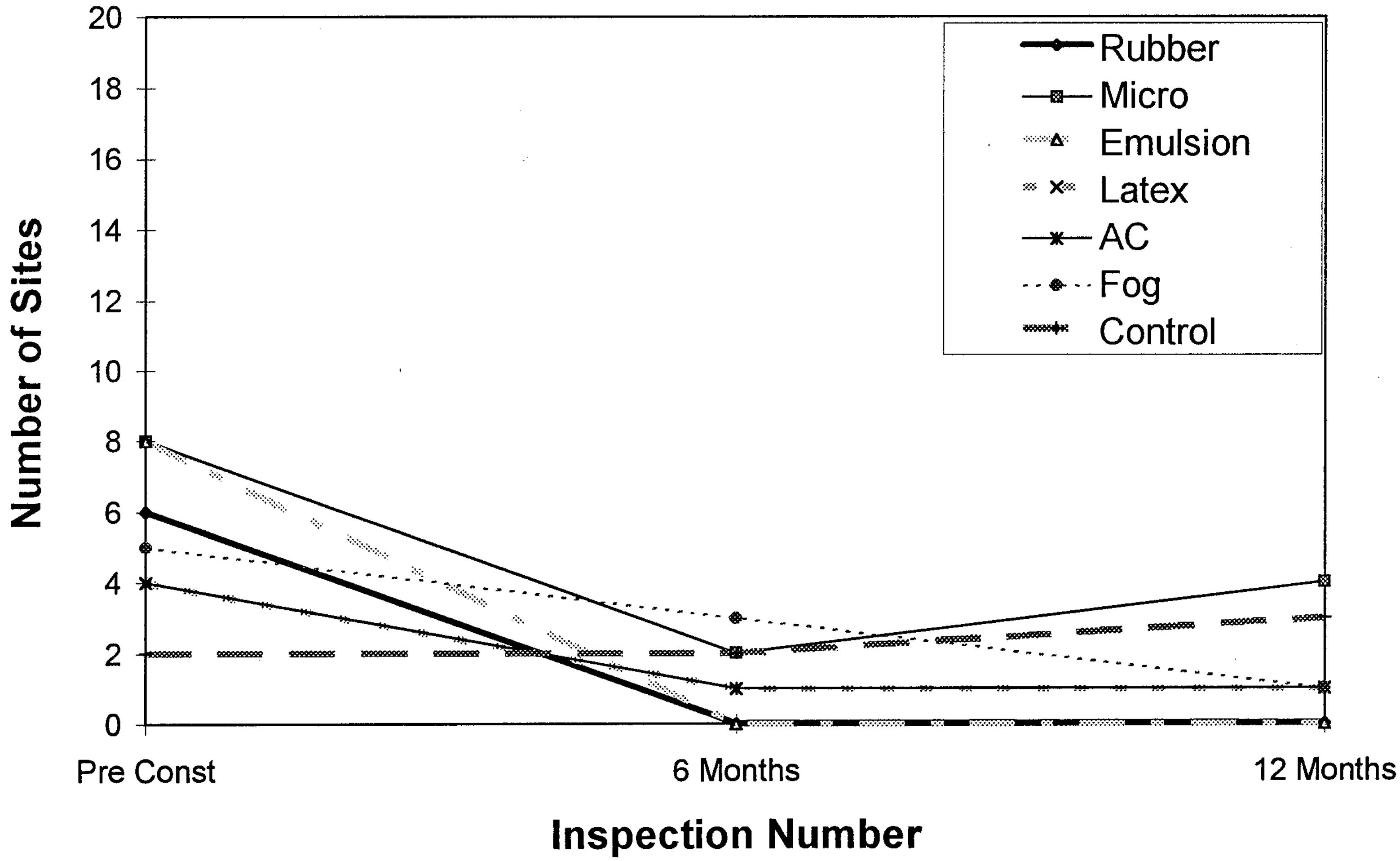


Figure 4. Effect of Treatments on Number of Sites with Alligator Cracking

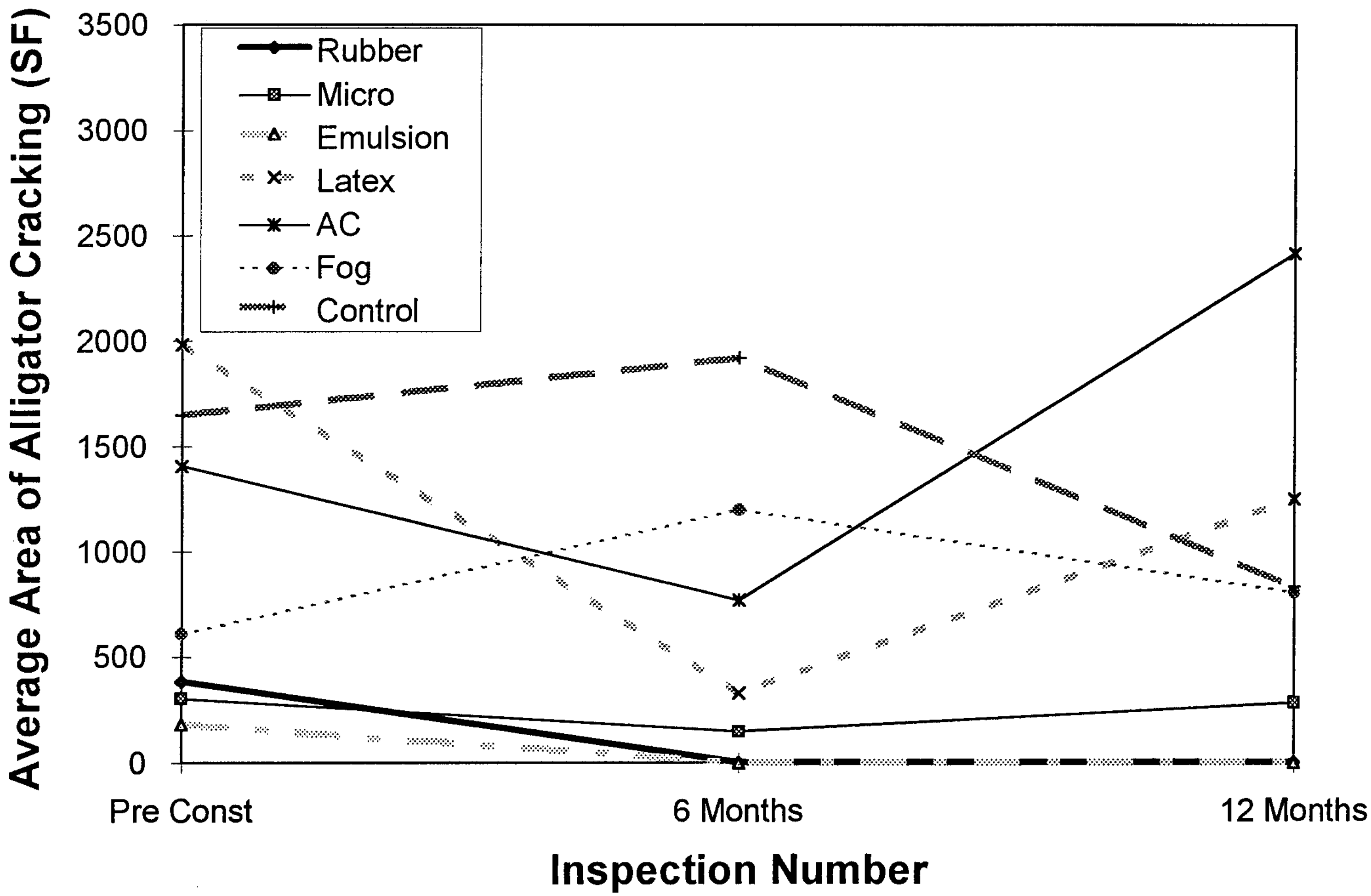


Figure 5. Average Area of Alligator Cracking for Sites With Alligator Cracking

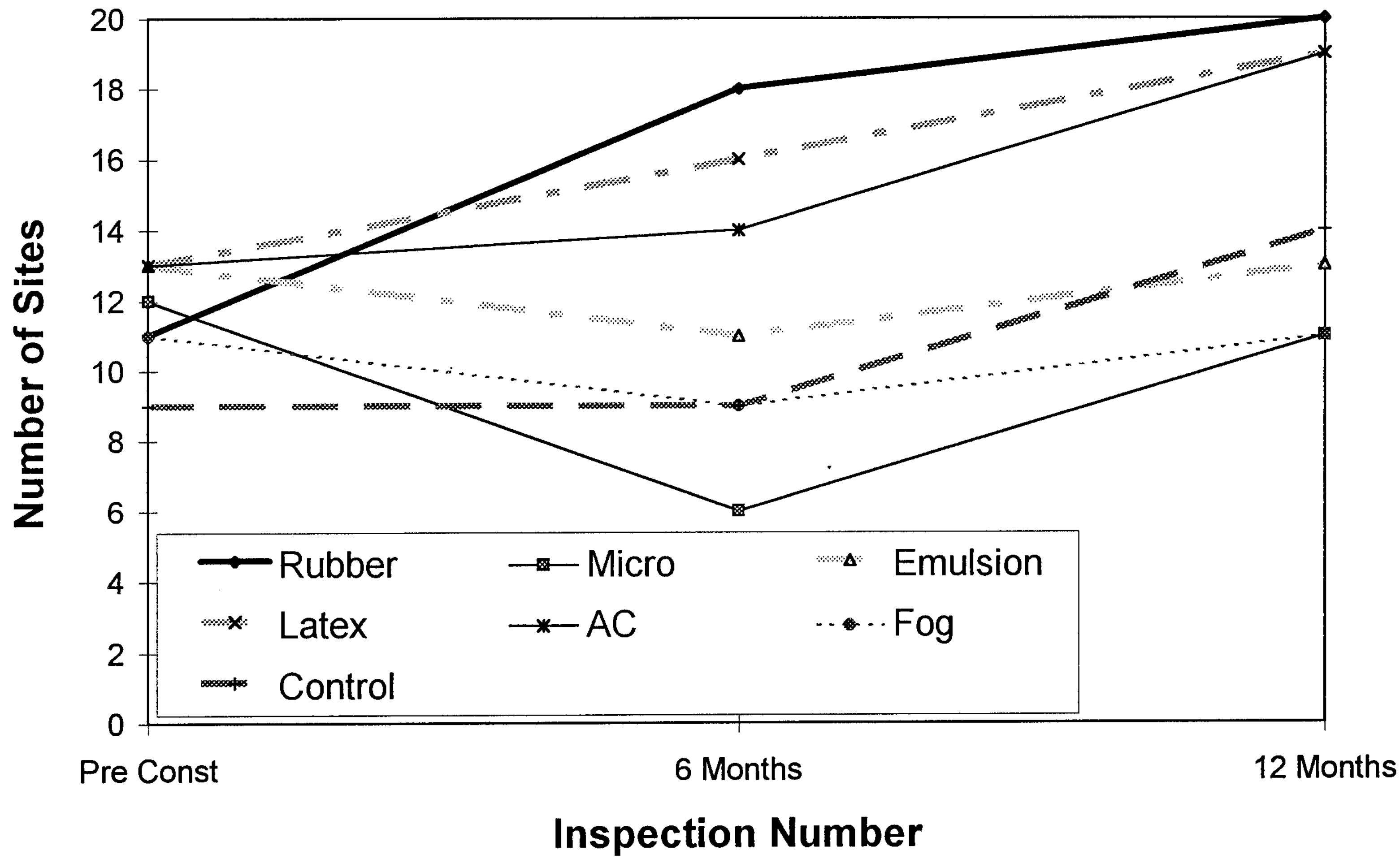


Figure 6. Effect of Treatments on Number of Sites with Bleeding

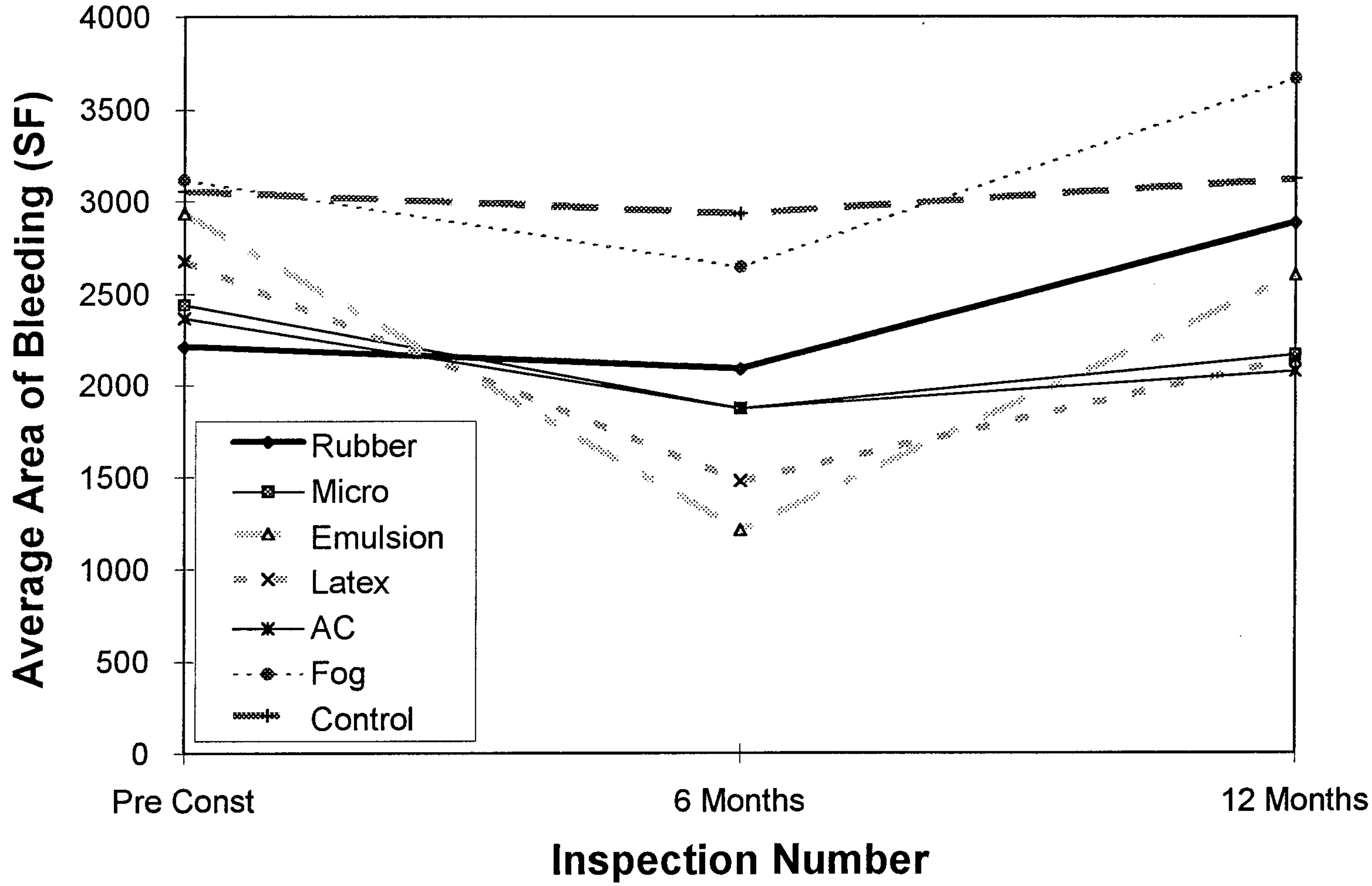


Figure 7. Effect of Treatments on Average Area of Bleeding for Sites With Bleeding

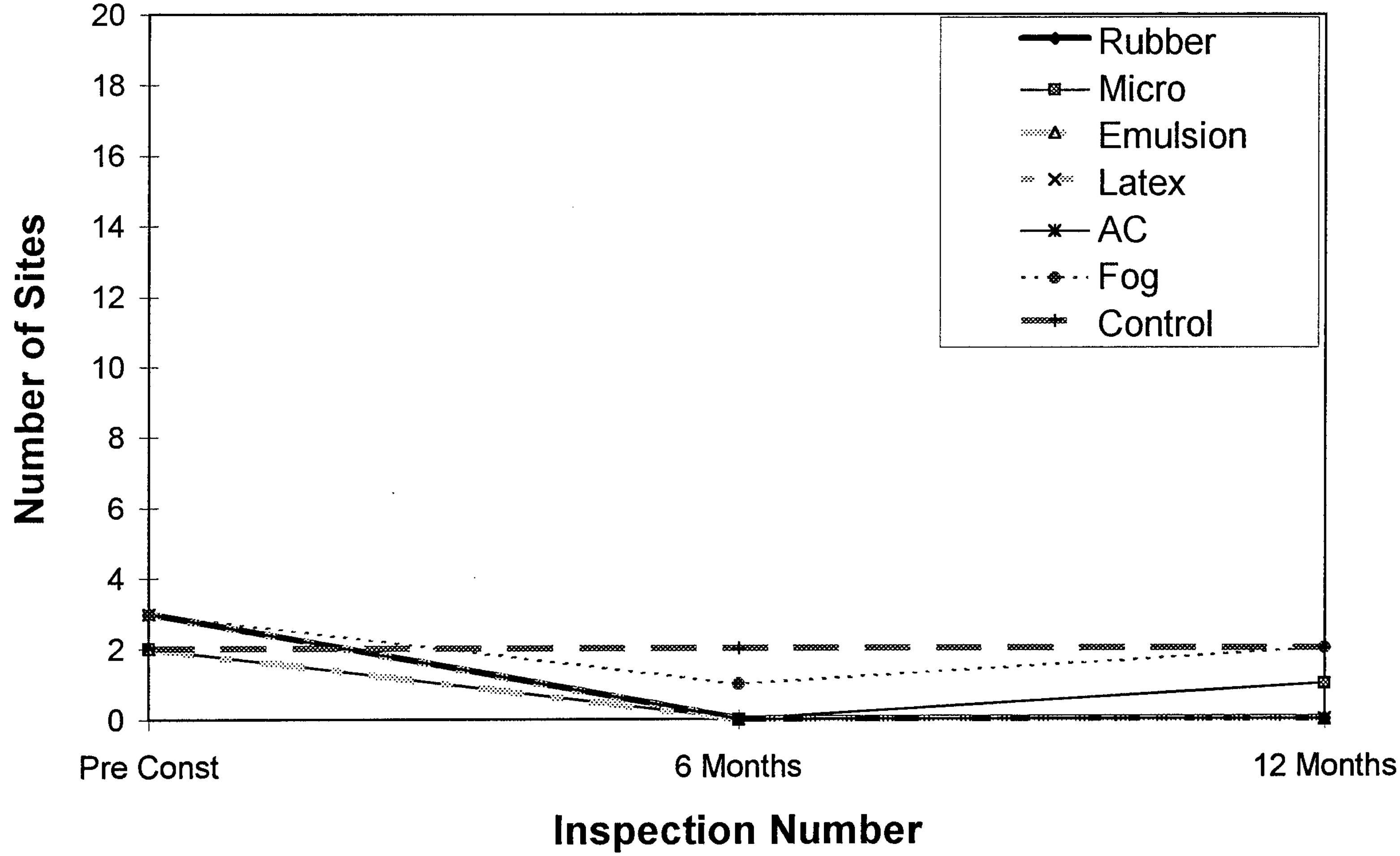


Figure 8. Effect of Treatments on Number of Sites with Block Cracking

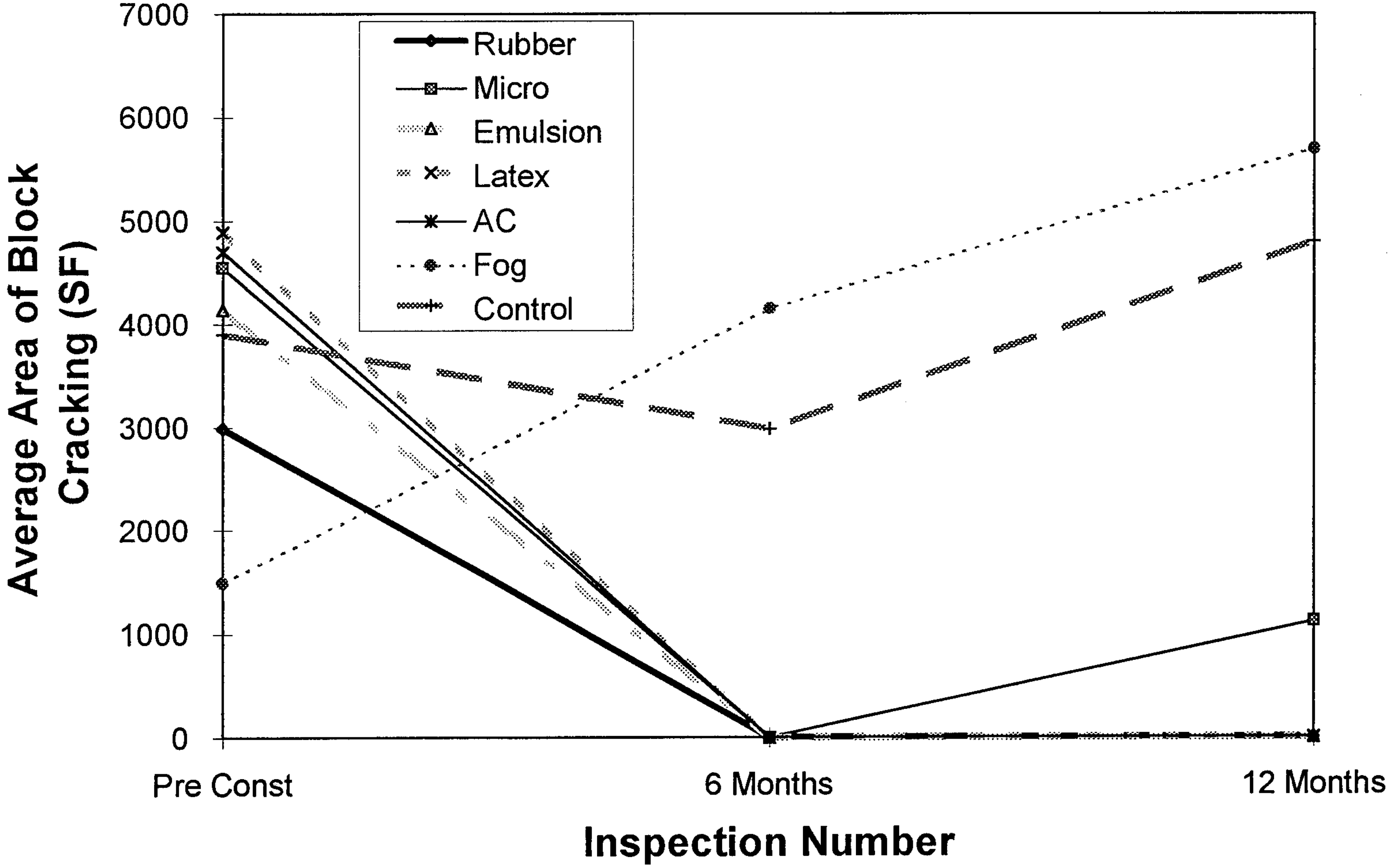


Figure 9. Effect of Treatments on Average Area of Block Cracking for Sites With Block Cracking

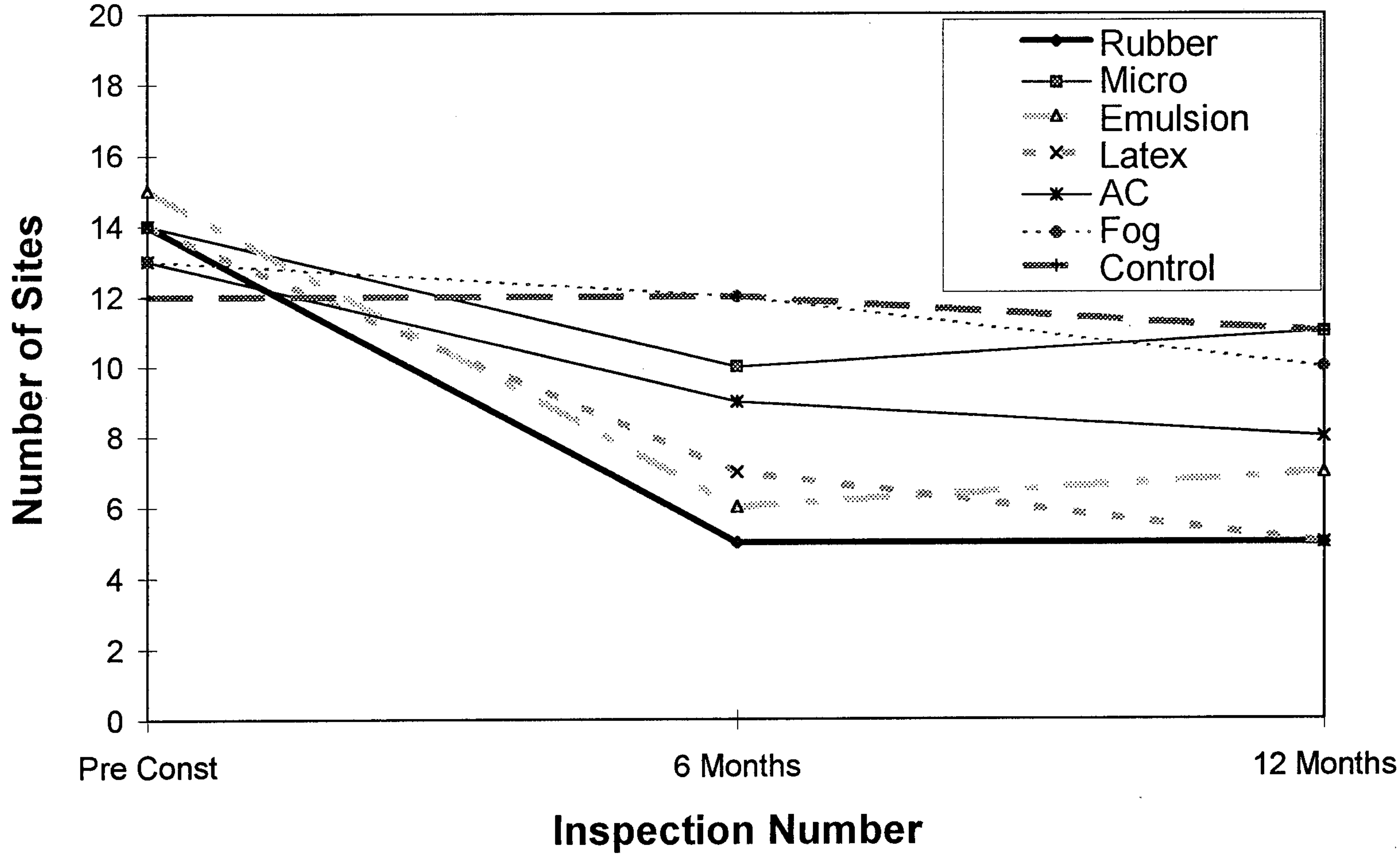


Figure 10. Effect of Treatments on Number of Sites for Longitudinal and Transverse Cracking

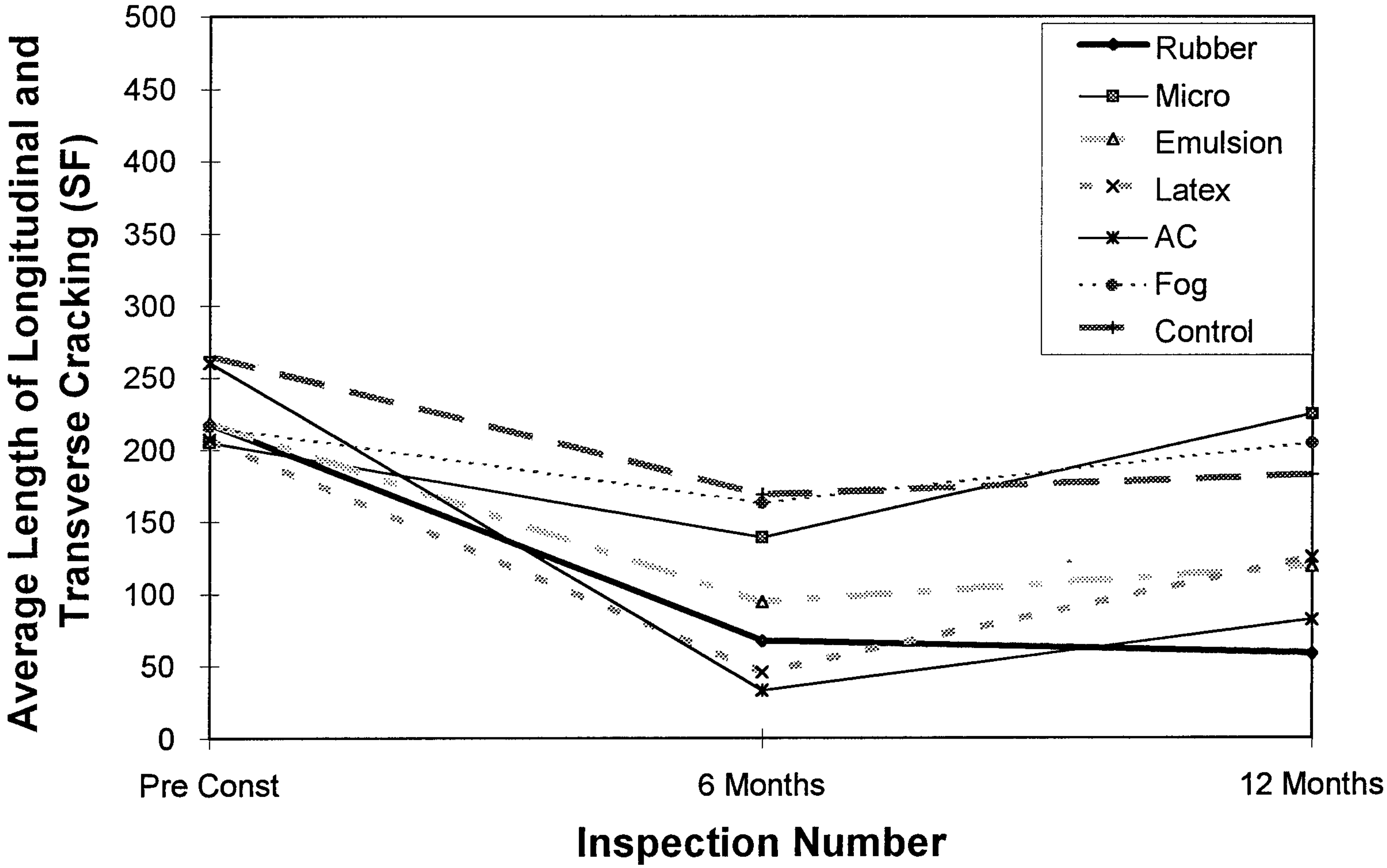


Figure 11. Average Length of Longitudinal and Transverse Cracking for Sites With Longitudinal and Transverse Cracking

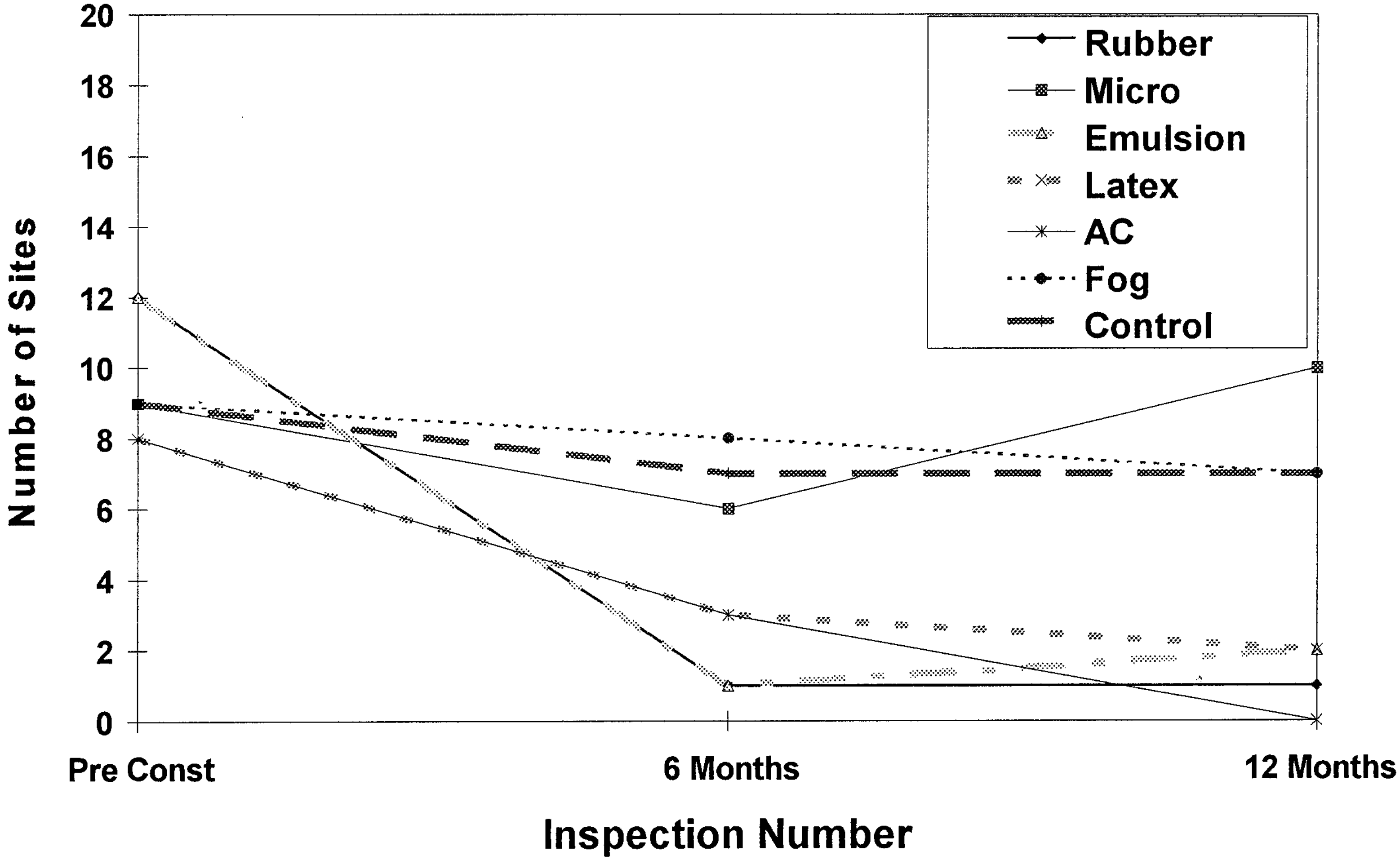


Figure 12. Effect of Treatments on Number of Sites With Longitudinal Cracking in the Wheelpaths

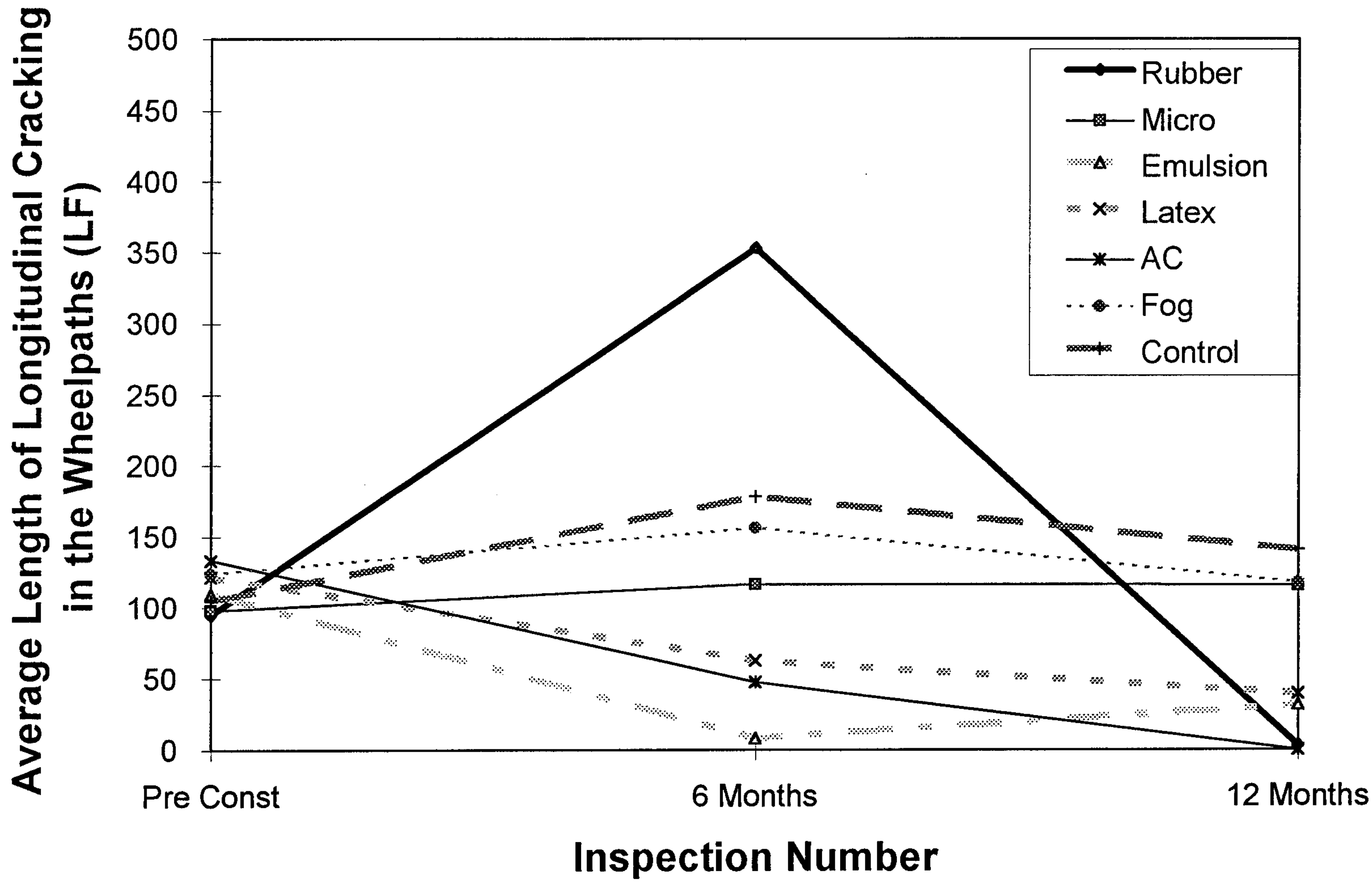


Figure 13. Effect of Treatments on Average Length of Longitudinal Cracking in the Wheelpaths for Sites With Longitudinal Cracking in the Wheelpaths

