SEWER ELECTRO-SCAN

CEDAR CREEK STREAM CROSSINGS

CITY OF OLATHE

KANSAS

JULY 2011

For:

CH2M HILL INC
PO Box 241329
Denver, CO 80224

Purchase Order: PO 945755

By:

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CONTENTS

Appendix A: Sewer Electro-Scans - Pipe Full and CCTV Logs (see Addendum)

1. INTRODUCTION

CH2M Hill requested Leak Busters, Inc. to carry out an electro-scan study of approximately 6,000 ft of trunk line sanitary sewer pipes using the sewer electro-scan system to assist with the location of pipe defects that are potential leaks.

2. SEWER DESCRIPTION

The pipes electro-scanned were 30, 42 and 54-inch diameter concrete sanitary sewers. Access to the sewers was through manholes with an average separation of 300 ft and depth of 15 ft. The natural flow varied between 10% and 20% of the pipe at 4 to 5 ft/sec.

The pipe route follows the valley of Cedar Creek. The pipe sections electro-scanned where generally within 50 ft of the creek bed and crossed the creek bed at seven locations.

The names of the manholes of the electro-scanned sewer sections are those shown on the sewer plans supplied by the City of Olathe and listed in Table 1. The manhole to manhole distances shown in the results were those supplied by the City of Olathe. Each manhole to manhole test section is reference by the upstream manhole number. The distances shown on the scans are referenced to the center of the upstream manhole.

The sewer electro-scans are shown in Appendix A.

3. METHODOLOGY

3.1 Technology

Sewer electro-scanning utilizes the variation of electric current flow through a sewer pipe wall to locate pipe defects that are potential water leakage paths either into or out of the pipe.

Most sewer pipe materials such as clay, plastic, concrete, asbestos reinforced concrete, steel reinforced concrete and brick are electrical insulators and thus have high resistance to electrical current. A defect in the pipe that leaks water will also leak electrical current, whether or not water infiltration is occurring at the time of the test.

The sewer electro-scan is carried out by applying an electric voltage between an electrode in the pipe, called a probe, and an electrode on the surface, which is usually a metal stake pushed into the ground. A simplified electrical circuit for this procedure is shown in Figure 1. The water in the pipe is at a level that ensures that the pipe is full at the probe location. The electrical resistance of the current path between the probe and the surface electrode is very low except for through the pipe wall. The high electrical resistance of the pipe wall prevents electrical current from flowing between the two electrodes unless there is a defect in the pipe, such as a crack, defective joint or faulty connection.

