

TG 340
.F54
2004

FIELD PERFORMANCE OF *SURTREAT* TPS A SURFACE APPLIED, PENETRATING CORROSION INHIBITOR

Construction Report
March, 2004

Daniel Q. Humphrey
Research Project Manager

Gary Williams, P.E.
Engineering Manager



Planning & Research Division
Oklahoma Department of Transportation
200 N.E. 21st Street, Room 3A7
Oklahoma City, Oklahoma 73105
Telephone (405) 521-2671
FAX (405) 521-6948

TG340
.F54
2004
OKDOT
Library
C.1

42

TECHNICAL REPORT DOCUMENTATION PAGE

1. REPORT NO. FHWA OK 04(04)		2. GOVERNMENT ACCESSION NO.		3. RECIPIENT'S CATALOG NO.	
4. TITLE AND SUBTITLE Field Performance of Surtreat TPS A Surface Applied, Penetrating Corrosion Inhibitor			5. REPORT DATE March 2004		
			6. PERFORMING ORGANIZATION CODE		
7. AUTHOR(S) Daniel Q. Humphrey			8. PERFORMING ORGANIZATION REPORT		
9. PERFORMING ORGANIZATION NAME AND ADDRESS Oklahoma Department of Transportation Planning and Research Division 200 N.E. 21st Street, Room 2A2 Oklahoma City, OK 73105			10. WORK UNIT NO.		
			11. CONTRACT OR GRANT NO. Job Piece Number: 20679 (05)		
12. SPONSORING AGENCY NAME AND ADDRESS U.S. Department of Transportation Federal Highway Administration 300 N. Meridian Ave., Suite 105-S Oklahoma City, OK 73107			13. TYPE OF REPORT AND PERIOD COVERED Construction Report September 2003 - March 2004		
			14. SPONSORING AGENCY CODE		
15. SUPPLEMENTARY NOTES					
16. ABSTRACT <i>Surtreat TPS</i> penetrates into the PCC structure being treated, reacting with the cement phase of the concrete to increase hardness and compressive strength, decrease permeability, and render the concrete inert to attack and penetration by acids, bases and other aggressive chemical solutions.					
17. KEY WORDS Corrosion Inhibitor, Existing Structures, Reinforcing Steel			18. DISTRIBUTION STATEMENT No restrictions. This publication is available from The Planning and Research Division, Oklahoma DOT.		
19. SECURITY CLASSIF. (OF THIS REPORT) Unclassified		20. SECURITY CLASSIF. (OF THIS PAGE) Unclassified		21. NO. OF PAGES 42	22. PRICE

Research Div.
Library

ACKNOWLEDGMENTS

The author would like to express his appreciation to Bryan Hurst, Wilson Brewer, David Girdner, Sam Ruble, George Murray, Chuck Donovan, and Jay Herbert from the Planning & Research Division of the Oklahoma Department of Transportation in the role of researching, monitoring, and recording data during construction. Others needing to be acknowledged are Mark Majors and Walt Peters, Project Engineers for the Bridge Division with the procedures and planning of the project; Muskogee Residency for controlling the field operation; Don Olsen of Surtreat the prime contractor. A special thanks goes to Gary Williams, the Engineering Manager from Planning & Research Division that organized and developed the work plan as well as helping oversee the entire project.

The contents of this report reflect the views of the author(s) who is responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the views of the Oklahoma Department of Transportation or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation. While trade names may be used in this report, it is not intended as an endorsement of any machine, contractor, process, or products.

SI (METRIC) CONVERSION FACTORS

<i>Approximate Conversions to SI Units</i>					<i>Approximate Conversions from SI Units</i>				
Symbol	When you know	Multiply by	To Find	Symbol	Symbol	When you know	Multiply by	To Find	Symbol
LENGTH					LENGTH				
in	inches	25.40	millimeters	mm	mm	millimeters	0.0394	inches	in
ft	feet	0.3048	meters	m	m	meters	3.281	feet	ft
yd	yards	0.9144	meters	m	m	meters	1.094	yards	yd
mi	miles	1.609	kilometers	km	km	kilometers	0.6214	miles	mi
AREA					AREA				
in ²	square inches	645.2	square millimeters	mm ²	mm ²	square millimeters	0.00155	square inches	in ²
ft ²	square feet	0.0929	square meters	m ²	m ²	square meters	10.764	square feet	ft ²
yd ²	square yards	0.8361	square meters	m ²	m ²	square meters	1.196	square yards	yd ²
ac	acres	0.4047	hectares	ha	ha	hectares	2.471	acres	ac
mi ²	square miles	2.590	square kilometers	km ²	km ²	square kilometers	0.3861	square miles	mi ²
VOLUME					VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL	mL	milliliters	0.0338	fluid ounces	fl oz
gal	gallon	3.785	liters	L	L	liters	0.2642	gallon	gal
ft ³	cubic feet	0.0283	cubic meters	m ³	m ³	cubic meters	35.315	cubic feet	ft ³
yd ³	cubic yards	0.7645	cubic meters	m ³	m ³	cubic meters	1.308	cubic yards	yd ³
MASS					MASS				
oz	ounces	28.35	grams	g	g	grams	0.0353	ounces	oz
lb	pounds	0.4536	kilograms	kg	kg	kilograms	2.205	pounds	lb
T	short tons (2000 lb)	0.907	megagrams	Mg	Mg	megagrams	1.1023	short tons (2000 lb)	T
TEMPERATURE (exact)					TEMPERATURE (exact)				
°F	degrees Fahrenheit	(°F-32)1.8	degrees Celsius	°C	°C	degrees Fahrenheit	9/5(°C)+32	degrees Celsius	°F
FORCE and PRESSURE or STRESS					FORCE and PRESSURE or STRESS				
lbf	poundforce	4.448	Newtons	N	N	Newtons	0.2248	poundforce	lbf
lbf/in ²	poundforce per square inch	6.895	kilopascals	kPa	kPa	kilopascals	0.1450	poundforce per square inch	lbf/in ²

**FIELD PERFORMANCE EVALUATION OF *SURTREAT TPS*
A SURFACE APPLIED, PENETRATING CORROSION
INHIBITOR**

CONSTRUCTION REPORT

March 2004

**Daniel Q. Humphrey
Research Project Manager**

**Gary Williams, P.E.
Engineering Manager**

**Planning & Research Division
Oklahoma Department of Transportation
200 Northeast 21st Street RM 2A2
Oklahoma City, Oklahoma 73105**

TABLE OF CONTENTS

EXECUTIVE SUMMARY.....	1
BACKGROUND.....	2
PURPOSE.....	2
OBJECTIVES.....	3
PROJECT INFORMATION.....	4
CONSTRUCTION.....	5
DATA COLLECTION.....	6
DISCUSSION.....	7
RESULTS.....	8
REFERENCES.....	9
APPENDIX A, Technical Data Sheet.....	A
APPENDIX B, Half-Cell Data.....	B

LIST OF FIGURES

Figure 1. Bridge during application of Surtreat..... 4

Figure 2. Water blasting the deck..... 5

Figure 3. Water blasting the deck..... 5

Figure 4. Treating the deck..... 5

Figure 5. Treating the deck..... 5

Figure 6. Taking test cores..... 6

Figure 7. Gathering chloride samples..... 6

EXECUTIVE SUMMARY

Corrosion is a major problem for most concrete structures, occurring in the steel bars used to reinforce the concrete. The expense incurred in North America as a result of corrosion-induced repair numbers in the billions of dollars, with more than 50% of the 575,000 bridges in the United States affected by corrosion. Corrosion inhibitors are one of the most cost-effective solutions to this problem, but little independent information is available on their effectiveness in actual use.

Reinforced concrete structures are usually durable in average environments, but their integrity can be compromised when exposed to carbonation or other environments such as chloride salts. [1] These environments reduce the potential service life of reinforced concrete structures and increase maintenance costs. A number of options exist for prolonging the life of concrete structures exposed to aggressive environments, and corrosion inhibitors are among these options. While corrosion inhibitors are available and have been used for increasing the protectiveness of concrete in new construction, [2] the focus of this report is on the reduction of corrosion in existing structures. The costs resulting from damage due to corrosion of existing concrete structures is estimated to be approximately \$8.3 billion per year for highway bridges alone, [3] and there are many other types of concrete structures that are also exposed to corrosion.[4]

Steel corrosion can be mitigated through several approaches. In concrete bridges, the damaged area can be periodically repaired. However, the cost of such repair over the life of a structure can often exceed the cost of total replacement. Another approach is cathodic protection. This can be very effective, but it requires long-term maintenance and a continual supply of electrical power or sacrificial anodes, depending on the selected mode.

BACKGROUND

The Oklahoma Department of Transportation (ODOT) experimentally treated the deck of an existing bridge with *Surtreat TPS*, a surface applied, penetrating corrosion inhibitor. *Surtreat TPS* reportedly can abate corrosion, by creating a passivating ionic film on the reinforcing steel. *Surtreat TPS* claims to permanently modify the cement matrix of existing PCC structures. These modifications result in increased strength and lower permeability. If successful, the use of *Surtreat TPS* could substantially reduce the cost of corrosion maintenance by arresting corrosion - caused spalls, thus reducing the necessity for patching and other repairs.

PURPOSE

The purpose of this study is to evaluate the effectiveness of *Surtreat TPS* corrosion inhibitor in a field performance situation. *Surtreat TPS* is a proprietary product produced by the *Surtreat* Corporation of Pittsburgh, Pennsylvania. According to the manufacturer's literature, *Surtreat TPS* penetrates into the PCC structure being treated, reacting with the cement phase of the concrete to increase hardness and compressive strength, decrease permeability, and render the concrete inert to attack and penetration by acids, bases and other aggressive chemical solutions. This project will focus on *Surtreat*'s reported ability to decrease corrosion in an existing structure.

OBJECTIVES

- Conduct half-cell potential tests (ASTM 876-91) on the bridge (Bridge no. 4621 0140 X, NBI 17601, McIntosh County), before and after the application of *Surtreat TPS* to evaluate *Surtreat's* ability to reduce corrosion.
- Conduct Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration tests (AASHTO 277) to determine if the compound demonstrates the ability to reduce the amount of chloride present in the concrete.
- Conduct pH testing using Germann Instruments Rainbow Dye Test on the existing deck before and after treatment to determine any change in pH.
- Conduct the Standard Test for Abrasion resistance by sandblasting (ASTM 418) before and after *Surtreat TPS* application to document any change in this property.
- Monitor the application process. A. Document application rate, including time required for treatment. B. Document lane closure requirements.
- Conduct surveys of the general condition of the deck at regular intervals after treatment.
- Conduct half-cell potential tests on the bridge (Bridge No. 4621 0140 X, NBI 17601, McIntosh County), one and two years after the application of *Surtreat TPS* to evaluate *Surtreat's* ability to reduce corrosion on a long-term basis.

PROJECT INFORMATION

Surtreat TPS has the potential to reduce maintenance and life cycle costs and can be used for deck rehabilitation. ODOT will be using this product on S.H. 150 (bridge) over lake Eufaula in McIntosh County as shown in Figure 1. The bridge deck is 100 percent in PONTIS condition state 4 (repaired areas and spalls are more than 10 percent but less than or equal to 25 percent of the total deck area). The project consisted of preparation and treatment of the bridge deck, 2505 square yards, with *Surtreat TPS 2*, a surface applied inorganic migratory corrosion inhibitor. The goal of the project is to abate corrosion at the level of the reinforcing steel, minimizing the need for future deck patching. ODOT has no prior experience with this product, and considers it an experimental application at this point, the application and the treated bridge will be monitored by the Research Section, Engineering Services Branch of ODOT's Planning & Research Division as described below.



