APPENDIX F

GEOTECHNICAL INVESTIGATION

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Geotechnical Investigation for Class Environmental Assessment Study
Ninth Line Transportation Corridor Improvements, Highway 407 to 10 Side Road
Region of Halton

Prepared for:

Urban and Environmental Management Inc.
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Mississauga, Ontario
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File: 14057
August 24, 2015

■ FOUNDATION INVESTIGATIONS ■ ENVIRONMENTAL SITE ASSESSMENTS AND CLEANUP ■ GROUNDWATER STUDIES ■ SLOPE STABILITY STUDIES
■ ASPHALT TECHNOLOGY ■ ASPHALT MIX DESIGNS ■ PAVEMENT PERFORMANCE ANALYSIS ■ CONSTRUCTION MATERIALS TESTING & INSPECTION
■ ANALYSIS OF SOIL CORROSION POTENTIAL ■ PAVEMENT REHABILITATION & TENDER SPECIFICATIONS ■ CONCRETE QUALITY ASSURANCE TESTING
■ ROOF INSPECTIONS ■ INFRASTRUCTURE NEEDS STUDIES ■ FAILURE ANALYSIS AND EXPERT WITNESS SERVICES ■ AGGREGATE EVALUATION

EXECUTIVE SUMMARY

Landtek Limited is pleased to submit the geotechnical investigation report for the proposed road widening of Ninth Line (Regional Road 13) from Steeles Avenue to 10 Side Road (Regional Road 10) from two to four lanes, in the Town of Halton Hills.

SITE CONDITIONS

The limits of the study site location are shown in Figure 1. The study section of Ninth Line (Regional Road 13) has a two-lane asphalt surfaced rural cross-section with narrow granular shoulders. There are ditches on both sides of the road and no sidewalks. The posted speed limit is 80 km/hr and there is predominantly farm land along the study area with some residential pockets.

Geology map data[1] indicates that Ninth Line is in an area of clay to silt textured soil of the Halton formation overlying Queenston shale. The borehole information is consistent with the background geology data and indicates that the predominant native subgrade soil is silt till overlying shale bedrock.

MANAGEMENT OF EXCAVATED EXCESS MATERIALS

Analyses for metals and inorganic parameters were carried out on composite subgrade samples from all the boreholes and the results are provided in Appendix D. The samples were tested in relation to MOE Table 1 Full Depth Background Site Conditions and the MOE Table 3 soil quality standards and compared to both the Residential/Parkland/Institutional property use and the Industrial/Commercial/Community criteria given in the MOE document "Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act", dated April 15, 2011. The results are summarized in Table 2.

When compared to the MOE Table 3 Industrial/Commercial/Community Land Use Standards, the parameters of the soils tested met all soil quality standards. Elevated results for Electrical Conductivity (EC) and Sodium Absorption Ratio (SAR) occurred in boreholes 1, 5, 9, 10, 11, and 12 when compared to the MOE Table 1-Full Depth Background Site Condition Standards and the MOE Table 3 Residential/Parkland/Institutional Land Use Standards.

PAVEMENT AND BIKE LANE CONSIDERATIONS

Future road improvements are expected to include both rehabilitation and upgrading of existing asphalt pavement and transition areas, and new asphalt pavement construction for lane widening and bicycle lanes. The asphalt on Ninth Line generally has a substantial thickness that typically ranges from 75 mm to 300 mm and likely reflects past resurfacing practices. As well, crack sealing maintenance practices have been kept up to date such that the current road surface is in good condition without immediate need for major repairs and/or resurfacing. Section 5.0 provides recommendations to address new pavement construction, bike lane construction, and future resurfacing.

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1.0 INTRODUCTION

Landtek Limited is pleased to submit the geotechnical investigation report for the proposed road widening of Ninth Line (Regional Road 13) from Steeles Avenue to 10 Side Road (Regional Road 10) from two to four lanes, in the Town of Halton Hills. The work was carried out under engineering agreement with Urban & Environmental Management Inc. in accordance with the Landtek proposal P13210 dated November 28, 2013.

The geotechnical investigation is part of the "Ninth Line Transportation Corridor Class EA [Environmental Assessment] Study" that consists of a 7.5 km long section of road improvements to Ninth Line between Steeles Avenue and 10 Side Road.

The primary objectives of the investigation were: (1) determine the existing pavement structure, shoulder, and subgrade soil conditions to be encountered during the road improvements; and, (2) assess options to address the pavement conditions and provide recommendations for construction.

2.0 METHODOLOGY

Fieldwork was carried out in May of 2015. A visual survey of the road section conditions was completed by Landtek and the borehole locations were marked out in the field. Following the clearance of utilities the borehole drilling was completed on May 28 and 29, 2015 under the full time supervision of a Landtek representative using a truck mounted CME continuous flight power auger soil drilling rig. A total of fifteen (15) boreholes were drilled on the paved potion of the road and on the shoulder to a depth of approximately 3.5 m. Standard Penetration Tests (SPT) and split spoon samples were taken in each borehole at selected depths. The borehole locations are shown on drawings 1 to 6, inclusive, and are provided with the borehole logs in Appendix C.

The borehole soil samples were transported to Landtek Limited and visually examined in the laboratory to determine their textural classification. Moisture contents were determined for each soil sample and density determinations were completed on selected samples.

Composite soil subgrade samples from each of the fifteen boreholes were submitted to AGAT Laboratories Ltd. to assess the concentrations of metals and inorganic parameters. The AGAT test results are provided in Appendix D.

3.0 SITE AND SUBSURFACE CONDITIONS

The limits of the study site location are shown in Figure 1. The study section of Ninth Line (Regional Road 13) has a two-lane asphalt surfaced rural cross-section with narrow granular shoulders. There are ditches on both sides of the road and no sidewalks. The posted speed limit is 80 km/hr and there is predominantly farm land along the study area with some residential pockets.

Photographs of typical site conditions are presented in Appendix E. Table 1 summarizes the borehole data and presents the pavement structure and road widening area conditions on Ninth Line (Regional Road 13).

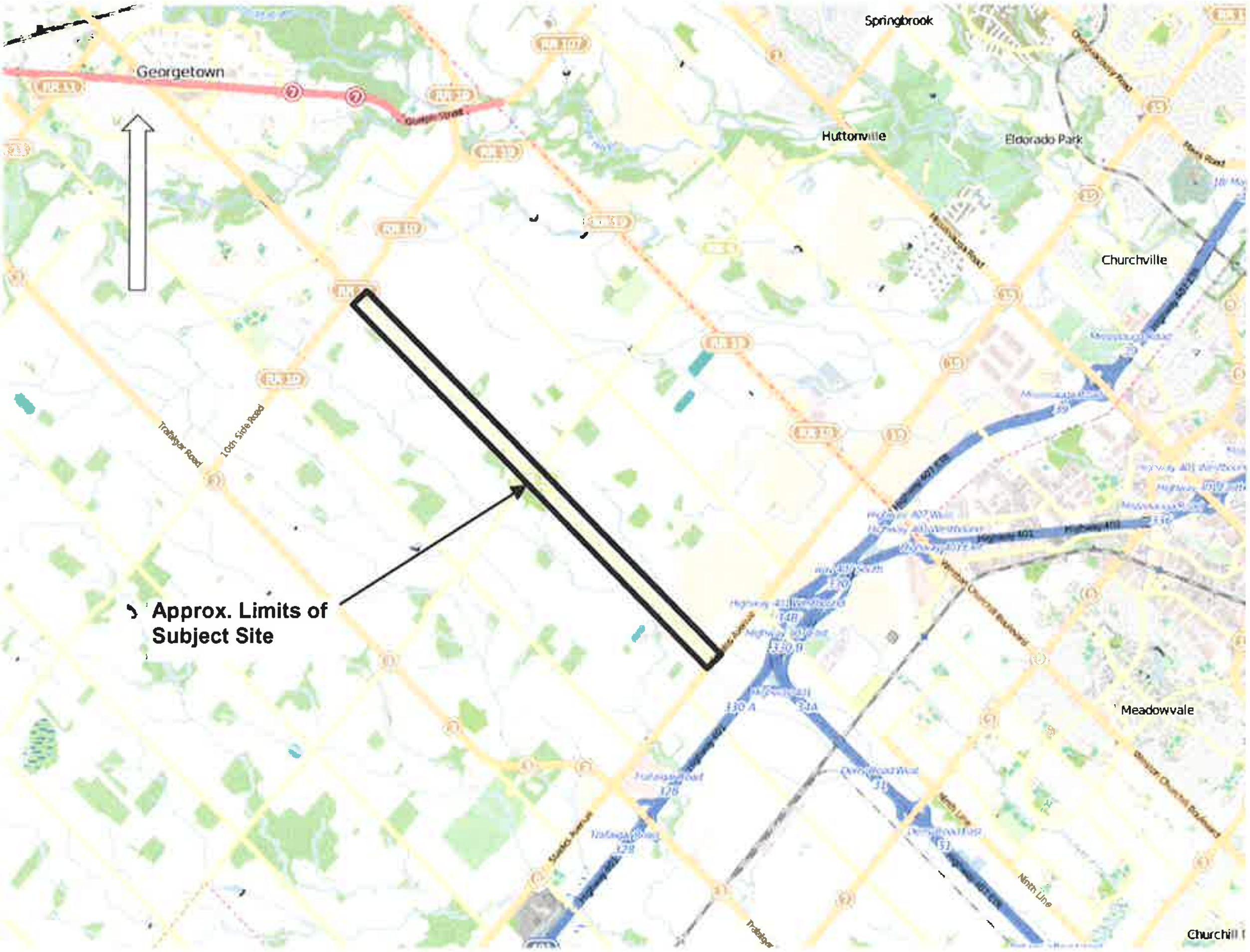


FIGURE 1 – KEY PLAN OF STUDY SITE LOCATION

3.1 TRAFFIC VOLUMES

The average annual daily traffic (AADT) provided for this section of road is 5,500 vehicles per day and two-way traffic volumes during peak hour is 1,200 vehicles per hour. Ninth Line traffic volumes are forecasted to increase to 2,600 vehicles per hour by 2031 exceeding the capacity of the current two lanes.

3.2 PAVEMENT STRUCTURE CONDITIONS

The overall pavement condition across the study area is good with no indication of significant pavement structural deficiencies such as wheelpath rutting or distortion, or fatigue related alligator and map cracking. However, there is some transverse cracking, edge cracking and longitudinal joint cracking.

Boreholes 1, 2, 3, 5, 7, 9, 12, and 14 were drilled through the existing pavement. The asphalt thickness ranges from 75 mm to 300 mm and the granular base thickness is variable between 75 mm and 300 mm with the majority of the thickness measurements being in excess of 175 mm.

TABLE 1 - SUMMARY BOREHOLE CONDITIONS

BOREHOLE NUMBER (see Note 1)	BITUMINOUS THICKNESS (mm)	GRANULAR BASE THICKNESS (mm)	TOPSOIL or ORGANIC SOIL THICKNESS (mm)	SUBGRADE CONDITIONS
1	75	175	-	FILL to 1.4 m depth, over compact silt till to EOH @ 3.5 m
2	125	175	-	FILL to 1.4 m depth, over a compact to dense silt till to EOH @ 3.5 m
3	75	300	-	FILL to 1.4 m depth, over a compact to very dense silt till to 2.2 m, over shale to EOH @ 3.5 m
4*	-	-	75	FILL to 1.4 m depth, over compact silt till to EOH @ 3.5 m
5	300	75	-	FILL to 1.4 m depth, over dense to very dense silt till to EOH @ 3.5 m
6*			200	FILL to 2.0 m depth, over loose silt till to2.8 m, over compact sand to EOH @ 3.5 m
7	75	300	-	FILL to 1.4 m depth, over compact to dense silt till to EOH @ 3.5 m
8*			200	Compact silt till to 2.5 m, over silty sand to EOH @ 3.5 m
9	250	150	-	Compact silt till to EOH @ 3.5 m
10*			150	Loose to compact silt till to 2.8 m, over dense silty sand to EOH @ 3.5 m
11*			350	FILL to 1.4 m depth, over compact silt till to 2.8 m over compact silty sand to EOH @ 3.5 m
12	200	200	-	FILL to 0.9 m depth, over compact silt till to 2.2 m over dense to very dense silty sand to EOH @ 3.5 m
13*		300	-	Compact to very dense silt till to EOH @ 3.5 m.
14	250	250	-	FILL to 2.0 m depth, over compact to very dense silt till to EOH @ 3.5 m
15*			200	Compact to very dense silt till to EOH @ 3.5 m

Notes:
Boreholes with an "*" after the number were drilled on the opposite side of the ditch from the road. Borehole 13 was drilled on the opposite side of the ditch (culvert) from the road in a gravel driveway. All other boreholes were drilled on the paved portion of the road.

3.3 SUBGRADE CONDITIONS

Geology map data[1] indicates that Ninth Line is in an area of clay to silt textured soil of the Halton formation overlying Queenston shale. The borehole information is consistent with the background geology data and indicates that the predominant native subgrade soil is silt till overlying shale bedrock.

Boreholes 4, 6, 8, 10, 11, and 15 were drilled on the opposite side of the ditch from Ninth Line in the grass. A layer of organic soil/topsoil was encountered at the surface of these boreholes ranging in thickness from 75 mm to 350 mm. Borehole 13 was also drilled on the opposite side of the ditch, just beyond the culvert, in an existing gravel driveway/lane way. Approximately 300 mm of granular material was encountered at the surface of borehole 13.

Fill

Underlying the pavement or organic soils, fill was encountered in boreholes 1 to 7, 11, 12, and 14 to depths ranging from 0.9 m to 2.0 m. The fill was generally firm and consisted of a mixture of clayey silt with some gravel and organics.

Silt Till

Underlying the fill (boreholes 1 to 7, 11, 12, and 14), organic soils (boreholes 8, 10, and 15), pavement (boreholes 9), or granular (borehole 13), a layer of loose to very dense brown silt till was encountered to a depth ranging from 2.2 m to the final depth investigated (3.5 m). Typical SPT values of 8 to 86 blows for 300 mm penetration of the sampler, and 50 blows per 100 mm penetration of the sampler, were recorded and moisture contents ranged from 9 to 20 percent.

Sand and Silty Sand

A brown silty sand layer was encountered under the silt till deposit to the final depth investigated (3.5 m) in boreholes 8, 10, 11, and 12 and a brown sand layer was encountered in borehole 6 under the silt till deposit to the final depth investigated (3.5 m). SPT values of 13 to 52 blows for 300 mm penetration of the sampler were recorded and moisture contents ranged from 8 to 17 percent.

Shale

Shale was encounter in borehole 4 at a depth of 2.2 m and extended to the termination depth of 3.5 m.

4.0 MANAGEMENT OF EXCAVATED EXCESS MATERIALS

Analyses for metals and inorganic parameters were carried out on composite subgrade samples from all the boreholes and the results are provided in Appendix D. The samples were tested in relation to MOE Table 1 Full Depth Background Site Conditions and the MOE Table 3 soil quality standards and compared to both the Residential/Parkland/Institutional property use and the Industrial/Commercial/Community criteria given in the MOE document "Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act", dated April 15, 2011. The results are summarized in Table 2.

When compared to the MOE Table 3 Industrial/Commercial/Community Land Use Standards, the parameters of the soils tested met all soil quality standards. Elevated results for Electrical Conductivity (EC) and Sodium Absorption Ratio (SAR) occurred in boreholes 1, 5, 9, 10, 11, and 12 when compared to the MOE Table 1-Full Depth Background Site Condition Standards and the MOE Table 3 Residential/Parkland/Institutional Land Use Standards.

TABLE 2 - SUMMARY OF ANALYTICAL TEST DATA

SAMPLE IDENTIFICATION	Comparison to Table 1 - Full Depth Background Site Condition Standards		Comparison to Table 3 **RESIDENTIAL/PARKLAND/INSTITUTIONAL** Land Use Standards for a non-potable groundwater situation		Comparison to Table 3 **INDUSTRIAL/COMMERCIAL/COMMUNITY** Land Use Standards for a non-potable groundwater situation	
	Meets Criteria	Does Not Meet Criteria	Meets Criteria	Does Not Meet Criteria	Meets Criteria	Does Not Meet Criteria
Borehole 1		EC	√		√	
Borehole 2	√		√		√	
Borehole 3	√		√		√	
Borehole 4	√		√		√	
Borehole 5		EC, SAR		SAR	√	
Borehole 6	√		√		√	
Borehole 7	√		√		√	
Borehole 8	√		√		√	
Borehole 9		EC, SAR		EC, SAR	√	
Borehole 10		SAR	√		√	
Borehole 11		SAR	√		√	
Borehole 12		EC, SAR		SAR	√	
Borehole 13	√		√		√	
Borehole 14		EC, SAR		EC, SAR	√	
Borehole 15	√		√		√	

The elevated EC results are considered to be related to the historical use of road salts for winter de-icing operations and do not present an adverse health risk. Some variability in soil quality parameters may occur within a given sample as well as along the length of a road section. During the course of excavation and mixing of materials the EC and/or SAR parameters may not be an issue. Ontario Regulation 153 indicates that elevated residual road salt parameters in soils within the road allowance that result from winter salting that was placed to address safety issues are not regarded as an environmental problem that requires remediation.

5.0 PAVEMENT AND BIKE LANE CONSIDERATIONS

Future road improvements are expected to include both rehabilitation and upgrading of existing asphalt pavement and transition areas, and new asphalt pavement construction for lane widening and bicycle lanes. The asphalt on Ninth Line generally has a substantial thickness that typically ranges from 75 mm to 300 mm and likely reflects past resurfacing practices. As well, crack sealing maintenance practices have been kept up to date such that the current road surface is in good condition without immediate need for major repairs and/or resurfacing. The following sections therefore provide recommendations to address new pavement construction, bike lane construction, and future resurfacing.

5.1 NEW PAVEMENT CONSTRUCTION

The existing roadway accommodates cars as well as heavy commercial truck traffic and it is anticipated that new pavement construction will incorporate a flexible asphalt on granular structure that is consistent with the existing pavement structure. Traffic information provided to Landtek indicates that for the majority of the study section of Ninth Line the total two lane AADT (Average Annual Daily Traffic) is about 5,500 vehicles per day. The percent of commercial truck traffic was not provided however a recommended design value of about 8 % is assumed. A recommended pavement structure design was developed based on using The Asphalt Institute[2] methodology for a 20-year design life and the following data:

Percent commercial truck/bus traffic	8.0 %
Estimated AADT (both ways)	5,500
Design traffic split	50/50
Average yearly growth rate in design period	2.5 %
Average subgrade support resilient modulus	35 MPa

The total accumulated 80 kN Equivalent Single Axle Loads (ESAL's) in the 20-year design period for the design lane is to be confirmed. The total pavement structure thickness should be at least one-half the anticipated maximum depth of freezing.

Hot Mix Asphalt

The binder course asphalt should meet current Region of Halton specifications for Heavy Duty Binder Course (HDBC) or HL8 HS. HDBC hot mix asphalt identified in OPSS 1150, Table 1 is a binder course intended for use in locations where rutting and deformation is likely to occur due to frequent heavy traffic loading. The surface course asphalt should meet OPSS specifications for HL3 HS material and have a minimum compacted thickness of 50 mm.

Asphalt cement should conform to OPSS 1101 specifications for Performance Graded asphalt cement binder. All hot mix asphalt should incorporate PG 58-28 grade asphalt cement binder as a minimum requirement. Given that the road is used for commercial truck traffic it is recommended that the grade of asphalt cement be upgraded to PG 64-28 (one level higher than required for the Ontario climate zone) for both the top asphalt and the binder course asphalt.

TABLE 3 - PAVEMENT STRUCTURE DESIGN RECOMMENDATIONS

PAVEMENT LAYER	RECOMMENDED PAVEMENT DESIGN
ASPHALT	50 mm HL 3 HS 100 mm HDBC (two 50 mm lifts)
GRANULAR BASE	150 mm OPSS Granular A
GRANULAR SUBBASE	350 mm OPSS Granular B, Type II
TOTAL THICKNESS (GBE)	650 mm (800)

Note 1: Best paving practice is to specify the compacted lift thickness to be at least 3 times the nominal maximum aggregate size (NMAS) of the mix. For HL 3 HS the NMAS is typically 13.2 mm such that the compacted lift thickness should be at least 39.6 mm to minimize segregation, broken aggregate and other placement problems.

Granular Basecourse and Subbase

The granular base course materials should meet OPSS Granular A specifications. Quarried 20 mm limestone, crushed to Granular "A" gradation specifications, is recommended. The granular subbase material should meet OPSS Granular "B" Type II specifications. OPSS Type II subbase material is assumed in the design and consists of 100 percent crushed aggregate from a quarried rock source. Quarried 50 mm crusher-run limestone, processed to Granular "B" gradation specifications, is recommended.

Compaction

Granular base course and subbase course fill material should be compacted to 100 percent Standard Proctor Density. Hot mix asphalt should be compacted to the criteria set out in the Region's paving specifications, which requires a minimum of 91 to 92 percent of the Marshall Maximum Relative Density (MRD) depending on mix type.

5.2 RECLAMATION AND REUSE OF EXISTING PAVEMENT MATERIALS

The existing bituminous material and granular can be considered for on-site reclamation and reuse in the new pavement using in-place pulverization methods however because of the substantial asphalt layer thicknesses it may not be practical and cost-effective since the depth of the pulverization should be at least two and half times the asphalt thickness to avoid high proportions of asphalt coated particles in the reclaimed granular.

The gradation quality of the recovered pulverized material is expected to be quite variable and the gradation of the reclaimed material is expected to not consistently meet OPSS Granular B Type I gradation limits. For this reason the reclaimed granular should be restricted to the lower half of the subbase layer in the new pavement. If the intention is to pulverize and reclaim the granular and bituminous material for reuse it is advisable to investigate the in-situ materials more thoroughly by means of test pits.

5.3 SUBGRADE PREPARATION

The subgrade soil conditions are expected to be variable along the road section consequently from time to time it may be necessary to complete subgrade repairs by excavating poor quality soils and placing structural fill. Subgrade repair areas should be compacted to a target density of 97 % of the Standard Proctor Maximum Dry Density.

It is recommended that prior to the placement of pavement granular fill, the exposed subgrade soil should be observed and proof-rolled using a loaded tandem axle truck to traverse the exposed subgrade and provide for full coverage. The proof-rolling should be monitored by a geotechnical representative of this office to delineate any soft areas, which may require repair. Repairs should be undertaken to avoid creating "bathtub" conditions in the subgrade within the pavement structure.

5.4 EXISTING PAVEMENT REHABILITATION

There is no evidence that the existing pavement structure of Ninth Line has been structurally deficient to date and therefore it is expected that future rehabilitation can focus on road surface improvements. road realignment, grade changes, and/or geometric changes may dictate that other types of more extensive rehabilitation methodologies be examined. The potential rehabilitation options are as follows:

Option 1	Partial depth cold milling with new hot mix asphalt resurfacing.
Option 2	In-place full depth pulverization and recycling of the bituminous layer and granular (OPSS 330) plus new asphalt resurfacing.

Option 1, partial depth milling with hot mix asphalt resurfacing, is the most straight forward rehabilitation option and should fit the needs for Ninth Line over the next 10 to 20 years. This option has a relatively low impact on traffic flow, and enables an acceptable grade height and road crossfall to be maintained.

Options 2 uses road re-profiling and reclaiming equipment to recycle existing pavement materials and minimize off-site removals.

For preliminary design purposes to address pavement rehabilitation over the next 10 to 20 years the following option is recommended as follows:

Partial depth cold milling with new hot mix asphalt paving.

1. Complete Cold Milling to a depth of at least ±60 mm; milling depth may have to be adjusted and increased to meet surface grade access requirements at existing properties;
2. Carry out base repairs based on visual distress conditions in milled pavement;
3. Proceed with 60 mm of HL 8 HS (HDBC) binder course paving;
4. Complete surface paving with 50 mm of HL 3 HS hot mix asphalt;
5. Utilize PG 64-28 asphalt cement in both the binder course and surface course mixes;

5.5 BASE REPAIRS AND SHOULDER BIKE LANE CONSTRUCTION

Ninth Line generally does not exhibit areas of distortion and severe cracking that require full depth base repairs. In the event that areas of distress occur or become evident after milling these areas should be repaired prior to pavement resurfacing. Full base repairs should be carried out and should be include excavation to a depth of 500 mm, or deeper if organic soils are encountered, and the placement and compaction of Granular A to 100 % SPMDD.

Wherever possible "bathtub" subgrade conditions should be avoided and the subgrade should be "daylighted" out to the ditch line. This may require additional shoulder excavation to achieve the optimum drainage conditions. Figure 2 below illustrates full depth base repairs to avoid bathtub subgrade conditions.

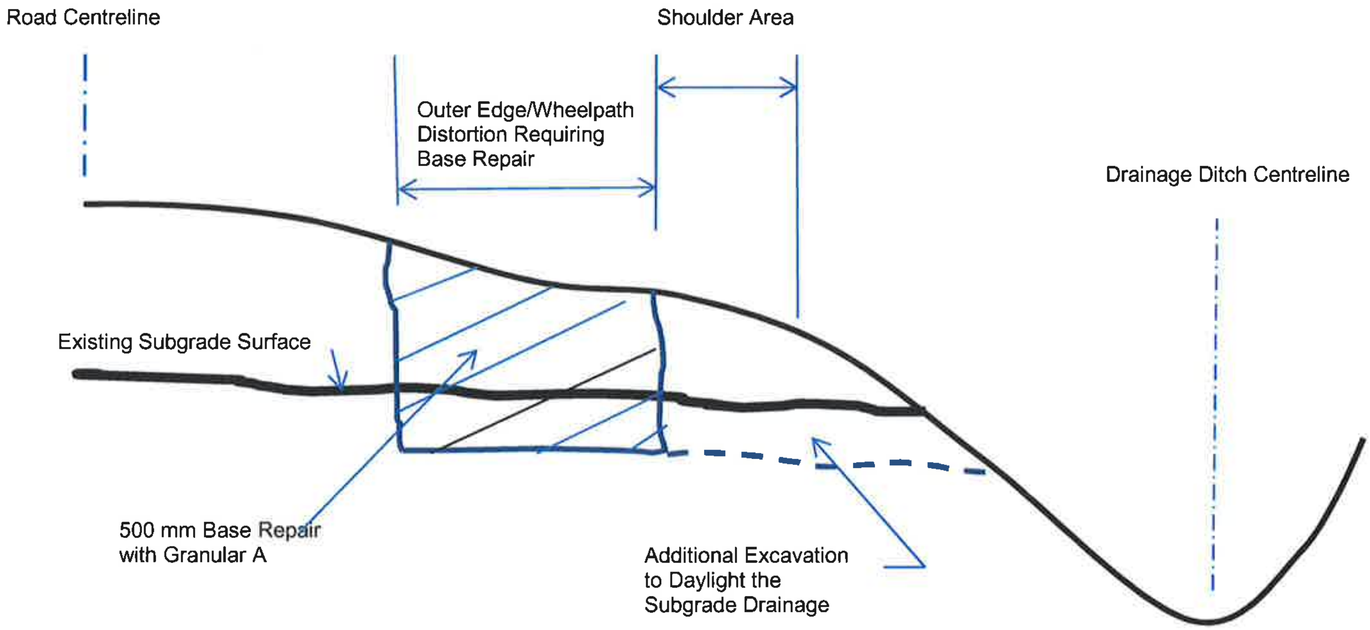


FIGURE 2 – HALF ROAD SECTION SHOWING BASE REPAIR TREATMENT (NTS)

6.0 CLOSURE

The Limitations of Report, as stated in Appendix A, are an integral part of this report.

Soil samples will be retained and stored by Landtek Limited for a period of three months after the report is issued. The samples will be disposed of at the end of the three month period unless a written request from the client to extend the storage period is received.

I trust this report will assist you with your project. Should you have any questions, please do not hesitate to contact our office.

Yours very truly,

LANDTEK LIMITED

LICENSED PROFESSIONAL ENGINEER
24 Aug 2018
G. W. WUISMAN
PROVINCE OF ONTARIO

Cory Zanatta, E.I.T.

Greg Wuisman, P.Eng.

REFERENCES

[1] Quaternary Geology of the Niagara Area, Map P764, Ontario Division of Mines, Ministry of Natural Resources, 1972

[2] Thickness Design - Asphalt Pavements for Highways and Streets, The Asphalt Institute Manual Series No. 1

APPENDIX A
LIMITATIONS OF REPORT

The conclusions and recommendations given in this report are based on information determined at the borehole locations. Subsurface and ground water conditions between and beyond the Boreholes may be different from those encountered at the borehole locations, and conditions may become apparent during construction that could not be detected or anticipated at the time of the geotechnical investigation. It is recommended practice that Landtek be retained during construction to confirm that the subsurface conditions throughout the site are consistent with the conditions encountered in the Boreholes.

The comments made in this report on potential construction problems and possible remedial methods are intended only for the guidance of the designer. The number of boreholes may not be sufficient to determine all the factors that may influence construction methods and costs. For example, the thickness and quality of surficial topsoil or fill layers may vary markedly and unpredictably. Contractors bidding on the project, or undertaking construction on the site should make their own interpretation of the factual borehole information, and establish their own conclusions as to how the subsurface conditions may affect their work.

The survey elevations in the report, if available, were obtained by Landtek Limited or others, and are strictly for use by Landtek in the preparation of the geotechnical report. The elevations should not be used by any other parties for any other purpose.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Landtek Limited accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this report.

This report does not reflect environmental issues or concerns related to the property unless otherwise stated in the report. The design recommendations given in the report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not be known, it is recommended that Landtek Limited be retained during the final design stage to verify that the design is consistent with the report recommendations, and that the assumptions made in the report are still valid.

APPENDIX B
SYMBOLS AND TERMS USED IN THE REPORT

RELATIVE PROPORTIONS

Term	Range
Trace	0 - 5%
A Little	5 – 15%
Some	15 – 30%
With	30 – 50%

CLASSIFICATION BY PARTICLE SIZE

Boulder		> 200 mm
Cobble		200 mm – 80 mm
Gravel -		
	Coarse	80 mm – 19 mm
	Fine	19 mm – 4.75 mm
Sand -		
	Coarse	4.75 mm – 2 mm
	Medium	2 mm – 0.425 mm
	Fine	0.425 mm – 0.075mm
Silt		0.075 mm – 0.002 mm
Clay		< 0.002 mm

DENSITY OF NON-COHESIVE SOILS

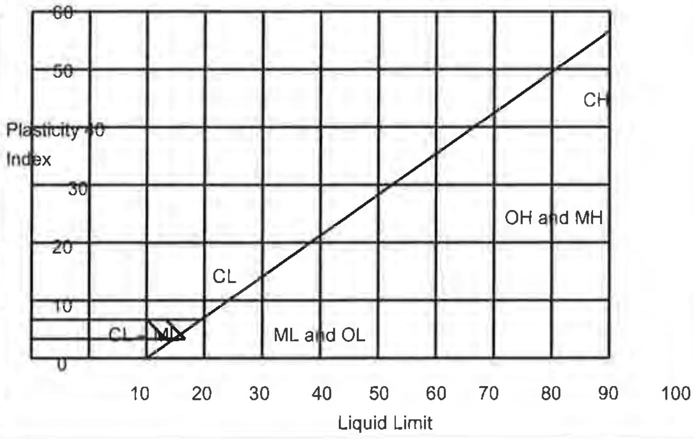
Descriptive Term	Relative Density	Standard Penetration Test	
Very Loose	0 – 15%	0 – 4	Blows Per 300 mm Penetration
Loose	15 – 35%	4 – 10	Blows Per 300 mm Penetration
Compact	35 – 65%	10 – 30	Blows Per 300 mm Penetration
Dense	65 – 85%	30 – 50	Blows Per 300 mm Penetration
Very Dense	85 – 100%	Over 50	Blows Per 300 mm Penetration

CONSISTENCY OF COHESIVE SOILS

Descriptive Term	Undrained Shear Strength kPa (psf)	N Value Standard Penetration Test	Remarks
Very Soft	< 12 (< 250)	< 2	Can penetrate with fist
Soft	12 – 25 (250 – 500)	2 – 4	Can indent with fist
Firm	25 – 50 (500 –1000)	4 – 8	Can penetrate with thumb
Stiff	50 – 100 (1000 – 2000)	8 – 15	Can indent with thumb
Very Stiff	100 – 200 (2000 – 4000)	15 – 30	Can indent with thumb-nail
Hard	> 200 (> 4000)	> 30	Can indent with thumb-nail

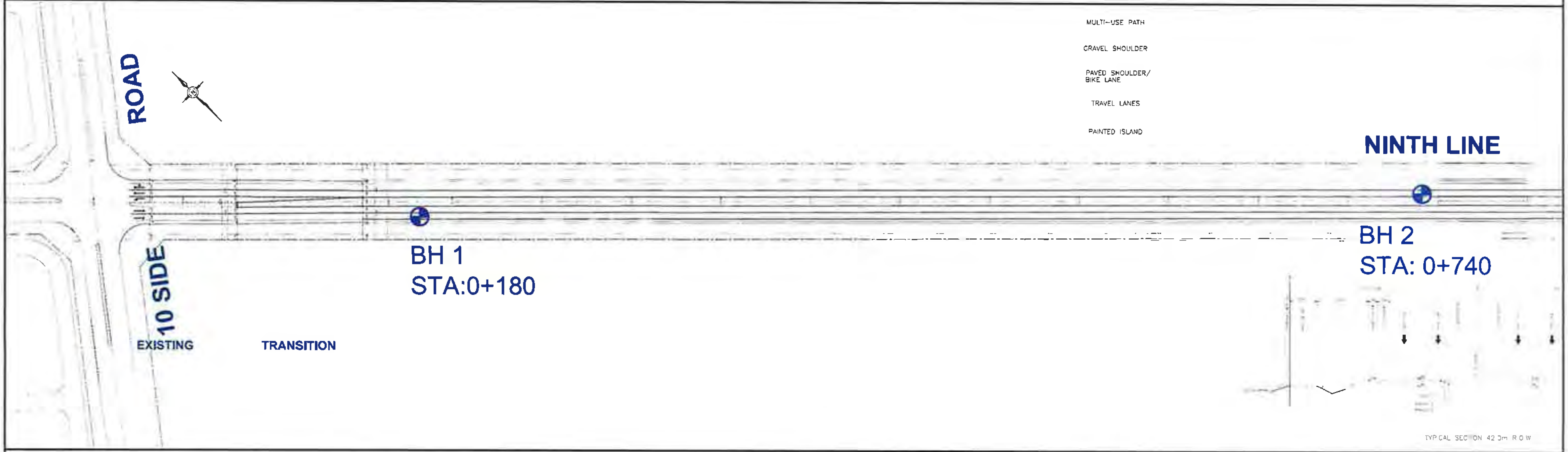
Notes: 1. Relative density determined by standard laboratory tests.
2. N value – blows/300 mm penetration of a 623 N (140 Lb.) hammer falling 760 mm (30 in.) on a 50 mm O.D. split spoon soil sampler. The split spoon sampler is driven 450 mm (18 in.) or 610 mm (24 in.). The “N” value is the Standard Penetration Test (SPT) value and is normally taken as the number of blows to advance the sampler the last 300 mm.

ENCLOSURE 2
CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES
ASTM Designation: D 2487 - 69 AND D 2488 – 69
(Unified Soil Classification System)

Major Divisions			Group Symbols	Typical Names	Classification Criteria		
Coarse-grained soils More than 50% retained on No. 200 sieve *	Gravels 50% or more of coarse fraction retained on No. 4 sieve	Clean gravels	GW	Well-graded gravels and gravel-sand mixtures, little or no fines	Classification on basis of percentage of fines Less than 5% pass No. 200 sieve . . . . . . GW, GP, SW, SP More than 12% pass No. 200 sieve . . . . . GM, GC, SM, SC 5 to 12% pass No.200 sieve . . . . Borderline classifications requiring use of dual symbols	C_u=D60/D10 greater than 4; $C_z = (D30)^2/(D10xD60)$ between 1 and 3	
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines		Not meeting both criteria for GW	
		Gravels with fines	GM	Silty gravels, gravel-sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures		Atterberg limits above "A" line with P.I. greater than 7	
	Sands More than 50% of coarse fraction passes No. 4 sieve	Clean Sands	SW	Well-graded sands and gravelly sands, little or no fines		C_u=D60/D10 greater than 6; $C_z = (D30)^2/ (D10xD60)$ between 1 and 3	
			SP	Poorly graded sands and gravelly sands, little or no fines		Not meeting both criteria for SW	
		Sands with fines	SM	Silty sands, sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures		Atterberg limits above "A" line with P.I. greater than 7	
Fine-grained soils 50% or more passes No. 200 sieve *	Silts and clays Liquid limit 50% or less		ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands	Plasticity Chart For classification of fine-grained soils and fine fraction of coarse-grained soils. Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols. Equation of A-line: PI=0.73 (LL-20) 		
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silts			
			OL	Organic silts and organic silts of low plasticity			
	Silts and clays Liquid limit greater than 50%		MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts			
			CH	Inorganic clays of high plasticity, fat clays			
			OH	Organic clays of medium to high plasticity			
	Highly organic soils		Pt	Peat, much and other highly organic soils	* Based on the material passing the 3 in. (76mm) sieve.		

APPENDIX C

DRAWINGS - SITE PLANS SHOWING BOREHOLE LOCATIONS
+
LOGS OF BOREHOLES



LEGEND

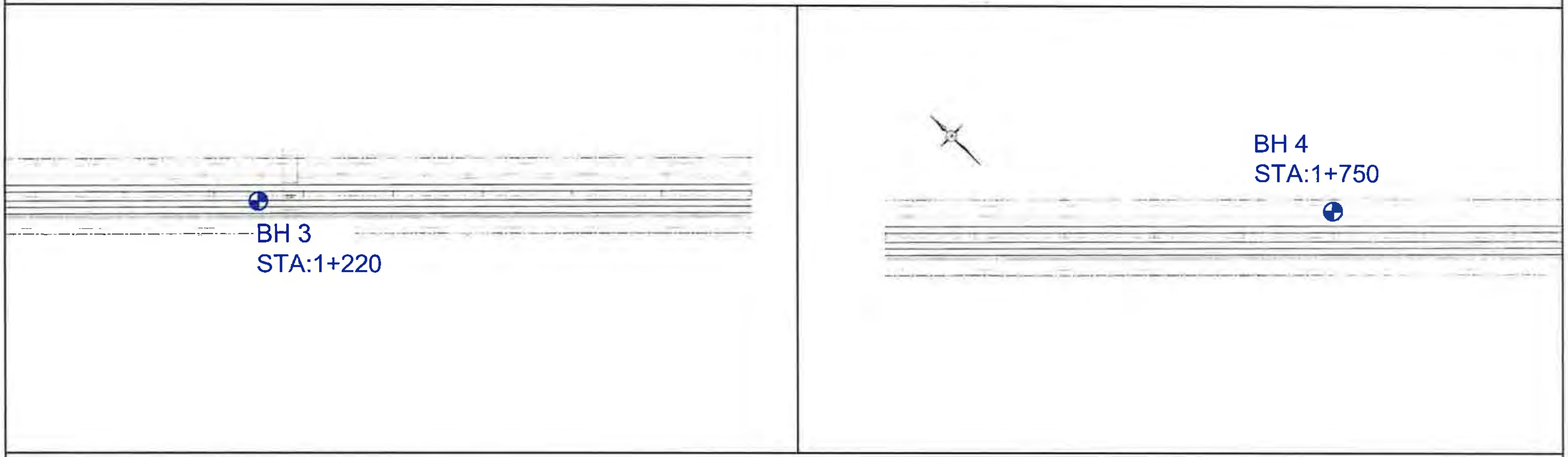
● Approximate locations of boreholes drilled by Landtek Limited on May 29, and June 1, 2015

NOTES

Base plan provided by UEM.

LANDTEK LIMITED
CONSULTING ENGINEERS
205 NEBO ROAD, HAMILTON, ONTARIO, L8W 2E1

DRAWING:	Borehole Location Plan		
PROJECT:	Ninth Line Class A ESA Ninth Line from Ten Side Road to Steeles Avenue, Halton Hills, Ontario		
SCALE:	NTS	**PROJECT NO.**	14057
DATE:	July, 2015	**DRAWING NO.**	1



LEGEND

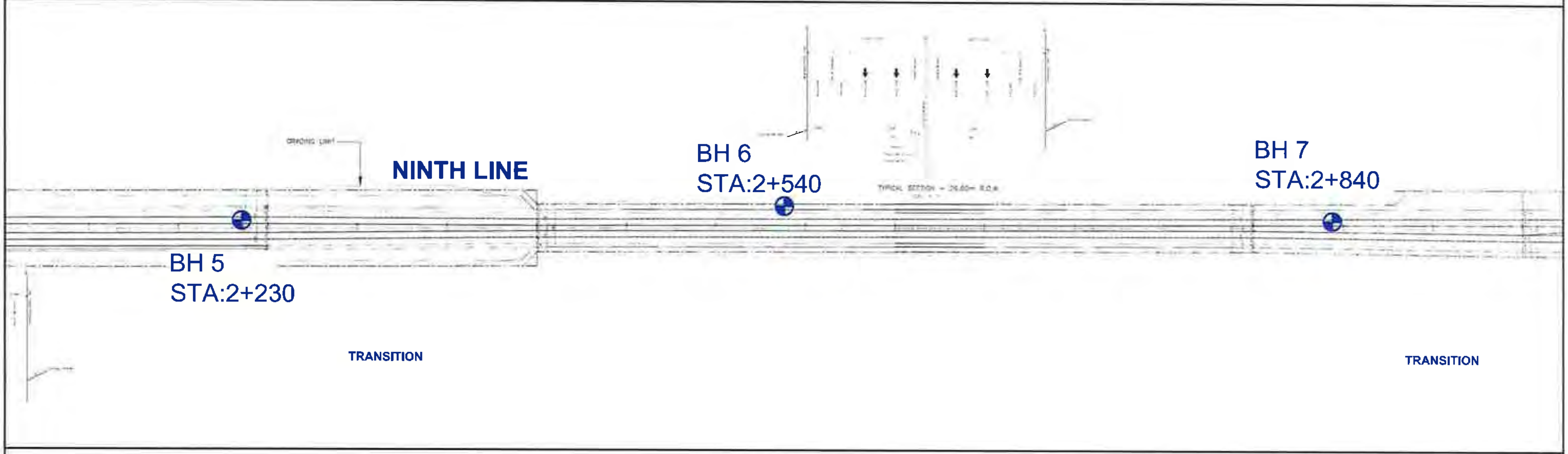
● Approximate locations of boreholes drilled by Landtek Limited on May 29, and June 1, 2015

NOTES

Base plan provided by UEM.

LANDTEK LIMITED
CONSULTING ENGINEERS
205 NEBO ROAD, HAMILTON, ONTARIO, L8W 2E1

DRAWING:	Borehole Location Plan		
PROJECT:	Ninth Line Class A ESA Ninth Line from Ten Side Road to Steeles Avenue, Halton Hills, Ontario		
SCALE:	NTS	**PROJECT NO.**	14057
DATE:	July, 2015	**DRAWING NO.**	2



LEGEND

● Approximate locations of boreholes drilled by Landtek Limited on May 29, and June 1, 2015

NOTES

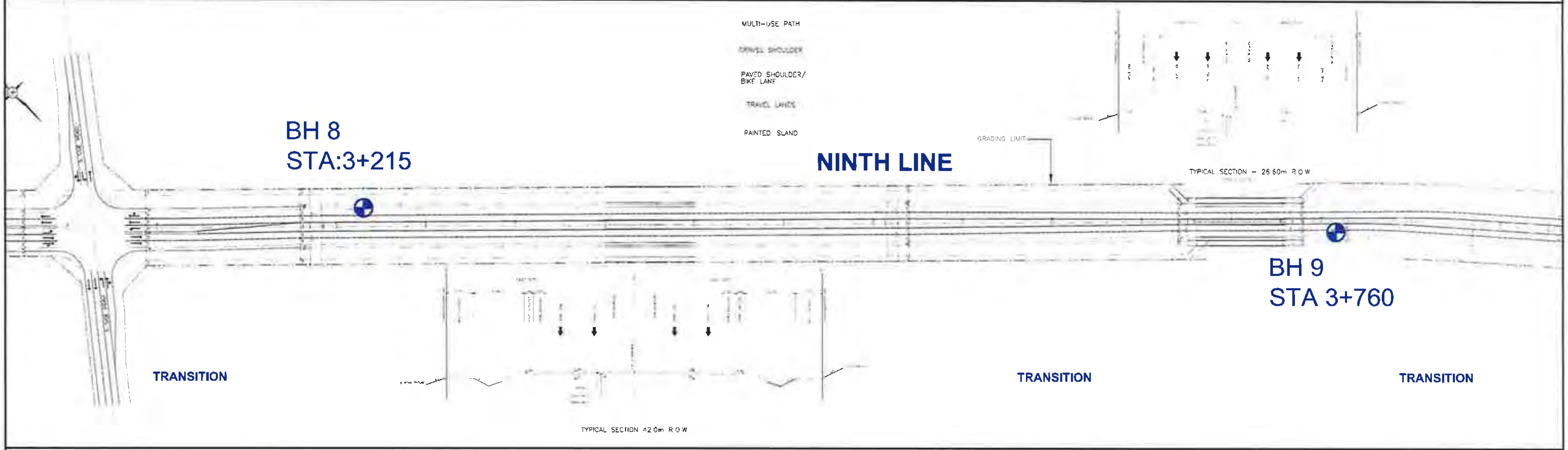
Base plan provided by UEM.

LANDTEK LIMITED
CONSULTING ENGINEERS
205 NEBO ROAD, HAMILTON, ONTARIO, L8W 2E1

DRAWING: Borehole Location Plan

PROJECT: Ninth Line Class A ESA
Ninth Line from Ten Side Road to Steeles Avenue, Halton Hills, Ontario

SCALE:	NTS	**PROJECT NO.**	14057
DATE:	July, 2015	**DRAWING NO.**	3



LEGEND

● Approximate locations of boreholes drilled by Landtek Limited on May 29, and June 1, 2015

NOTES

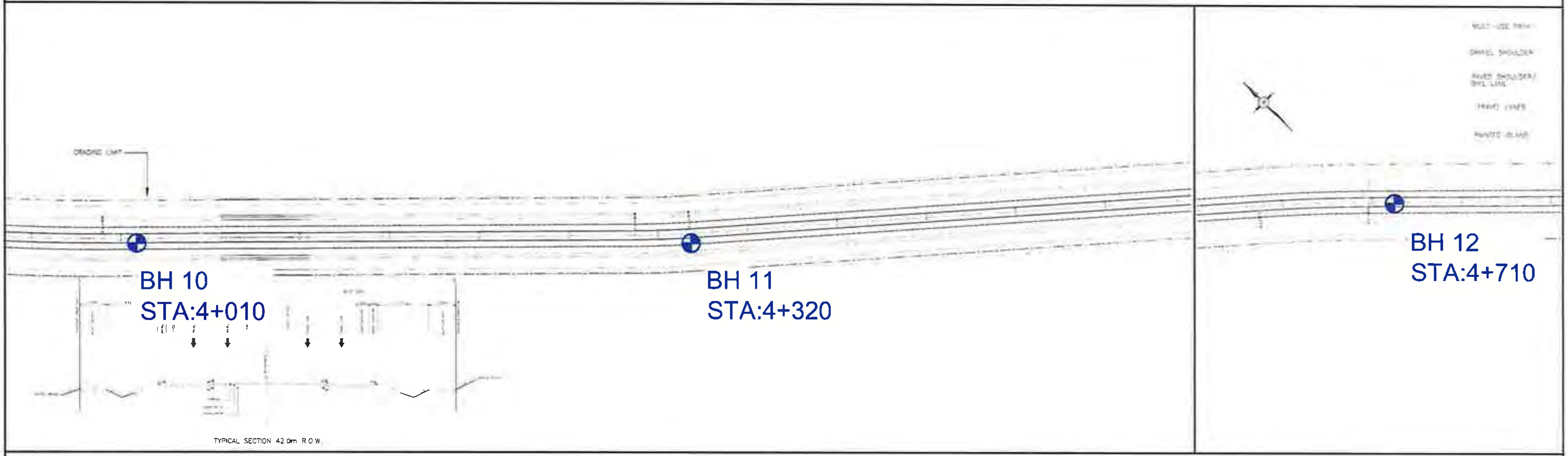
Base plan provided by UEM.

LANDTEK LIMITED
CONSULTING ENGINEERS
205 NEBO ROAD, HAMILTON, ONTARIO, L8W 2E1

DRAWING: Borehole Location Plan

PROJECT: Ninth Line Class A ESA
Ninth Line from Ten Side Road to Steeles Avenue, Halton Hills, Ontario

SCALE:	NTS	**PROJECT NO.**	14057
DATE:	July, 2015	**DRAWING NO.**	4



LEGEND

● Approximate locations of boreholes drilled by Landtek Limited on May 29, and June 1, 2015

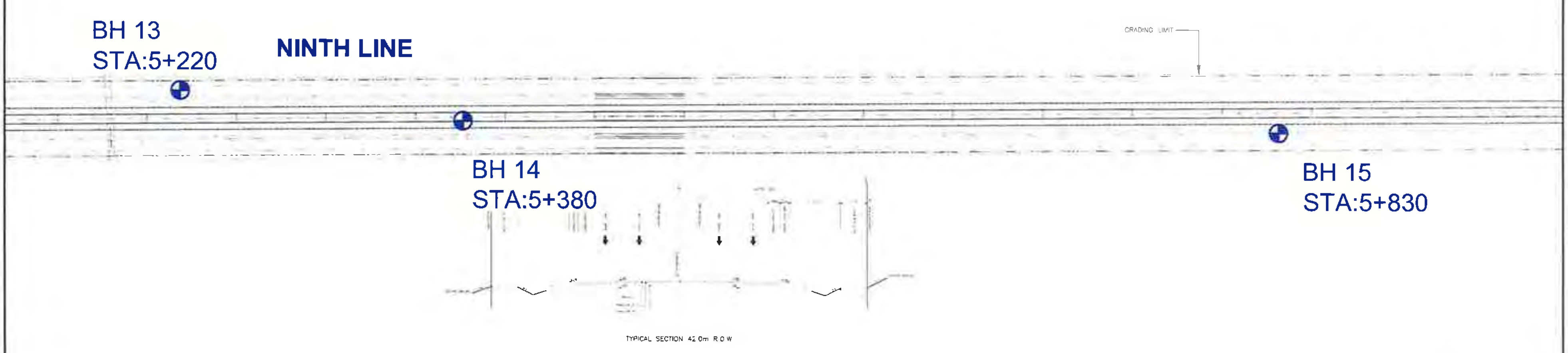
NOTES

Base plan provided by UEM.

LANDTEK LIMITED
CONSULTING ENGINEERS
205 NEBO ROAD, HAMILTON, ONTARIO, L8W 2E1

DRAWING:	Borehole Location Plan
PROJECT:	Ninth Line Class A ESA Ninth Line from Ten Side Road to Steeles Avenue, Halton Hills, Ontario

SCALE:	NTS	**PROJECT NO.**	14057
DATE:	July, 2015	**DRAWING NO.**	5



LEGEND

◐ Approximate locations of boreholes drilled by Landtek Limited on May 29, and June 1, 2015

NOTES

Base plan provided by UEM.