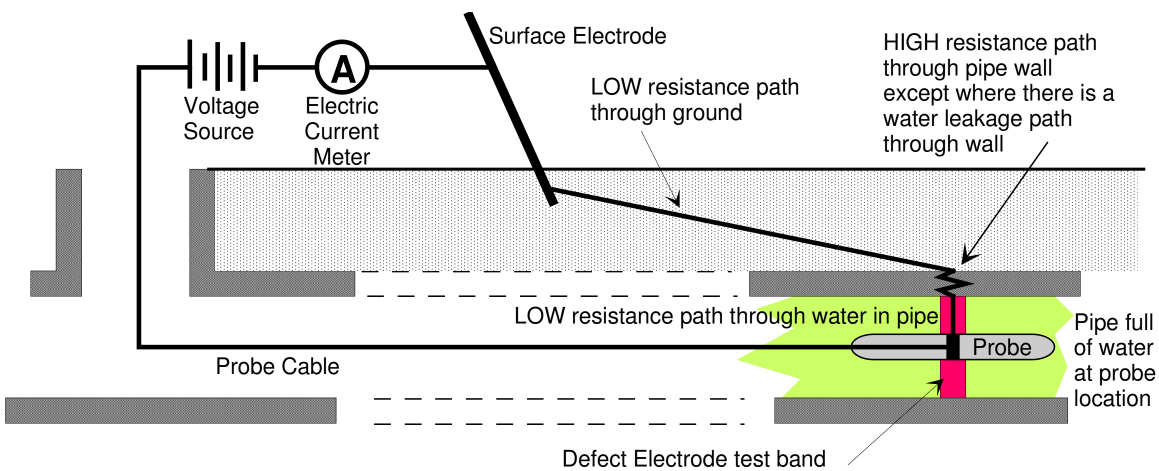


Figure 1. Electro-Scan Electrical Schematic

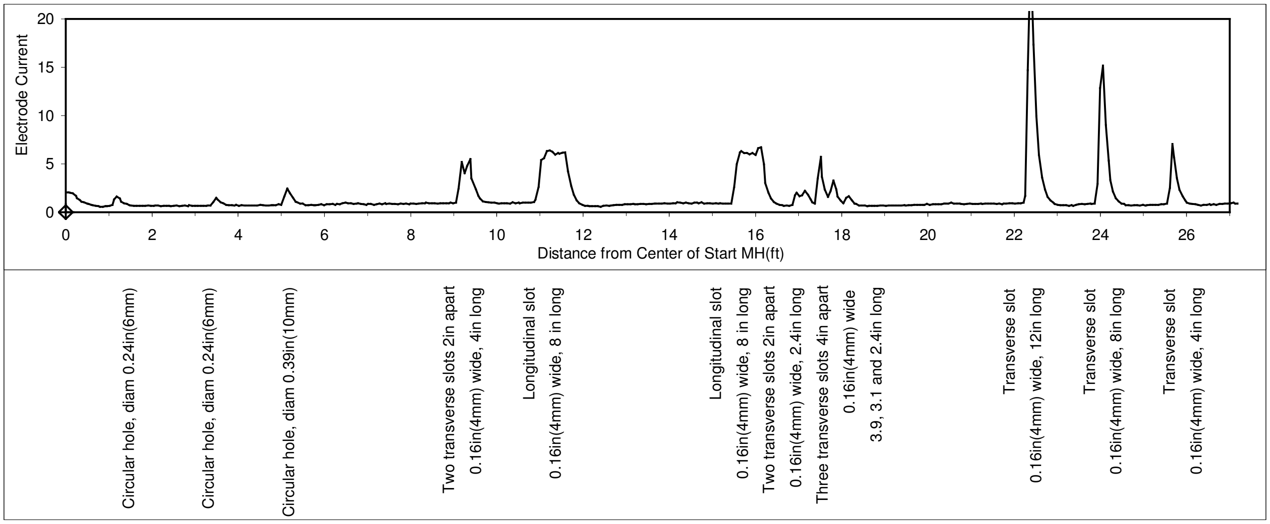
To detect defects around the complete circumference of the pipe wall the sewer needs to be completely full of water in the region of the probe. If the pipe is only partly full in the region of the probe then only that part of the pipe that is covered with water is electro-scanned.

The sewer electro-scan is carried out by pulling the probe through a pipe at a speed of 30 ft/min. The current flow between the surface electrode and the probe is recorded at approximately 0.5 inch intervals along the pipe. Most sewer pipe materials have high resistance to electrical current and there is only a small current flow except where there is a pipe defect. As the center of the probe approaches within about 1 inch of a pipe defect, the current from the focused electrode increases, reaching a maximum when the center of the probe is radialy aligned with a defect. An example of the electro-scan output is shown in Appendix A??

3.2 Variation of Electro-Scan Current with Defect Size

The electro-scan of a pipe that was buried after holes were cut in the pipe is shown in Figure 2.

Figure 2 Electro-scan – Pipe Material: PVC, Diameter 8 inch



Note that the greater the defect size the greater the s-e current. The defect size is one of the factors that will control the amount of water that will leak through the defect. Other factors that affect the leakage volume include the differential water pressure between the inside and outside of the pipe and the permeability of the soil surrounding the pipe. If these factors are the same for two pipe sections then the pipe with more or larger defects will have a higher leakage rate.

3.3 Data Collection

As the probe is pulled through the pipe the electrical current flow through the pipe wall and the position of the probe in the pipe are recorded and displayed in real time as an "electro-scan" on a notebook computer. The processed electro-scans from this study are shown in Appendix A.

A region on the electro-scan where the probe current level is above the threshold level is called an "anomaly". The threshold level is shown as the lowest unbroken horizontal line on the electro-scan.

3.4 Data Processing

The electro-scan is processed using a computer program in the following steps:

- Removal of the current offset above zero.
  This process enables a computer program to automatically pick and grade the electro-scan "anomalies" (see below)

- Setting a probe current "threshold" level.
  The value of the threshold level was selected to provide discrimination between what might be "slightly" leaking joints or defects and other defects. Electro-scan values above the threshold level are called "anomalies".

For this study the threshold level selected was 1.0 and is shown as the lowest unbroken horizontal line on the electro-scans. This threshold level was based on experience from electro-scanning full pipes up to a diameter of 18 inch.

Further other methods of testing or investigation may lead to modification of this threshold level.

- Grading the anomalies as Large, Medium or Small according to the maximum value of the electro-scan anomaly.

  The Large-Medium and Medium-Small current level boundaries of 7.0 and 4.0 respectively are shown as unbroken horizontal lines on the electro-scan. The location and length of an anomaly is the location and longitudinal length of the electrical defect along the pipe. The maximum current level of the anomaly is a measure of the amount of current flow through the defect and is related to the size of the defect.

  For this study the Grading levels were selected from the experience of electro-scanning full pipes up to a diameter of 18 inch.

  The boundaries between Large, Medium and Small may be refined using the results of other types of testing or investigation.

  These Grades provide a means of establishing priority for the further investigation and/or repair of the pipelines.