Figure 1. Bridge during application of Surtreat

CONSTRUCTION

Concrete Services Corporation of Tulsa was awarded the contract to prepare and treat the deck. Traffic control was provided by ODOT Division 1 maintenance personnel. ODOT specified treatment of the deck with *Surtreat TPS 2* at a rate of one gallon per 100 square feet. Preparation of the bridge deck included careful water blasting to remove surface dirt and debris, without causing further delamination or removal of repair material. One lane of traffic was maintained in service at all times during the construction period. The cleaning and treatment of the entire bridge took 6 days. The first 2 days were used to clean the entire bridge deck and the remaining 4 days for application of *Surtreat TPS 2*. *Surtreat* was applied with low pressure sprayers in 3 applications, followed by a clean water misting. Low areas were broomed to minimize puddling of the *Surtreat*. Actual lane closing time was 8 hours or less for each work day. Traffic was resumed on both lanes every day after the work area was rinsed. Traffic was restricted to one lane for less than 48 hours for the entire construction period, minimizing inconvenience to highway users.



Figure 2. Water blasting the deck

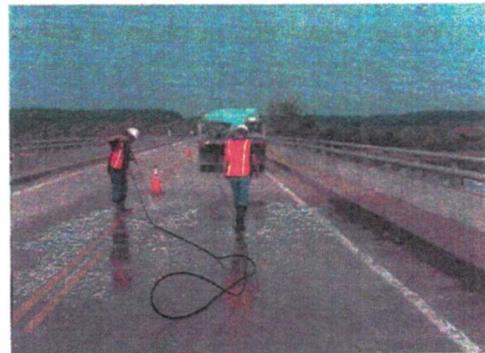


Figure 3. Water blasting the deck



Figure 4. Treating the deck



Figure 5. Treating the deck

DATA COLLECTION

Research activity was included in monitoring the application process, including any necessary preparation work such as cleaning, sandblasting, joint repair, etc. Information was gathered on application rate and time required to treat the bridge, with lane closure (time) requirements. A survey of the general condition of the deck was completed before *Surtreat TPS* application. Half-cell testing of the deck was done before and after *Surtreat* application to quantify any reduction in corrosion activity. In order to insure that the *Surtreat* has time to work, the time between application and half-cell testing was 4 months which was recommended by the *Surtreat* representative. Cores were taken before and after *Surtreat* application. These will be tested for abrasion resistance and permeability to determine the amount of improvement after treatment.

A second survey will be done one year after application. This will include half-cell testing, and a survey of the treated area's general condition. A final survey will be done two years after treatment. The same data will be collected for both the one-year and two-year surveys.



Figure 6. Taking test cores

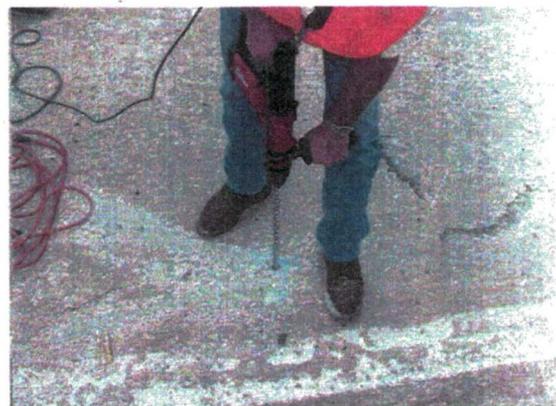


Figure 7. Gathering chloride samples

DISCUSSION

For the *Surtreat TPS* to extend the service life of structures undergoing active chloride induced corrosion they must:

- penetrate the cover concrete to depth of the reinforcing steel
- penetrate accumulated corrosion products in pitting cells to the depth where oxidation of the steel is occurring and or retard or stop the cathode reaction.
- inhibit active chloride induced corrosion cells in the presence of relatively high chloride concentrations

It is difficult to determine if the *Surtreat* actually penetrated the concrete cover. This could be helped by having the manufacturer put some type of dye in the product and conduct some type of color test to determine the presence of the product and to what depth was obtained. A small number of cores were taken for the project. Tests on the cores may show the depth obtained by the product.

A question that needs to be answered is how much of the chemical is getting to the steel surface? Also how much is being absorbed into the concrete and with that how much concentration on the surface is needed to reduce or stop corrosion?

There have been some questions regarding the delamination of the bridge deck and if that would cause the half-cell numbers to be unreliable. The half-cell potential numbers should have decreased if the *Surtreat* was working as intended. However, our results showed that the majority of the numbers either stayed the same or increased. This could show that the treatment was not as effective as we had expected, 4 months was not long enough to see these improvements in the half-cell numbers, or the delamination in the deck caused some of the numbers to be unreliable.

RESULTS

Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration (AASHTO 277):

	<u>Charge Passed (Coulombs)</u>	<u>Relative Chloride Permeability</u>
Prior to application	4712	High
4 months after application	4176	High

Abrasion Resistance of concrete by sandblasting (ASTM C418):

	<u>SSD Weight, g</u>		<u>Loss, g</u>	<u>% Loss</u>
	<u>Before</u>	<u>After</u>		
Prior to application	229.47	228.07	1.40	0.61
4 months after application	168.28	167.30	0.98	0.58

* The reason for the difference in weight before and after is due to size of the cores that were tested.

Half-cell results can be found in Appendix B:

pH testing using Germann Instruments Rainbow Dye Test:

	<u>pH level</u>
prior to application	11
4 months after application	11

REFERENCES

1. Bjegovic and B. Miksic (CORTEC), "Migrating Corrosion Inhibitor Protection of Concrete", *Materials Performance* Vol. 38, No. 11, pp. 52-56 (1999) November.
2. D. Bjegovic and B. Miksic, "MCI Protection of Concrete," *Cortec Supplement to Materials Performance*, January 2001, pages 10-13.
3. Cost of Corrosion Study, http://nace.org/nace/content/nacenews/news_win/html/costcorr.htm, July 2002.
4. Corrosion in Concrete, <http://corrosion.ksc.nasa.gov/html/corrincon.htm>, July 2002.

APPENDIX A

Technical Surtreat Data



SURTREAT TPS 2 Material Safety Data Sheet

SECTION I SUPPLIER INFORMATION

Common Name: SURTREAT-TPS 2
Chemical Name:
Formula:
Supplier: SURTREAT
437 Grant Street, 1210 Frick Building
Pittsburgh, PA 15219
(412) 281 - 1202
Phone:
Emergency Phone: Chem-Tel 1-800-255-3924 (24 hours)
Date Prepared: Monday, June 09, 2003

SECTION II HAZARDOUS INGREDIENT INFORMATION

CFR 29 Part 1910.1000 Table Z-1 (July 1, 1996 issue)

Ingredient	CAS Number	PEL-OSHA (ppm)	TWA-OSHA (mg/m ³)	TLV-ACGIH (ppm)	STEL-ACGIH (ppm)
------------	------------	----------------	-------------------------------	-----------------	------------------

This product contains no hazardous materials.

SECTION III PHYSICAL/CHEMICAL CHARACTERISTICS

Boiling Point:	212 °F
Specific Gravity:	1.094
Melting Point:	N/A °F
pH:	12
Vapor Pressure (mm Hg):	N/A
Vapor Density (Air=1):	N/A
Evaporation Rate (Butyl Acetate =1):	N/A
Solubility in Water:	100%
Appearance and Odor:	A clear liquid with a sweet odor.

SECTION IV FIRE AND EXPLOSION HAZARD DATA

Flash Point:	none °F
Auto-Ignition Temperature:	N/A °F
LEL:	N/A %
UEL:	N/A %
Extinguisher Media:	This material is not expected to burn.
Special Fire Fighting Procedures:	None known.
Unusual Fire and Explosion Hazards:	None known

SECTION V REACTIVITY DATA

Stability	Stable
Conditions and Materials to Avoid	Flammable hydrogen gas may be produced on prolonged contact with metals such as aluminum, tin, lead, and zinc. Avoid contact with glass and reactive metals.
Hazardous Decomposition or By-Products	Hydrogen gas.
Polymerization	Will not occur.
Conditions to Avoid	None known

SECTION VI HEALTH HAZARD DATA

Inhalation

Acute	Causes irritation to the respiratory tract.
Chronic	No data available.

Turnkey Technical Solutions for Concrete Restoration, Rejuvenation and Protection

SURTREAT CORP.

INFORMATION

INTRODUCTION

Technological advances made by Surtreat Corp. are based on the fact that the deterioration of Portland cement concrete is largely a chemical process which can be chemically inhibited and reversed.

The internationally accepted SURTREAT® method is the most effective and inexpensive way to restore the original properties of deteriorating concrete and to offer long-term protection to all surfaces exposed to hostile environments.

BENEFITS

The unique SURTREAT system increases the ability of concrete to resist physical and chemical breakdown by:

- ***Increasing compression strength, hardness***
- ***Inhibiting reinforcing steel corrosion***
- ***Resisting attack and penetration by acids, salts and other aggressive chemical solutions***
- ***Extracting chlorides and pacifying chloride activity***
- ***Pacifying alkali-silica reaction***
- ***Elevating the pH***

APPLICATION

The benefits are achieved by continuous application of a combination of SURTREAT proprietary chemical formulations which penetrate into the concrete microstructure in liquid and vapor state to combine with the cement phase of the concrete and deposit on steel components. Application is made by Surtreat Corp. or a qualified contractor.

TESTING

Performance of **SURTREAT-GPHP** has been verified on numerous projects as well as through extensive laboratory testing performed by Professional Service Industries, Inc., Pittsburgh, PA. Results of the tests reflect the following:

Compression Strength Increase

ASTM C-42 increased by 300 to 2000 psi depending on original strength and number of applications.

Water Penetration Reduction

100% resistance after 14 days exposure to 6 inch column of water.

75% resistance after 28 days exposure to 6 inch column of water.

90% resistance after 24 hours @ 100 psi.

Freeze Thaw Resistance

ASTM C-672 – 50 cycles no surface loss.

AASHTO T-161 – 146 cycles no surface loss.

Chloride Penetration Resistance

AASHTO T-250 – 30% decrease at 1 inch depth.

ASTM C-672 – 42% decrease at 2 inch depth.

Water-soluble Chloride Reduction

Gel pour extraction method.

Reduced by 58% at 1-inch depth.

Reduced by 67% at 2-inch depth.

Increase in Hardness

ASTM C-418 – 14% increase in hardness of new concrete.

ASTM C-414 – 64% increase in hardness of deteriorated concrete.

ASTM C-501 – 1000 cycles – 38% increase in wear index.

Reduced Rebar Corrosion Potential

ASTM C-876 – Half-cell potential – reduced voltage by 50% in 14 days (400 to 200mV).

Increased Surface Adhesion

No failure of epoxy bonded to treated surface.

Reduced Chemical Reactivity

Resistant to attack and penetration by concentrated hydrochloric acid.

Flexural Strength

Increased from 423 to 543 psi.