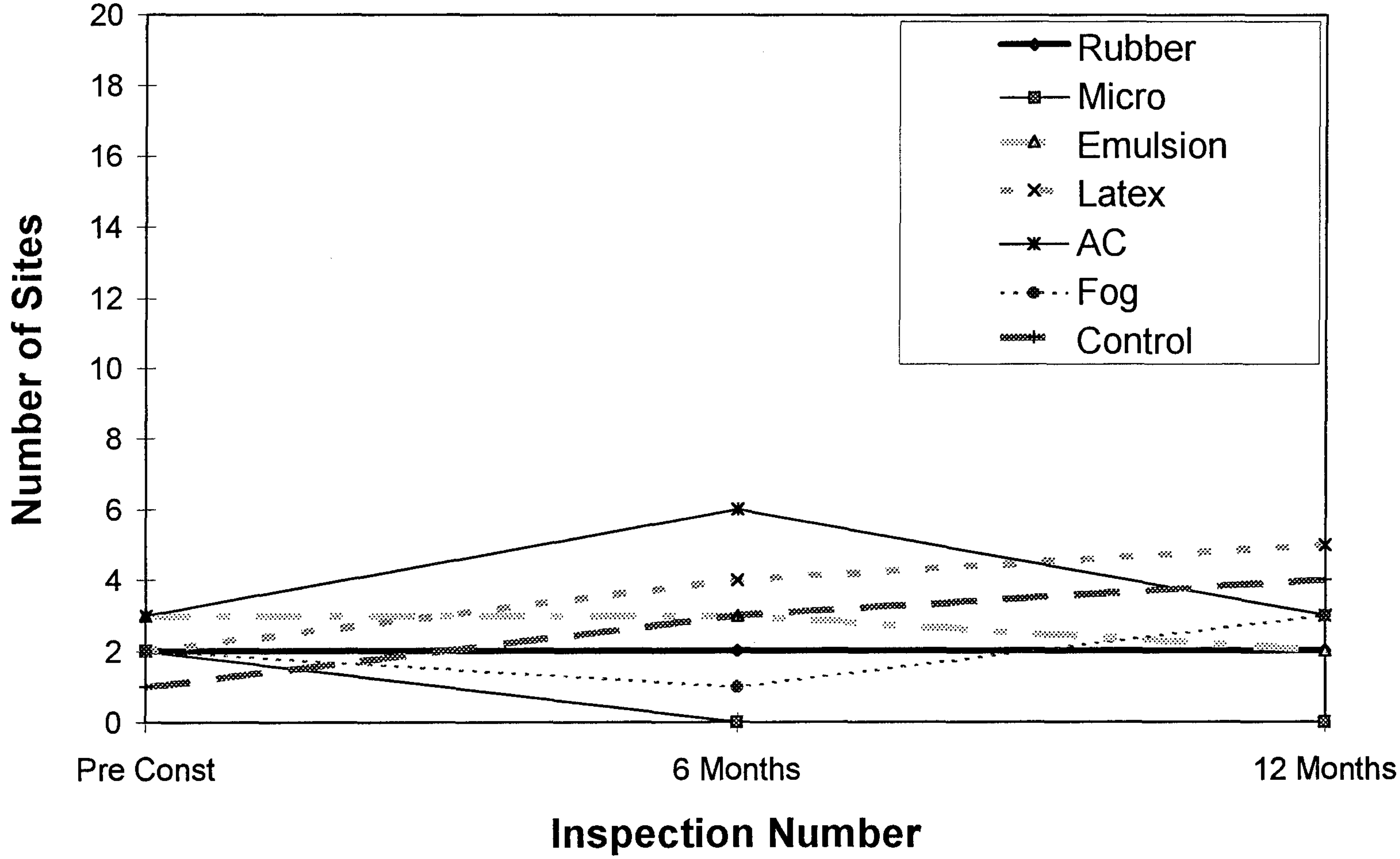


Figure 14. Effect of Treatments on Number of Sites With Ravelling

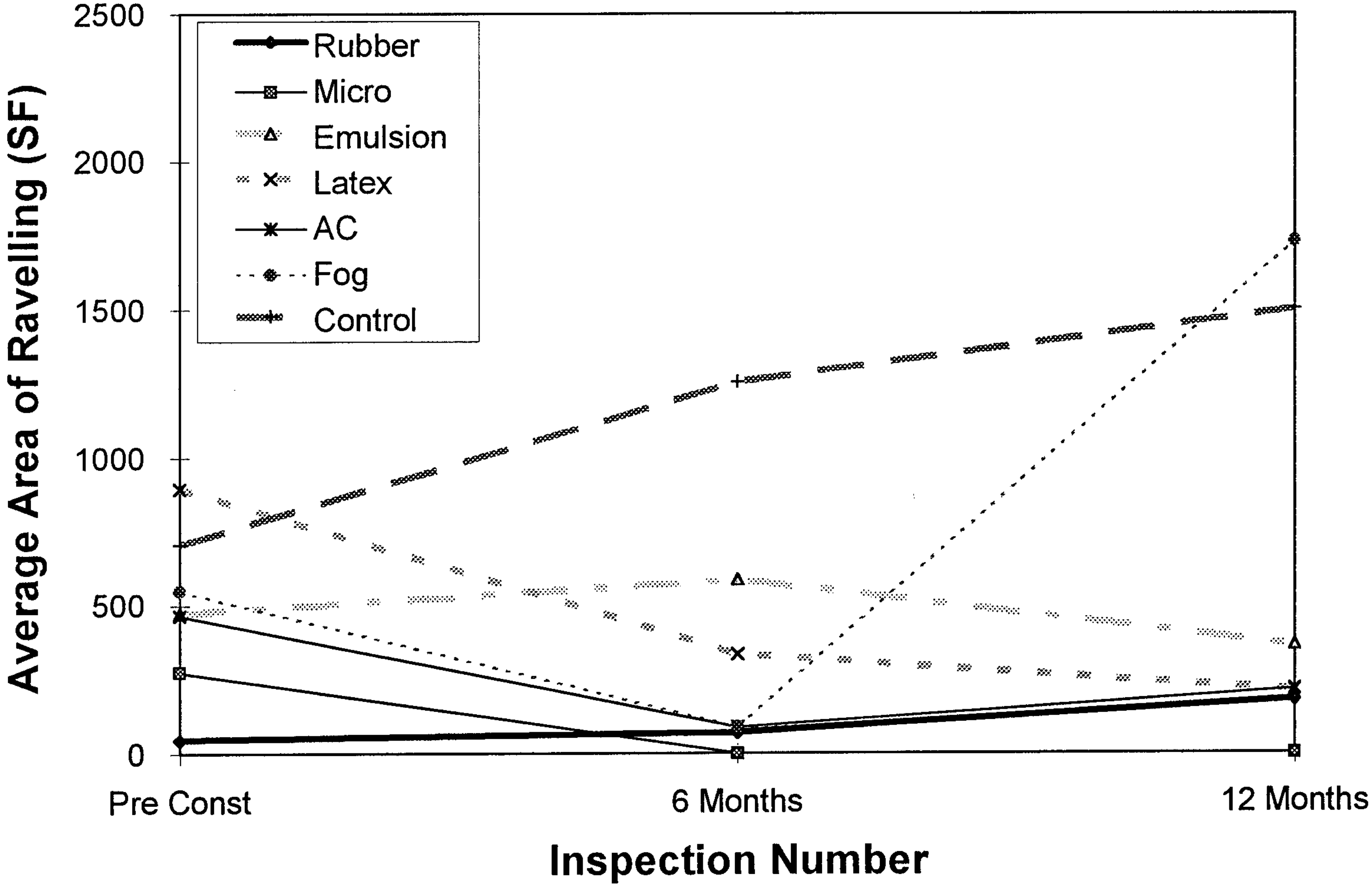


Figure 15. Effect of Treatments on Average Area of Ravelling for Sites With Ravelling

Appendix A contains the results of the site inspections on a site by site basis.

SITE PROBLEMS

To date, one site (48Q19, site 17 in Panola county west of Carthage) has failed and been taken out of service. The entire roadway section is to be rehabilitated due to structural failure. The Fog Seal and Control Section at one other site (48G08, site 7 in Taylor county southeast of Abilene) have been lost due to maintenance forces placing a chip seal on top of these sections. A contributing factor may have been that this site did not have the test section signs installed.

FUTURE WORK

Since the treatments have been constructed, the next stages will be to monitor the performance of the sections and to continue the analysis of that performance. It has been proposed that a distress survey be performed on a yearly basis. This data should be recorded in the SHRP compatible format. If possible, the frequency of inspection should be increased. The short term nature of this maintenance research project suggests that the data should be taken as often as possible. This will allow us to determine a seasonal correction for distress and will improve the predictive nature of the experiment.

Additional data collection will include inspecting all of the test sections using the ARAN. Non-destructive deflection testing will be performed one year after construction and then every two years. All of the sections will be monitored until failure.

The data analysis should begin after the next cycle of distress surveys. If these treatments behave similarly to the SHRP H-101 test sections, distress will remain relatively minimal until at least eighteen months after construction. However, due to the condition of some of the test sections prior to construction, the SMERP test sections may exhibit some early distress including bleeding, rutting, and on one or two sections, alligator cracking. Future analysis will determine the effectiveness of each treatment based on the different conditions at each site. The analysis of the cost-effectiveness should begin when adequate data is available. To date, no attempt has been made to include the severity of the distress in the analysis. While the analysis of progression of distress from low to high is very important, there is not yet enough data to support this type of analysis. However the data will exist in the near future, and this task should be undertaken. This task will be made easier if the distress surveys are conducted twice per year.

REFERENCES

1. Smith, R. E., T. J. Freeman, and O. Pendleton, "H-101 Pavement Maintenance Effectiveness," Strategic Highway Research Program, National Research Council, 1993.

2. "Distress Identification Manual for the Long-Term Pavement Performance Project," Strategic Highway Research Program, National Research Council, SHRP-P-338, 1993.

3. "Data Base Structure Reference Manual," Strategic Highway Research Program, National Research Council, 1993.

4. Freeman, T. J., and E. Rmeili, "Development and Construction of the Texas Supplemental Maintenance Effectiveness Research Program (SMERP) Experiment," TxDOT, May 1994.