LANDTEK LIMITED
CONSULTING ENGINEERS
205 NEBO ROAD, HAMILTON, ONTARIO, L8W 2E1

DRAWING: Borehole Location Plan

PROJECT: Ninth Line Class A ESA
Ninth Line from Ten Side Road to Steeles Avenue, Halton Hills, Ontario

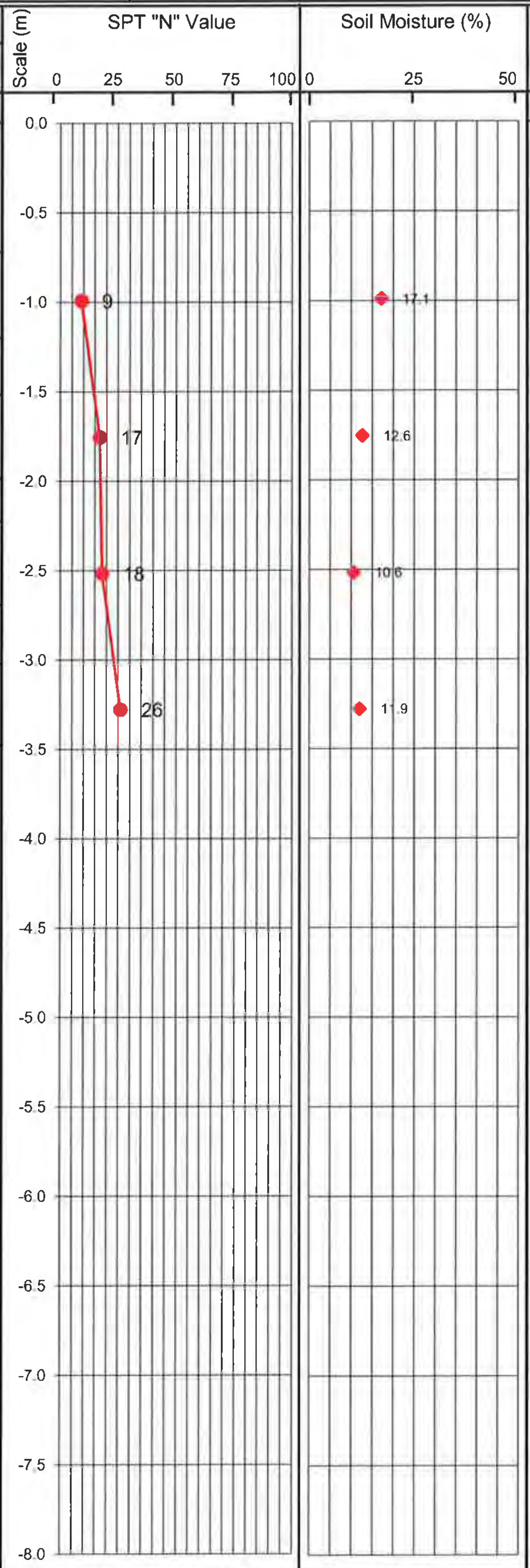
SCALE:	NTS	**PROJECT NO.**	14057
DATE:	July, 2015	**DRAWING NO.**	6

LANDTEK LIMITED

LOG OF BOREHOLE NO. 1

Project No.:	14057	Drill Date:	May 28 to May 29, 2015
Project:	Ninth Line Class A ESA	Drill Method:	[x] solid stem [ ] hollow stem [ ] vibratory
Location:	Ninth Line, Milton, Ontario	Datum:	Geodetic

Material Description	Symbol	Elev. Depth	Samples No.	Samples Type	GWL	Monitor Details	Test Data
Ground Surface							
±75 mm of asphalt ±175 mm of granular	■ ▨	0.0					
FILL mixture of clayey silt, some gravel, trace organics staining, brown, moist, (Stiff)	▨		1	SS			
SILT TILL trace clay, sand and gravel, brown, moist (Compact)	▨	1.4	2 3 4	SS SS SS			
BOREHOLE TERMINATED		3.5					



Notes: 1. Upon completion of drilling, borehole was open to 3.0 m and dry.

PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

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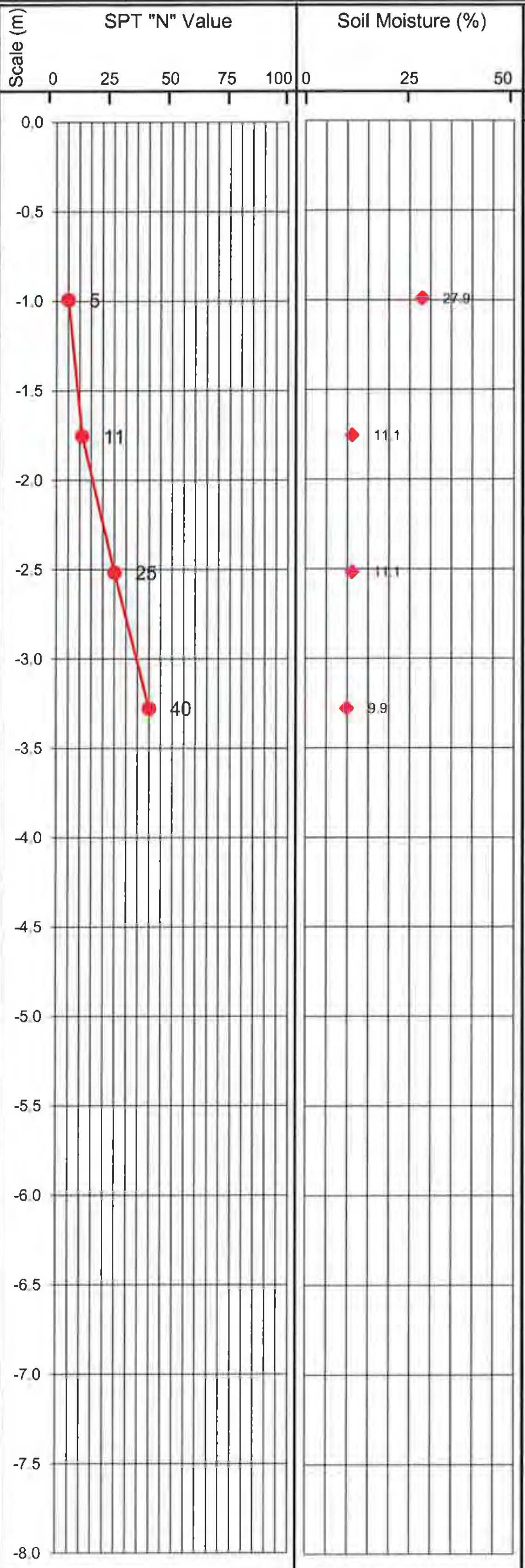
LOG OF BOREHOLE NO. 2

Project No.: 14057
Project: Ninth Line Class A ESA
Location: Ninth Line, Milton, Ontario
Drill Date: May 28 to May 29, 2015
Drill Method: [x] solid stem [ ] hollow stem [ ] vibratory
Datum: Geodetic

Material Description	Symbol	Elev. Depth	Samples No.	Type	SPT "N" Value	Soil Moisture (%)	GWL	Monitor Details	Test Data
Ground Surface									
±125 mm of asphalt ±175 mm of granular		0.0							
FILL mixture of silty clay, some gravel, trace organics staining, brown, moist, (Firm)			1	SS	5	27.9			
SILT TILL trace clay, sand and gravel, brown, moist (Compact to Dense)		1.4	2	SS	11	11.1			
			3	SS	25	11.1			
			4	SS	40	9.9			
BOREHOLE TERMINATED		3.5							



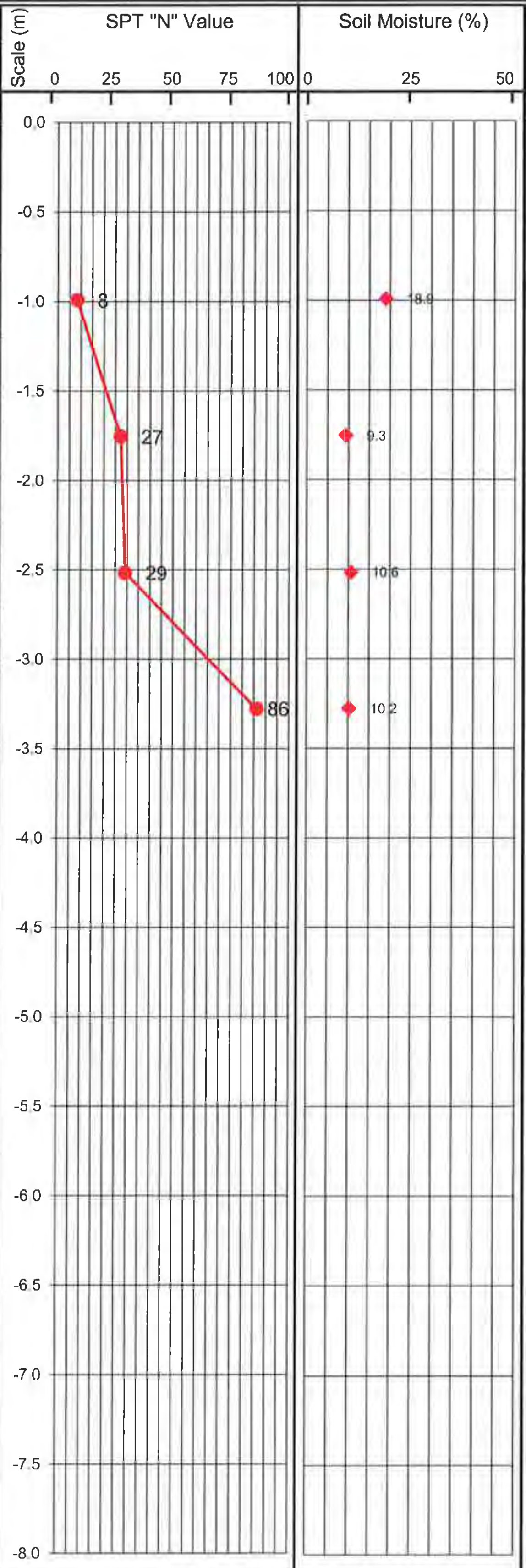
Notes: 1. Upon completion of drilling, borehole was open to 3.0 m and dry.

PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

LANDTEK LIMITED | **LOG OF BOREHOLE NO. 3**

Project No.:	14057	Drill Date:	May 28 to May 29, 2015
Project:	Ninth Line Class A ESA	Drill Method:	[x] solid stem [ ] hollow stem [ ] vibratory
Location:	Ninth Line, Milton, Ontario	Datum:	Geodetic

Material Description	Symbol	Elev. Depth	Samples No.	Samples Type	GWL	Monitor Details	Test Data
Ground Surface							
±75 mm of asphalt ±300 mm of granular		0.0					
FILL mixture of silty clay, trace gravel, brown, very moist, (Firm)			1	SS			
SILT TILL trace clay, sand and gravel, brown, moist (Compact to Very Dense)		1.4	2	SS			
			3	SS			
			4	SS			
BOREHOLE TERMINATED		3.5					



Notes: 1. Upon completion of drilling, borehole was open to 3.0 m and dry.

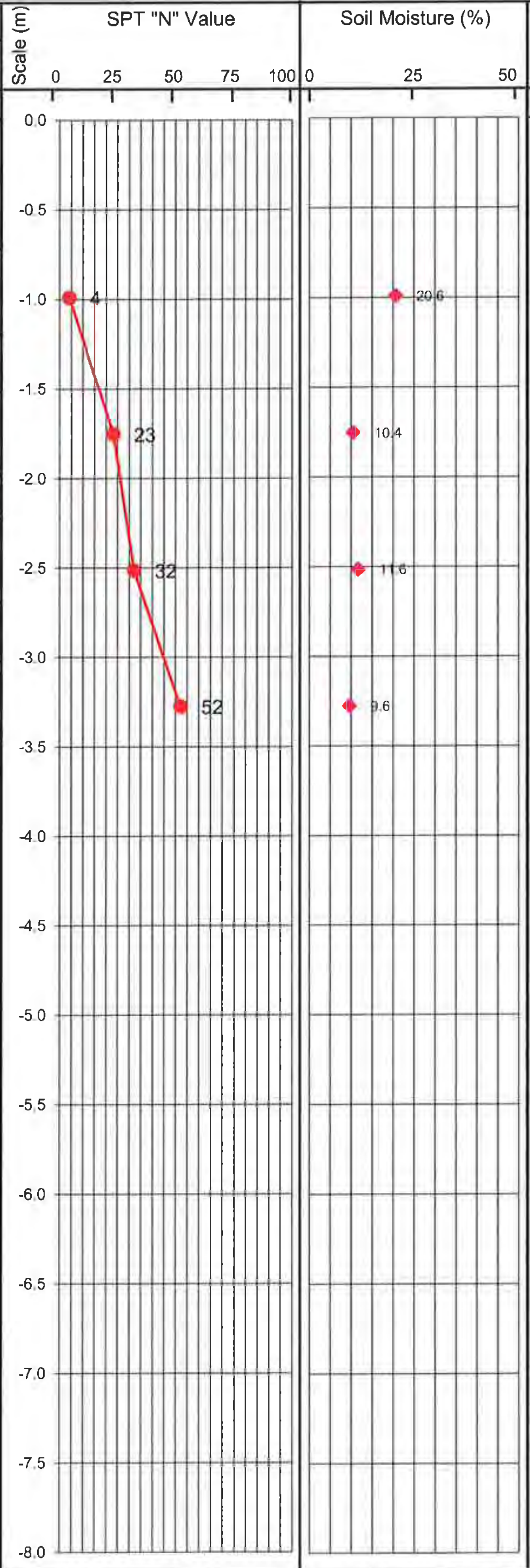
PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

LANDTEK LIMITED

LOG OF BOREHOLE NO. 4

Project No.:	14057	Drill Date:	May 28 to May 29, 2015
Project:	Ninth Line Class A ESA	Drill Method:	[x] solid stem [ ] hollow stem [ ] vibratory
Location:	Ninth Line, Milton, Ontario	Datum:	Geodetic

Material Description	Symbol	Elev. Depth	Samples No.	Samples Type	GWL	Monitor Details	Test Data
Ground Surface							
±75 mm of organic soil	▨	0.0					
FILL mixture of clayey silt, some sand and gravel, brown, very moist (Firm)	▨		1	SS			
SILT TILL trace clay, sand and gravel, brown, moist (Compact to Very Dense)	▨	1.4	2	SS			
SHALE (Queenston Formation) weathered, red, moist (Hard)	▤	2.2	3	SS			
	▤		4	SS			
BOREHOLE TERMINATED		3.5					



Notes: 1. Upon completion of drilling, borehole was open to 3.0 m and dry.

PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

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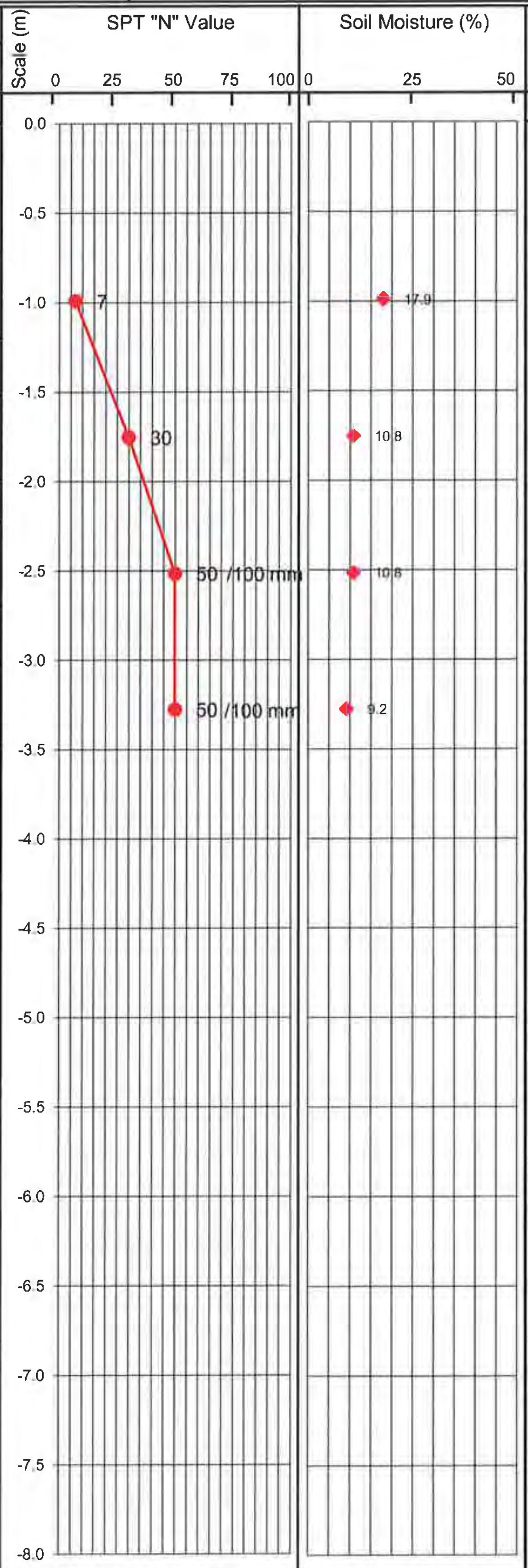
LOG OF BOREHOLE NO. 5

Project No.:	14057	Drill Date:	May 28 to May 29, 2015
Project:	Ninth Line Class A ESA	Drill Method:	[x] solid stem [ ] hollow stem [ ] vibratory
Location:	Ninth Line, Milton, Ontario	Datum:	Geodetic

Material Description	Symbol	Elev. Depth	Samples No.	Samples Type
Ground Surface				
±300 mm of asphalt ±75 mm of granular		0.0		
FILL mixture of clayey silt, some sand and gravel, brown, very moist (Firm)			1	SS
SILT TILL some sand, trace clay and gravel, brown, moist, (Dense to Very Dense)		1.4	2	SS
			3	SS
			4	SS
BOREHOLE TERMINATED		3.5		

GWL	Monitor Details	Test Data



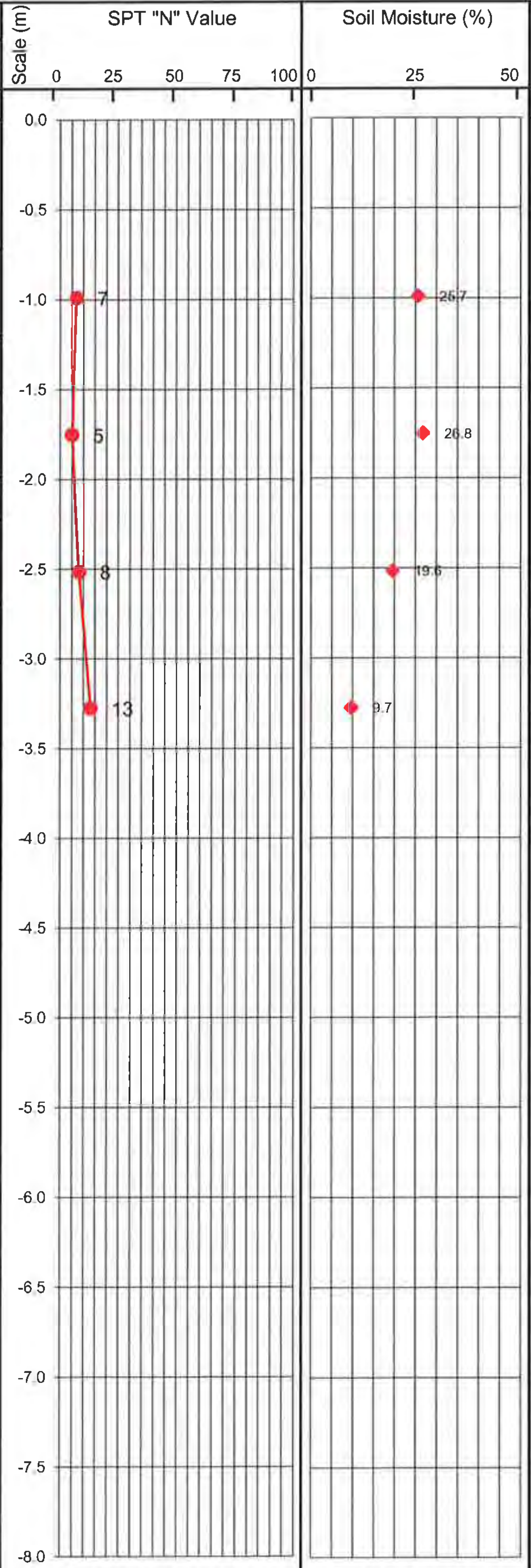
Notes: 1. Upon completion of drilling, borehole was open to 3.0 m and dry.

PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

LANDTEK LIMITED **LOG OF BOREHOLE NO. 6**

Project No.:	14057	Drill Date:	June 1, 2015
Project:	Ninth Line Class A ESA	Drill Method:	[x] solid stem [ ] hollow stem [ ] vibratory
Location:	Ninth Line, Milton, Ontario	Datum:	Geodetic

Material Description	Symbol	Elev. Depth	Samples No.	Samples Type	GWL	Monitor Details	Test Data
Ground Surface							
±200 mm organic soil	▨	0.0					
FILL mixture of clayey silt, some sand and gravel, brown, very moist (Firm)	▨		1 2	SS SS			
SILT TILL some sand, trace clay and gravel, brown, moist, (Loose)	▨	2.0	3	SS			
SAND medium grained, trace gravel and silt, brown, moist (Compact)	░	2.8	4	SS			
BOREHOLE TERMINATED		3.5					



Notes: 1. Upon completion of drilling, borehole was open to 3.0 m and dry.

PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

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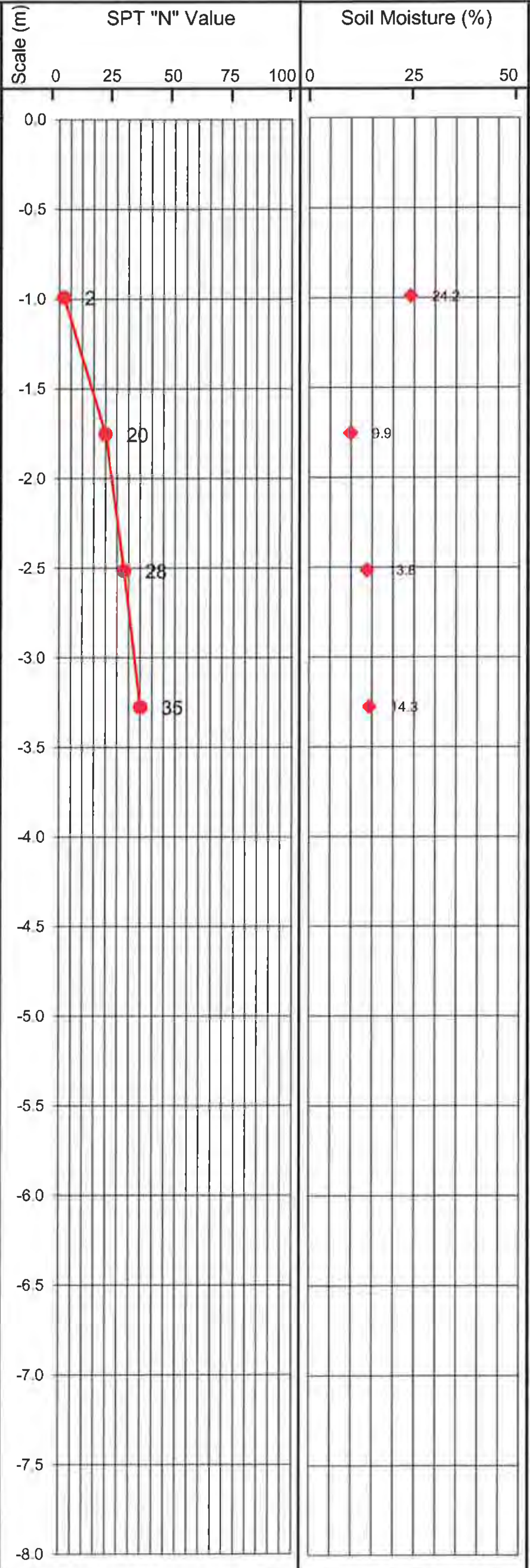
LOG OF BOREHOLE NO. 7

Project No.:	14057	Drill Date:	May 28, 2015
Project:	Ninth Line Class A ESA	Drill Method:	[x] solid stem [ ] hollow stem [ ] vibratory
Location:	Ninth Line, Milton, Ontario	Datum:	Geodetic

Material Description	Symbol	Elev. Depth	Samples No.	Samples Type	SPT "N" Value	Soil Moisture (%)	GWL	Monitor Details	Test Data
Ground Surface									
±75 mm of asphalt ±300 mm of granular		0.0							
FILL organic clayey silt, trace sand, brown to black, very moist (Soft)			1	SS	2	24.2			
SILT TILL some sand, trace clay and gravel, brown, moist, (Compact to Dense)		1.4	2	SS	20	9.9			
			3	SS	28	13.8			
sand seam ±3.3 m			4	SS	35	14.3			
BOREHOLE TERMINATED		3.5							



Notes: 1. Upon completion of drilling, borehole was open to 3.0 m and dry.

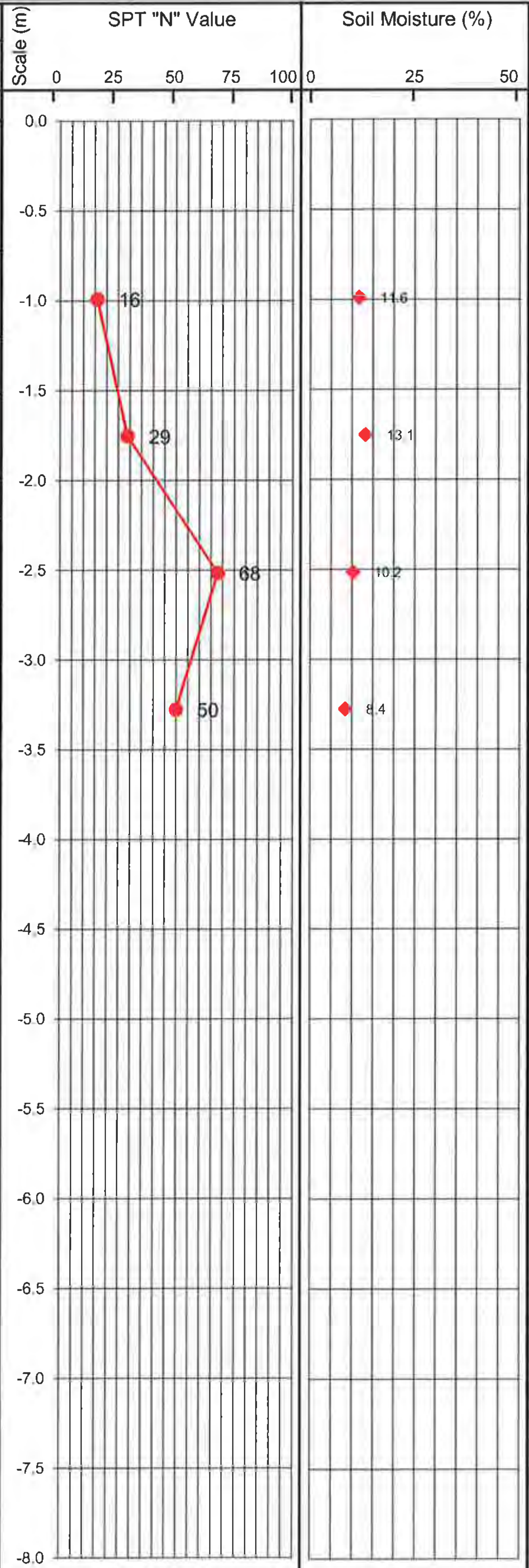
PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

LANDTEK LIMITED

LOG OF BOREHOLE NO. 8

Project No.:	14057	Drill Date:	May 28, 2015
Project:	Ninth Line Class A ESA	Drill Method:	[x] solid stem [ ] hollow stem [ ] vibratory
Location:	Ninth Line, Milton, Ontario	Datum:	Geodetic

Material Description	Symbol	Elev. Depth	Samples No.	Samples Type	GWL	Monitor Details	Test Data
Ground Surface							
±200 mm of topsoil		0.0					
SILT TILL some sand, trace clay and gravel, brown, moist, (Compact)			1 2 3	SS SS SS			
SILTY SAND trace gravel, brown, moist (Very Dense) sand seam ±3.3 m		2.5	4	SS			
BOREHOLE TERMINATED		3.5					



Notes: 1. Upon completion of drilling, borehole was open to 3.0 m and dry.

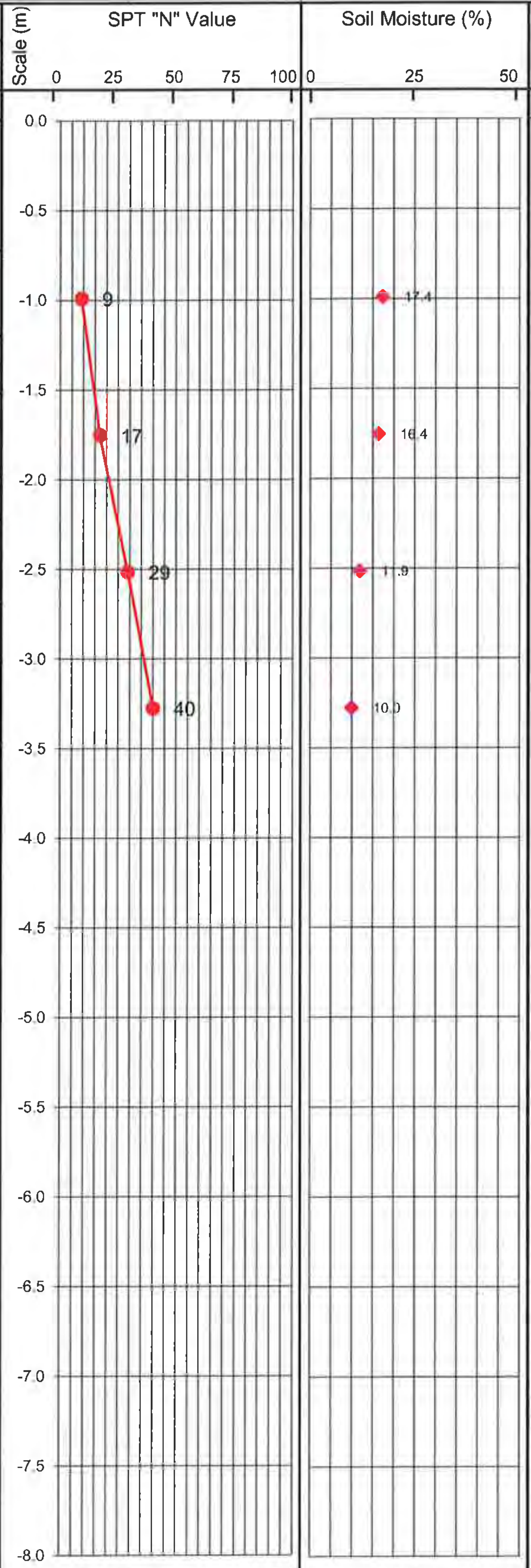
PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

LANDTEK LIMITED

LOG OF BOREHOLE NO. 9

Project No.:	14057	Drill Date:	May 28, 2015
Project:	Ninth Line Class A ESA	Drill Method:	[x] solid stem [ ] hollow stem [ ] vibratory
Location:	Ninth Line, Milton, Ontario	Datum:	Geodetic

Material Description	Symbol	Elev. Depth	Samples No.	Samples Type	GWL	Monitor Details	Test Data
Ground Surface							
±250 mm of asphalt ±150 mm of granular		0.0					
SILT TILL some sand, trace clay and gravel, brown, moist, (Compact)			1	SS			
			2	SS			
			3	SS			
			4	SS			
BOREHOLE TERMINATED		3.5					



Notes: 1. Upon completion of drilling, borehole was open to 3.0 m and dry.

PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

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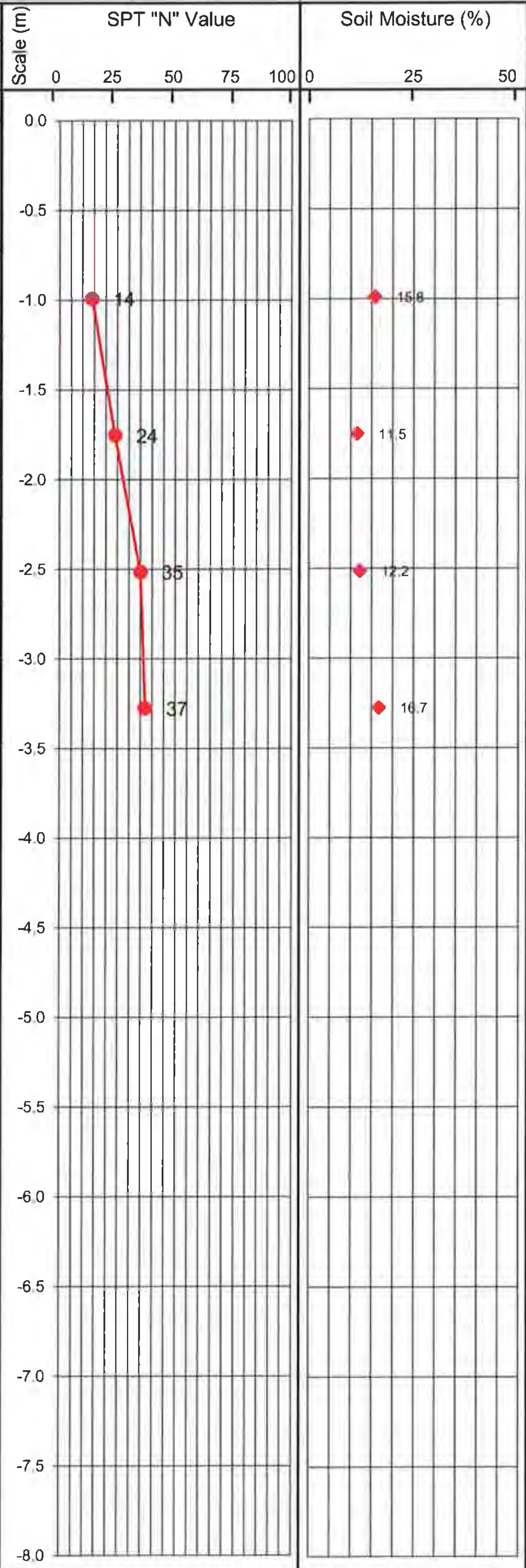
LANDTEK LIMITED

LOG OF BOREHOLE NO. 10

Project No.:	14057	Drill Date:	June 1, 2015
Project:	Ninth Line Class A ESA	Drill Method:	[x] solid stem [ ] hollow stem [ ] vibratory
Location:	Ninth Line, Milton, Ontario	Datum:	Geodetic

Material Description	Symbol	Elev. Depth	Samples No.	Samples Type	GWL	Monitor Details	Test Data
Ground Surface							
±150 mm of topsoil	▨	0.0					
SILT TILL some sand, trace clay and gravel, brown, moist, (Loose to Compact)	▨		1	SS			
	▨		2	SS			
	▨		3	SS			
SILTY SAND trace gravel, brown, saturated (Dense)	░	2.8	4	SS			
BOREHOLE TERMINATED		3.5					



Notes: 1. Upon completion of drilling, borehole was open to 1.0 m and water level at 1.0 m.

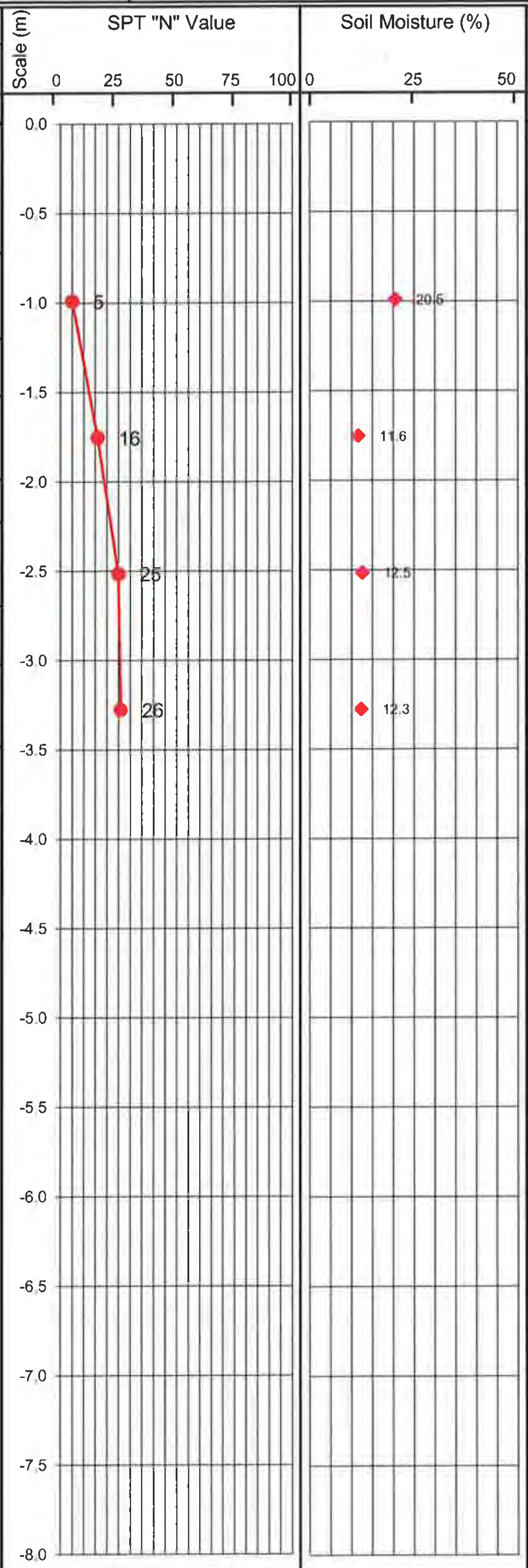
PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

LANDTEK LIMITED

LOG OF BOREHOLE NO. 11

Project No.:	14057	Drill Date:	June 1, 2015
Project:	Ninth Line Class A ESA	Drill Method:	[x] solid stem [ ] hollow stem [ ] vibratory
Location:	Ninth Line, Milton, Ontario	Datum:	Geodetic

Material Description	Symbol	Elev. Depth	Samples No.	Samples Type	GWL	Monitor Details	Test Data
Ground Surface							
±350 mm of topsoil	▩	0.0					
FILL silty clay, trace sand and gravel, brown, very moist (Firm)	▨		1	SS			
SILT TILL some sand, trace clay and gravel, brown, moist, (Compact)	▩	1.4	2 3	SS SS			
SILTY SAND trace gravel, unoxidized grey, wet (Compact)	▒	2.8	4	SS			
BOREHOLE TERMINATED		3.5					



Notes: 1. Upon completion of drilling, borehole was open to 2.4 m and water level at 2.4 m.

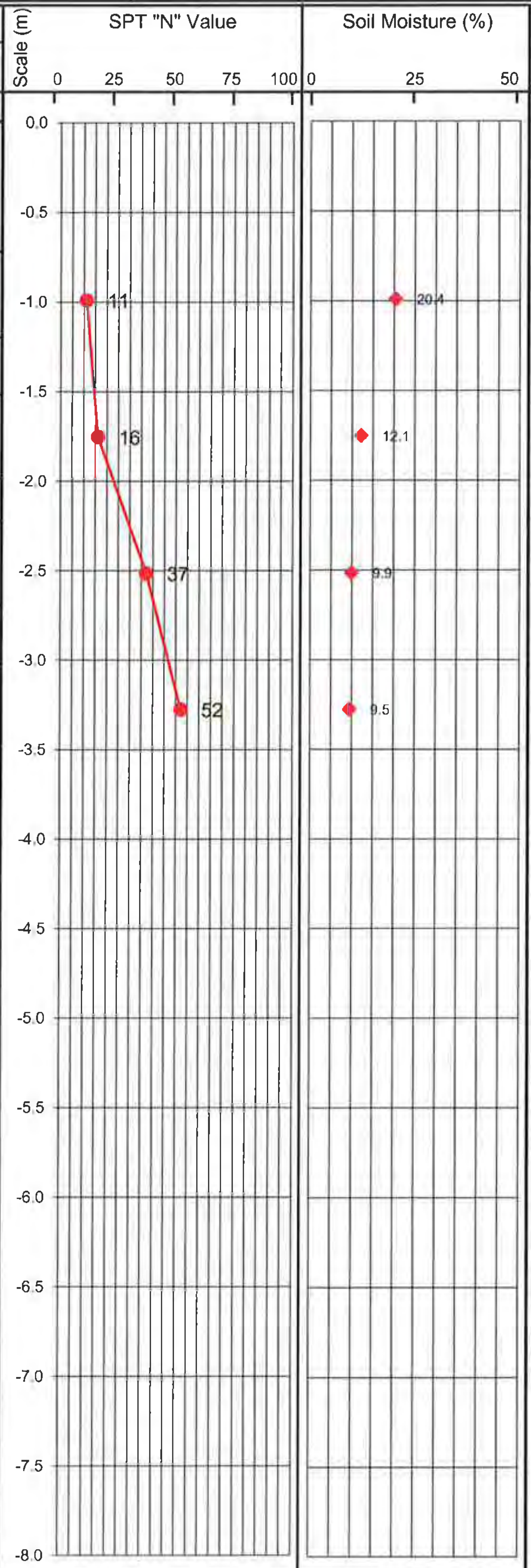
PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

LANDTEK LIMITED

LOG OF BOREHOLE NO. 12

Project No.:	14057	Drill Date:	June 1, 2015
Project:	Ninth Line Class A ESA	Drill Method:	[x] solid stem [ ] hollow stem [ ] vibratory
Location:	Ninth Line, Milton, Ontario	Datum:	Geodetic

Material Description	Symbol	Elev. Depth	Samples No.	Samples Type
Ground Surface				
±200 mm of asphalt ±200 mm of granular		0.0		
FILL organic silty clay				
SILT TILL some sand, trace clay and gravel, brown, moist, (Compact)		0.9	1 2	SS SS
SILTY SAND trace gravel, brown, very moist (Dense to Very Dense)		2.2	3 4	SS SS
BOREHOLE TERMINATED		3.5		



GWL | Monitor Details | Test Data

Notes: 1. Upon completion of drilling, borehole was open to 3.0 m and water level at 2.7 m.

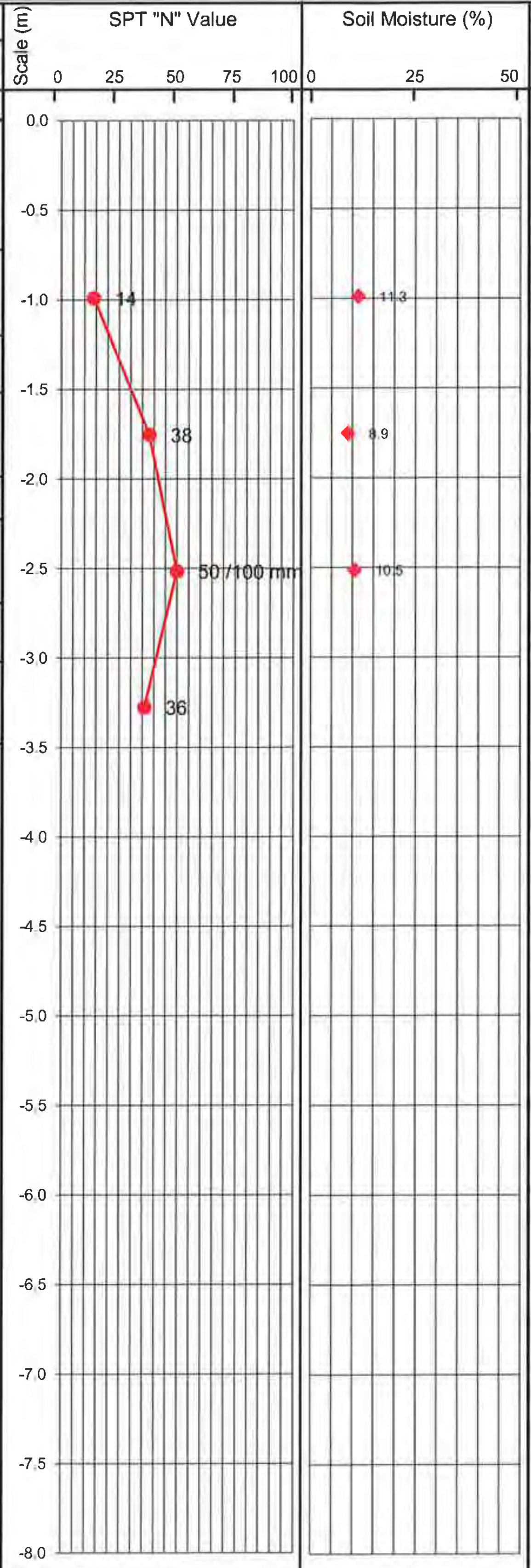
PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

LANDTEK LIMITED

LOG OF BOREHOLE NO. 13

Project No.: 14057
Project: Ninth Line Class A ESA
Location: Ninth Line, Milton, Ontario
Drill Date: June 1, 2015
Drill Method: [x] solid stem [ ] hollow stem [ ] vibratory
Datum: Geodetic

Material Description	Symbol	Elev.	Samples		GWL	Monitor Details	Test Data
		Depth	No.	Type			
Ground Surface							
±300 mm of granular	▒	0.0					
SILT TILL some sand, trace clay and gravel, brown, moist, (Compact to Very Dense)	▨		1	SS			
	▨		2	SS			
	▨		3	SS			
	▨		4	SS			
BOREHOLE TERMINATED		3.5					



Notes: 1. Upon completion of drilling, borehole was open to 2.9 m and dry.

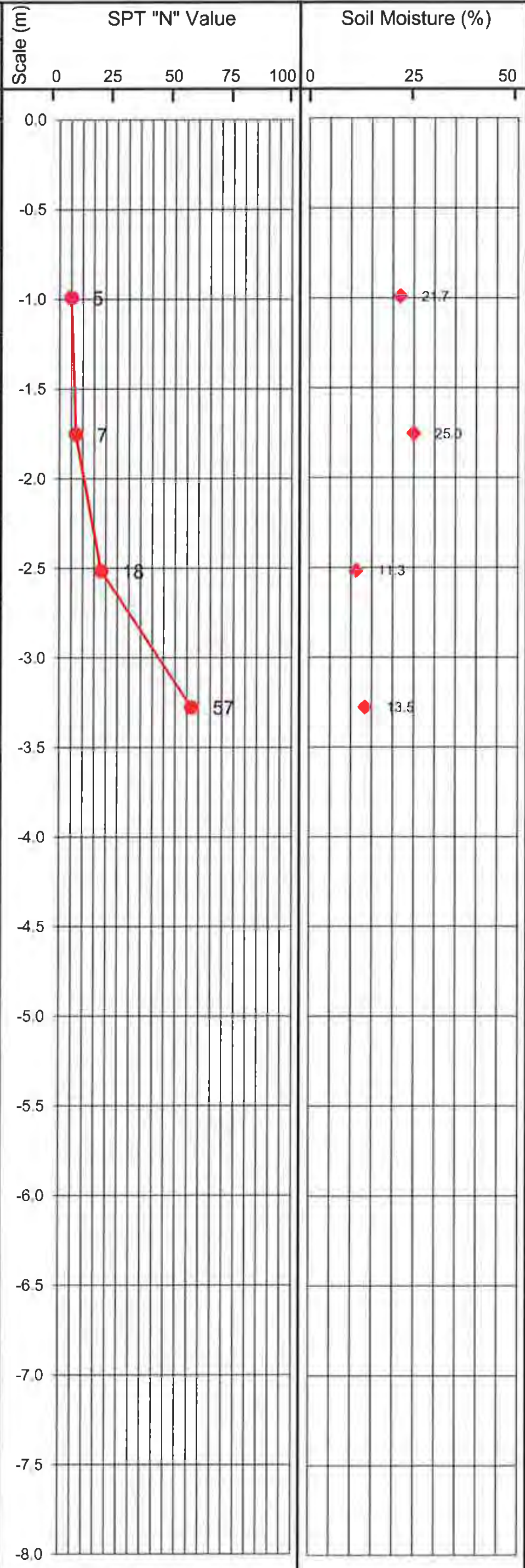
PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

LANDTEK LIMITED

LOG OF BOREHOLE NO. 14

Project No.:	14057	Drill Date:	June 1, 2015
Project:	Ninth Line Class A ESA	Drill Method:	[x] solid stem [ ] hollow stem [ ] vibratory
Location:	Ninth Line, Milton, Ontario	Datum:	Geodetic

Material Description	Symbol	Elev. Depth	Samples No.	Samples Type	GWL	Monitor Details	Test Data
Ground Surface							
±250 mm of asphalt		0.0					
±250 mm of granular							
FILL clayey silt, some organics and organic staining, trace sand and gravel, brown, very moist (Firm)			1	SS			
			2	SS			
SILT TILL some sand, trace clay and gravel, brown, moist, (Compact to Very Dense)		2.0	3	SS			
			4	SS			
BOREHOLE TERMINATED		3.5					



Notes: 1. Upon completion of drilling, borehole was open to 3.0 m and water level at 2.7 m.

PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

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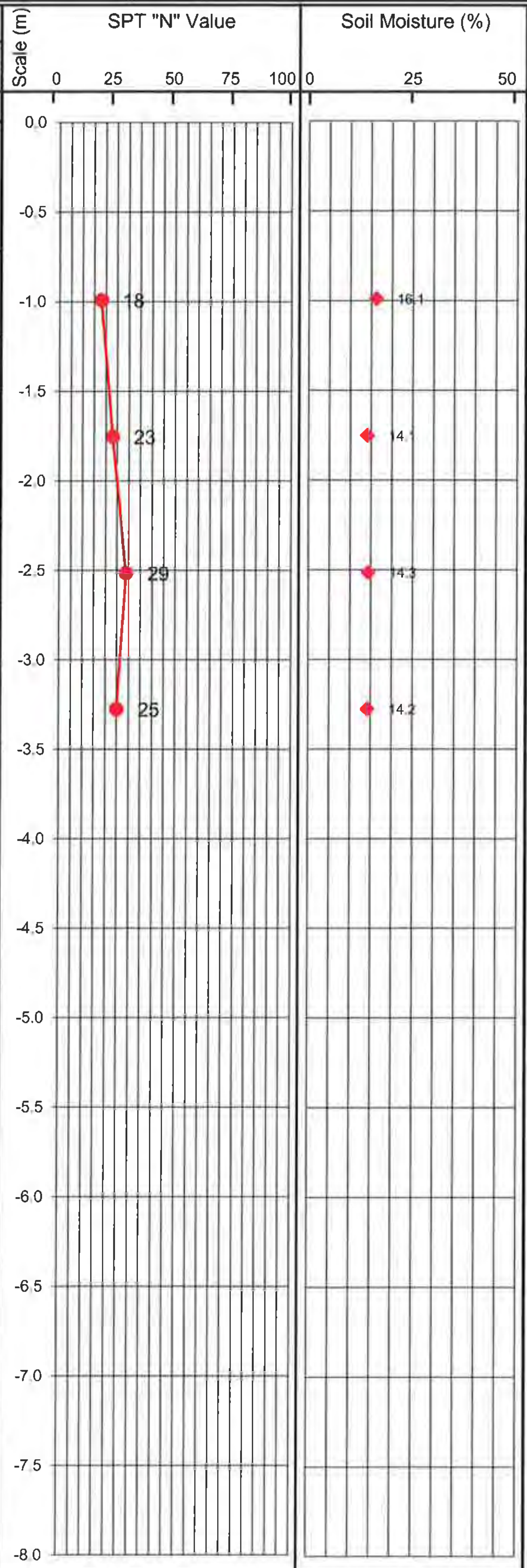
LANDTEK LIMITED

LOG OF BOREHOLE NO. 15

Project No.: 14057
Project: Ninth Line Class A ESA
Location: Ninth Line, Milton, Ontario

Drill Date: June 1, 2015
Drill Method: [x] solid stem [ ] hollow stem [ ] vibratory
Datum: Geodetic

Material Description	Symbol	Elev. Depth	Samples No.	Samples Type	GWL	Monitor Details	Test Data
Ground Surface							
±200 mm of organic soil	▨	0.0					
SILT TILL some sand, trace clay and gravel, brown, moist, (Compact to Very Dense)	▨		1	SS			
	▨		2	SS			
	▨		3	SS			
	▨		4	SS			
BOREHOLE TERMINATED		3.5					



Notes: 1. Upon completion of drilling, borehole was open to 3.0 m and dry.