- Plotting joint locations.

  Anomalies that occur at regular intervals are usually due to joint defects. To assist with the identification of these joint anomalies the processing program can be used by the operator to plot "+" marks on the electro-scan at a regular interval. The processing program can then select anomalies that occur at the "+" marks and plot a "◇" over the "+". These anomalies are considered to be associated with a joint defect. Other anomalies are usually due to structural faults or faulty connections.

- Tabulating anomalies and calculating relative anomaly occurrence.

  The processing program picks, measures and grades the size and type (joint or other) of the anomalies and calculates the total length of anomalies for each test section. This is a measure of the potential relative leakage for each manhole to manhole pipe section.

3.5 Other Pipe Defects

A "comment" is attached to the electro-scan at the locations of anomalies that do not occur at joint locations. The comment is a description of the type of pipe defect that may have caused the anomaly based on the shape of the electro-scan at that location. The comments used are:

PD: radial	a crack or fracture around the circumference of the pipe
PD: longitudinal	a crack or fracture along the pipe

3.6 Scan Summary

For each sewer segment electro-scanned a "Scan Summary" is produced that summarizes the anomalies that occur above the threshold, their grades and type (joint or other). (See Table 1)

The Scan summary shows the number of defects. The sum of the lengths of the defects within each grade for a particular test section is also determined. However this parameter is dependant on length of the test section. So pipe segment scans can be compared with each other the following parameter is calculated and is also shown in Table 1.

> Percentage of anomaly length per length of scanned pipe
> = (100 x sum of anomaly lengths in scanned pipe section) / (length of scanned pipe section)

4. FIELD OPERATIONS

The general field procedure used for electro-scanning 30-inch and larger diameter pipes is outlined below:

- String lines are strung between the upstream and the downstream (MH) of each of the pipe sections to be electro-scanned.
- A plug is inserted into the outlet of the downstream MH and the sewer flow begins filling the pipe.
- The string line is used to pull the probe from the upstream to the downstream MH and the electro-scan recorded.
- When the water level in the pipe reaches the crown of the upstream pipe outlet, the probe is pulled from the downstream to the upstream MH and the electro-scan recorded.
- The string line is detached from the probe and retrieved from the pipe.
- The outlet of the downstream MH of the next downstream pipe section to be scanned is plugged.
- The plug used to back up the water in the upstream pipe section previously electro-scanned is removed and the water used to fill the next section of pipe to be electro-scanned.
- The string line is used to pull the probe……………..and so on.

The probe usually used for 30-inch and larger diameter pipes has a diameter of 10-inch and length of 60-inch (S100 Probe). Pipe sections D14-008, D14-007, D14-006 and D14-005 were electro-scanned using this probe. The S100 Probe became non-operational after completing these pipe sections. A replacement or repair of the S100 Probe was not possible in the time allocated for this pilot project. The remainder of the pipe sections were electro-scanned using a S50 probe that has a diameter of 3-inch and length 30-inch.

A repeat electro-scan of pipe section D14-008 was carried out using the S50 Probe.

To ensure that the S50 probe was able to effectively electro-scan 54-inch pipe the 54-inch pipe section B12-019 to B12-001 was electro-scanned downstream with the probe attached to floats so that the probe passed along the crown (top of the pipe). The floats were removed and the probe pulled upstream with the probe on the invert (bottom of the pipe).

5. RESULTS

5.1 Electro-Scan Processing

All the electro-scans were processed using the same threshold level of 1.0 and the same anomaly grade levels of 7.0 for the Large-Medium and 4.0 for the Medium-Small current level boundaries. These levels maybe refined using selective joint pressure testing or other investigation methods.

Anomalies that occur at regular intervals are usually due to joint defects. To assist with the identification of these joint anomalies the processing program was used to plot "+"marks on the electro-scan at a regular interval. The processing program can then select anomalies that occur at the "+" marks and plot a "◇" over the "+". These anomalies are considered to be associated with a joint defect. Other anomalies are usually due to structural faults or faulty connections. A "comment" was attached to the electro-scan at the locations of anomalies that do not occur at joint locations.

5.2 Anomaly Graphic Summary

The anomaly graphic summary using the "percentage of anomaly length per length of scanned pipe" shows at a glance the relative occurrence and size of the anomalies. From this information it is straight forward to make an assessment of the relative potential leakage for each pipe section electro-scanned and prioritize rehabilitation programs. The graphic summary also shows the distribution of the defects between joint defects and other faults such as pipe cracks. This analysis may assist the design of a rehabilitation program.