APPENDIX

Results of Distress Data Collection

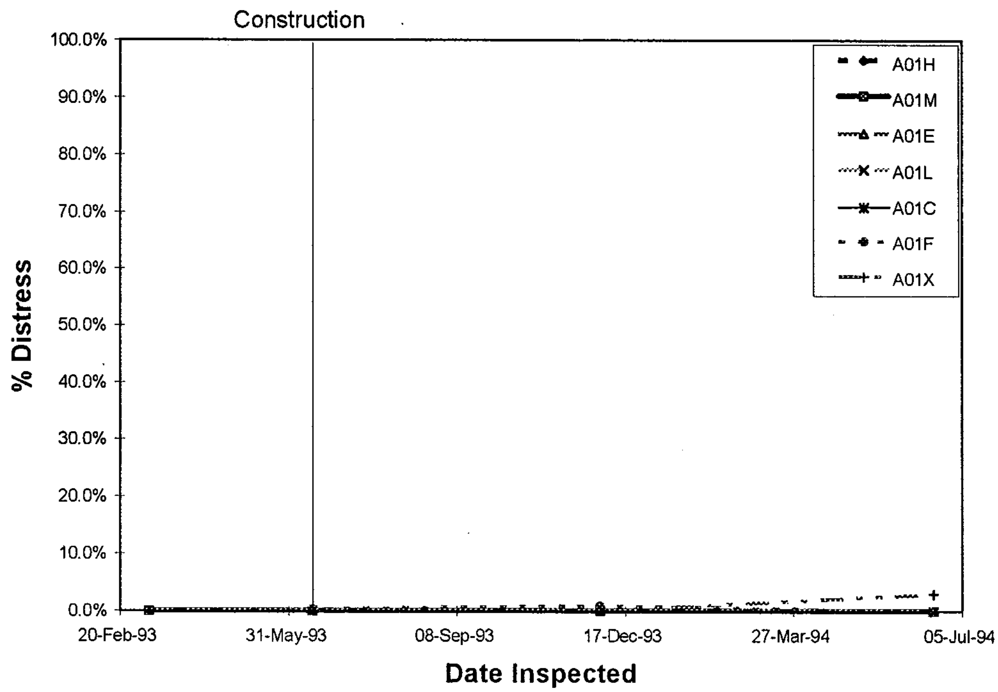


Figure A-1. Alligator Cracking for Site A01

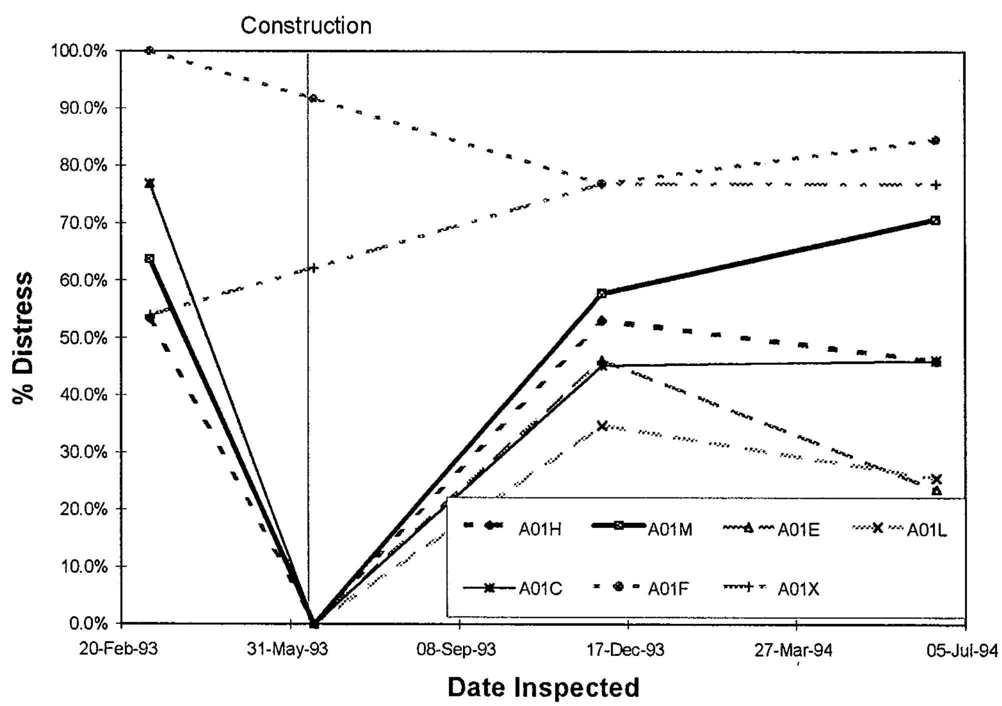


Figure A-2. Bleeding for Site A01

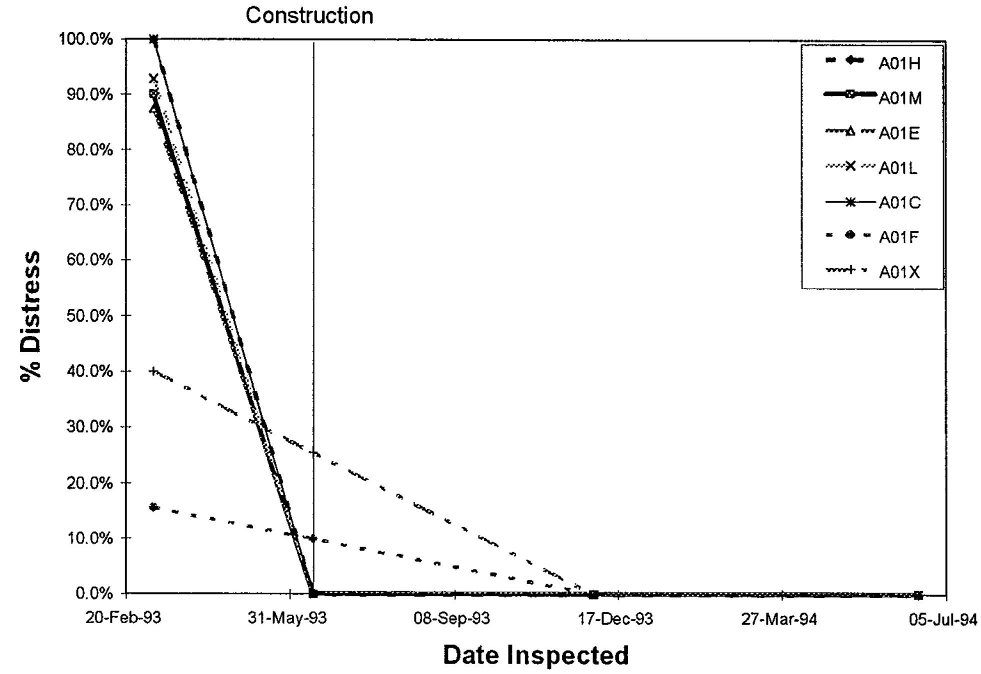


Figure A-3. Block Cracking for Site A01

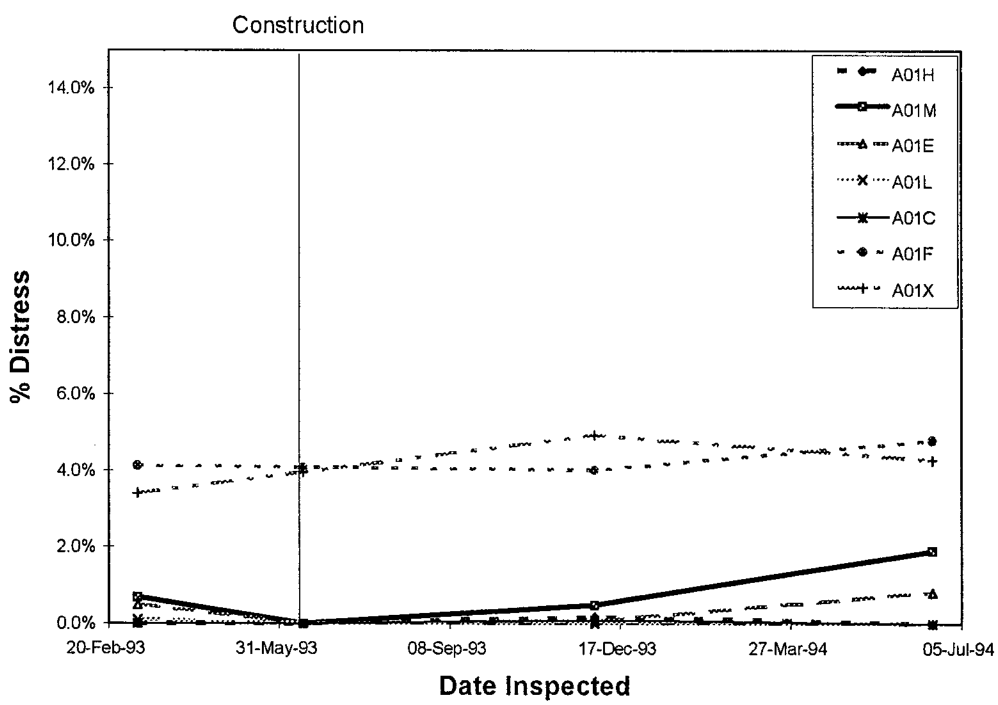


Figure A-4. Longitudinal and Transverse Cracking for Site A01

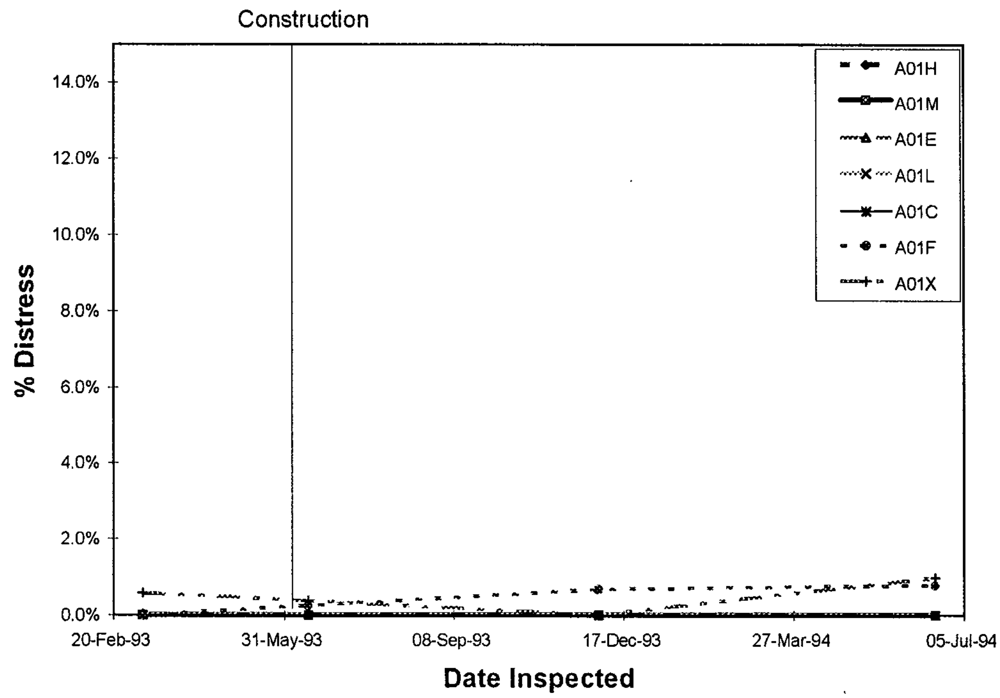


Figure A-5. Longitudinal Cracking in the Wheelpaths for Site A01

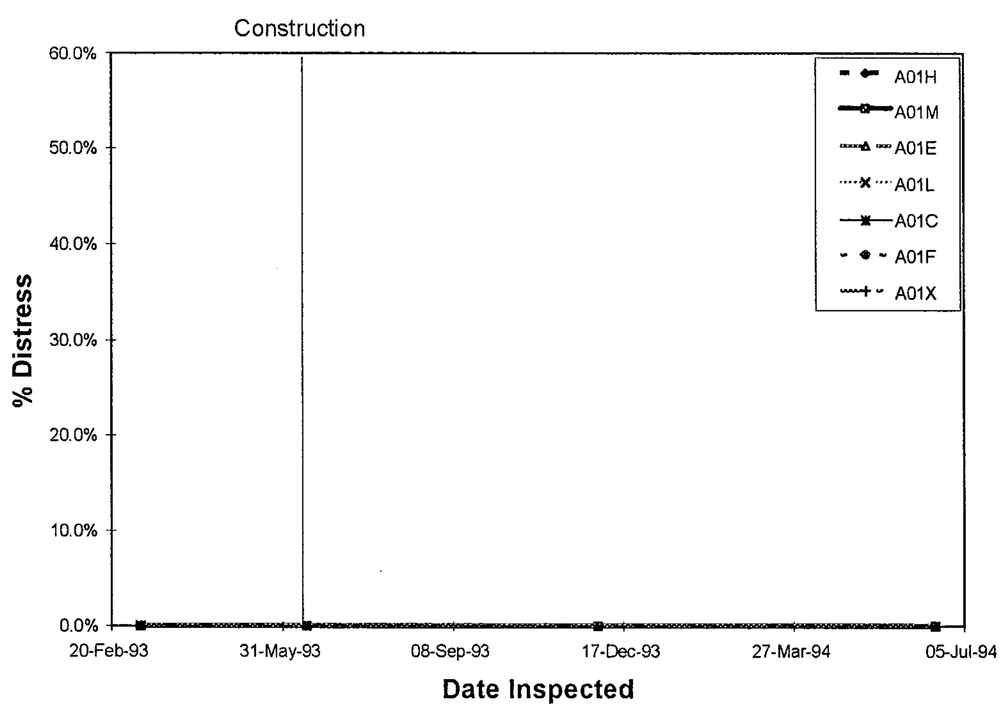


Figure A-6. Ravelling for Site A01

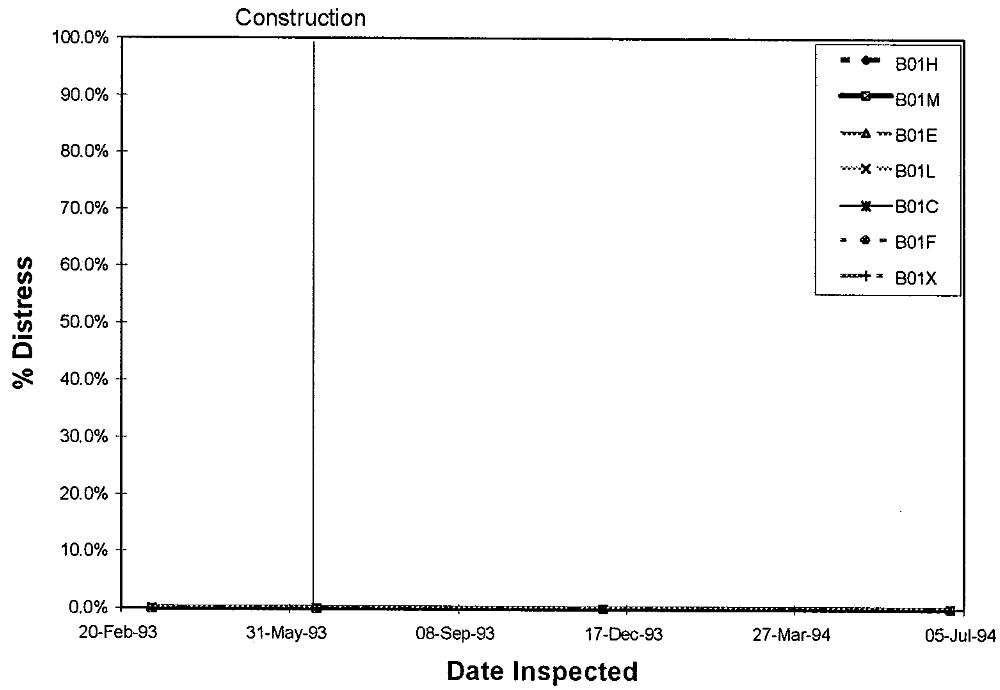


Figure A-7. Alligator Cracking for Site B01

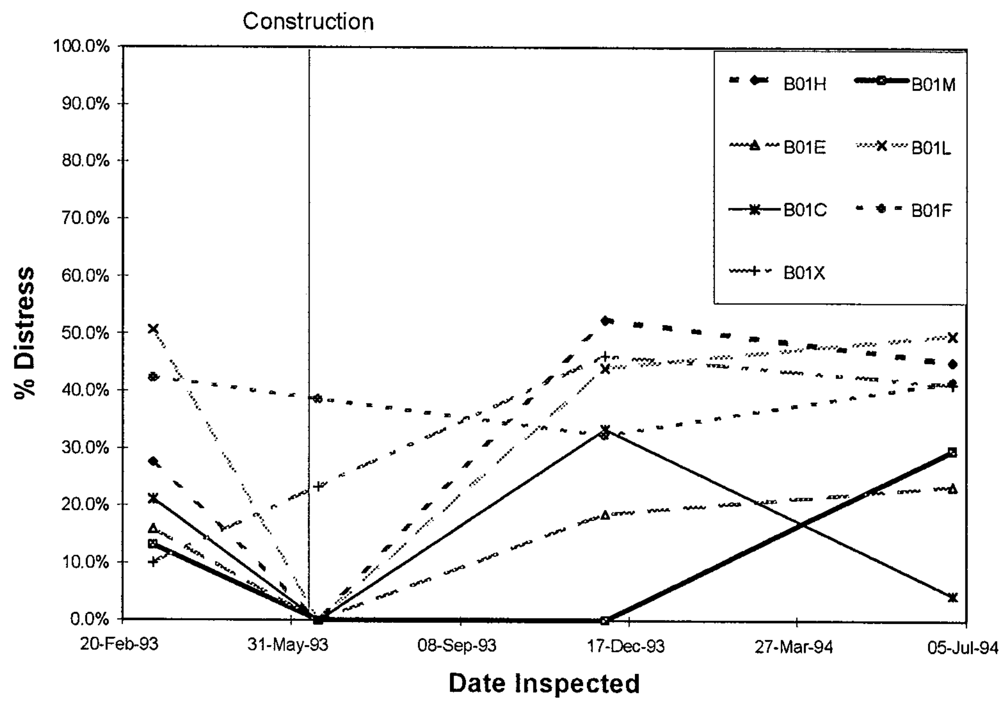


Figure A-8. Bleeding for Site B01

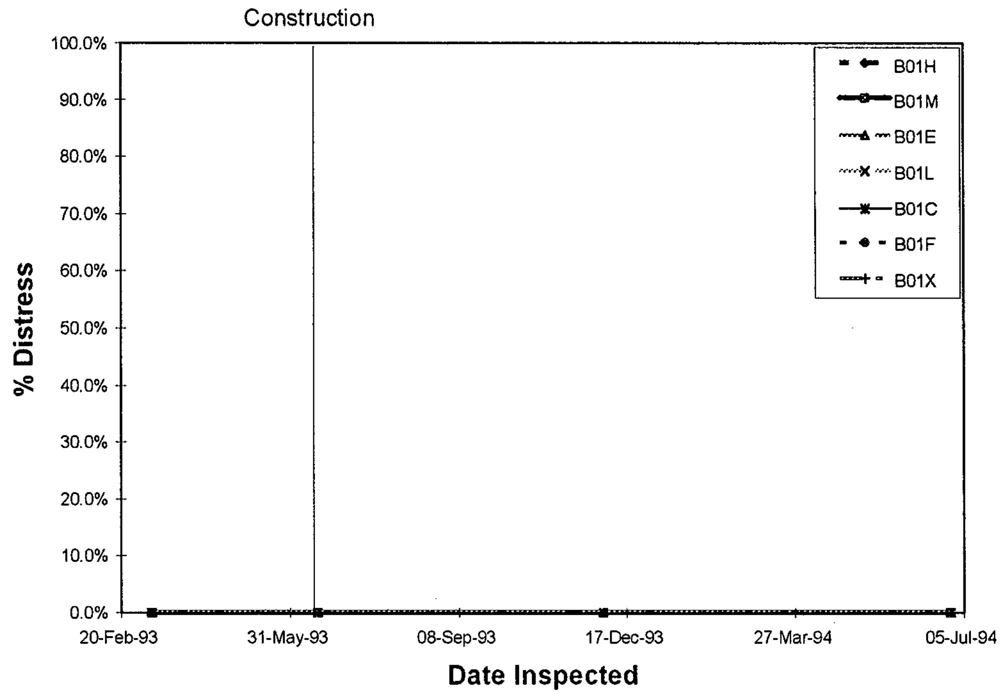


Figure A-9. Block Cracking for Site B01

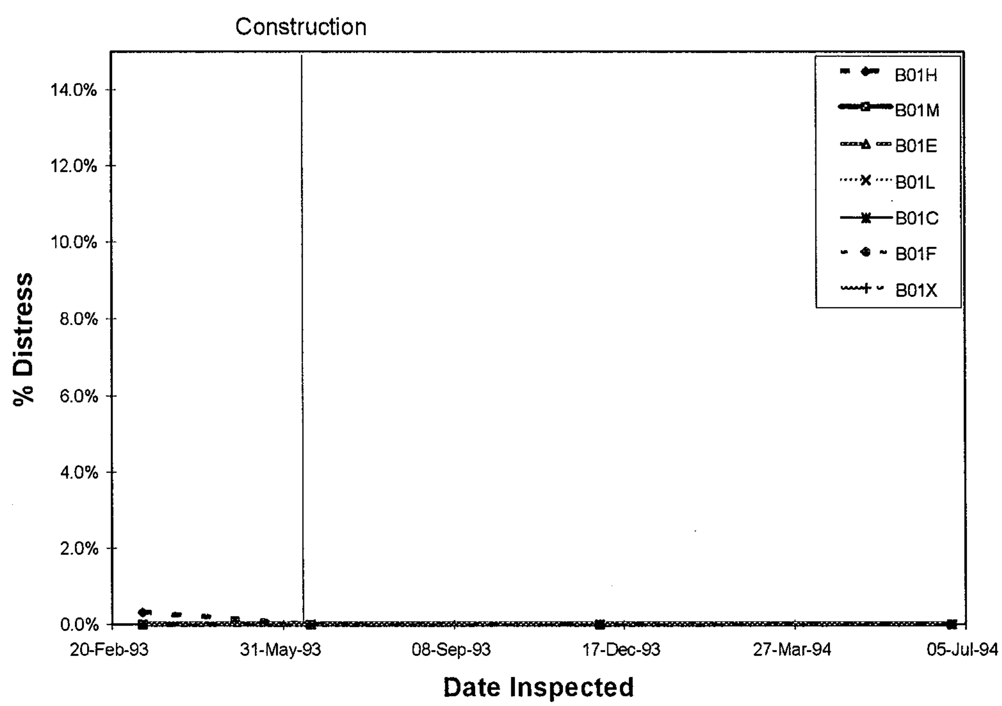


Figure A-10. Longitudinal and Transverse Cracking for Site B01

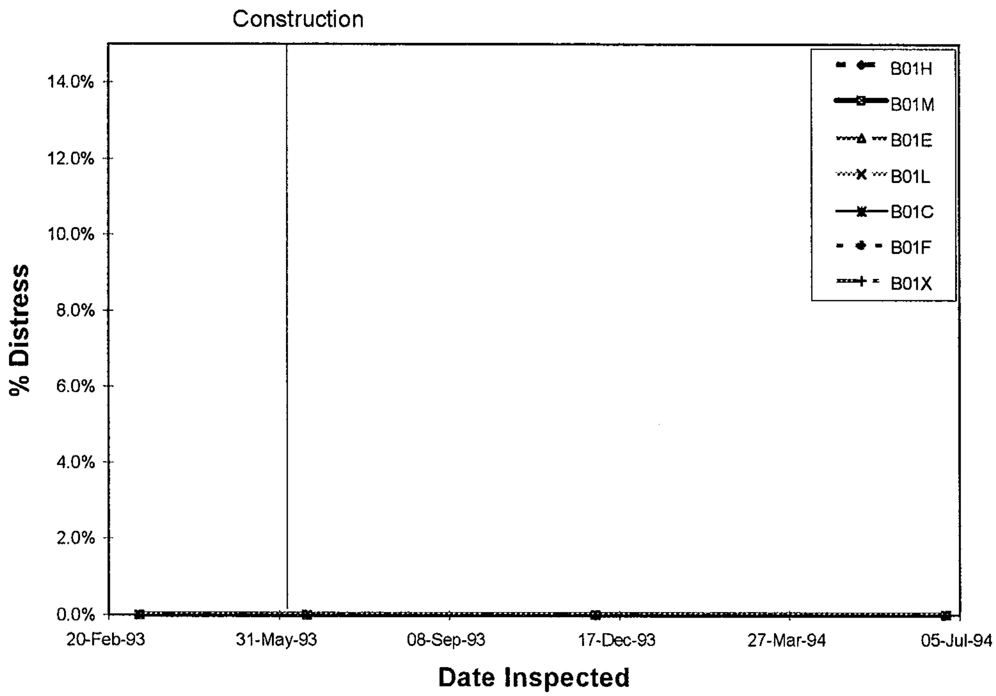


Figure A-11. Longitudinal Cracking in the Wheelpaths

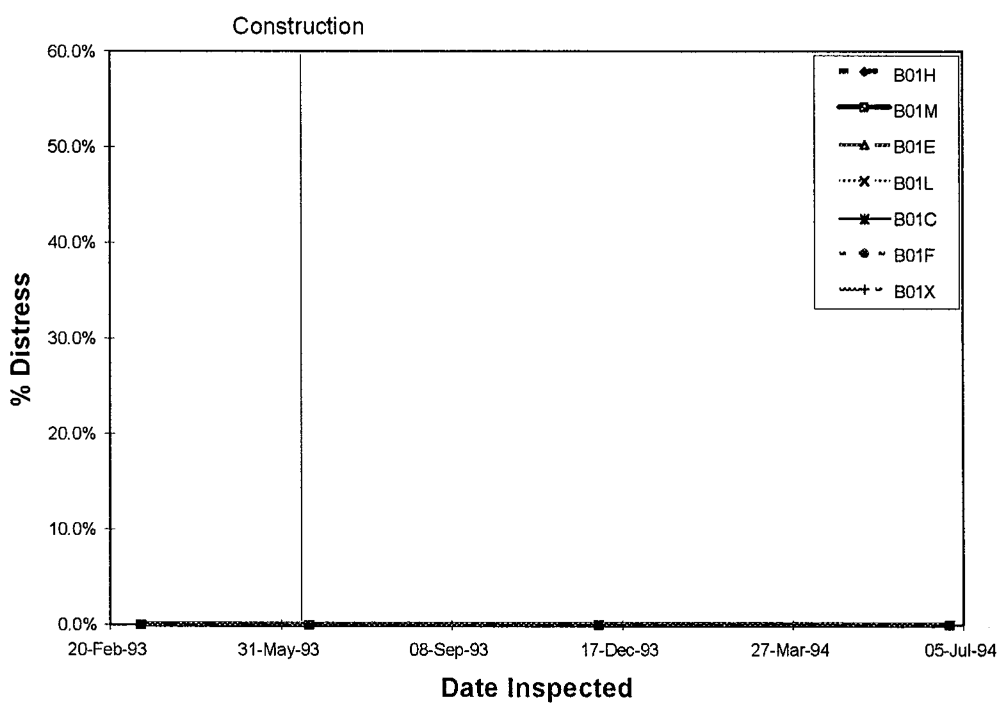


Figure A-12. Ravelling for Site B01

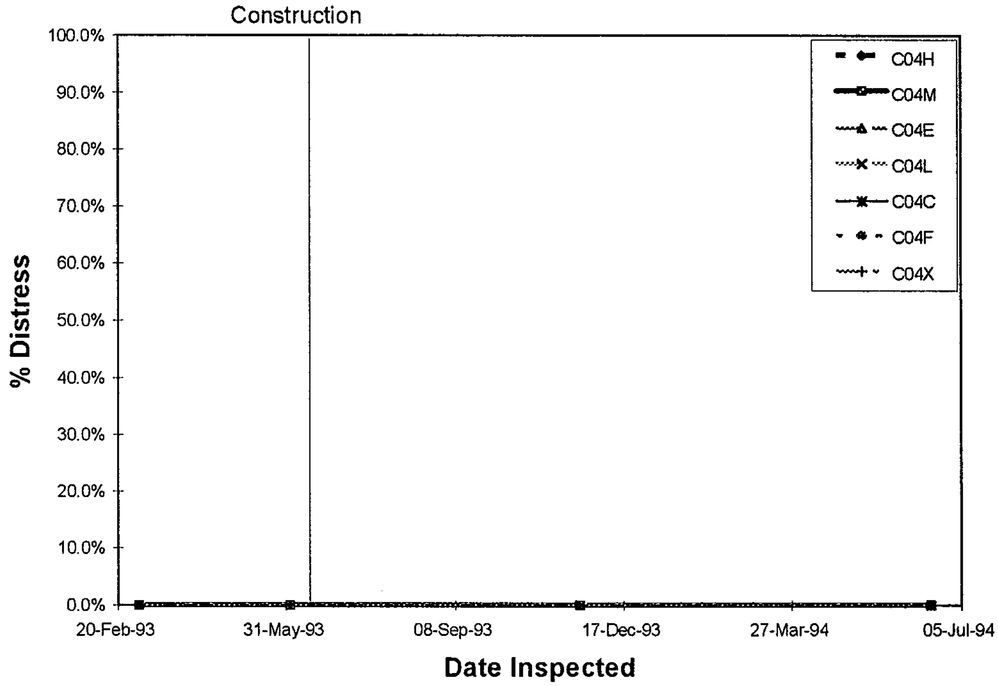


Figure A-13. Alligator Cracking for Site C04

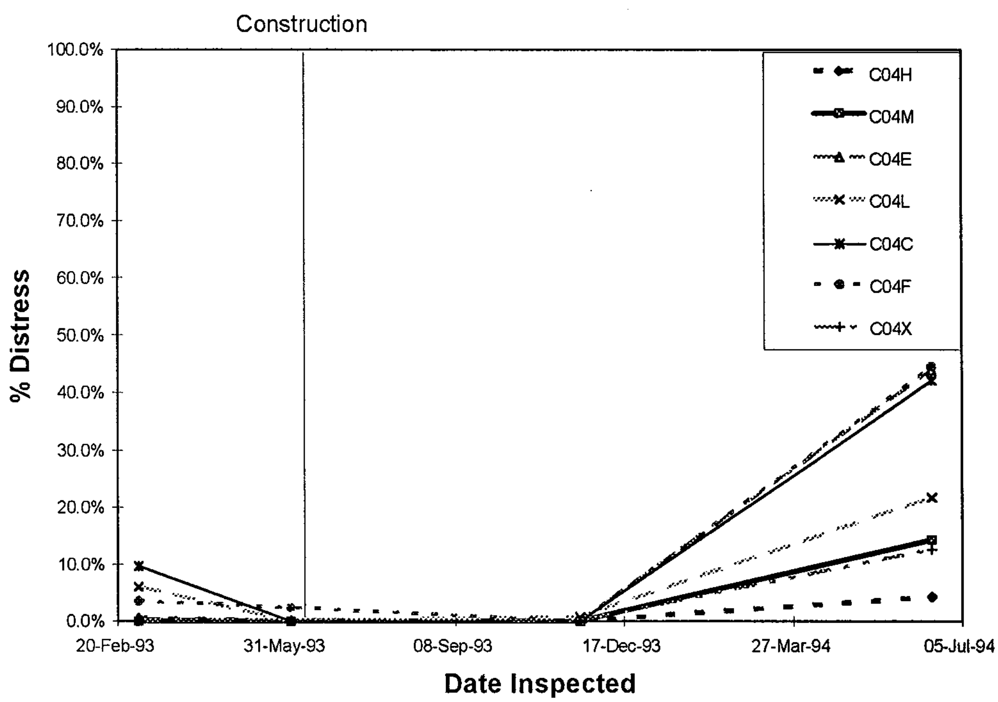


Figure A-14. Bleeding for Site C04

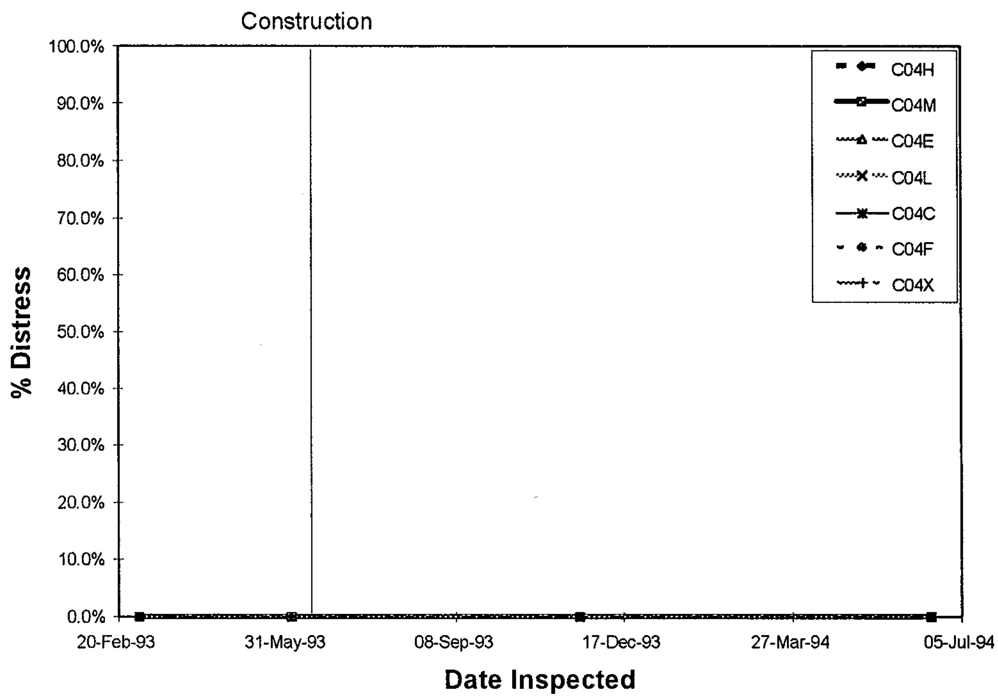


Figure A-15. Block Cracking for Site C04

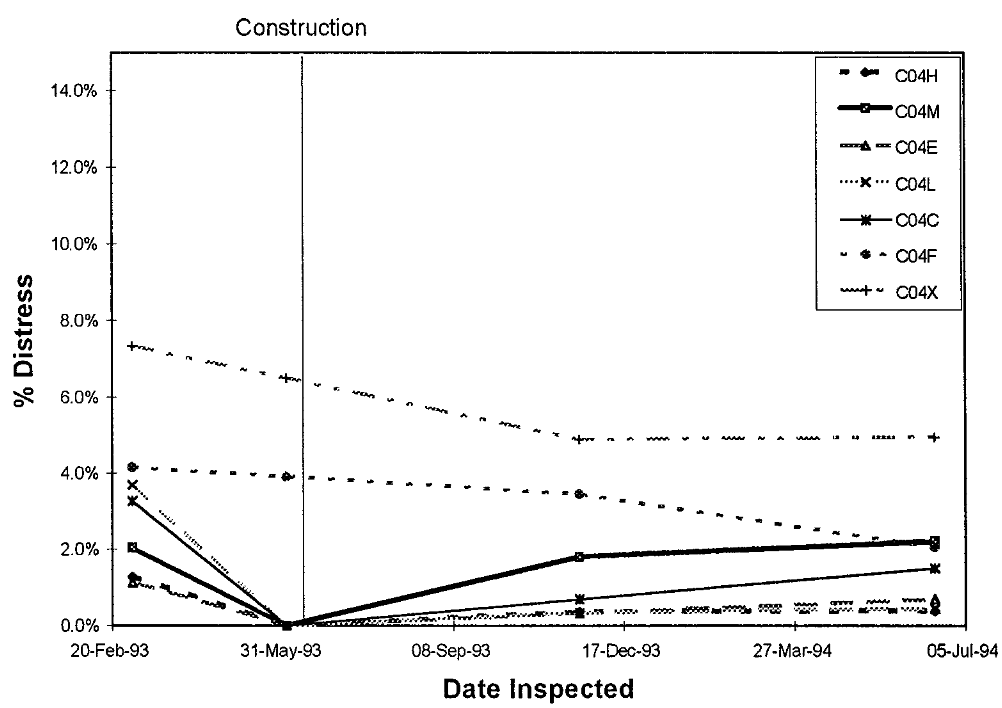


Figure A-16. Longitudinal and Transverse Cracking for Site C04

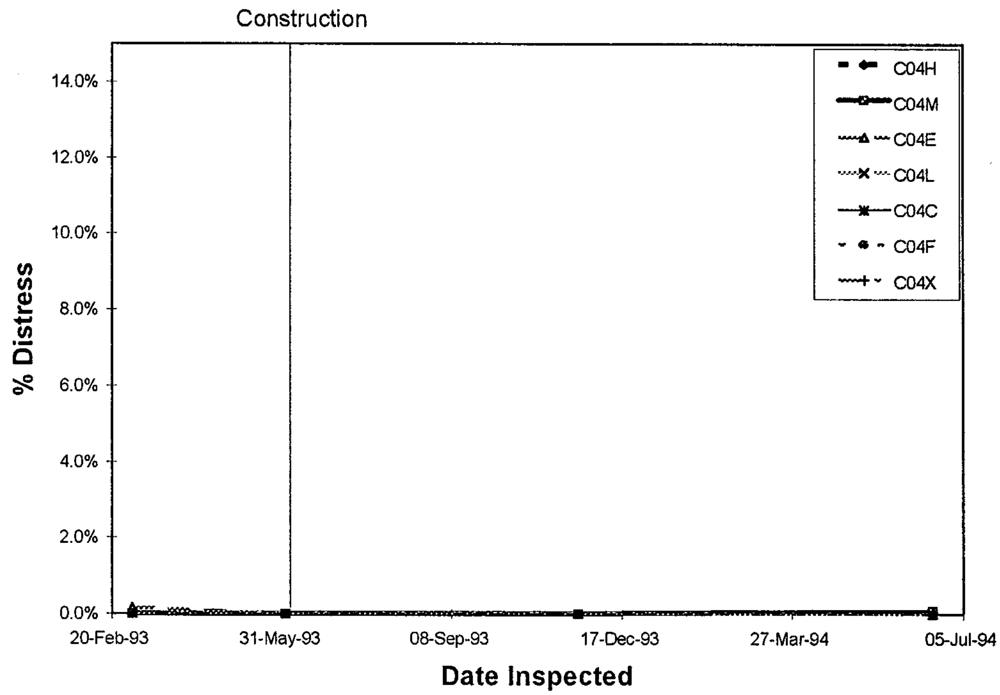


Figure A-17. Longitudinal Cracking in the Wheelpaths

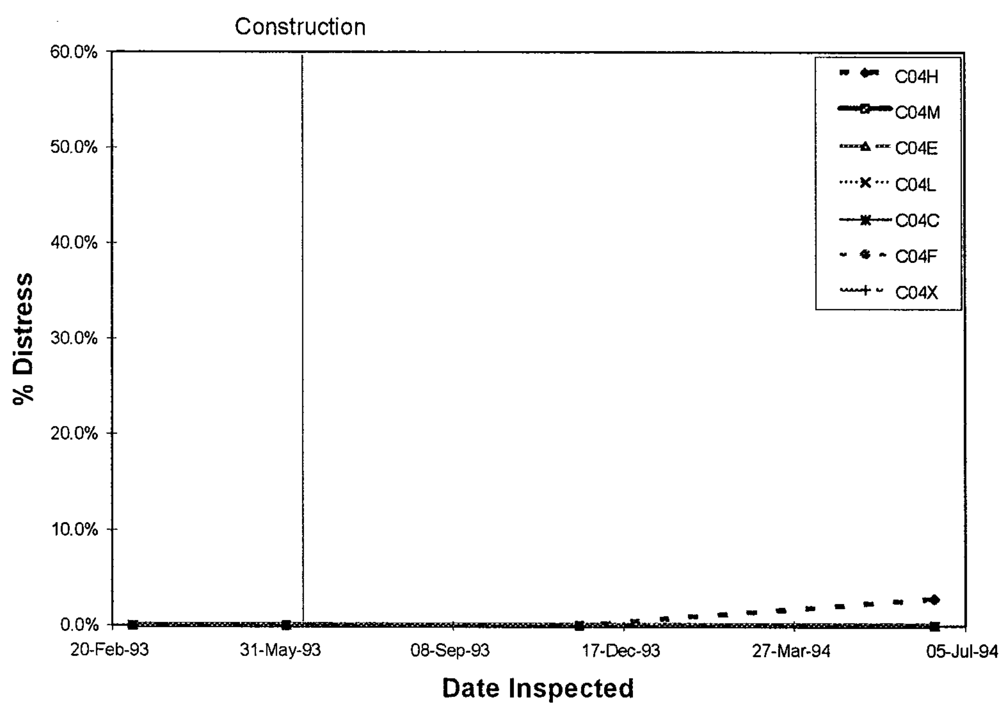


Figure A-18. Ravelling for Site C04

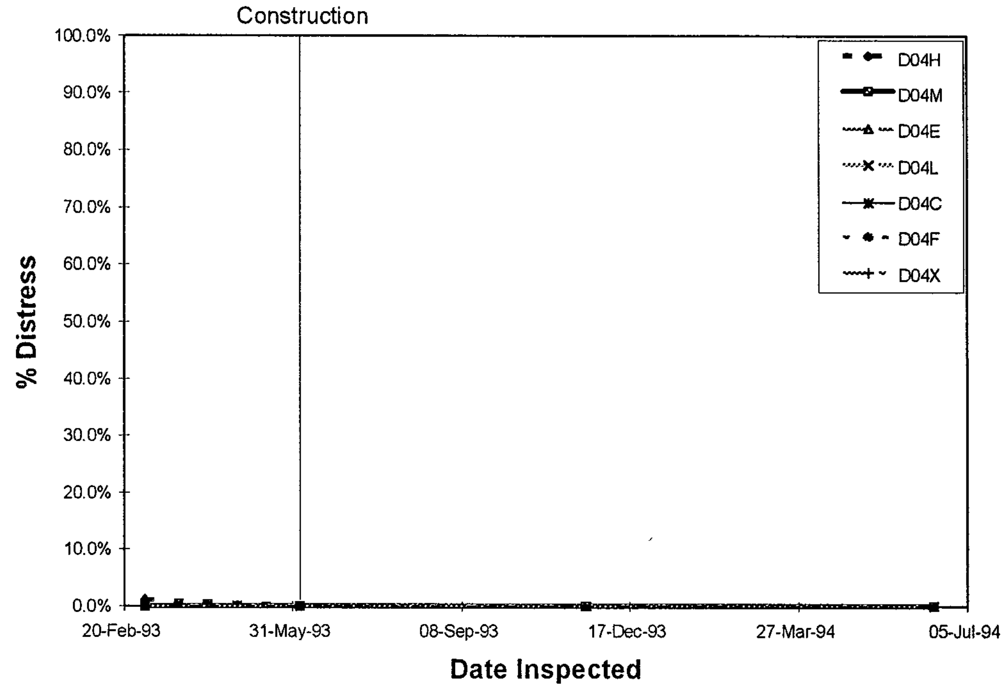


Figure A-19. Alligator Cracking for Site D04

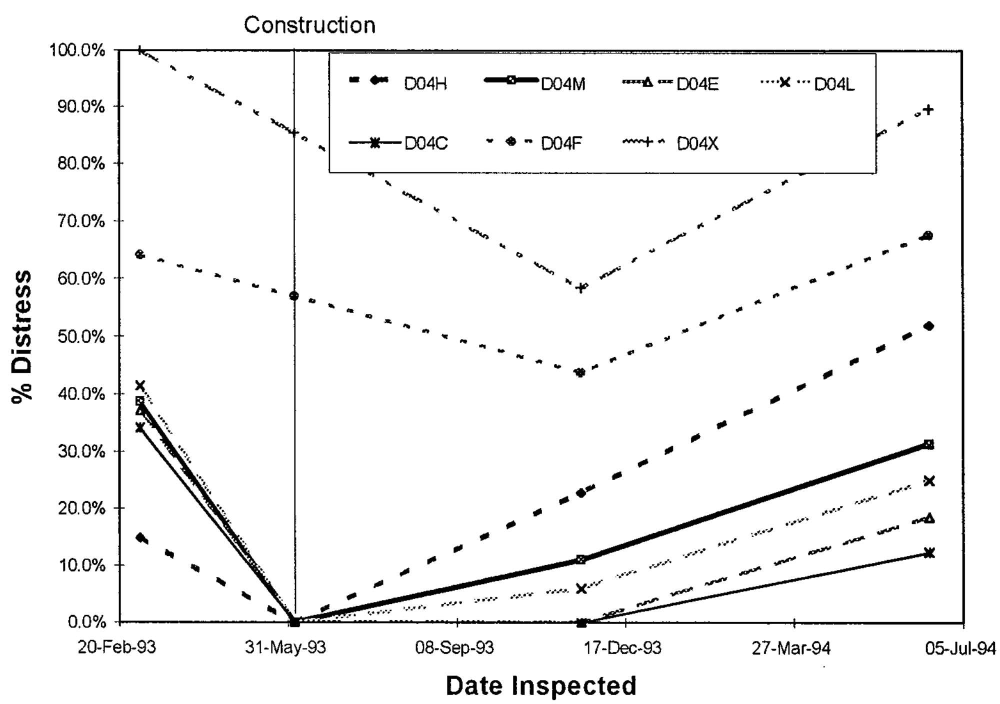


Figure A-20. Bleeding for Site D04

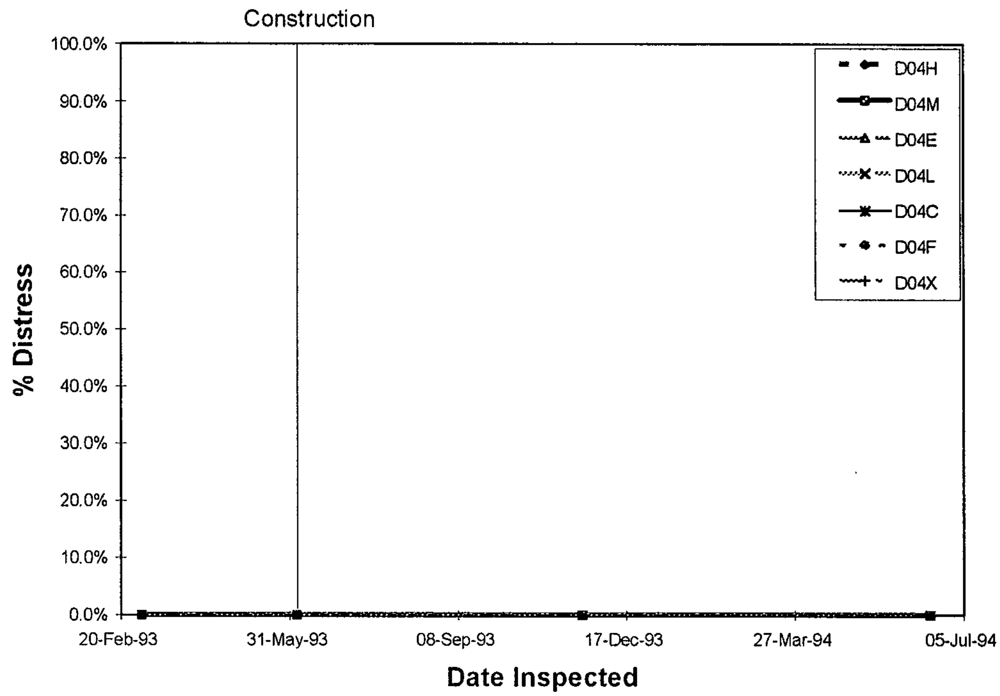


Figure A-21. Block Cracking for Site D04

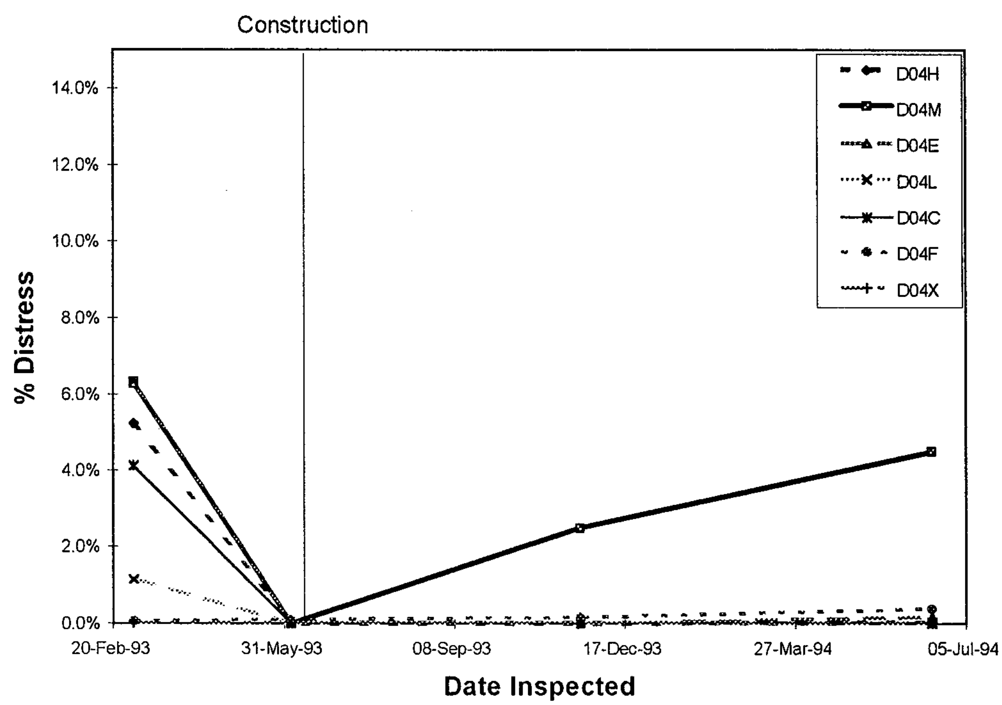


Figure A-22. Longitudinal and Transverse Cracking for Site D04

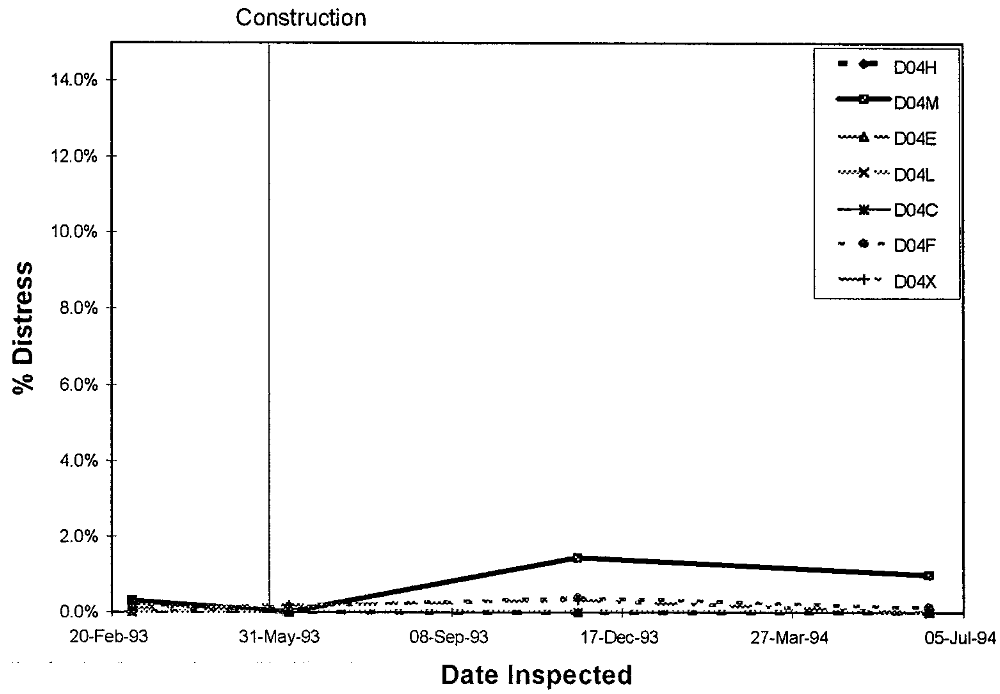


Figure A-23. Longitudinal Cracking in the Wheelpaths

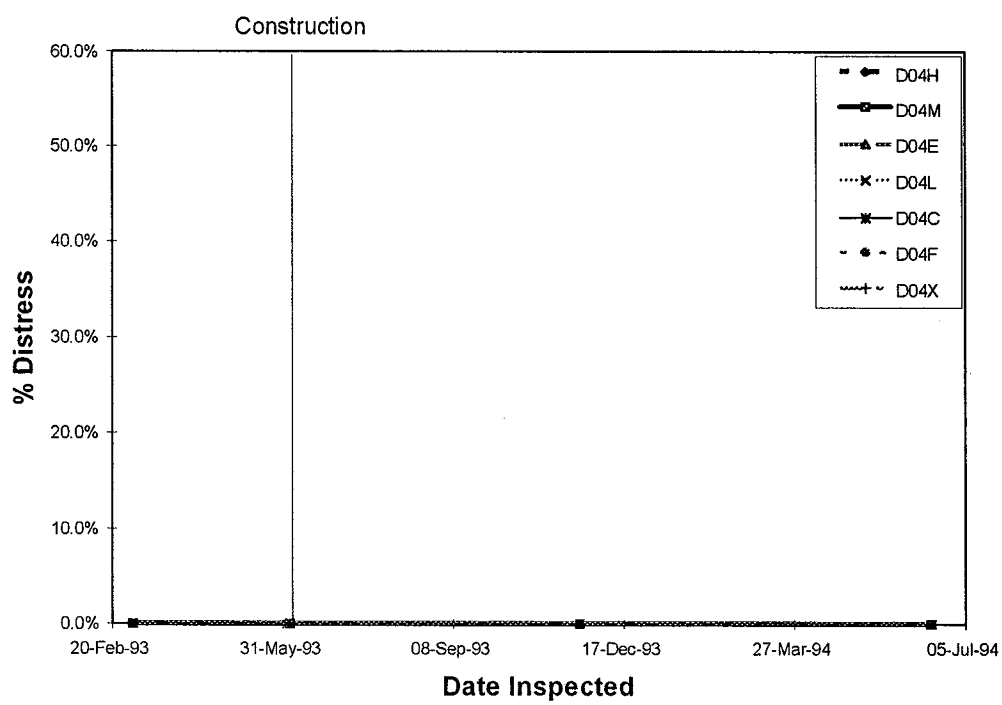


Figure A-24. Ravelling for Site D04

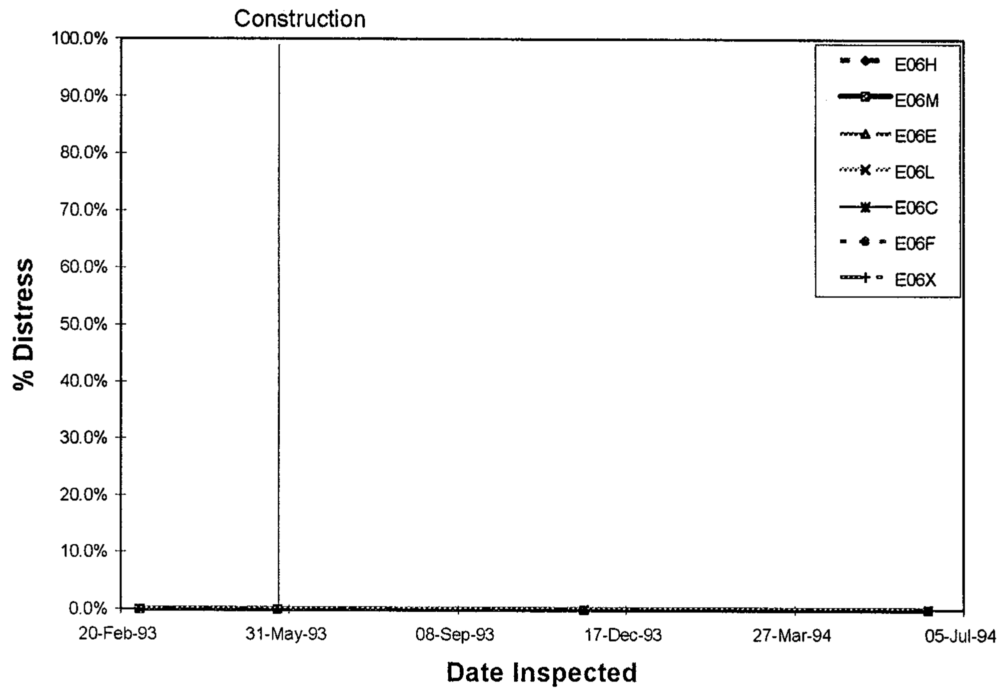


Figure A-25. Alligator Cracking for Site E06

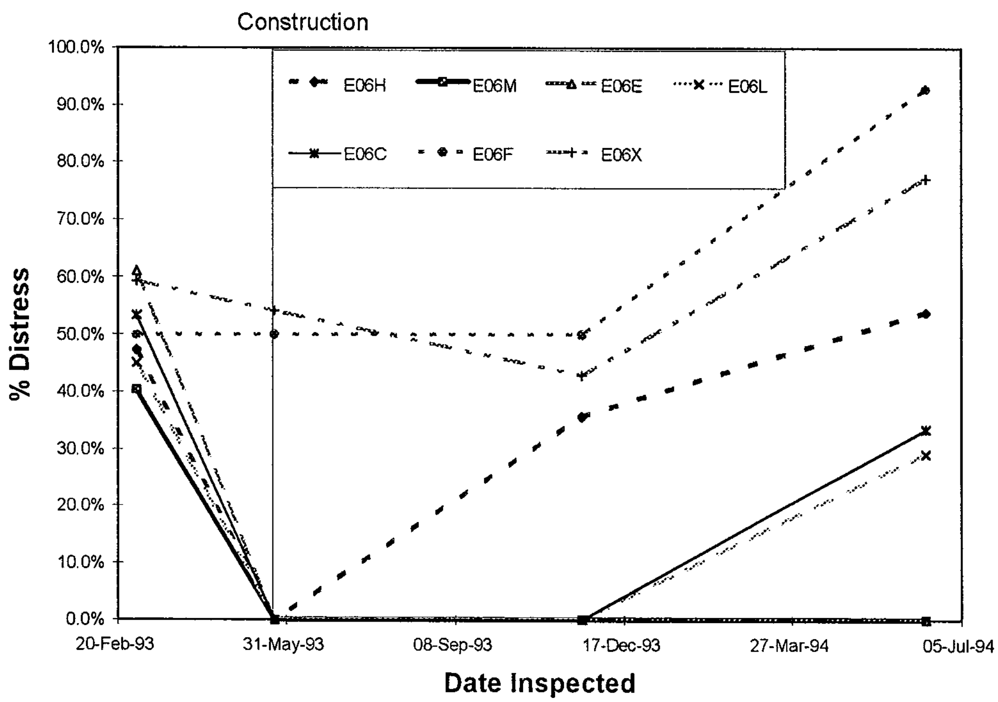


Figure A-26. Bleeding for Site E06

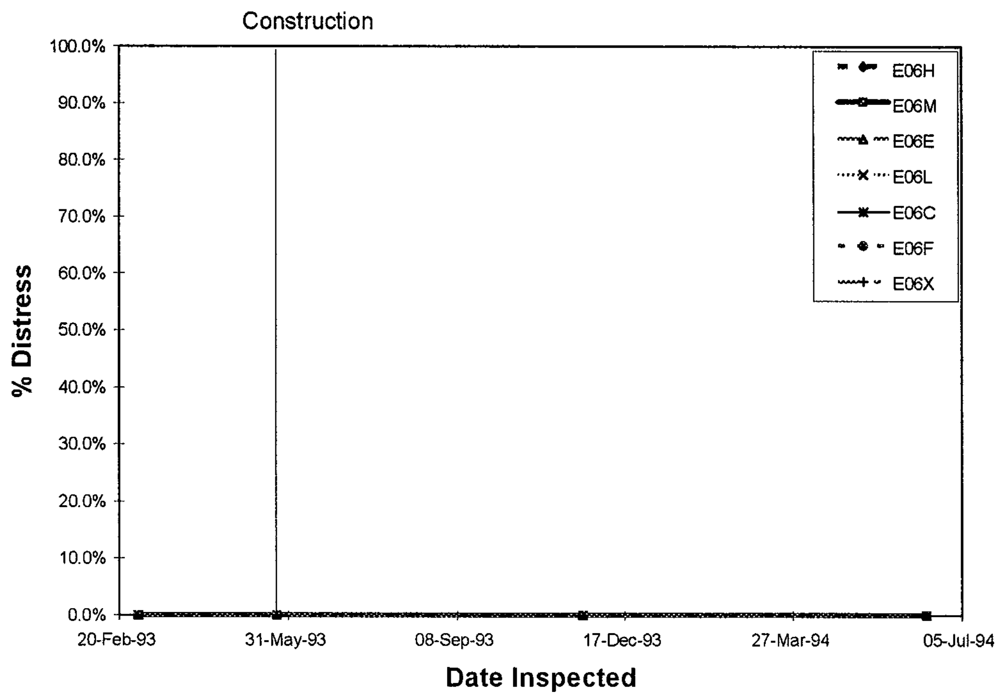


Figure A-27. Block Cracking for Site E06

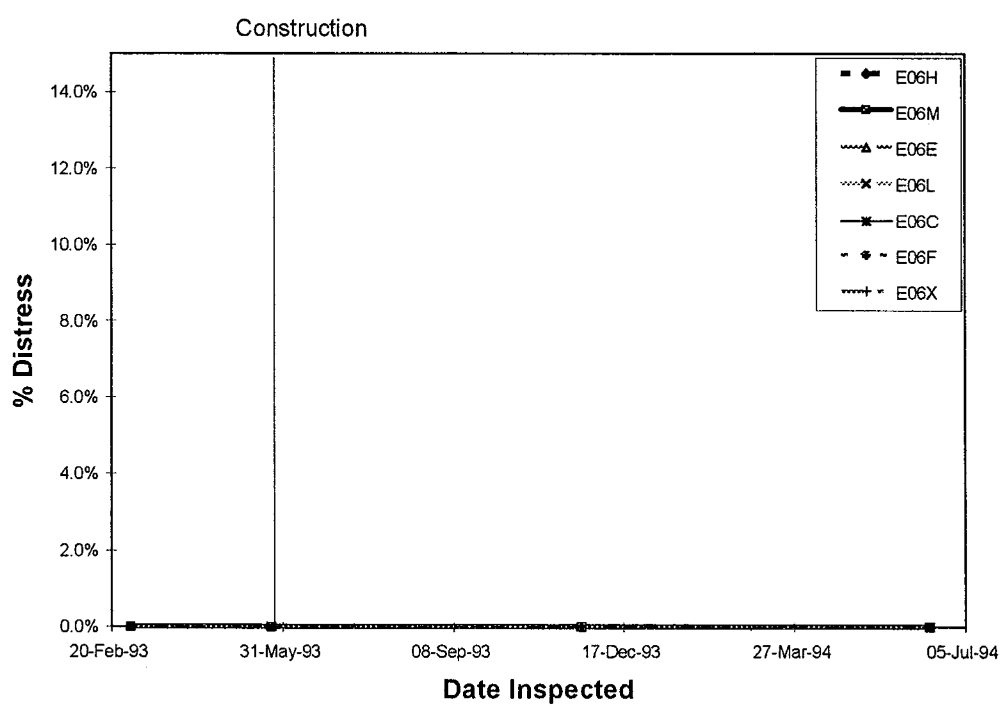


Figure A-28. Longitudinal and Transverse Cracking for Site E06

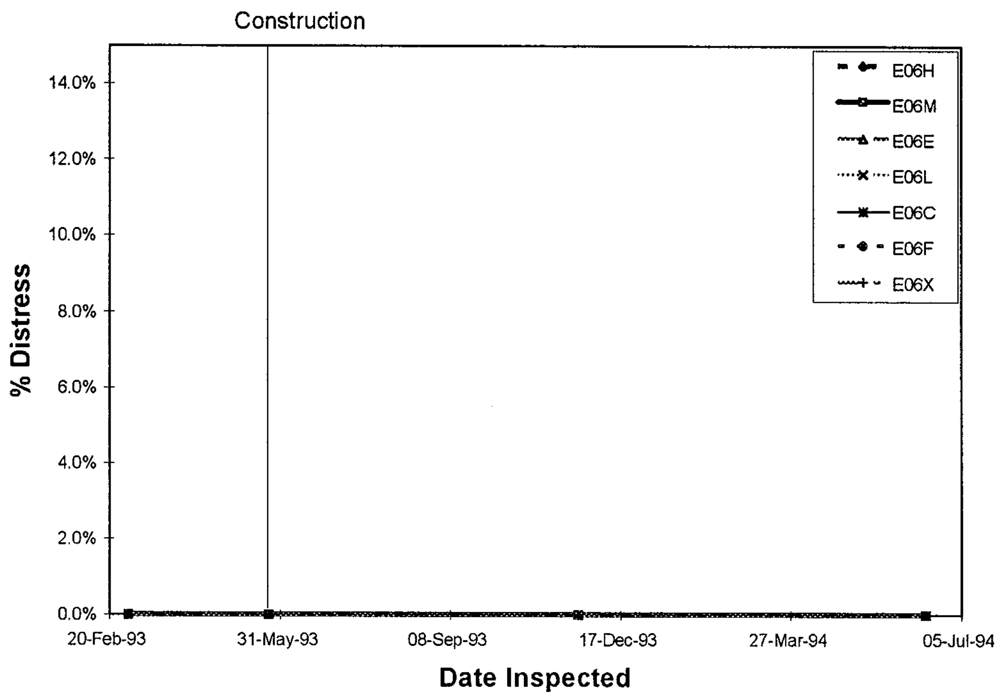
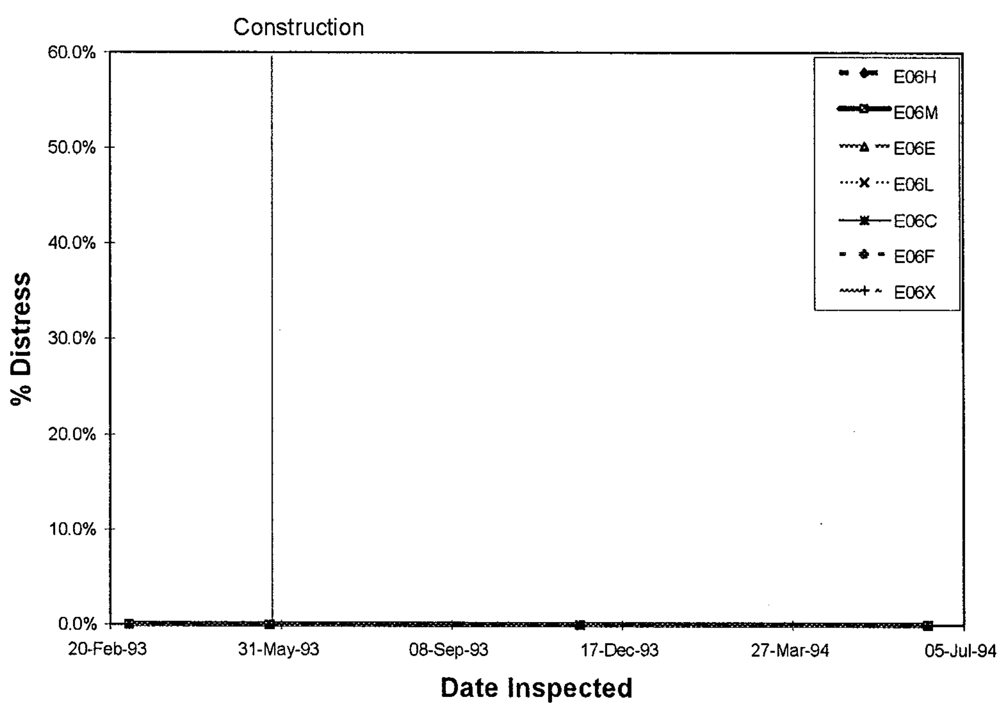