PP = pocket penetrometer TCV = total combustible vapour BRD = bulk relative density
PL = plastic limit LL = liquid limit PI = plasticity index FV = field vane LV = lab vane VS = vane sensitivity

APPENDIX D

RESULTS OF CHEMICAL ANALYSES BY AGAT LABORATORIES LTD.

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: **LANDTEK LTD.**
205 NEBO ROAD, UNIT 3
HAMILTON, ON L8W2E1
(905) 383-3733

ATTENTION TO: **Cory Zanatta**

PROJECT: **14057**

AGAT WORK ORDER: **15T992589**

SOIL ANALYSIS REVIEWED BY: **Mike Muneswar, BSc (Chem), Senior Inorganic Analyst**

DATE REPORTED: **Jul 13, 2015**

PAGES (INCLUDING COVER): **8**

VERSION*: **1**

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

NOTES
VERSION 1: Partial report excluding the Chromium VI data for sample 6712702 sent on July 13, 2015

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 15T992589

PROJECT: 14057

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www agatlabs com

CLIENT NAME: LANDTEK LTD.

SAMPLING SITE:

ATTENTION TO: Cory Zanatta

SAMPLED BY:

O. Reg. 153(511) - Metals & Inorganics (Soil)

DATE RECEIVED: 2015-07-06

DATE REPORTED: 2015-07-10

			SAMPLE DESCRIPTION:	**BH1**	**BH2**	**BH3**	**BH4**	**BH5**	**BH6**	**BH7**	**BH8**
			SAMPLE TYPE:	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**
			DATE SAMPLED:	**6/22/2015**	**6/22/2015**	**6/22/2015**	**6/22/2015**	**6/22/2015**	**6/22/2015**	**6/22/2015**	**6/22/2015**
Parameter	**Unit**	**G / S**	**RDL**	**6712687**	**6712688**	**6712689**	**6712690**	**6712691**	**6712692**	**6712693**	**6712695**
Antimony	µg/g	1.3	0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Arsenic	µg/g	18	1	5	4	4	4	2	3	4	4
Barium	µg/g	220	2	68	61	42	62	21	33	94	96
Beryllium	µg/g	2.5	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Boron	µg/g	36	5	6	6	7	8	<5	<5	7	5
Boron (Hot Water Soluble)	µg/g	NA	0.10	0.13	0.11	0.50	0.12	<0.10	<0.10	0.12	0.13
Cadmium	µg/g	1.2	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium	µg/g	70	2	14	13	12	13	6	11	15	12
Cobalt	µg/g	21	0.5	8.9	8.3	7.1	7.6	3.1	5.8	8.6	7.4
Copper	µg/g	92	1	33	28	28	32	11	16	31	27
Lead	µg/g	120	1	8	7	7	7	3	6	8	9
Molybdenum	µg/g	2	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Nickel	µg/g	82	1	18	16	14	15	6	12	18	15
Selenium	µg/g	1.5	0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Silver	µg/g	0.5	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Thallium	µg/g	1	0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Uranium	µg/g	2.5	0.5	0.5	<0.5	0.5	<0.5	<0.5	<0.5	0.6	<0.5
Vanadium	µg/g	86	1	19	18	18	18	12	18	22	17
Zinc	µg/g	290	5	48	42	38	39	18	32	48	40
Chromium VI	µg/g	0.66	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cyanide	µg/g	0.051	0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
Mercury	µg/g	0.27	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Electrical Conductivity	mS/cm	0.57	0.005	**0.588**	0.484	0.472	0.151	**0.608**	0.299	0.498	0.213
Sodium Adsorption Ratio	NA	2.4	NA	1.69	1.46	2.11	0.959	**7.41**	1.98	2.37	1.74
pH, 2:1 CaCl2 Extraction	pH Units		NA	7.66	7.70	7.87	7.68	7.29	7.32	7.69	7.88

Certified By:

AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 15T992589

PROJECT: 14057

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: LANDTEK LTD.

ATTENTION TO: Cory Zanatta

SAMPLING SITE:

SAMPLED BY:

O. Reg. 153(511) - Metals & Inorganics (Soil)

DATE RECEIVED: 2015-07-06

DATE REPORTED: 2015-07-10

			SAMPLE DESCRIPTION:	BH9	BH10	BH11	BH12	BH13	BH14	BH15
			SAMPLE TYPE:	Soil	Soil	Soil	Soil	Soil	Soil	Soil
			DATE SAMPLED:	6/22/2015	6/22/2015	6/22/2015	6/22/2015	6/22/2015	6/22/2015	6/22/2015
Parameter	**Unit**	**G / S**	**RDL**	**6712697**	**6712698**	**6712699**	**6712700**	**6712701**	**6712702**	**6712703**
Antimony	µg/g	1.3	0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Arsenic	µg/g	18	1	4	3	5	4	3	4	5
Barium	µg/g	220	2	84	46	78	55	55	77	89
Beryllium	µg/g	2.5	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.6
Boron	µg/g	36	5	5	<5	<5	<5	<5	5	8
Boron (Hot Water Soluble)	µg/g	NA	0.10	0.16	<0.10	0.10	<0.10	<0.10	0.16	0.14
Cadmium	µg/g	1.2	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium	µg/g	70	2	14	7	14	12	9	14	20
Cobalt	µg/g	21	0.5	9.0	4.6	8.5	7.9	5.9	9.5	13.7
Copper	µg/g	92	1	51	23	29	35	28	30	33
Lead	µg/g	120	1	8	8	10	8	6	8	11
Molybdenum	µg/g	2	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Nickel	µg/g	82	1	17	9	18	15	11	17	27
Selenium	µg/g	1.5	0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Silver	µg/g	0.5	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Thallium	µg/g	1	0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Uranium	µg/g	2.5	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.6
Vanadium	µg/g	86	1	21	13	20	17	15	21	26
Zinc	µg/g	290	5	46	28	45	42	31	50	62
Chromium VI	µg/g	0.66	0.2	<0.2	<0.2	<0.2	<0.2	<0.2		<0.2
Cyanide	µg/g	0.051	0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
Mercury	µg/g	0.27	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Electrical Conductivity	mS/cm	0.57	0.005	**1.14**	0.224	0.313	**0.617**	0.111	**0.791**	0.169
Sodium Adsorption Ratio	NA	2.4	NA	**9.21**	**3.38**	**4.20**	**5.64**	0.304	**6.45**	0.278
pH, 2:1 CaCl2 Extraction	pH Units		NA	7.73	7.83	7.71	7.87	7.82	7.40	7.73

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to Table 1: Full Depth Background Site Condition Standards - Soil - Residential/Parkland/Institutional/Industrial/Commercial/Community Property Use

6712687-6712703 EC & SAR were determined on the DI water extract obtained from the 2:1 leaching procedure (2 parts DI water:1 part soil). pH was determined on the 0.01M CaCl2 extract prepared at 2:1 ratio.

Certified By:

Guideline Violation

AGAT WORK ORDER: 15T992589
PROJECT: 14057

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: LANDTEK LTD.

ATTENTION TO: Cory Zanatta

SAMPLEID	SAMPLE TITLE	GUIDELINE	ANALYSIS PACKAGE	PARAMETER	GUIDEVALUE	RESULT
6712687	BH1	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Electrical Conductivity	0.57	0.588
6712691	BH5	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Electrical Conductivity	0.57	0.608
6712691	BH5	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio	2.4	7.41
6712697	BH9	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Electrical Conductivity	0.57	1.14
6712697	BH9	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio	2.4	9.21
6712698	BH10	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio	2.4	3.38
6712699	BH11	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio	2.4	4.20
6712700	BH12	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Electrical Conductivity	0.57	0.617
6712700	BH12	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio	2.4	5.64
6712702	BH14	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Electrical Conductivity	0.57	0.791
6712702	BH14	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio	2.4	6.45

Quality Assurance

CLIENT NAME: LANDTEK LTD.
PROJECT: 14057
SAMPLING SITE:

AGAT WORK ORDER: 15T992589
ATTENTION TO: Cory Zanatta
SAMPLED BY:

Soil Analysis

RPT Date:			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
O. Reg. 153(511) - Metals & Inorganics (Soil)															
Antimony	6712698	6712698	<0.8	<0.8	0.0%	< 0.8	93%	70%	130%	83%	80%	120%	82%	70%	130%
Arsenic	6712698	6712698	3	3	0.0%	< 1	99%	70%	130%	97%	80%	120%	97%	70%	130%
Barium	6712698	6712698	46	47	2.2%	< 2	93%	70%	130%	95%	80%	120%	94%	70%	130%
Beryllium	6712698	6712698	<0.5	<0.5	0.0%	< 0.5	83%	70%	130%	97%	80%	120%	90%	70%	130%
Boron	6712698	6712698	<5	<5	0.0%	< 5	85%	70%	130%	97%	80%	120%	85%	70%	130%
Boron (Hot Water Soluble)	6712687	6712687	0.13	0.12	8.0%	< 0.10	106%	60%	140%	98%	70%	130%	96%	60%	140%
Cadmium	6712698	6712698	<0.5	<0.5	0.0%	< 0.5	103%	70%	130%	99%	80%	120%	98%	70%	130%
Chromium	6712698	6712698	7	8	13.3%	< 2	83%	70%	130%	100%	80%	120%	94%	70%	130%
Cobalt	6712698	6712698	4.6	4.7	2.2%	< 0.5	90%	70%	130%	100%	80%	120%	93%	70%	130%
Copper	6712698	6712698	23	23	0.0%	< 1	87%	70%	130%	102%	80%	120%	95%	70%	130%
Lead	6712698	6712698	8	8	0.0%	< 1	100%	70%	130%	98%	80%	120%	94%	70%	130%
Molybdenum	6712698	6712698	<0.5	<0.5	0.0%	< 0.5	102%	70%	130%	97%	80%	120%	100%	70%	130%
Nickel	6712698	6712698	9	9	0.0%	< 1	92%	70%	130%	98%	80%	120%	91%	70%	130%
Selenium	6712698	6712698	<0.4	<0.4	0.0%	< 0.4	79%	70%	130%	96%	80%	120%	98%	70%	130%
Silver	6712698	6712698	<0.2	<0.2	0.0%	< 0.2	80%	70%	130%	101%	80%	120%	97%	70%	130%
Thallium	6712698	6712698	<0.4	<0.4	0.0%	< 0.4	96%	70%	130%	104%	80%	120%	99%	70%	130%
Uranium	6712698	6712698	<0.5	<0.5	0.0%	< 0.5	101%	70%	130%	104%	80%	120%	100%	70%	130%
Vanadium	6712698	6712698	13	13	0.0%	< 1	86%	70%	130%	99%	80%	120%	95%	70%	130%
Zinc	6712698	6712698	28	28	0.0%	< 5	94%	70%	130%	101%	80%	120%	101%	70%	130%
Chromium VI	6723563		<0.2	<0.2	0.0%	< 0.2	105%	70%	130%	105%	80%	120%	91%	70%	130%
Cyanide	6712687	6712687	<0.040	<0.040	0.0%	< 0.040	106%	70%	130%	110%	80%	120%	108%	70%	130%
Mercury	6712698	6712698	<0.10	<0.10	0.0%	< 0.10	104%	70%	130%	100%	80%	120%	92%	70%	130%
Electrical Conductivity	6712687	6712687	0.588	0.584	0.7%	< 0.005	101%	90%	110%	NA			NA		
Sodium Adsorption Ratio	6712687	6712687	1.69	1.75	3.5%	NA	NA			NA			NA		
pH, 2:1 CaCl2 Extraction	6712693	6712693	7.69	7.80	1.4%	NA	100%	80%	120%	NA			NA		

Comments: NA signifies Not Applicable.

Certified By:

Method Summary

CLIENT NAME: LANDTEK LTD.

PROJECT: 14057

SAMPLING SITE:

AGAT WORK ORDER: 15T992589

ATTENTION TO: Cory Zanatta

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Antimony	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Arsenic	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Barium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Beryllium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Boron	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Boron (Hot Water Soluble)	MET-93-6104	EPA SW 846 6010C; MSA, Part 3, Ch.21	ICP/OES
Cadmium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Chromium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Cobalt	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Copper	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Lead	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Molybdenum	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Nickel	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Selenium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Silver	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Thallium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Uranium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Vanadium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Zinc	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Chromium VI	INOR-93-6029	SM 3500 B; MSA Part 3, Ch. 25	SPECTROPHOTOMETER
Cyanide	INOR-93-6052	MOE CN-3015 & E 3009 A;SM 4500 CN	TECHNICON AUTO ANALYZER
Mercury	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Electrical Conductivity	INOR-93-6036	McKeague 4.12, SM 2510 B	EC METER
Sodium Adsorption Ratio	INOR-93-6007	McKeague 4.12 & 3.26 & EPA SW-846 6010B	ICP/OES
pH, 2:1 CaCl2 Extraction	INOR-93-6031	MSA part 3 & SM 4500-H+ B	PH METER

AGAT Laboratories

5835 Coopers Avenue
Mississauga, ON
L4Z 1Y2
www.agatlabs.com • webearth.agatlabs.com
P: 905.712.5100 • F: 905.712.5122

Chain of Custody Record

Laboratory Use Only

Arrival Temperature: 9.8-9-7-8.9
AGAT WO #: 8.8-8-7-8.0
Lab Temperature:
Notes: 15T992589

Client Information

Company: Landtek Limited
Contact: Cory Zanatta
Address: 205 Nebo Rd
Hamilton.
Phone: 905-383-3733 Fax: 905-383-8433
Project: 14057 PO:
AGAT Quotation #:

Please note, if quotation number is not provided, client will be billed full price for analysis.

Regulatory Requirements

☑ Regulation 153/04

Table 1 (Indicate one)

☑ Ind/Com
☑ Res/Park
☐ Agriculture

Soil Texture (check one): ☐ Coarse ☑ Fine

☐ Sewer Use

Region (Indicate one)

☐ Sanitary
☐ Storm

☐ Regulation 558
☐ CCME
☐ Other (specify)
☐ Prov. Water Quality Objectives (PWQO)
☐ None

Turnaround Time Required (TAT) Required*

Regular TAT

☑ 5 to 7 Working Days

Rush TAT (please provide prior notification)
Rush Surcharges Apply

☐ 3 Working Days
☐ 2 Working Days
☐ 1 Working Day

OR

Date Required (Rush surcharges may apply):

*TAT is exclusive of weekends and statutory holidays

Invoice To

Same: Yes ☑ No ☐
Company:
Contact:
Address:

Is this a drinking water sample?
(potable water intended for human consumption)
☐ Yes ☐ No
If "Yes", please use the **Drinking Water Chain of Custody Form**

Is this submission for a **Record of Site Condition**?
☐ Yes ☐ No

Legend Matrix

GW Ground Water **O** Oil
SW Surface Water **P** Paint
SD Sediment **S** Soil

Report Information – reports to be sent to:

1. Name: Cory Zanatta
Email: cory@landtek limited.com
2. Name:
Email:

Sample Identification	Date Sampled	Time Sampled	Sample Matrix	# of Containers	Comments Site/Sample Information	Metals and Inorganics	Metal Scan	Hydride Forming Metals	Client Custom Metals	ORPs: ☐ B-HWS ☐ Cl- ☐ CN- ☐ EC ☐ FOC ☐ Cr+6 ☐ SAR ☐ NO_3/NO_2 ☐ N-Total ☐ Hg ☐ pH	Nutrients: ☐ TP ☐ NH_3 ☐ TKN ☐ NO_3 ☐ NO_2 ☐ NO_3/NO_2	VOC: ☐ VOC ☐ THM ☐ BTEX	CCME Fractions 1 to 4	ABNs	PAHs	Chlorophenols	PCBs	Organochlorine Pesticides	TCLP Metals/Inorganics	Sewer Use
BH1	June 22/15			1		X														
BH2	↓			1		X														
BH3				1		X														
BH4				1		X														
BH5				1		X														
BH6				1		X														
BH7				1		X														
BH8				1		X														
BH9				1		X														
BH10				1		X														
BH11				1		X														
BH12				1		X														

Samples Relinquished By (Print Name and Sign):	Date/Time	Samples Received By (Print Name and Sign):	Date/Time	
			12:45	Pink Copy - Client
Samples Relinquished By (Print Name and Sign):	Date/Time	Samples Received By (Print Name and Sign):	Date/Time	Yellow Copy - AGAT
			4:45	White Copy - AGAT

Page 1 of 2

Nº: 56242

AGAT Laboratories

5835 Coopers Avenue
Mississauga, ON
L4Z 1Y2
www.agatlabs.com · webearth.agatlabs.com

Chain of Custody Record

P: 905.712.5100 · F: 905.712.5122

Laboratory Use Only

Arrival Temperature: 89- 8.7-9.0
AGAT WO #: 7.9- 7.7-8.0
Lab Temperature:
Notes:

Client Information

Company: Landtek Limited
Contact: Cory Zanatta
Address: 205 Nebo
Hamilton Ont
Phone: 905.383-3733 Fax: 905-383-8433
Project: 14057 PO:
AGAT Quotation #:

Please note, if quotation number is not provided, client will be billed full price for analysis.

Regulatory Requirements

☑ Regulation 153/04 reg 511 Amend
Table 1 (Indicate one)
☑ Ind/Com
☑ Res/Park
☐ Agriculture
Soil Texture (check one)
☐ Coarse ☑ Fine

☐ Sewer Use
Region ______ (Indicate one)
☐ Sanitary
☐ Storm

☐ Regulation 558
☐ CCME
☐ Other (specify) ______
☐ Prov. Water Quality Objectives (PWQO)
☐ None

Turnaround Time Required (TAT) Required*

Regular TAT
☑ 5 to 7 Working Days

Rush TAT (please provide prior notification)
Rush Surcharges Apply
☐ 3 Working Days
☐ 2 Working Days
☐ 1 Working Day

OR

Date Required (Rush surcharges may apply):

**TAT is exclusive of weekends and statutory holidays*

Invoice To

Same: Yes ☑ No ☐
Company:
Contact:
Address:

Is this a drinking water sample? (potable water intended for human consumption)
☐ Yes ☐ No

If "Yes", please use the *Drinking Water Chain of Custody Form*

Is this submission for a **Record of Site Condition?**
☐ Yes ☑ No

Legend Matrix

GW	Ground Water	**O**	Oil
SW	Surface Water	**P**	Paint
SD	Sediment	**S**	Soil

Report Information – reports to be sent to:

1. Name: Cory Zanatta
Email: Cory@landteklimited.com
2. Name:
Email:

Sample Identification	Date Sampled	Time Sampled	Sample Matrix	# of Containers	Comments Site/Sample Information	Metals and Inorganics	Metal Scan	Hydride Forming Metals	Client Custom Metals	ORPs: ☐ B-HWS ☐ Cl- ☐ CN- ☐ EC ☐ FOC ☐ Cr+6- ☐ SAR ☐ NO_3/NO_2 ☐ N-Total ☐ Hg ☐ pH	Nutrients: ☐ TP ☐ NH_3 ☐ TKN ☐ NO_3 ☐ NO_2 ☐ NO_3/NO_2	VOC: ☐ VOC ☐ THM ☐ BTEX	CCME Fractions 1 to 4	ABNs	PAHs	Chlorophenols	PCBs	Organochlorine Pesticides	TCLP Metals/Inorganics	Sewer Use								
BH 13	June 22/15			1		X																						
BH 14				|		X																						
BH 15	↓			|		X																						

Samples Relinquished By (Print Name and Sign):	Date/Time	Samples Received By (Print Name and Sign):	Date/Time		
			[illegible] 12:45	Pink Copy - Client	Page 2 of 2
Samples Relinquished By (Print Name and Sign):	Date/Time	Samples Received By (Print Name and Sign):	Date/Time	Yellow Copy - AGAT	
			[illegible] 4:45	White Copy- AGAT	Nº: 56231

APPENDIX E

PHOTOGRAPHS 1 TO 4 SHOWING TYPICAL SITE CONDITIONS

Photograph #1
View looking south along Ninth Line from
location of Borehole 1

Photograph #2
View looking northalong Ninth Line from
location of Borehole 10.

Photograph #3
View looking south along Ninth Line from
location of Borehole 8

Photograph #4
View looking north along Ninth Line from
location of Borehole 13.

LANDTEK LIMITED

Project No.: 14057		Date: August, 2015
Project:	Class Environmental Study Ninth Line Region of Halton	
Title:	Photographs of Typical Site Conditions	

APPLIED RESEARCH ASSOCIATES, INC.
TRANSPORTATION

EXPANDING THE REALM OF POSSIBILITY

PR-2494

PAVEMENT DESIGN REPORT
NINTH LINE

From Steeles Avenue
To No. 10 Sideroad

Submitted to:

Regional Municipality of Halton
Engineering & Services Division
1151 Bronte Road
Oakville, Ontario
L6M 3L1

December 2005

Halton
A World Class Place To Be.

ARA Project Number 16931

December 5, 2005

PAVEMENT INVESTIGATION

NINTH LINE RESURFACING
FROM STEELES AVENUE TO No. 10 SIDEROAD
TOWN OF MILTON, ONTARIO

Submitted to:

The Regional Municipality of Halton

Applied Research Associates Inc.
5401 Eglinton Avenue West, Suite 204
Toronto, Ontario M9C 5K6
Telephone: 416-621-9555 Facsimile: 416-621-4917
Website: www.ara.com\transportation

TABLE OF CONTENTS

1.0 INTRODUCTION

Applied Research Associates Inc. (ARA) was retained by The Regional Municipality of Halton to complete a pavement evaluation and to provide recommendations for the rehabilitation of Ninth Line, from Steeles Avenue to No. 10 Sideroad in the Town of Milton, Ontario. Written authorization to proceed with this assignment was provided in a letter dated May 16th, 2005.

We understand that Halton Region is considering rehabilitating this section of roadway as part of their 2006 asphalt-resurfacing program.

The purpose of this assignment was to determine the current condition of the in-place pavement and subgrade materials, estimate the remaining life of the in-place pavement structure, identify potential rehabilitation options, and recommend a cost-effective pavement rehabilitation strategy.

2.0 INVESTIGATION METHOLODGY

The field investigation for this assignment consisted of the following tasks:

- A detailed pavement surface condition survey was completed to determine the location, extent and severity of pavement distresses. All distresses were identified in 100 m sections for both lanes on Ninth Line.

- Cross fall and rut depth measurements were completed on regular intervals throughout the project limits.

- Pavement coring was completed at roughly 100 m intervals to determine information on the type and thickness of the various asphalt layers throughout the roadway.

- Boreholes were advanced to determine both the type and thickness of the existing pavement structure components, as well as the subgrade and groundwater conditions at the site. Borehole locations were established at a frequency of roughly 500 m, with four boreholes advanced in distressed areas.

- Falling Weight Deflectometer (FWD) testing was completed to determine the structural adequacy of the pavement.

The pavement surface condition survey was completed over the period from May 24-27, 2005. The survey consisted of a detailed examination of the pavement surface noting the general conditions of the pavement including areas of pavement distress and distortion. The survey was conducted in general accordance with the *MTO Manual for Condition Rating of Flexible Pavements, SP-024.*

Project stationing for the field investigation was referenced from the intersection of Ninth Line and Steeles Avenue. The intersection chainage was assumed to be Station 0+000.

The structural adequacy of the existing pavement was evaluated by FWD pavement load/deflection testing. At each test location, a series of four load applications was applied to the pavement surface. The first application was a "seating" load to ensure the FWD load plate was firmly resting on the pavement surface. The next three loads were approximately 30, 40, and 50 kN. Pavement surface deflections under the load were measured by sensors (velocity transducers) placed at fixed spacing from the load plate in accordance with SHRP testing protocols. The FWD testing was conducted in each lane at roughly 100 m intervals. The testing was completed on May 25, 2005.

The geotechnical work for this investigation was carried out on July 12, 2005 and comprised a total of 57 cores and 15 boreholes advanced to a depth of 1.5 m below existing grade. The cores were selected randomly at roughly 100 m intervals while the borehole locations were selected to investigate structurally deficient locations as identified through the FWD testing as well as to supplement the geotechnical investigation previously completed by others.

The boreholes were advanced using a truck-mounted drill rig equipped with continuous flight solid stem augers supplied and operated by Malone's Soil Samples Company Ltd. A member of the ARA technical staff provided full-time supervision of the drilling operations.

Representative samples of the granular base/subbase and subgrade materials encountered in the boreholes were retained for detailed visual examination and laboratory classification testing. Routine laboratory testing consisted of grain size analysis, moisture content determination, and Atterburg Limits. Groundwater conditions were recorded during and on completion of drilling.

3.0 PHYSIOGRAPHIC SETTING

The site lies within the physiographic region known as the Peel Plain, *The Physiography of Southern Ontario, 3rd edition, L.J. Chapman and D.F. Putnam*. The underlying geological material of the plain consists predominately of till containing large amounts of shale and limestone. In much of the Peel plain this material has been modified by a veneer clay which, when deep enough, can be varved. The area has a gradual and fairly uniform slope towards Lake Ontario

4.0 SITE CONDITIONS

4.1 Condition Survey

The pavement section on Ninth Line from Steeles Avenue to No. 10 Sideroad comprises a 2-lane rural collector roadway. There is a 3-lane urban section at the intersection with Steeles Avenue and a 5-lane urban section at the intersection of No. 10 Sideroad.

The condition of the existing pavement was assessed to be in fair to good condition with local poor areas. The Pavement Condition Rating (PCR) was evaluated to be 68 from Steeles Avenue to No. 5 Sideroad and 58 from No. 5 Sideroad to No. 10 Sideroad. The ride quality was considered to be fair with few to intermittent bumps or depressions. The predominate distresses throughout this pavement section included; longitudinal cracking in the wheel paths, transverse cracking, and alligator cracking. Many of the older longitudinal cracks had been sealed. Localized areas of patching and rutting were found within this pavement section. A summary of the detailed surface distress survey results is presented in Appendix A. Typical photographs of the site can be seen in Appendix B

In addition to the detailed distress survey, wheel path rut depths and transverse cross fall was measured along the sections. A summary of the rut and cross fall survey is presented in Table 4.1 and the detailed results can be seen in Appendix C.

Table 4.1: Summary of Rut Depth and Cross Fall

Section From	Section To	Mean LWP Rut	Mean RWP Rut	Mean Crossfall
Steeles Avenue	No. 5 Sideroad	7.6 mm	5.0 mm	1.47%
No. 5 Sideroad	No. 10 Sideroad	11.0 mm	9.5 mm	1.17%

4.2 Subsurface conditions

Based on the results of the geotechnical field investigation, the subsurface conditions within the study area comprise a flexible pavement structure underlain by the clayey silt till/silty clay subgrade.

Based on the cores/boreholes completed as part of this assignment, the existing asphalt thickness on the traveled portion of Ninth Line was found to range from a low of 100 mm to a high of 270 mm but was typically found to be in the order of 140 to 170 mm. At several locations along the project, substantial differences in asphalt thickness were found between the northbound and southbound lanes. At Station 4+500, in the northbound lanes, a 90 mm buried asphalt layer was found at a depth of 250 mm. For ease of reference, Table 4.2 summarizes the main lane pavement and granular thickness from boreholes.

Granular base/sub-base was encountered beneath the asphalt layer at the borehole locations. The granular base generally consisted of a crushed gravel layer with a typical thickness typically varying between 300 and 500 mm. At three locations (Stations 1+635, 4+500, and 4+575), the granular base thickness was only 100 to 130 mm. At these locations, a layer of granular subbase was penetrated. At two locations, the granular base was measured to be 550 and 750 mm thick. The moisture content of samples tested from the granular base varied from 3.4 and 4.2 percent.

The sub-base material consisted of brown sand that sometimes contained trace gravel. This subbase material was only encountered at three location (Stations 1+635, 4+500, and 4+570). The moisture content of this layer was measured at 3.7%.

The grain size analysis of selected granular base/subbase samples indicated that all of the tested samples were found to be finer that OPSS gradation requirements for Granular A and Granular B.

Specifics of the field investigation are summarized in Appendices D and E. The evaluation of the pavement cores is presented in Appendix D. Borehole logs summarizing the geotechnical field investigation; including soil classification, groundwater observations, and moisture content determination are presented in Appendix E.

Table 4.2: Summary of Main Lane Pavement Thickness

Station	**Direction**	**Asphalt Thickness (mm)**	**Granular Base (mm)**	**Granular Subbase (mm)**	**Total Granular Thickness (mm)**
Steeles Avenue to No. 5 Sideroad					
0+500	NB	165	410	-	410
1+000	SB	120	750	-	750
1+500	NB	180	450	-	450
1+635	SB	100	120	280	400
2+005	SB	120	550	-	550
2+500	NB	170	430	-	430
2+970	NB	105	465	-	465
No. 5 Sideroad to No. 10 Sideroad					
3+494	NB	110	340	-	340
4+100	SB	140	325	-	325
4+500	NB	150	100**	100	290
4+570	NB	170	130	270	400
4+805	NB	150	335	-	335
5+000	SB	150	370	-	370
5+500	NB	150	300	-	300
5+715	SB	150	400	-	400
Average		**141.4**	**365**	**217**	**423**
Std Dev		**26.2**	**169.0**	**101.2**	**114.2**

** - a layer of buried asphalt was encountered between the granular layers (thickness of 90 mm)

Underlying the pavement structure on Ninth Line, the subgrade generally comprised of brown clayey silt till. The moisture content of the clayey silt till varied from 11 to 12 percent, which is considered to be dryer than the plastic limit for this material. At Station 1+000, the moisture content was measured at 22 percent, which is considered to be wetter than the plastic limit.

4.3 Groundwater Conditions

On completion of drilling, free water was not encountered in any of the boreholes. The regional ground water table is likely lower than the depth investigated.

4.4 Falling Weight Deflectometer Testing

Several analysis methodologies were used to analyse the FWD deflection data.

Materials Characterization: The pavement thickness data from the boreholes was used in conjunction with the FWD results to estimate the stiffness (strength) of the existing pavement. Pavement layer stiffness back-calculation uses closed form models to estimate layer elastic modulus values, given the layer thickness and FWD data. The FWD data provides the magnitude and contact area of the load and the output from the FWD deflection sensors.

The procedure as outlined in the *AASHTO 1993 Guide for Design of Pavement Structures*, Part III, Chapter 5, was used to determine the properties of the as-constructed flexible pavements. The resultant data includes the composite elastic modulus (E_p) for the combination of all bound layers above the subgrade (e.g., the asphalt concrete and granular bases), the subgrade elastic modulus (E_s), and the subgrade resilient modulus (M_r). Typically, M_r is calculated from E_s by reducing the value of E_s by a factor of 3.

Maximum Normalized Deflection: The maximum deflection (D_0), measured in the centre of the load plate, is a good indicator of overall pavement strength. The deflection at this location is a function of the pavement layer stiffness, as well as the support capacity of the subgrade. Because deflection is a function of load, and because of slight variations in measured load at each test point, a linear extrapolation of the measured deflection is made to adjust deflections at all test locations to a "standard" load level of 40 kN.

Effective Structural Number: Based on the back-calculated pavement moduli, the effective structural number (SN_{eff}) of the existing pavement was calculated using the 1993 AASHTO Guide for Design of Pavement Structures procedure.

The detailed results of the pavement load/deflection testing and data analysis are presented in Appendix G and summarized in the following Table 4.3.

Table 4.3: Summary of FWD Test Results

	D_0 (μm)		M_R (MPa)		E_P (MPa)		SN_{eff} (cm)	
Station	**Mean**	**St. Dev**	**Mean**	**St. Dev**	**Mean**	**St. Dev**	**Mean**	**St. Dev**
Steeles Avenue to No. 5 Sideroad								
0+000 - 1+000	430	58.1	30	3.6	459	87.3	10.3	0.6
1+000 - 2+000	465	133.7	29	4.4	449	151.4	10.1	1.2
2+000 - 3+110	442	160.2	30	5.1	491	154.2	10.4	1.2
No. 5 Sideroad to No. 10 Sideroad								
3+110 - 4+000	560	199.6	28	9.1	370	133.7	9.5	1.2
4+000 - 5+000	512	180.6	30	7.9	392	116.5	9.7	1.0
5+000 - 6+000	550	112.2	24	4.1	361	72.4	9.5	0.7

The FWD test results were divided into 1 km sections to show any variation along the project. The normalized deflection, D_0,varied between 289 and 1,117 μm. The M_r of the subgrade was found to be in the order of 30 MPa. These values would indicate poor to fair subgrade support.

The effective structural number (SN_{eff}) for the entire roadway varied 7.2 and 12.3 cm. In general, SN_{eff} was in the order of 10 cm between Steeles Ave and No. 5 Sideroad, and around 9.5 cm between No. 5 Sideroad and No. 10 Sideroad.

5.0 ENGINEERING CONSIDERATIONS

We understand that Halton Region is considering infrastructure improvements to the roadway, including rehabilitation of the existing pavement.

To evaluate the structural adequacy of the existing pavement structure, new pavement designs were developed for Ninth Line. The designs were completed in accordance with the AASHTO *Guide for the Design of Pavement Structures, 1993.*

Key inputs for the pavement design include subgrade soils, pavement layer material types and thickness, current and projected traffic data including heavy vehicle volumes and distributions and consideration of the roadway classification and utilization. The output of the 1993 AASHTO flexible model is a structural number that characterizes the structural capacity of the pavement layers required for the given set of inputs. This structural number

(SN) is then distributed in terms of thickness among the various pavement layers (e.g., HMA surface, binder, aggregate base, and so on) according to coefficients characterizing the relative structural support of each material. The AASHTO design method and input parameters were adapted and verified for pavement design in Ontario as outlined in the 2001 MI-183 publication (ERES 2001). Details on the input data used for the pavement designs are given in the following sections.

5.1 Traffic Loading

Traffic data was provided for our use by Halton Region and summarized as follows. Traffic volumes on Ninth Line between Steeles Avenue and No. 10 Sideroad are in the order of 11,500 AADT. The distribution of vehicles was broken down into the following vehicle categories; 96.1, 0.6, 0.6, and 2.7 percent for cars, small trucks, medium trucks, and heavy trucks, respectively. A growth rate of 5.0 percent was projected.

The AASHTO pavement design methodology measures the damaging effect of traffic loading using the concept of equivalent single axle loads (ESAL's). An ESAL is defined as an 80 kN single axle load. Assuming a 20-year design period, these traffic parameters yield some 3,481,000 ESALs.

5.2 Structural Requirements

5.2.1 New Pavement Design

New pavement designs were completed in accordance with the AASHTO *Guide for the Design of Pavement Structures, 1993.* The designs were based on the type and frost susceptibility of the roadbed soils (clayey silt – low frost susceptibility), along with the anticipated traffic volumes over a 20-year design period.

The output of the 1993 AASHTO Guide flexible pavement model is a structural number that characterizes the structural capacity of the pavement layers required for the given set of inputs. This structural number is then distributed in terms of thickness among the various pavement layers (e.g., hot mix asphalt (HMA) surface, binder, aggregate base, subbase and so on) according to coefficients characterizing the relative structural support of each material. The following inputs were chosen for calculation of the required structural number (SN) for flexible pavements in the AASHTO method:

- Design ESAL's = 3.48 million
- Design Period = 20 years
- Initial serviceability, P_i = 4.4
- Terminal serviceability, P_t = 2.2
- Subgrade resilient modulus = 29 MPa
- Reliability level, R = 90 percent
- Overall standard of deviation, S_0 = 0.44
- HMA layer coefficient, a_i = 0.42
- Granular A layer coefficient, a_i = 0.14
- Granular B layer coefficient, a_i = 0.09
- Drainage coefficient for all layers, m_i = 1.0

In accordance with the AASHTO *Guide for the Design of Pavement Structures, 1993,* and based on the measured in-situ strength of the subgrade, along with the anticipated traffic volumes over a 20 year design period, a design SN of 12.2 cm was calculated. An appropriate pavement design is suggested as follows:

40 mm	HL-1 Surface Course
50 mm	HDBC Upper Binder Course
50 mm	HDBC Lower Binder Course
150 mm	Granular A
475 mm	Granular B

5.2.2 Existing Pavement - Steeles Avenue to No. 5 Sideroad

The SN_{eff} for this section of Ninth Line, based on the FWD testing, was found to average around 10.3 cm with 90% of the SN_{eff} values above 8.8 cm. When compared to the design SN of 12.2 cm, this section of Ninth Line is considered to be structurally deficient.

To increase most of the SN_{eff} to the design SN for future traffic loading, an additional 80 mm of HMA would be required.

5.2.3 Existing Pavement - No. 5 Sideroad to No. 10 Sideroad

The average SN_{eff} for this section of Ninth Line, based on the FWD testing, was found to be around 9.5 cm with 90% of the measurements exceeding 8.3 cm. When compared to the design SN of 12.2 cm, this section of Ninth Line is also considered to be structurally deficient.

To increase most of the SN_{eff} to the required SN_{des} level, an additional 95 mm of HMA would be required.

5.3 Pavement Functional Requirements

An important component of the pavement rehabilitation process is estimating the remaining life of the in-service pavements. Remaining life should be defined in terms of both structural capacity and functional serviceability. As noted in the previous section, the structural capacity of the pavement is currently inadequate for future traffic requirements.

The functional performance of a pavement is the users' perceived ride quality. Based on the ARA condition survey of the existing pavements, the roadway is in fair to good functional condition.

6.0 RECOMMENDATIONS

Both sections of Ninth Line are structurally deficient and will require rehabilitation of the existing travel lanes to support future traffic. A prioritized needs assessment synthesizing rehabilitation, replacement, and operational improvement components was required to develop cost-effective rehabilitation strategies. The selection of the most appropriate rehabilitation strategy for Ninth Line may be affected by the strategies and budgets developed by other disciplines. After identifying all potential options for rehabilitating the roadway, the following feasible options emerge for the existing flexible pavement.

6.1 Appropriate Options for the Rehabilitation of the Existing Pavement

The existing sections of Ninth Line were found to be structurally deficient. Rehabilitation of Ninth Line would therefore need to consider structural improvements. This can be accomplished selecting a rehabilitation technique that will increase the structural capacity of the existing pavement structure.

Partial-Depth Removal and Placement HMA Overlay

A common technique for the rehabilitation of asphalt concrete pavements is a mill and overlay strategy. This strategy involves the removal of 40 mm of the existing HMA followed by replacement with 90 mm of new HMA. This strategy does not include remediation of existing distress areas that will likely lead to premature deterioration of the pavement as a result of reflection cracking. As existing pavement distresses are not being treated, a service life of only 3 to 7 years is expected.

Partial-Depth Removal, Crack Repair, and Placement of an HMA Overlay

An enhanced mill/overlay strategy that would mitigate the occurrence of reflection cracking, would include repair of distressed pavement sections. As noted in Section 5.2, a structural overlay in the order of 100 mm would be required to improve structural adequacy of the existing pavement for the anticipated future traffic loading. However, to be successful, existing pavement distresses would need to be remediated. Untreated cracks in old asphalt layers have a tendency to reflect through overlays, resulting in a reduced overlay service life.

Areas exhibiting fatigue or multiple cracking would require full depth removal of the asphalt to the granular base. Treatment of existing distress would include a combination of saw cut with removal/replacement of larger areas or crack strip milling. Due to the density of the cracks encountered during the distress survey, this type of repair would represent approximately 50% of the project limits.

Assuming a milled depth of 40 mm, the overlay requirement would therefore be 135 mm. The service life expected for this option is 10 to 12 years.

Pulverize and Overlay

An alternative rehabilitation solution to address cracked flexible pavements is to pulverize (Full Depth In-Place Reclamation) the existing HMA, grade and compact, followed by placement of a new HMA overlay. Pulverizing of the existing roadway should be carried out in accordance with OPSS 330, *Construction Specification for In-Place Reclamation of Bituminous Pavement and Underlying Granular*. This rehabilitation method would eliminate the occurrence of reflection cracking, permit reprofiling the road grade, and improve the overall ride quality of the pavement.

The following pulverizing and overlay strategy is recommended for the existing main lanes should this alternative be considered.

	Ninth Line	
	Steeles Avenue to No. 5 Sideroad	**No. 5 Sideroad to No. 10 Sideroad**
HL-1 Surface Course	40 mm	40 mm
HDBC Upper Binder	50 mm	50 mm
HDBC Lower Binder	50 mm	50 mm
New Granular A*	50 mm	50 mm
Pulverized Thickness	~300 mm	~300 mm

* - The Granular A addition is often beneficial for fine grading the granular base layer. The use of this layer is considered to be optional.

Alternatively, the pulverizing option can be supplemented with expanded asphalt stabilization. The expanded/foamed asphalt method is an in-place recycling technique that uses foamed asphalt as a stabilizing agent. Foaming occurs when small amounts of water are added to hot asphalt in a controlled expansion chamber. The advantages of foamed asphalt stabilization over other stabilization techniques, include: can have lower costs, an acceptable driving surface immediately after placing and compaction, reduces the overall grade raise required, and the method is relatively insensitive to environmental constraints (ambient weather) during placement. The following pulverizing and expanded asphalt strategy is recommended for the existing main lanes should this alternative be considered.

	Ninth Line	
	Steeles Avenue to No. 5 Sideroad	**No. 5 Sideroad to No. 10 Sideroad**
HL-1	50 mm	40 mm
HDBC	70 mm	60 mm
Stabilization with Foamed Asphalt	~150 mm	~150 mm
Pulverize Existing Pavement	~300 mm	~300 mm

Expanded asphalt stabilization of the existing roadway should be carried out in accordance with OPSS 331, *Construction Specification for Full Depth Reclamation With Expanded Asphalt Stabilization.*

The service life expected for this option approximately 15 years.

Reconstruction with HMA

Another potential rehabilitation option is to completely reconstruct the existing traffic lanes, or portions of them. Reconstruction consists of removal of all of the existing HMA layers and replacement. Reconstruction is usually considered when the cost of restoration for the amount of existing distresses is too high, there is little remaining life in the original pavement, or the original pavement no longer serves the purpose for which it was intended (e.g., geometrics, structural capacity). A minimum 250 mm of additional Granular A and 140 mm of new HMA would be required to support future traffic over the service life of the pavement. The expected service life for this option is 15 to 17 years.

6.2 Rehabilitation of Existing Pavement

The four alternatives presented above were compared based on the initial construction costs as well as the expected maintenance and rehabilitation costs over a 30-year analysis period. Assuming a discount rate of 6 percent, a simplified life-cycle cost analysis yields the following:

	Estimated Initial Construction Cost ($)	Estimated Life-Cycle Cost ($)
Pulverize and Overlay	102,500	134,000
Mill and Overlay, with Distress Repair	104,500	149,500
Reconstruction	123,000	154,000
Mill and Overlay	85,000	209,000

Note: Assumed costs based on lane-km.
Alternatives ranked based on assumed 30 year Life-Cycle cost.

Based on the results of the simplified life-cycle cost analysis, the pulverize and overlay option is considered to be the life-cycle cost efficient alternative when considering a 30-year analysis period. This alternative will mitigate reflective cracking, as well as, allow for reprofiling with granular material rather than padding with HMA. The recommended pavement design for the pulverizing strategy is presented in Table 6.1.

Table 6.1: Recommended Pulverize and Overlay Design

Layer	Steeles Avenue to No. 5 Sideroad	No. 5 Sideroad to No. 10 Sideroad
HL-1 Surface Course	40 mm	40 mm
HDBC Upper Binder	50 mm	50 mm
HDBC Lower Binder	50 mm	50 mm
New Granular A	50 mm	50 mm
Pulverized Thickness	300 mm	300 mm

To ensure that the existing roadway can be properly pulverized, milling is recommended to bring the HMA thickness to no greater than 200 mm. Milling of the surface HMA should be completed at the locations identified in the Table 6.2 and Figures 6.1 and 6.2.

Table 6.2. Milling Areas Required Prior to Milling

Direction	Station From	Station To	Mill Depth (mm)
NB	2+100	2+300	50
SB	3+200	3+600	70
SB	4+600	4+800	50

6.3 Shoulders

In consideration of grade increases in the order of 200 to 300 mm, a review of the shoulder geometry should be completed to determine if shoulder improvements are required.

6.4 Transition Treatments

Smooth transitions will be required where the new pavement meets the existing pavement at the limits of the work project.

At the ends of the work project, the tie-ins at the existing pavement should be cold planed to a depth of 40 mm, full width, to ensure that the new surface course can be placed flush with the top of the existing pavement surface. A tack coat should be utilized between all asphalt courses and at all tie-ins and vertical surfaces.

Figure 6.1: Areas that Require Milling Prior to Pulverization

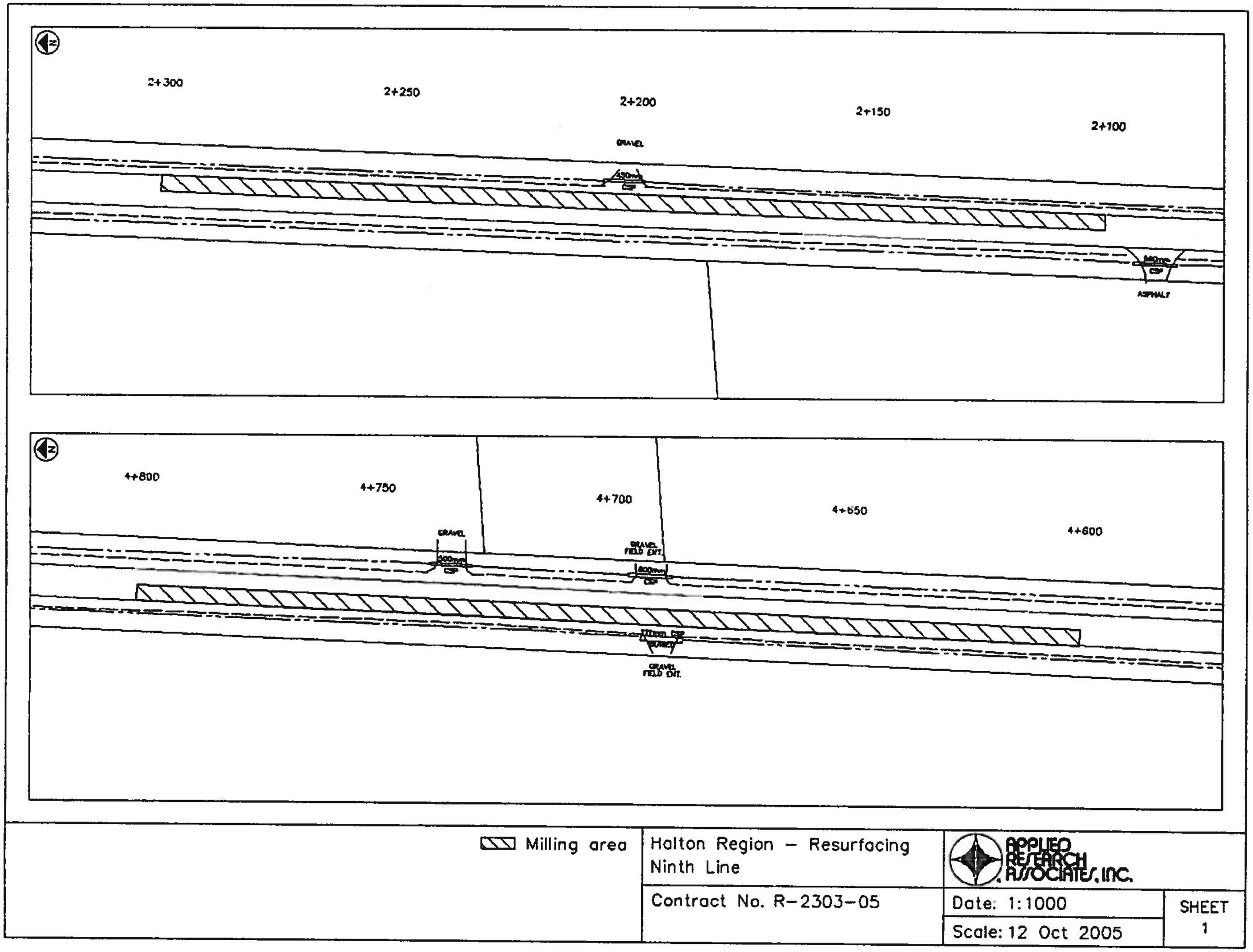
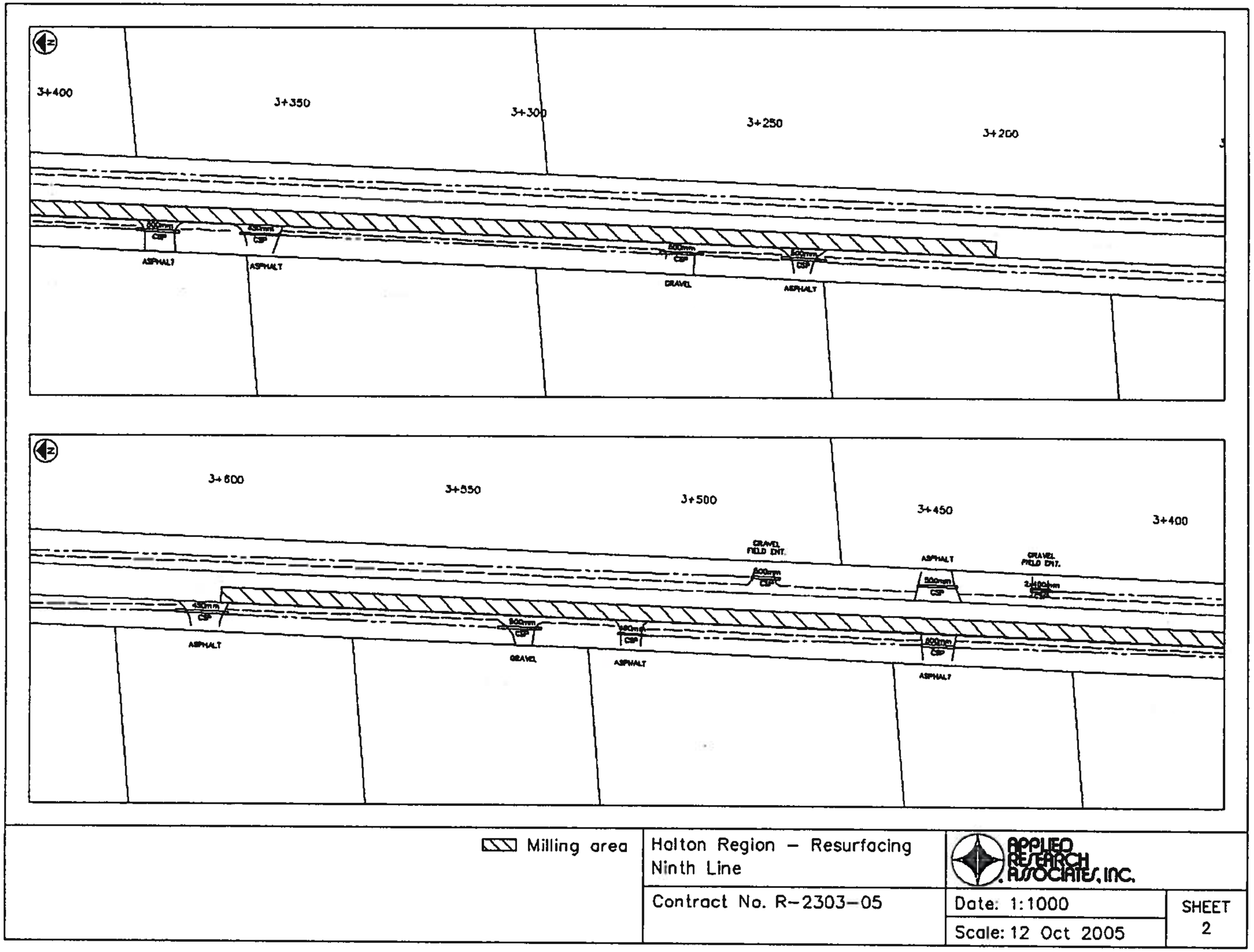


Figure 6.2: Areas that Require Milling Prior to Pulverization



At potential widenings and/or turn tapers, tie-ins must be constructed to ensure positive drainage from the base of the existing granular sub-base. This can be achieved by constructing the base of the new pavement granular at or below the base of the existing granular.