5.3 Pipe Sections Electro-Scanned with the Pipe Full (Full Pipe - FP)

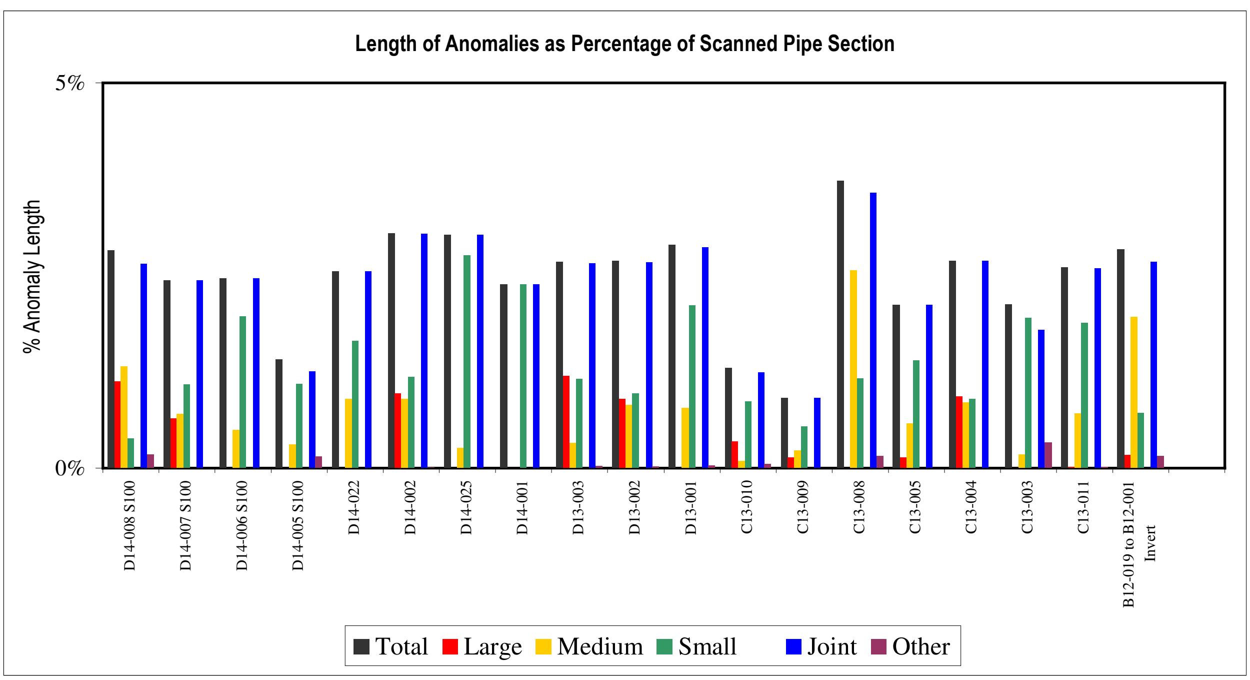
A list, upstream to downstream, of the pipe sections electro-scanned with the pipe full and therefore scanning the entire circumference of the pipe at the probe location is shown in Table 1. A summary of the electro-scan anomalies is also shown in Table 1. The electro-scans are shown in Appendix A. Manhole names and comments on "Other" (non-joint) anomalies are also shown on the electro-scans. An Anomaly Graphic summary of the anomalies shown in Table 1 is shown on Figure 3.

The upstream manhole number references each electro-scan. The distances shown on the electro-scans are in the downstream direction and begin from the upstream start of the pipe section. The electro-scans have been plotted so the left hand manhole on the electro-scan is the upstream manhole. Note that the 54-inch diameter pipe electro-scan, B12-019 to B12-001, includes intermediate manholes.