Figure A-29. Longitudinal Cracking in the Wheelpaths for Site E06



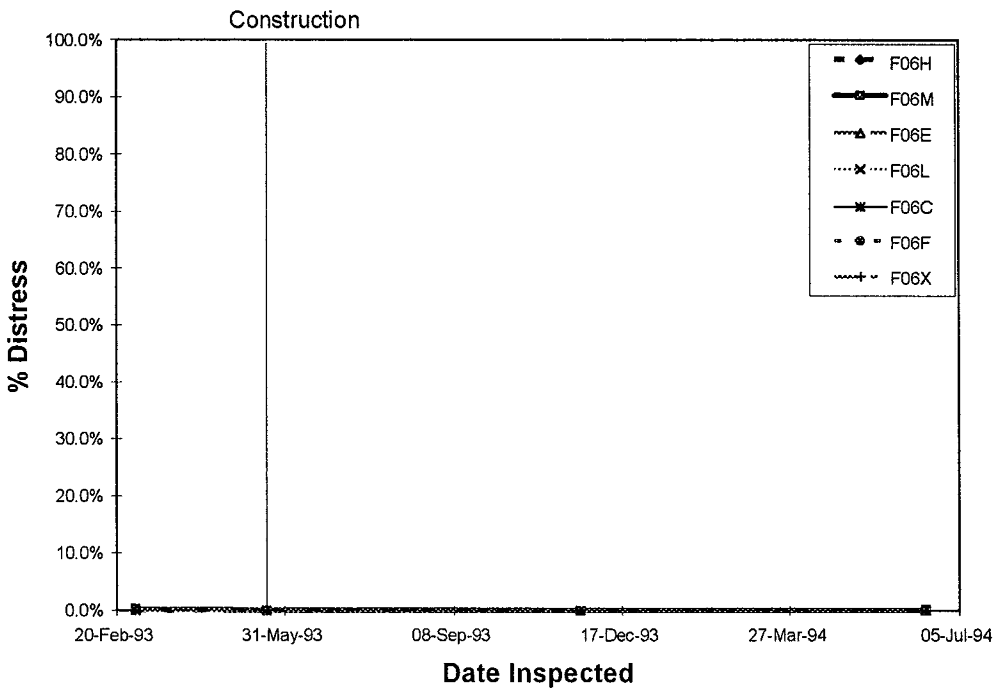


Figure A-31. Alligator Cracking for Site F06

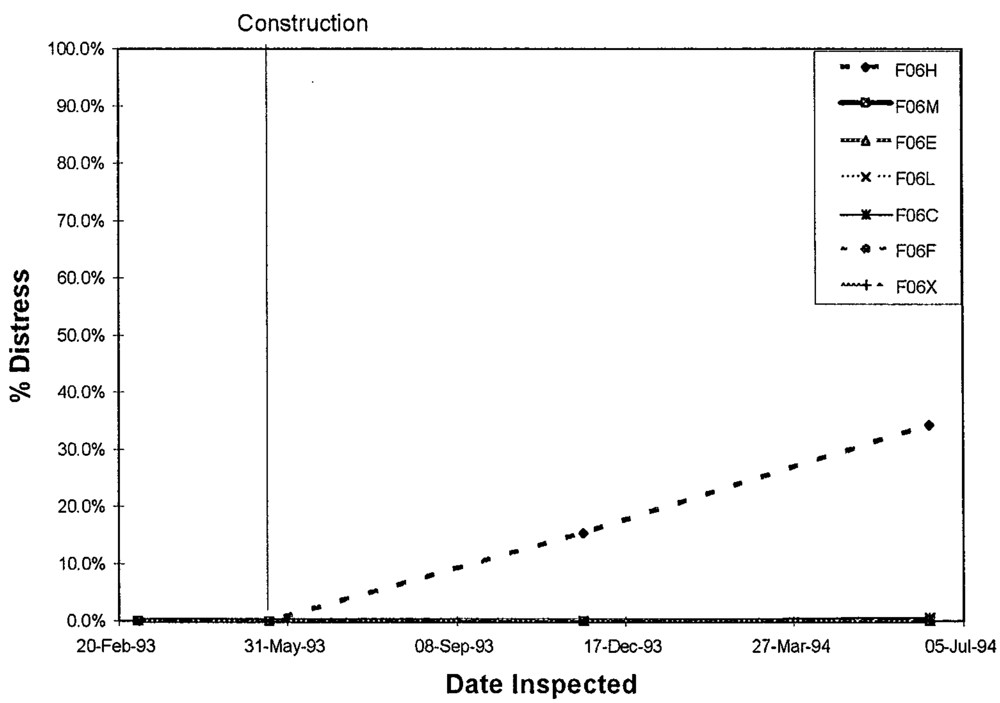


Figure A-32. Bleeding for Site F06

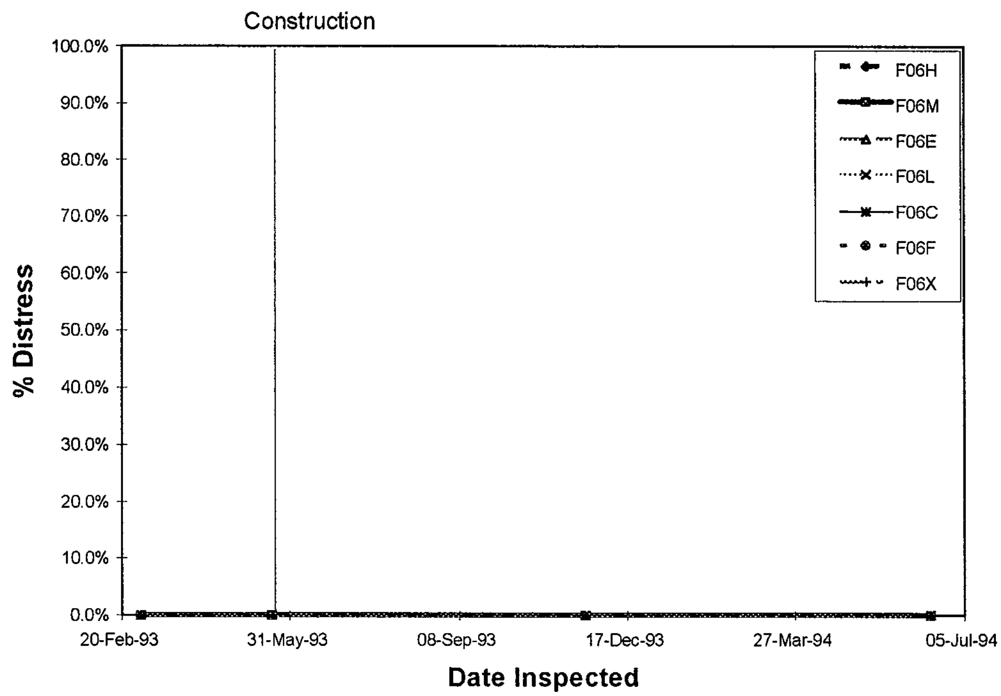


Figure A-33. Block Cracking for Site F06

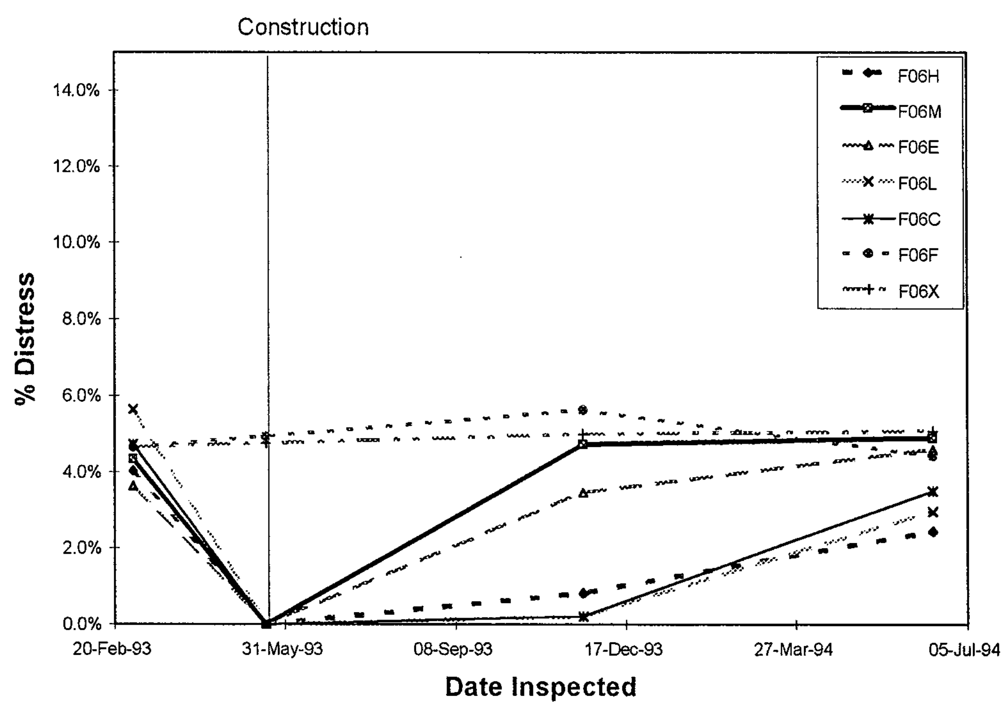


Figure A-34. Longitudinal and Transverse Cracking for Site F06

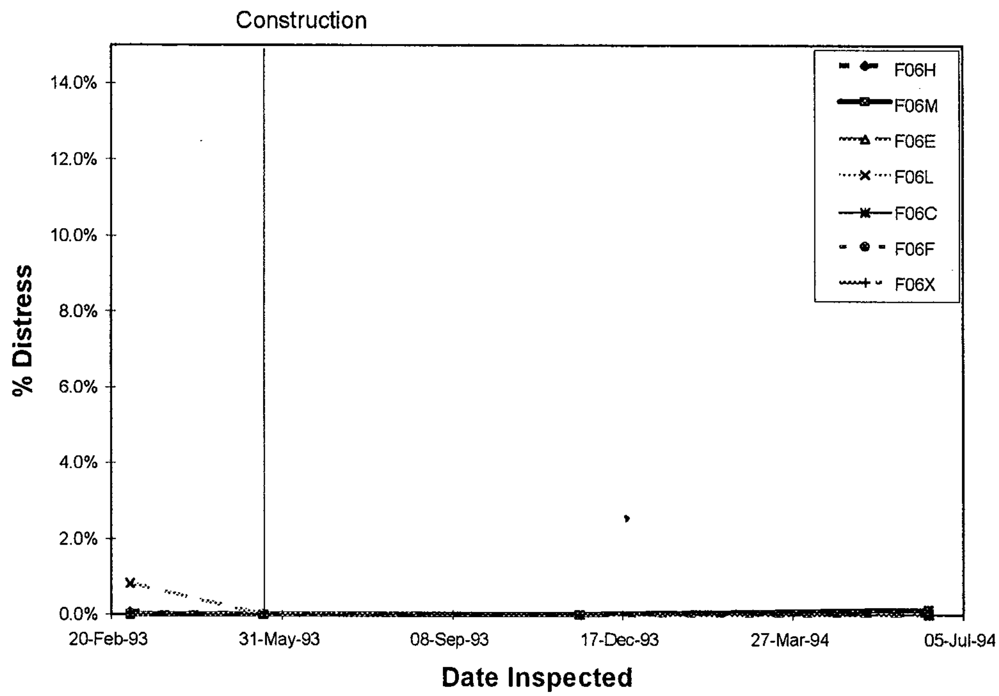


Figure A-35. Longitudinal Cracking in the Wheelpaths for Site F06

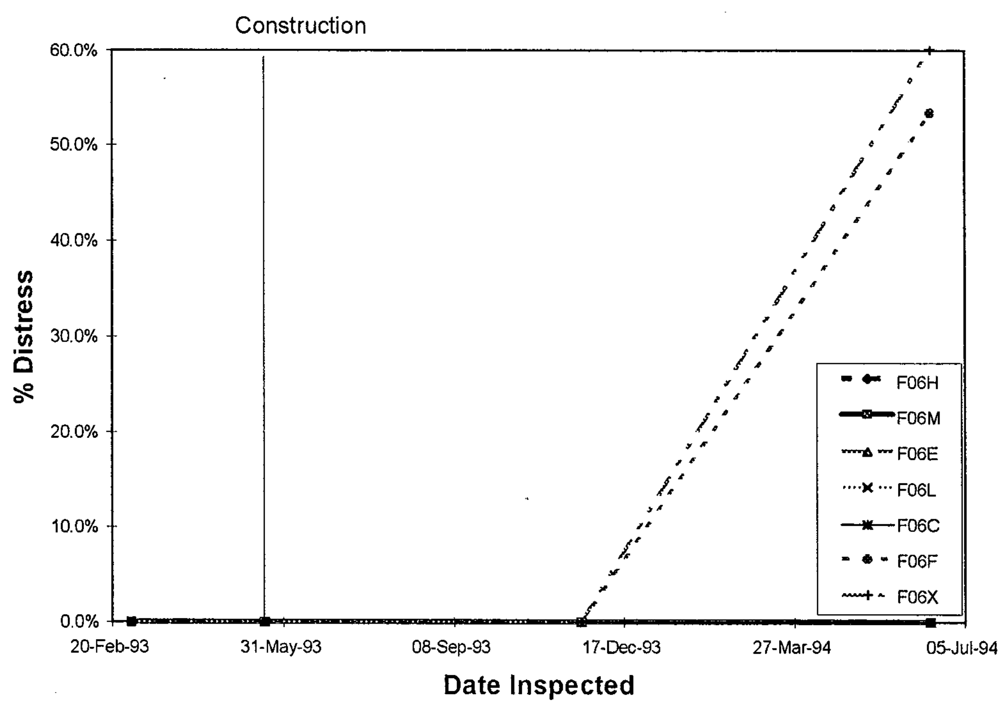


Figure A-36. Ravelling for Site F06

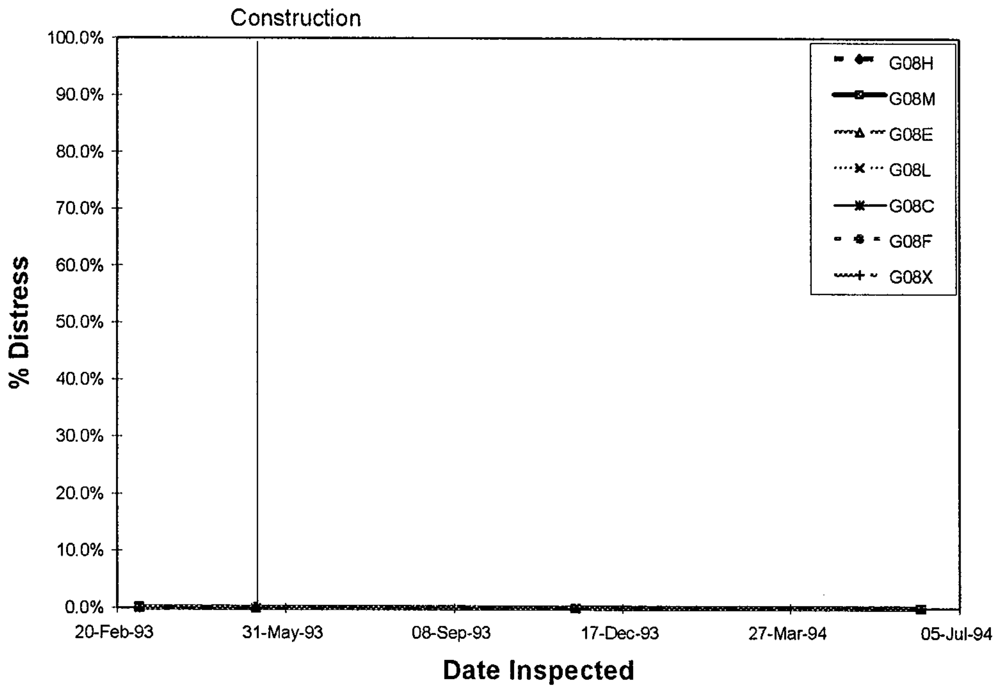


Figure A-37. Alligator Cracking for Site G08

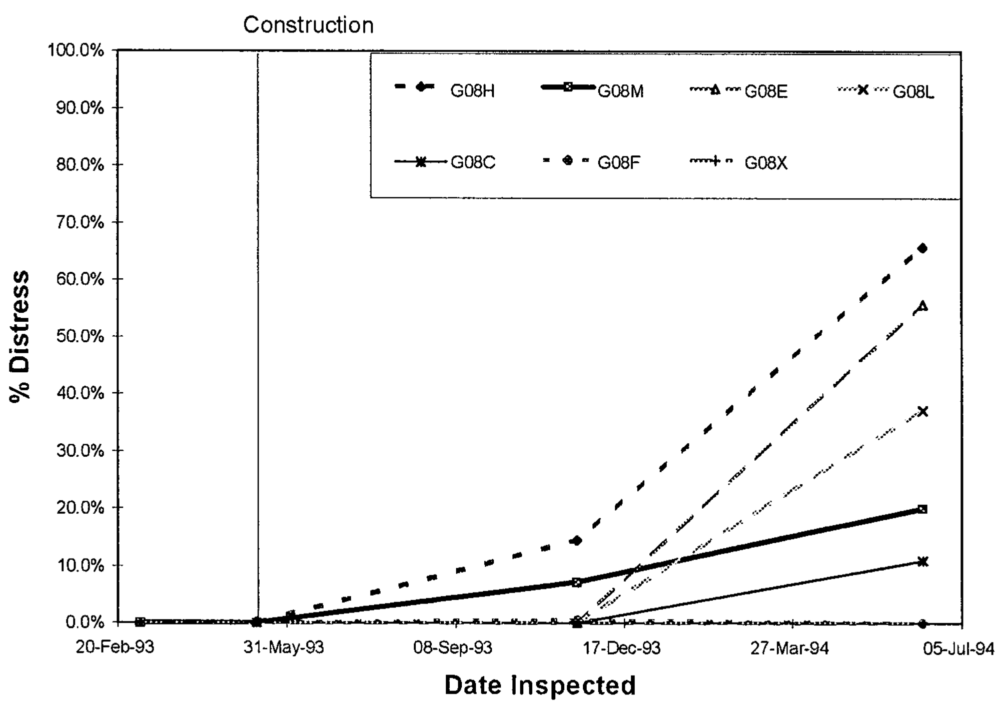


Figure A-38. Bleeding for Site G08

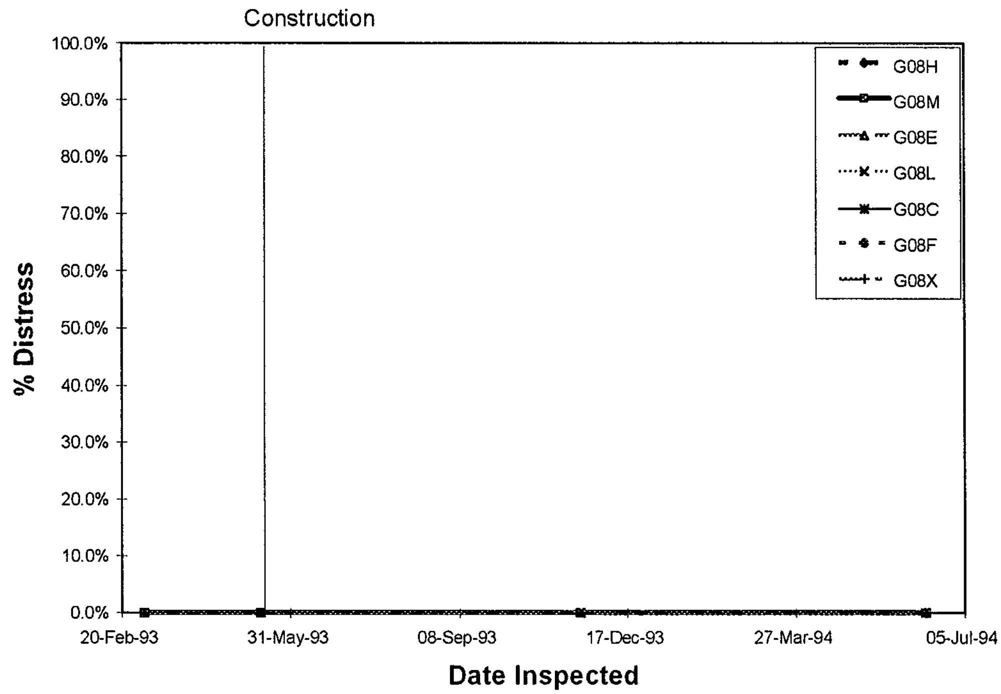


Figure A-39. Block Cracking for Site G08

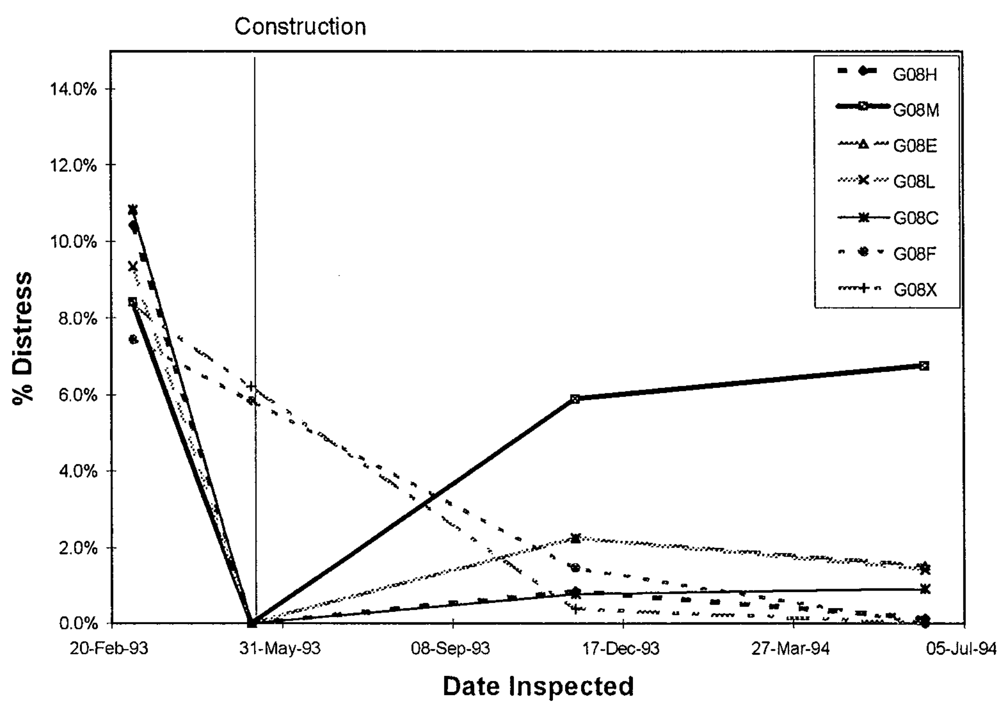


Figure A-40. Longitudinal and Transverse Cracking for Site G08

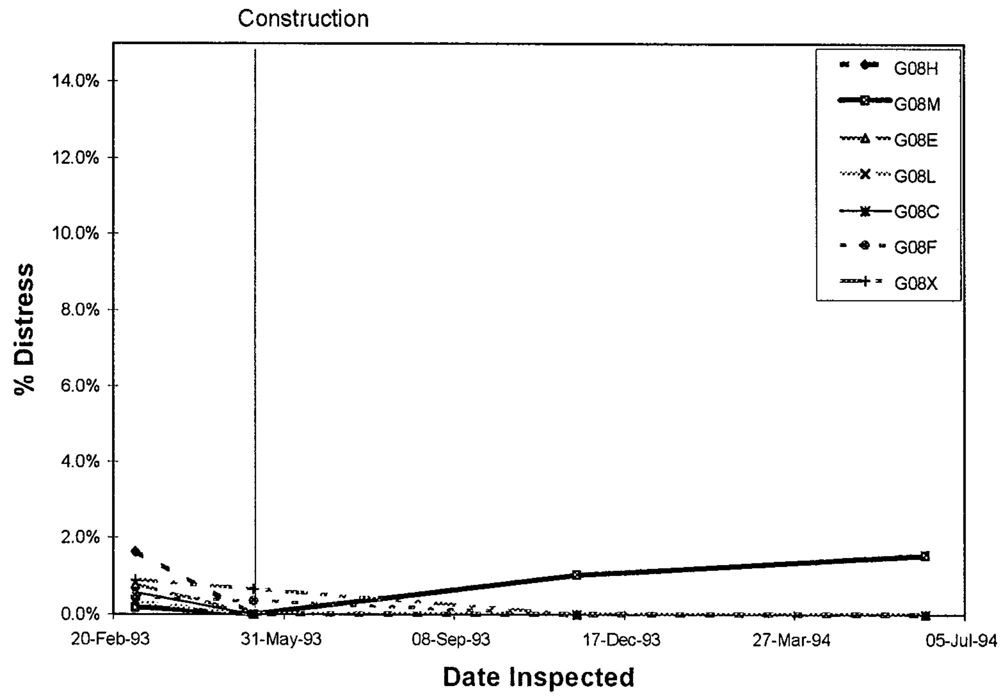


Figure A-41. Longitudinal Cracking in the Wheelpaths for Site G08

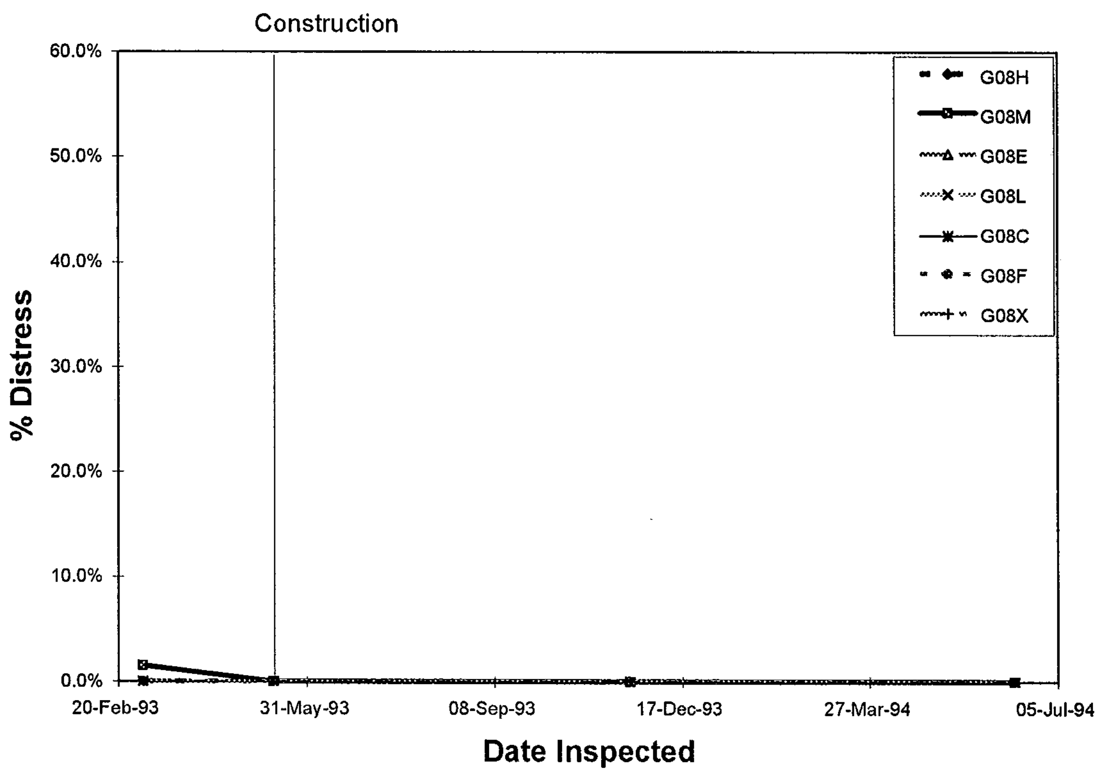


Figure A-42. Ravelling for Site G08

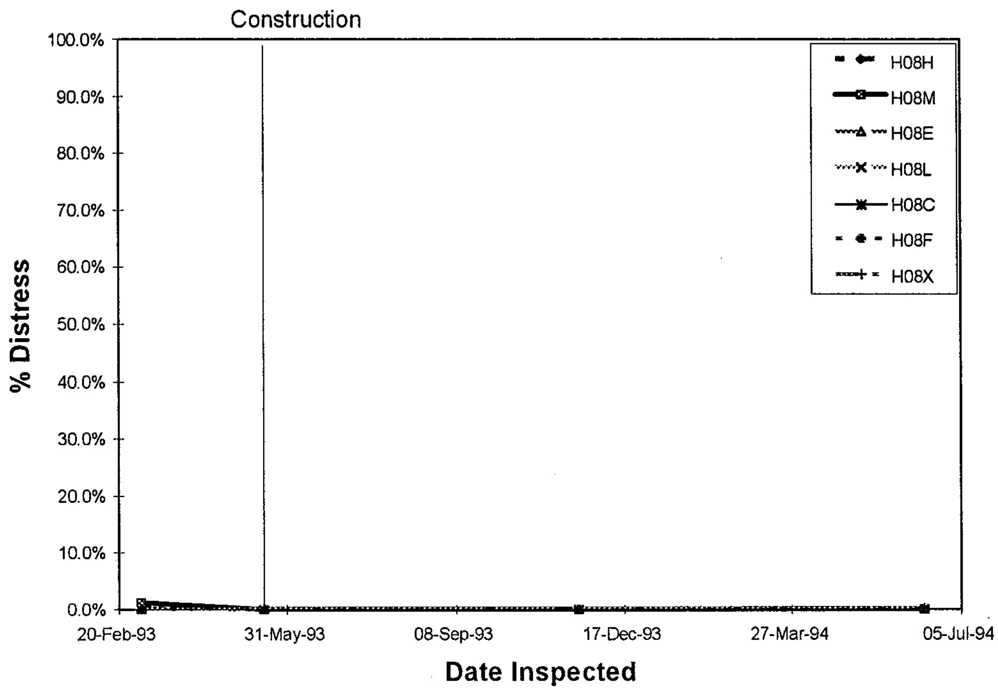


Figure A-43. Alligator Cracking for Site H08

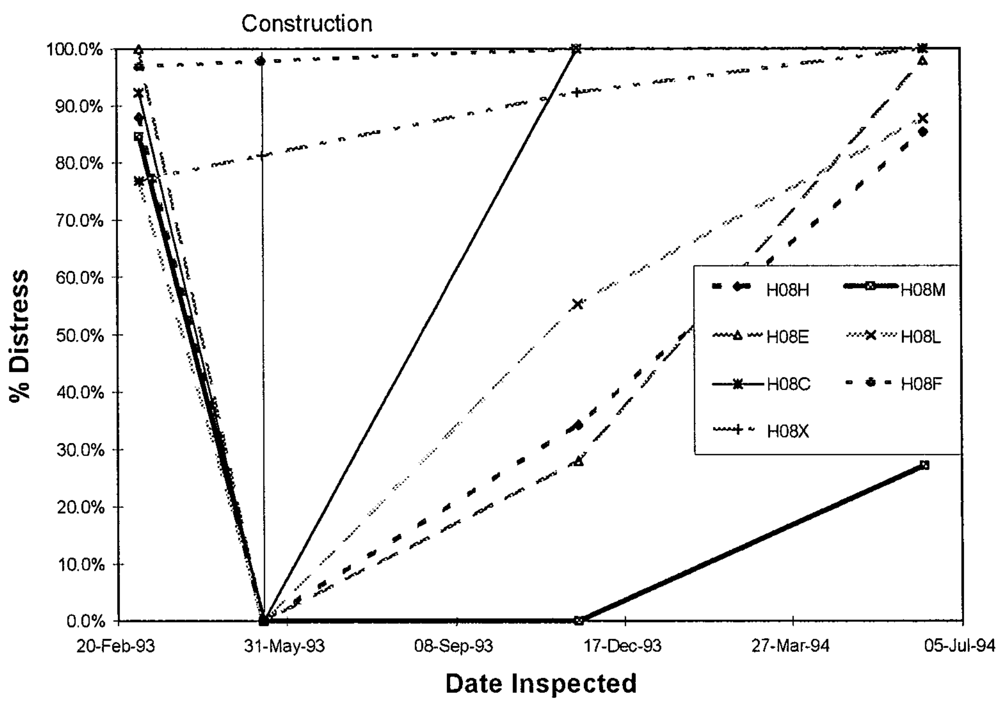


Figure A-44. Bleeding for Site H08

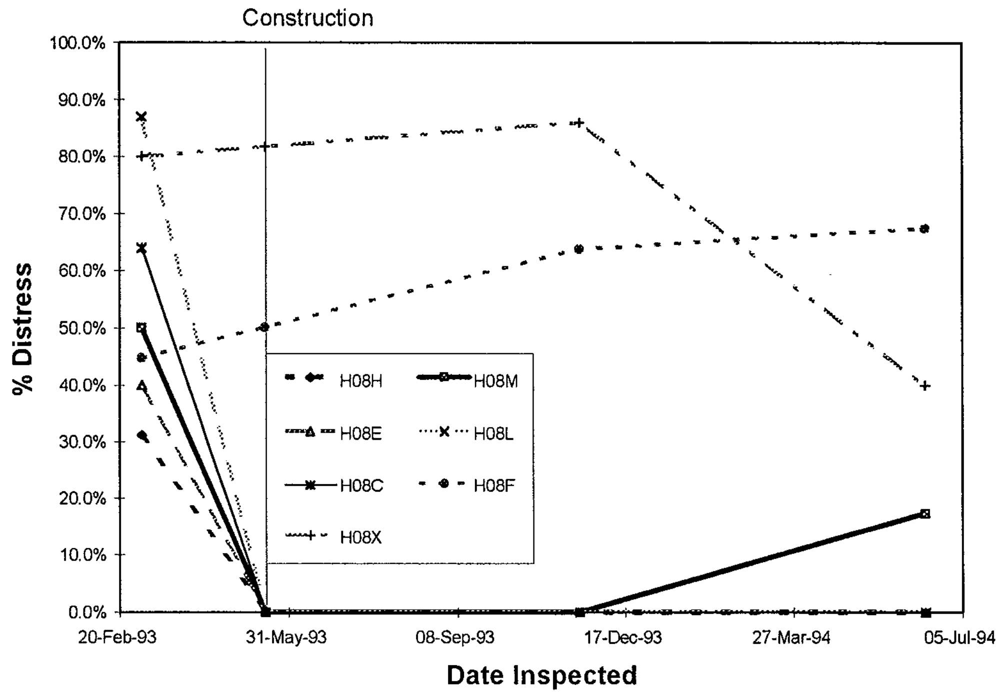


Figure A-45. Block Cracking for Site H08

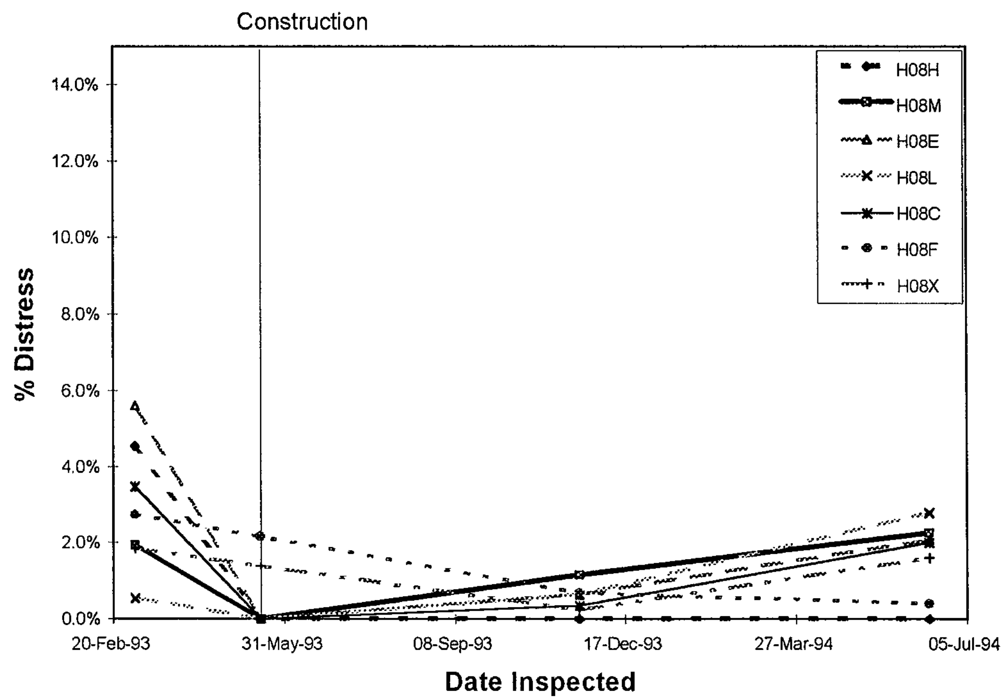


Figure A-46. Longitudinal and Transverse Cracking for Site H08

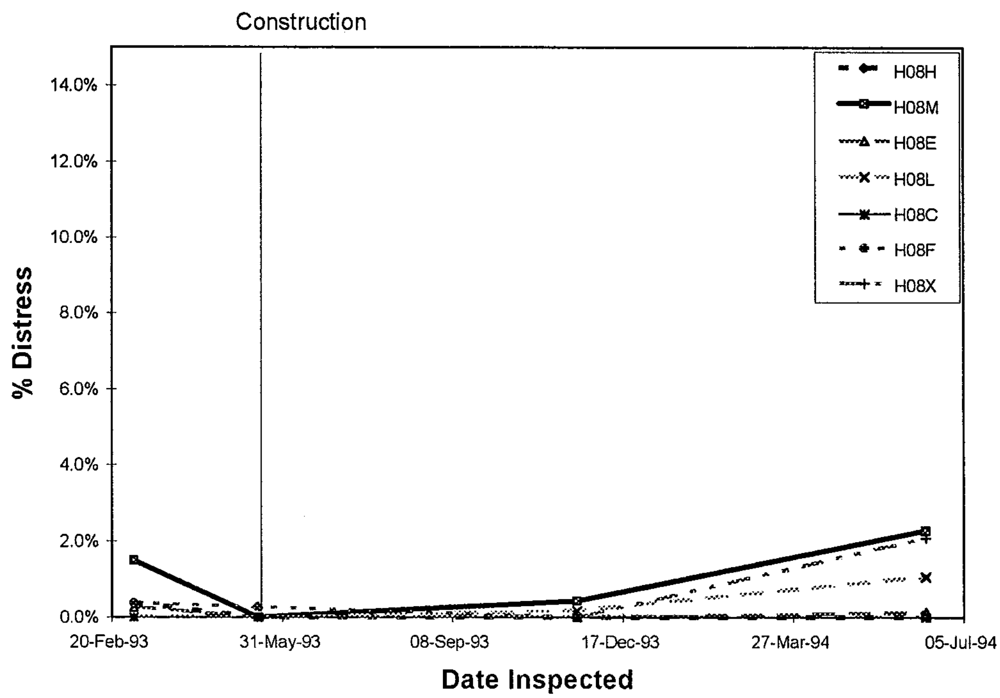


Figure A-47. Longitudinal Cracking in the Wheelpaths for Site H08

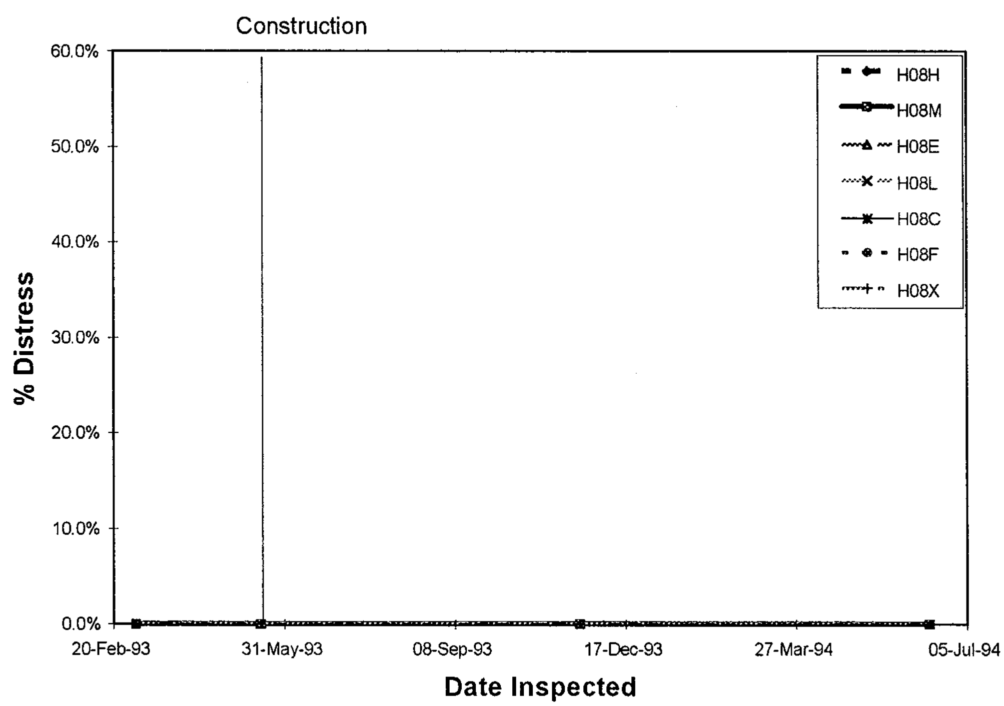