6.5 Materials

The crossfall measurements indicated an average cross-slope of 1.65% from Steeles Avenue to No. 5 Sideroad and 1.32% for the 2.89 km section from No. 5 Sideroad to No. 10 Sideroad. The crossfall can be corrected when regrading the pulverized surface.

The following table specifies the material quantities required for the mainline pavement rehabilitation:

Table 6.3. Estimated Material Quantities

Item	**Conversion**	**Quantity**
HL-1	2.512 tonne/m^3	5,275 tonne
HDBC	2.45 tonne/m^3	13,425 tonne
Granular A	2.4 tonne/m^3	7,200 tonne
Shoulder Granular	2.4 tonne/m^3	17,500 tonne*
Tack Coat		99,200 m^2

* - Shoulder quantity considers no geometric improvements to the shoulders.

6.5.1 New Construction Materials

All HMA materials should meet the requirements of the Region of Halton Specifications for Hot Mix Asphalt Paving, Materials, Sampling and Testing and be compacted to at least 97 percent of the Marshall density. PG 58-28 asphalt cement is recommended for all mixes.

All granular base and subbase materials should meet the requirements of OPSS 1010 and be compacted to at least 100 percent of the standard Proctor density. The granular base should meet the gradation and characteristic requirements of OPSS Granular A.

6.5.2 Recycling Existing Materials

The pulverizing alternative will allow for 100 percent recycling of existing materials within the project.

6.6 Grade Raises

The pulverize alternative will require grade raises to Ninth Line. The geometric issues arising from the grade raise should be reviewed as part of the detailed design process.

7.0 CLOSURE

The recommendations provided in this report are for the use of the Regional Municipality of Halton and their design engineers. Details of the investigation and the recommendations given in this report are considered to be complete. However, should any questions arise, please do to hesitate to contact our office.

Sincerely,
Applied Research Associates, Inc.

Mark Popik, M.Eng., P.Eng.
Project Engineer

LICENSED PROFESSIONAL ENGINEER
M.J. POPIK
12/06/05
PROVINCE OF ONTARIO

Chris Olidis, P.Eng.
Senior Engineer

APPENDIX A

DETAILED DISTRESS SURVEYS

APPLIED RESEARCH ASSOCIATES, INC.

ARA Project No 16431

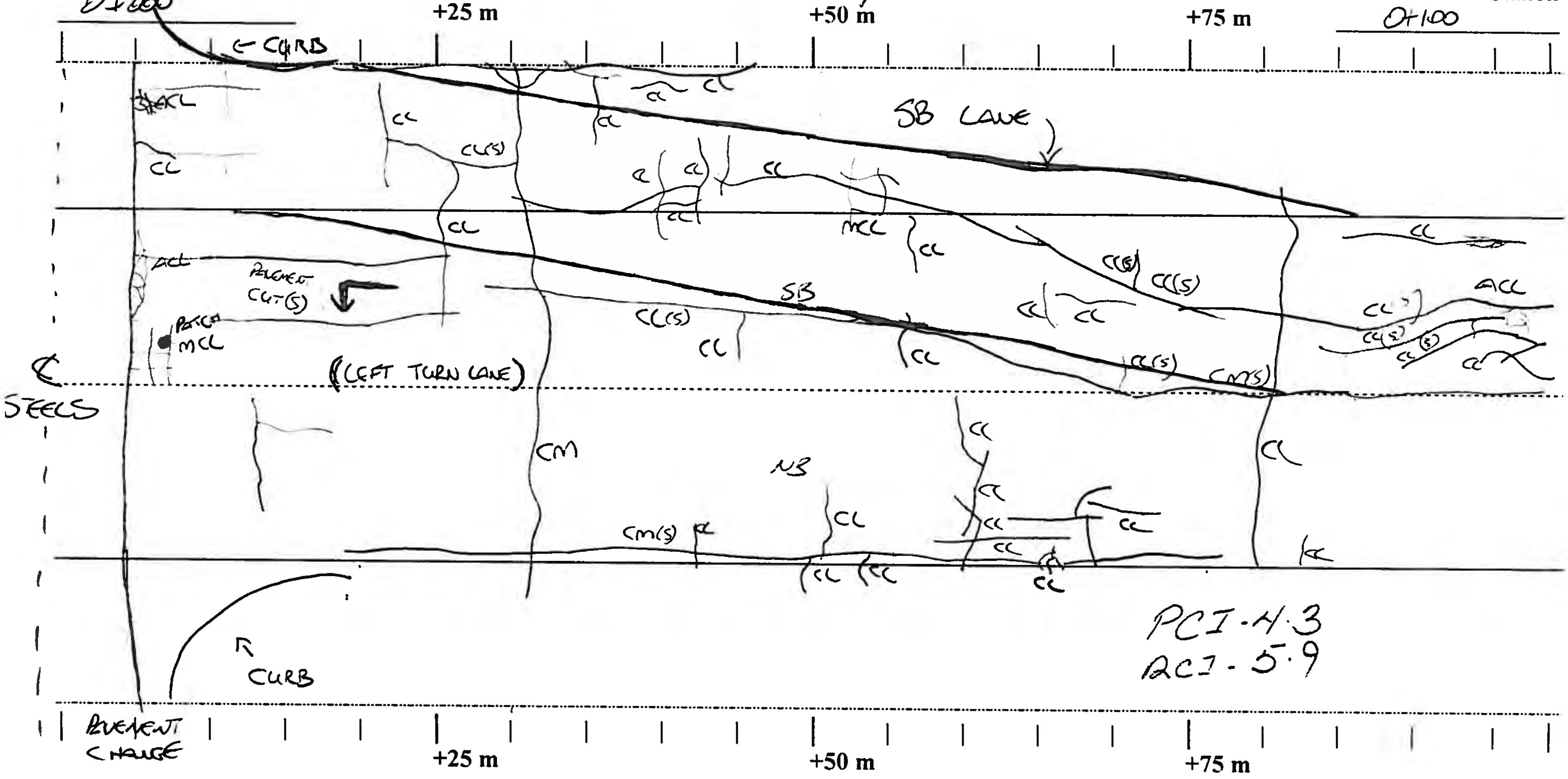
PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th Line Direction ______ From Station 0+000 To Station 0+100

Surveyed By NIC EGGER Date Surveyed 11/aug 24/05 Conditions ______

Start Station 0+000

End Station 0+100



PCI - 4.3
RCI - 5.9

APPLIED RESEARCH ASSOCIATES, INC.

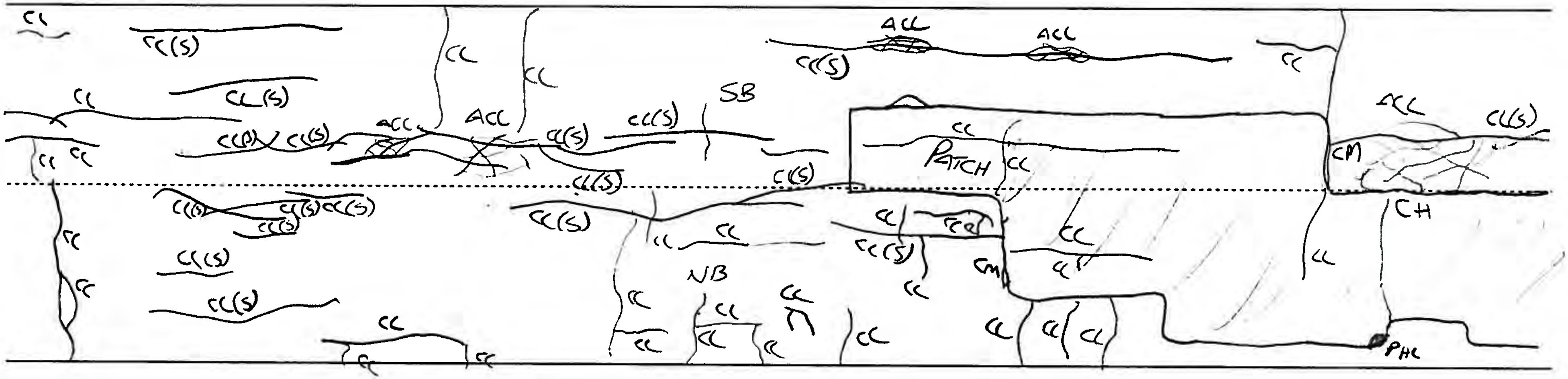
ARA Project No 16931

PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th Line Direction ______ From Station 0+000 To Station 5+100

Surveyed By NIC EULER Date Surveyed May 24/05 Conditions ______

Start Station 0+100 +25 m +50 m +75 m End Station 0+200



PCI-3.9
RCI-5.6

+25 m +50 m +75 m

APPLIED RESEARCH ASSOCIATES, INC.

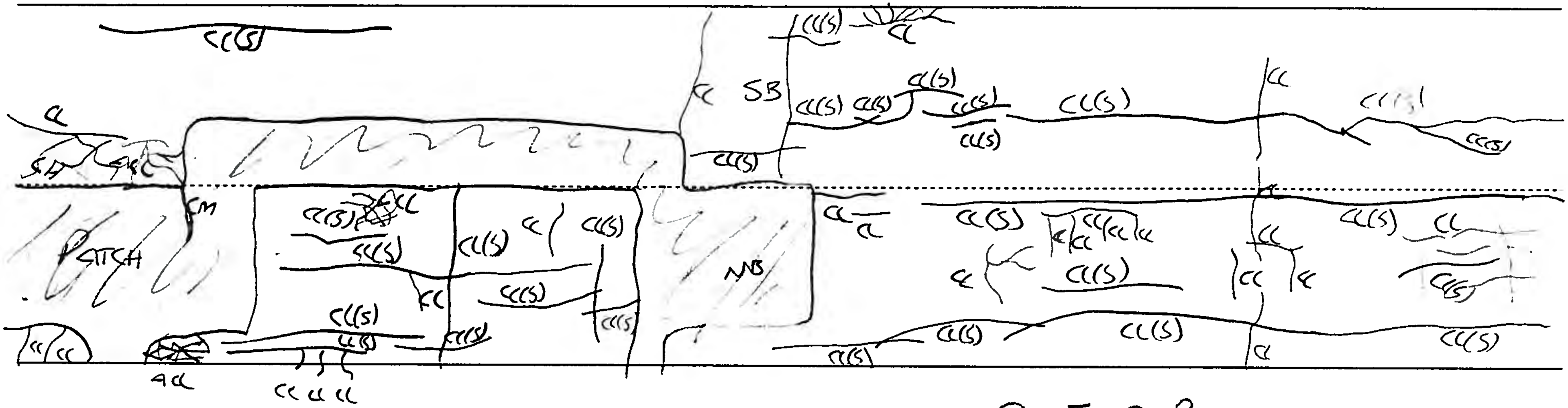
ARA Project No 16931

PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th Line Direction ____ From Station 0+000 To Station 6+100

Surveyed By NIC Gucce Date Surveyed May 24/05 Conditions ____

Start Station 0+200 +25 m +50 m +75 m End Station 0+300



PCI · 3.9
RCI · 5.5

+25 m +50 m +75 m

APPLIED RESEARCH ASSOCIATES, INC.

ARA Project No 16931

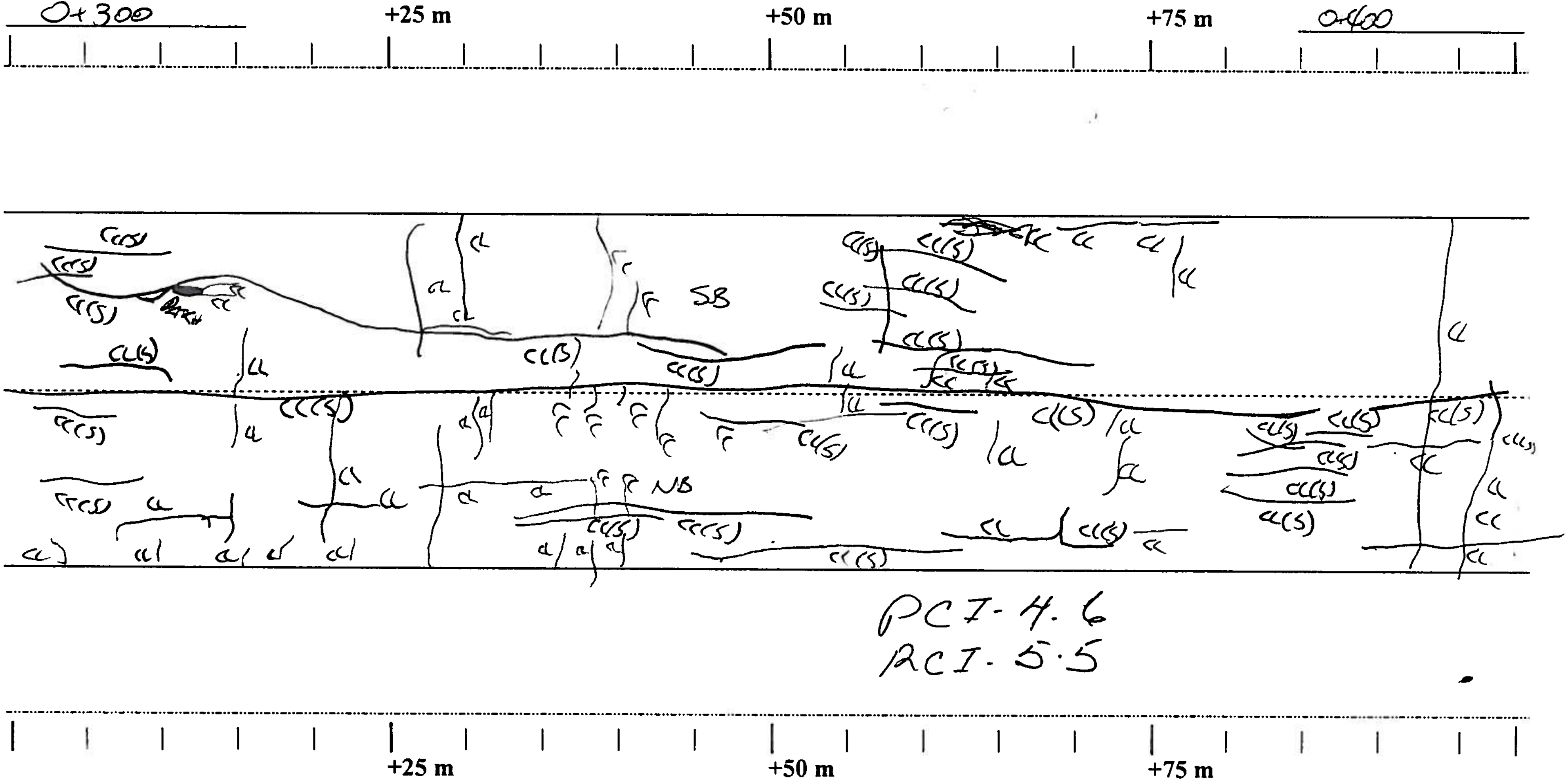
PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th Line Direction ____ From Station 0+000 To Station 6+100

Surveyed By NJC GULER Date Surveyed May 24/05 Conditions ____

Start Station 0+300

End Station 0+400



PCI-4.6
RCI-5.5

APPLIED RESEARCH ASSOCIATES, INC.

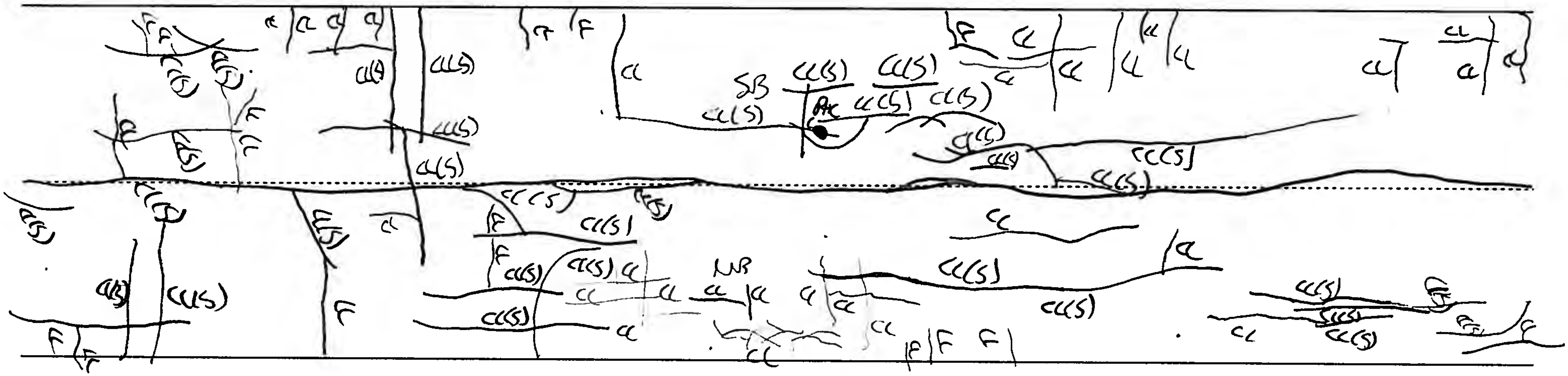
ARA Project No 16931

PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th Line Direction ________ From Station 0+000 To Station 6+100

Surveyed By WJC ELLER Date Surveyed May 24/02 Conditions ________

Start Station 0+400 +25 m +50 m +75 m End Station 0+500



PCI-4.3
RCI-5.4

+25 m +50 m +75 m

APPLIED RESEARCH ASSOCIATES, INC.

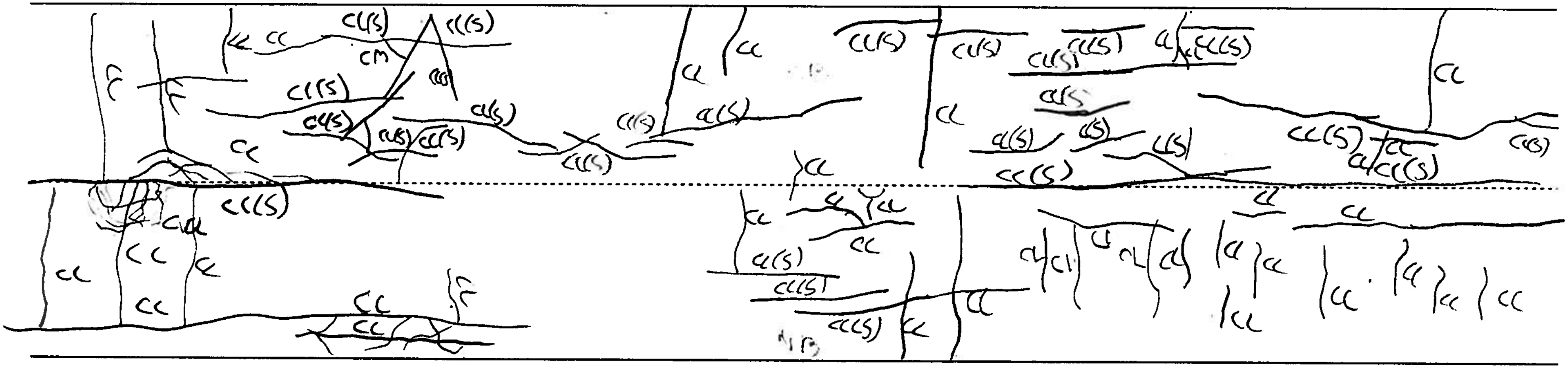
ARA Project No 16931

PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th Line Direction ______ From Station 0+000 To Station 6+100

Surveyed By ALEC ELCER Date Surveyed May 24/05 Conditions ______

Start Station 0+500 +25 m +50 m +75 m End Station 6+600



PCI- 4.4
RCI- 5.4

+25 m +50 m +75 m

APPLIED RESEARCH ASSOCIATES, INC.

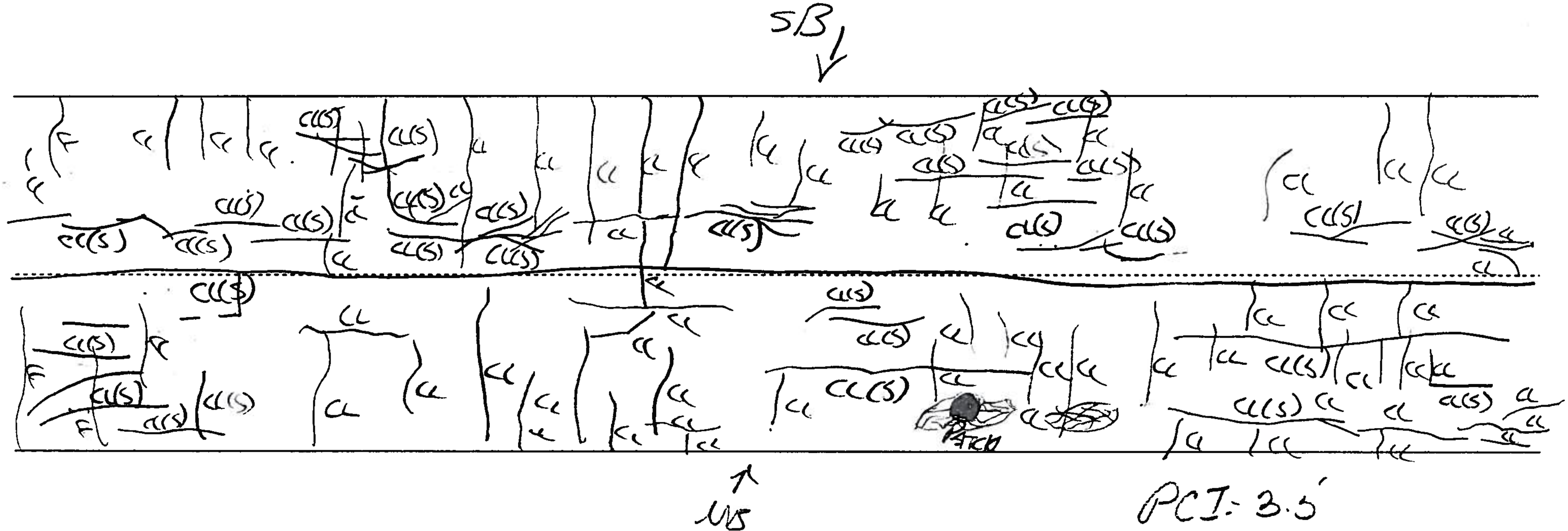
ARA Project No 16931

PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th Line Direction ____ From Station 0+000 To Station 6+100

Surveyed By [illegible] Date Surveyed May 24/05 Conditions ____

Start Station 0+600 | +25 m | +50 m | +75 m | End Station 0+700



PCI: 3.5

RCI: 5.9

+25 m | +50 m | +75 m

APPLIED RESEARCH ASSOCIATES, INC.

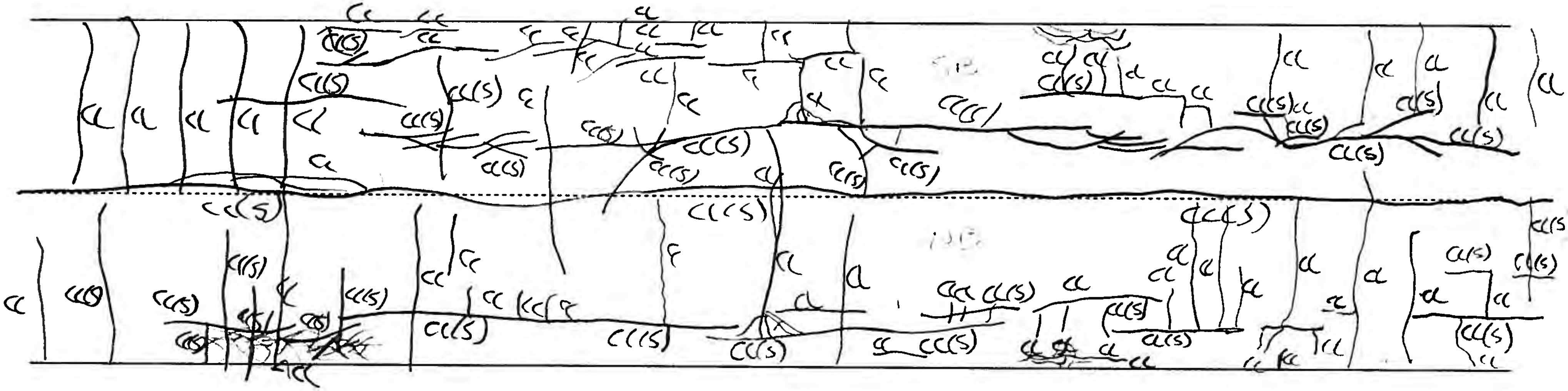
ARA Project No 16931

PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th line Direction ______ From Station 0+000 To Station 5+100

Surveyed By Vic Gulen Date Surveyed May 24/05 Conditions ______

Start Station 0+700 +25 m +50 m +75 m End Station 0+800



PCI- 3.5
RCI- 6.0

+25 m +50 m +75 m

APPLIED RESEARCH ASSOCIATES, INC.

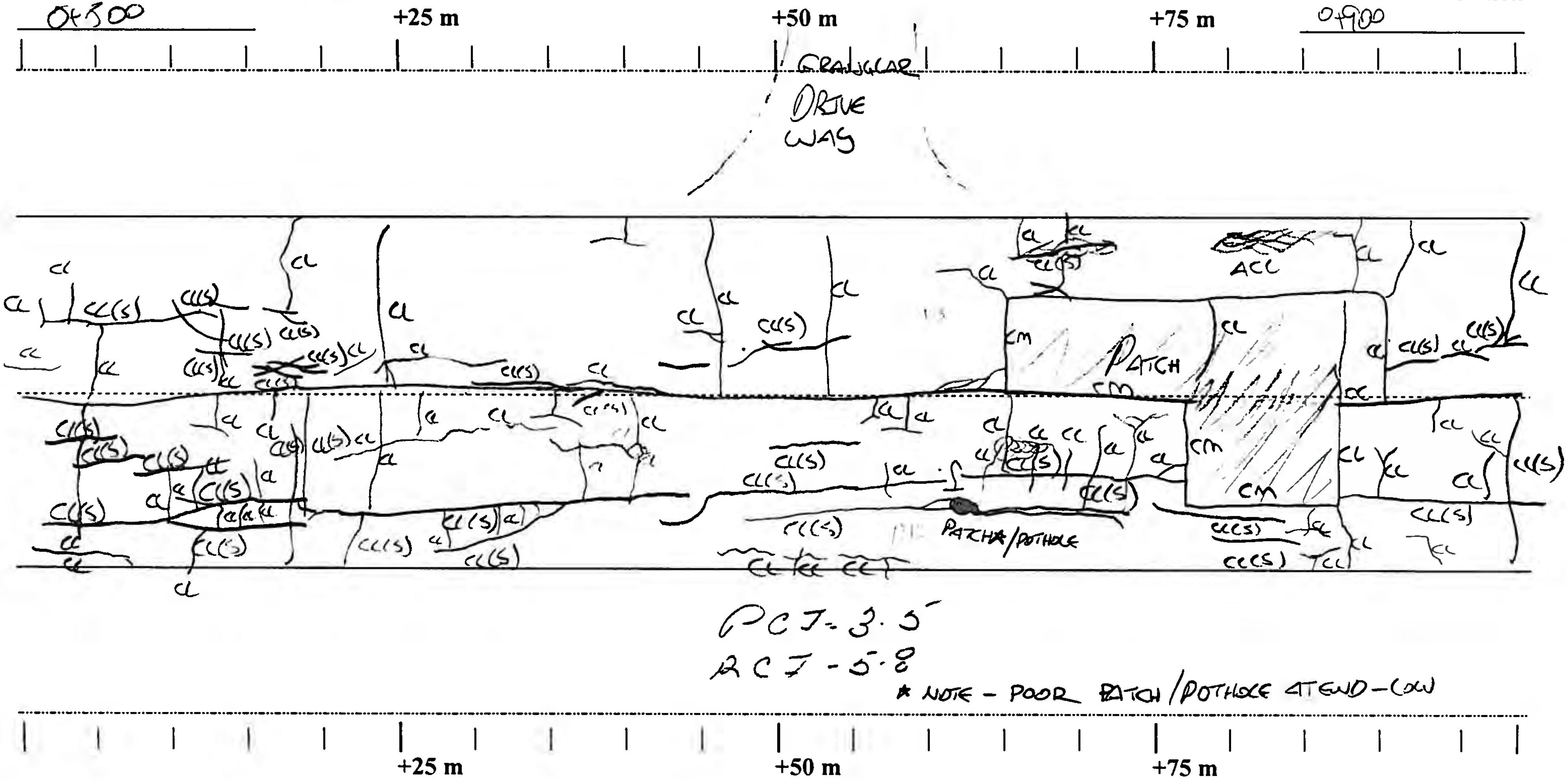
ARA Project No 16931

PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th line Direction ________ From Station 0+000 To Station 5+100

Surveyed By NIC ELLEL Date Surveyed May 24/25 Conditions ________

Start Station 0+800 End Station 0+900



PCI = 3.5

RCI - 5.8

★ NOTE – POOR PATCH/POTHOLE AT END – COW

ARA Project No 16737

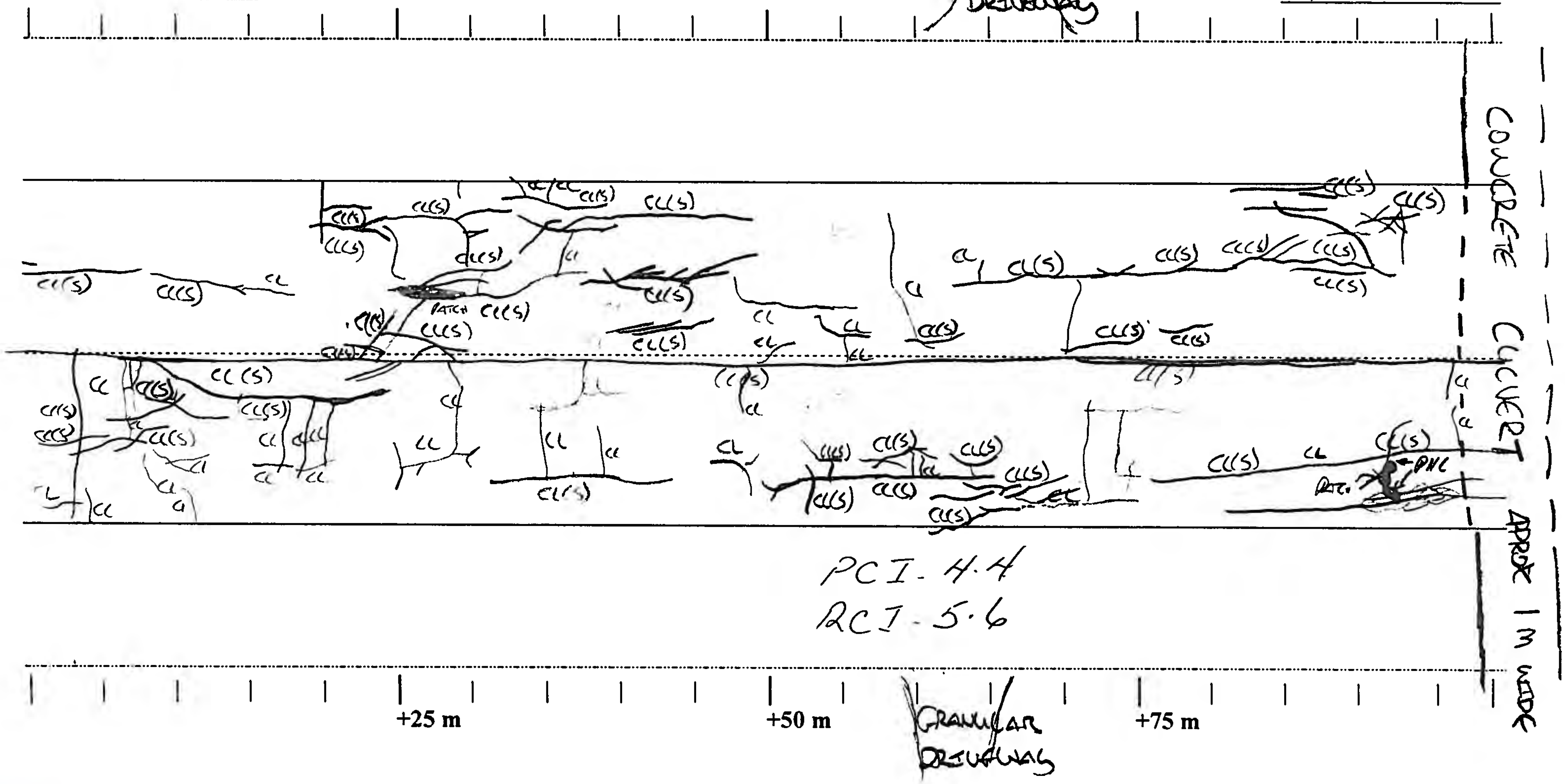
PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th line Direction ____ From Station 0+000 To Station 0+100

Surveyed By NIC ELLER Date Surveyed May 24/05 Conditions ____

Start Station 0+900

End Station 1+000



PCI - 4.4
RCI - 5.6

APPLIED RESEARCH ASSOCIATES, INC.

ARA Project No 16131

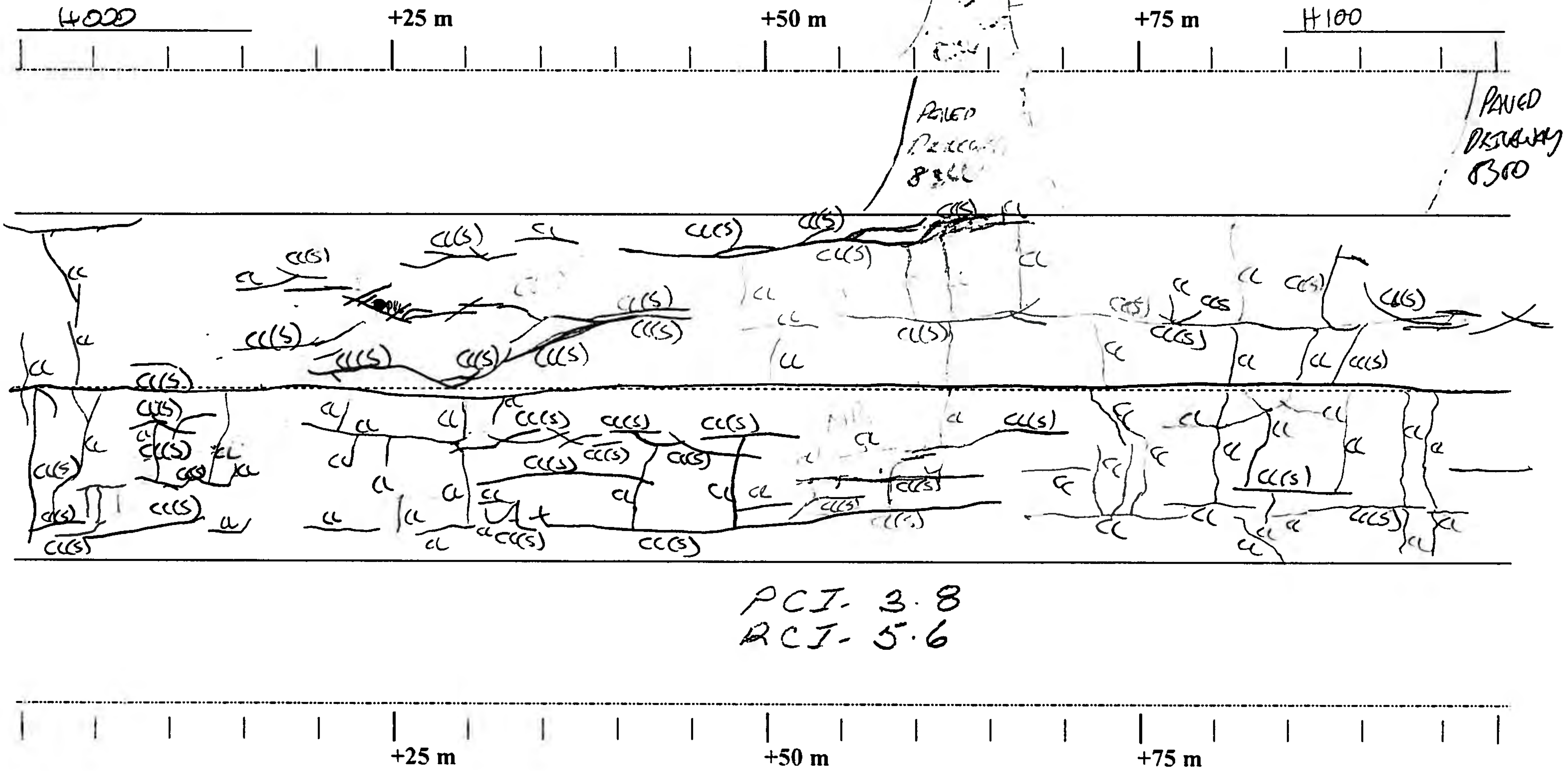
PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th Line Direction ______ From Station 4+000 To Station 4+100

Surveyed By AEC ELDER Date Surveyed May 24/05 Conditions ______

Start Station 4+000

End Station 4+100



PCI- 3.8
RCI- 5.6

APPLIED RESEARCH ASSOCIATES, INC.

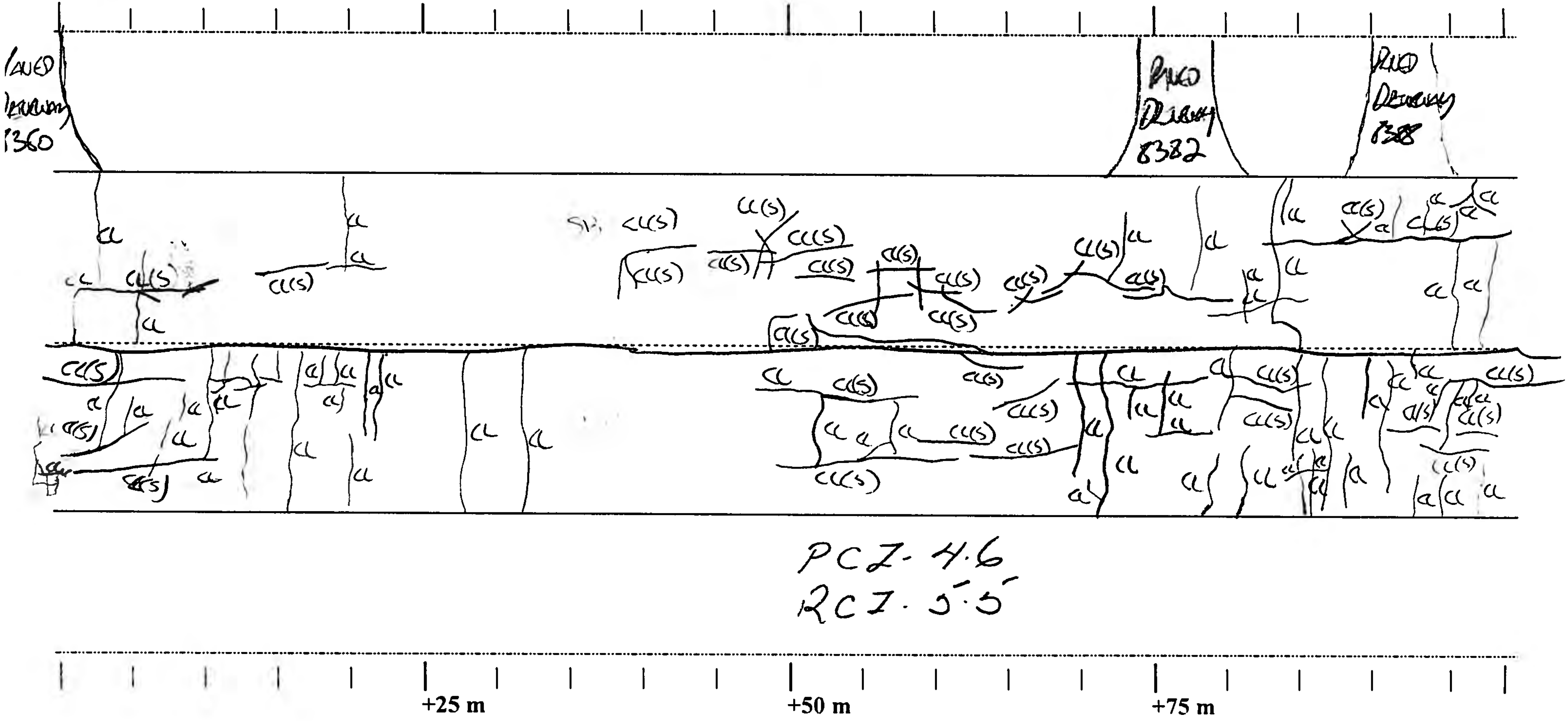
ARA Project No 16931

PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th Line Direction ________ From Station 0+000 To Station 6+100

Surveyed By NIC ELCER Date Surveyed May 24/05 Conditions ________

Start Station 1+120 +25 m +50 m +75 m End Station 1+200



PCI 4.6
RCI 5.5

APPLIED RESEARCH ASSOCIATES, INC.

ARA Project No 16931

PAVEMENT DISTRESS MAPPING SURVEY

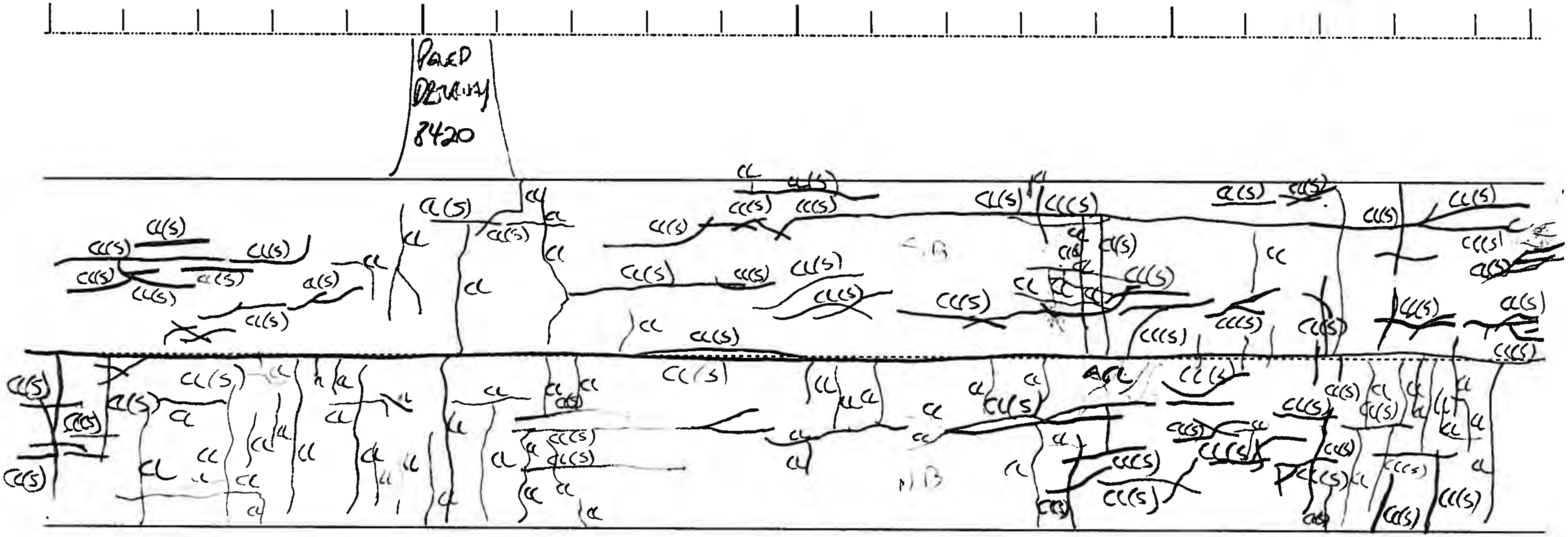
Highway 9th line Direction ______ From Station 0+006 To Station 6+100

Surveyed By Neil Clcce Date Surveyed May 24/05 Conditions ______

Start Station 1+200

+25 m +50 m +75 m

End Station 1+300



PCI - 3.5
RCI - 6.0

+25 m +50 m +75 m

APPLIED RESEARCH ASSOCIATES, INC.

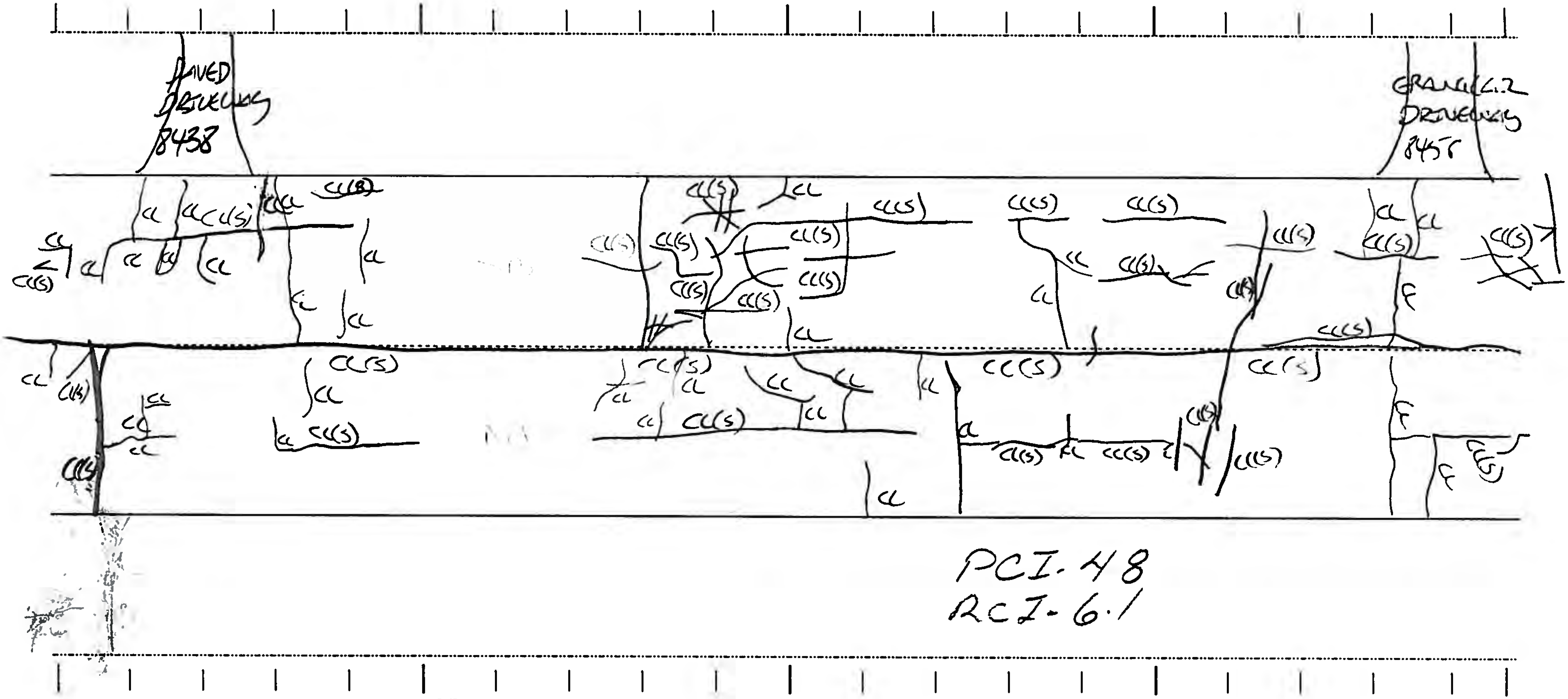
ARA Project No 16921

PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th Line Direction ____ From Station 0+000 To Station 6+100

Surveyed By NIC ELLER Date Surveyed May 24/05 Conditions ____

Start Station 1+300 +25 m +50 m +75 m End Station 1+400



PCI-48
RCI-6.1

+25 m +50 m +75 m

APPLIED RESEARCH ASSOCIATES, INC.

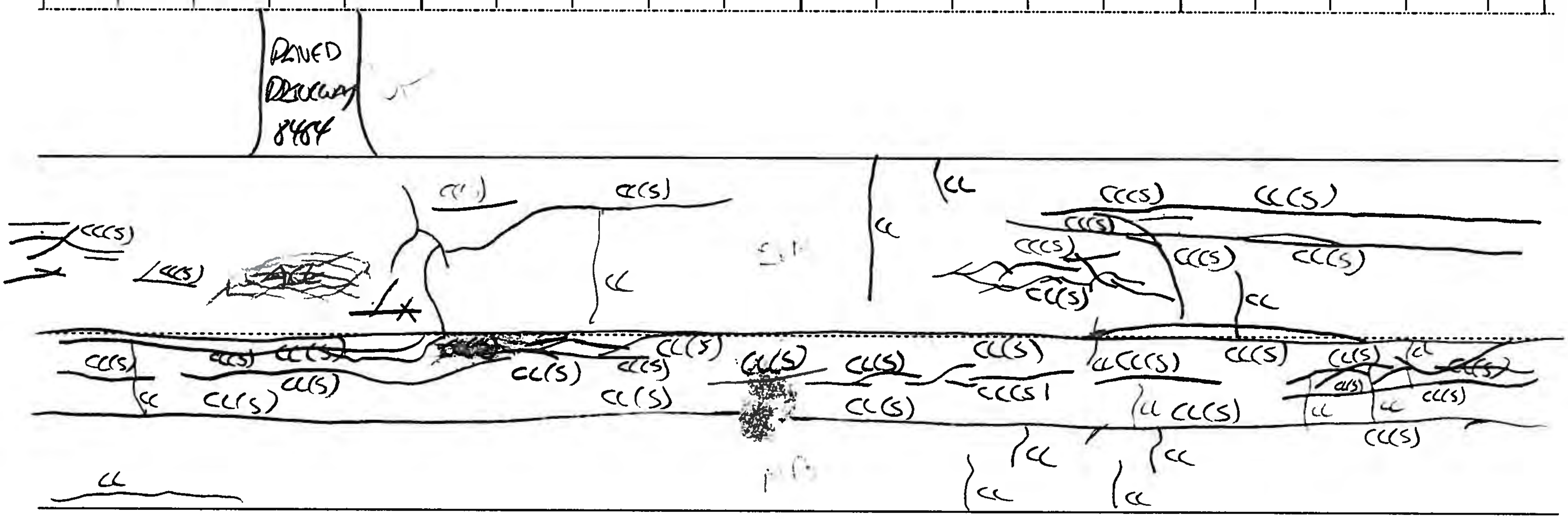
ARA Project No 16731

PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th line Direction ______ From Station 0+000 To Station 6+100

Surveyed By VIC ELLER Date Surveyed May 24/05 Conditions ______

Start Station 1+400 +25 m +50 m +75 m End Station 1+500



PCI- 4.2

RCI- 5.4

+25 m +50 m +75 m

APPLIED RESEARCH ASSOCIATES, INC.