Table 1. Pipe Sections Electro-Scanned with the Pipe Full

Pipe Section Name	Downstream MH	MH Dist.	Pipe Diam.	Anomaly Summary(Number of Defects)						% Anomaly Length of Pipe Length Tested						Joints		
(Upstream MH)	Total	5887		Large	Med	Small	Joint	Other	Total	Large	Medium	Small	Joint	Other	Total	Total	Defective	
D14-008 S100	D14-007	378	30	12	19	11	40	2	42	1.1%	1.3%	0.4%	2.7%	0.2%	2.8%	46	39	85%
D14-007 S100	D14-006	422	30	7	10	22	39	0	39	0.6%	0.7%	1.1%	2.4%	0.0%	2.4%	52	39	75%
D14-006 S100	D14-005	230	30	0	3	21	22	2	24	0.0%	0.5%	2.0%	2.5%	0.0%	2.5%	27	21	78%
D14-005 S100	D14-004	312	30	0	2	20	20	2	22	0.0%	0.3%	1.1%	1.3%	0.2%	1.4%	38	19	50%
D14-022	D14-002	289	42	0	6	17	21	2	23	0.0%	0.9%	1.7%	2.6%	0.0%	2.6%	22	21	95%
D14-002	D14-025	326	42	3	4	16	22	1	23	1.0%	0.9%	1.2%	3.0%	0.0%	3.1%	26	22	85%
D14-025	D14-001	173	42	0	1	12	13	0	13	0.0%	0.3%	2.8%	3.0%	0.0%	3.0%	12	12	100%
D14-001	D14-023	184	42	1	0	13	13	1	14	0.0%	0.0%	2.4%	2.4%	0.0%	2.4%	13	13	100%
D13-003	D13-002	289	30	7	5	24	32	4	36	1.2%	0.3%	1.2%	2.7%	0.0%	2.7%	35	32	91%
D13-002	D13-001	391	42	4	6	20	27	3	30	0.9%	0.8%	1.0%	2.7%	0.0%	2.7%	29	26	90%
D13-001	D13-010	219	42	1	5	14	16	4	20	0.0%	0.8%	2.1%	2.9%	0.0%	2.9%	17	16	94%
C13-010	C13-009	213	30	3	1	18	17	5	22	0.3%	0.1%	0.9%	1.2%	0.1%	1.3%	25	17	68%
C13-009	C13-008	282	30	1	3	18	22	0	22	0.1%	0.2%	0.5%	0.9%	0.0%	0.9%	34	22	65%
C13-008	C13-007	328	42	0	17	8	24	1	25	0.0%	2.6%	1.2%	3.6%	0.2%	3.7%	24	24	100%
C13-005	C13-004	331	30	2	7	32	38	3	41	0.1%	0.6%	1.4%	2.1%	0.0%	2.1%	41	38	93%
C13-004	C13-003	507	30	11	15	36	60	2	62	0.9%	0.9%	0.9%	2.7%	0.0%	2.7%	62	56	90%
C13-003	C13-011	240	42	0	1	23	18	6	24	0.0%	0.2%	1.9%	1.8%	0.3%	2.1%	18	18	100%
C13-011	C13-002	455	42	2	9	30	35	6	41	0.0%	0.7%	1.9%	2.6%	0.0%	2.6%	35	34	97%
B12-019 to B12-001 Invert	B12-001	318	54	3	15	15	22	11	33	0.2%	2.0%	0.7%	2.7%	0.2%	2.8%	21	21	100%

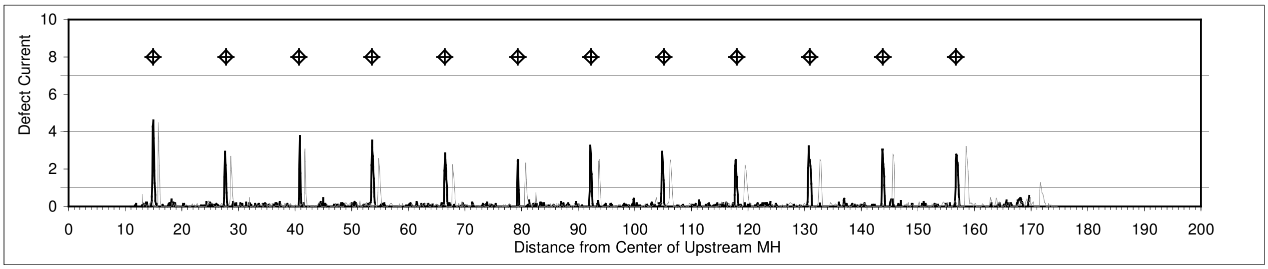
Figure 3. Anomaly Graphic Summary



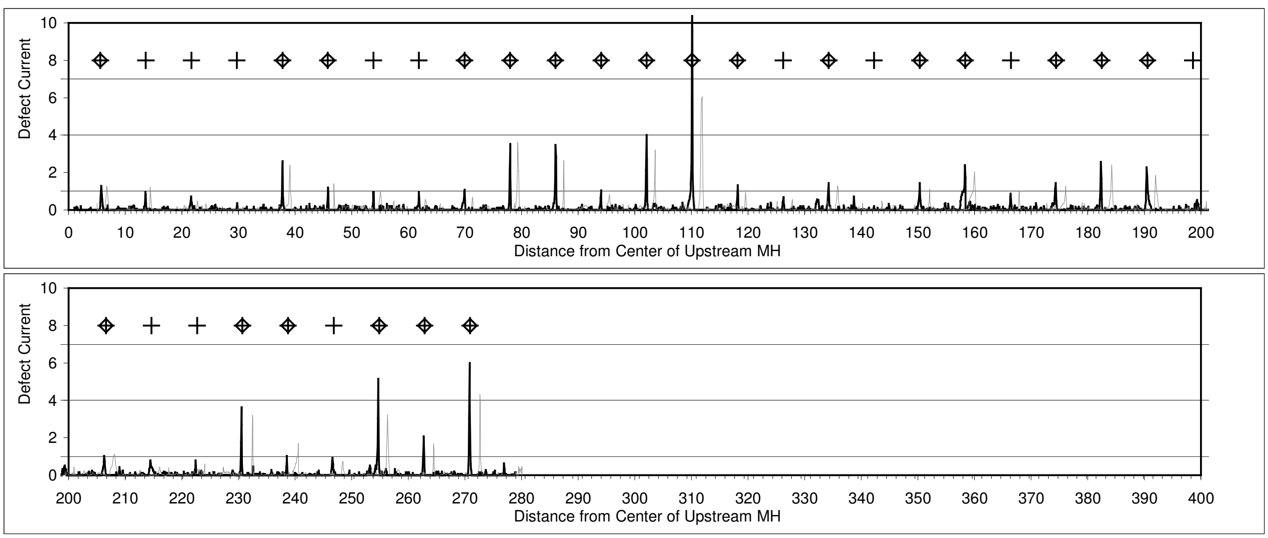
5.4 Comparison of Electro-Scans of the Same Pipe Sections