Figure A-48. Ravelling for Site H08

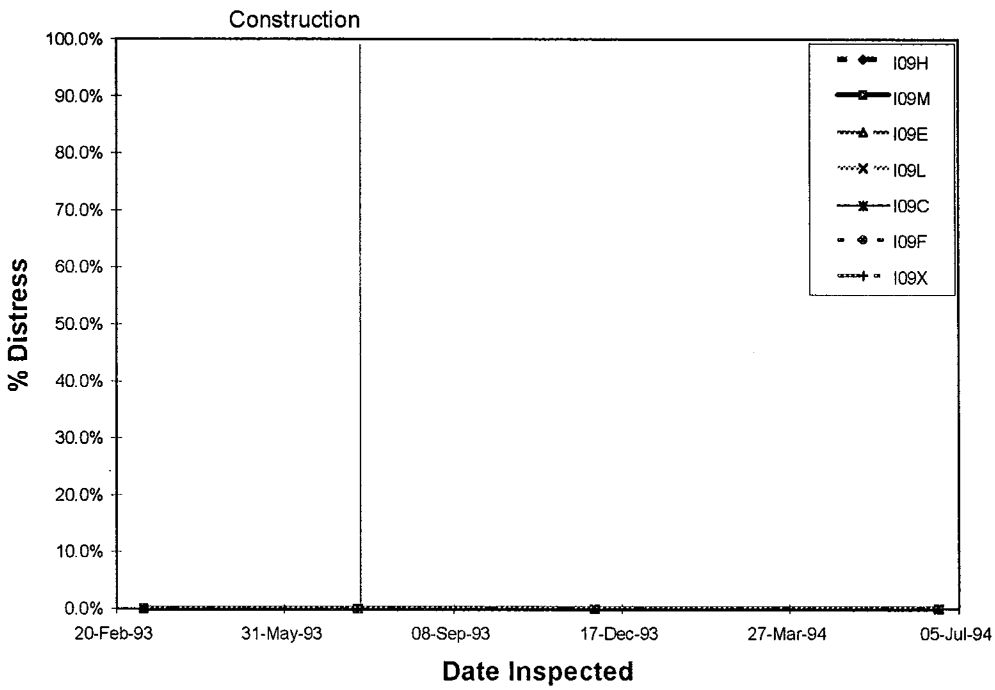


Figure A-49. Alligator Cracking for Site I09

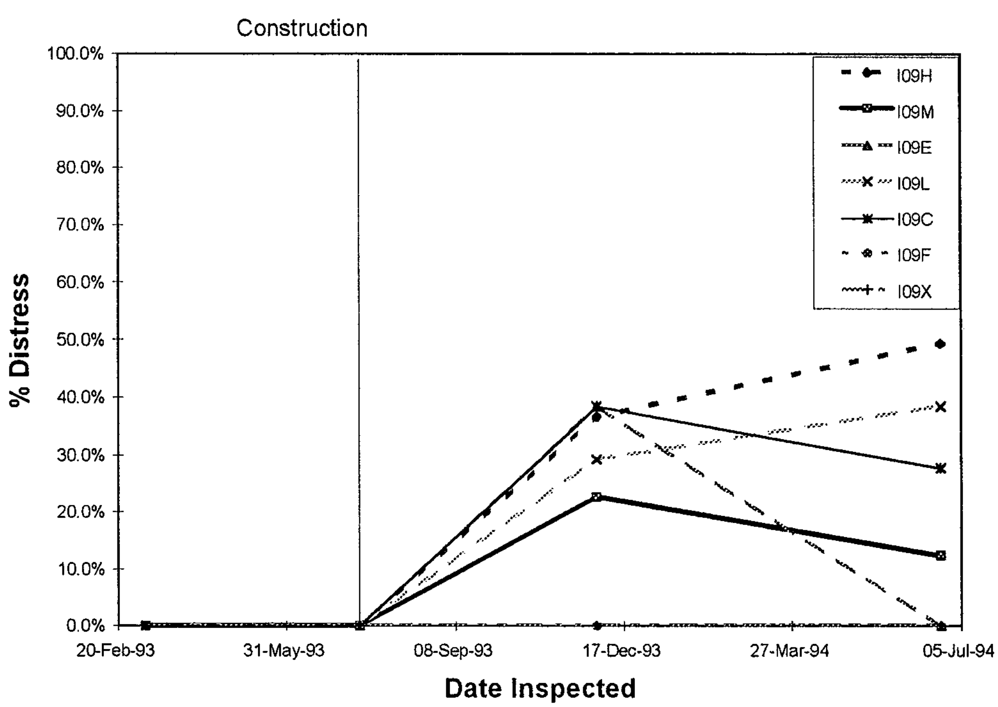


Figure A-50. Bleeding for Site I09

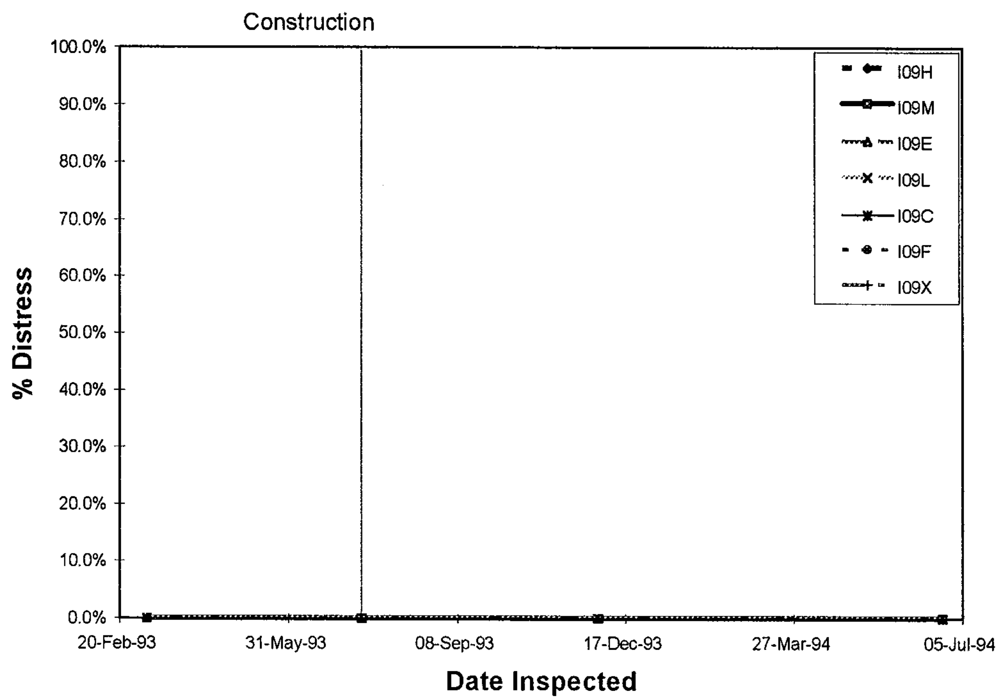


Figure A-51. Block Cracking for Site I09

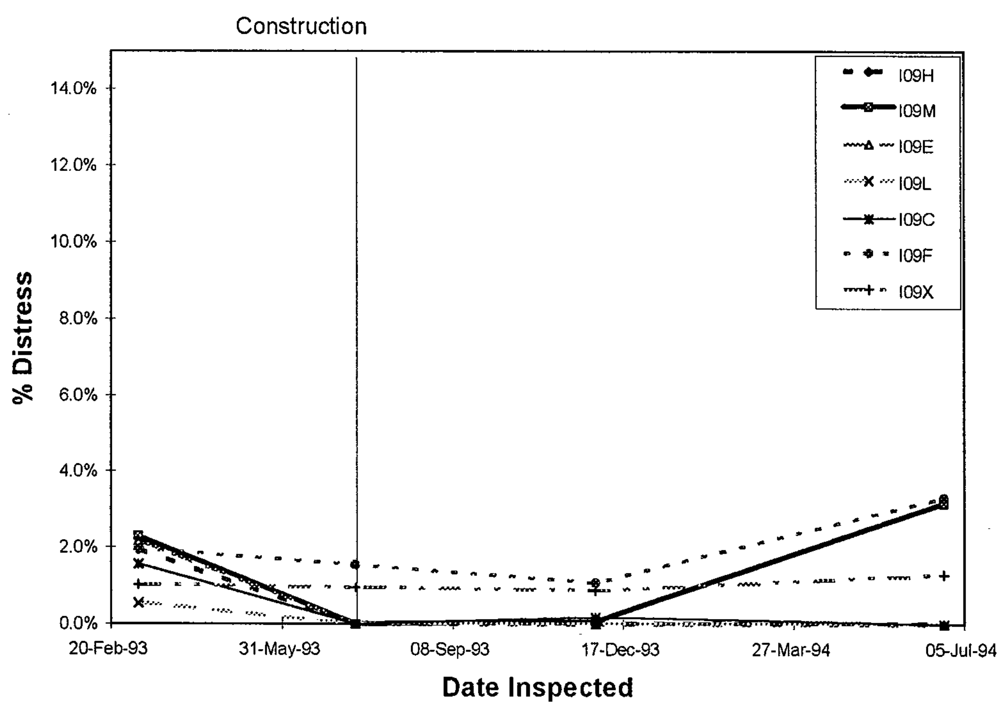


Figure A-52. Longitudinal and Transverse Cracking for Site I09

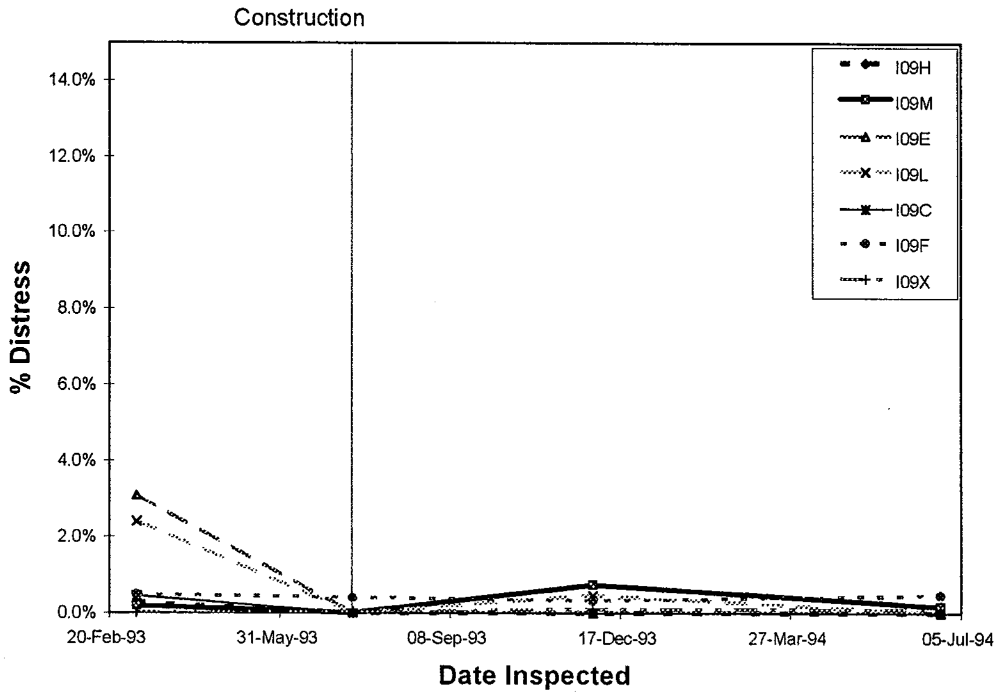


Figure A-53. Longitudinal Cracking in the Wheelpaths for Site I09

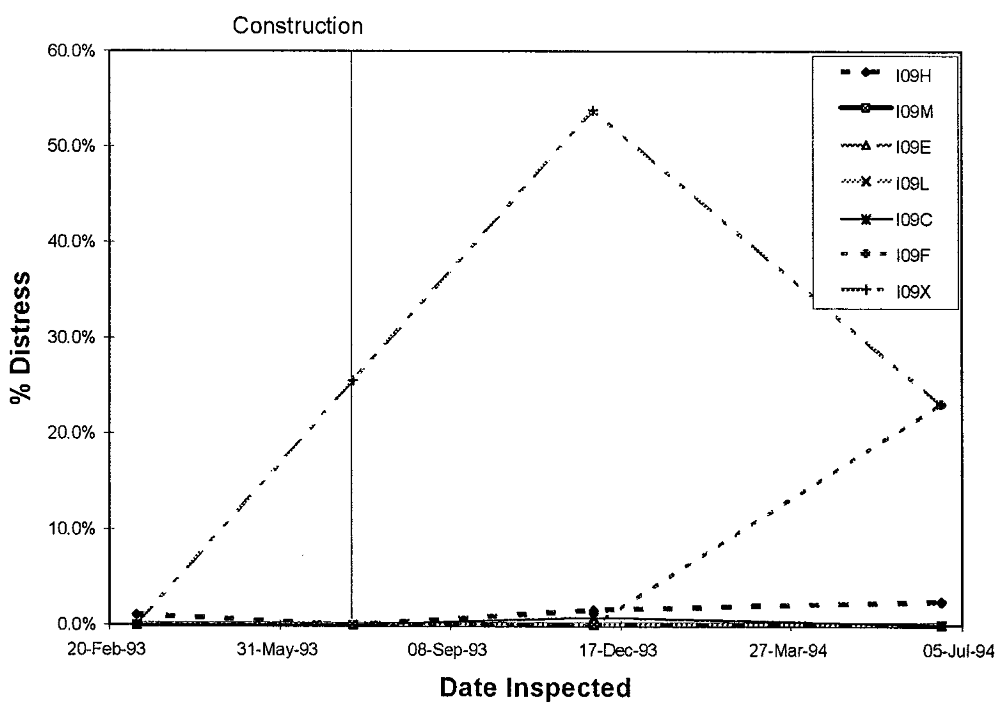


Figure A-54. Ravelling for Site I09

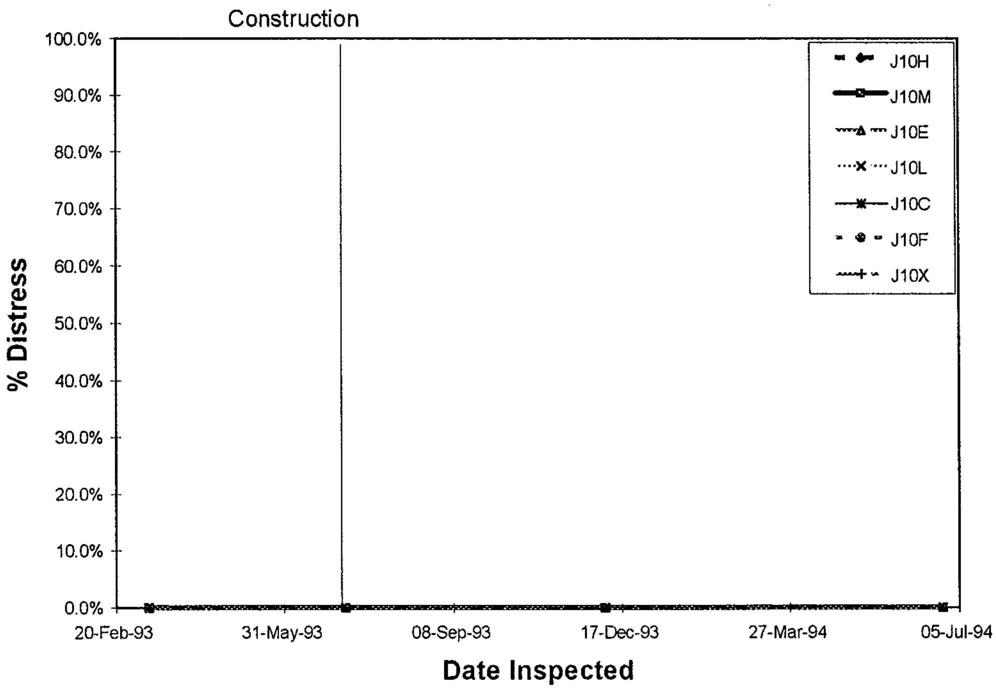


Figure A-55. Alligator Cracking for Site J10

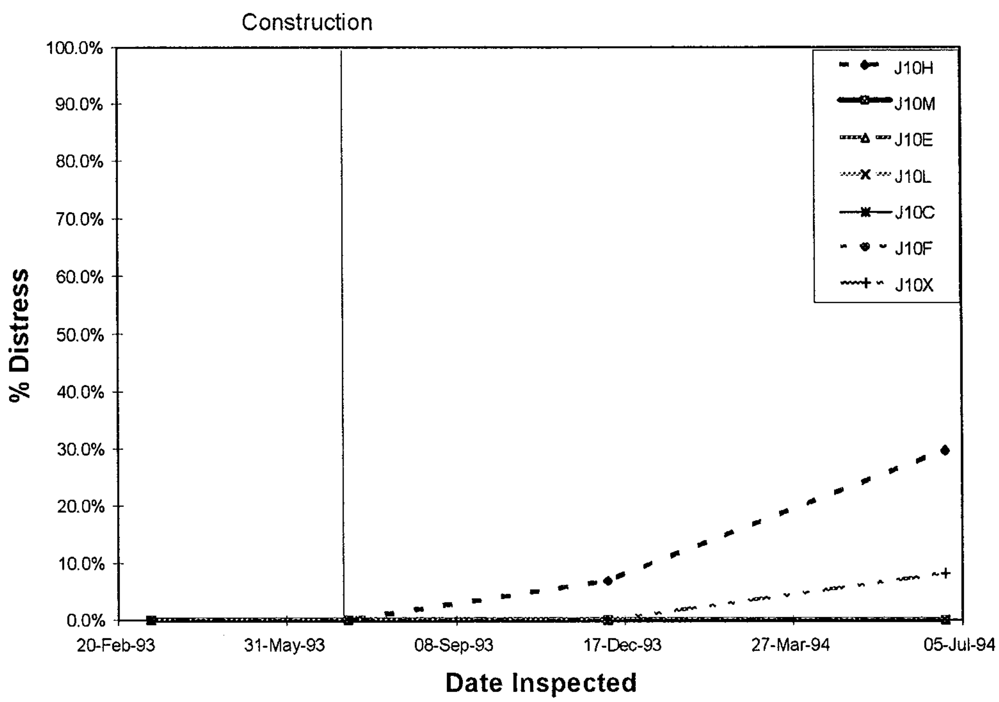


Figure A-56. Bleeding for Site J10

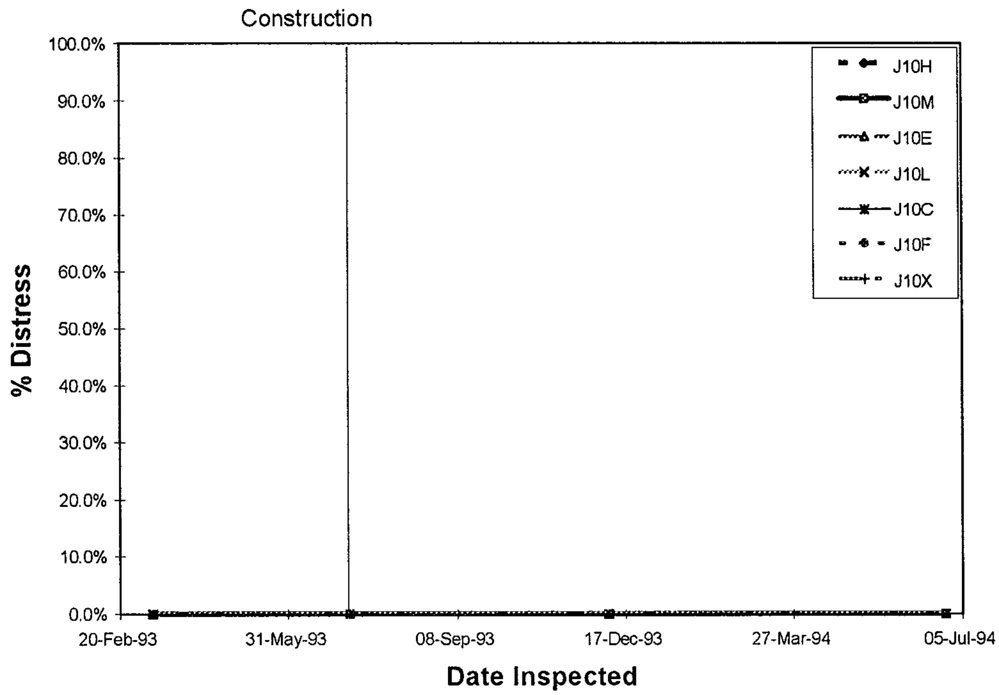


Figure A-57. Block Cracking for Site J10

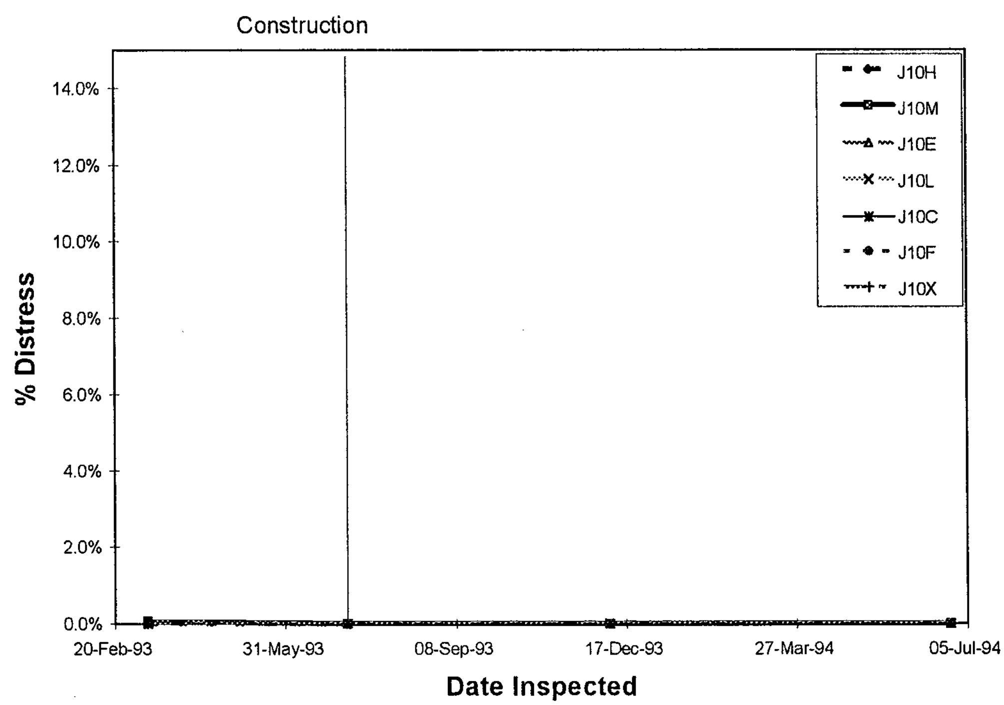


Figure A-58. Longitudinal and Transverse Cracking for Site J10

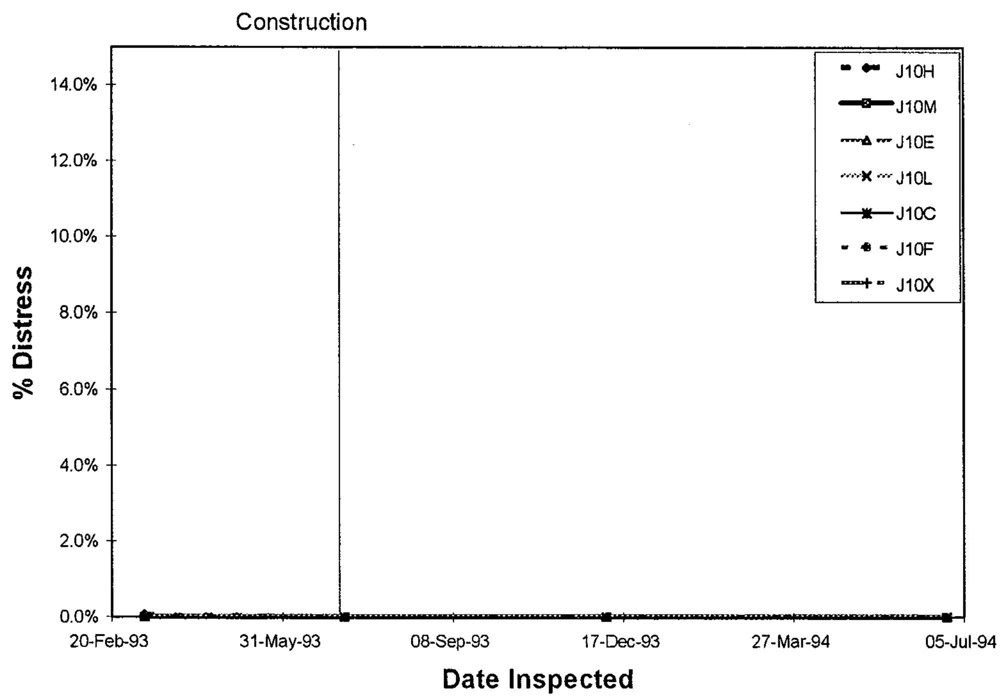


Figure A-59. Longitudinal Cracking in the Wheelpaths for Site J10

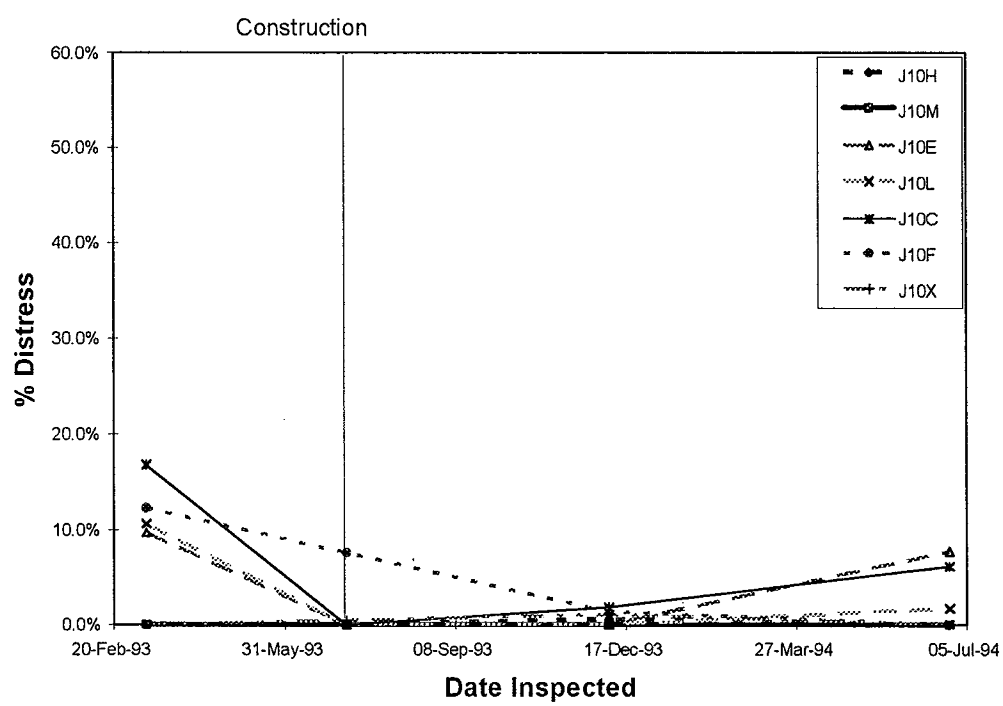


Figure A-60. Ravelling for Site J10

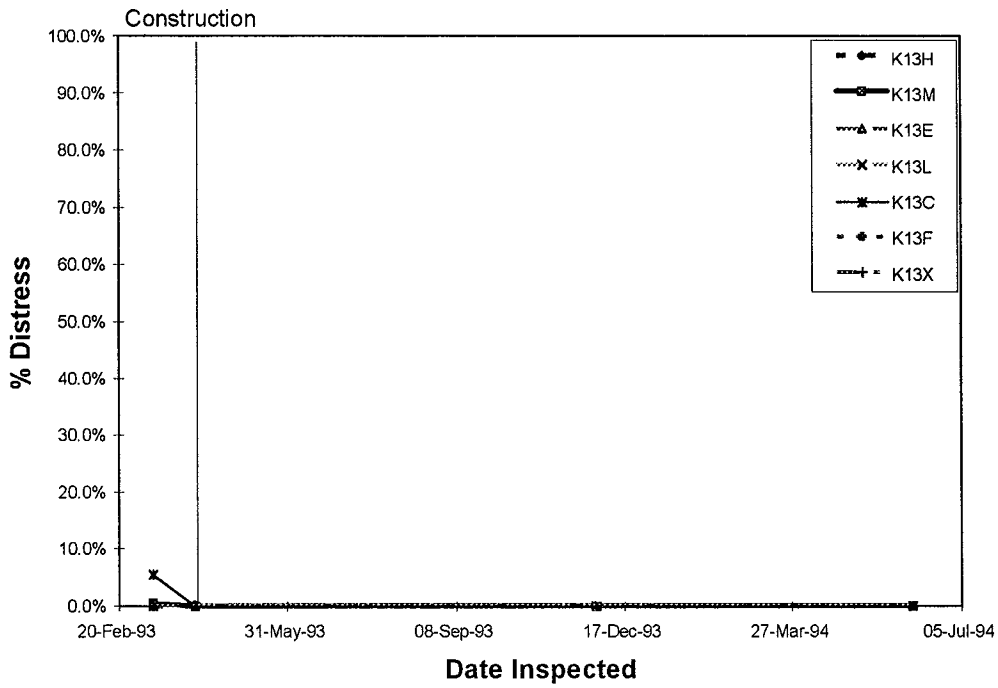


Figure A-61. Alligator Cracking for Site K13

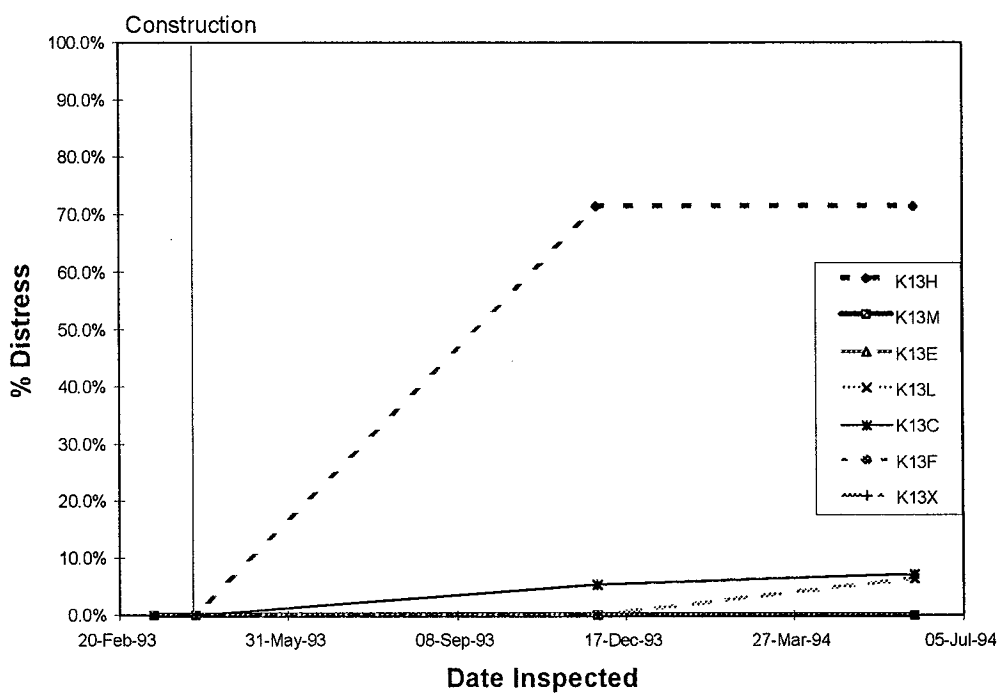


Figure A-62. Bleeding for Site K13

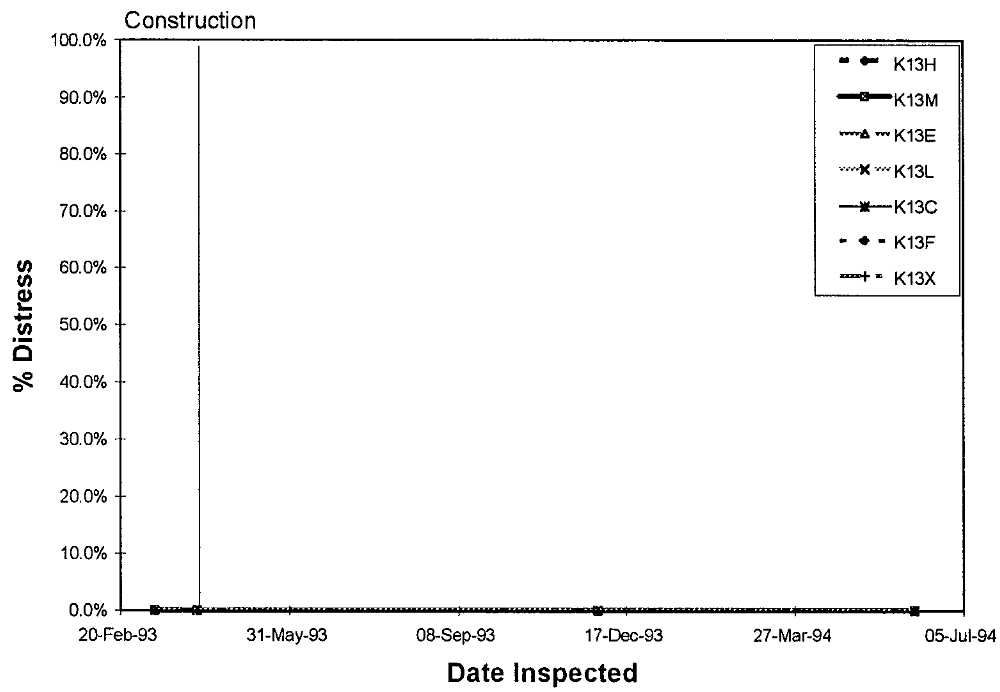


Figure A-63. Block Cracking for Site K13

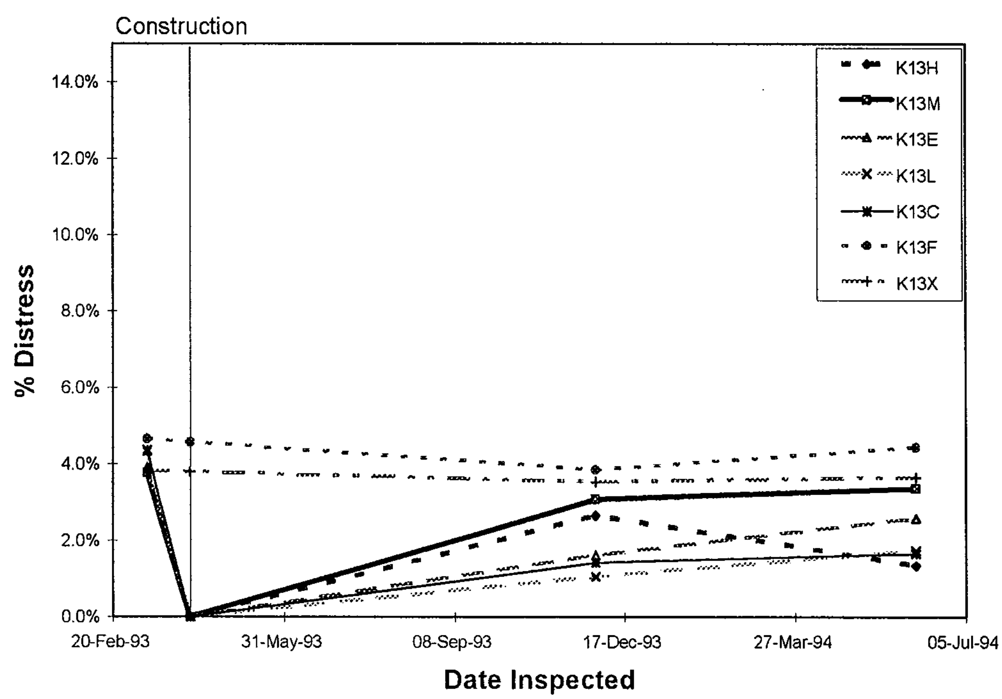


Figure A-64. Longitudinal and Transverse Cracking for Site K13

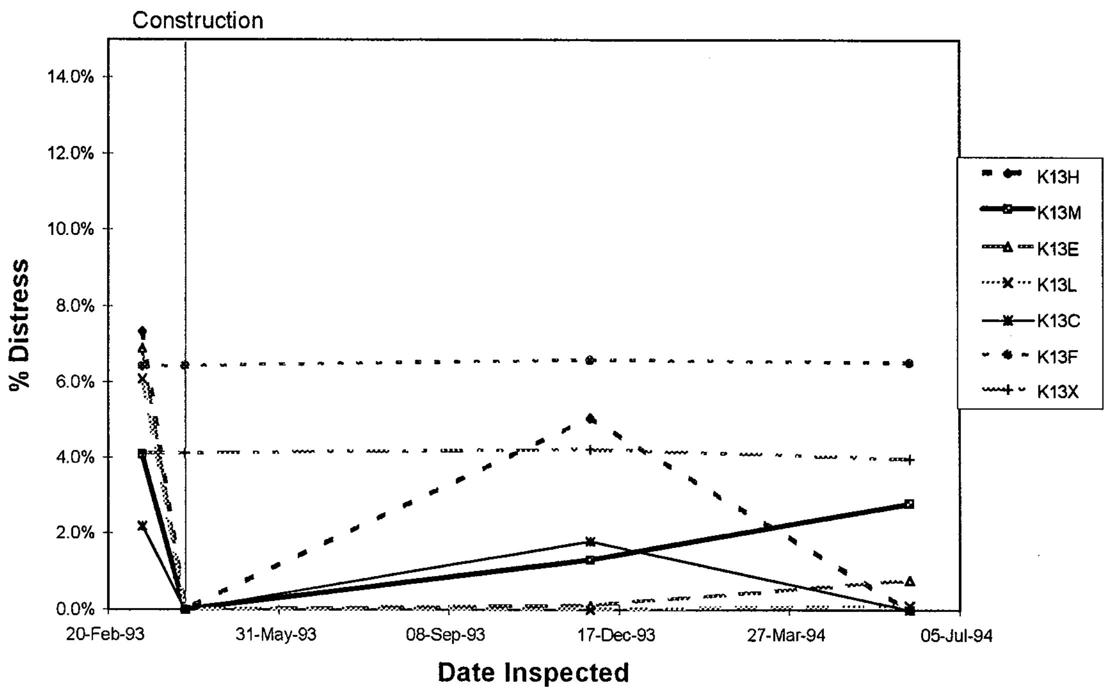


Figure A-65. Longitudinal Cracking in the Wheelpaths for Site K13

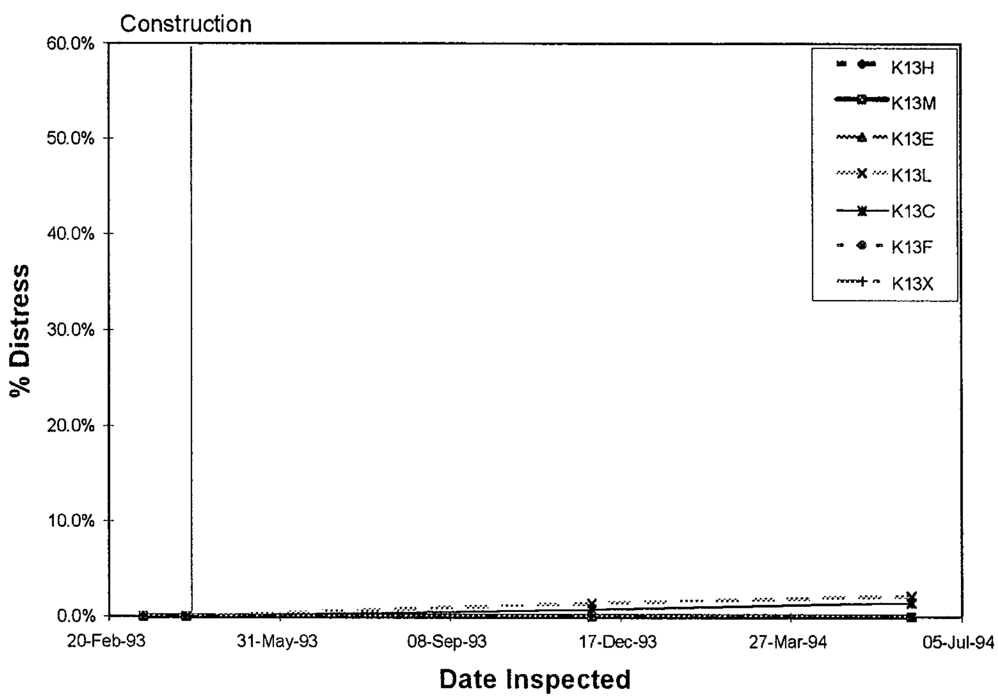