ARA Project No 16931

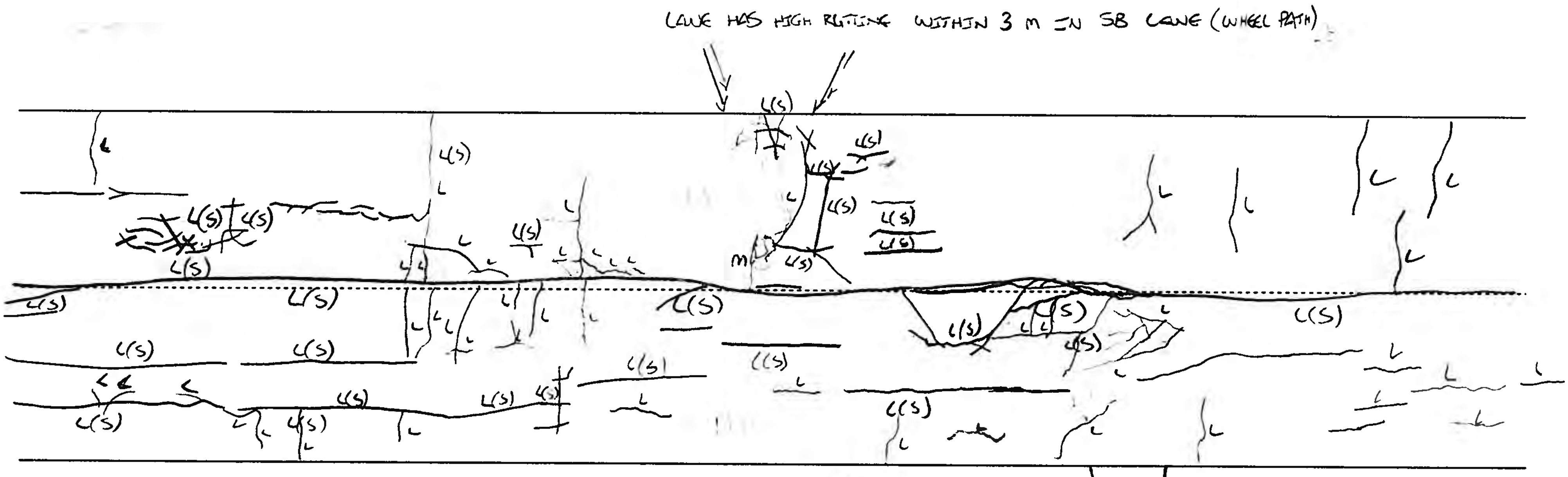
PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th Line Direction ______ From Station 0+000 To Station 6+100

Surveyed By NIC ELLER Date Surveyed May 25/05 Conditions ______

Start Station 1+500 +25 m +50 m +75 m End Station 1+600

LANE HAS HIGH RUTTING WITHIN 3 m IN SB LANE (WHEEL PATH)



RCI. 8.2
PCI - 4.1

GRANULAR DRIVEWAY 8519

+25 m +50 m +75 m

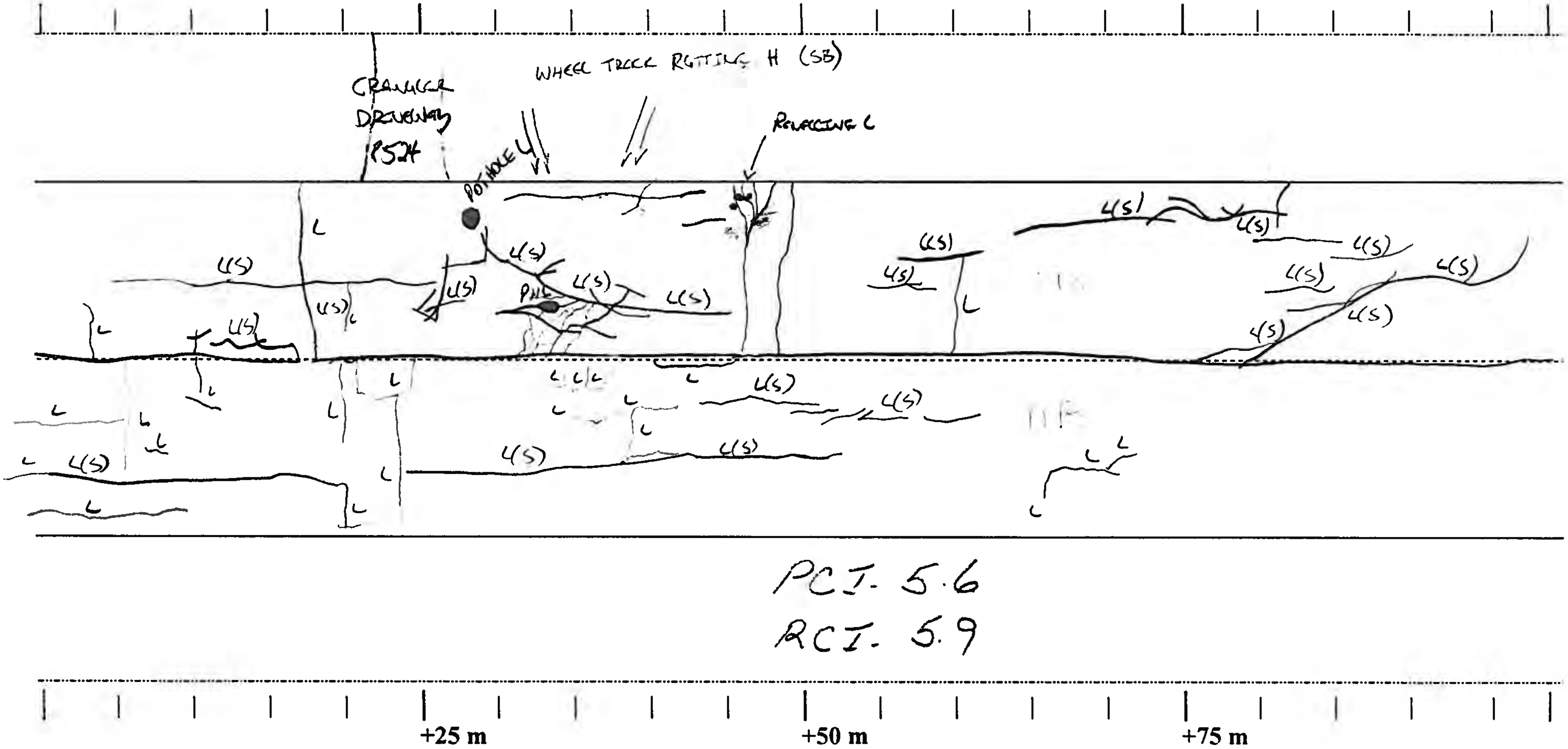
ARA Project No 16737

PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th Line Direction ______ From Station 0+000 To Station 6+100

Surveyed By NIC EGGER Date Surveyed May 25/05 Conditions ______

Start Station 1+600 +25 m +50 m +75 m End Station 1+700



PCI- 5.6
RCI- 5.9

+25 m +50 m +75 m

APPLIED RESEARCH ASSOCIATES, INC.

ARA Project No 16931

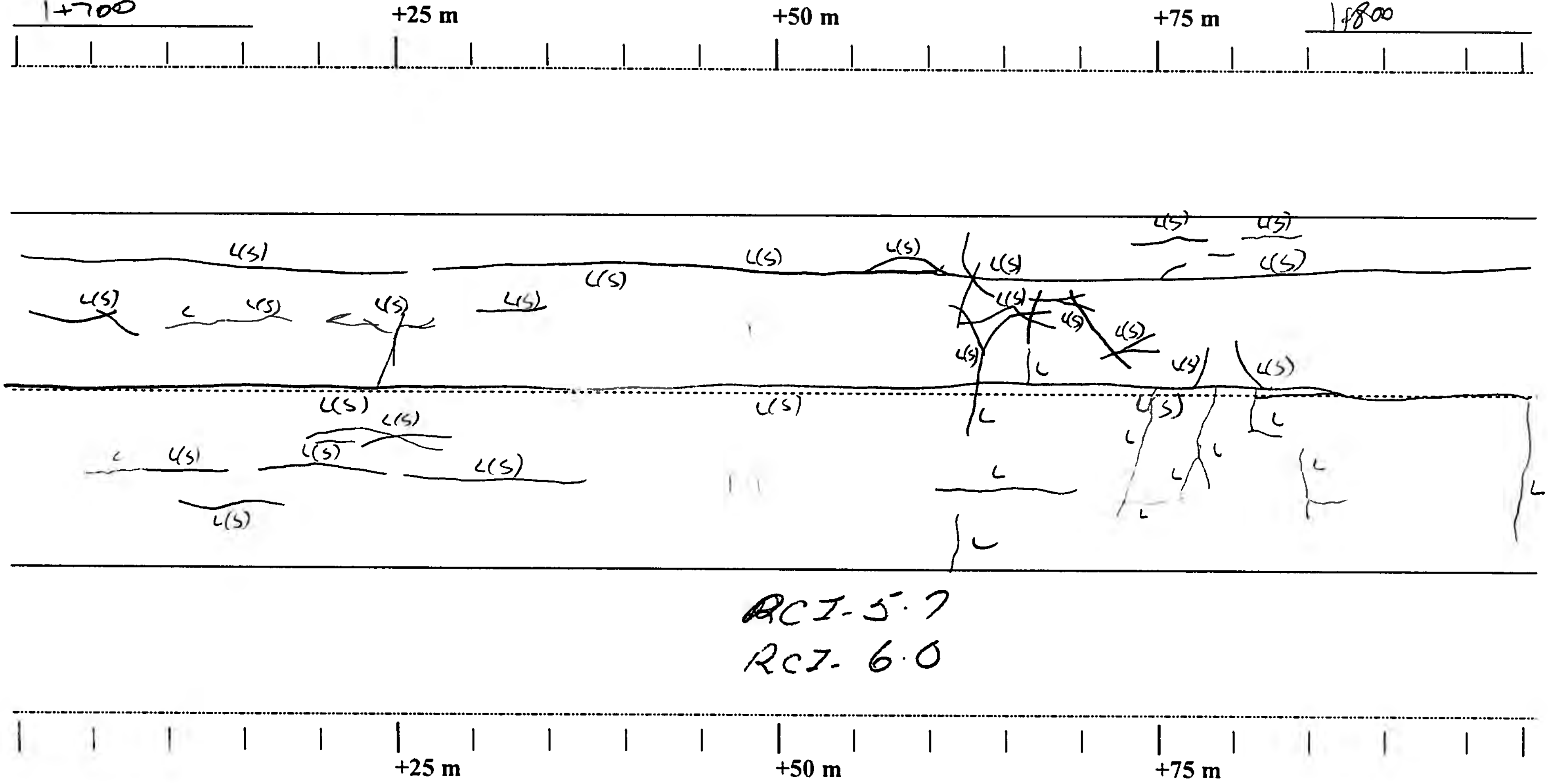
PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th Line Direction ______ From Station 0+000 To Station 5+100

Surveyed By Nic Euler Date Surveyed May 25/05 Conditions ______

Start Station 1+700

End Station 1800



RCI-5.7
RCI-6.0

APPLIED RESEARCH ASSOCIATES, INC.

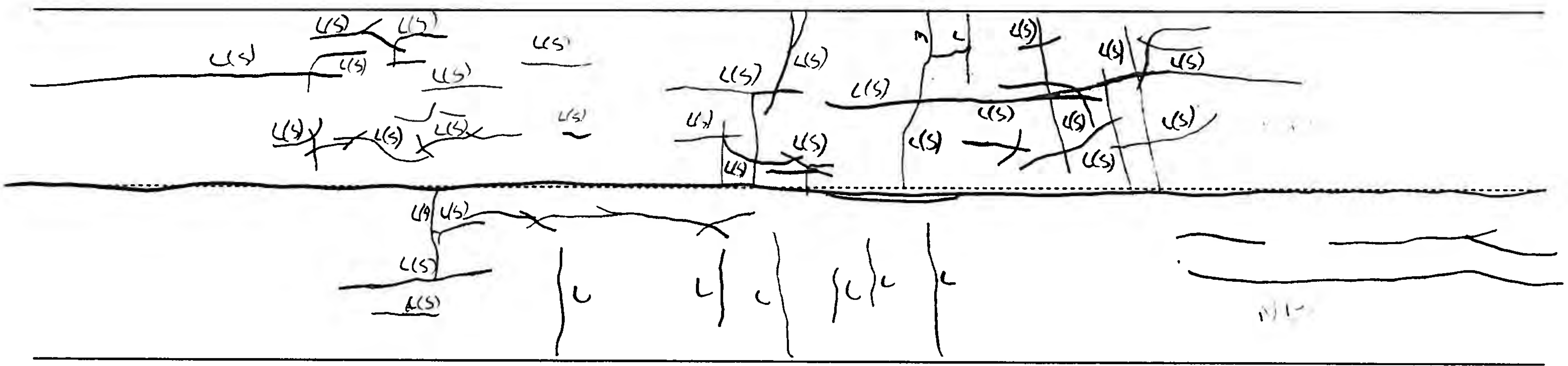
ARA Project No [illegible]

PAVEMENT DISTRESS MAPPING SURVEY

Highway 16th Line Direction From Station 0+000 To Station 6+100

Surveyed By [illegible] Date Surveyed May 25/05 Conditions

Start Station 1+800 +25 m +50 m +75 m End Station 1+900



PCI 5.9
RCI 6.2

PAVED DRIVEWAY 8629

+25 m +50 m +75 m

APPLIED RESEARCH ASSOCIATES, INC.

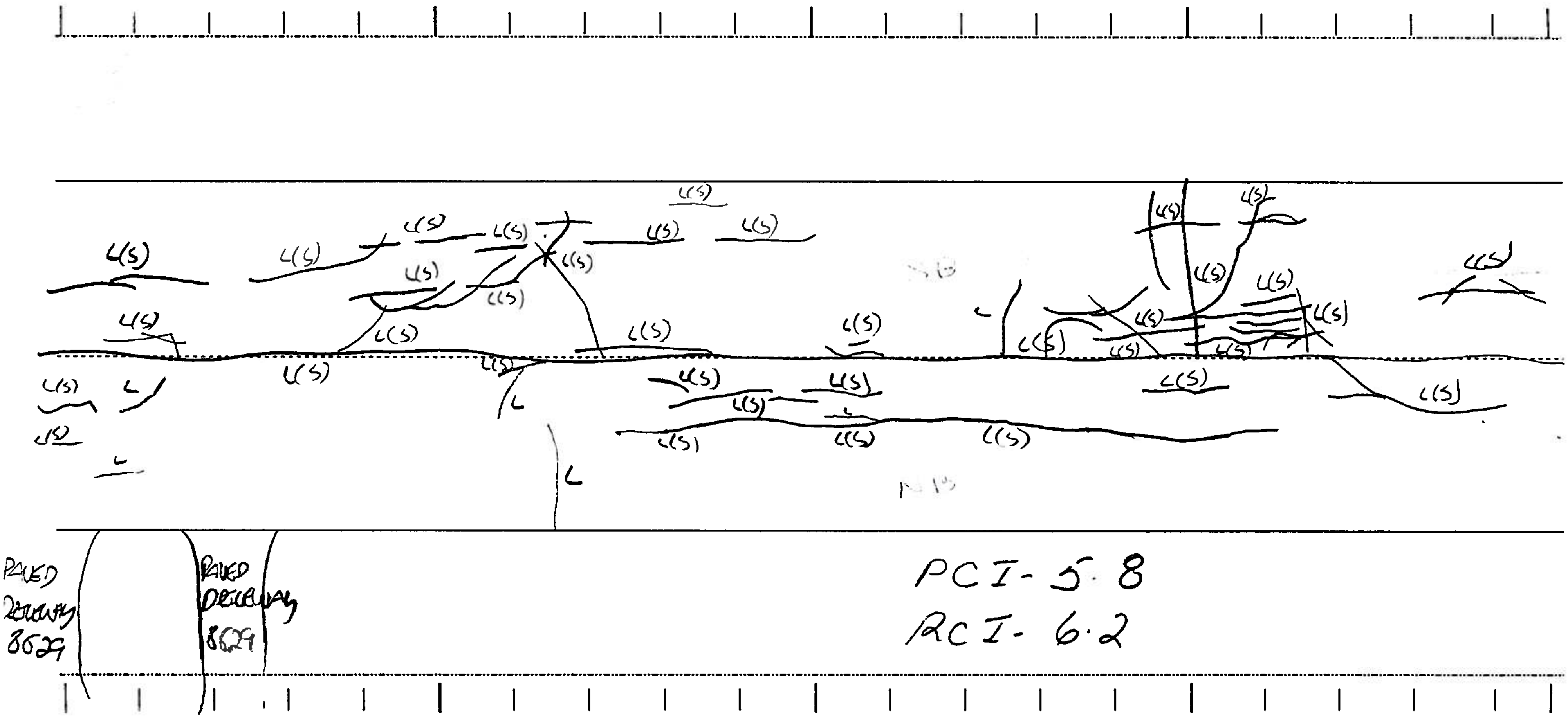
ARA Project No 16931

PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th line Direction ______ From Station 0+000 To Station 6+100

Surveyed By Nic Ecker Date Surveyed May 25/05 Conditions ______

Start Station 1+900 +25 m +50 m +75 m End Station 2+000



PCI - 5.8
RCI - 6.2

+25 m +50 m +75 m

APPLIED RESEARCH ASSOCIATES, INC.

ARA Project No 16931

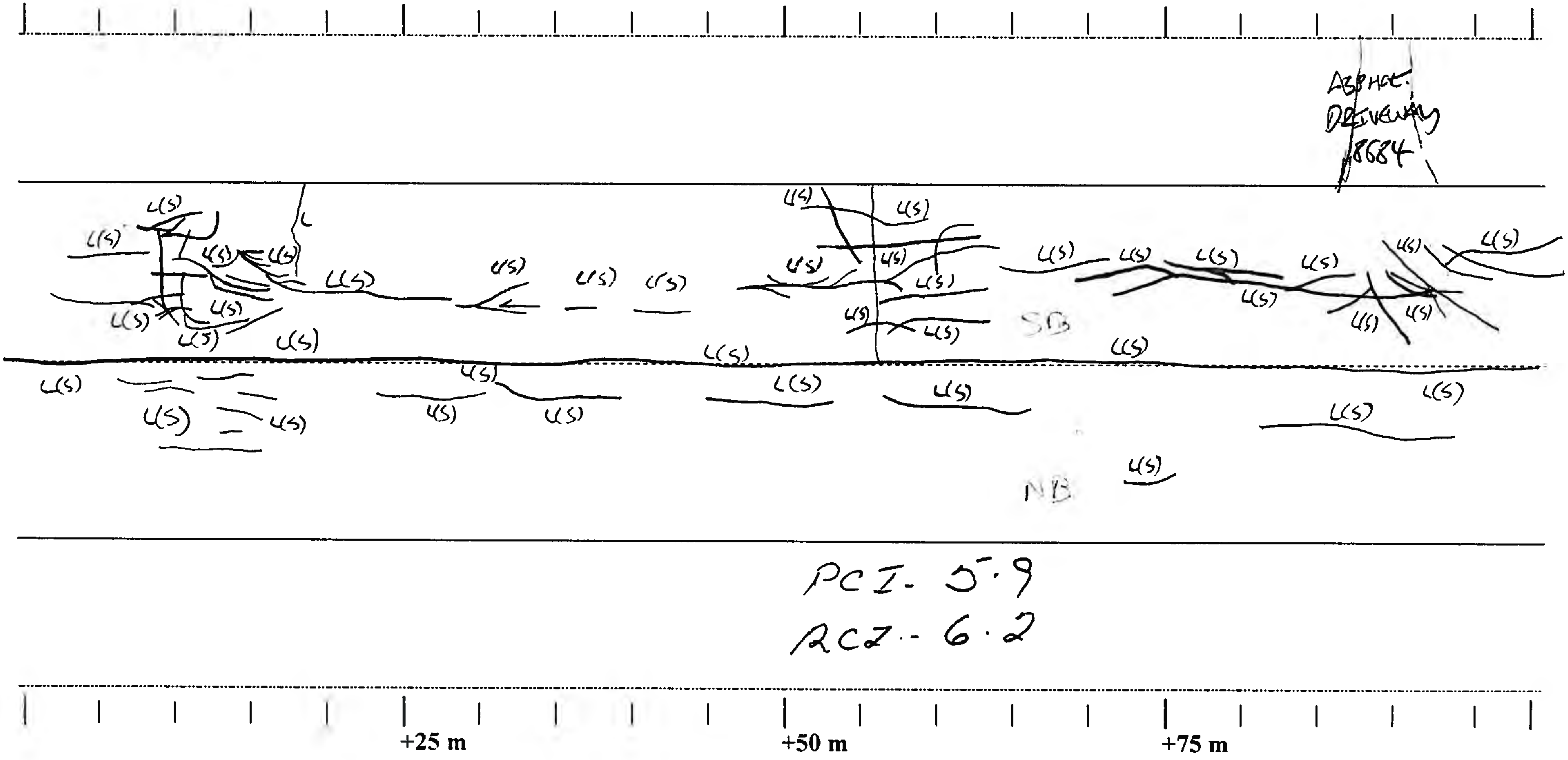
PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th Line Direction ______ From Station 1+000 To Station 6+100

Surveyed By NK EGGER Date Surveyed May 25/05 Conditions ______

Start Station 2+000

End Station 2+100



PCI - 5.9

RCI - 6.2

ARA Project No 16931

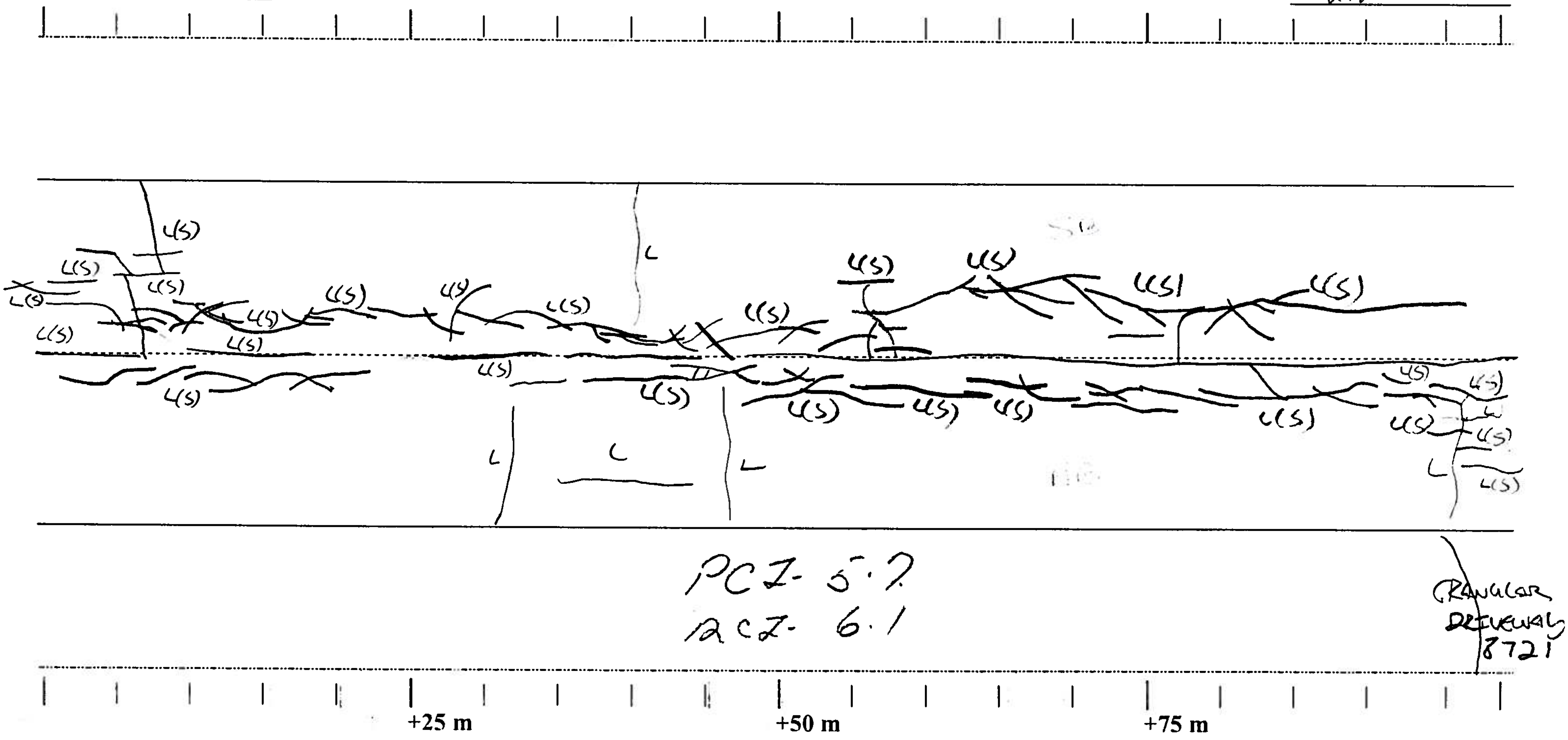
PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th Line Direction ______ From Station 6+000 To Station 6+100

Surveyed By Nic Egler Date Surveyed May 25/05 Conditions ______

Start Station 2+100

End Station 2+200



PCI- 5.7
RCI- 6.1

APPLIED RESEARCH ASSOCIATES, INC.

ARA Project No 16731

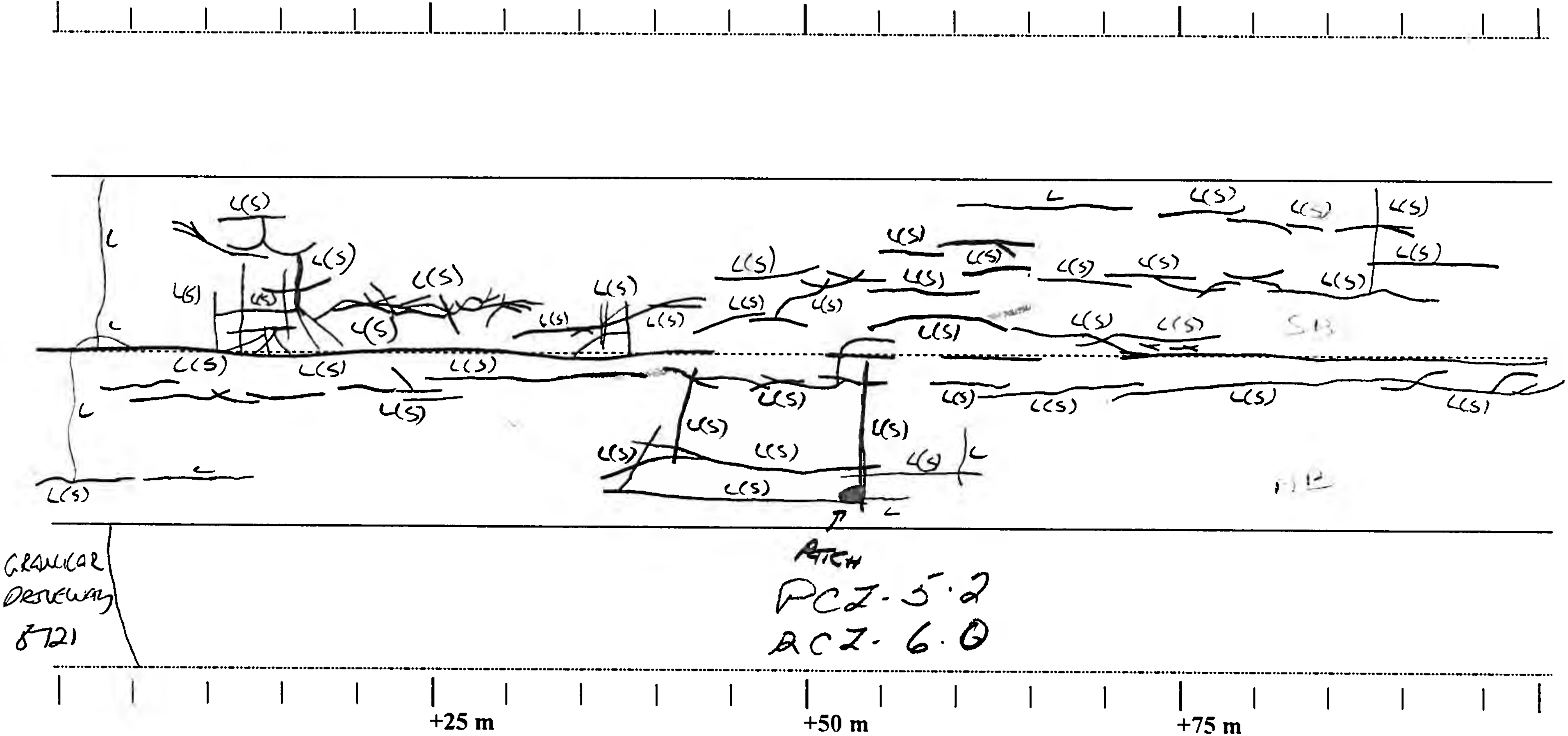
PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th Line Direction ______ From Station 0+000 To Station 6+100

Surveyed By Nic Fuller Date Surveyed May 25/05 Conditions ______

Start Station 2+200

End Station 2+300



APPLIED RESEARCH ASSOCIATES, INC.

ARA Project No 16931

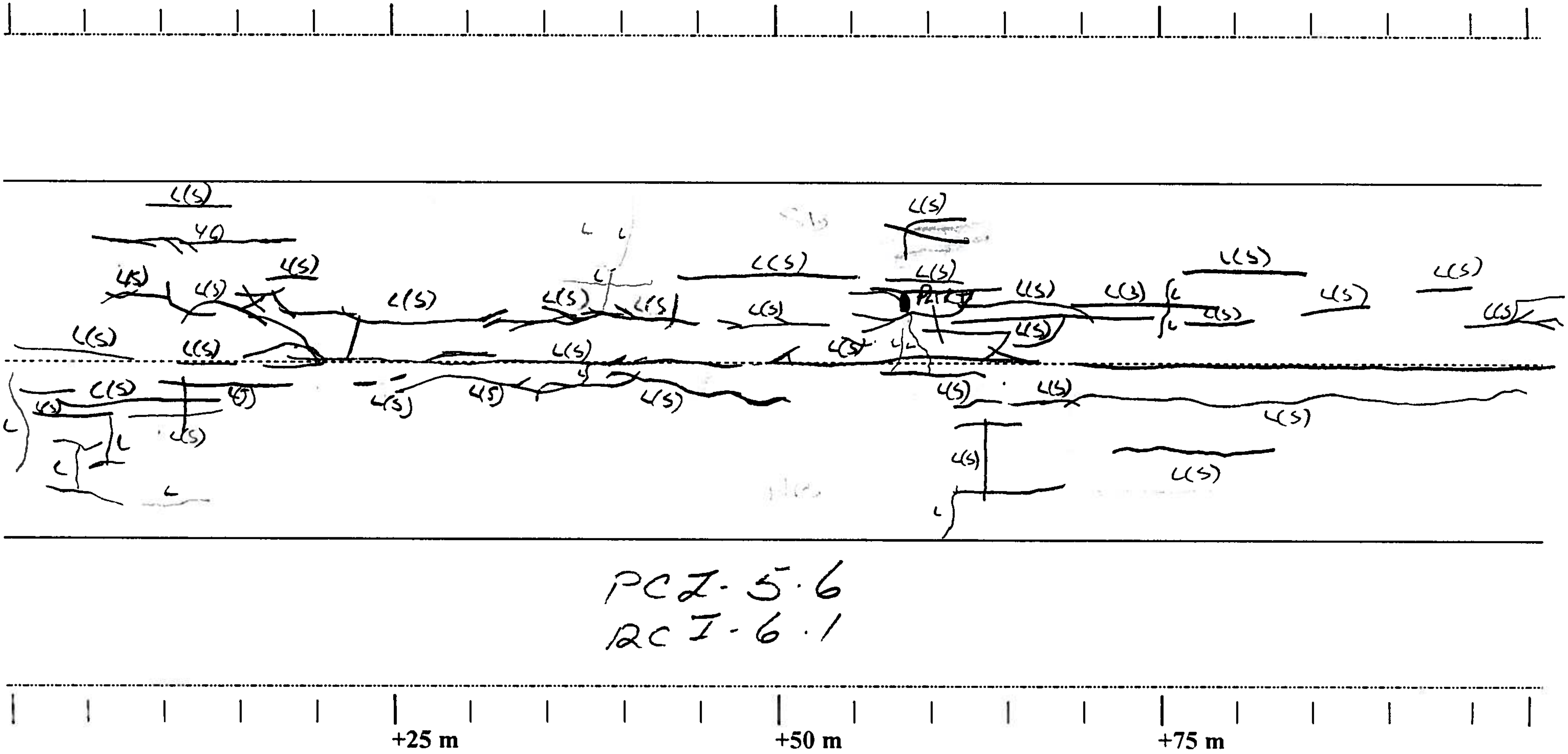
PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th Line Direction _____ From Station 0+000 To Station 6+100

Surveyed By NIC ELLER Date Surveyed May 25/05 Conditions _____

Start Station 2+300

End Station 2+400



PCI - 5.6
RCI - 6.1

APPLIED RESEARCH ASSOCIATES, INC.

ARA Project No 16619

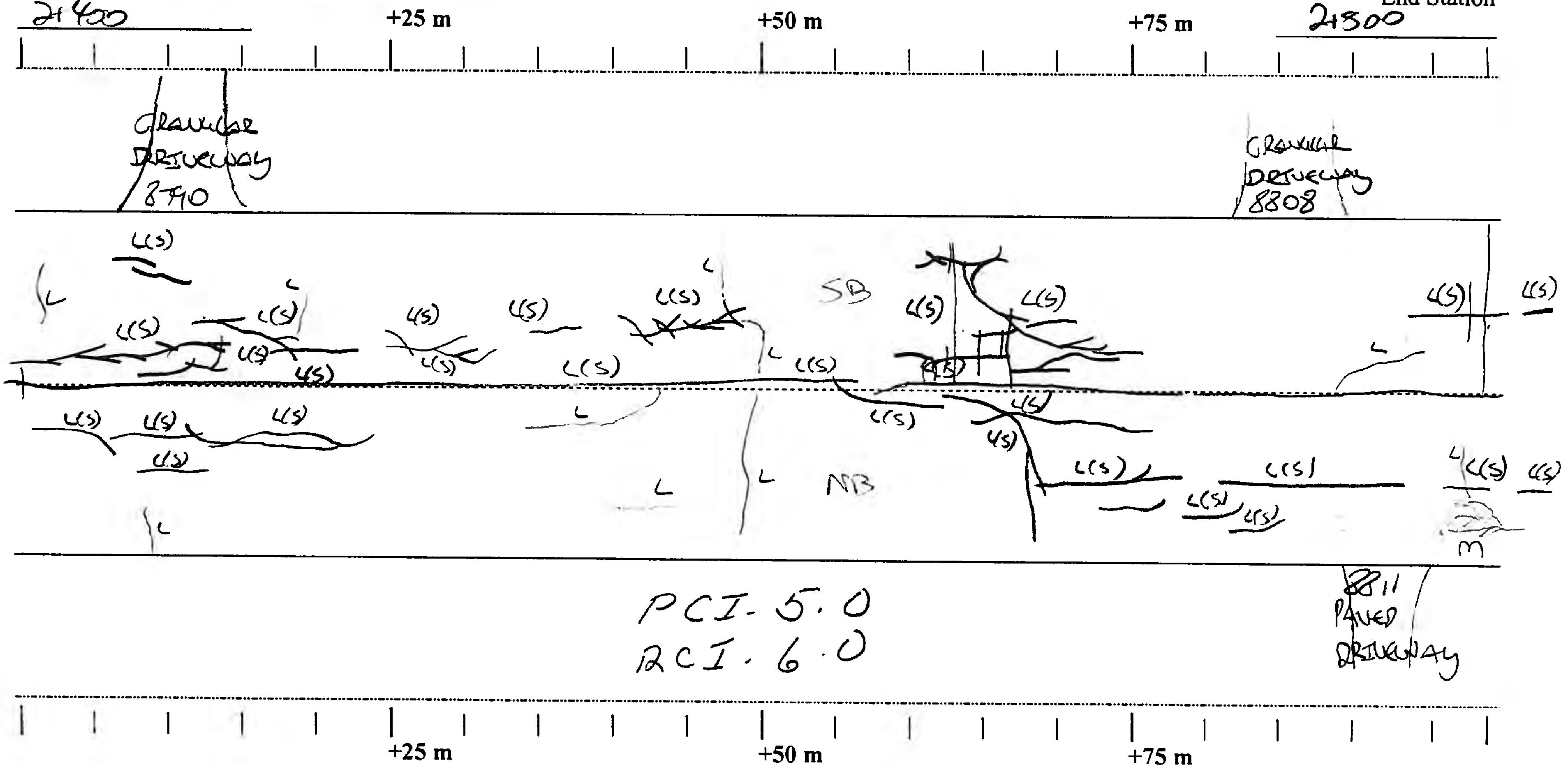
PAVEMENT DISTRESS MAPPING SURVEY

Highway 911 line Direction ______ From Station 6+000 To Station 6+100

Surveyed By NIC ELLER Date Surveyed May 25/05 Conditions ______

Start Station 2+400

End Station 2+500



PCI- 5.0
RCI. 6.0

APPLIED RESEARCH ASSOCIATES, INC.

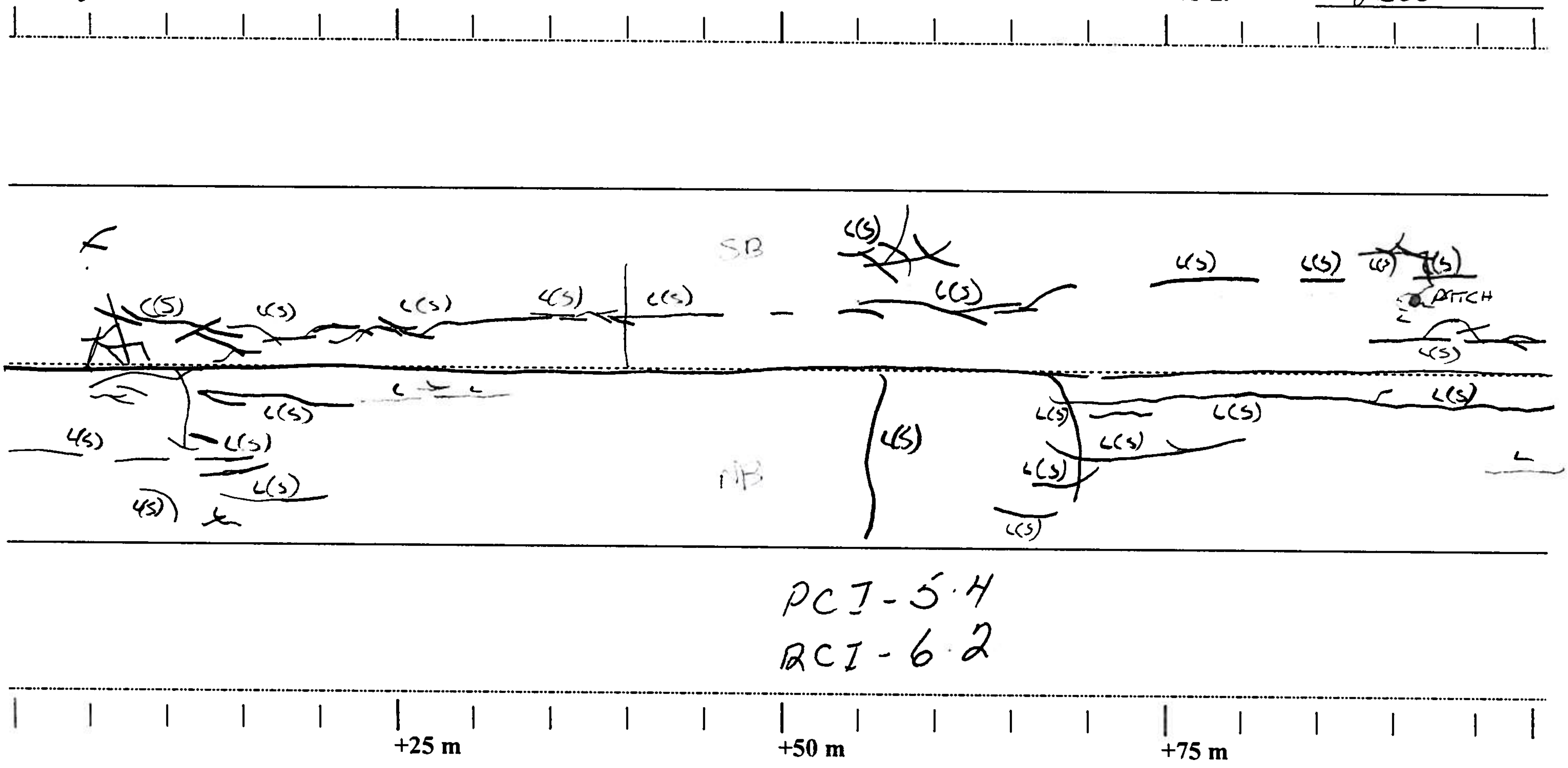
ARA Project No 16931

PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th Line Direction ____ From Station 6+000 To Station 6+100

Surveyed By NIC Fuller Date Surveyed May 25/05 Conditions ____

Start Station 2+500 +25 m +50 m +75 m End Station 2+600



PCI - 5.4
RCI - 6.2

APPLIED RESEARCH ASSOCIATES, INC.

ARA Project No 16931

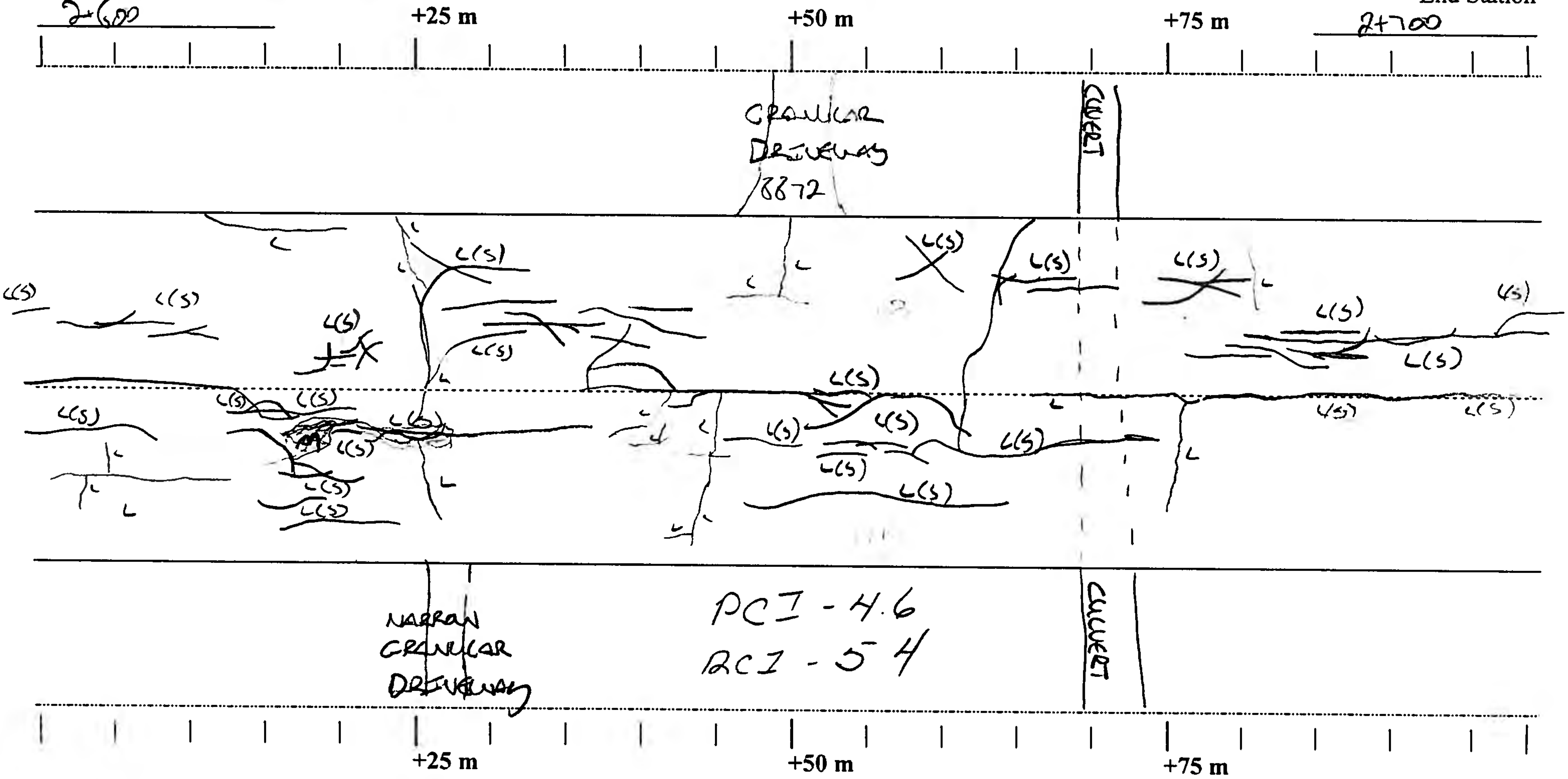
PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th Line Direction ____ From Station 5+000 To Station 6+100

Surveyed By NIC EGGER Date Surveyed May 25/05 Conditions ____

Start Station 2+600

End Station 2+700



PCI - 4.6

RCI - 5.4

APPLIED RESEARCH ASSOCIATES, INC.

ARA Project No 16931

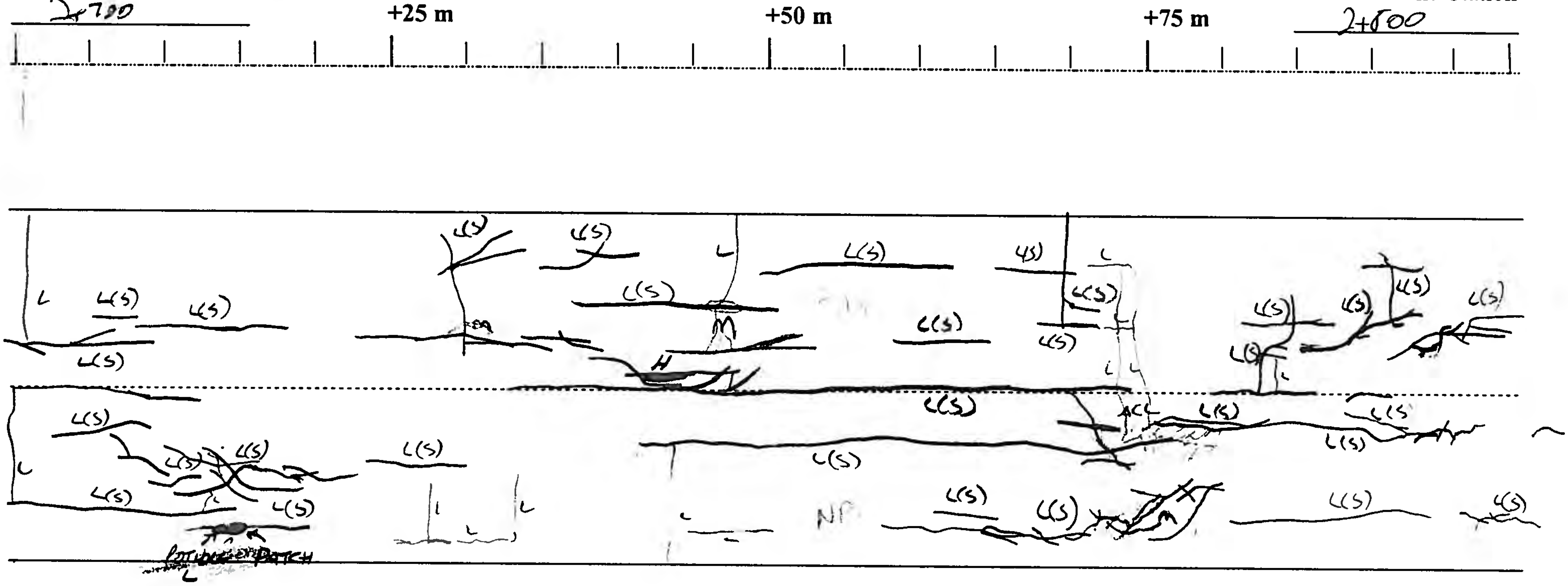
PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th Ave Direction ____ From Station 0+000 To Station 6+100

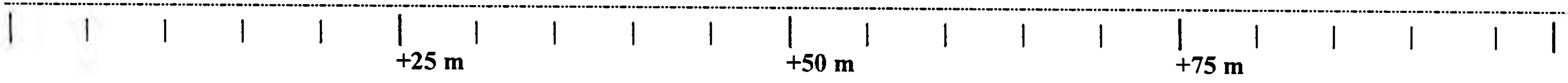
Surveyed By NIC ELLER Date Surveyed May 25/05 Conditions ____

Start Station 2+700

End Station 2+800



PCI - 4.7
RCI - 5.3



APPLIED RESEARCH ASSOCIATES, INC.

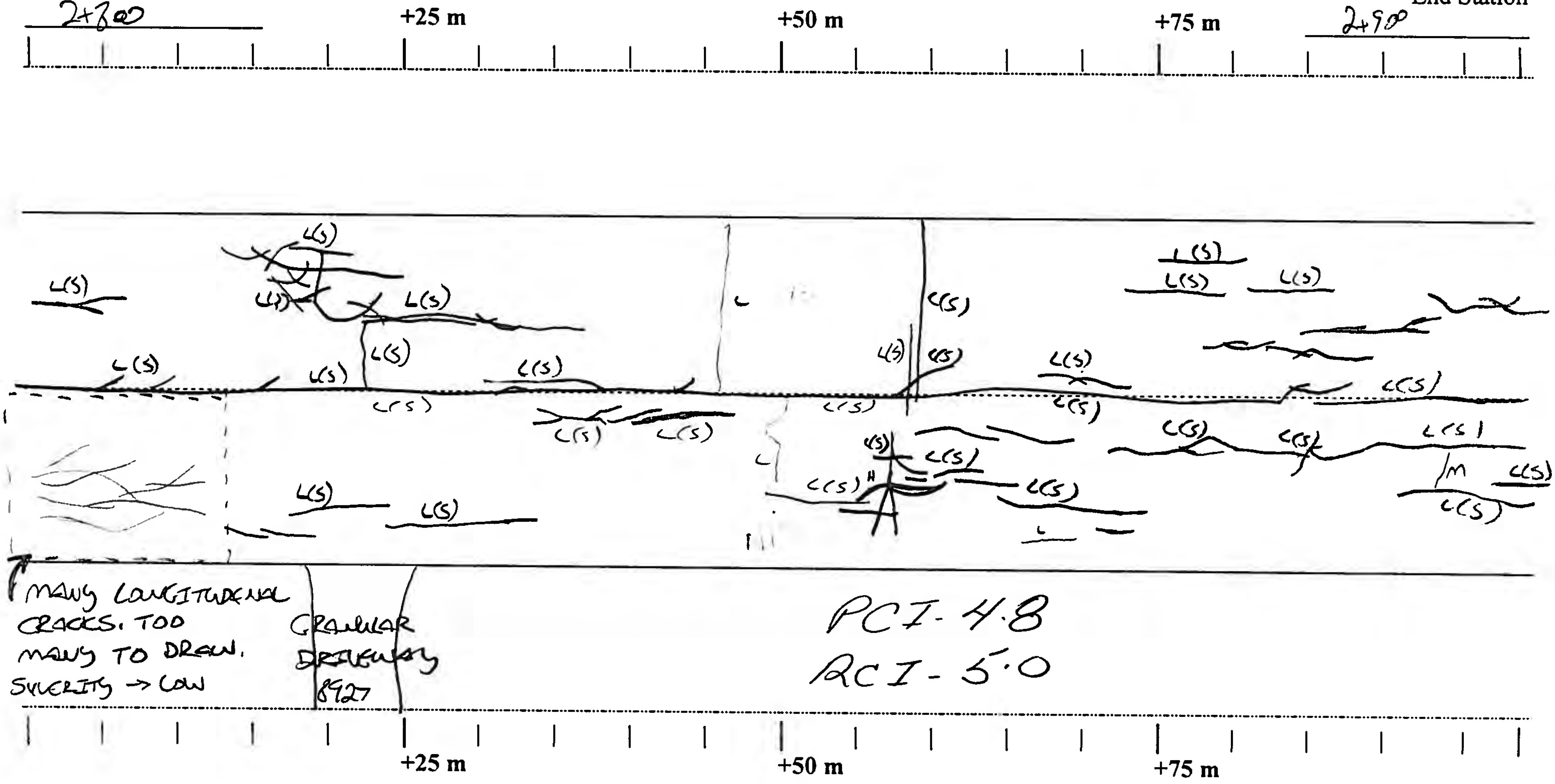
ARA Project No 16931

PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th Line Direction From Station 0+000 To Station 6+100

Surveyed By NIC ELLCE Date Surveyed May 25/05 Conditions

Start Station 2+800 End Station 2+900



PCI - 4.8

RCI - 5.0

APPLIED RESEARCH ASSOCIATES, INC.