On some occasions, when the probe was pulled to the downstream manhole the pipe was full for the entire section. The electro-scans for two pipe sections that were recorded in both directions when the pipe was full are shown below. For ease of comparison the electro-scan recorded with the probe moving downstream is slightly offset downstream.

Electro-scans with the Pipe Full in Both Directions: Pipe Section D14-025



Electro-scans with the Pipe Full in Both Directions: Pipe Section C13-009



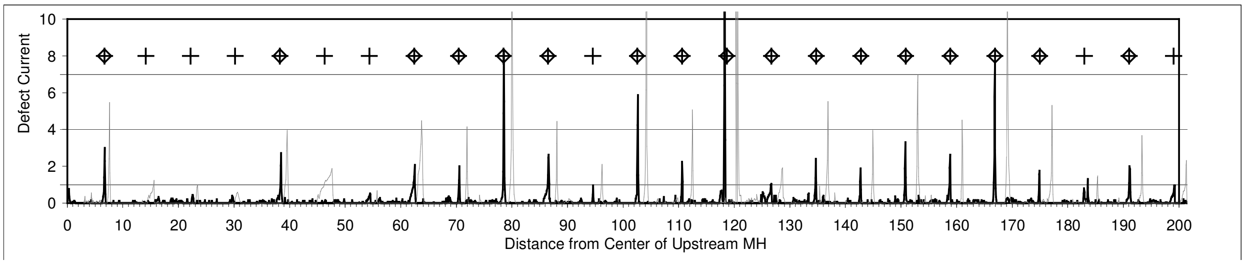
Note that the significant parameter on the scan is the maximum value of the anomalies. The scans show some small differences. This can be attributed to the speed at which the probe is pulled downstream by hand was not as closely controlled as when it is pulled upstream by the electric power winch. Also the measurement system records a value every 0.5 inch as the probe moves along the pipe. That is each measurement is not exactly at the same location for each of the scans. The location of the current measurement for each scan could vary by +/- 0.25 inch.

Taking into account these factors, the comparison of these electro-scans shows a high degree of repeatability of the electro-scan.

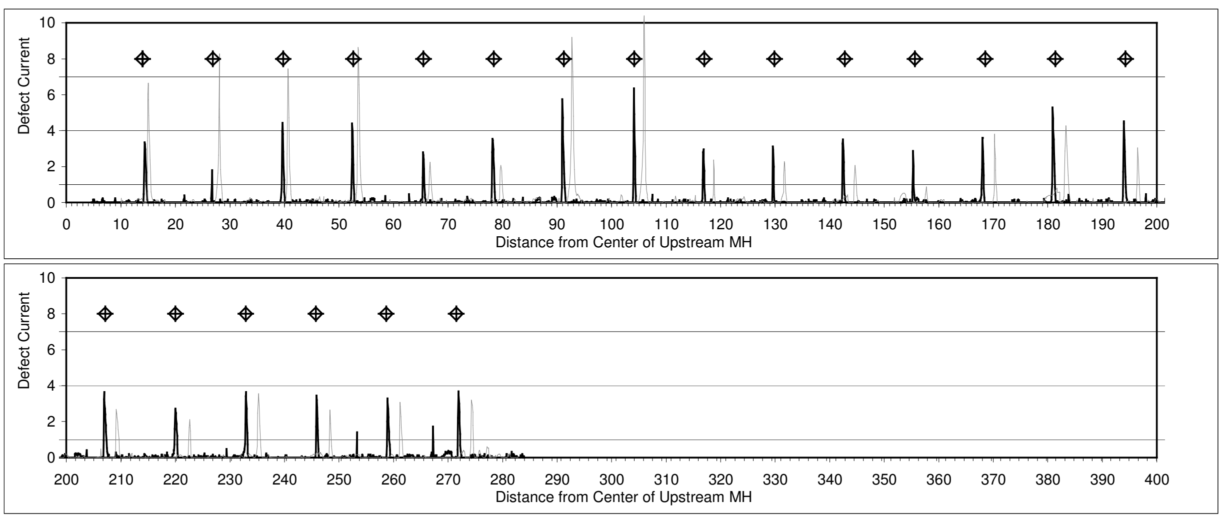
5.6 Pipe Sections Electro-Scanned with the Pipe Partly Full (Part Pipe – PP)