Figure A-66. Ravelling for Site K13

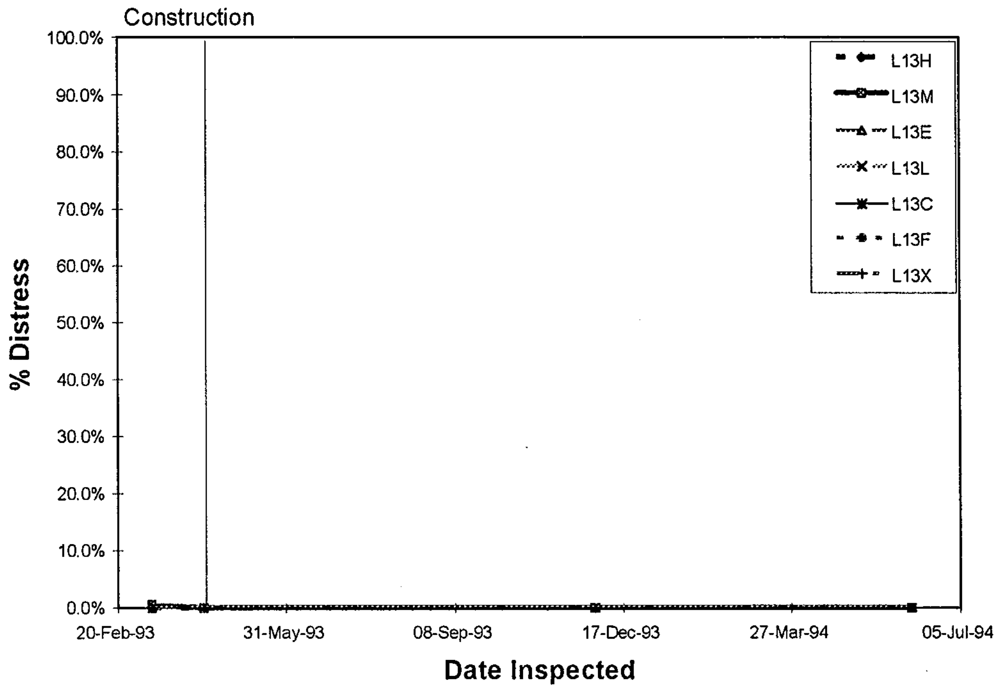


Figure A-67. Alligator Cracking for Site L13

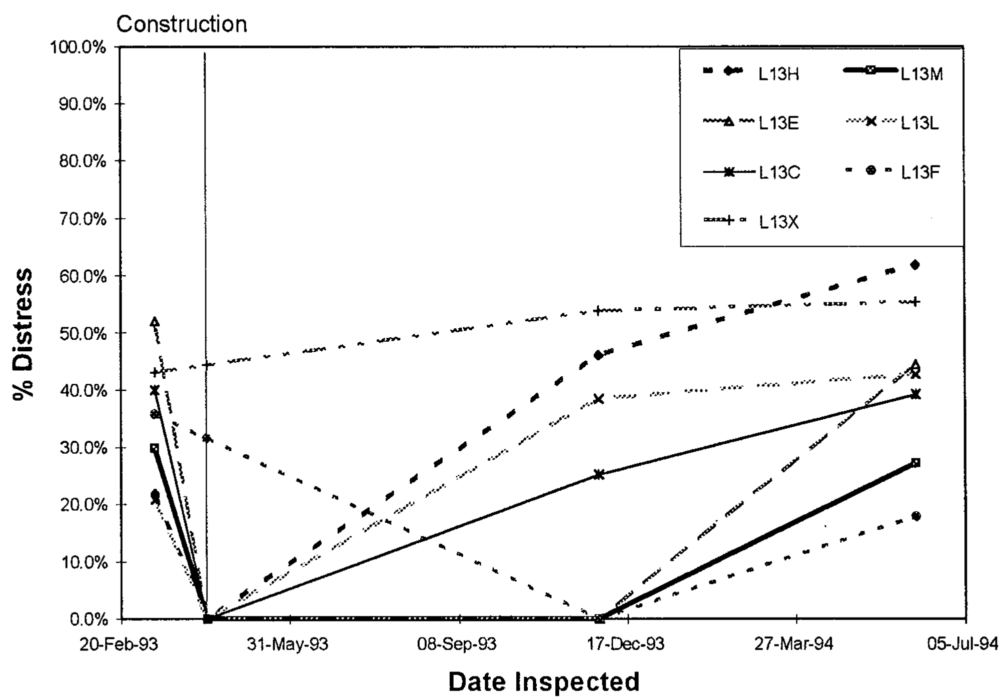


Figure A-68. Bleeding for Site L13

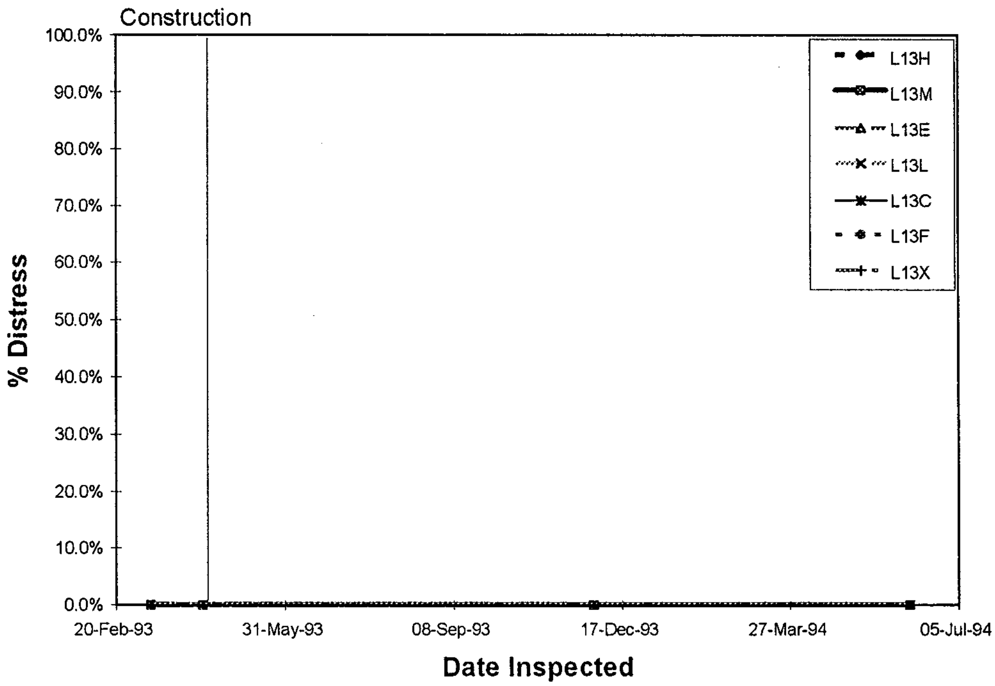


Figure A-69. Block Cracking for Site L13

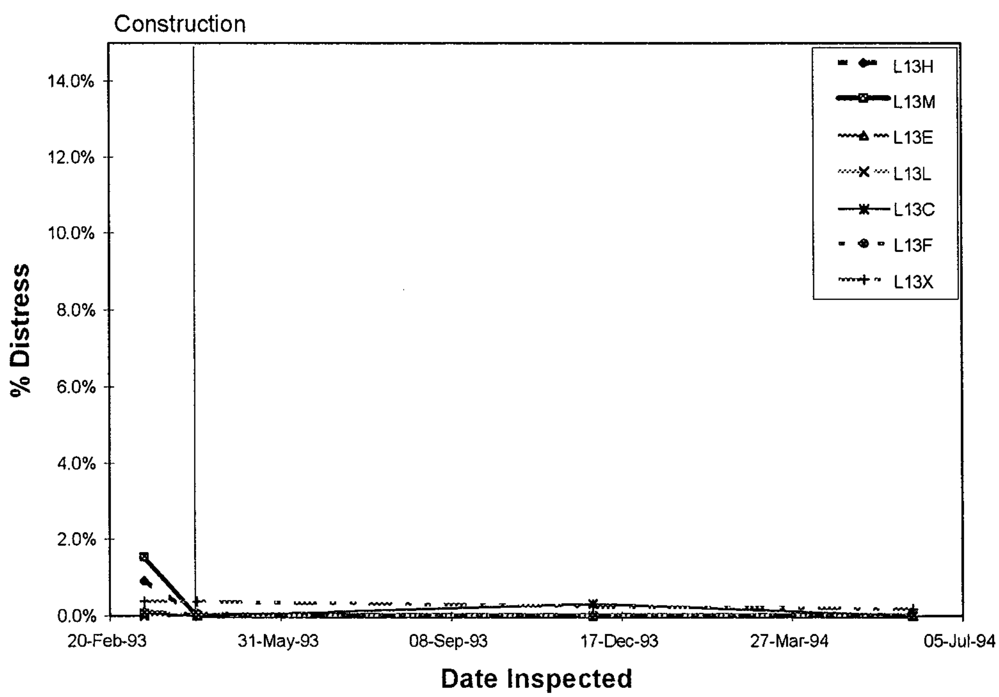


Figure A-70. Longitudinal and Transverse Cracking for Site L13

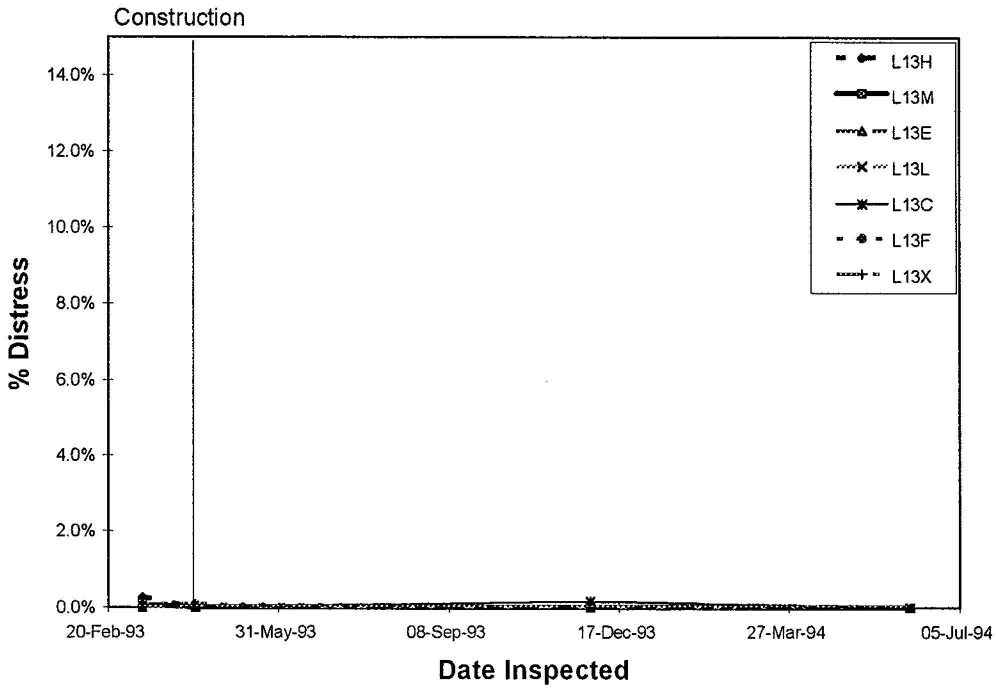


Figure A-71. Longitudinal Cracking in the Wheelpaths for Site L13

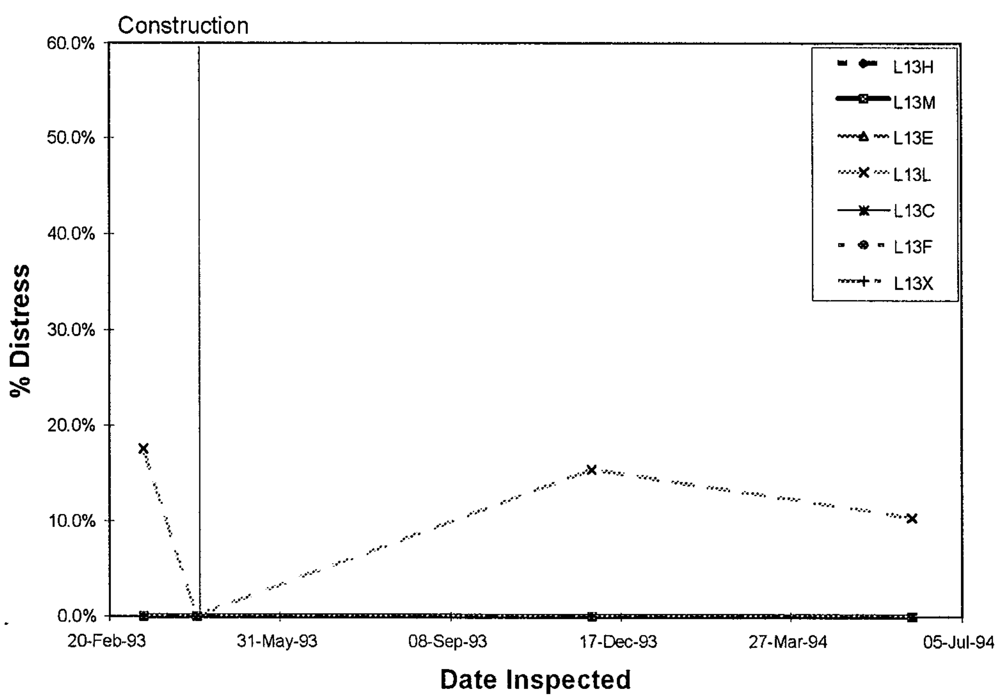


Figure A-72. Ravelling for Site L13

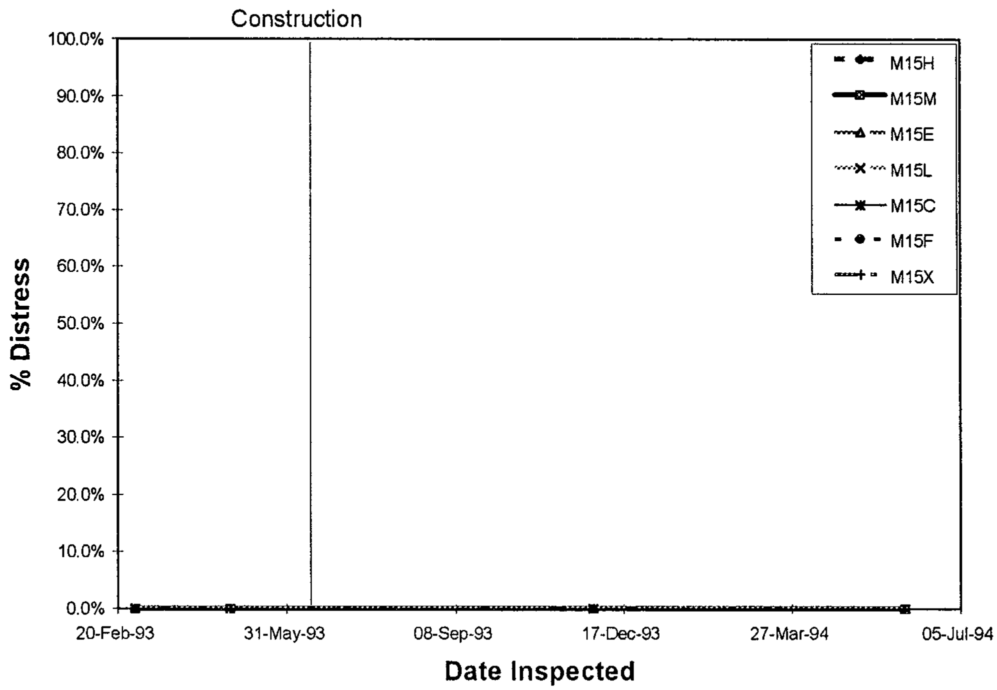


Figure A-73. Alligator Cracking for Site M15

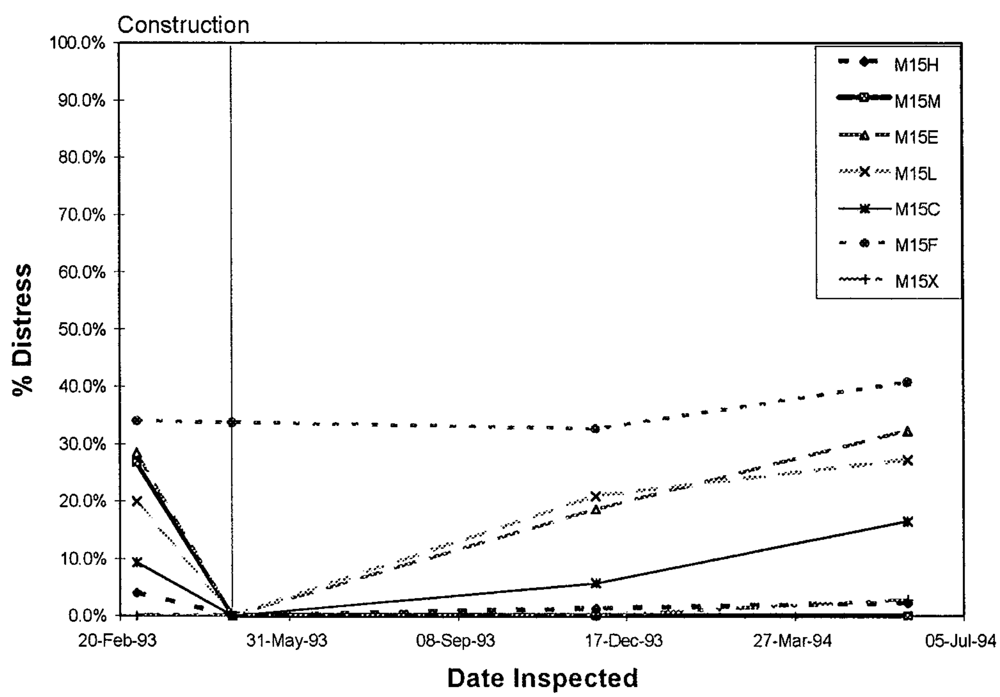


Figure A-74. Bleeding for Site M15

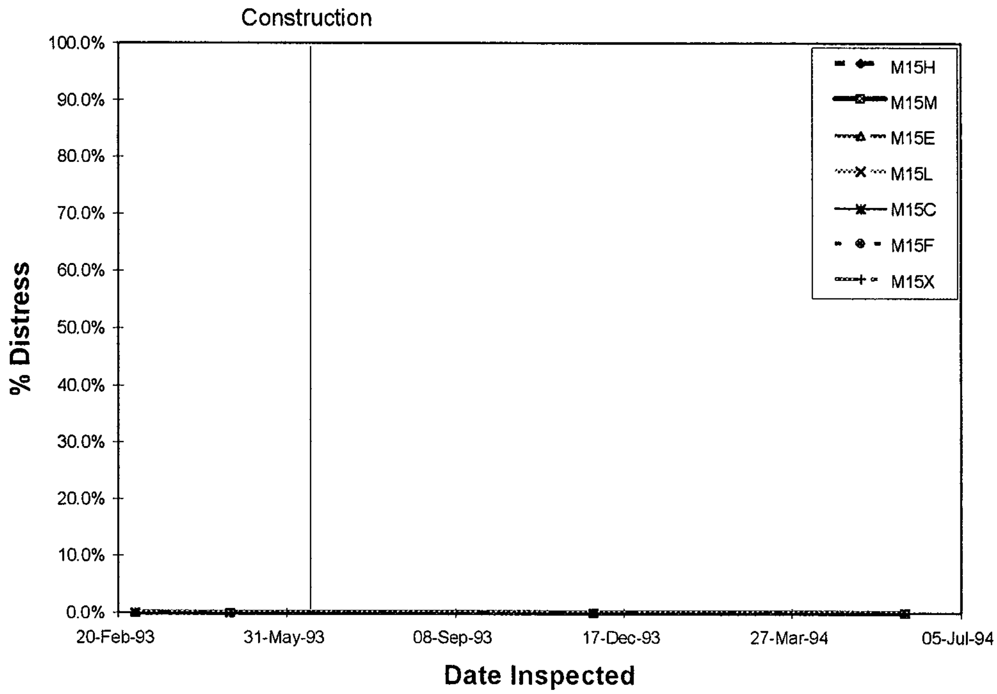


Figure A-75. Block Cracking for Site M15

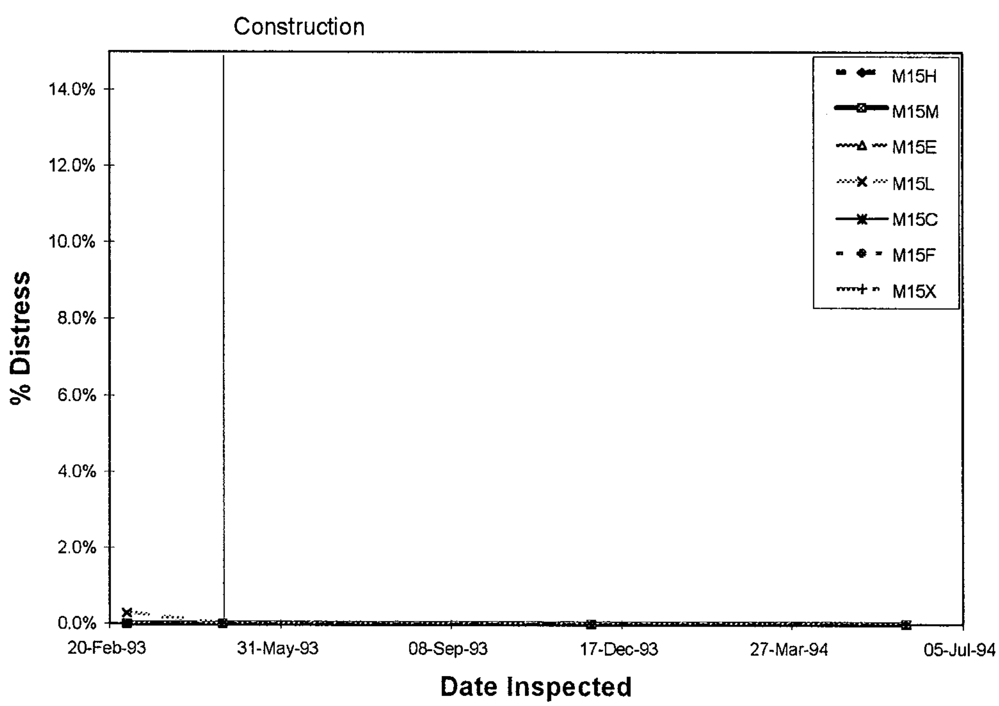


Figure A-76. Longitudinal and Transverse Cracking for Site M15

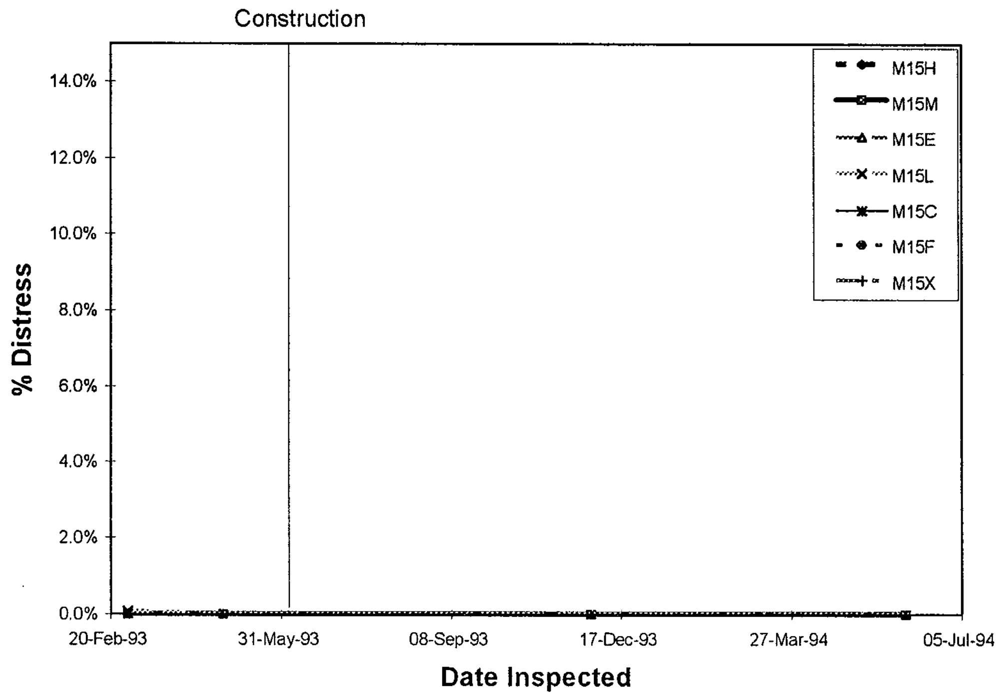


Figure A-77. Longitudinal Cracking in the Wheelpaths for Site M15

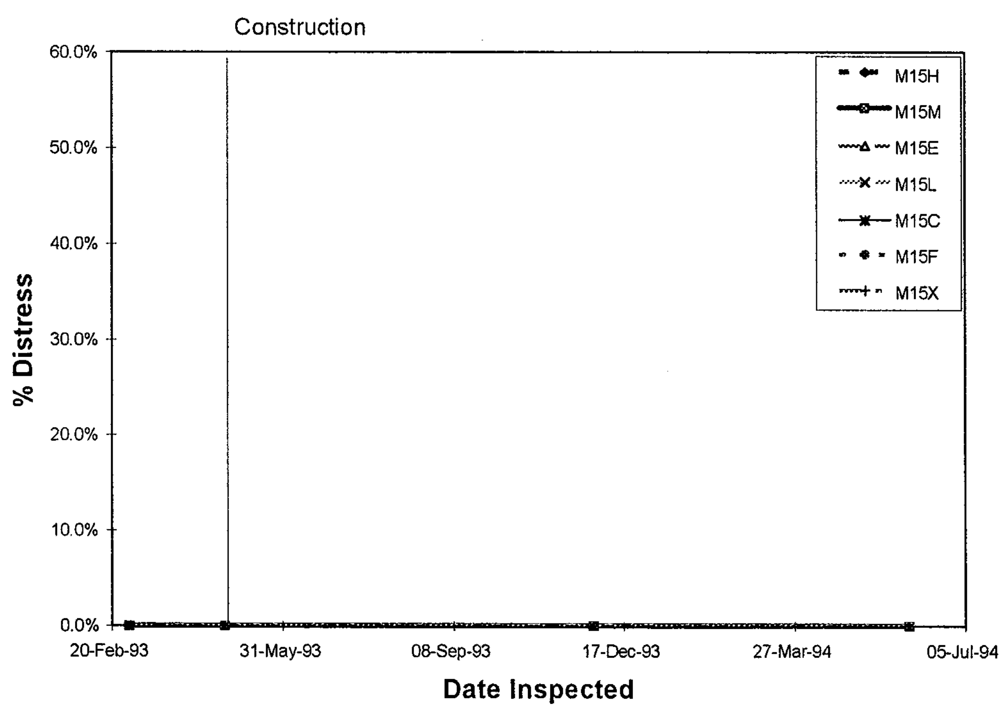


Figure A-78. Ravelling for Site M15

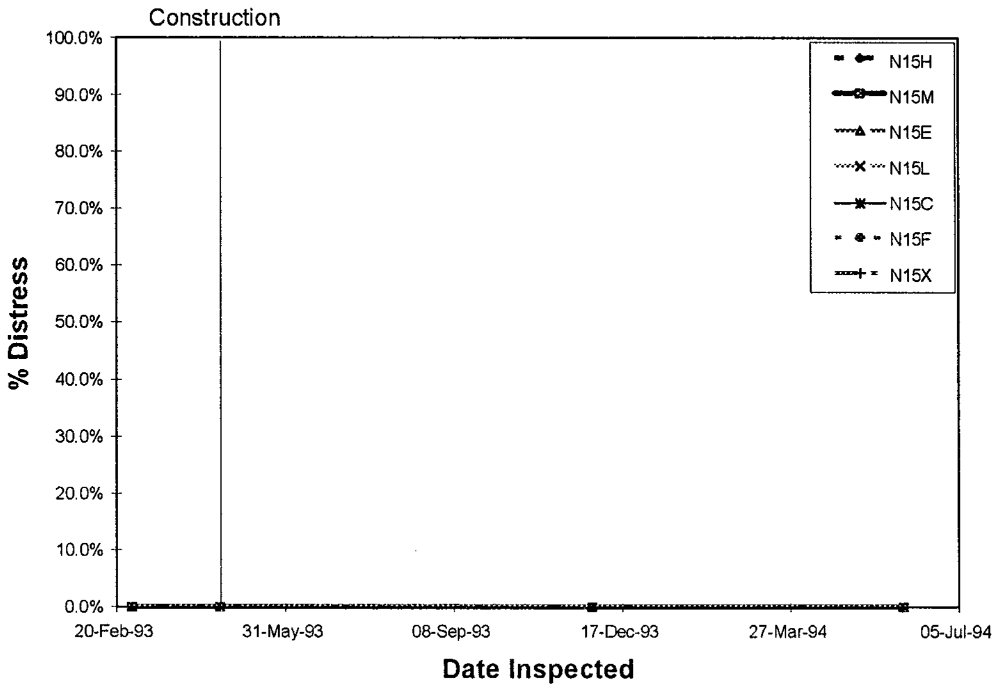


Figure A-79. Alligator Cracking for Site N15

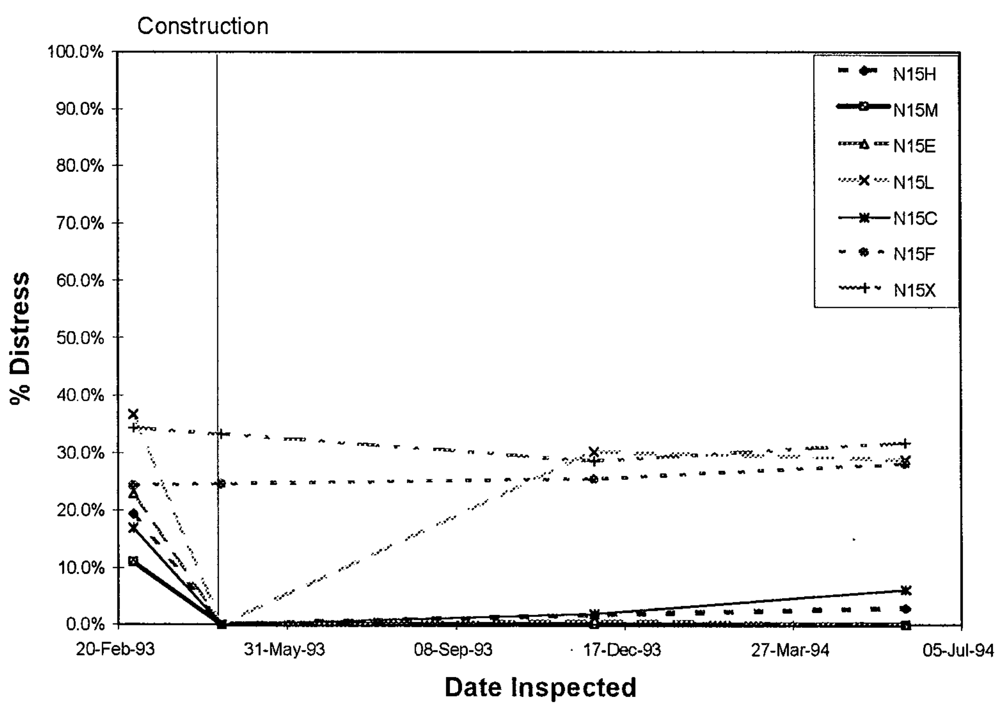


Figure A-80. Bleeding for Site N15

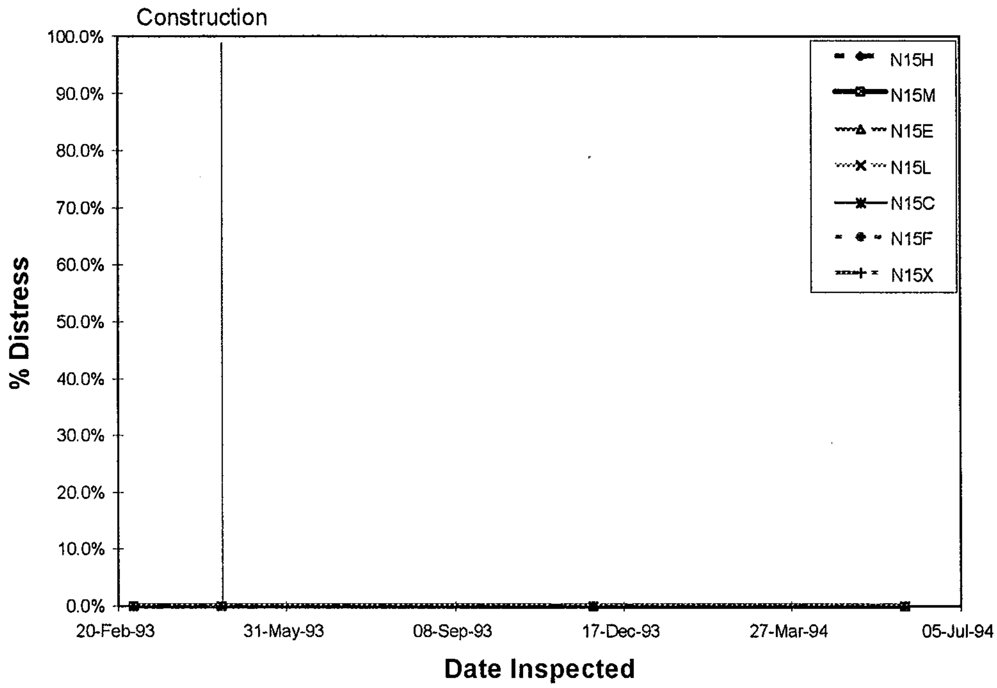


Figure A-81. Block Cracking for Site N15

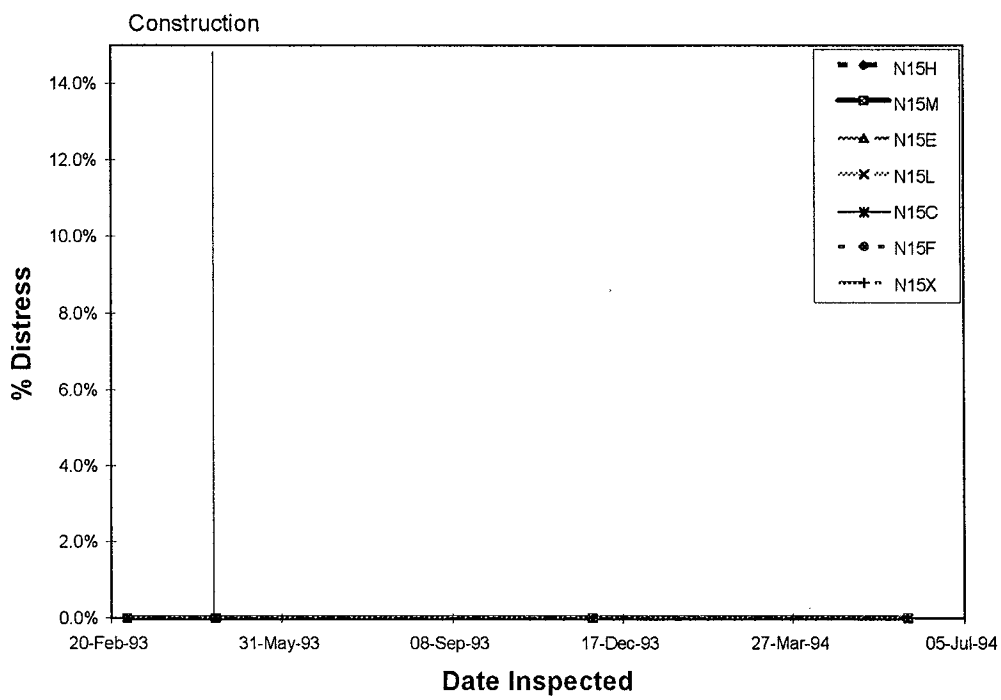


Figure A-82. Longitudinal and Transverse Cracking for Site N15

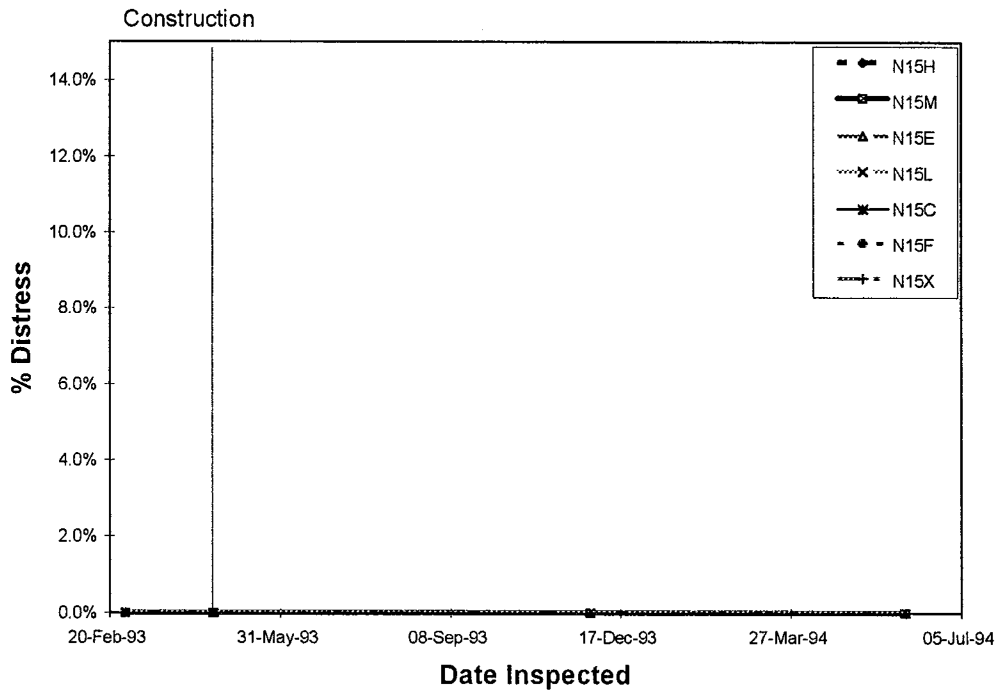


Figure A-83. longitudinal Cracking in the Wheelpaths for Site N15

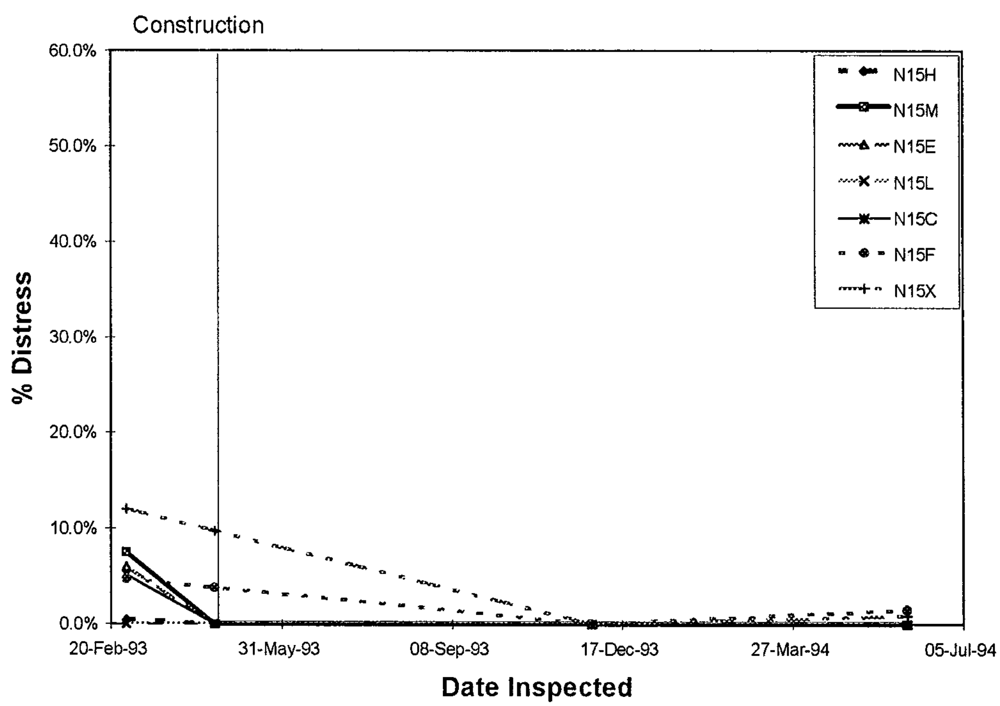


Figure A-84. Ravelling for Site N15