ARA Project No 16931

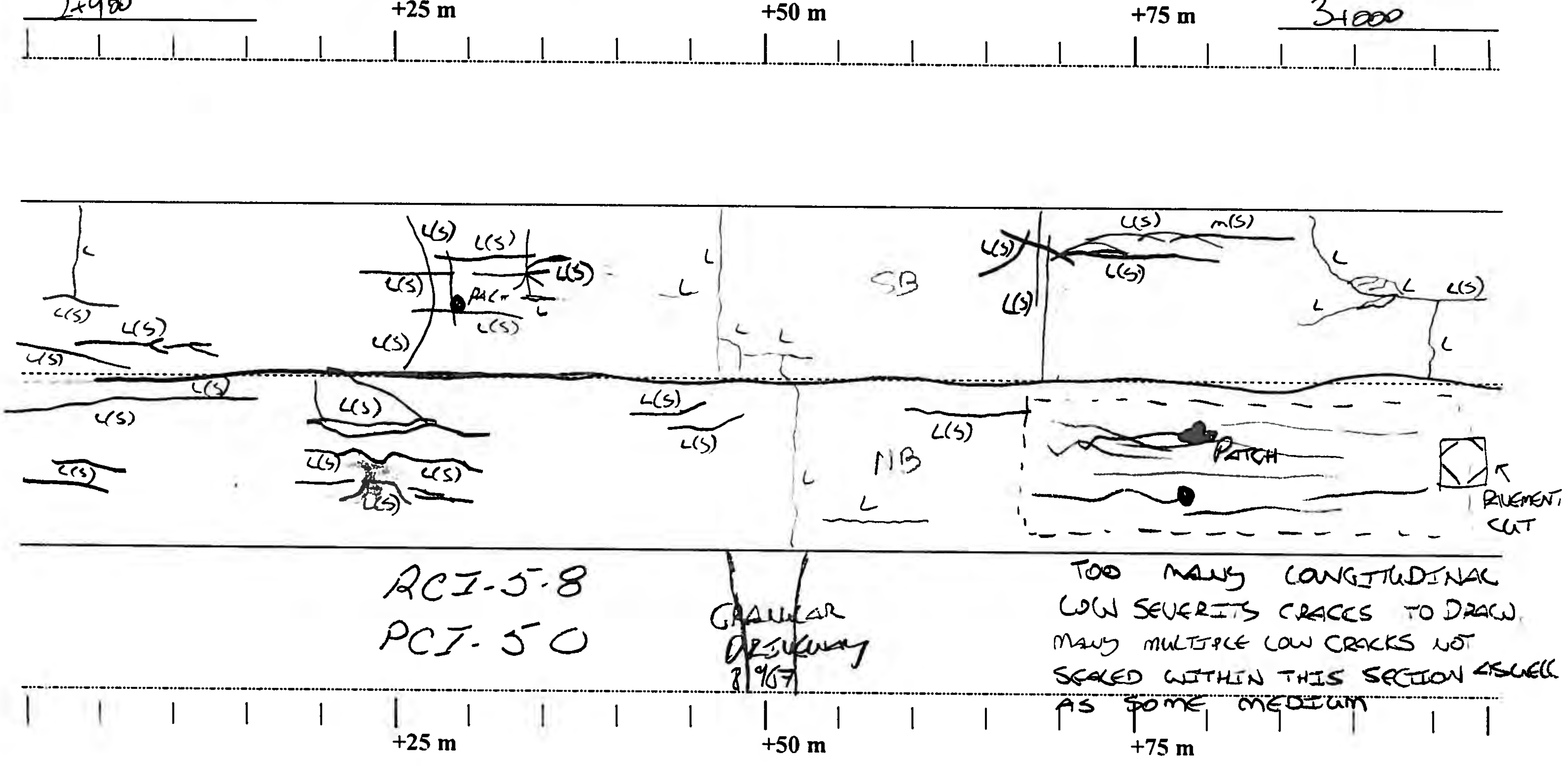
PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th Line Direction ______ From Station 0+000 To Station 6+100

Surveyed By NIC FULLER Date Surveyed May 25/05 Conditions ______

Start Station 2+900

End Station 3+000



RCI-5.8
PCI-50

TOO MANY LONGITUDINAL LOW SEVERITY CRACKS TO DRAW. MANY MULTIPLE LOW CRACKS NOT SEALED WITHIN THIS SECTION AS WELL AS SOME MEDIUM

APPLIED RESEARCH ASSOCIATES, INC.

ARA Project No 16931

PAVEMENT DISTRESS MAPPING SURVEY

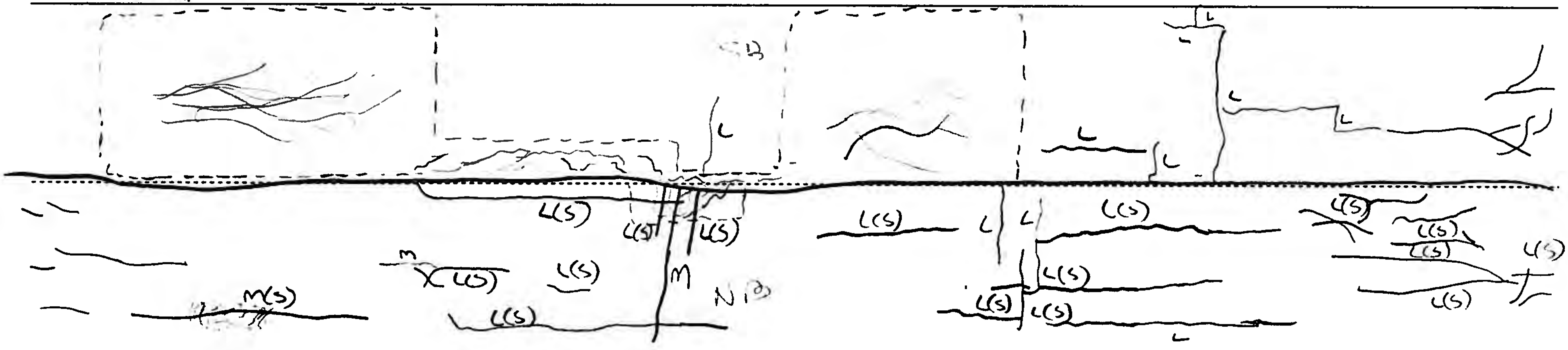
Highway 9th line Direction From Station 0+000 To Station 6+100

Surveyed By NIC EULER Date Surveyed May 25/05 Conditions

Start Station 3+000 +25 m +50 m +75 m End Station 3+100

GRAVEL DRIVEWAY 8986

TOO MANY LOW/MED CRACKS SEALED AND NOT SEALED TO DRAW



PCI - 4.8

RCI - 5.1

+25 m +50 m +75 m

APPLIED RESEARCH ASSOCIATES, INC.

ARA Project No 16931

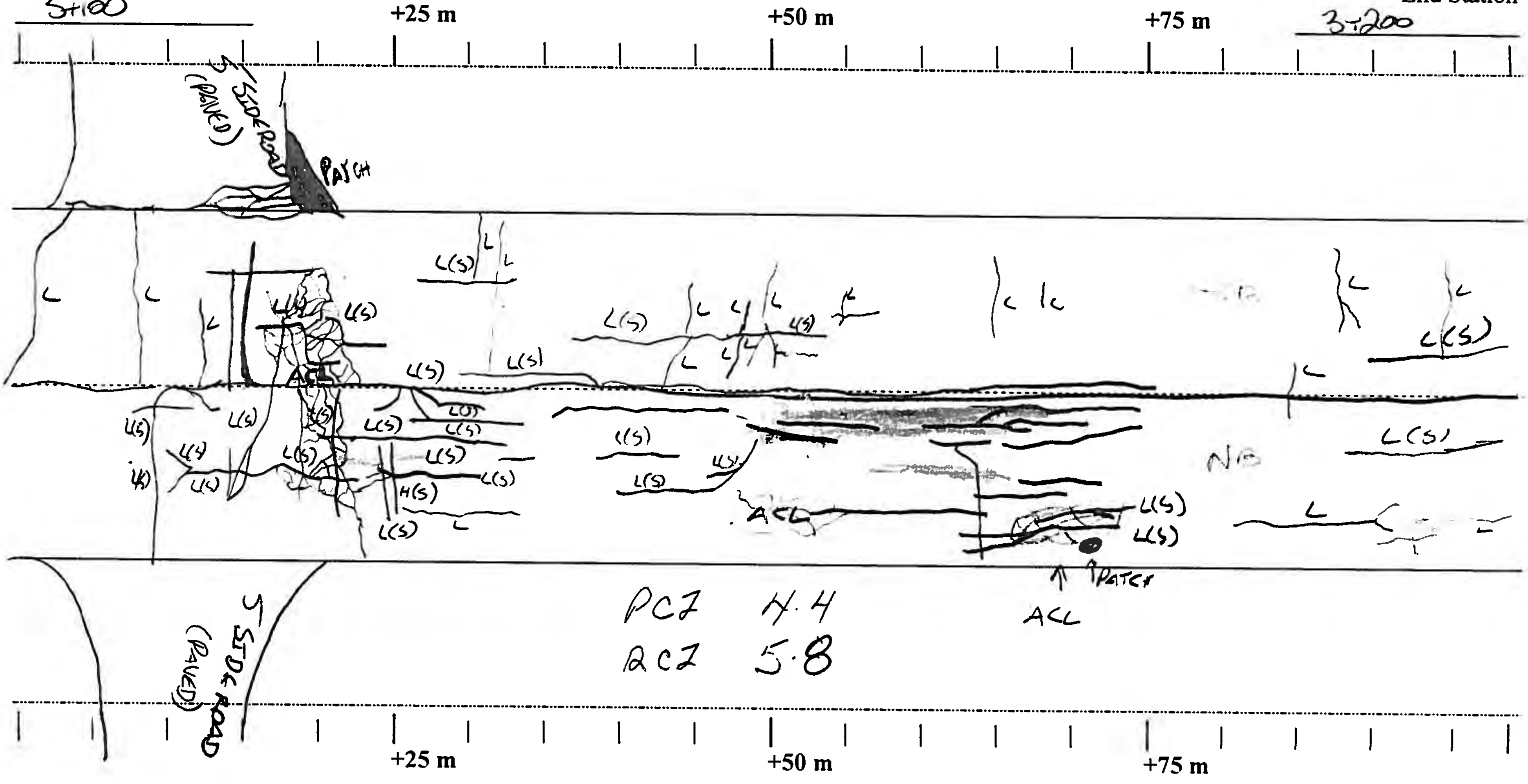
PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th Line Direction ______ From Station 0+000 To Station 6+100

Surveyed By NIC ELLER Date Surveyed May 26.05 Conditions ______

Start Station 3+100

End Station 3+200



PCI 4.4
RCI 5.8

APPLIED RESEARCH ASSOCIATES, INC.

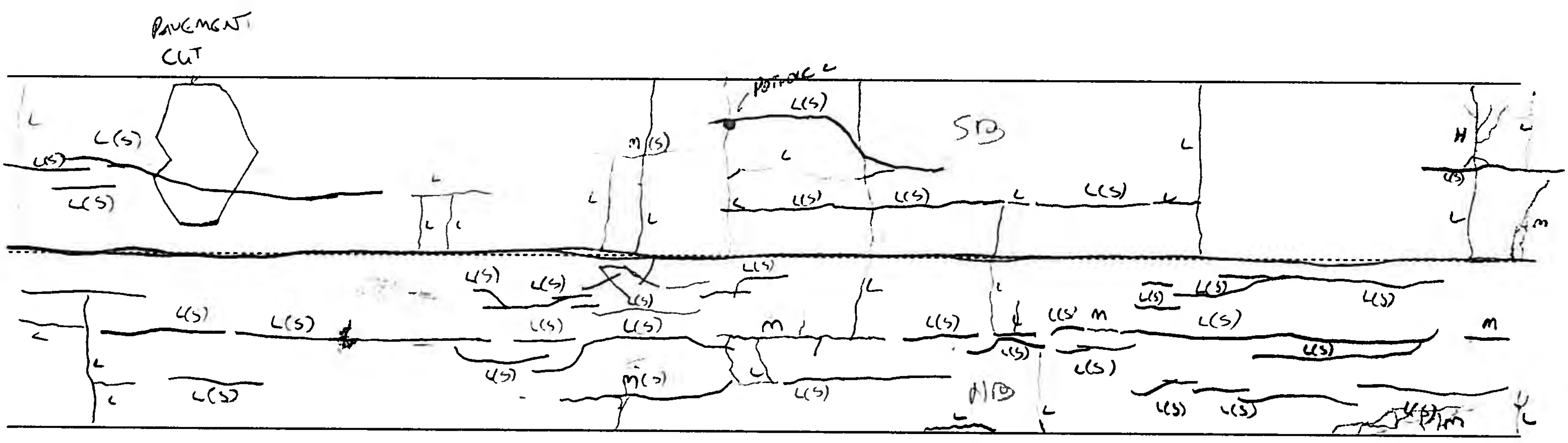
ARA Project No 16931

PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th line Direction ______ From Station 0+000 To Station 5+100

Surveyed By NEC Cuccl Date Surveyed May 26/05 Conditions ______

Start Station 3+200 +25 m +50 m +75 m End Station 3+300



PCI - 4.5
RCI - 5.7

+25 m +50 m +75 m

APPLIED RESEARCH ASSOCIATES, INC.

ARA Project No 16931

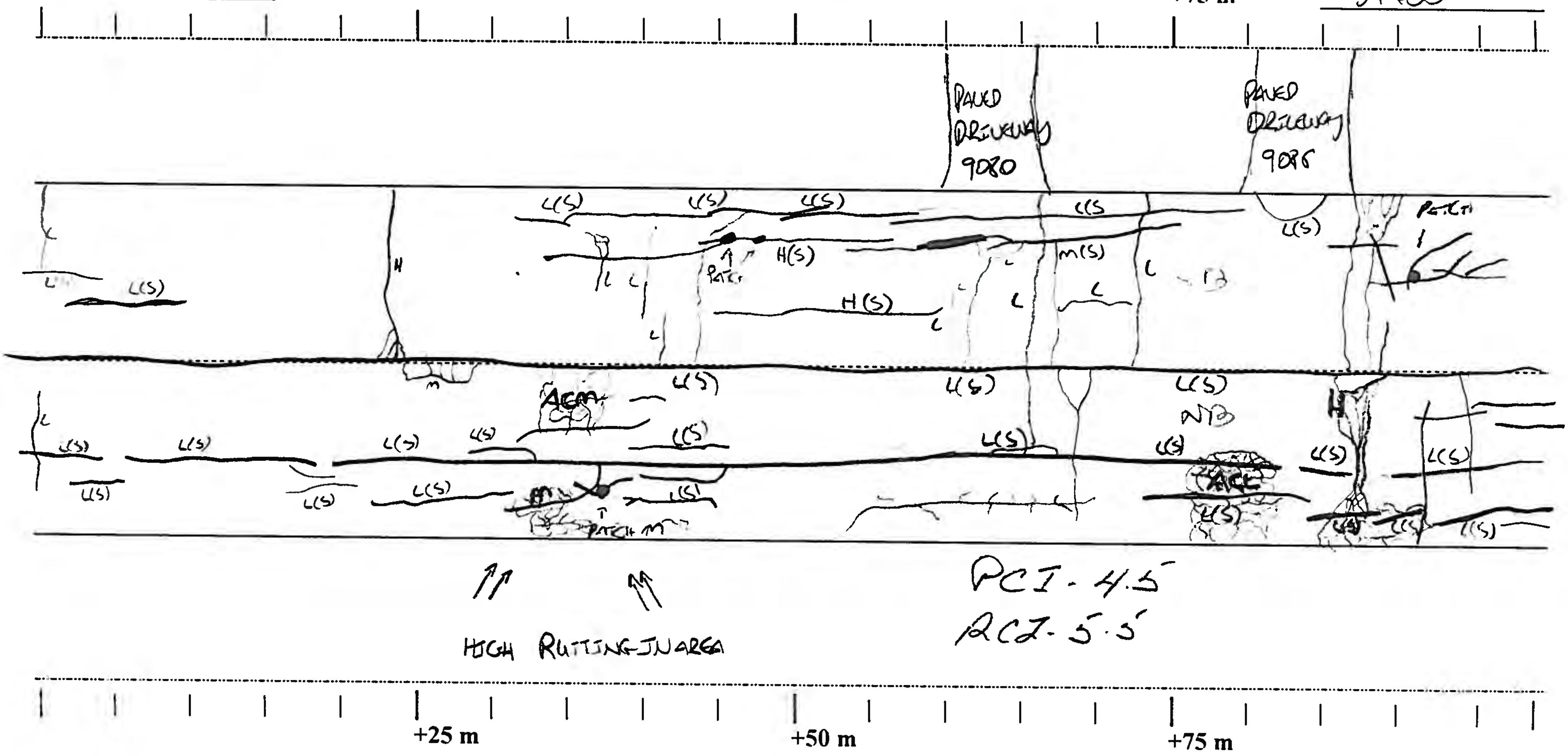
PAVEMENT DISTRESS MAPPING SURVEY

Highway 11th Ave Direction _____ From Station 0+000 To Station 6+400

Surveyed By NIC ELLER Date Surveyed May 26/05 Conditions _____

Start Station 3+300

End Station 3+400



HIGH RUTTING IN AREA

PCI - 4.5

RCI - 5.5

APPLIED RESEARCH ASSOCIATES, INC.

ARA Project No 16931

PAVEMENT DISTRESS MAPPING SURVEY

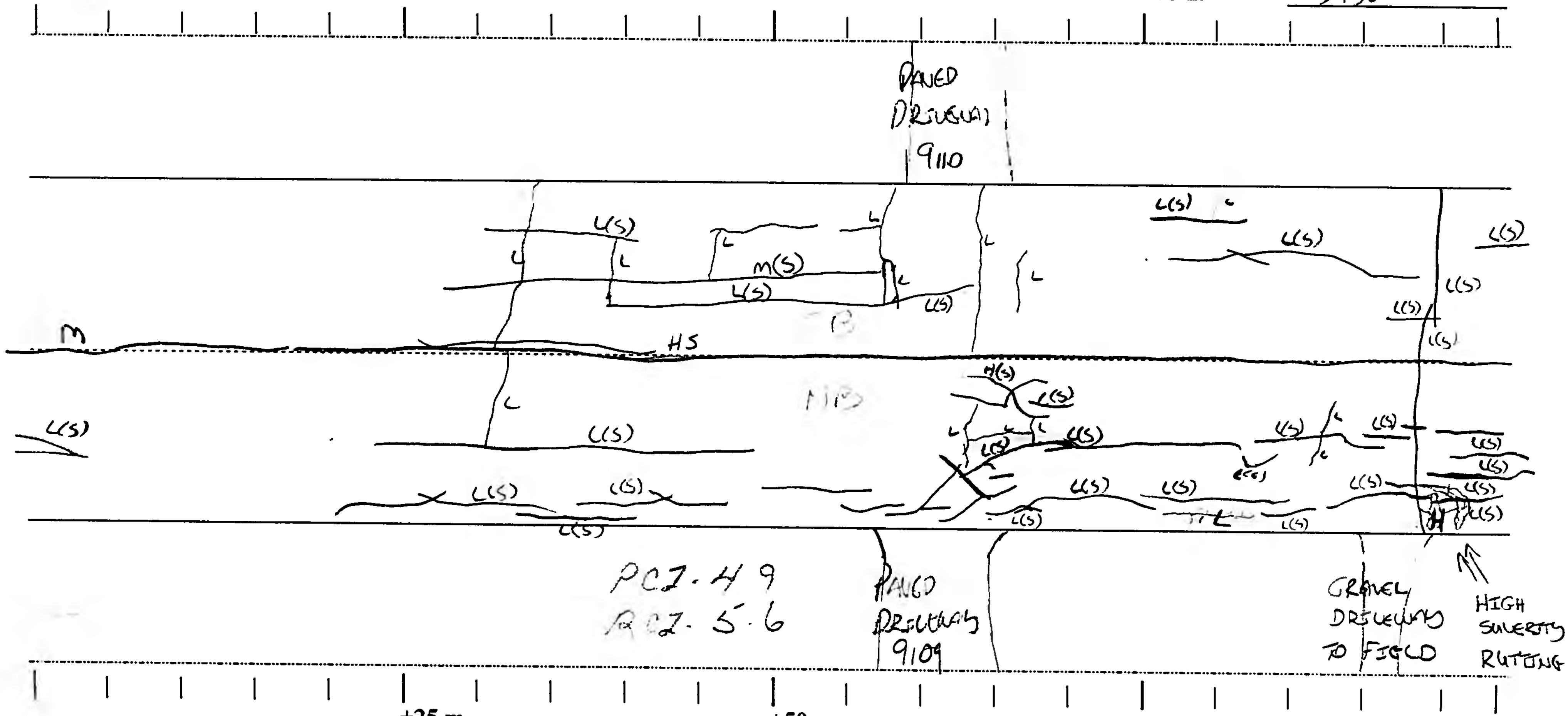
Highway 9th Line Direction ________ From Station 0+000 To Station 6+100

Surveyed By NIC ELLCK Date Surveyed May 26/05 Conditions ________

Start Station 3+400

+25 m +50 m +75 m

End Station 3+500



APPLIED RESEARCH ASSOCIATES, INC.

ARA Project No 11.021

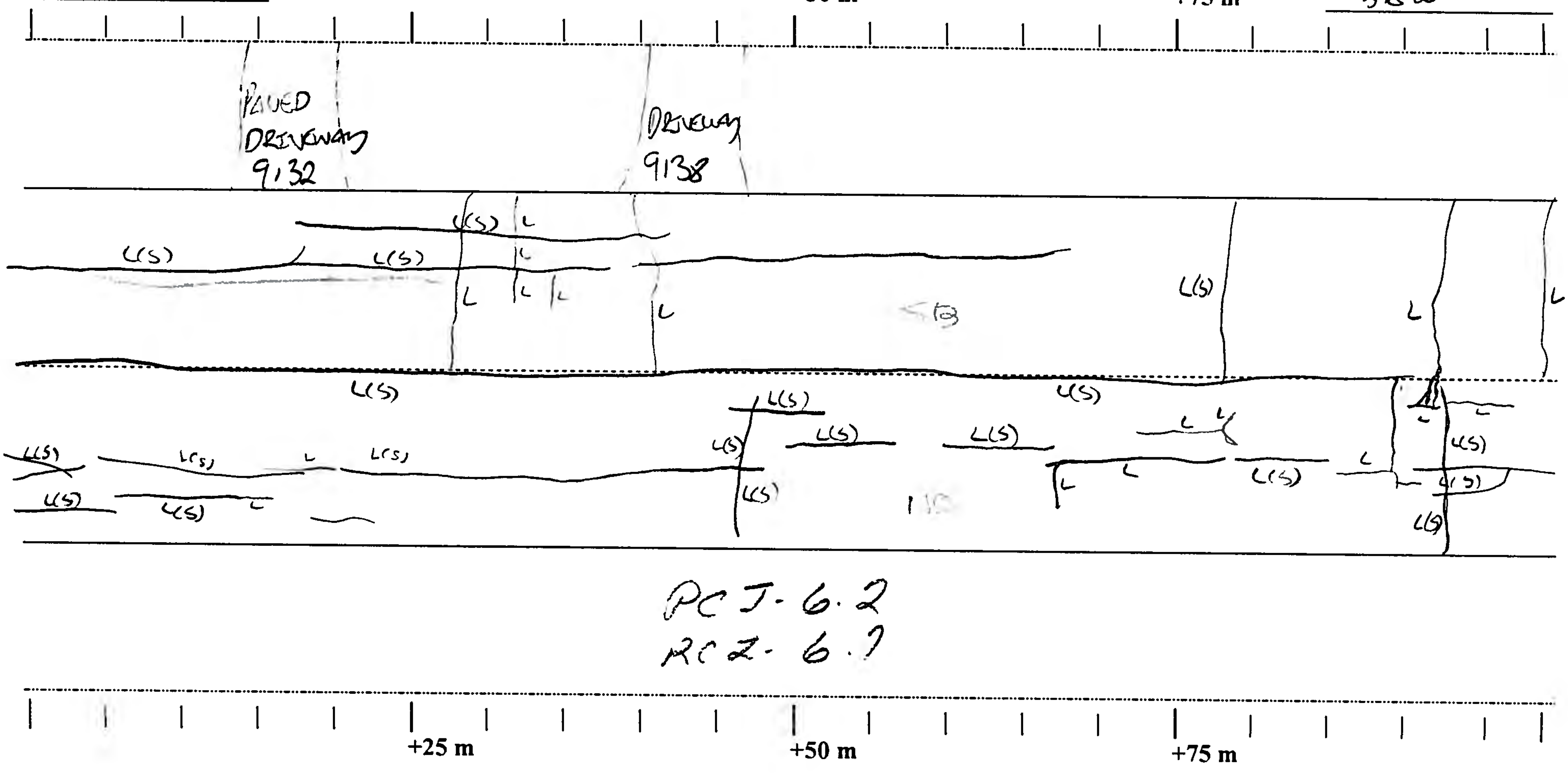
PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th line Direction ____ From Station 0+000 To Station 6+100

Surveyed By NIC EULER Date Surveyed May 26/05 Conditions ____

Start Station 3+500

End Station 3+600



PCI - 6.2
RCI - 6.7

APPLIED RESEARCH ASSOCIATES, INC.

ARA Project No [illegible]

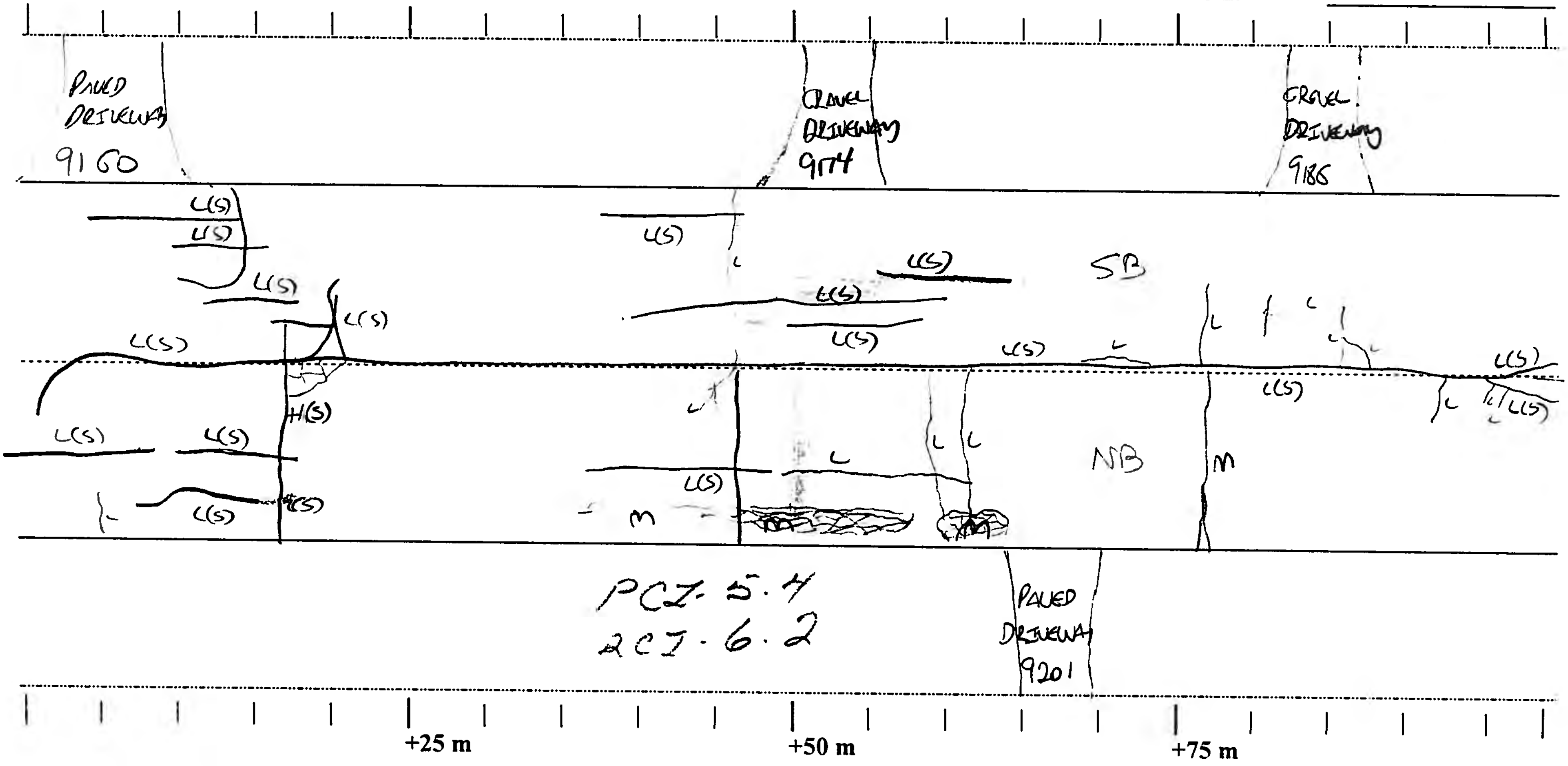
PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th Line Direction ______ From Station 0+000 To Station 5+100

Surveyed By NIC ELLER Date Surveyed May 26/25 Conditions ______

Start Station 3+600

End Station 3+700



APPLIED RESEARCH ASSOCIATES, INC.

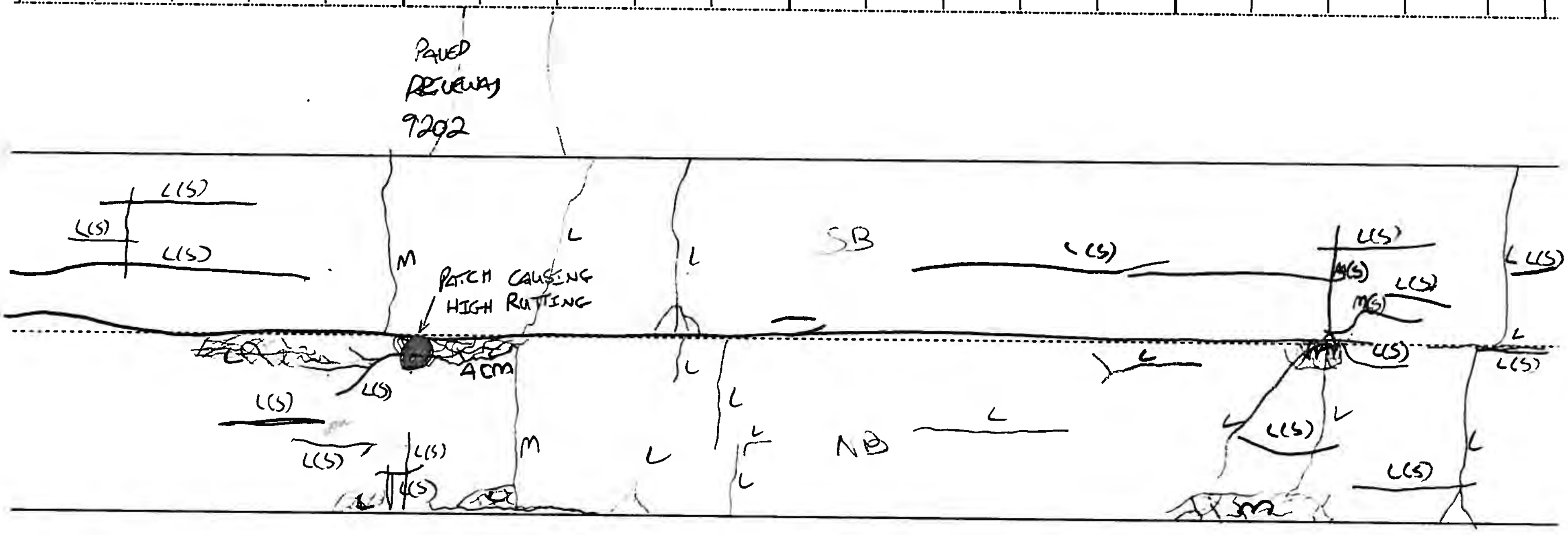
ARA Project No 16731

PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th Line Direction ____ From Station 0+030 To Station 6+100

Surveyed By NTC [illegible] Date Surveyed May 20/05 Conditions ____

Start Station 3+700 +25 m +50 m +75 m End Station 3+800



PCI-5.2
wcI-6.3

+25 m +50 m +75 m

APPLIED RESEARCH ASSOCIATES, INC.

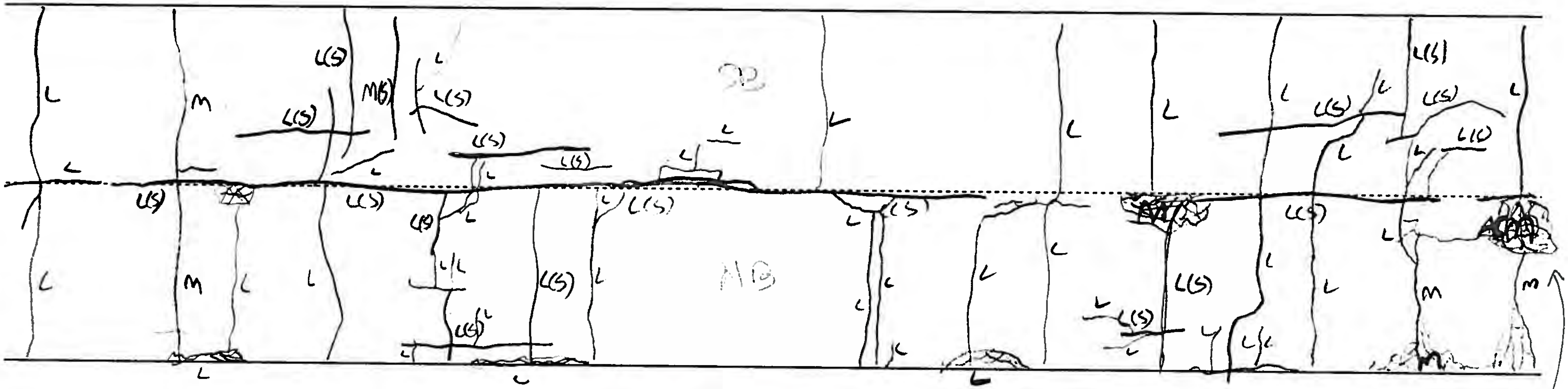
ARA Project No 16931

PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th Line Direction ______ From Station 0+000 To Station 6+100

Surveyed By ______ Date Surveyed ______ Conditions ______

Start Station 3+880 +25 m +50 m +75 m End Station 3+900



PCI- 5.2
RCI- 6.8

CAUSING HIGH RUTTING

+25 m +50 m +75 m

APPLIED RESEARCH ASSOCIATES, INC.

ARA Project No 16931

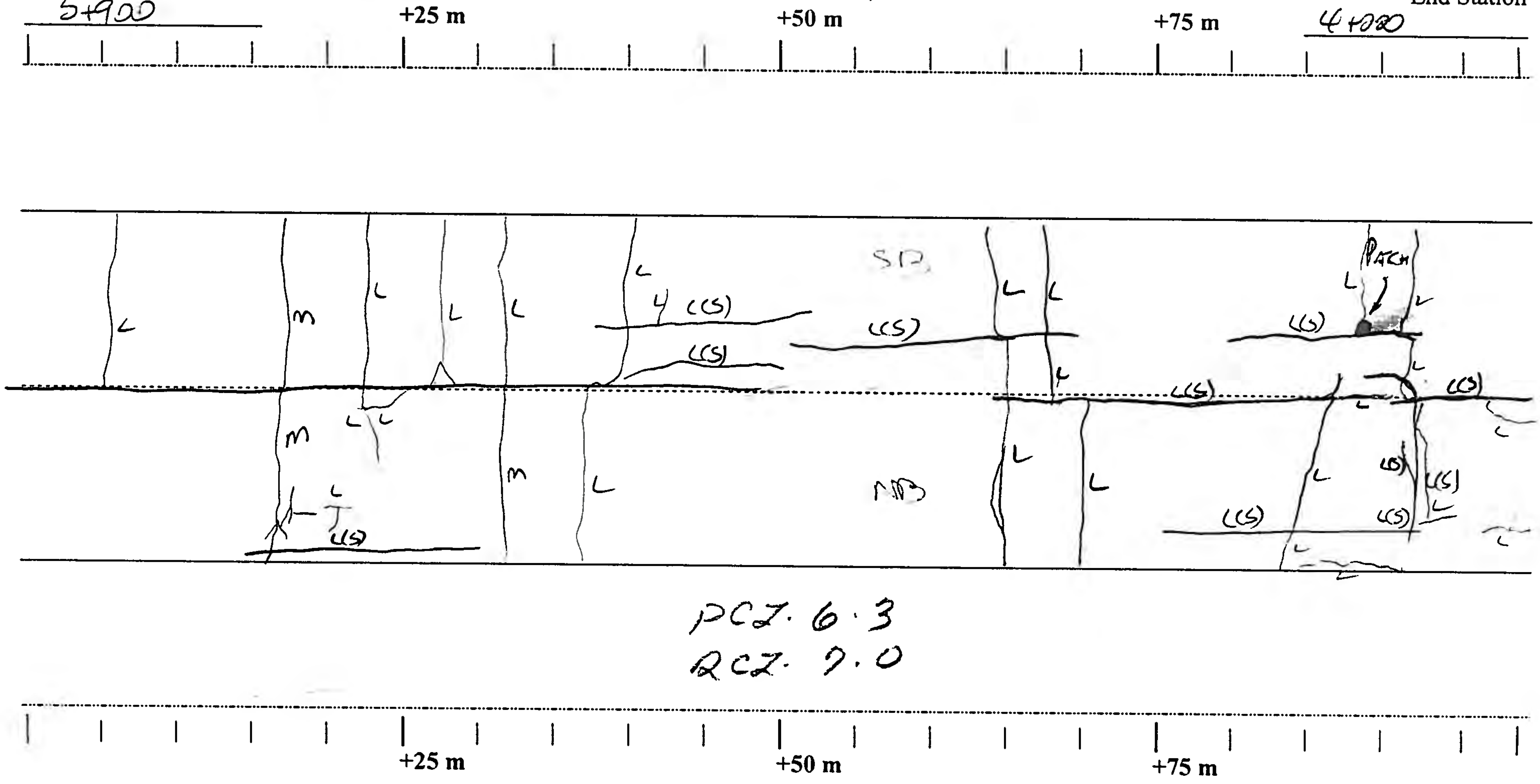
PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th Ave Direction _____ From Station 0+000 To Station 6+100

Surveyed By NIC GUCER Date Surveyed May 20/05 Conditions _____

Start Station 3+900

End Station 4+080



PCI. 6.3
RCI. 7.0

APPLIED RESEARCH ASSOCIATES, INC.

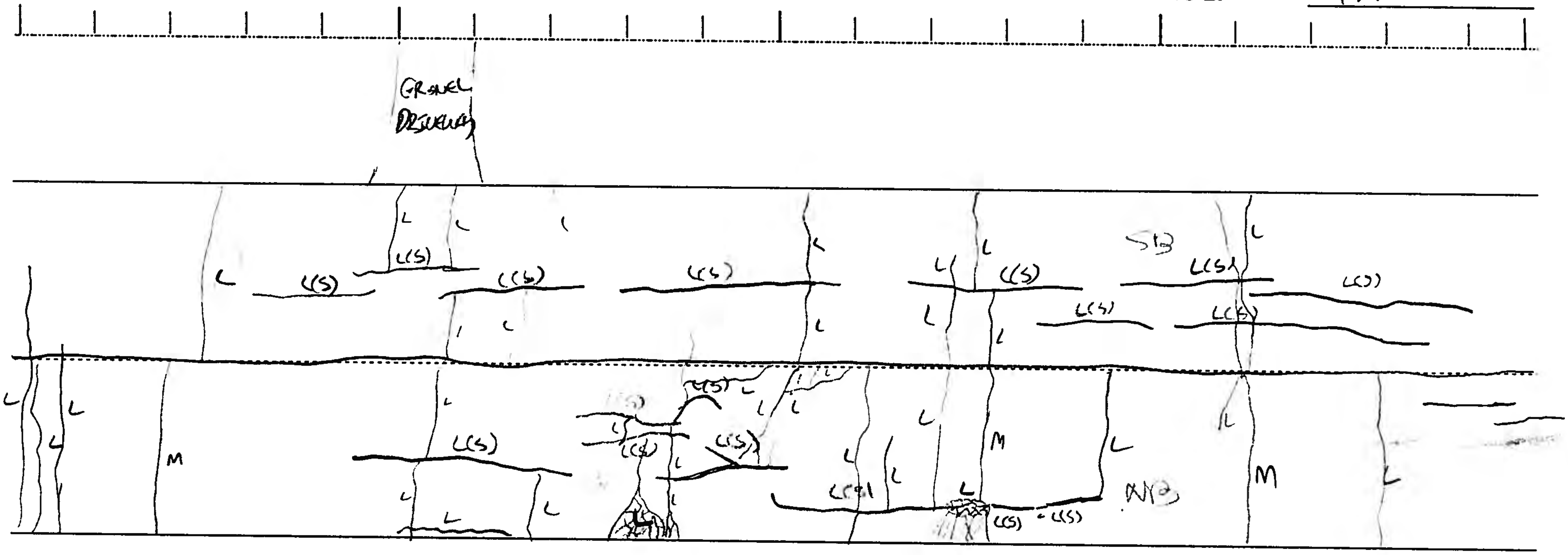
ARA Project No 16931

PAVEMENT DISTRESS MAPPING SURVEY

Highway [illegible] Direction ____ From Station 4+000 To Station 4+100

Surveyed By NJC EUGR Date Surveyed May 26/05 Conditions ____

Start Station 4+000 +25 m +50 m +75 m 4+100 End Station



PCI · 5.5
RCI · 6.2

+25 m +50 m +75 m

APPLIED RESEARCH ASSOCIATES, INC.

ARA Project No 16131

PAVEMENT DISTRESS MAPPING SURVEY

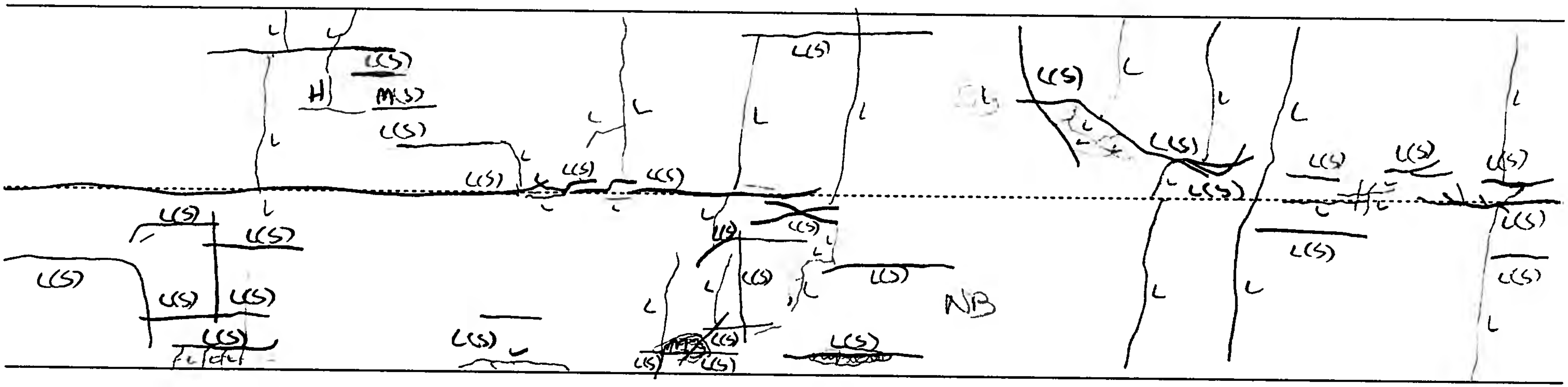
Highway 9th Line Direction ______ From Station 01600 To Station 01700

Surveyed By NIC FUCCR Date Surveyed May 26/05 Conditions ______

Start Station 4+100

+25 m +50 m +75 m

End Station 4+200



PCI - 5.6
RCI - 6.4

+25 m +50 m +75 m

APPLIED RESEARCH ASSOCIATES, INC.

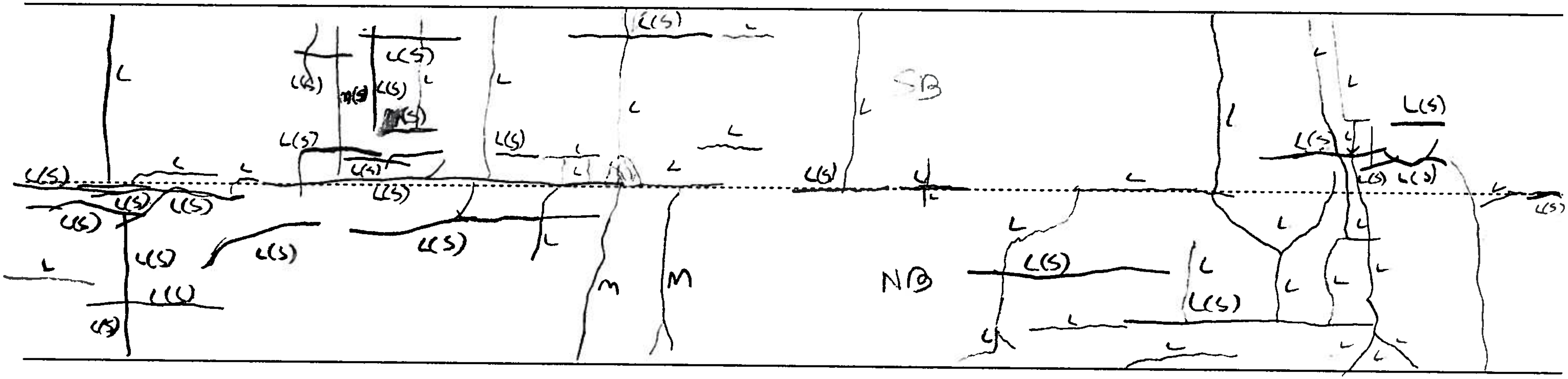
ARA Project No 16931

PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th Line Direction ______ From Station 0+000 To Station 6+100

Surveyed By NTC CULER Date Surveyed May 26/05 Conditions ______

Start Station 4+200 +25 m +50 m +75 m End Station 4+300



PCI. 5.2
RCI. 6.1

+25 m +50 m +75 m

APPLIED RESEARCH ASSOCIATES, INC.

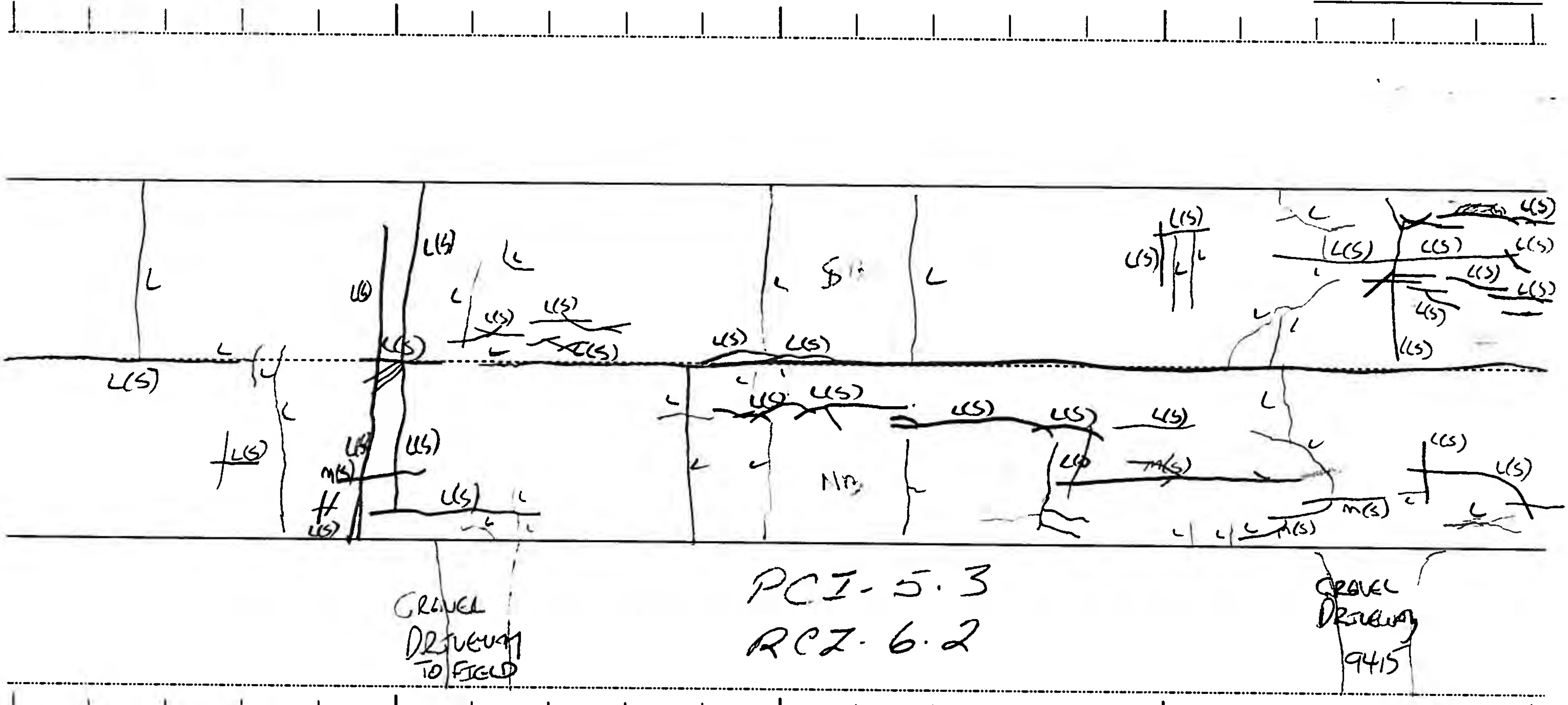
ARA Project No 16931

PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th line Direction ______ From Station 0+000 To Station 6+100

Surveyed By NIC EULER Date Surveyed May 20/05 Conditions ______

Start Station 4+300 +25 m +50 m +75 m End Station 4+400



PCI - 5.3
RCI - 6.2

+25 m +50 m +75 m

APPLIED RESEARCH ASSOCIATES, INC.