For a number of pipe sections the pipe was not completely full while the probe was pulled downstream and only that part of pipe circumference that is covered with water at the probe location was scanned. The electro-scans for two pipe sections that were recorded in both directions when the pipe was part full and full are shown below. For ease of comparison electro-scan recorded with the probe moving downstream is slightly offset downstream.

Electro-scans of Full and Part Full Pipe: Pipe Section C13-010



Electro-scans of Full and Part Full Pipe: Pipe Section D14-022



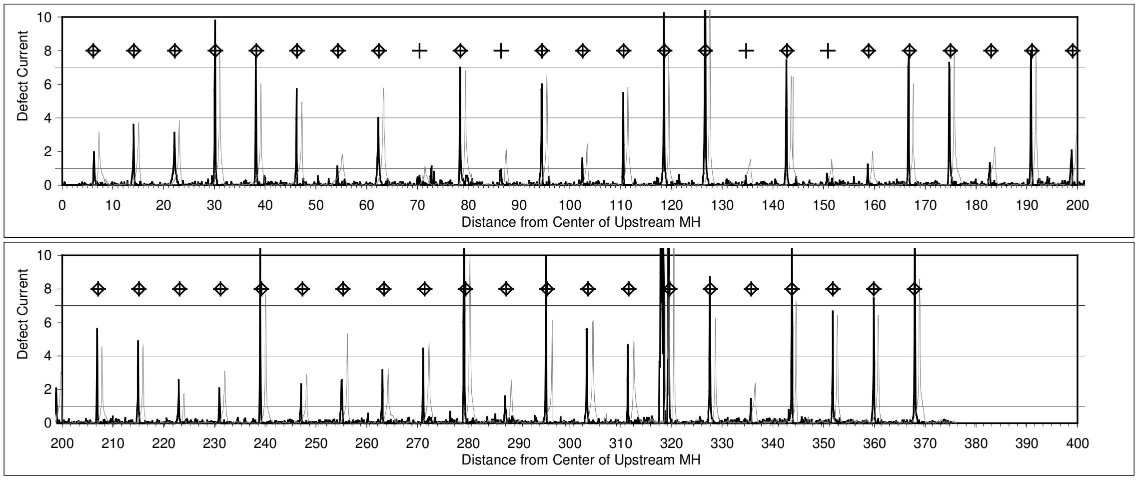
Note that the significant parameter on the scan is the maximum value of the anomalies. The most apparent difference is the significant number of larger anomalies on the part full pipe scans. This maybe due to the reduction of electrical current distribution density when the pipe is full. If this is the case then it is possible that the defects that show the larger anomalies are larger on the invert of the pipe than on the crown.

This comparison shows that for a pipe condition analysis involving a number of pipe sections it is not appropriate to compare electro-scans of full pipes with partly full pipes.

5.7 Comparison of Pipe Sections Electro-Scanned with the S100 and S50 Probe

The electro-scans shown below are for the S50 and S100 probe for pipe section D14-008. The S100 electro-scan is offset slightly downstream for ease of comparison.

Comparison of Electro-Scans with S100 Probe and the S50 Probe: Pipe Section D14-008



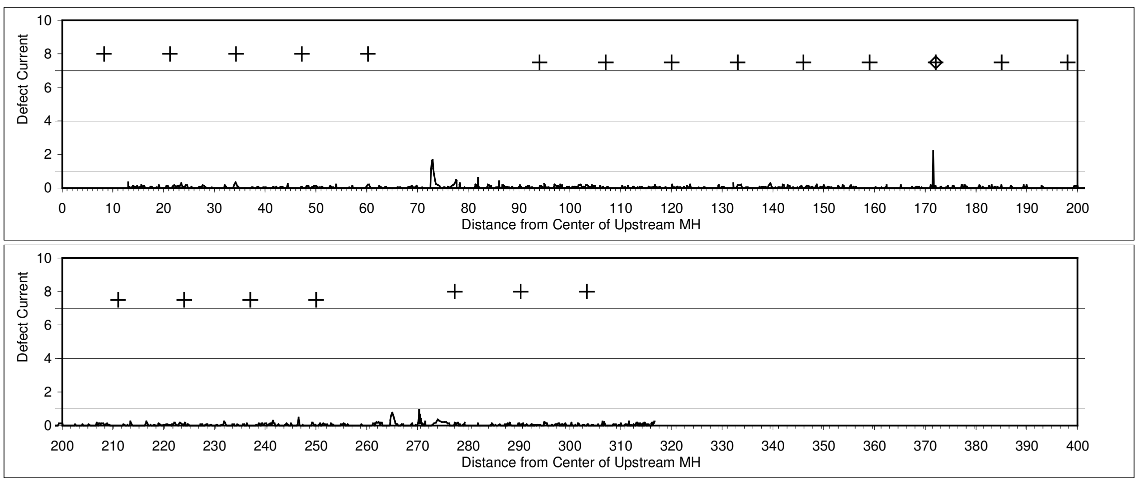
Note that the significant parameter on the scan is the maximum value of the anomalies. The scans show that the S100 probe is slightly more effective at detecting the low level defects close to the Threshold. At higher defect current levels there are only minor differences where the maximum value of the anomalies measured by the S50 probe are sometimes slightly larger and sometimes slightly smaller than that measured by the S100 probe. This can be attributed to the measurement system that records a value every 0.5 inch as the sonde moves along the pipe. That is each measurement is not exactly at the same location for each of the scans. The location of the current measurement for each scan could vary by +/- 0.25 inch.