The majority of projects that involve installation of **SURTREAT** products include comprehensive testing and analysis before and after the treatment. Tests performed on site often include: **Compression Strength (CAPO Pull Out), Water Permeability (Pressure Cell), pH (Indicator Dye), Corrosion Potential (Silver Chloride Half-Cell), Chloride Ion and Acid Reactivity.** Customer representatives or engineers are invited to observe testing procedures and verify the results. Comprehensive project reports are submitted on request.

**Surtreat Corp., 437 Grant Street, 1210 Frick Building, Pittsburgh, PA 15219
phone 412-281-1202, fax 412-281-1282, e-mail srtrt@nauticom.net**

SURTREAT® CORROSION INHIBITION PROCESS AND FORMULATIONS

The Process of Corrosion

Reinforcing steel corrosion is the most common cause of failure of concrete structures. Steel corrosion is an oxidation process requiring the presence of air (oxygen) and moisture. Corrosion is promoted by anions, like chloride, and an acid environment. Corrosion is inhibited by an alkaline environment, cations and barrier coatings.

Freshly poured low water-cement ratio concrete provides excellent protection for imbedded reinforcement. However, as time passes, under the influence of salts and atmospheric acids cement bonds in concrete begin to deteriorate, concrete becomes increasingly permeable and susceptible to intrusion of contaminants and moisture. As the pH of concrete falls, electrochemical activity increases. The process perpetuates itself as oxidized rebar expands forcing concrete to crack and delaminate, thus encouraging air and water penetration. Once started, rebar corrosion can not be stopped by simply waterproofing the surface of the concrete, in fact application of a waterproofing membrane or coating will make the situation worse by trapping the chlorides and moisture inside the concrete microstructure which in combination with a low pH is a perfect environment for corrosion.

SURTREAT® Process

The corrosion process is influenced and promoted by penetration of air, water, chloride, and an acid environment.

The SURTREAT process for corrosion inhibition includes application of SURTREAT Volatile Corrosion Inhibitor (VCI), which permeates throughout the structure as a vapor and deposit on rebar forming a passive film on the surface of the white steel. Application of SURTREAT VCI is usually followed by an application of SURTREAT General Purpose Restoration and Protection Formulation (GPHP).

SURTREAT GPHP penetrates the concrete surface reacting with Portland cement and solidifies inside becoming a permanent part of the structure. SURTREAT GPHP inhibits corrosion by:

- *Complexing water soluble chlorides*
- *Purging and inhibiting penetration of chlorides*
- *Raising the pH*
- *Restricting access of air and water to the rebar*

SURTREAT GPHP also reacts with iron oxide on the surface of imbedded reinforcement to convert it into an inert mass resistant to water and air penetration.

The effects of SURTREAT® formulations on the corrosion process have been verified through field evaluation as well as lab analysis. The following is a brief summary of the test results performed in our laboratory as well as in the field. All tests are done using a silver chloride half cell, the threshold point for corrosion is -190mV.

LABORATORY EVALUATION

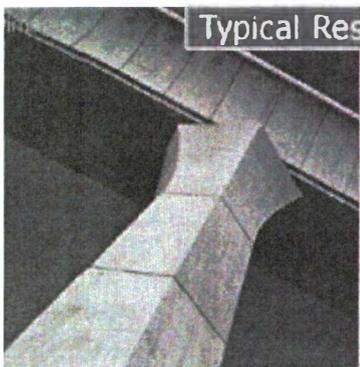
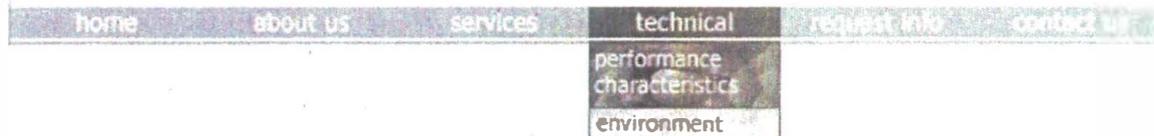
ID	CONDITION/EXPOSURE	mV	Kohm
<u>A</u>	Base Sample	+45	8.0
	Exposure to HCl/CaCl	-370	0.5
	5 applications of GPHP and		
	1 application of VCI	-115	2.2
<u>B</u>	Base Sample	-300	0.5
	3 applications of GPHP and		
	1 application of VCI	-200	1.0
	After one week	-125	1.5
<u>C*</u>	Base Sample	-325	0.4
	3 applications of GPHP	-300	0.4
	1 application of VCI	-275	0.5
	2 applications of GPHP	-235	0.6
	After one week	-200	0.7

*Sample labeled C came from a balcony of the Ocean Pines Complex in Cape Canaveral FL.

SUMMARY OF SILVER CHLORIDE HALF CELL MEASUREMENTS ON A BALCONY AT WINDJAMMER CONDOMINIUM, COCOA BEACH, FL

AREA	BEFORE mV	AFTER mV	NUMBER OF MEASUREMENTS
<u>A</u>	-326	-153	6
<u>B</u>	-350	-155	8
<u>C</u>	-229	-64	3
<u>D</u>	-285	-179	3

Surtreat application rate	50 sf/gal
Number of applications	2
Curing time	24 hours
Half cell corrosion point	-190 mV
Date performed	6/16 - 6/17/95.



Typical Res

The performance of Surtreat's chemistry has been verified by numerous independent engineering-consulting firms in the field as well as through extensive independent laboratory testing. The results of the testing reflect the following typical result characteristics:

- **Reduced Rebar Corrosion Potential** - ASTM (American Society for Testing Materials) C-876 - Half-cell potential showed a reduced voltage by 70% in 14 days (0.8 to 0.3)
- **Water Penetration Reduction** - 100% resistance after 14 days exposure to 6-inch column of water. 75% resistance after 28 days exposure to 6-inch column of water. 90% resistance after 24 hours when 100 psi is applied.
- **Freeze Thaw Resistance** - ASTM C-672 -50 cycles with no surface loss. AASHTO (American Association of State Highway and Transportation Officials) T-161 - 146 cycles with no surface loss.
- **Chloride Penetration Resistance** - AASHTO T-250 -30% decrease at 1-inch depth.
- **Water-soluble Chloride Reduction** - Reduced by 58% and 67% at 1 and 2 inches, respectively.
- **Increase in Hardness** - ASTM C-418 - 14% increase in hardness of new concrete. ASTM C-414 - 64% increase in hardness of deteriorated concrete. ASTM C-501 - 1,000 cycles with a 38% increase in wear index.
- **Reduced Rebar Corrosion Potential** - ASTM (American Society for Testing Materials) C-876 - Half-cell potential showed a reduced voltage by 70% in 14 days (0.8 to 0.3)
- **Increased Surface Adhesion** - No failure of epoxy bonded to treated surface.
- **Reduced Chemical Reactivity** - Resists reaction with concentrated hydrochloric acid
- **Flexural Strength** - Increased from 423 to 543 psi.
- **Increased pH Level** - Edges of concrete increased from 5 to 9, center of concrete increased from 9 to 12.

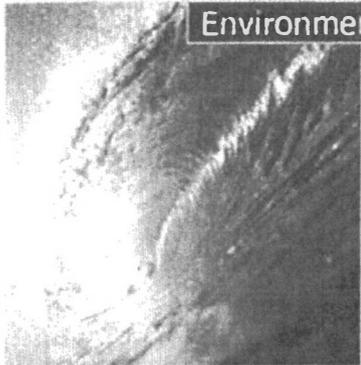
*Comprehensive project reports for select projects are available upon request. To request further information [click here](#).

[Intranet Login](#)

[Legal Notice / Copyright](#) © 2002 Surtreat®. All rights reserved.



home	about us	services	technical	request info	contact us
			performance characteristics		
			environment		



Surtreat operates according to the principle that responsibility for the environment is an integral part of every project that we execute.

Surtreat Project Managers operate to comply with all applicable laws and regulations, with emphasis on prevention and to minimize adverse environmental impacts by identifying and controlling potential environmental risks in advance.

Furthermore, Surtreat uses water-soluble organic and inorganic materials that are environmentally safe. Our systems contain no VOC's (volatile organic compounds) and have been tested by leading environmental firms showing no effect on the turbidity, pH, or dissolved oxygen content levels in water.

Surtreat's formulations bond inorganic compounds to the structure where they become part of the steel and concrete matrix indefinitely. Leaving no residues, coatings or materials that could potentially harm humans, animals, fish and the environment. Surtreat has been granted waivers and exemptions from the Environmental Quality Act, California Costal Commission, and other state and county agencies for use of its chemical treatment formulas, due to their non-toxic nature.

[Intranet Login](#)

[Legal Notice / Copyright](#) © 2002 Surtreat®. All rights reserved.

APPENDIX B

Half-cell results

17101 to 41.110.4N

DATE:

9/29/03

BRIDGE NO:

46210140X NBI NO: 17601

TESTED BY:

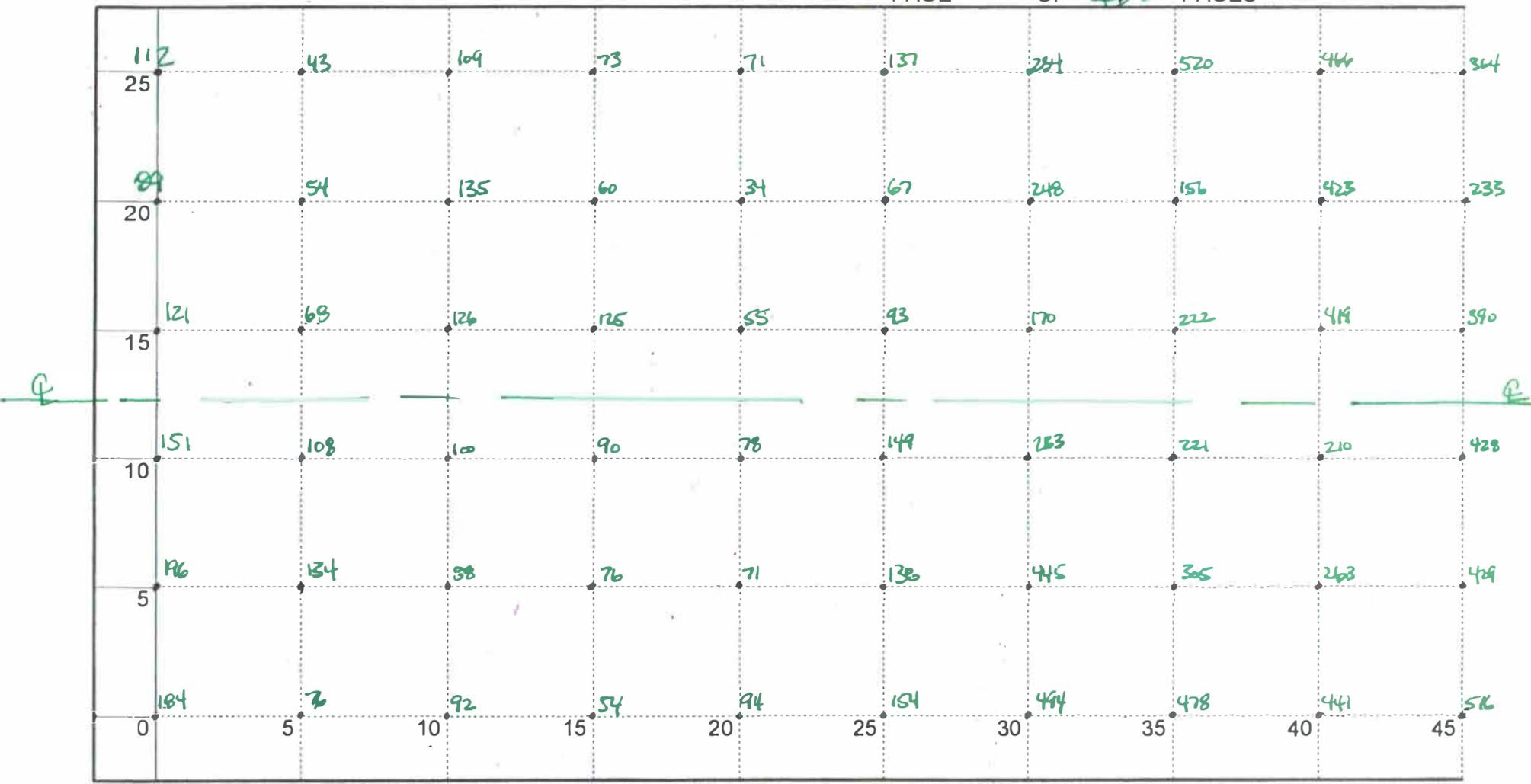
D. HUMPHREY

WEATHER:

HALF-CELL TEST



PAGE 1 OF ~~178~~ 8 PAGES

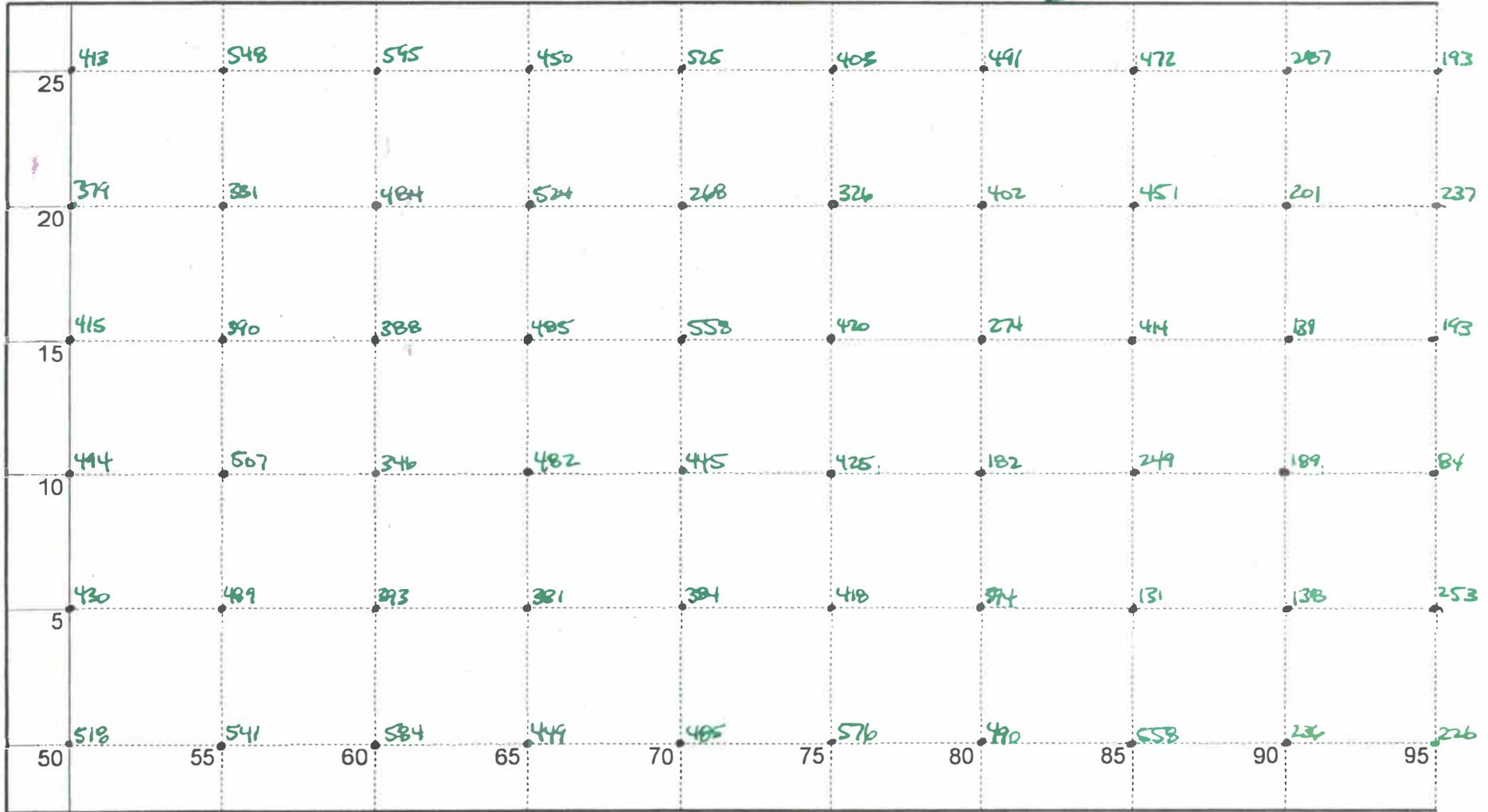


MV

DATE: 9/29/03
BRIDGE NO:
TESTED BY:

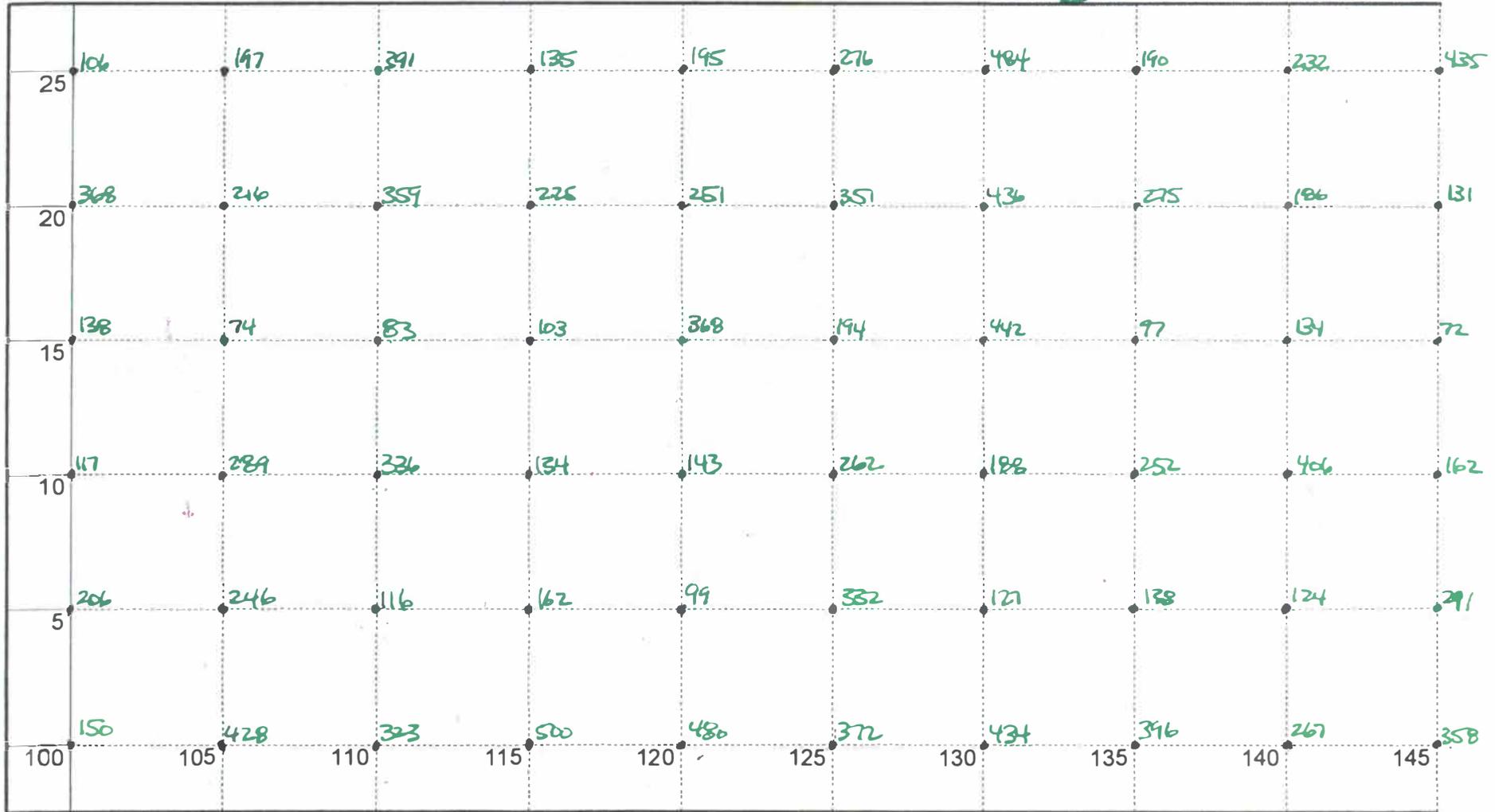
WEATHER:

PAGE 2 OF ~~178~~ 8 PAGES



DATE: 9/29/03
BRIDGE NO: _____
TESTED BY: _____

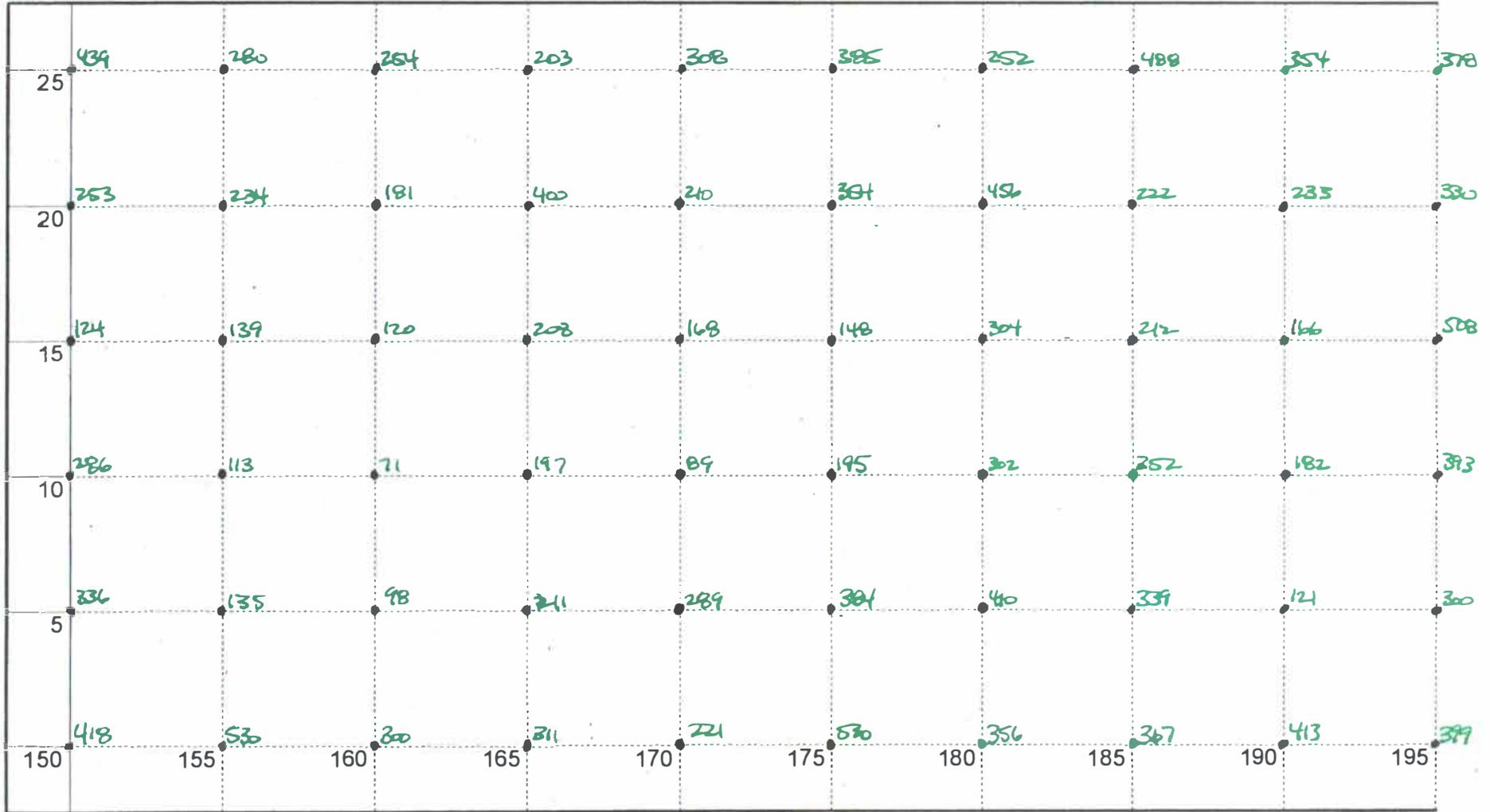
WEATHER: _____



DATE: _____
BRIDGE NO: _____
TESTED BY: _____

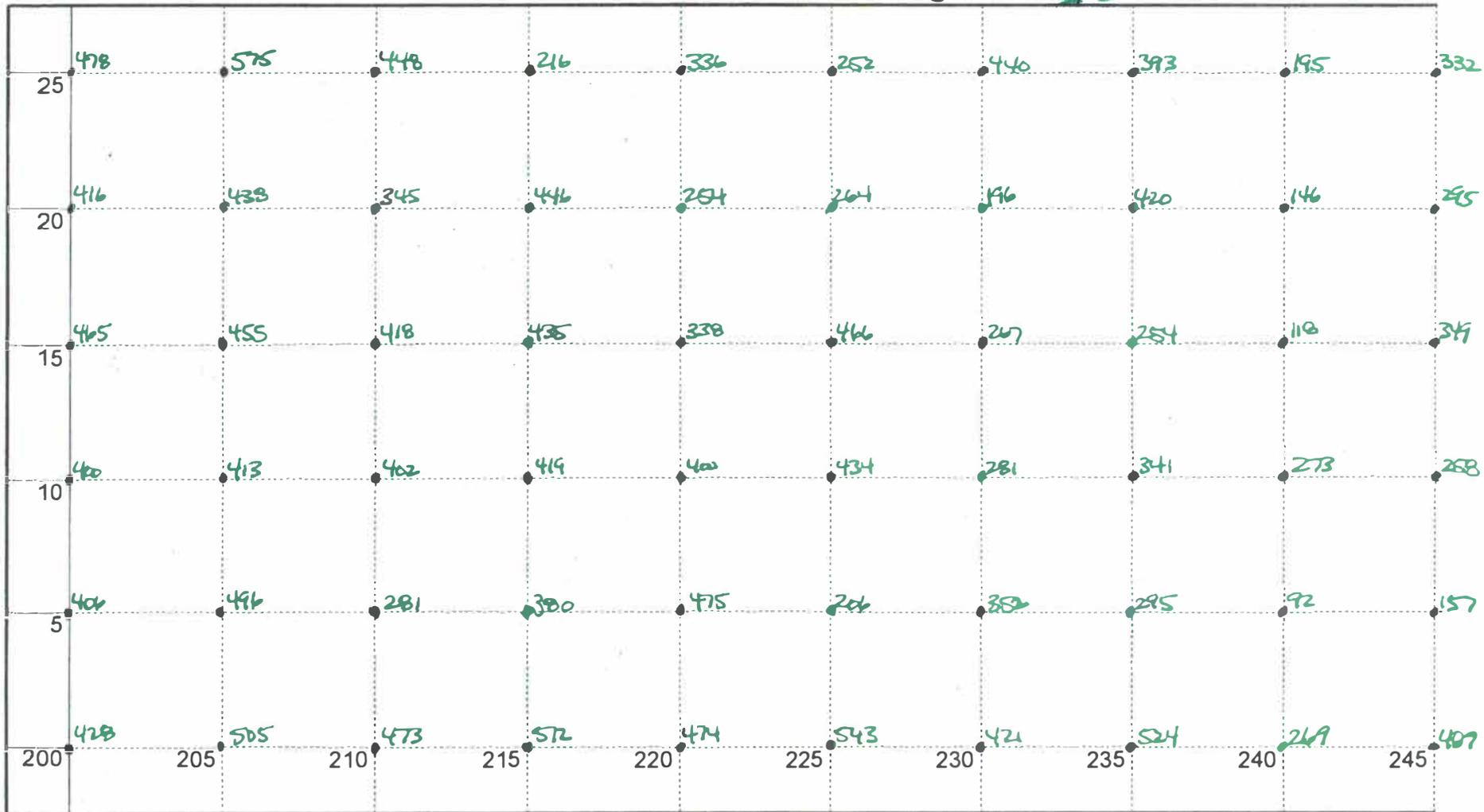
WEATHER: _____

PAGE 4 OF ~~28~~ PAGES



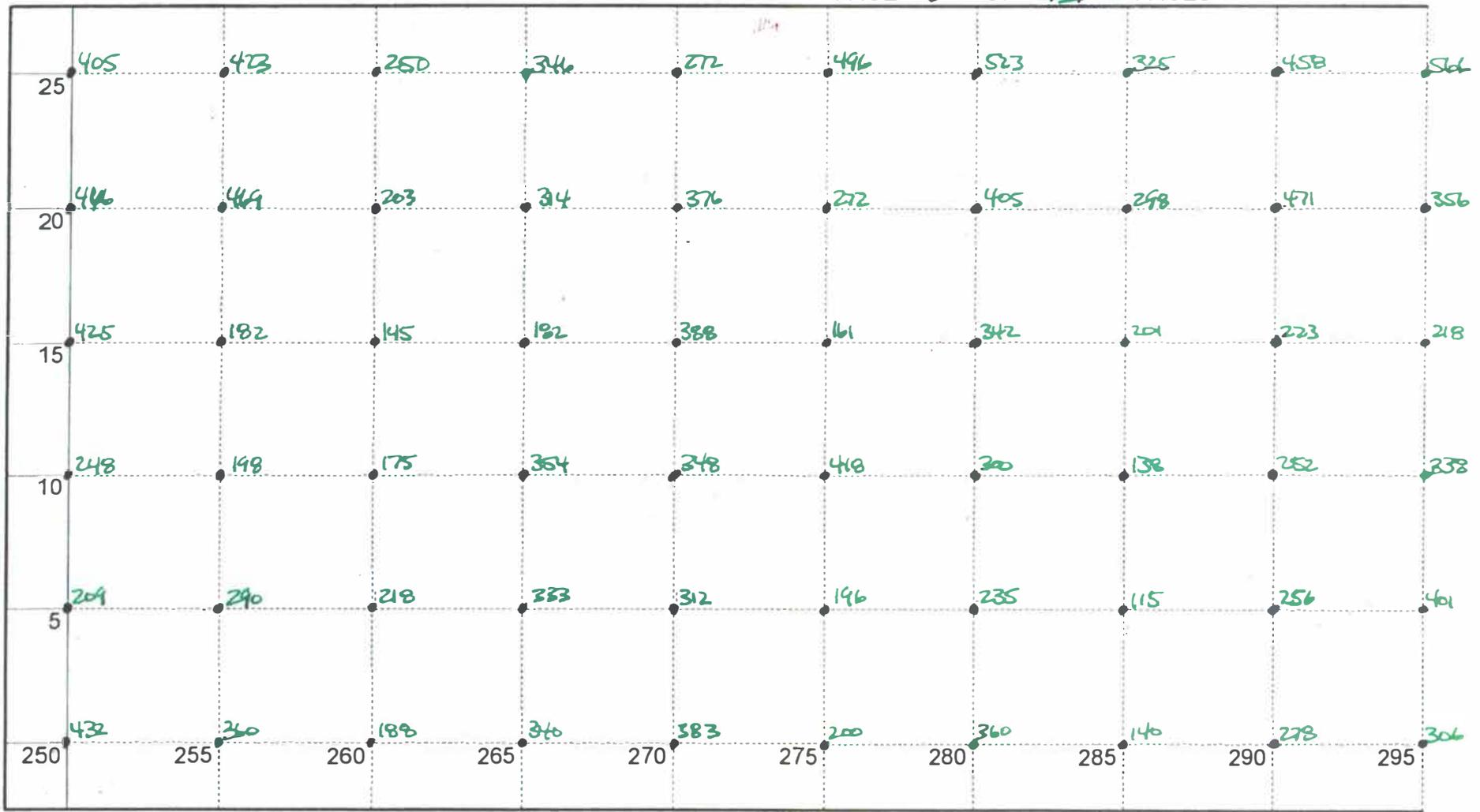
DATE: 9/29/03
BRIDGE NO:
TESTED BY:

WEATHER:



DATE: 9/29/03
BRIDGE NO: _____
TESTED BY: _____

WEATHER: _____



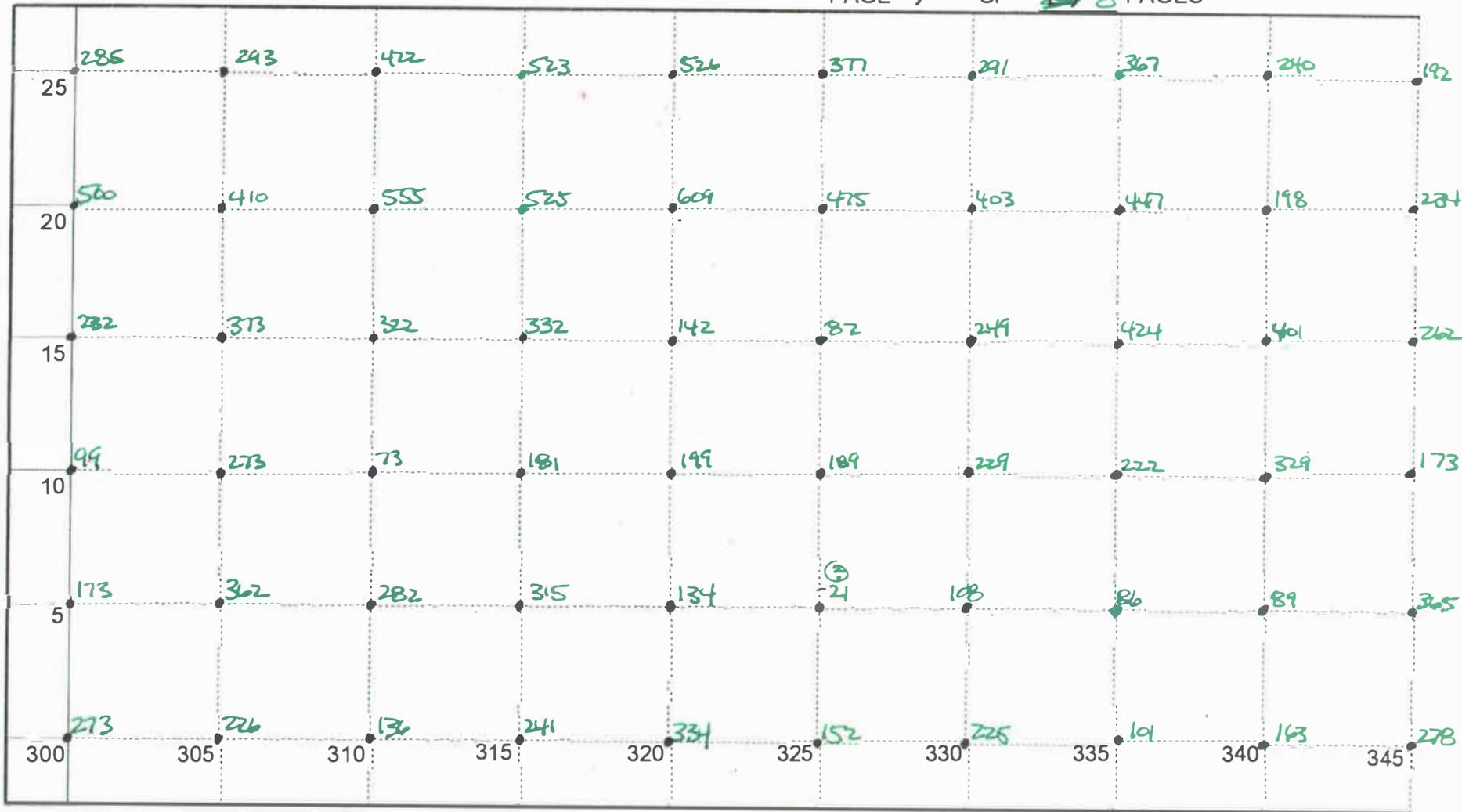
DATE: 9/29/03

BRIDGE NO: _____

TESTED BY: _____

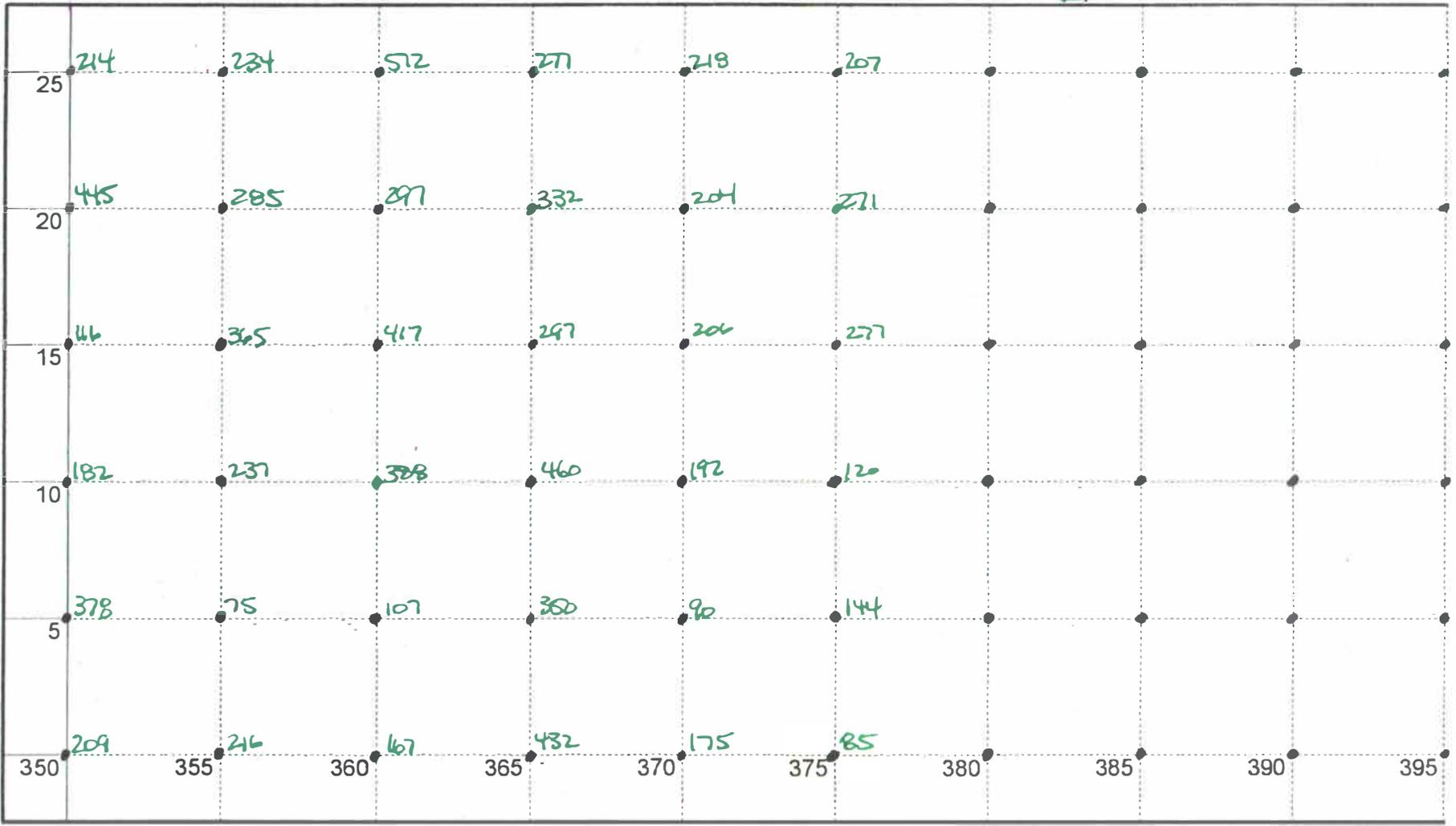
WEATHER: _____

PAGE 7 OF ~~178~~ PAGES



DATE: 9/29/03
BRIDGE NO:
TESTED BY:

WEATHER:



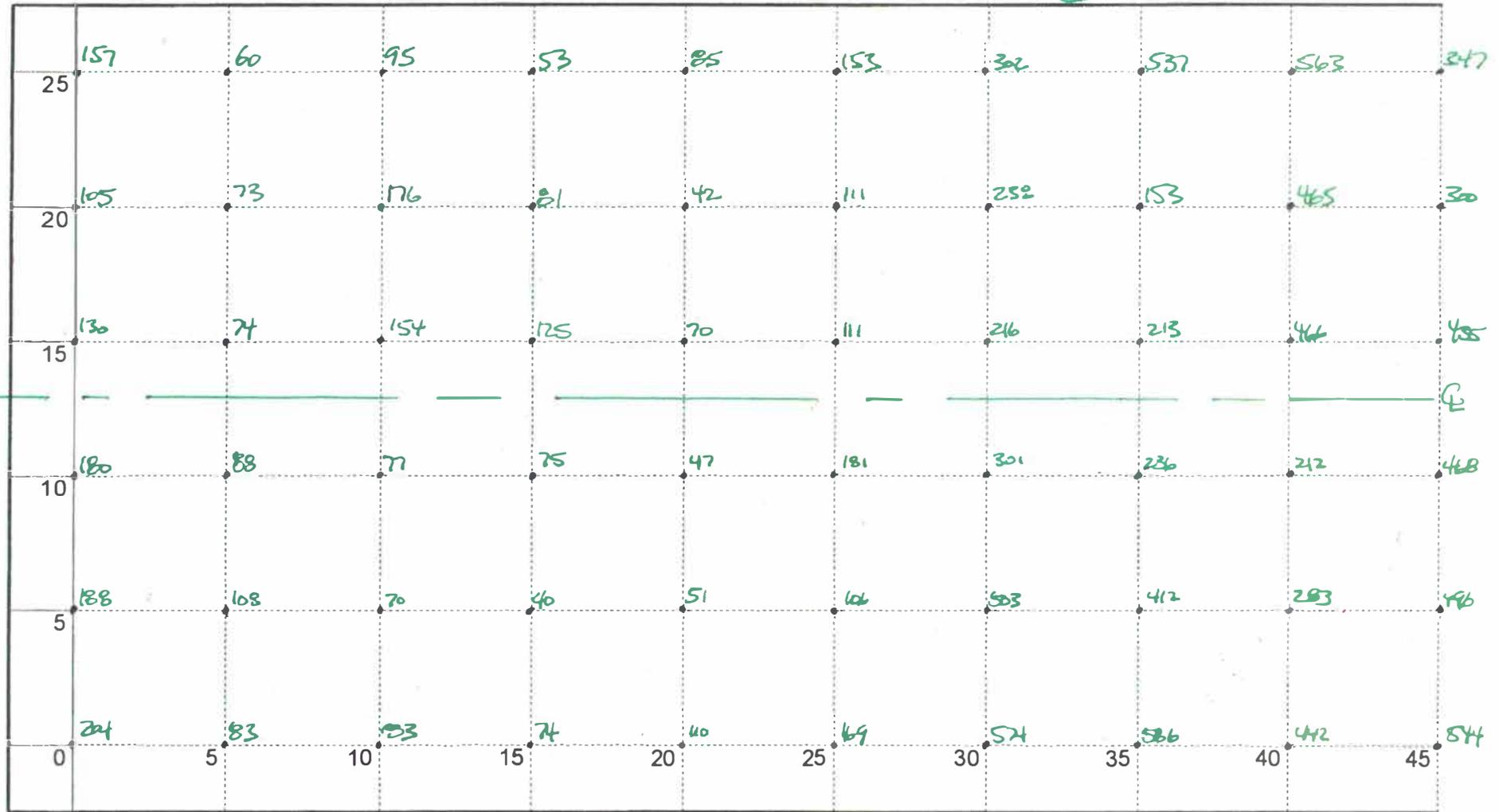
DATE: 2/18/04
 BRIDGE NO: 462.1 0140 X NBI NO: 17601
 TESTED BY: D. HUMPHREY

WEATHER:

HALF-CELL TEST



PAGE 1 OF ~~138~~ PAGES

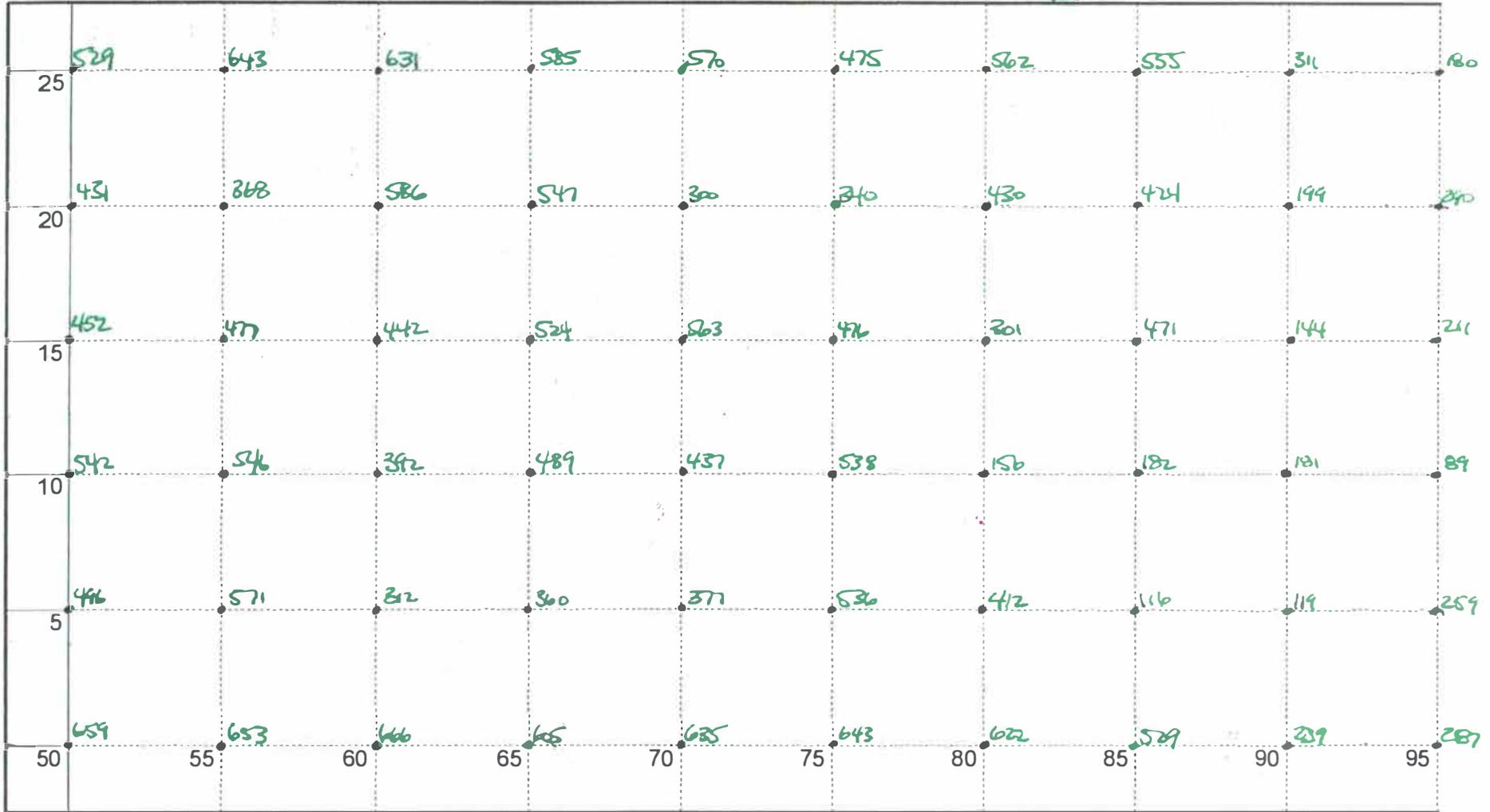


MV

DATE: 2/18/04
BRIDGE NO:
TESTED BY:

WEATHER:

PAGE 2 OF 78 PAGES



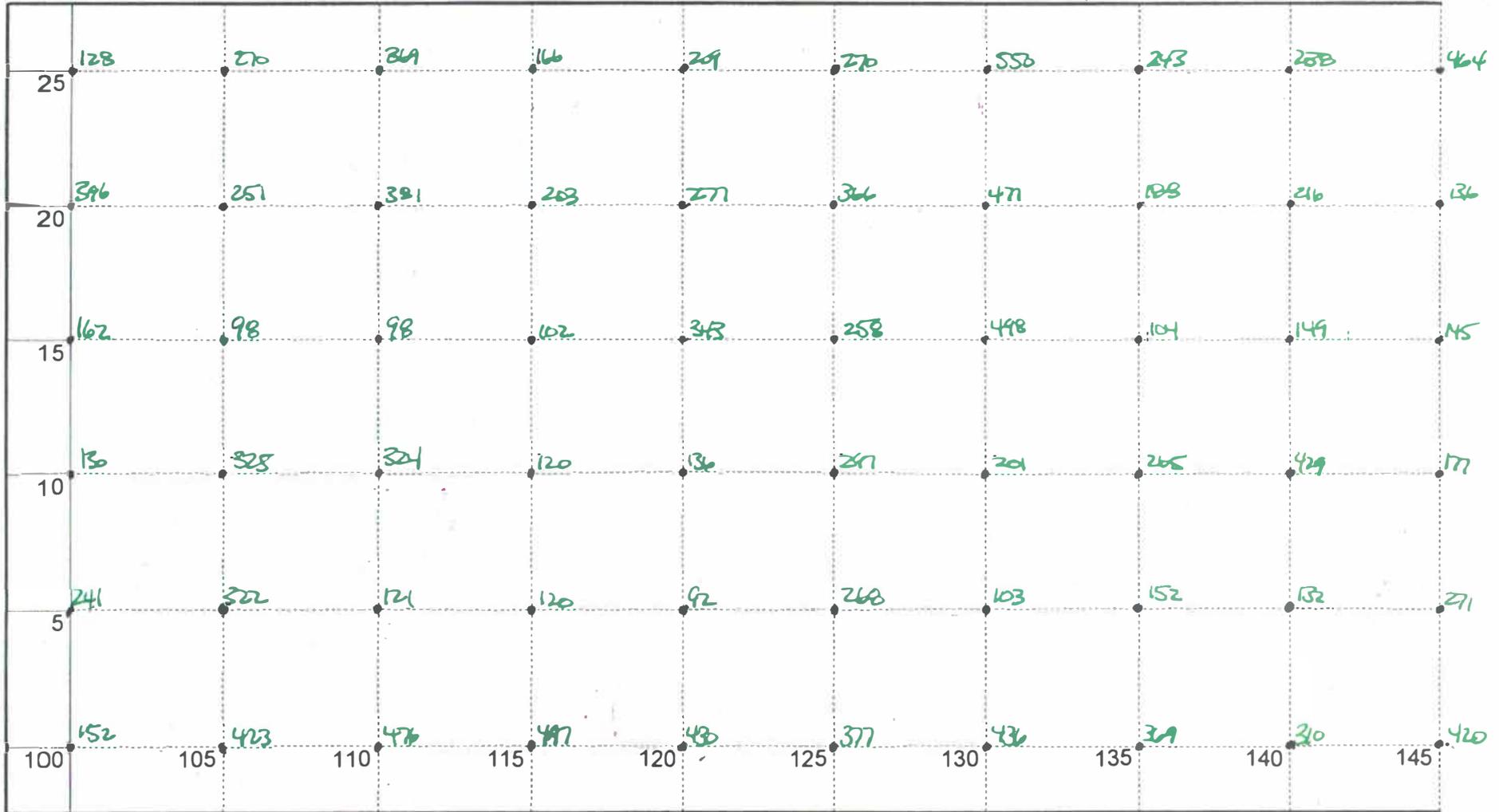
DATE: 2/18/04

BRIDGE NO: _____

TESTED BY: _____

WEATHER: _____

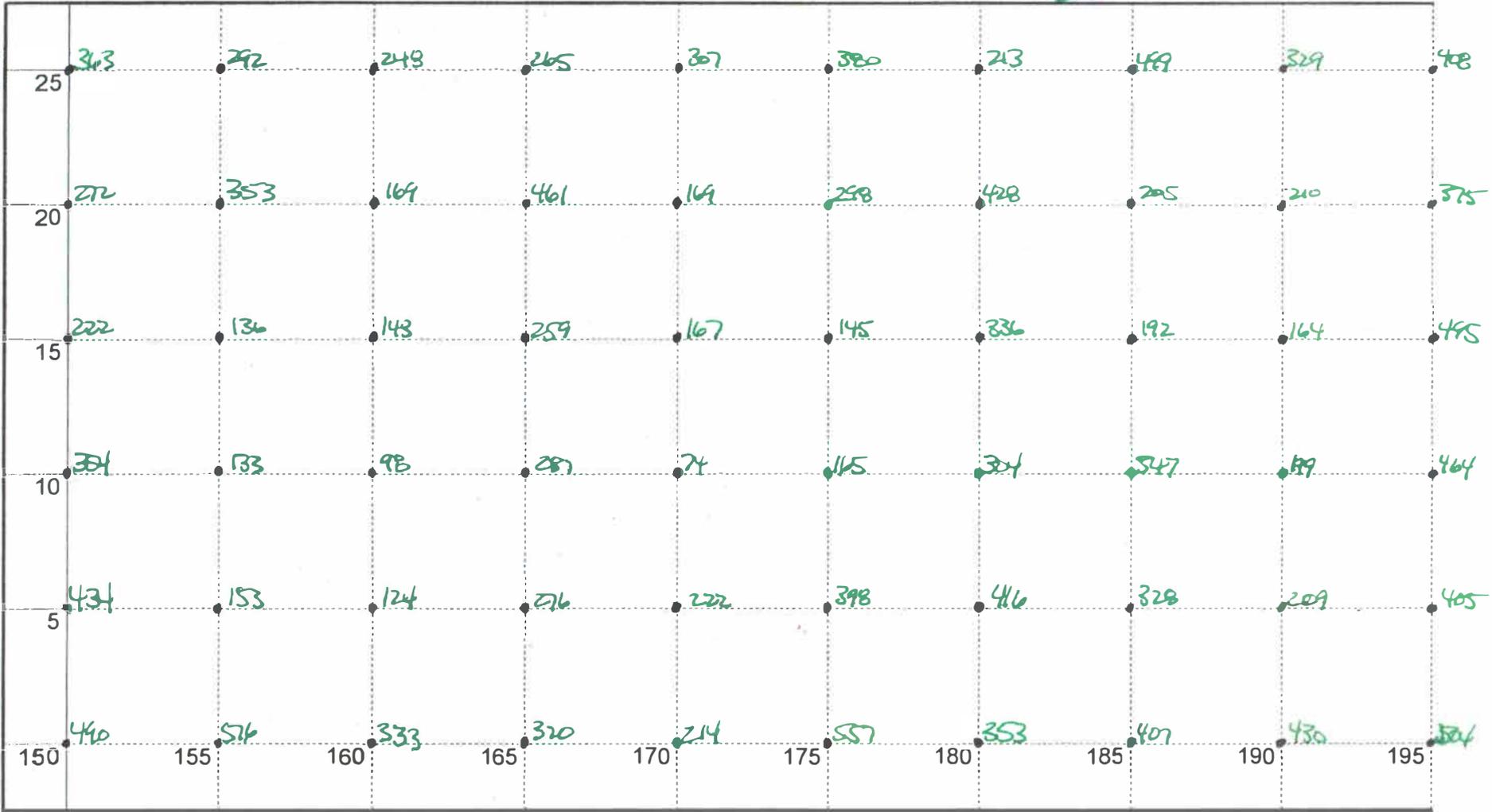
PAGE 3 OF 8 PAGES



DATE: 2/18/04
BRIDGE NO: _____
TESTED BY: _____

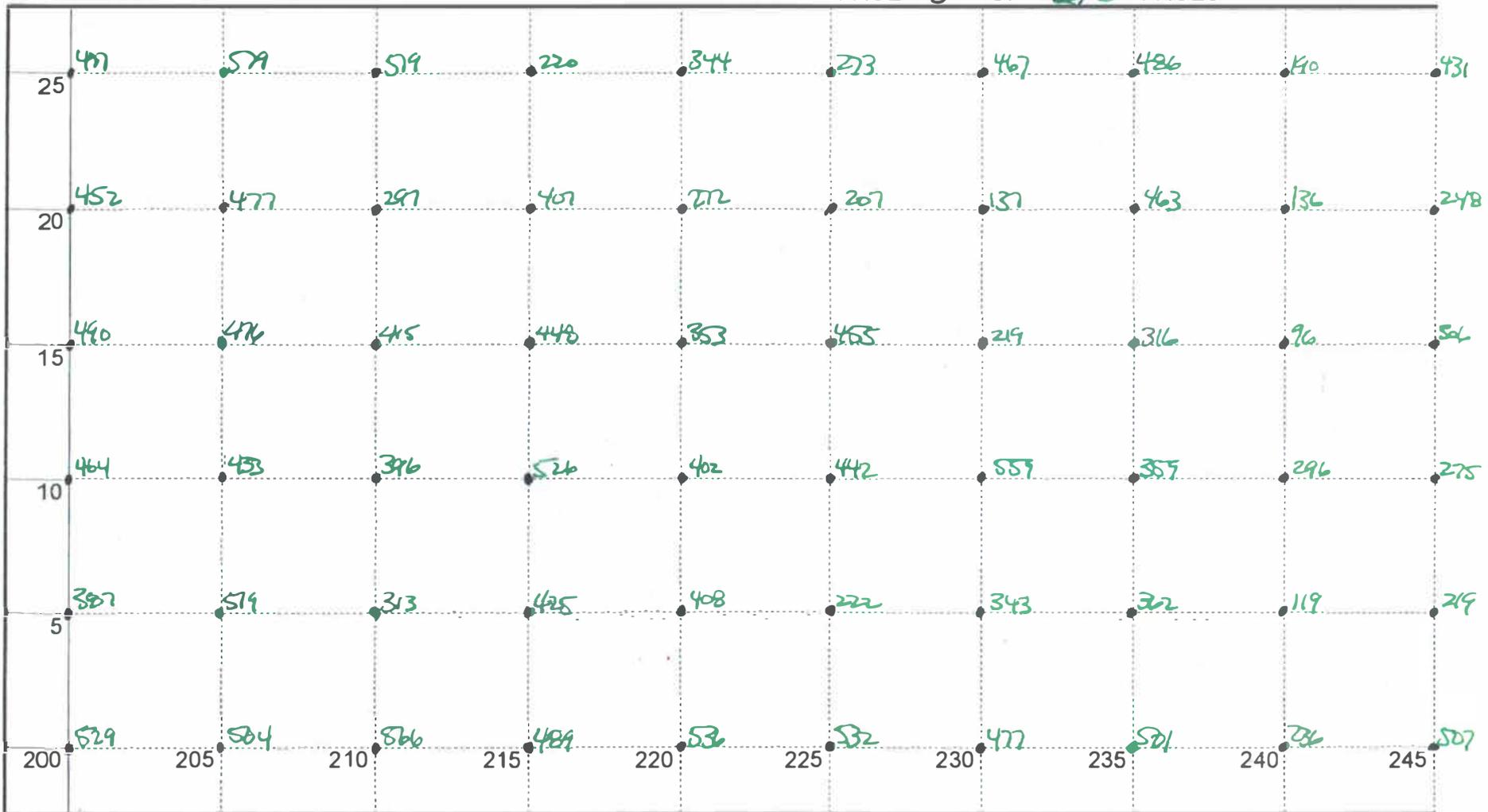
WEATHER: _____

PAGE 4 OF ~~10~~ PAGES



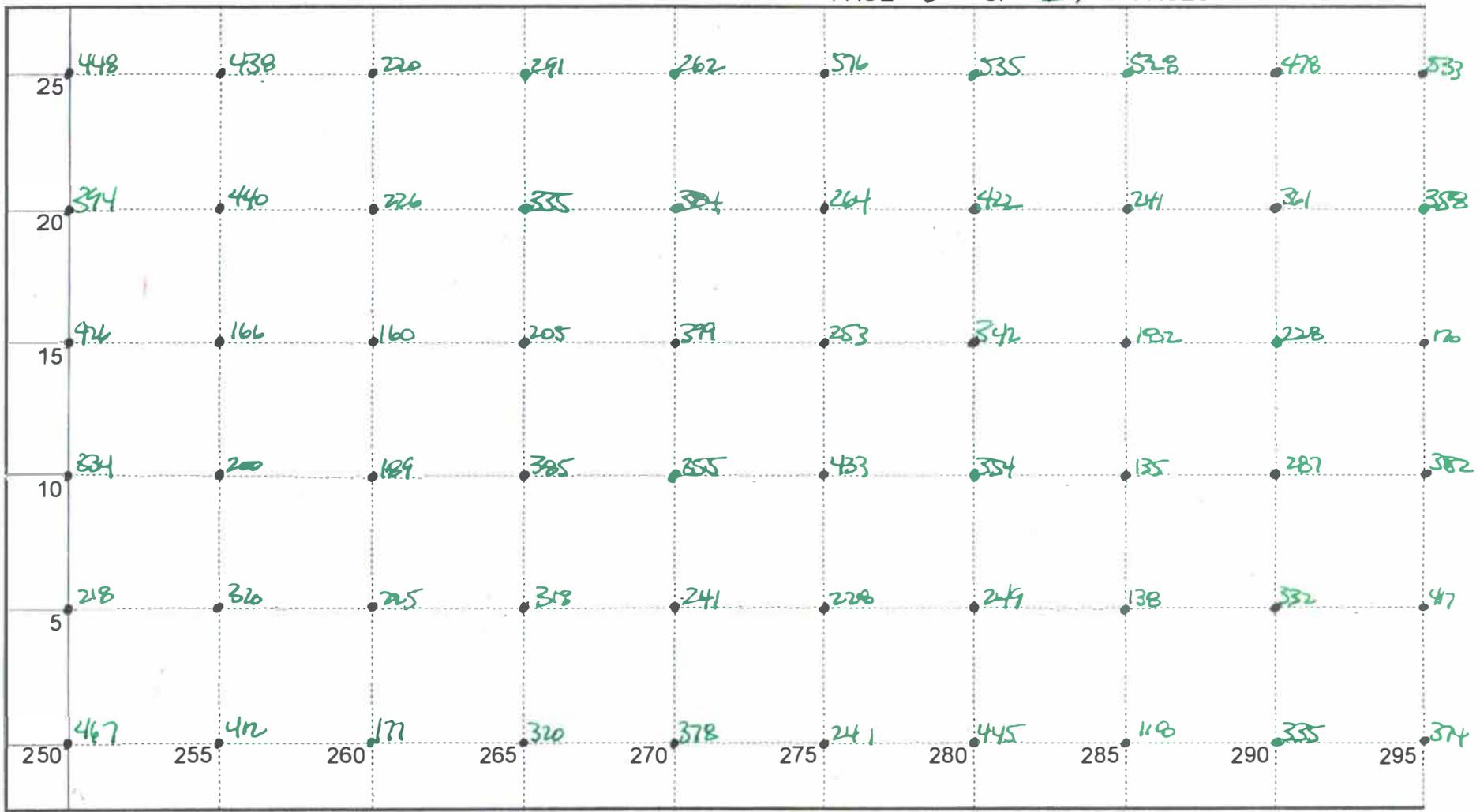
DATE: 2/18/04
BRIDGE NO: _____
TESTED BY: _____

WEATHER: _____



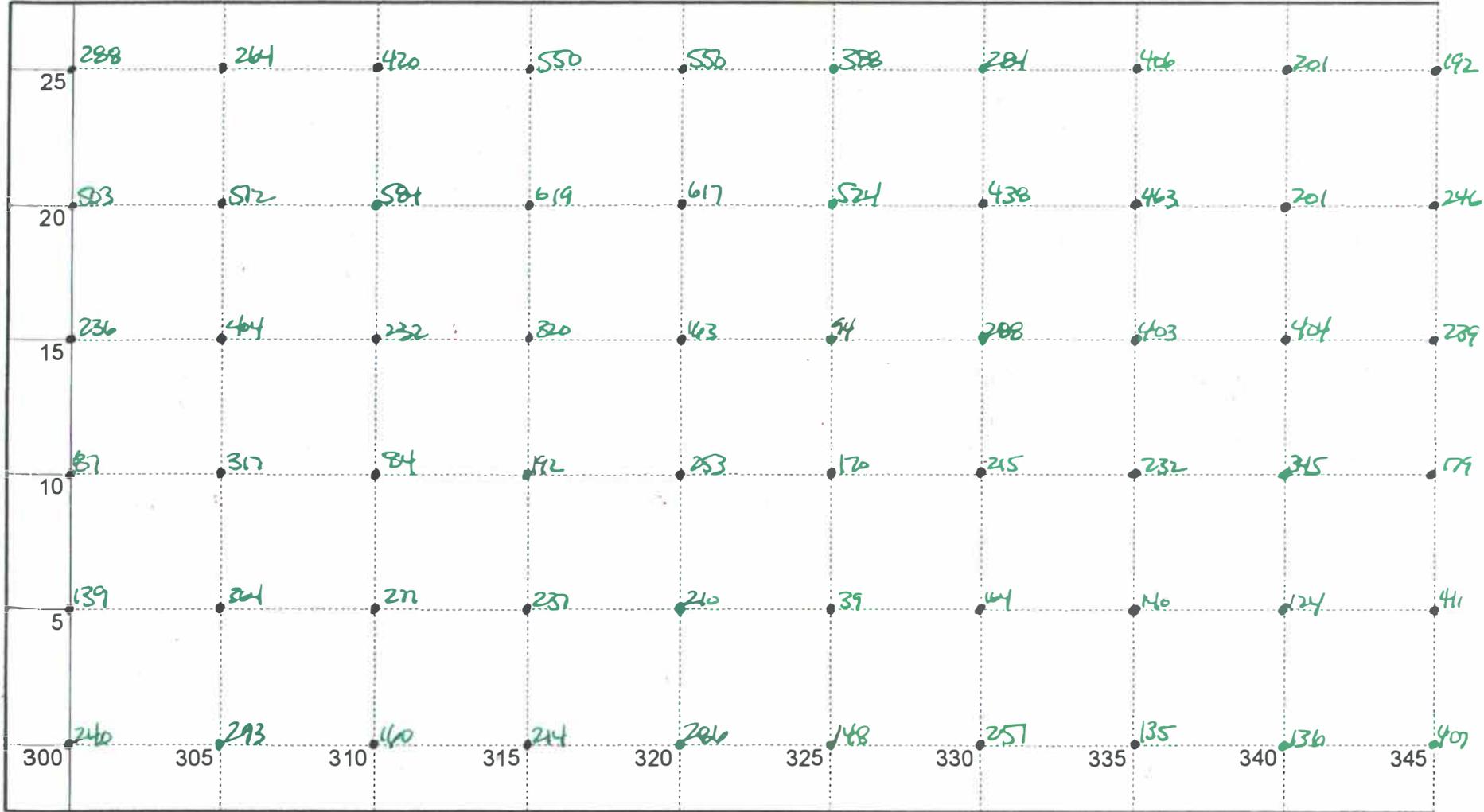
DATE: 2/18/04
BRIDGE NO: _____
TESTED BY: _____

WEATHER: _____



DATE: 2/18/04
BRIDGE NO:
TESTED BY:

WEATHER:



DATE: 2/18/04
BRIDGE NO: _____
TESTED BY: _____

WEATHER: _____