ARA Project No 16931

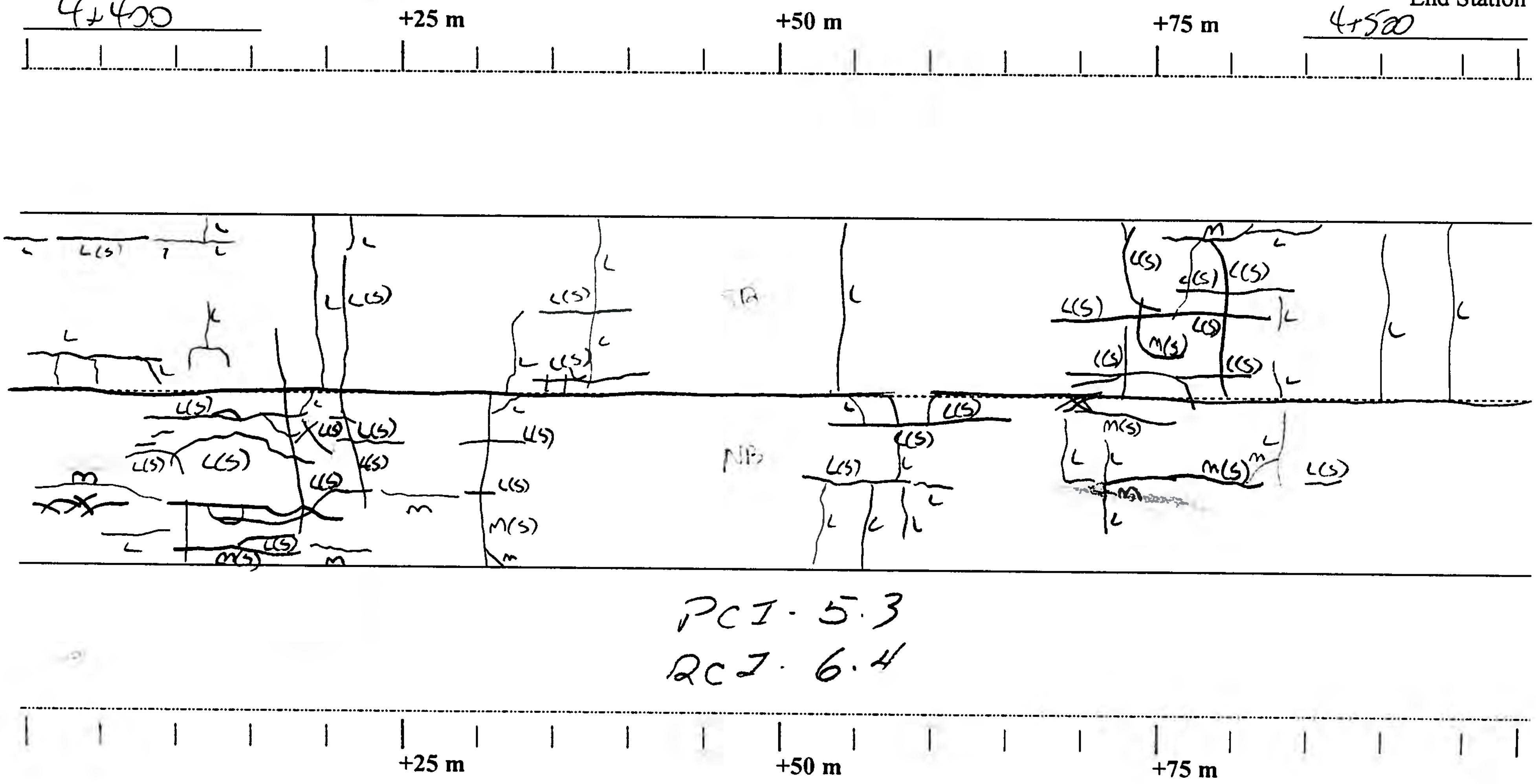
PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th Line Direction ____ From Station 0+000 To Station 0+100

Surveyed By NIC EGER Date Surveyed May 26/05 Conditions ____

Start Station 4+400

End Station 4+500



PCI · 5.3

RCI · 6.4

APPLIED RESEARCH ASSOCIATES, INC.

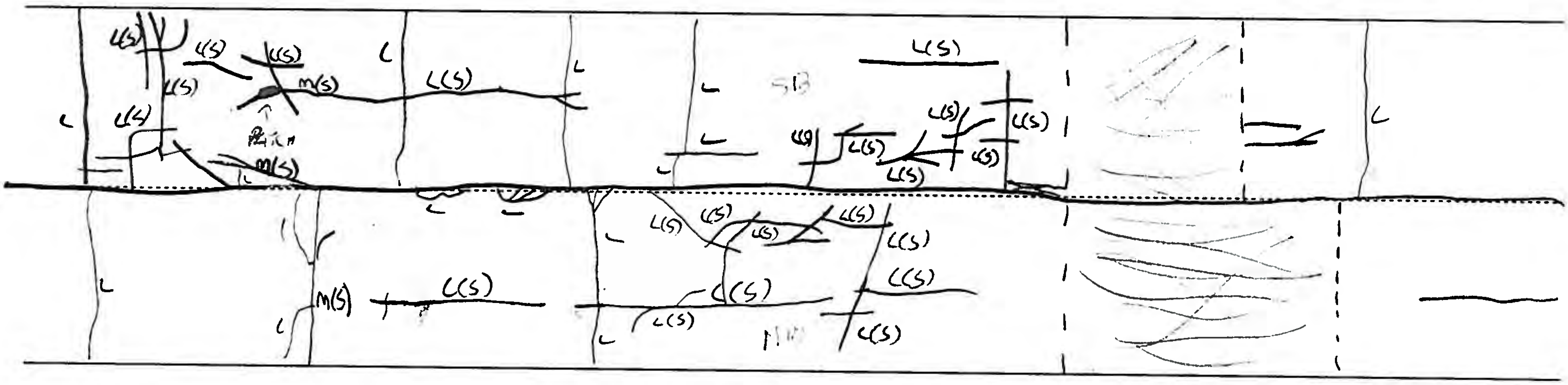
ARA Project No 16231

PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th Line Direction ______ From Station 01000 To Station 6+100

Surveyed By NIC EULER Date Surveyed May 26/05 Conditions ______

Start Station 4+500 +25 m +50 m +75 m End Station 4+600



PCI - 4.7
RCI - 5.9

↑ AREA IS FULL OF HIGH SEVERITY CRACKS(S), CRACKS, ALIGATOR CRACKS AND RUTTING. TOO MUCH TO DRAW IN DETAIL.

+25 m +50 m +75 m

APPLIED RESEARCH ASSOCIATES, INC.

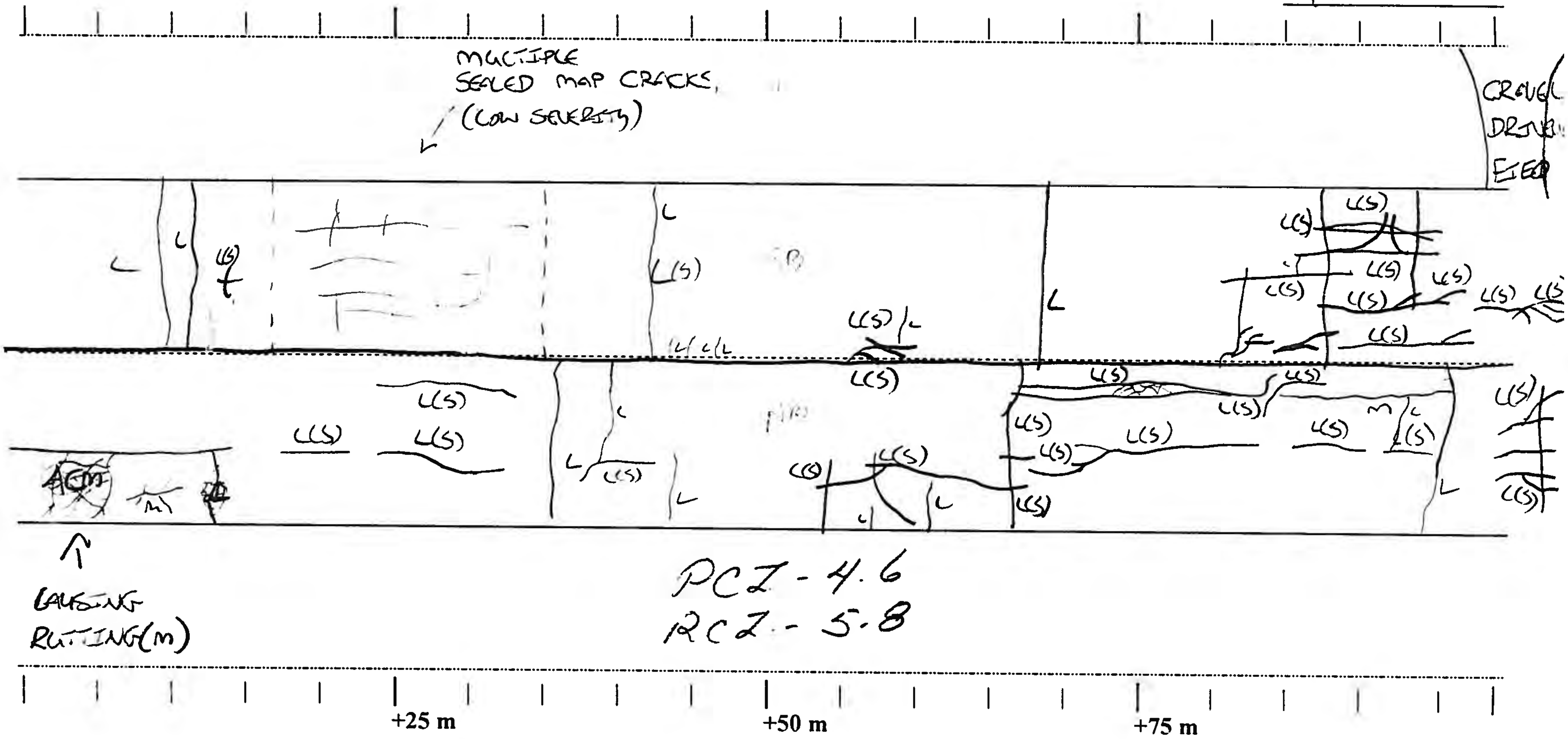
ARA Project No 10131

PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th line Direction ______ From Station 5+000 To Station [illegible]

Surveyed By NIC EUCER Date Surveyed May 25/05 Conditions ______

Start Station 4+600 End Station 4+700



PCI - 4.6
RCI - 5.8

APPLIED RESEARCH ASSOCIATES, INC.

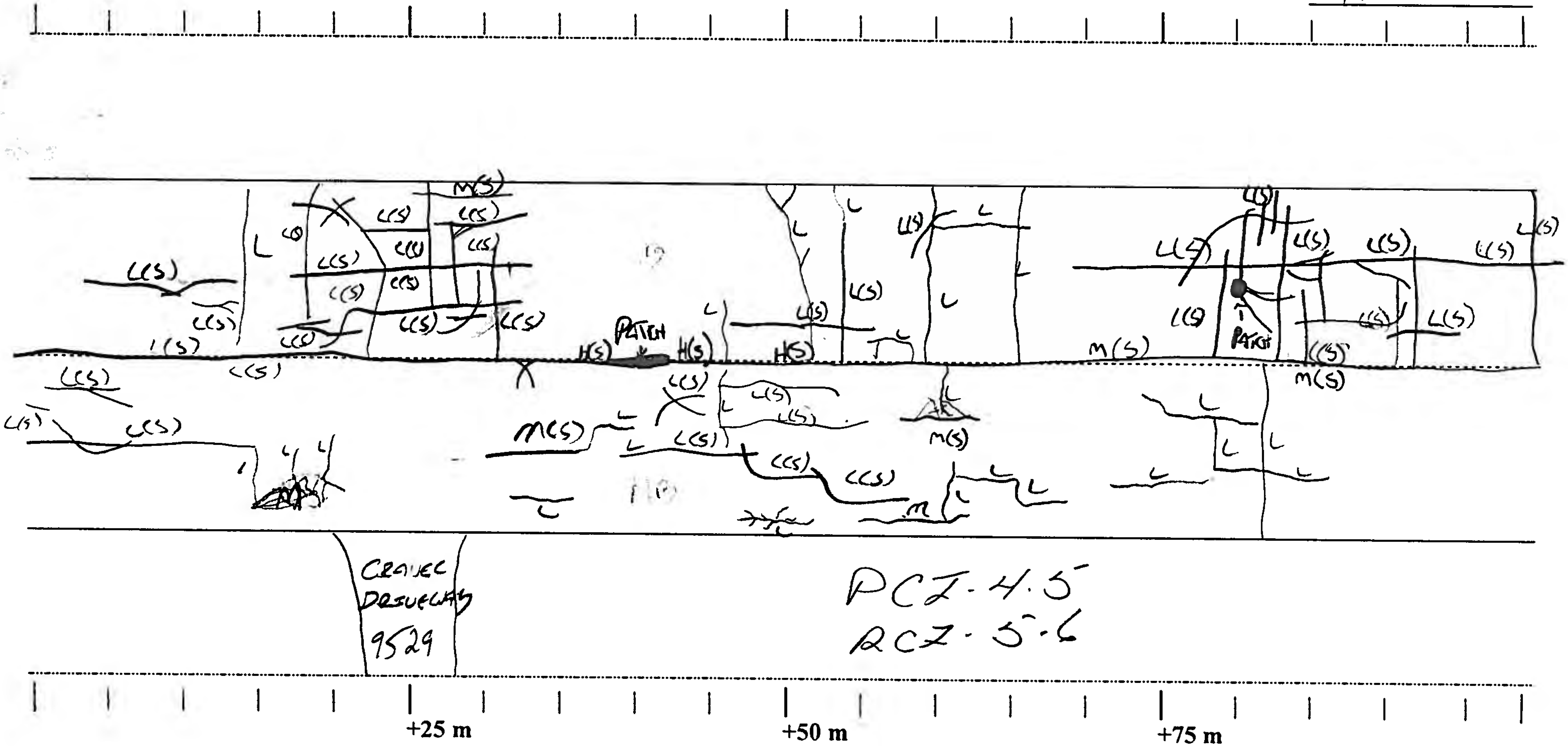
ARA Project No 16931

PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th Line Direction ______ From Station 0+000 To Station 6+100

Surveyed By NIC ELLO Date Surveyed May 26/05 Conditions ______

Start Station 4+700 +25 m +50 m +75 m End Station 4+800



PCI-4.5
RCI-5.6

APPLIED RESEARCH ASSOCIATES, INC.

ARA Project No 16731

PAVEMENT DISTRESS MAPPING SURVEY

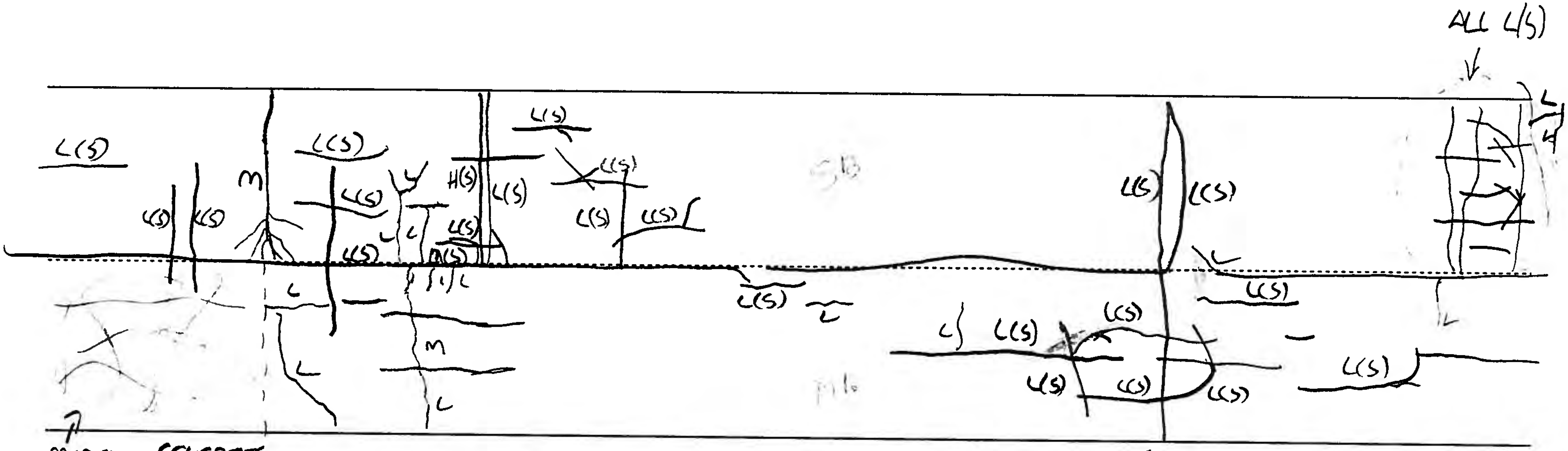
Highway 9th Line Direction ________ From Station 0+000 To Station 0+100

Surveyed By NIC ELLER Date Surveyed May 26/04 Conditions ________

Start Station 4+800

+25 m +50 m +75 m

End Station 4+900



MEDIUM SEVERITY ALIGATOR CRACKING 3 SEALED CRACKS.
HIGH SEVERITY RUTTING.

PCI 4.5
RCI 6.0

+25 m +50 m +75 m

APPLIED RESEARCH ASSOCIATES, INC.

ARA Project No 16931

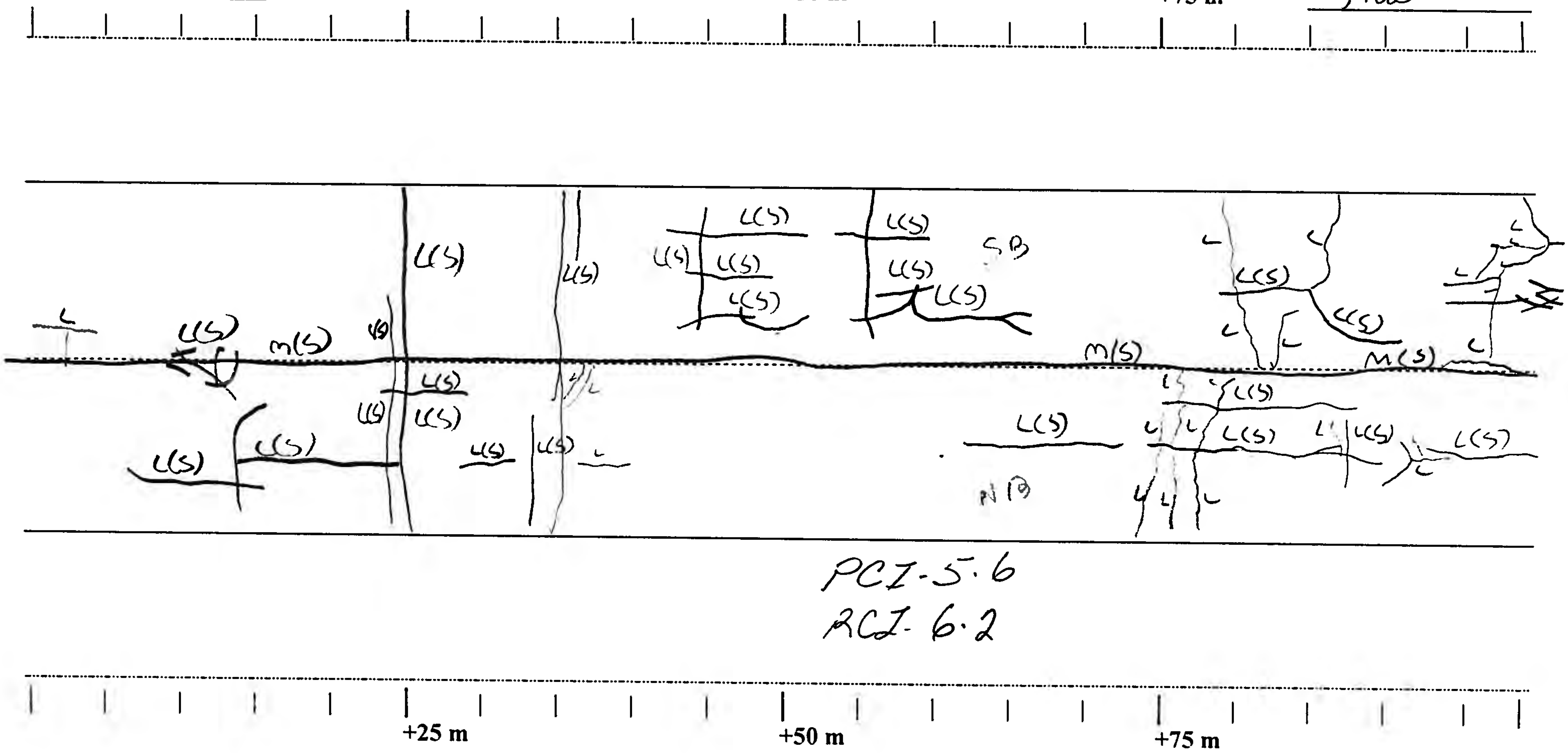
PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th Line Direction ____ From Station 0+000 To Station 6+100

Surveyed By NIC Eckle Date Surveyed May 26/04 Conditions ____

Start Station 4+900

End Station 5+000



PCI-5.6
RCI-6.2

ARA Project No 16937

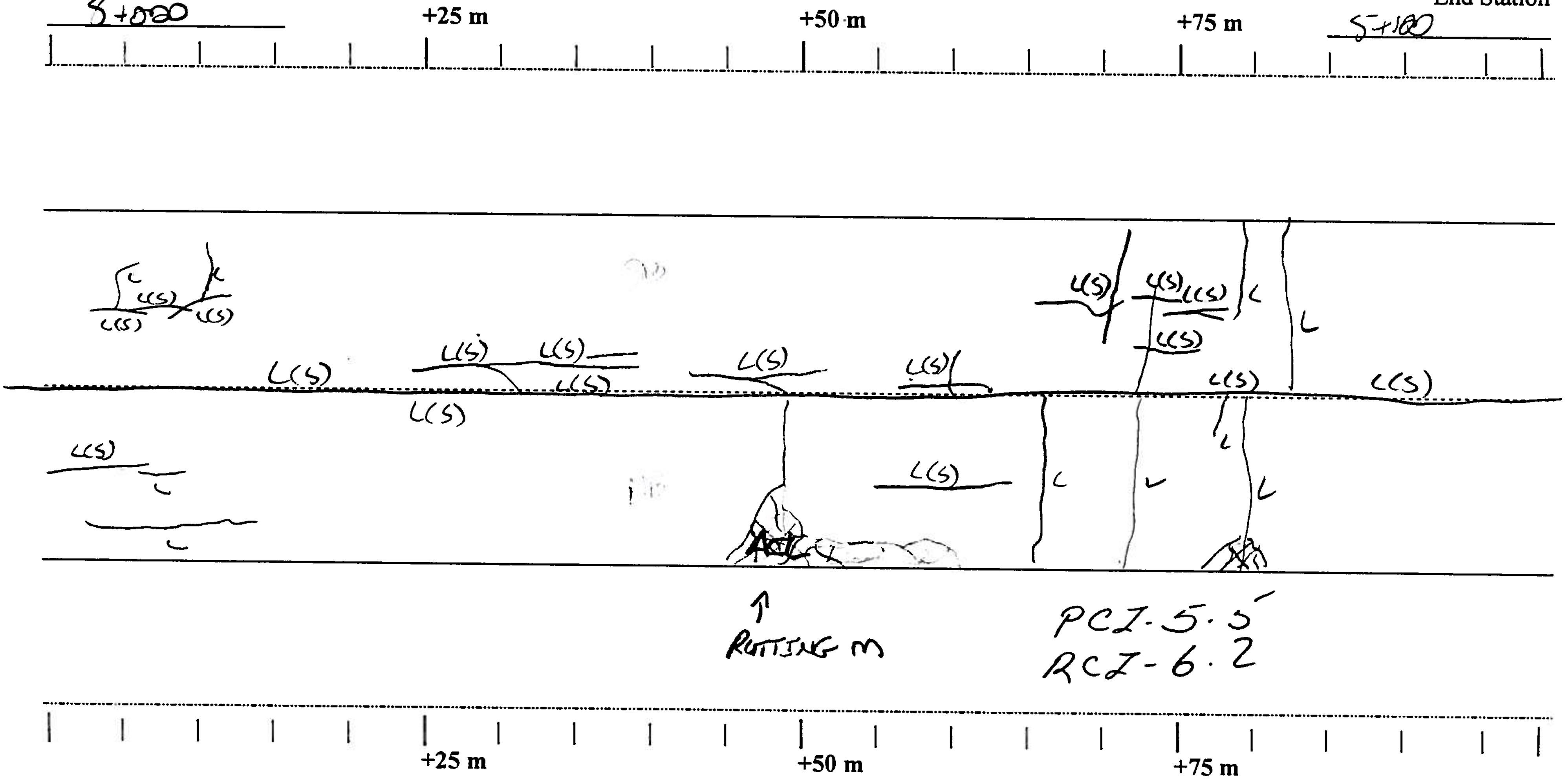
PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th Ave Direction ____ From Station 0+400 To Station 6+100

Surveyed By NIC Gulch Date Surveyed May 26/04 Conditions ____

Start Station 5+000

End Station 5+100



APPLIED RESEARCH ASSOCIATES, INC.

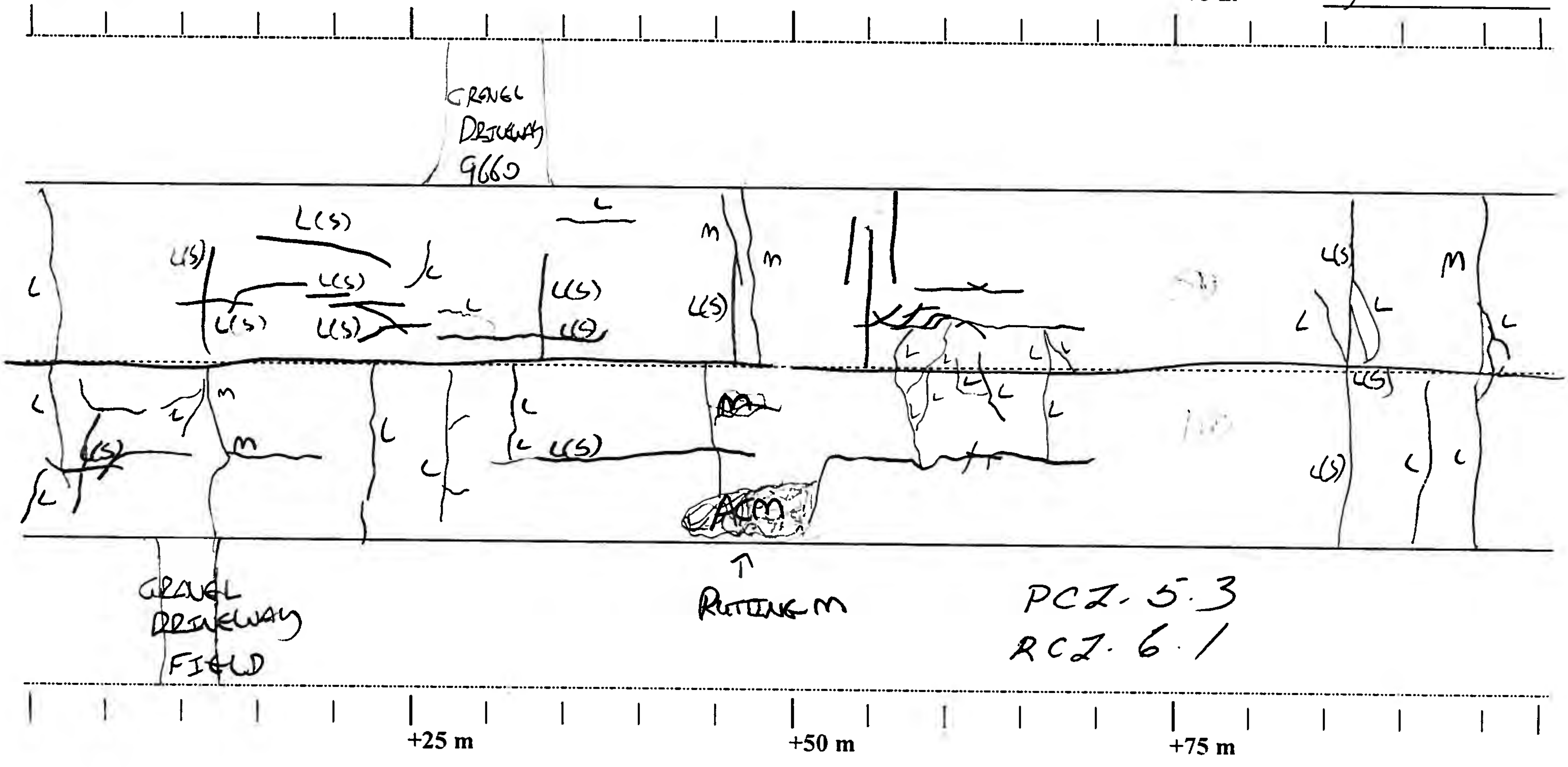
ARA Project No 16731

PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th Line Direction ____ From Station 01000 To Station 61100

Surveyed By NIC EULER Date Surveyed May 20/05 Conditions ____

Start Station 5+100 +25 m +50 m +75 m End Station 5+200



PCI. 5.3
RCI. 6.1

APPLIED RESEARCH ASSOCIATES, INC.

ARA Project No 16931

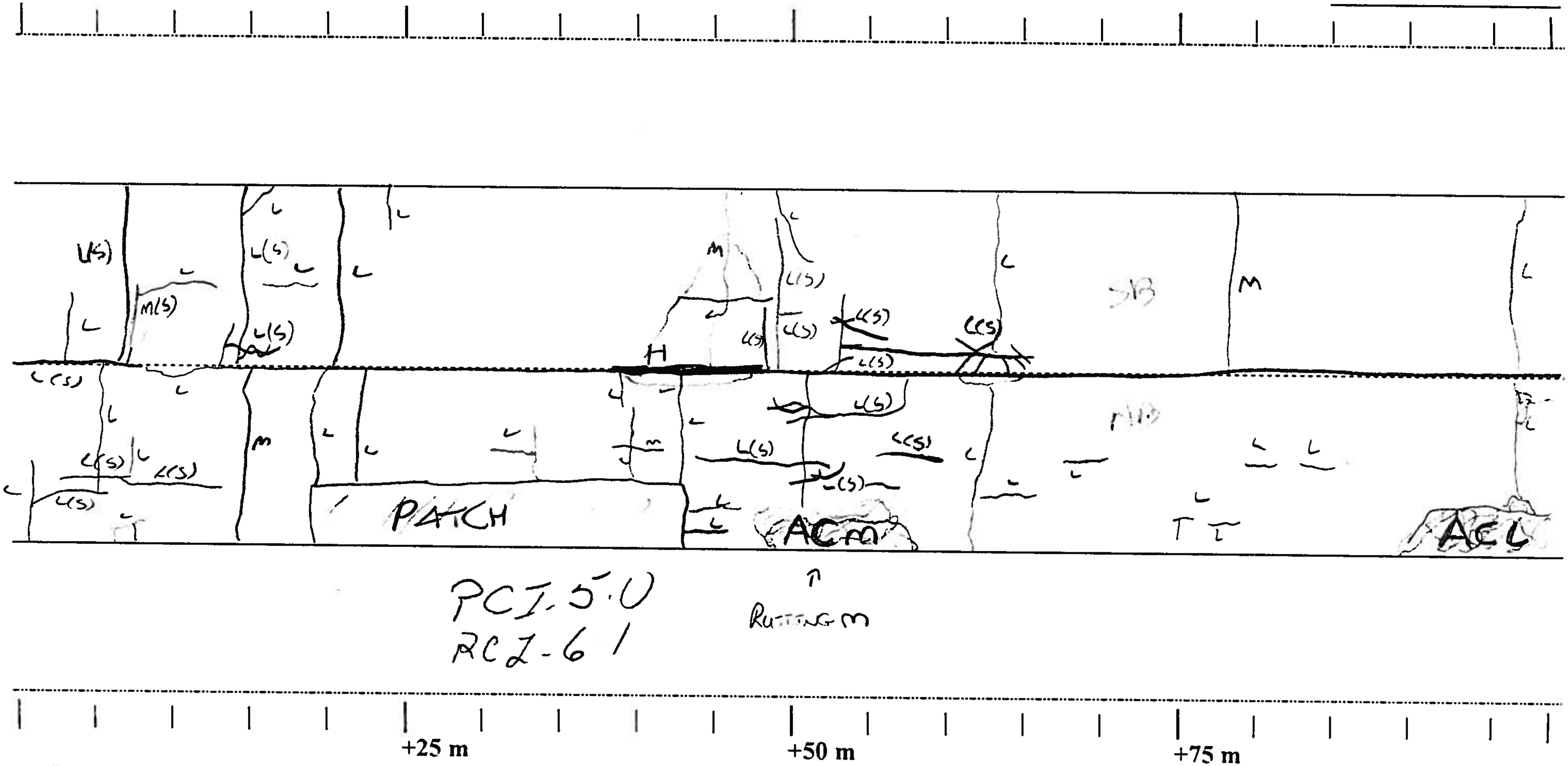
PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th Line Direction ______ From Station 0+000 To Station 6+100

Surveyed By NK Date Surveyed May 27/05 Conditions ______

Start Station 5+200

End Station 5+300



PCI-5.0
RCI-6.1

APPLIED RESEARCH ASSOCIATES, INC.

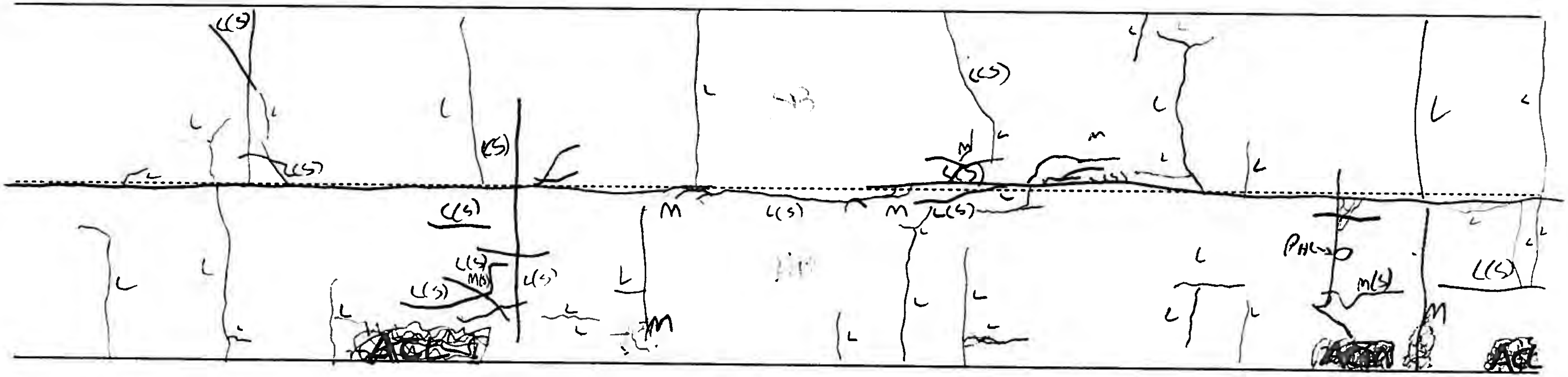
ARA Project No 16921

PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th line Direction ______ From Station 01000 To Station 01100

Surveyed By NIC ELCER Date Surveyed May 27/06 Conditions ______

Start Station 5+300 +25 m +50 m +75 m End Station 5+400



PCI-52
RCI 6.1

+25 m +50 m +75 m

APPLIED RESEARCH ASSOCIATES, INC.

ARA Project No 16937

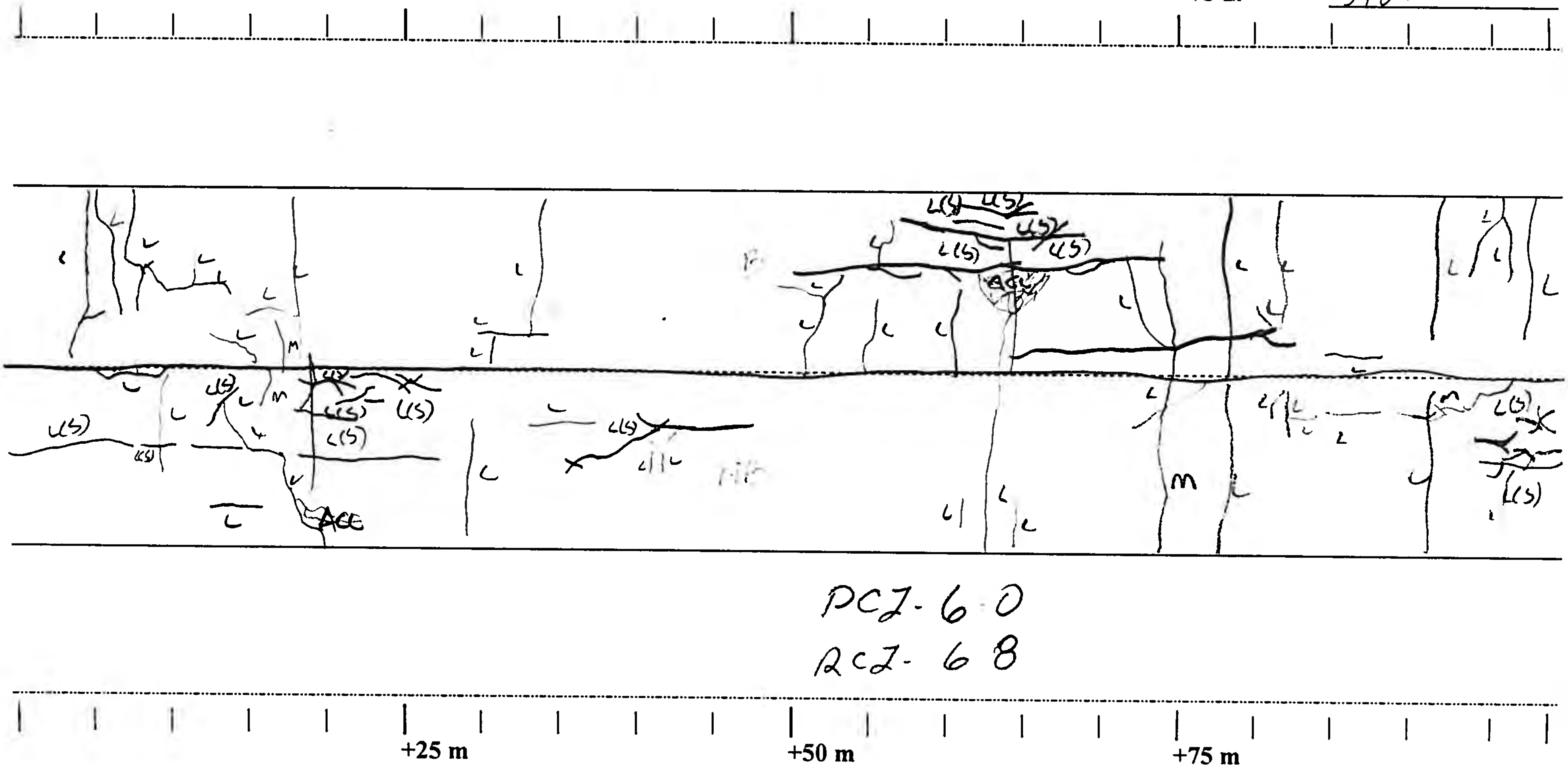
PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th Line Direction ______ From Station 0+000 To Station 5+900

Surveyed By NIC EUGER Date Surveyed May 27/25 Conditions ______

Start Station 5+400

End Station 5+500



PCJ-6.0
RCJ-6.8

APPLIED RESEARCH ASSOCIATES, INC.

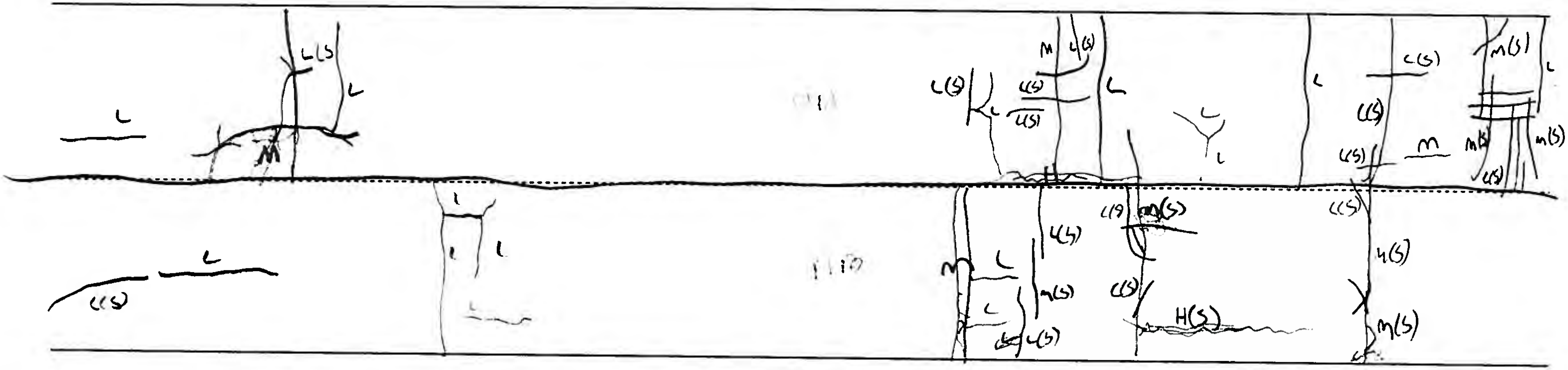
ARA Project No 15931

PAVEMENT DISTRESS MAPPING SUSVEY

Highway 9th Line Direction ____ From Station 0+000 To Station 6+400

Surveyed By MSC ELLER Date Surveyed May 27/05 Conditions ____

Start Station 5+500 +25 m +50 m +75 m End Station 5+600



PCI - 6.4
RCI - 7.1

+25 m +50 m +75 m

ARA Project No 16431

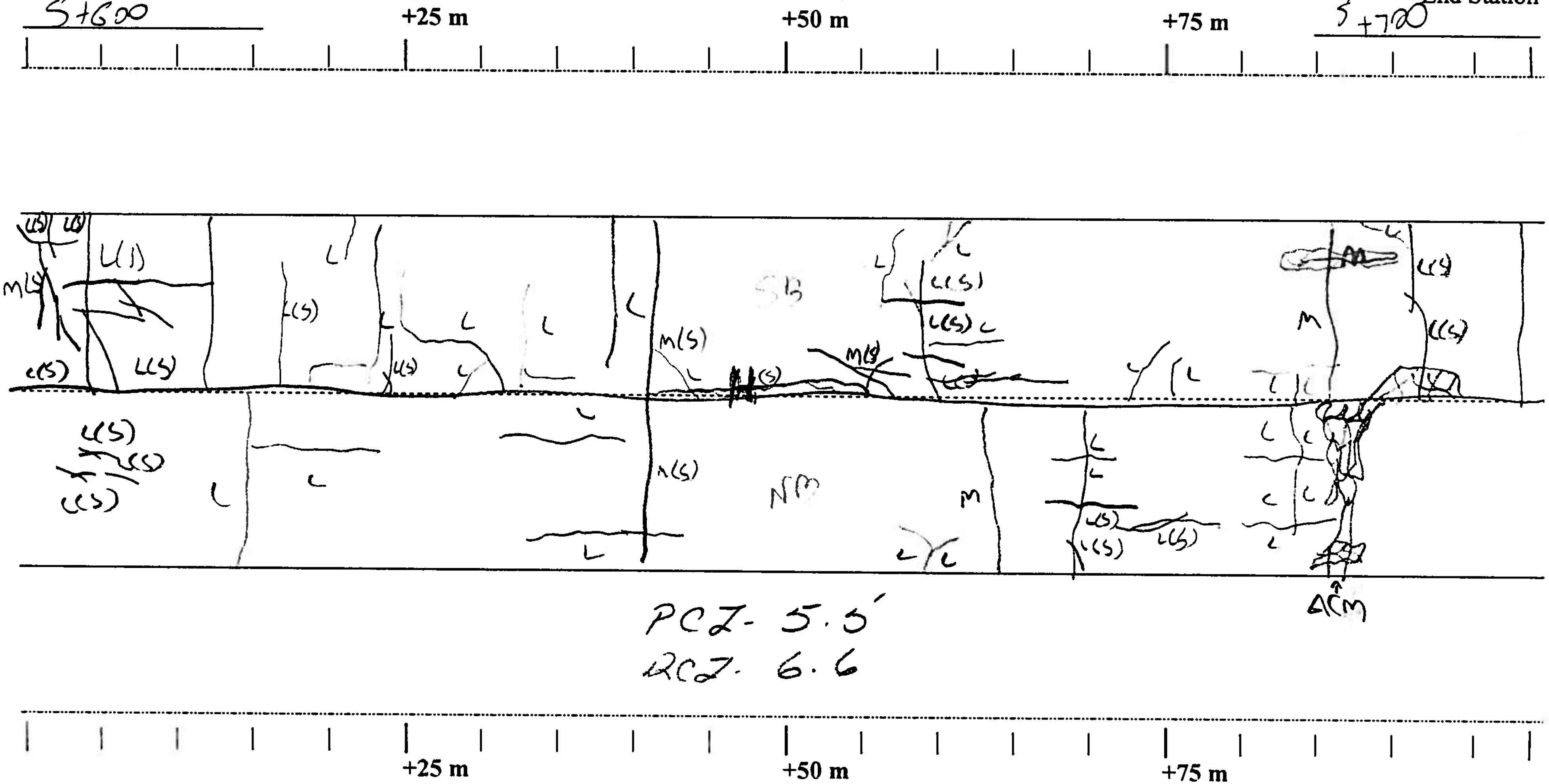
PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th line Direction ____ From Station 0+000 To Station 6+100

Surveyed By NTC Eucle Date Surveyed May 27/25 Conditions ____

Start Station 5+600

End Station 5+700



PCI- 5.5'
RCI- 6.6

APPLIED RESEARCH ASSOCIATES, INC.

ARA Project No 5321

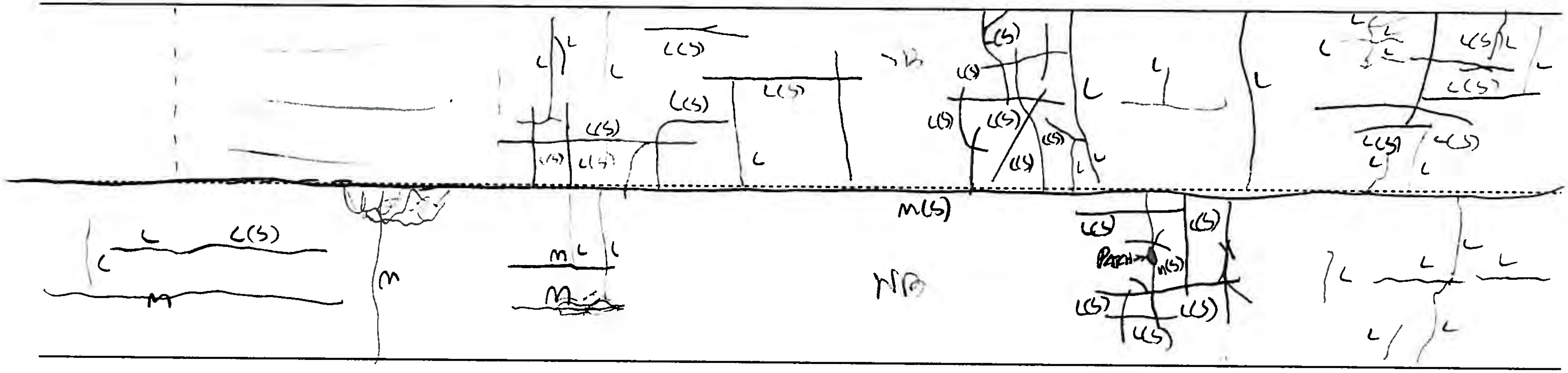
PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th Line Direction ______ From Station 0+000 To Station 6+100

Surveyed By NIC EULER Date Surveyed May 27/05 Conditions ______

Start Station 5+700 +25 m +50 m +75 m End Station 5+800

LOTS OF SEALED AND NOT SEALED MED/LOW/HIGH MAP CRACKS



PCI - 5.8
RCI - 6.4

+25 m +50 m +75 m

ARA Project No 16931

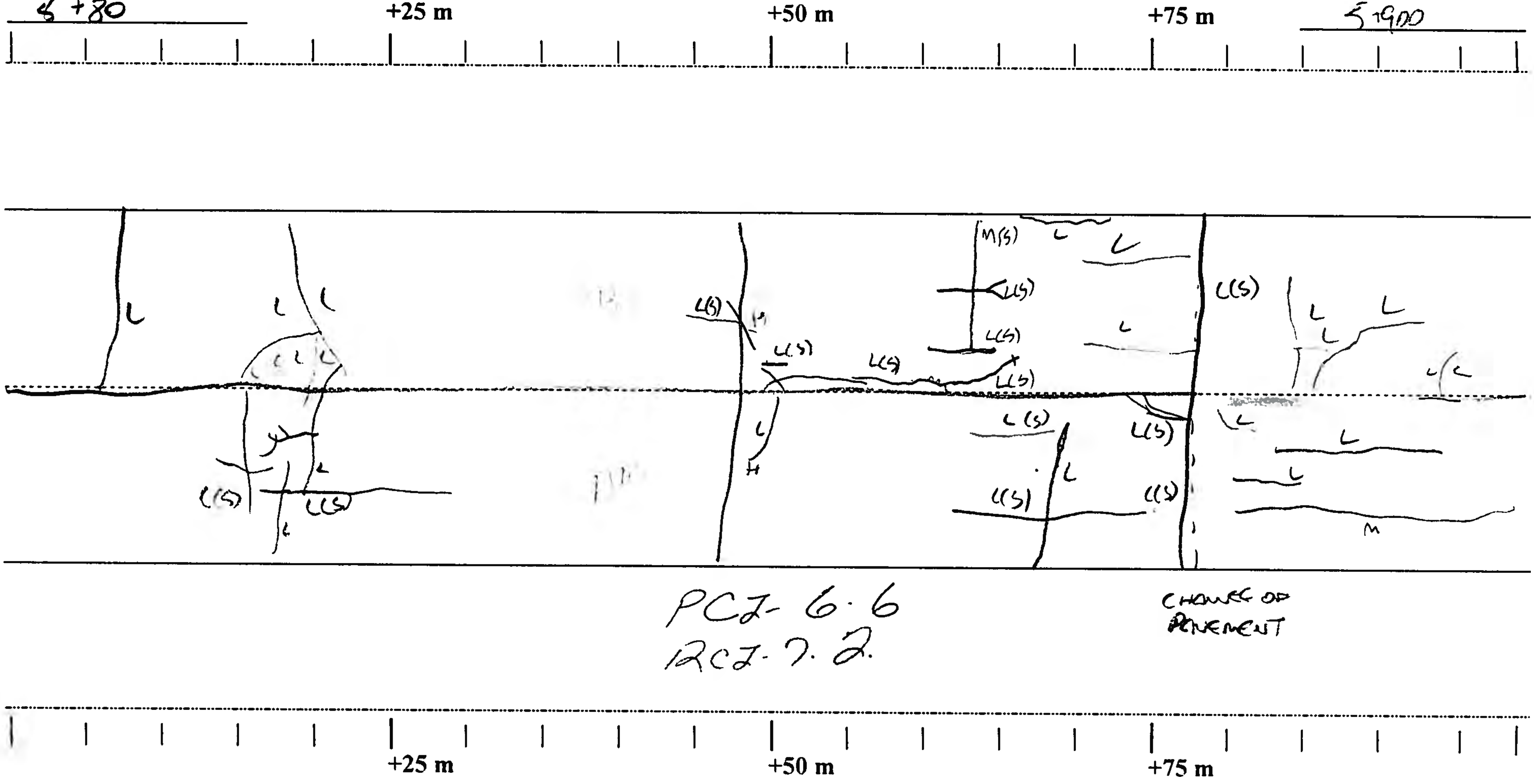
PAVEMENT DISTRESS MAPPING SURVEY

Highway 8th Line Direction ____ From Station 0+000 To Station 6+400

Surveyed By AJC GLCER Date Surveyed May 27/05 Conditions ____

Start Station 5+80

End Station 5+900



PCI- 6.6
RCI- 7.2

APPLIED RESEARCH ASSOCIATES, INC.