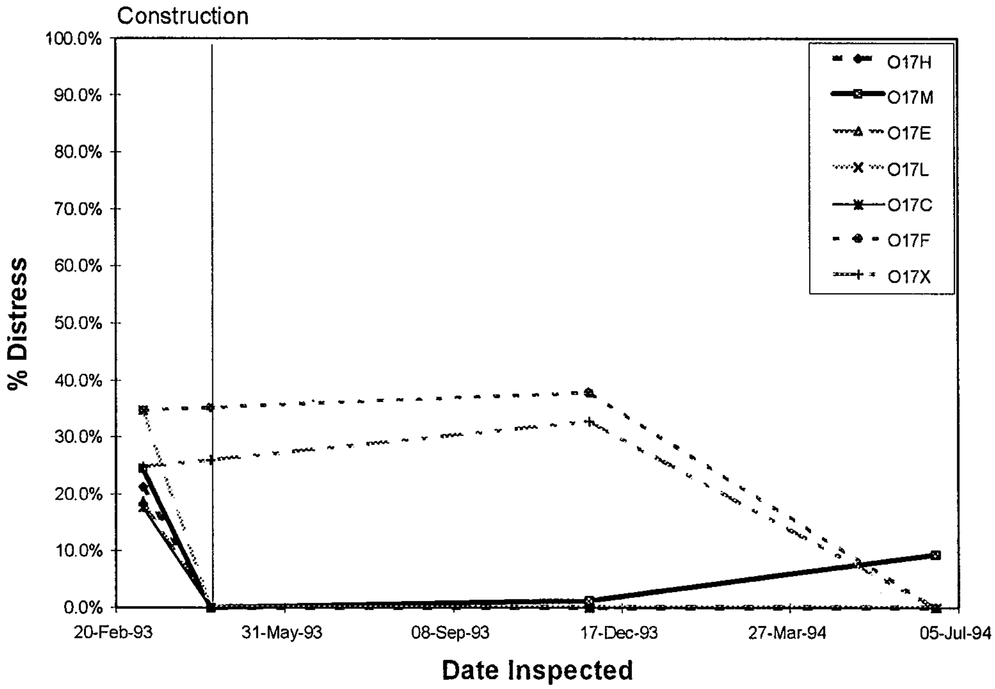


Figure A-85. Alligator Cracking for Site)17

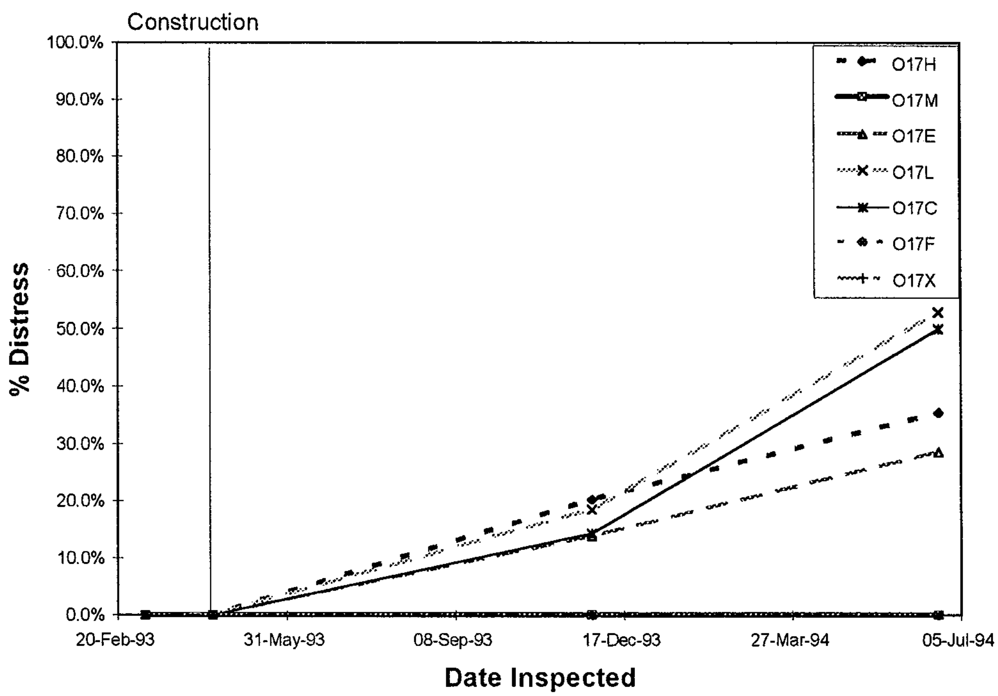


Figure A-86. Bleeding for Site O17

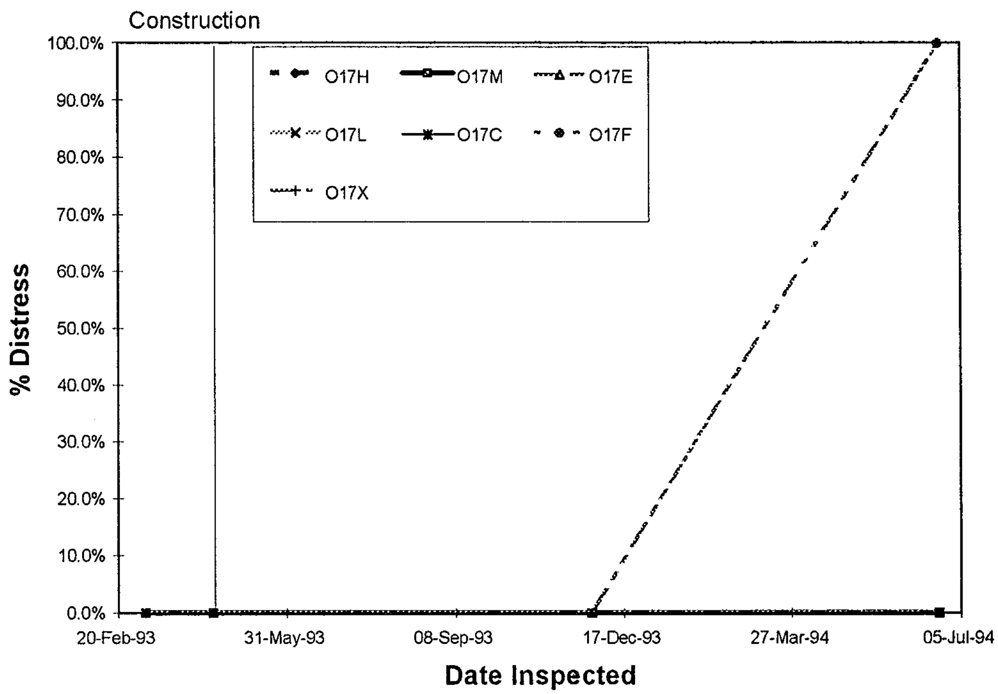


Figure A-87. Block Cracking for Site O17

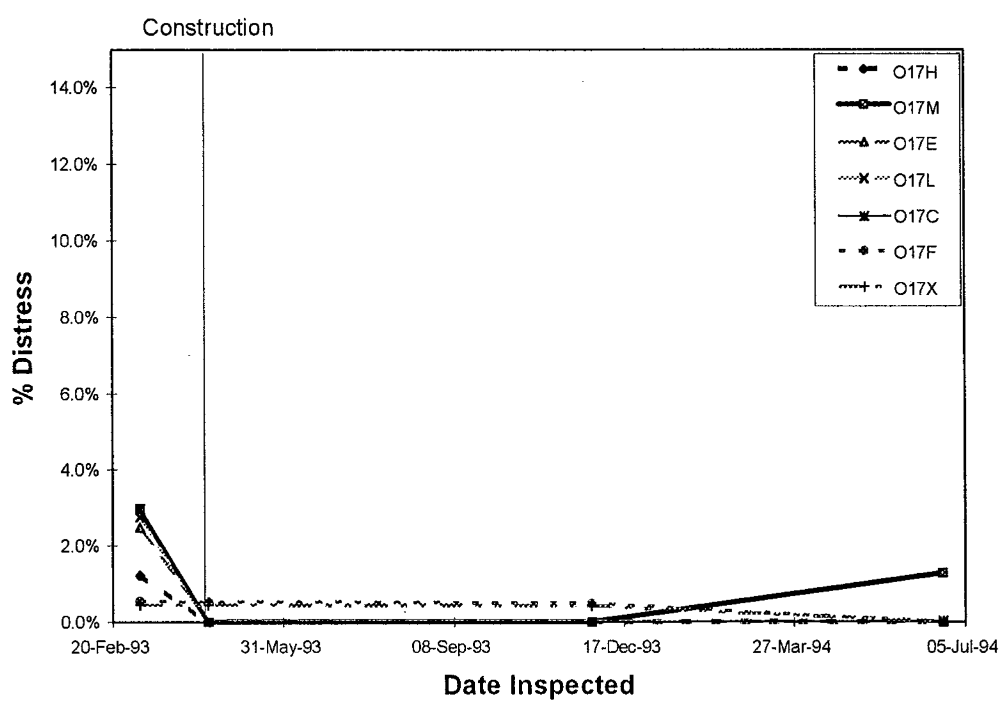


Figure A-88. Longitudinal and Transverse Cracking for Site O17

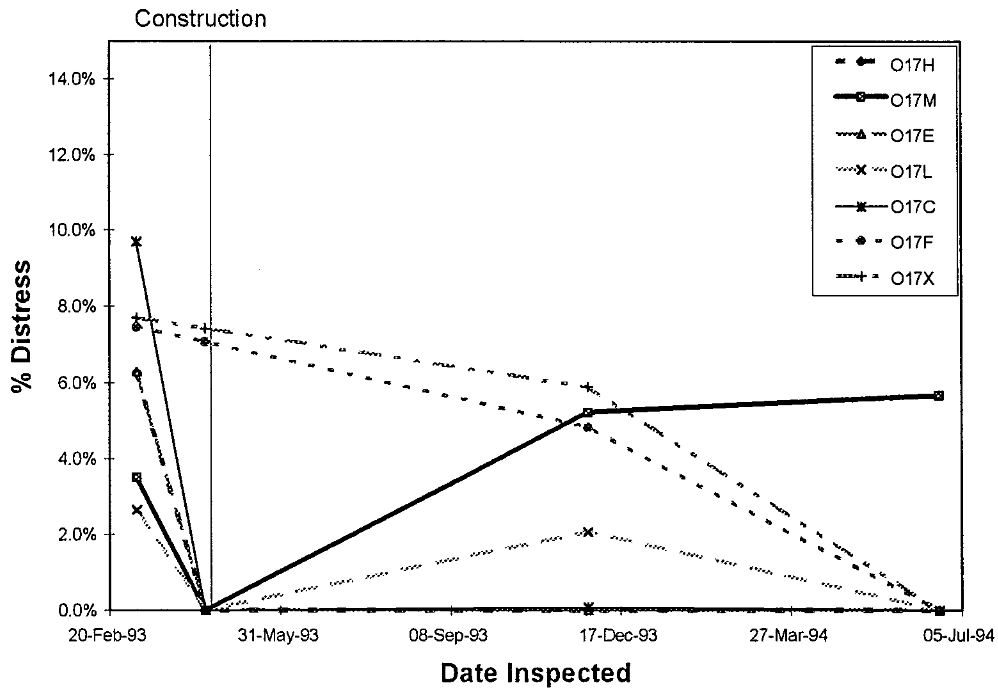


Figure A-89. Longitudinal Cracking in the Wheelpaths for Site O17

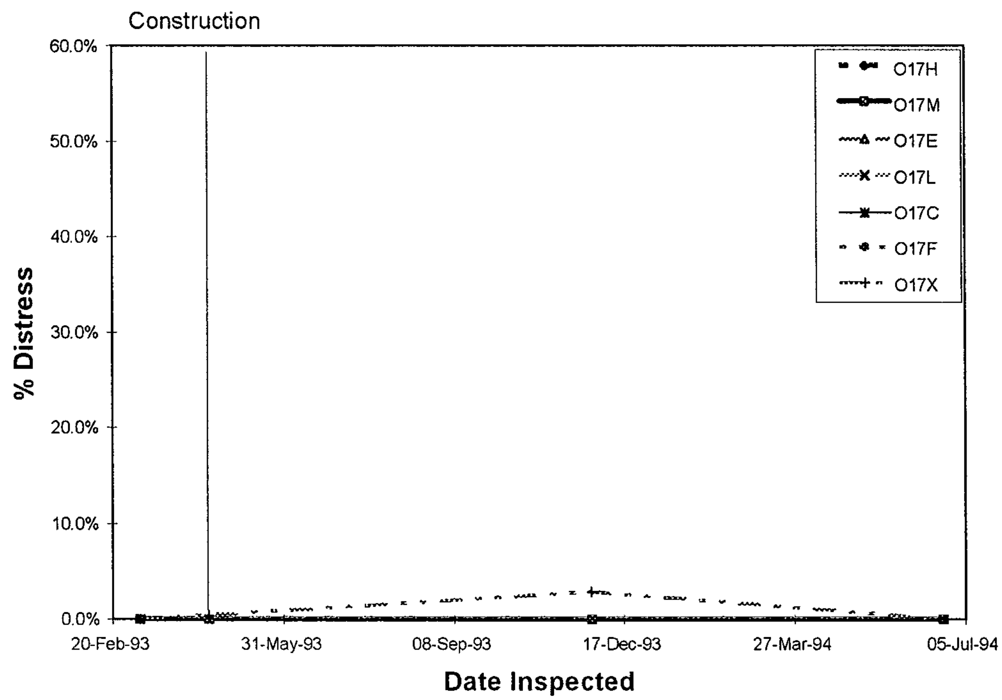


Figure A-90. Ravelling for Site O17

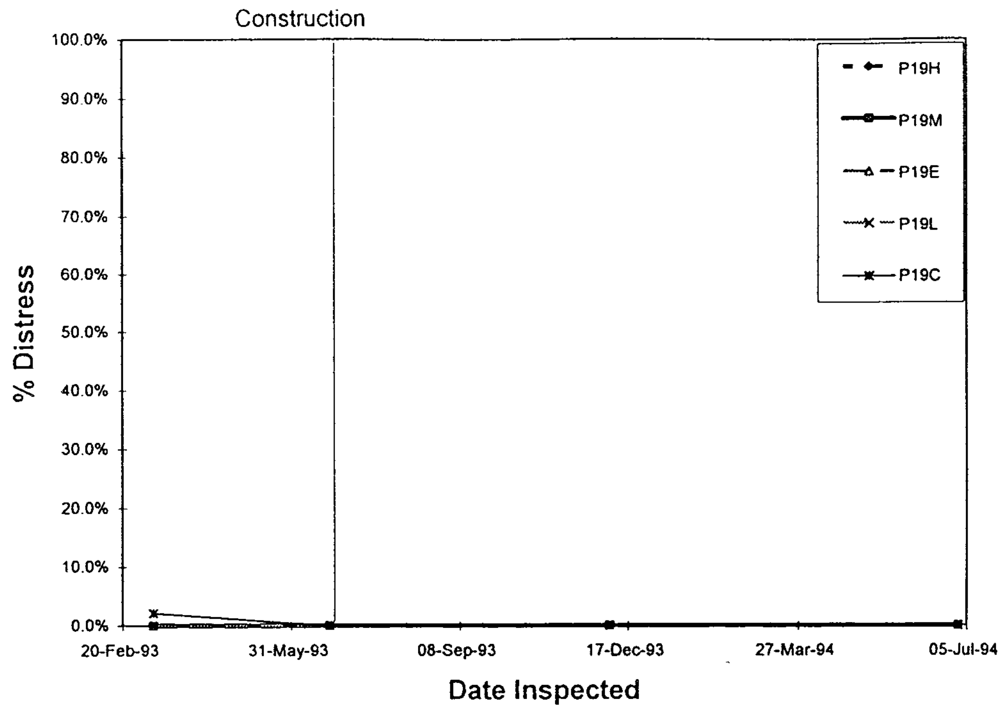


Figure A-91. Alligator Cracking for Site P19

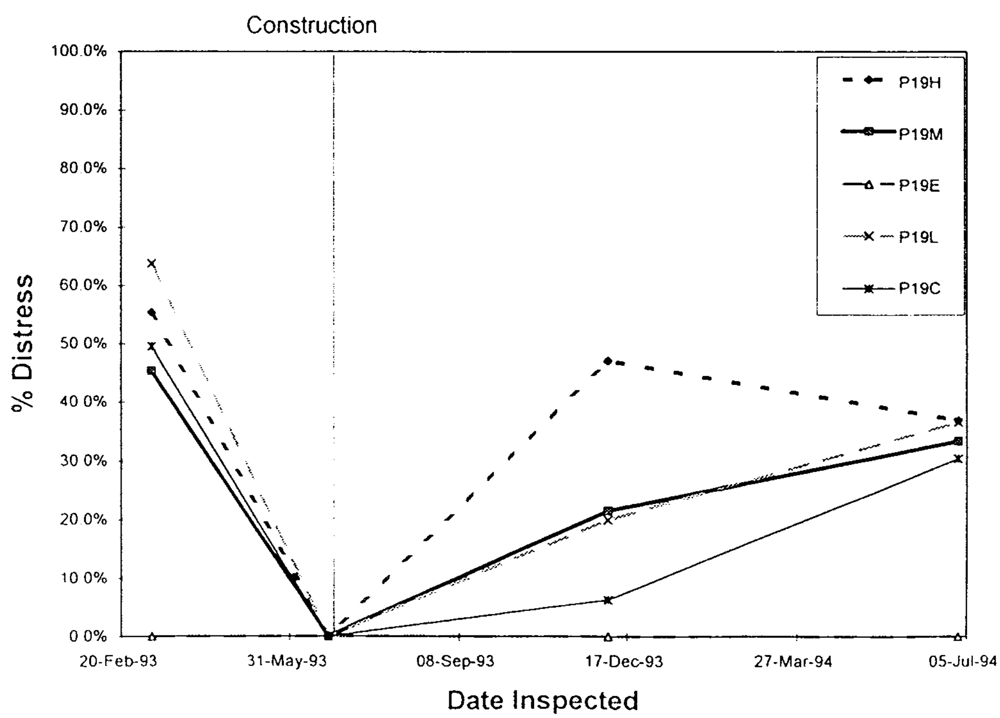


Figure A-92. Bleeding for Site P19

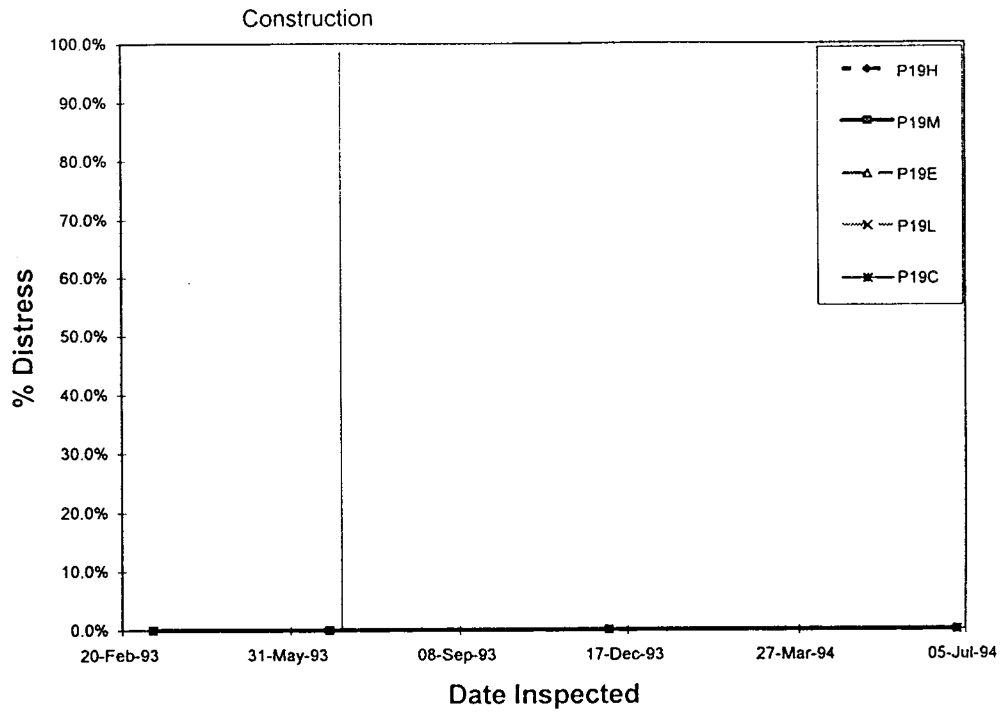


Figure A-93. Block Cracking for Site P19

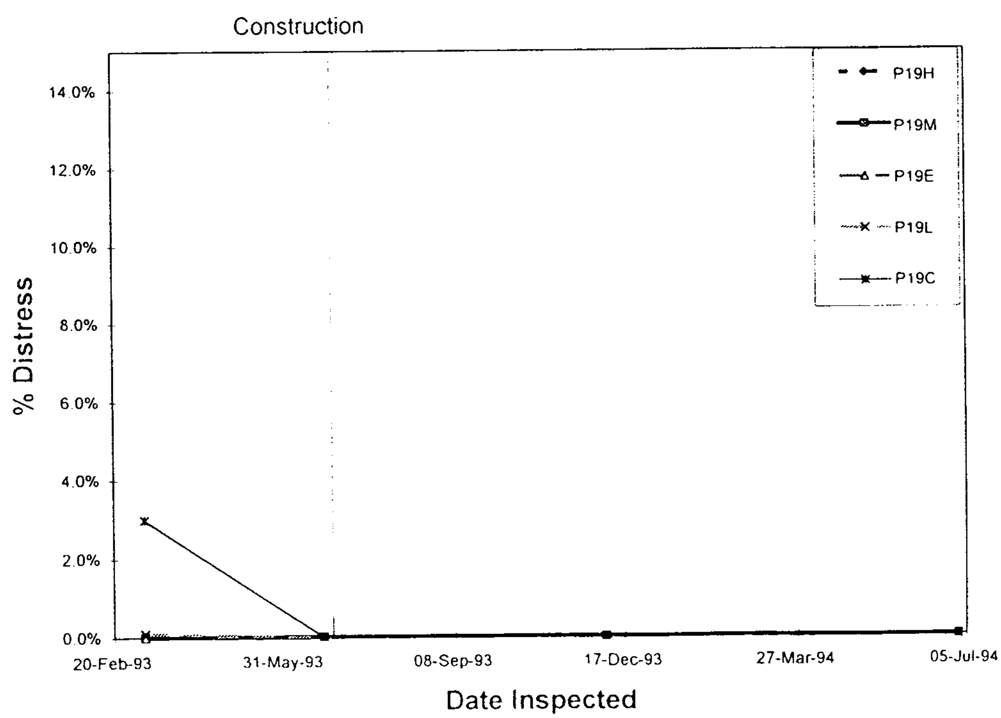


Figure A-94. Longitudinal and Transverse Cracking for Site P19

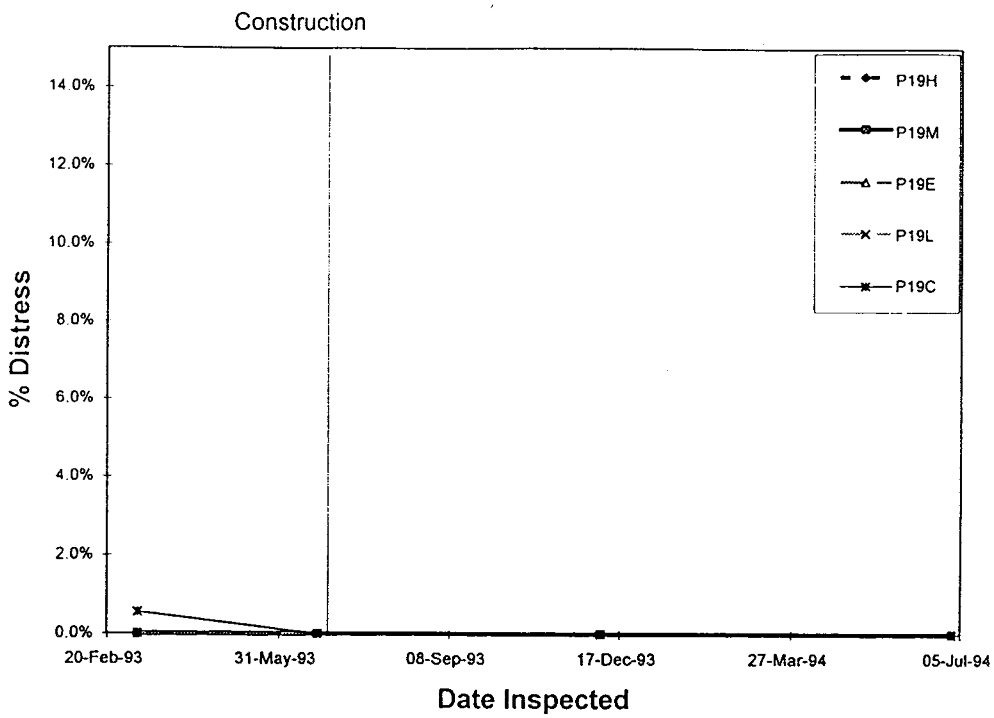


Figure A-95. Longitudinal Cracking in the Wheelpaths for Site P19

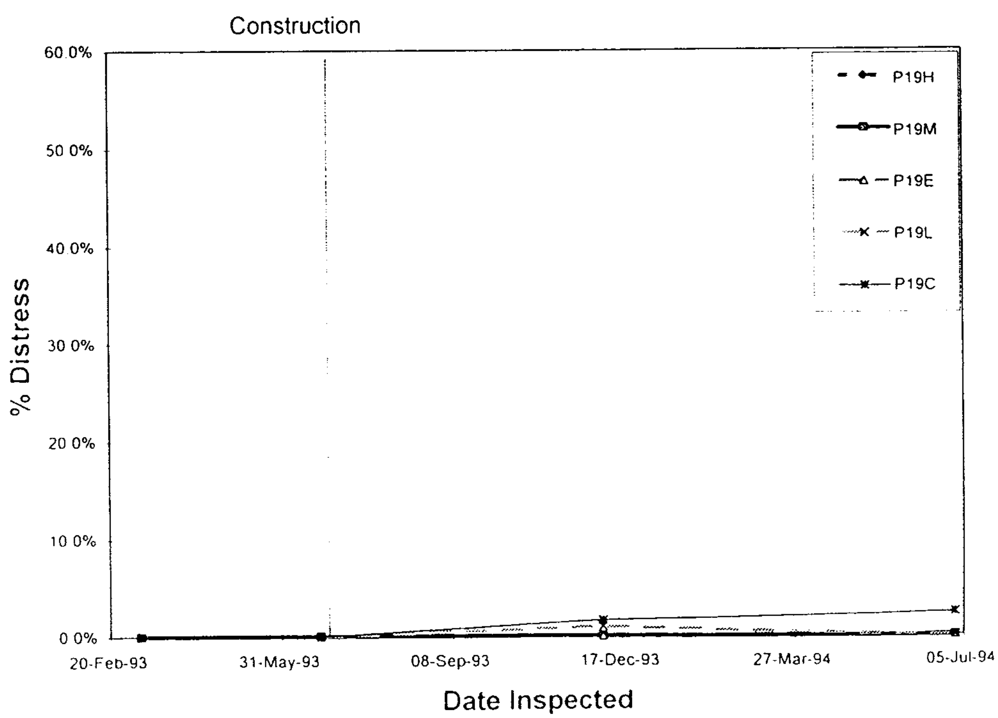


Figure A-96. Ravelling for Site P19

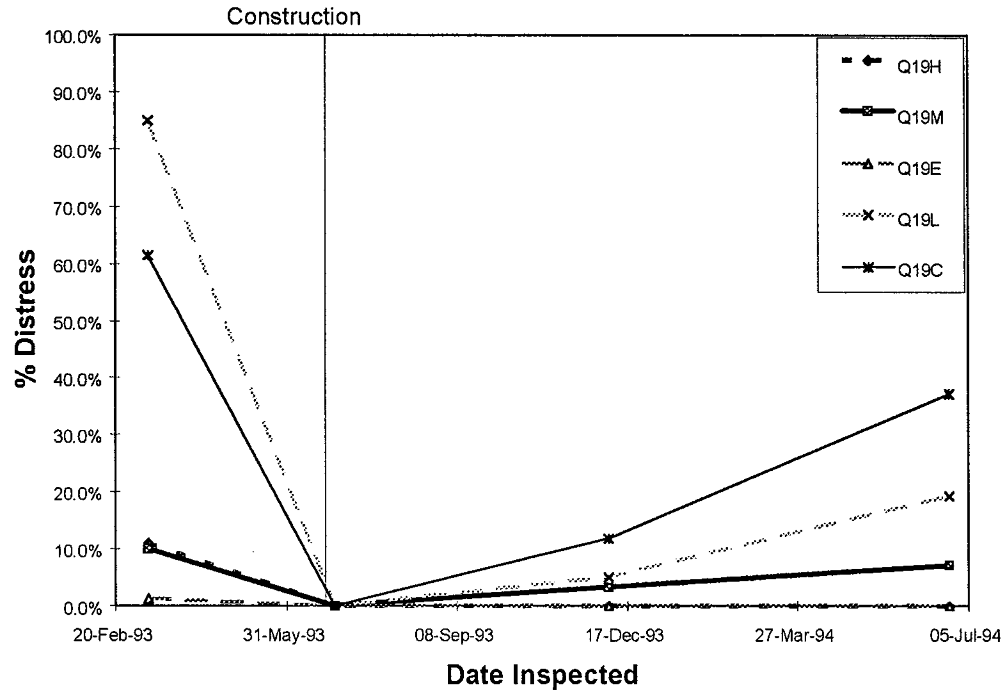


Figure A-97. Alligator Cracking for Site Q19

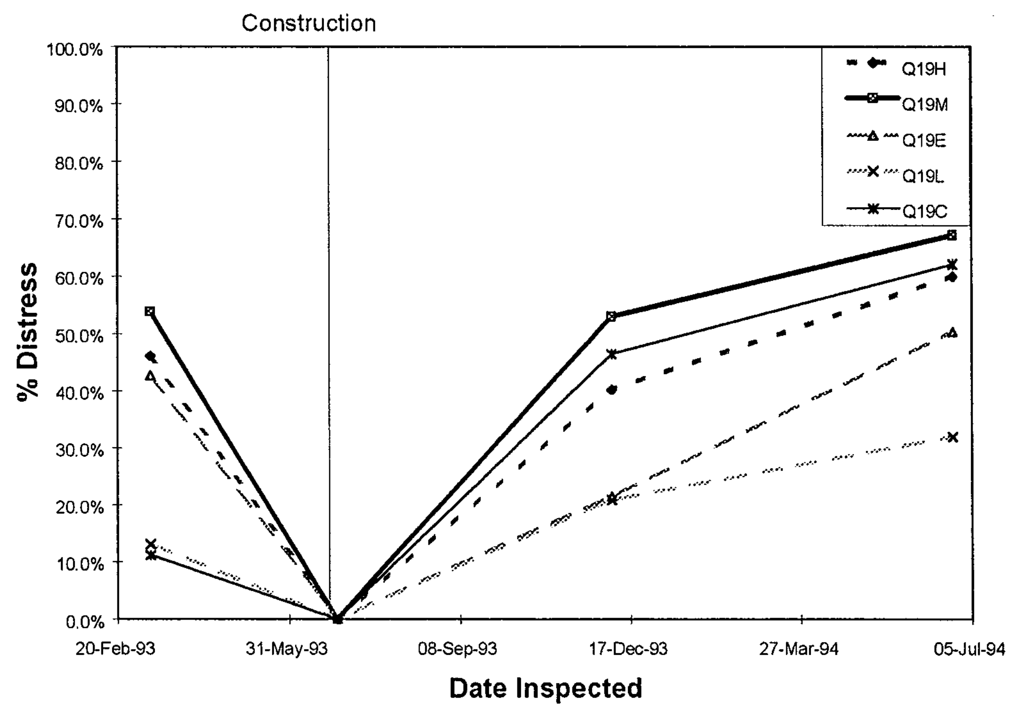


Figure A-98. Bleeding for Site Q19

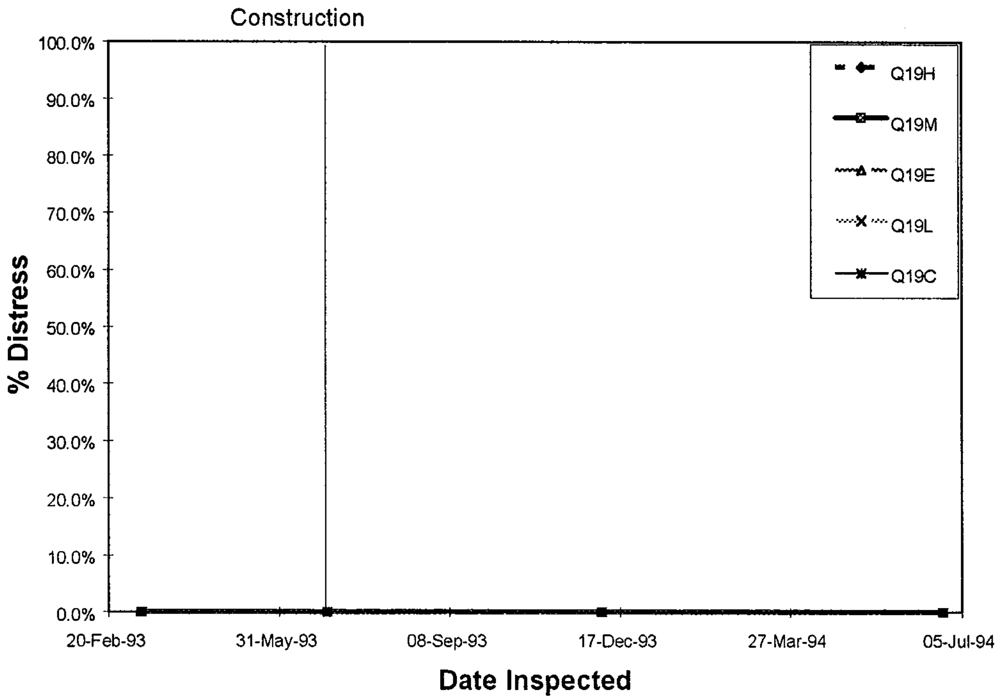


Figure A-99. Block Cracking for Site Q19

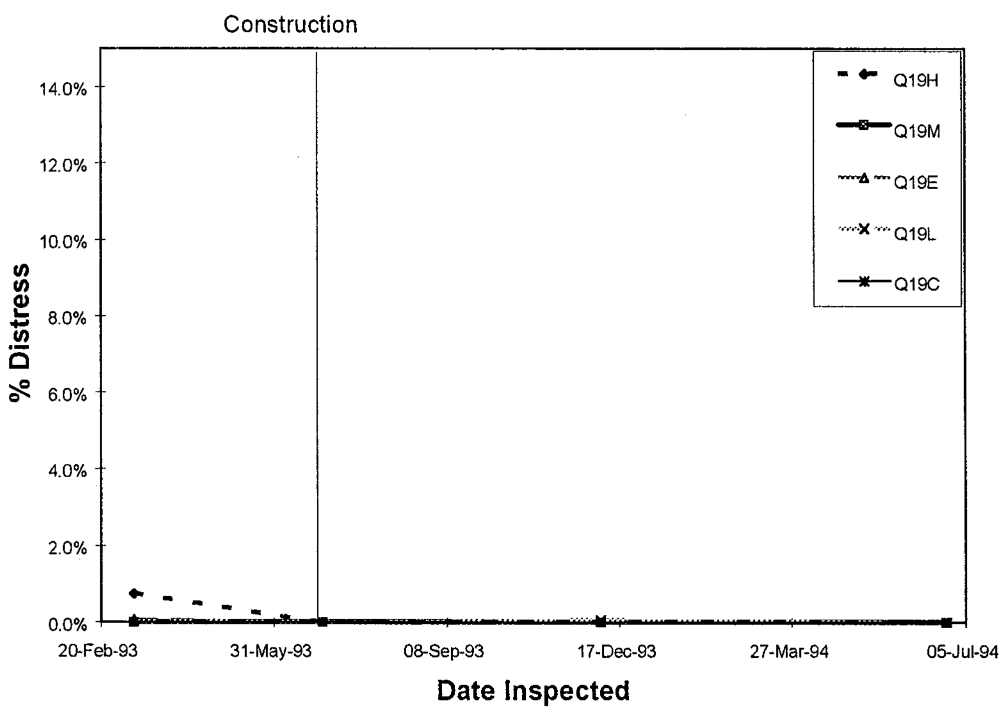


Figure A-100. Longitudinal and Transverse Cracking for Site Q19

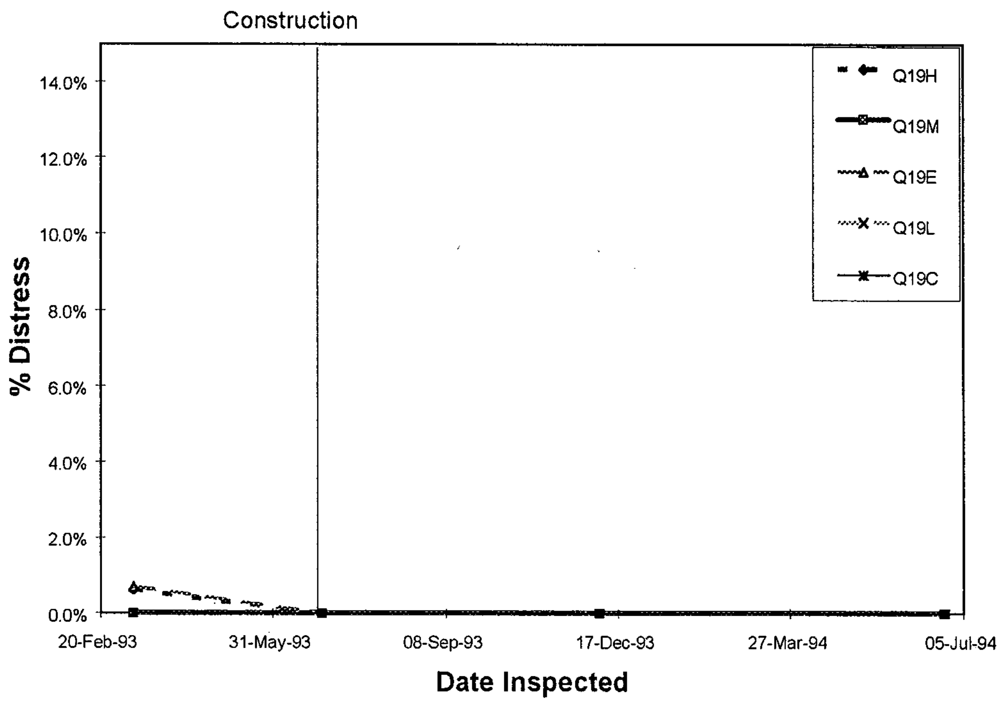


Figure A-101. Longitudinal Cracking in the Wheelpaths for Site Q19

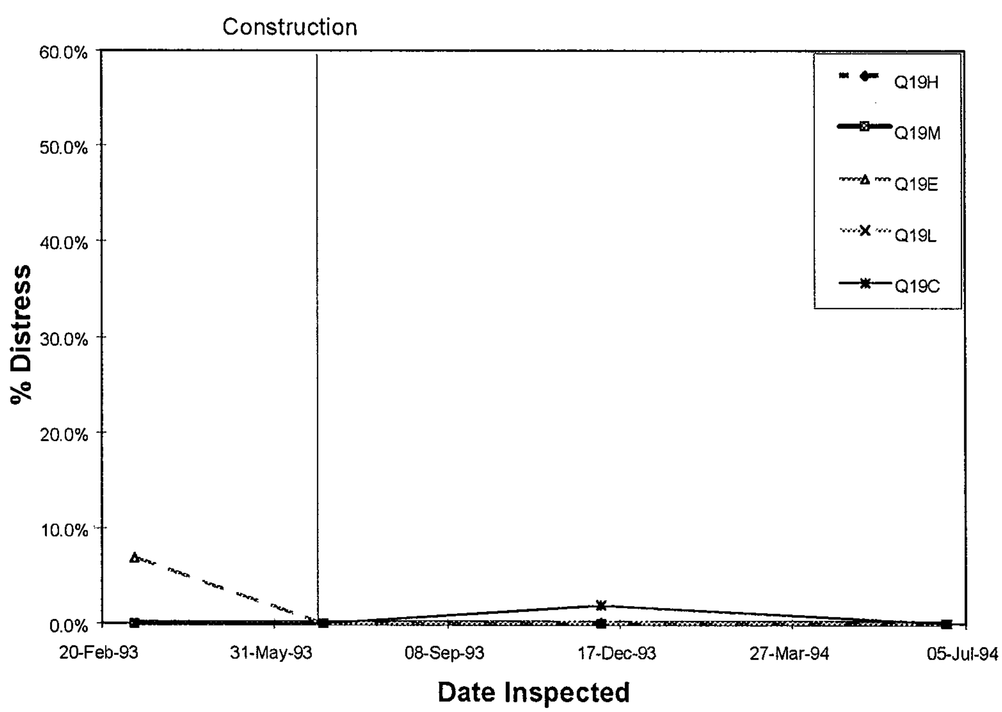


Figure A-102. Ravelling for Site Q19