ARA Project No 16921

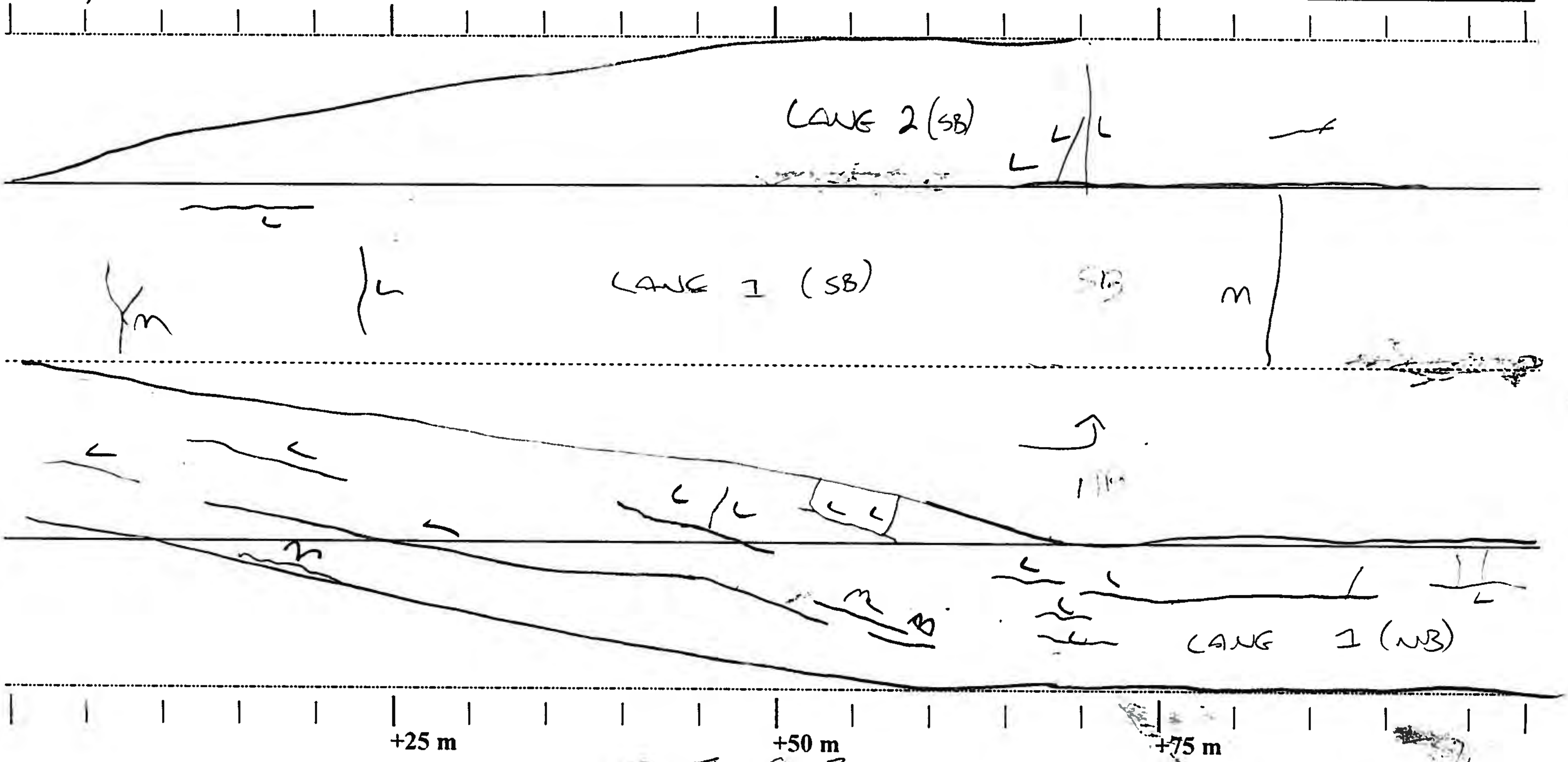
PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th Line Direction ____ From Station 0+000 To Station 6+100

Surveyed By NIC ELLER Date Surveyed May 27/05 Conditions ____

Start Station 5+900

End Station 6+000



PCI 7.3

APPLIED RESEARCH ASSOCIATES, INC.

ARA Project No 16931

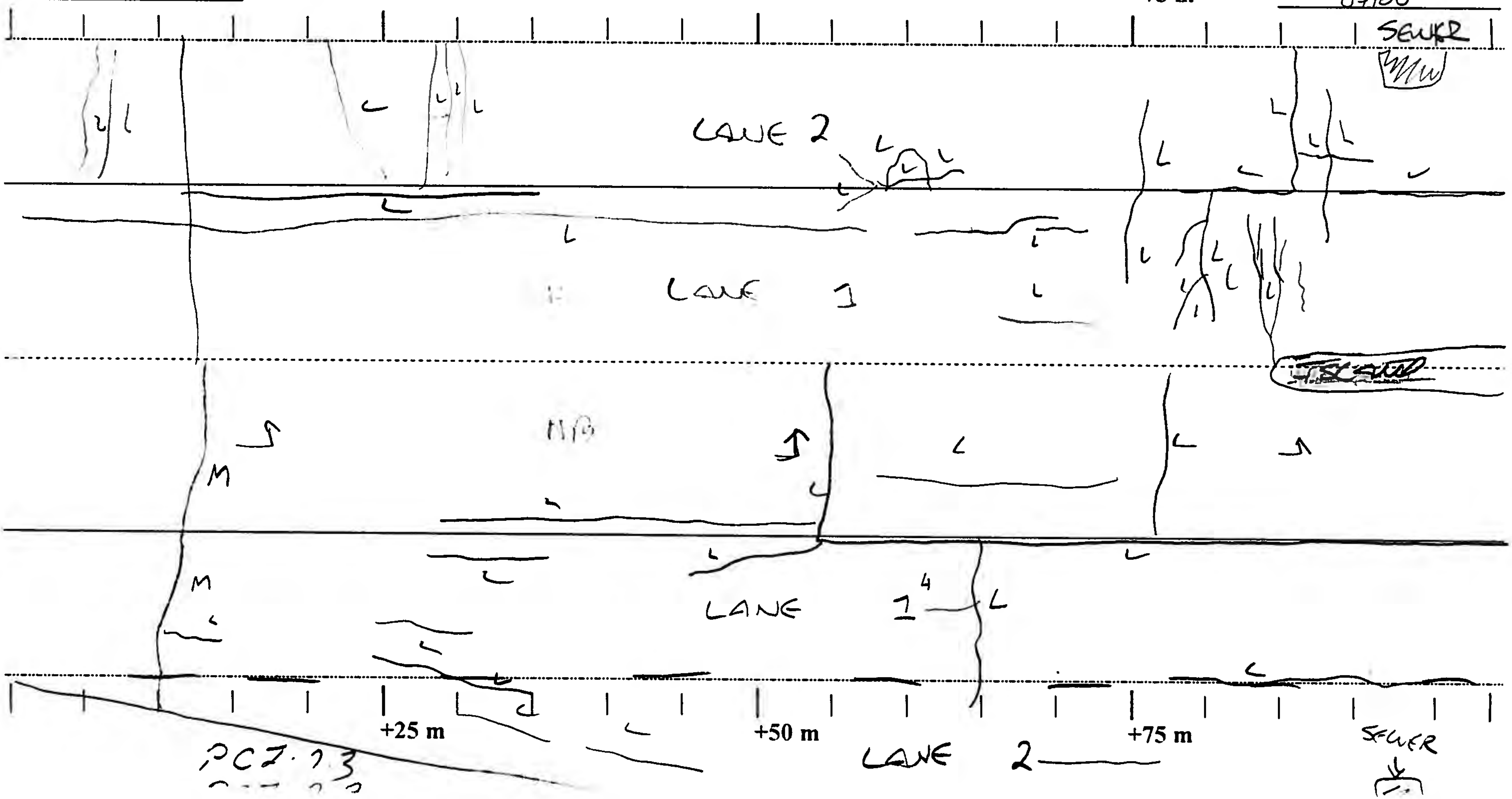
PAVEMENT DISTRESS MAPPING SURVEY

Highway 9th Line Direction ______ From Station 0+000 To Station 6+100

Surveyed By NIC ELLER Date Surveyed May 27/08 Conditions ______

Start Station 6+000

End Station 6+100



APPENDIX B

PHOTOGRAPHS OF TYPICAL PAVEMENT AND ASSOCIATED FEATURES

APENIDX B
Ninth Line
Steeles Avenue to No. 10 Sideroad
Photographs of Typical Pavement and Associated Features

	Station 0+200 Picture taken in the Northbound Direction.
	Station 1+200 Picture taken in the Northbound Direction.
	Station 1+700 Picture taken in the Northbound Direction.

APENIDX B
Ninth Line
Steeles Avenue to No. 10 Sideroad
Photographs of Typical Pavement and Associated Features

	Station 2+300 Picture taken in the Northbound Direction.
	Station 3+200 Picture taken in the Northbound Direction.
	Station 4+200 Picture taken in the Northbound Direction.

APPENDIX C

RUT DEPTH AND CROSS FALL RESULTS

APPENDIX C
Ninth Line
Steeles Avenue to No. 10 Sideroad
Detailed Cross Fall and Rut Depth Results
Northbound Lanes

Station	Lane	Road Cross Fall (mm)	Rut Depth (mm)	
			Left Wheel Path	Right Wheel Path
0+200	NB	70	7	10
0+400	NB	65	3	5
0+600	NB	55	5	7
0+800	NB	60	5	3
1+000	NB	65	5	0
1+200	NB	40	7	3
1+400	NB	35	10	12
1+600	NB	65	3	10
1+800	NB	65	7	5
2+000	NB	55	5	0
2+200	NB	35	12	10
2+400	NB	65	5	3
2+600	NB	30	7	7
2+800	NB	40	10	12
2+980	NB	60	20	5
3+200	NB	40	20	15
3+300	NB	40	12	5
3+400	NB	40	10	28
3+500	NB	40	7	7
3+600	NB	35	15	7
3+700	NB	20	7	5
3+800	NB	45	3	5
4+000	NB	45	20	5
4+200	NB	50	20	10
4+400	NB	40	10	10
4+575	NB	60	15	45
4+600	NB	40	10	10
4+800	NB	30	25	17
5+000	NB	55	20	10
5+200	NB	45	10	7
5+400	NB	65	10	20
5+600	NB	60	10	7
5+800	NB	50	7	7
5+900	NB	60	7	3

APPENDIX C
Ninth Line
Steeles Avenue to No. 10 Sideroad
Detailed Cross Fall and Rut Depth Results
Southbound Lanes

Station	Lane	Road Cross Fall (mm)	Rut Depth (mm)	
			Left Wheel Path	Right Wheel Path
0+050	SB	45	5	5
0+300	SB	95	5	0
0+500	SB	45	10	3
0+700	SB	60	7	7
0+900	SB	40	10	3
1+100	SB	40	12	3
1+100	SB	60	5	3
1+300	SB	50	3	3
1+500	SB	60	10	3
1+900	SB	40	7	7
2+100	SB	40	5	3
2+300	SB	60	10	10
2+500	SB	50	5	5
2+700	SB	90	12	0
2+900	SB	70	12	3
4+100	SB	40	0	5
4+300	SB	45	10	5
4+500	SB	40	7	5
4+700	SB	40	3	5
4+900	SB	35	10	3
5+100	SB	40	5	3
5+300	SB	40	5	5
5+500	SB	45	15	7
5+700	SB	40	15	5

APPENDIX D

CORE LOG SUMMARY

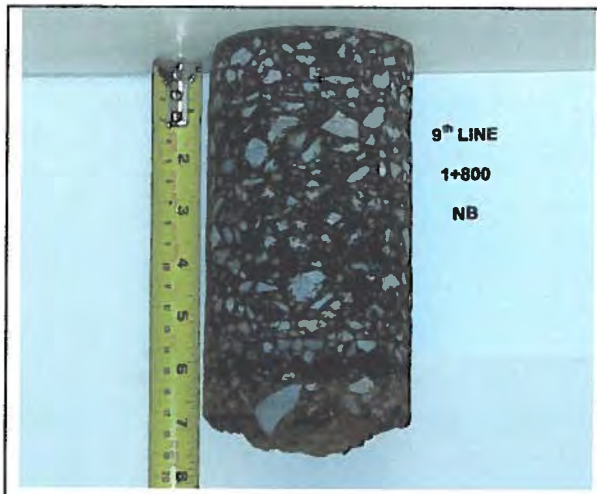
APPENDIX D
Ninth Line
Steeles Avenue to No. 10 Sideroad
Detailed Core Log Summary

Station	Direction	Asphalt Thickness						
		Surface Course	Binder Course	Binder Course	Surface Course	Surface Treatment	Surface Treatment	Total
Steeles Avenue to No. 5 Sideroad								
0+050	SB	30	90					**120**
0+200	NB	40	50	90				**180**
0+300	SB	50	80			40		**170**
0+400	NB	50	50		30	30	10	**170**
0+500	SB	30	60		40	50		**180**
0+600	NB	40	60			30		**130**
0+700	SB	40			60	25		**125**
0+800	NB	40	80			30	20	**170**
0+900	SB	30	60			30		**120**
1+000	NB	40	50	40		30	20	**180**
1+100	SB	40	60			30		**130**
1+200	NB	50	50			30	20	**150**
1+300	SB	50	70			30		**150**
1+400	NB	40	70		20	30		**160**
1+500	SB	30	60	40		30		**160**
1+600	NB	50	50		30	20		**150**
1+700	SB	40	40			20		**100**
1+800	NB	40	60	40		30		**170**
1+900	SB	50	40			30		**120**
2+000	NB	40	40	30		20	20	**150**
2+100	SB	50	40			30		**120**
2+200	NB	40	80		60	40		**220**
2+300	SB	60	50			30		**140**
2+400	NB	40	50	30		30		**150**
2+500	SB	50	60			30		**140**
2+600	NB	50	70			30		**150**
2+700	SB	50	80			25		**155**
2+800	NB	50	30			30		**110**
2+900	SB	40	50	40		30		**160**
2+980	NB	50	30			25		**105**

APPENDIX D
Ninth Line
Steeles Avenue to No. 10 Sideroad
Detailed Core Log Summary

Station	**Direction**	**Asphalt Thickness**						
		Surface Course	**Binder Course**	**Binder Course**	**Surface Course**	**Surface Treatment**	**Surface Treatment**	**Total**
			No. 5 Sideroad to No. 10 Sideroad					
3+200	NB	40	40		40	20		**140**
3+300	SB	50	50	50	60	20		**230**
3+400	NB	40	60			50		**150**
3+500	SB	40	70	60	30	40	30	**270**
3+600	NB	40	40		30	20		**130**
3+700	SB	50	70		30	20	30	**200**
3+800	NB	40	50			30		**120**
3+900	SB	50	60			30		**140**
4+000	NB	40	60			20		**120**
4+100	SB	50	60			30		**140**
4+200	NB	50	50			20	30	**150**
4+300	SB	50	50		40			**140**
4+400	NB	40	50			20	20	**130**
4+500	SB	60	40	70				**170**
4+600	NB	50	50	30		20	20	**170**
4+700	SB	40	60	40	40	30		**210**
4+800	NB	50	40		30	30		**150**
4+900	SB	60	50	50		40		**200**
5+000	NB	50	50		40	30		**170**
5+100	SB	50	60	50		30		**190**
5+200	NB	50	60	60				**170**
5+300	SB	50	50	30		20	20	**170**
5+400	NB	40	70		30	30		**170**
5+500	SB	40	60			30		**130**
5+600	NB	50	50			40	30	**170**
5+700	SB	50	50		50			**150**
5+800	NB	50	60			30	30	**170**

APPENDIX D
Ninth Line
Steeles Avenue to No. 10 Sideroad
Typical Photograph of Core Samples



Core Photo #1
1+800 Northbound
1.0m Lt OEP

Type	Core (mm)
Surface Course	40
Binder Course	60
Binder Course	40
Surface Treatment	30
Total	170

Core Photo #2
2+800 Northbound
1.0m Rt IEP

Type	Core (mm)
Surface Course	50
Binder Course	30
Surface Treatment	30
Total	110

Core Photo #3
5+500 Northbound
1.0m Rt IEP

Type	Core (mm)
Surface Course	40
Binder Course	60
Surface Treatment	30
Total	130

APPENDIX E

BOREHOLE LOGS

LOG OF BOREHOLES
Ninth Line
Steeles Avenue to Sideroad No. 10

0+500 NB 2 m Rt CL D -0.1

0 - 165 Asph

165 - 575 Br Cr Gr moist

575 - 1.5 Br Cl(y) Si Till moist

1+000 SB 2 m Lt CL D -0.1

0 - 120 Asph

120 - 870 Br Cr Gr moist
w @ 500mm = 4.22 %
4.75 mm = 55 %
0.075 mm = 16 %

870 - 1.5 Br Cl(y) Si Till wet

w @ m = %

1.5 - 1.95 Br Cl(y) Si Till wet
w @ 1.7m = 22.17
4.75 mm = 100 %
0.075 mm = 71 %
5.0 µm = 29 %
Unified Classification=CL
Liquid Limit=31.3
Plastic Limit=17.8
Plasticity Index=13.5
N value @ 1.5 m = 4

1+500 NB 2 m Rt CL D -0.1

0 - 180 Asph

180 - 630 Br Cr Gr moist

630 - 1.5 Br Cl(y) Si Till moist

1+635 SB 2 m Lt CL D -0.1

0 - 100 Asph

100 - 220 Br Cr Gr moist

220 - 500 Br Sa moist

500 - 1.5 Br Cl(y) Si Till moist

1.5 - 1.95 Br Cl(y) Si Till moist
w @ 1.75m = 11.9 %

N value @ 1.5 m = 18
Distressed Area

2+005 SB 2 m Lt CL D -0.1

0 - 120 Asph

120 - 670 Br Cr Gr moist

670 - 1.5 Br Cl(y) Si Till moist

2+500 NB 2 m Rt CL D -0.1

0 - 170 Asph

170 - 600 Br Cr Gr moist
w @ 400mm = 3.44 %
4.75 mm = 65 %
0.075 mm = 17 %
600 - 1.95 Br Cl(y) Si Till moist
w @ 1.7m = 12.57
4.75 mm = 93 %
0.075 mm = 59 %
5.0 µm = 21 %
N value 2@ 1.5 m = 25

2+970 NB 2 m Rt CL D -0.1

0 - 105 Asph

105 - 590 Br Cr Gr moist

590 - 1.5 Br Cl(y) Si Till moist

Note: Borehole offsets are referenced from roadway centreline

LOG OF BOREHOLES
Ninth Line
Steeles Avenue to Sideroad No. 10

3+494 NB 2 m Rt CL D -0.1

0 - 110	Asph	
110 - 450	Br Cr Gr	moist
450 - 1.5	Br Cl(y) Si Till	dry

4+100 SB 2 m Lt CL D -0.1

0 - 140	Asph	
140 - 480	Br Cr Gr	moist
480 - 1.5	Br Cl(y) Si Till	moist

4+500 NB 2 m Rt CL D -0.1

0 - 150	Asph	
150 - 250	Br Cr Gr	moist
250 - 340	Asph	
340 - 440	Br Cr Gr	moist
440 - 1.95	Br Cl(y) Si Till	moist

N value @ 1.5 m = 35

4+570 NB 2 m Rt CL D -0.1

0 - 170	Asph	
170 - 240	Br Cr Gr	moist
240 - 510	Br Sa Tr Gr	moist
	w @ 400mm =	3.71 %
	4.75 mm =	82 %
	0.075 mm =	19 %
510 - 1.95	Br Cl(y) Si Till	moist
	w @ 1.75m =	11.67
	4.75 mm =	94 %
	0.075 mm =	56 %
	5.0 µm =	20 %

N value @ 1.5 m = 54
Distressed Area

4+805 NB 2 m Rt CL D -0.1

0 - 150	Asph	
150 - 460	Br Cr Gr	moist
460 - 1.95	Br Cl(y) Si Till	moist
	w @ 1.75m =	12.02

N value @ 1.5 m = 27
Distressed Area

5+000 SB 2 m Lt CL D -0.1

0 - 150	Asph	
150 - 520	Br Cr Gr	moist
520 - 1.5	Br Cl(y) Si Till	moist

5+500 NB 2 m Rt CL D -0.1

0 - 150	Asph	
150 - 450	Br Cr Gr	moist
450 - 1.5	Br Si(y) Cl	moist

5+715 SB 2.0 m Lt CL D -0.1

0 - 150	Asph	
150 - 525	Br Cr Gr	moist
525 - 1.95	Br Si(y) Cl	moist
	w @ 1.75m =	11.67

Unified Classification=CL-ML
Liquid Limit=20.8
Plastic Limit=13.7
Plasticity Index=7.1

N Value @ 1.65 m = 16
Distressed Area

Note: Borehole offsets are referenced from roadway centreline

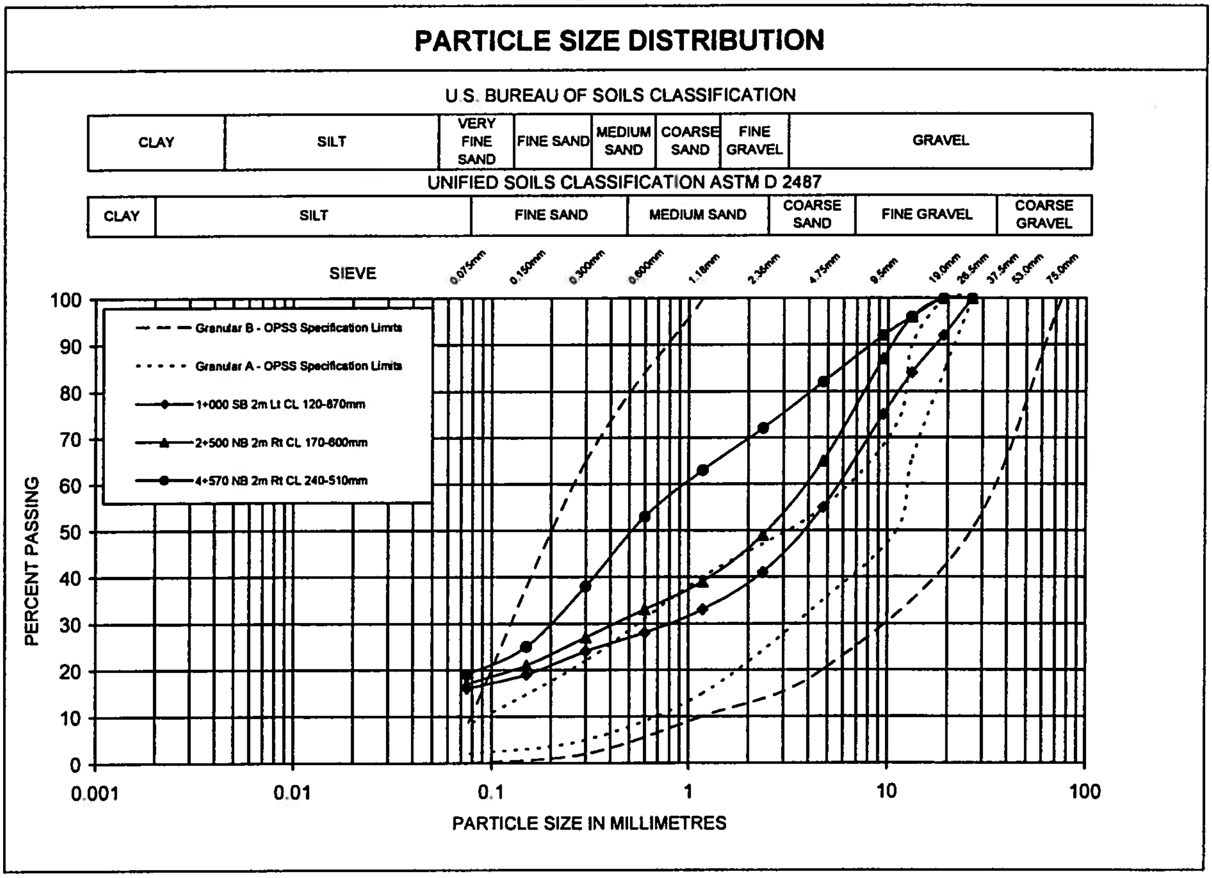
APPENDIX F

LABORATORY TEST RESULTS

Table F.1
Ninth Line
Steeles Avenue to No. 10 Sideroad
Summary of Granular Laboratory Test Results

Station (km)	Direction	Offset (m)		Depth (mm)	Field Classification	Percent Passing (%)		Water Content (%)	Frost Susceptibility
						4.75 mm	75 µm		
1+000	SB	2	Lt	120-870	Cr Gr	55	16	4.2	LSFH
2+500	NB	2	Rt	170-600	Cr Gr	65	17	3.4	LSFH
4+570	NB	2	Rt	240-510	Br Sa Tr Gr	82	19	3.7	LSFH

Figure F.1

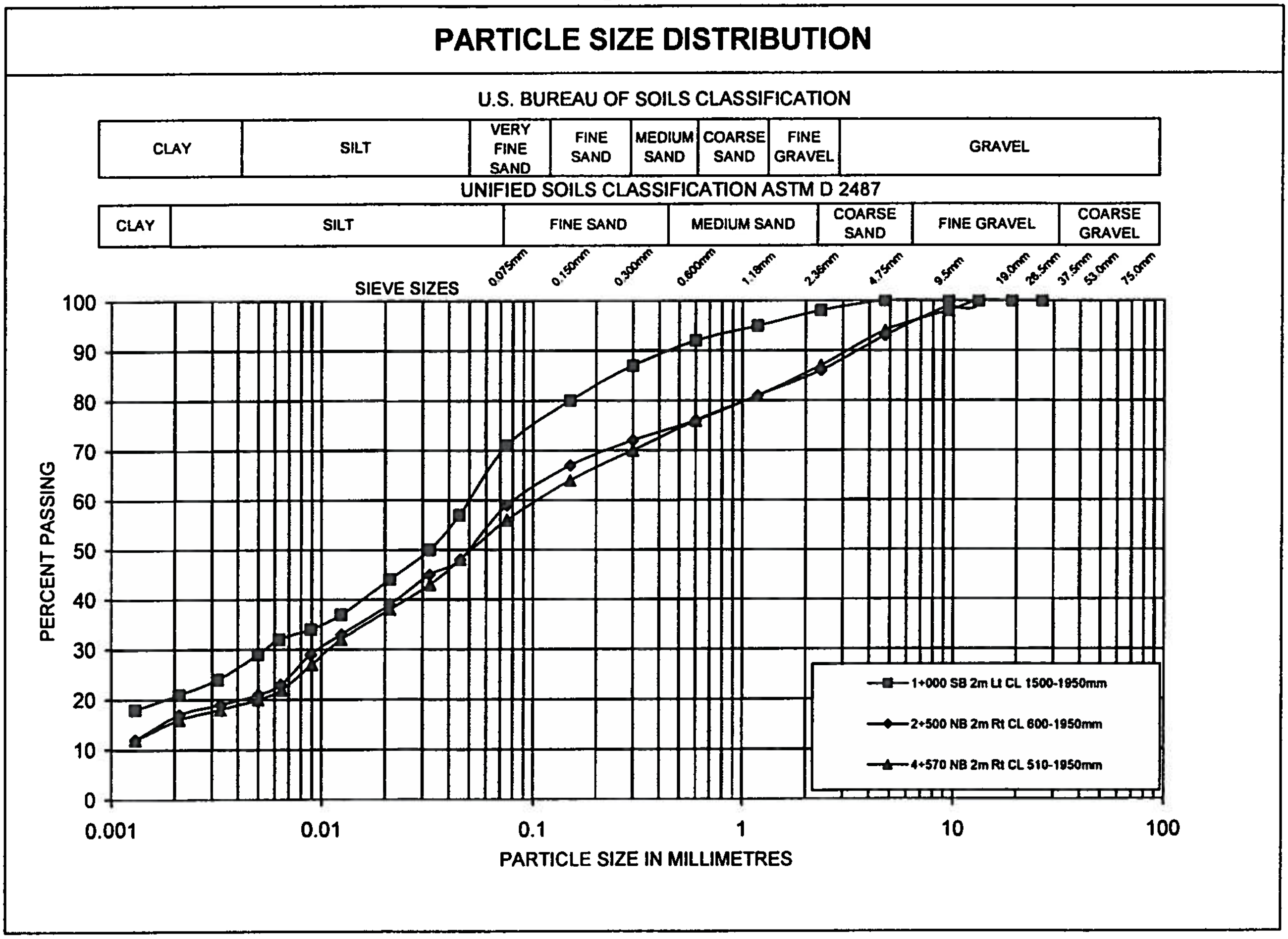


PARTICLE SIZE DISTRIBUTION

Table F.2
Ninth Line
Steeles Avenue to No. 10 Sideroad
Summary of Subgrade Laboratory Test Results

Station (km)	Direction	Offset (m)		Depth (mm)	Classification		Percent Passing (%)				Water Content (%)	Plasticity (%)		Frost Susceptibility	Soil Erodibility Factor, K
					Field	ASTM Unified	4.75 mm	75 µm	5 µm	Si&VFS		PI	PL		
1+000	SB	2	Lt	1500-1950	Br Cl(y) Si Till	CL	100	71	29	42	22.2	13.5	17.8	MSFH	0.25
2+500	NB	2	Rt	600-1950	Br Cl(y) Si Till	-	93	59	21	38	12.6	-	-	LSFH	0.23
4+570	NB	2	Rt	510-1950	Br Cl(y) Si Till	-	94	56	20	36	11.7	-	-	LSFH	0.22

Figure F.2



APPENDIX G

FALLING WEIGHT DEFLECTOMETER TEST RESULTS

APPENDIX G
Ninth Line
Steeles Avenue to No. 10 Sideroad
Falling Weight Deflectometer Test Results

General		FWD Results				Design Requirments		
Station (km)	Direction	D_o (µm)	M_R (MPa)	Ep (MPa)	SN_{eff} (cm)	SN_{Des} (cm)	SN Deficiency	Asphalt Required (mm)
0.050	SB	425	33	434	10.1	12.70	2.6	62
0.100	NB	292	37	719	12.0	12.70	0.7	17
0.150	SB	426	30	452	10.3	12.70	2.4	58
0.200	NB	415	25	518	10.7	12.70	2.0	47
0.250	SB	449	27	440	10.2	12.70	2.5	61
0.300	NB	426	33	426	10.1	12.70	2.6	63
0.350	SB	372	31	544	10.9	12.70	1.8	43
0.400	NB	442	29	433	10.1	12.70	2.6	62
0.450	SB	409	30	483	10.5	12.70	2.2	53
0.500	NB	508	24	389	9.7	12.70	3.0	70
0.550	SB	405	31	477	10.4	12.70	2.3	54
0.600	NB	535	29	326	9.2	12.70	3.5	83
0.650	SB	421	32	445	10.2	12.70	2.5	60
0.700	NB	464	31	389	9.7	12.70	3.0	70
0.750	SB	539	23	359	9.5	12.70	3.2	76
0.800	NB	367	29	574	11.1	12.70	1.6	38
0.850	SB	461	31	395	9.8	12.70	2.9	69
0.900	NB	409	33	457	10.3	12.70	2.4	57
0.950	SB	400	35	454	10.3	12.70	2.4	58
1.000	NB	330	35	616	11.4	12.70	1.3	32
1.050	SB	528	31	321	9.1	12.70	3.6	85
1.100	NB	397	35	463	10.3	12.70	2.4	56
1.150	SB	528	25	358	9.5	12.70	3.2	77
1.200	NB	539	26	341	9.3	12.70	3.4	80
1.250	SB	691	24	247	8.4	12.70	4.3	103
1.300	NB	331	32	644	11.5	12.70	1.2	28
1.350	SB	435	30	437	10.1	12.70	2.6	61
1.400	NB	415	34	442	10.2	12.70	2.5	60
1.450	SB	434	31	431	10.1	12.70	2.6	62
1.500	NB	299	36	704	11.9	12.70	0.8	19
1.550	SB	380	31	527	10.8	12.70	1.9	46
1.600	NB	376	30	547	10.9	12.70	1.8	42
1.635	SB	752	21	232	8.2	12.70	4.5	107
1.700	NB	363	29	584	11.2	12.70	1.5	36
1.750	SB	600	27	284	8.8	12.70	3.9	93
1.800	NB	302	35	711	11.9	12.70	0.8	19
1.850	SB	676	23	257	8.5	12.70	4.2	100
1.900	NB	416	27	498	10.6	12.70	2.1	50
1.950	SB	516	29	342	9.3	12.70	3.4	80
2.000	NB	289	33	778	12.3	12.70	0.4	10
2.050	SB	370	33	529	10.8	12.70	1.9	45
2.100	NB	379	27	572	11.1	12.70	1.6	38

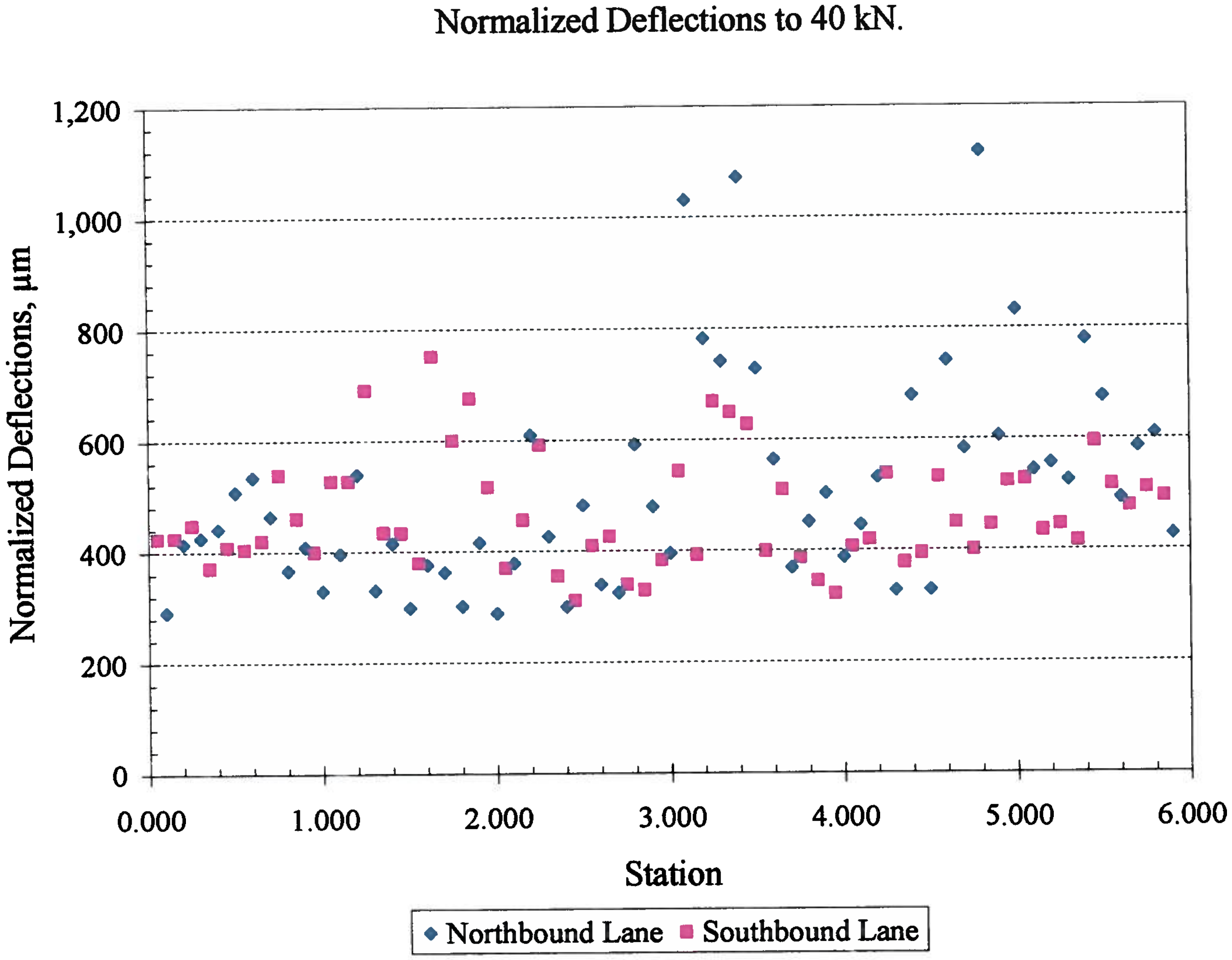
APPENDIX G
Ninth Line
Steeles Avenue to No. 10 Sideroad
Falling Weight Deflectometer Test Results

General		FWD Results				Design Requirments		
Station (km)	Direction	D_o (µm)	M_R (MPa)	Ep (MPa)	SN_{eff} (cm)	SN_{Des} (cm)	SN Deficiency	Asphalt Required (mm)
2.150	SB	457	29	408	9.9	12.70	2.8	67
2.200	NB	609	27	281	8.7	12.70	4.0	94
2.250	SB	592	28	287	8.8	12.70	3.9	93
2.300	NB	427	31	437	10.1	12.70	2.6	61
2.350	SB	356	37	530	10.8	12.70	1.9	45
2.400	NB	300	35	709	11.9	12.70	0.8	19
2.450	SB	312	39	633	11.5	12.70	1.2	29
2.500	NB	483	25	409	9.9	12.70	2.8	66
2.550	SB	410	30	477	10.4	12.70	2.3	54
2.600	NB	340	32	613	11.3	12.70	1.4	32
2.650	SB	427	34	419	10.0	12.70	2.7	64
2.700	NB	325	32	665	11.7	12.70	1.0	25
2.750	SB	340	32	619	11.4	12.70	1.3	31
2.800	NB	592	26	299	8.9	12.70	3.8	90
2.850	SB	330	32	646	11.5	12.70	1.2	28
2.900	NB	480	27	399	9.8	12.70	2.9	68
2.950	SB	384	30	525	10.8	12.70	1.9	46
3.000	NB	396	27	528	10.8	12.70	1.9	45
3.050	SB	544	23	357	9.5	12.70	3.2	77
3.100	NB	1031	15	168	7.4	12.70	5.3	127
3.150	SB	393	23	606	11.3	12.70	1.4	33
3.200	NB	782	19	226	8.1	12.70	4.6	109
3.250	SB	669	19	289	8.8	12.70	3.9	92
3.300	NB	741	22	231	8.2	12.70	4.5	107
3.350	SB	649	19	304	9.0	12.70	3.7	89
3.400	NB	1072	16	158	7.2	12.70	5.5	130
3.450	SB	628	20	305	9.0	12.70	3.7	88
3.500	NB	728	22	236	8.3	12.70	4.4	106
3.550	SB	399	38	443	10.2	12.70	2.5	60
3.600	NB	564	26	318	9.1	12.70	3.6	85
3.650	SB	510	26	367	9.6	12.70	3.1	75
3.700	NB	369	45	460	10.3	12.70	2.4	57
3.750	SB	387	36	473	10.4	12.70	2.3	55
3.800	NB	452	36	377	9.6	12.70	3.1	73
3.850	SB	345	38	549	10.9	12.70	1.8	42
3.900	NB	503	31	347	9.4	12.70	3.3	79
3.950	SB	322	39	600	11.3	12.70	1.4	34
4.000	NB	388	42	441	10.2	12.70	2.5	60
4.050	SB	407	42	413	10.0	12.70	2.7	65
4.100	NB	446	34	395	9.8	12.70	2.9	69
4.150	SB	420	30	459	10.3	12.70	2.4	57
4.200	NB	531	29	332	9.2	12.70	3.5	82

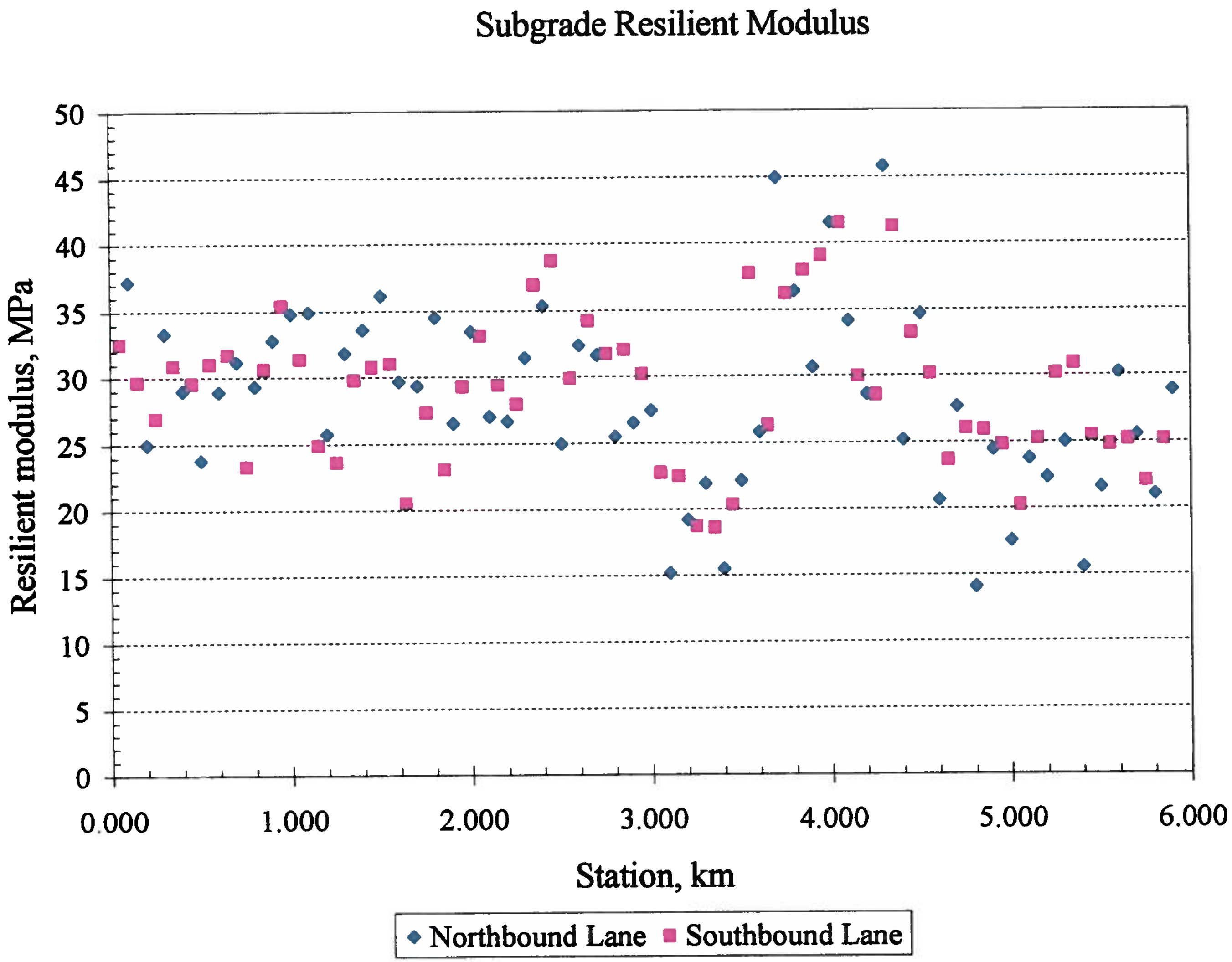
APPENDIX G
Ninth Line
Steeles Avenue to No. 10 Sideroad
Falling Weight Deflectometer Test Results

General		FWD Results				Design Requirments		
Station (km)	Direction	D_o (µm)	M_R (MPa)	Ep (MPa)	SN_{eff} (cm)	SN_{Des} (cm)	SN Deficiency	Asphalt Required (mm)
4.250	SB	538	29	326	9.2	12.70	3.5	84
4.300	NB	328	46	541	10.9	12.70	1.8	43
4.350	SB	378	41	460	10.3	12.70	2.4	57
4.400	NB	678	25	247	8.4	12.70	4.3	103
4.450	SB	395	33	477	10.4	12.70	2.3	54
4.500	NB	329	35	620	11.4	12.70	1.3	31
4.550	SB	532	30	323	9.2	12.70	3.5	84
4.600	NB	741	21	237	8.3	12.70	4.4	106
4.650	SB	450	24	471	10.4	12.70	2.3	55
4.700	NB	583	28	294	8.9	12.70	3.8	91
4.750	SB	401	26	535	10.8	12.70	1.9	44
4.800	NB	1117	14	155	7.2	12.70	5.5	131
4.850	SB	446	26	453	10.3	12.70	2.4	58
4.900	NB	605	24	295	8.9	12.70	3.8	91
4.950	SB	523	25	363	9.5	12.70	3.2	75
5.000	NB	832	18	215	8.0	12.70	4.7	112
5.050	SB	527	20	402	9.9	12.70	2.8	68
5.100	NB	544	24	350	9.4	12.70	3.3	78
5.150	SB	435	25	478	10.4	12.70	2.3	54
5.200	NB	556	22	349	9.4	12.70	3.3	78
5.250	SB	446	30	418	10.0	12.70	2.7	65
5.300	NB	525	25	359	9.5	12.70	3.2	76
5.350	SB	416	31	460	10.3	12.70	2.4	57
5.400	NB	779	16	253	8.4	12.70	4.3	101
5.450	SB	594	25	297	8.9	12.70	3.8	90
5.500	NB	675	22	266	8.6	12.70	4.1	98
5.550	SB	517	25	370	9.6	12.70	3.1	74
5.600	NB	493	30	360	9.5	12.70	3.2	76
5.650	SB	478	25	413	10.0	12.70	2.7	65
5.700	NB	585	26	304	9.0	12.70	3.7	89
5.750	SB	511	22	402	9.9	12.70	2.8	68
5.800	NB	609	21	314	9.1	12.70	3.6	86
5.850	SB	495	25	392	9.8	12.70	2.9	70
5.900	NB	428	29	455	10.3	12.70	2.4	58

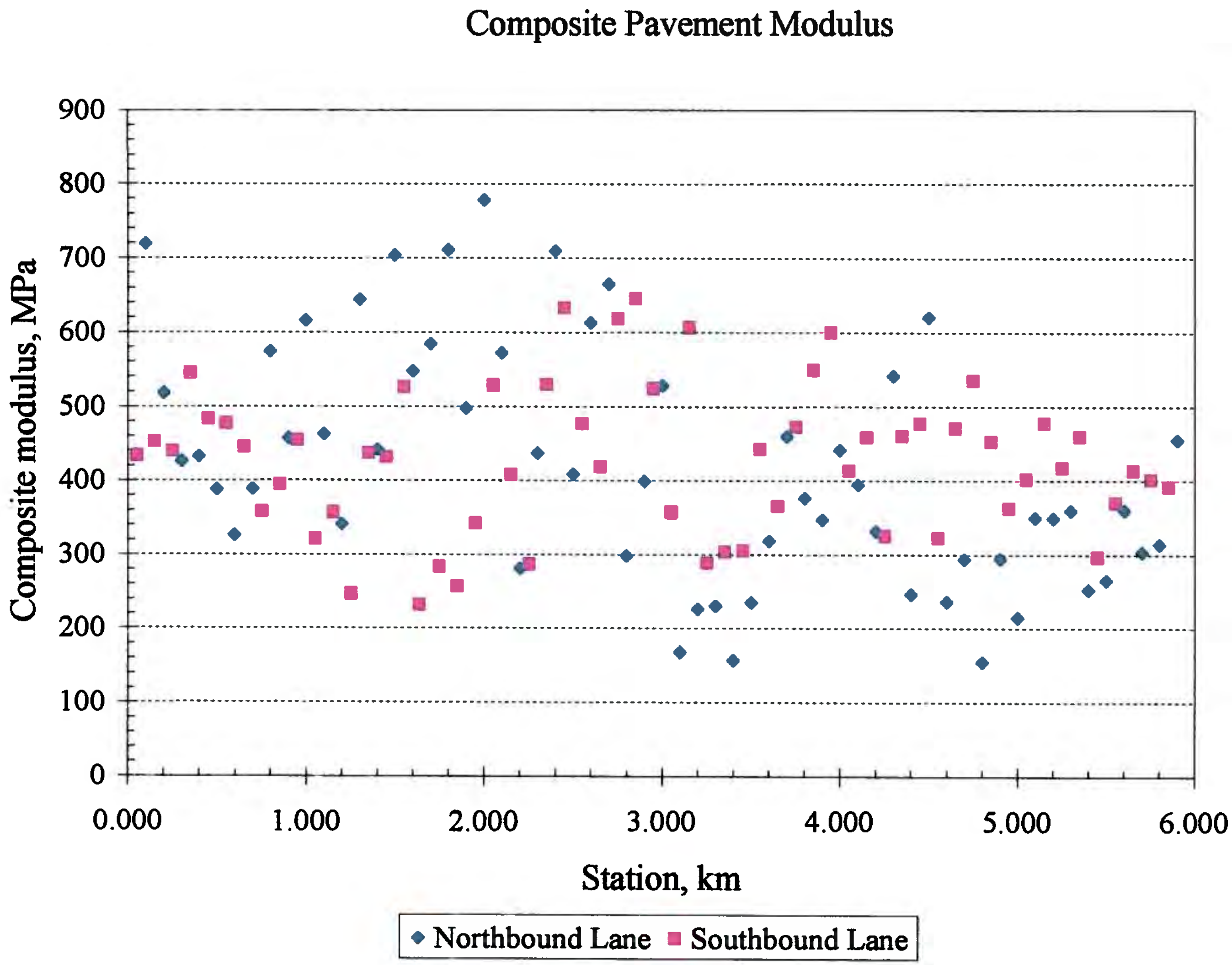
APPENDIX G
Ninth Line
Steeles Avenue to No. 10 Sideroad
Falling Weight Deflectometer Test Results



APPENIDX G
Ninth Line
Steeles Avenue to No. 10 Sideroad
Falling Weight Deflectometer Test Results



APPENIDX G
Ninth Line
Steeles Avenue to No. 10 Sideroad
Falling Weight Deflectometer Test Results



APPENIDX G
Ninth Line
Steeles Avenue to No. 10 Sideroad
Falling Weight Deflectometer Test Results