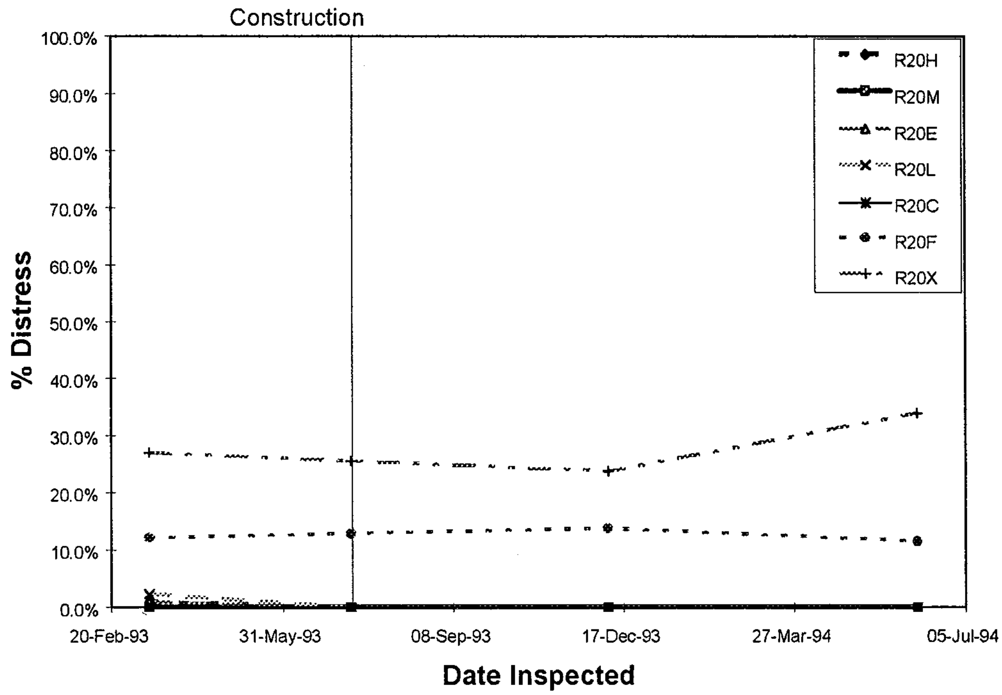


Figure A-103. Alligator Cracking for Site R20

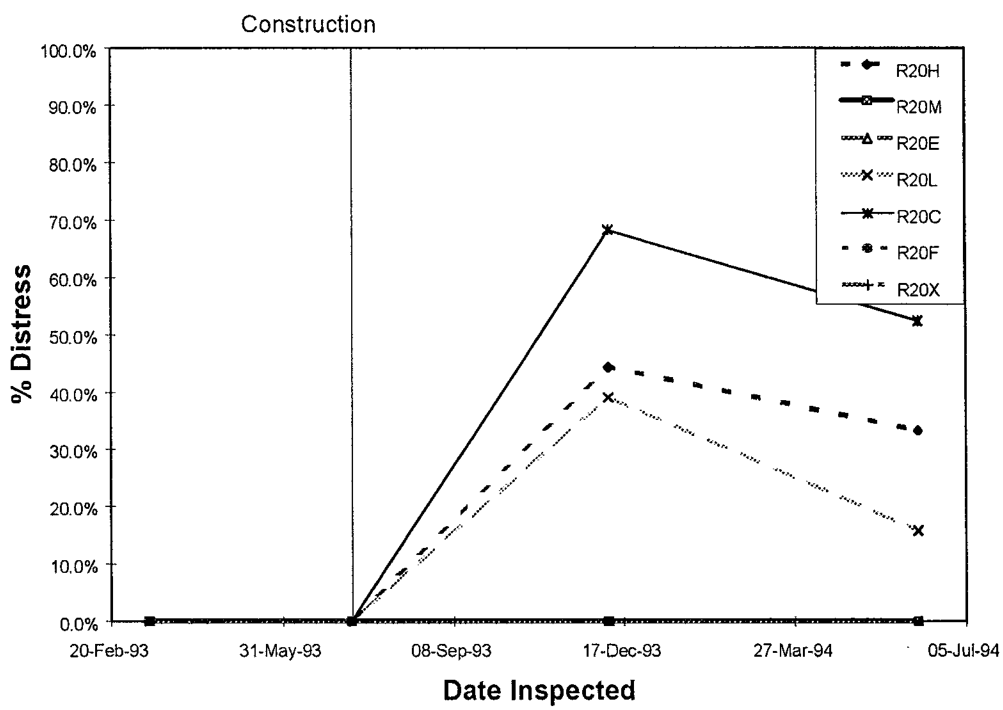


Figure A-104. Bleeding for Site R20

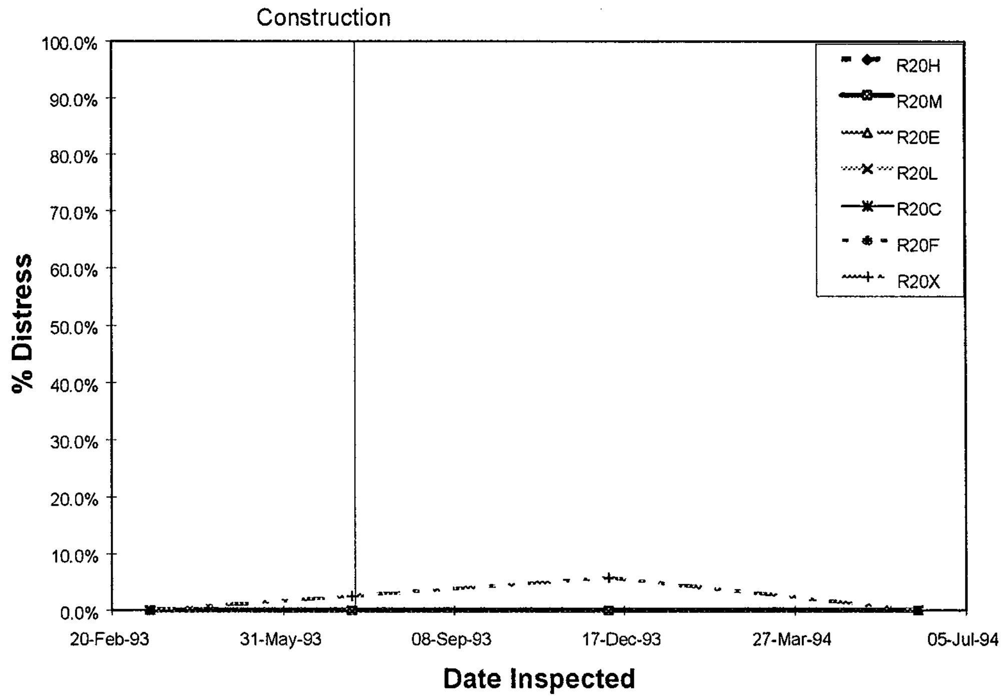


Figure A-105. Block Cracking for Site R20

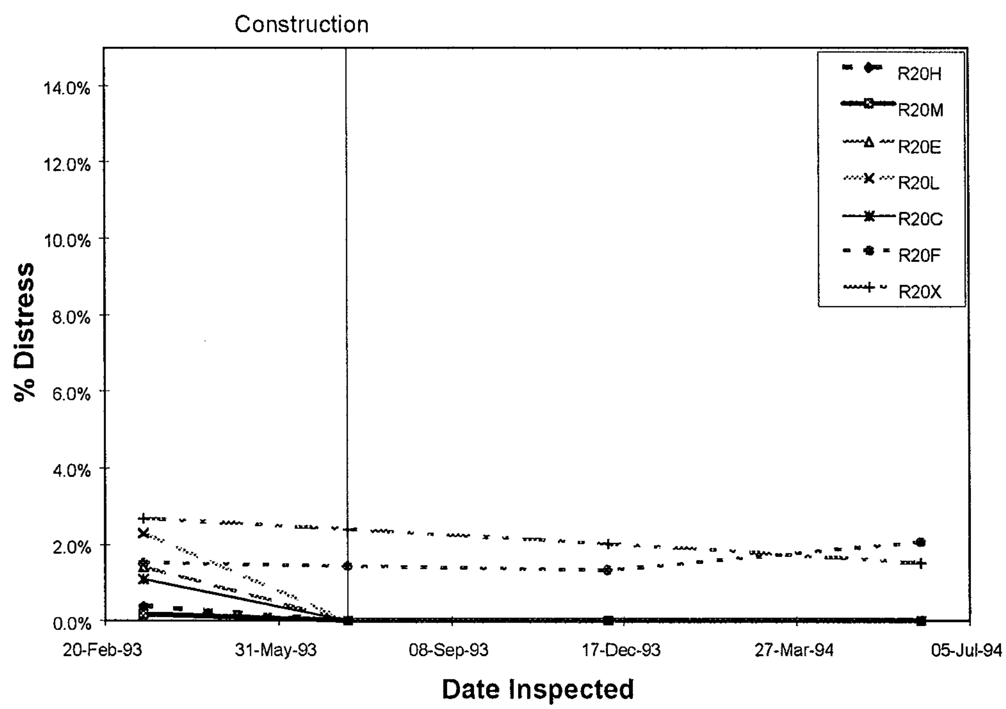


Figure A-106. Longitudinal and Transverse Cracking for Site R20

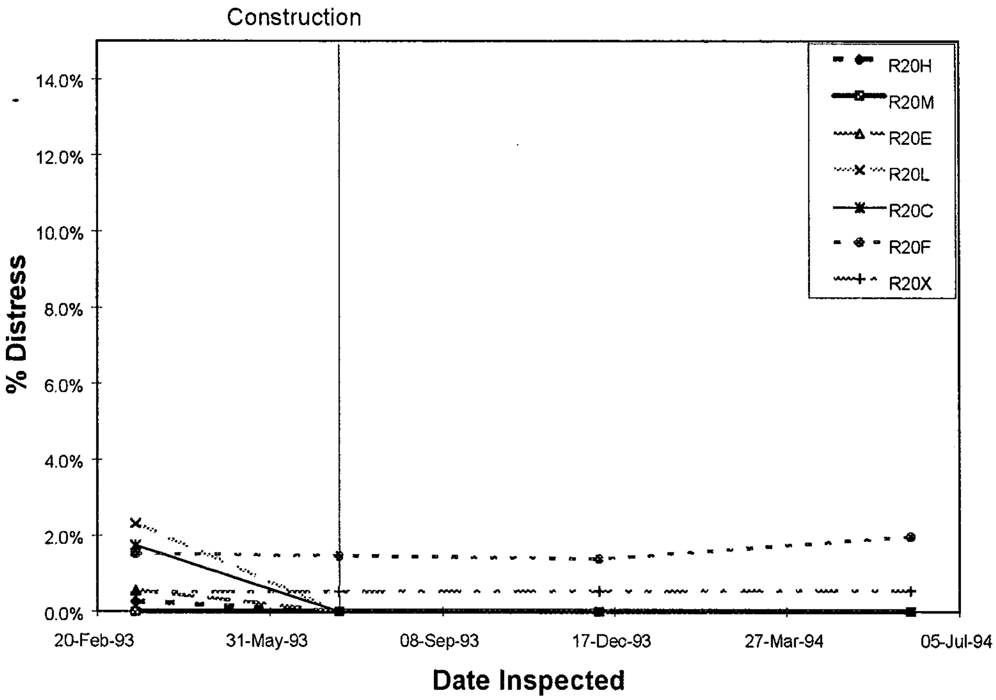


Figure A-107. Longitudinal Cracking in the Wheelpaths for Site R20

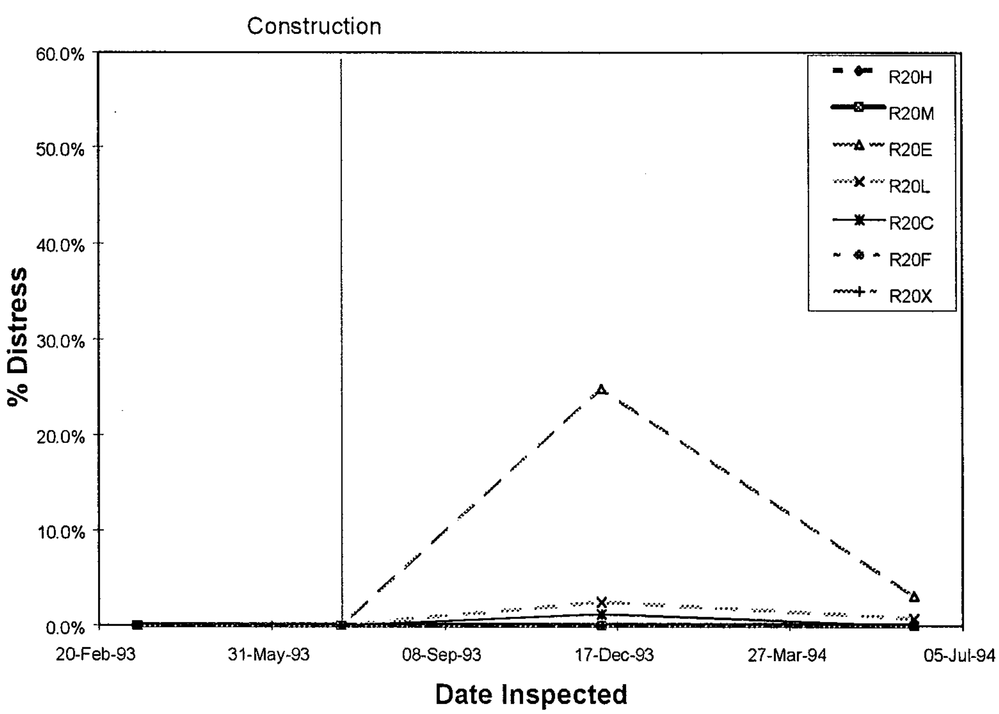


Figure A-108. Ravelling for Site R20

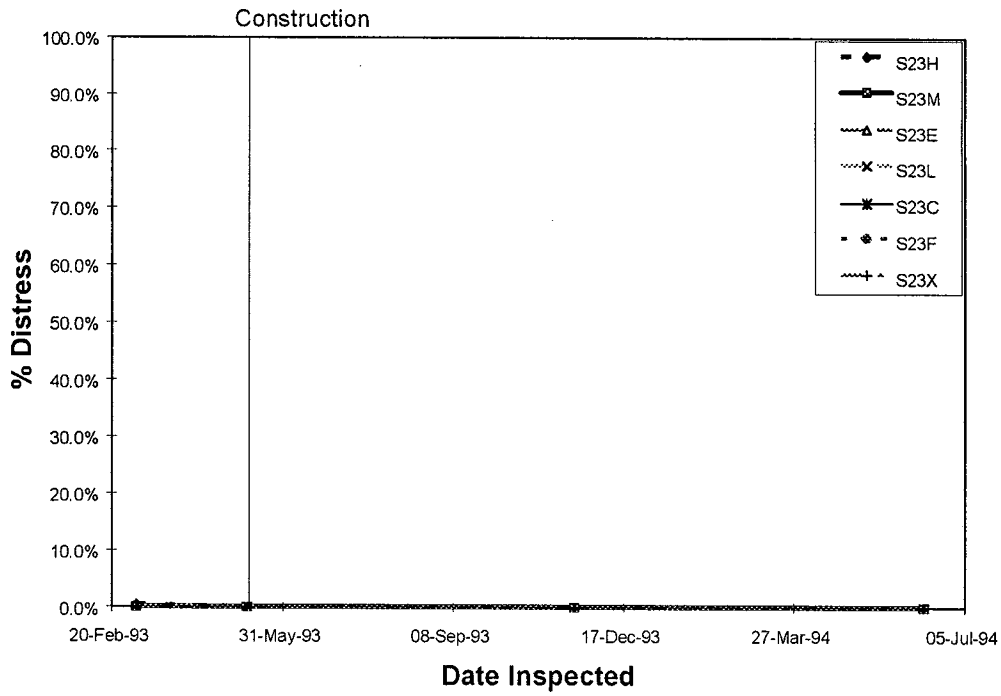


Figure A-109. Alligator Cracking for Site S23

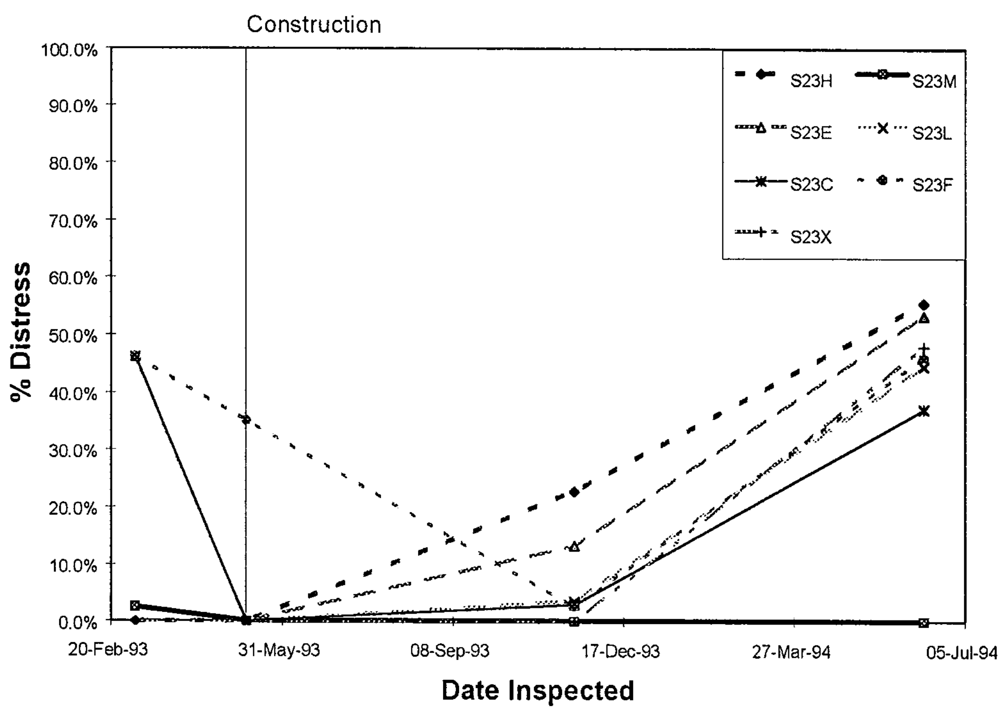


Figure A-110. Bleeding for Site S23

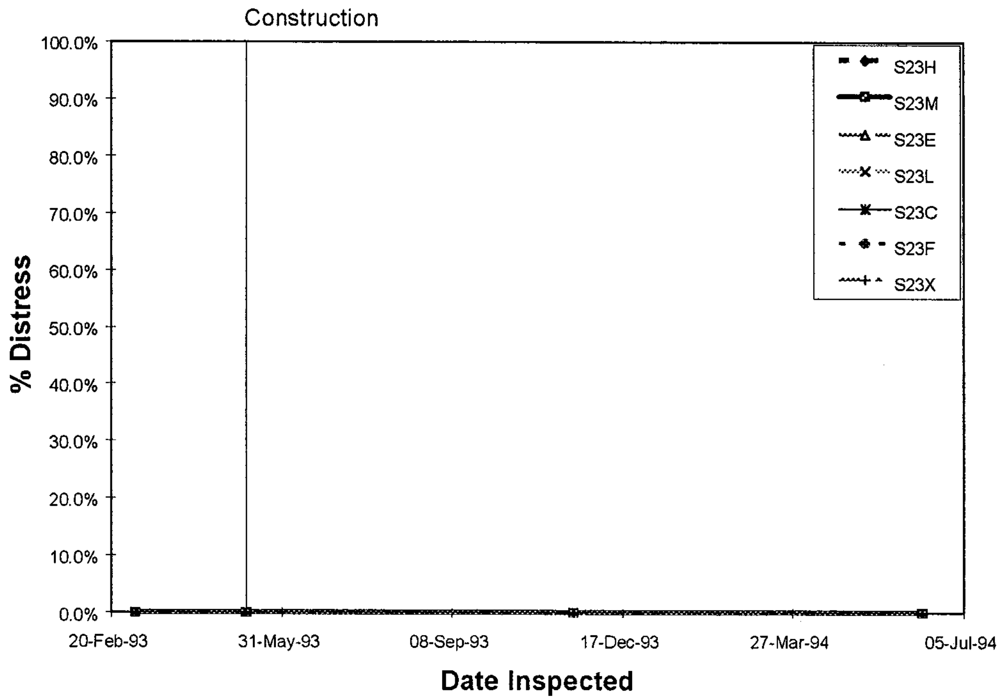


Figure A-111. Block Cracking for Site S23

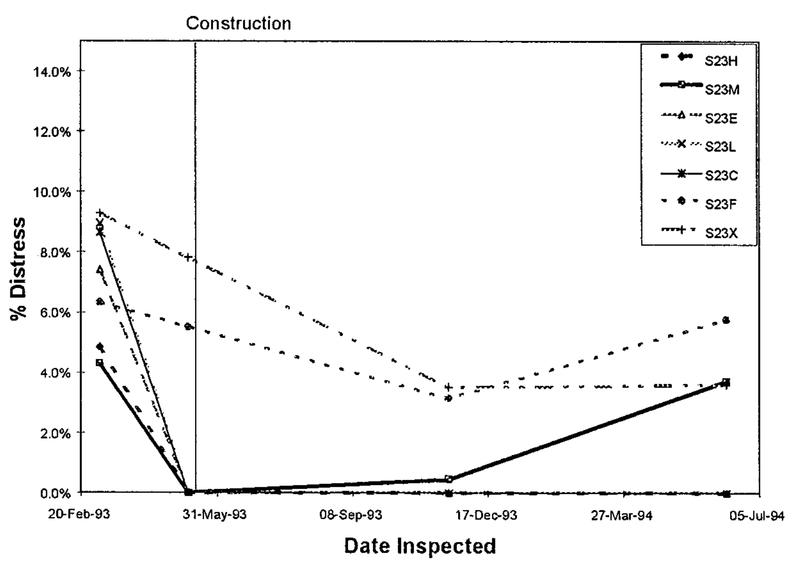


Figure A-112. Longitudinal and Transverse Cracking for Site S23

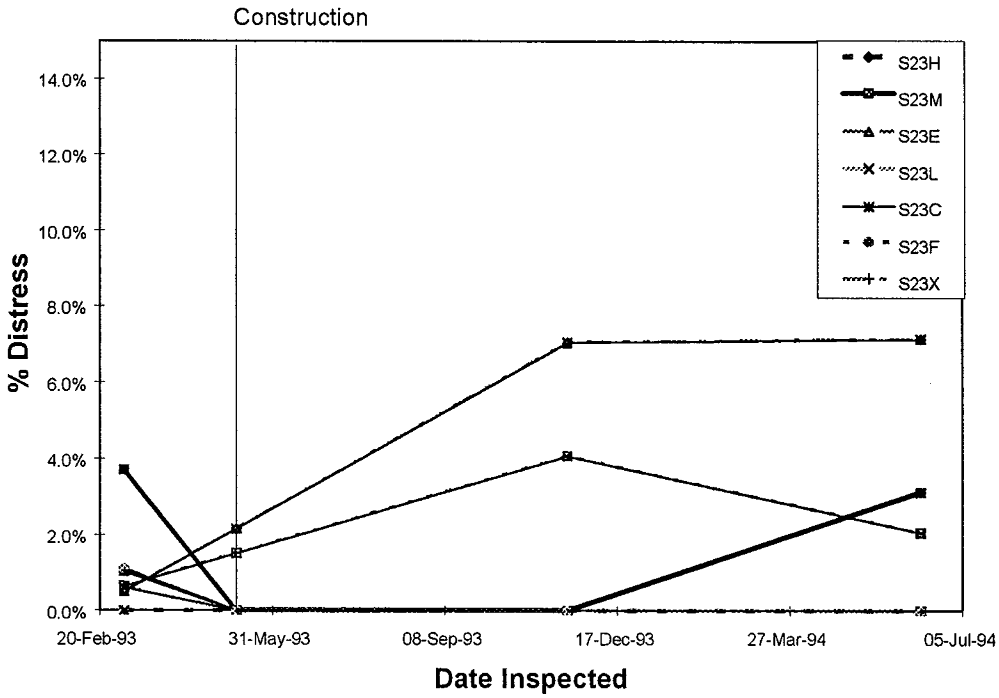


Figure A-113. Longitudinal Cracking in the Wheelpaths for Site S23

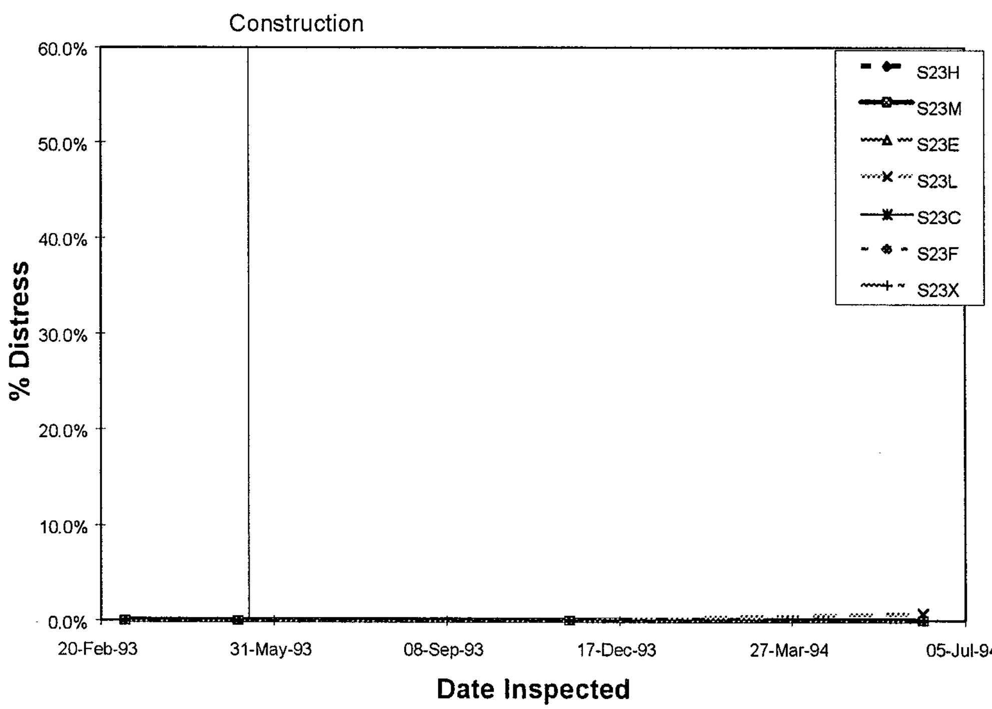


Figure A-114. Ravelling for Site S23

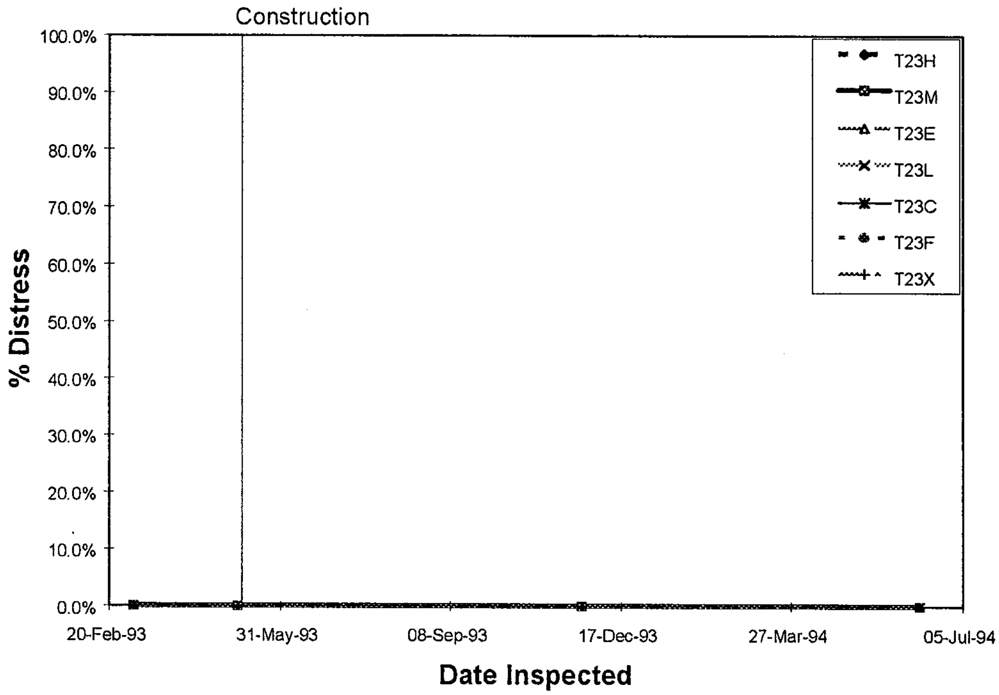


Figure A-115. Alligator Cracking for Site T23

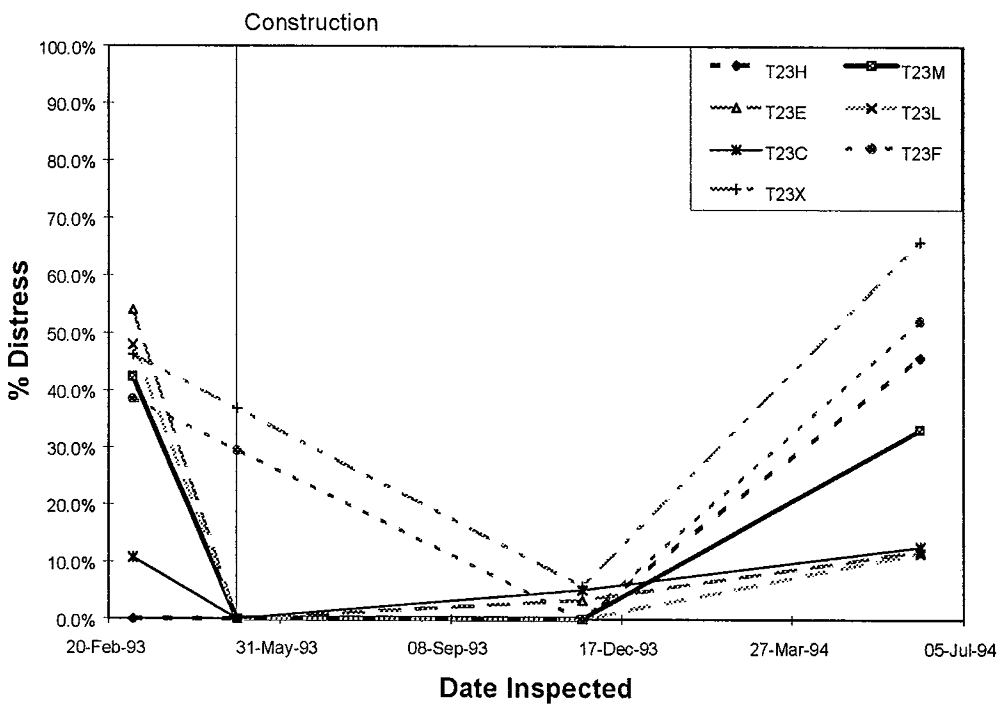


Figure A-116. Bleeding for Site T23

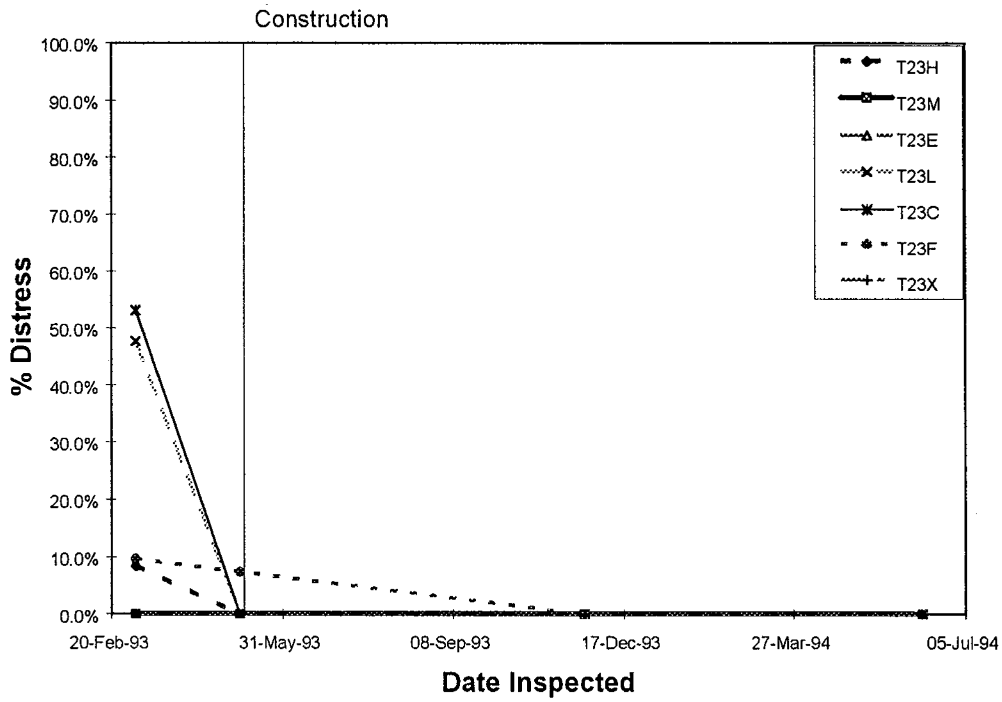


Figure A-117. Block Cracking for Site T23

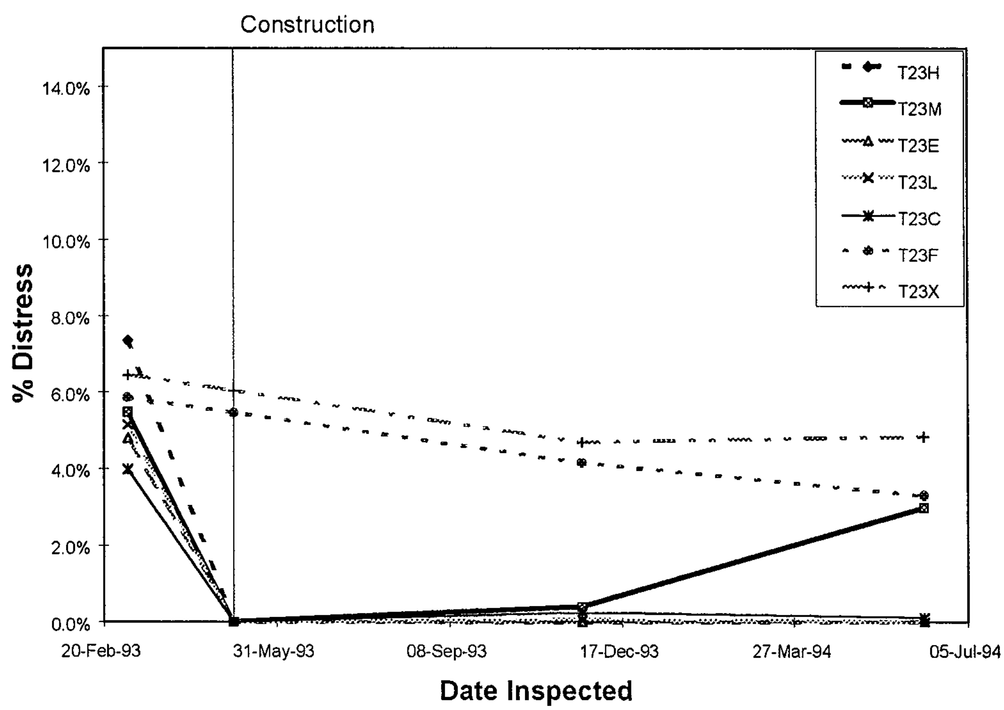


Figure A-118. Longitudinal and Transverse Cracking for Site T23

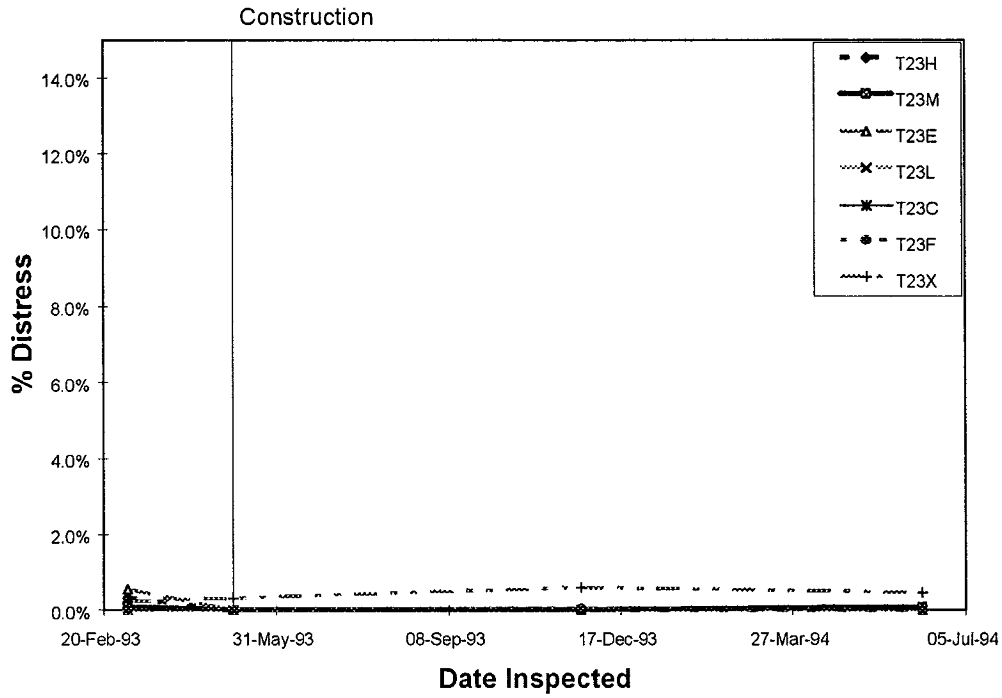


Figure A-119. Longitudinal Cracking in the Wheelpaths for Site T23

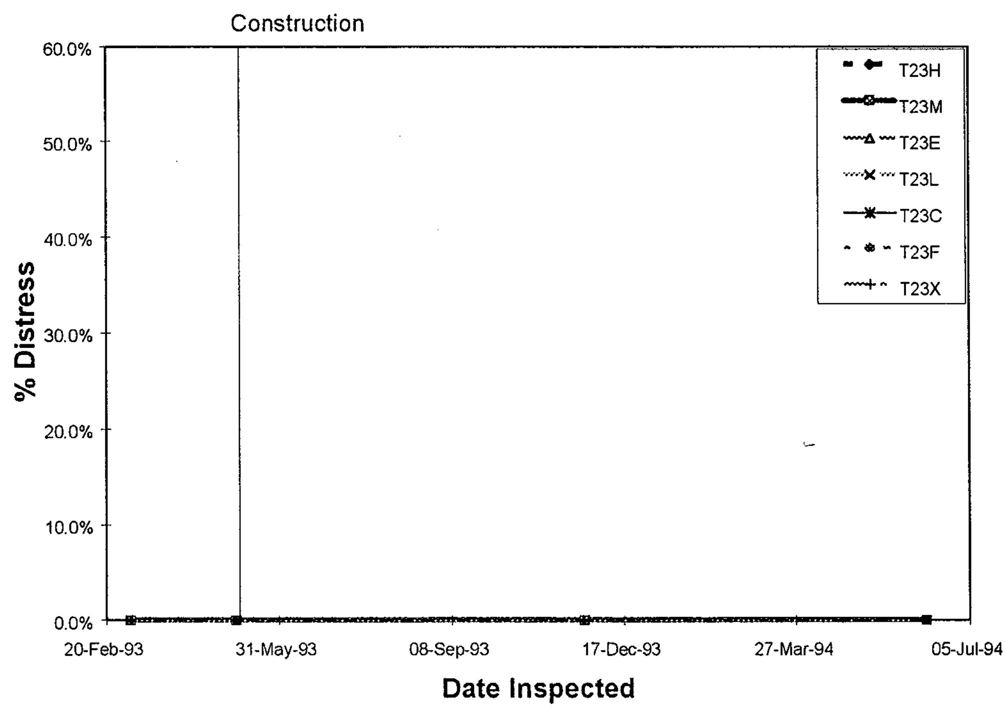


Figure A-120. Ravelling for Site T23