5.8 Comparison of Pipe Sections Electro-Scanned with the S50 Probe on the Invert (bottom of the pipe) and at the Crown (top of the pipe)

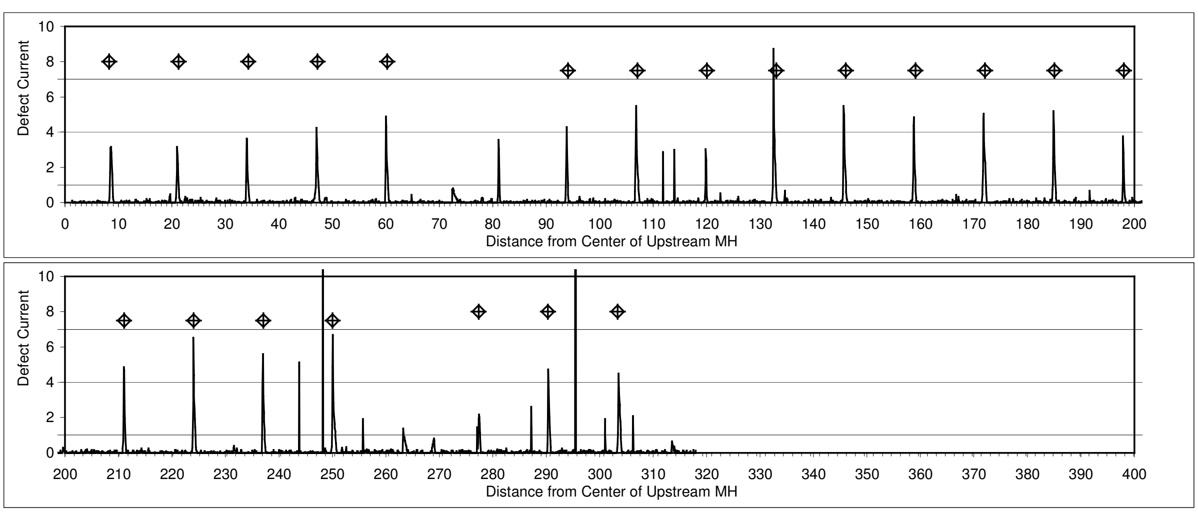
To ensure that the S50 probe was able to effectively electro-scan 54-inch pipe the 54-inch pipe section B12-019 to B12-001 was electro-scanned downstream with the probe attached to floats so that the probe passed along the crown (top of the pipe). The floats were removed and the probe pulled upstream with the probe on the invert (bottom of the pipe). The electro-scans are shown below.

MH B12-001 is 78-ft downstream of MH B12-019.
MH B12-018 is 269-ft downstream of MH B12-019

Electro-scan with Probe on Pipe Crown: Pipe Section B12-019 to B12-001



Electro-scan with Probe on Pipe Invert: Pipe Section B12-019 to B12-001



The crown electro-scan shows no joint anomalies except at 172-ft while the invert electro-scan shows anomalies at every joint. The only other anomaly shown by the crown electro-scan is at 73-ft. This corresponds with the manhole pipe entry and an anomaly on the invert electro-scan. There are two anomalies below the threshold each side of MH B12-018 at 269-ft on the crown electro-scan that correspond with anomalies on the invert electro-scan. This suggests that the defects associated with these manhole anomalies extend around the entire circumference of the pipe while the joint anomalies shown on the crown electro-scan only extend around part of the circumference.

6. COMMENTS

6.1 Field Operations

The pipe route access preparation, equipment for plugging the pipe sections and unlimited availability of the utility crew was very good and was a major factor in successfully completing the fieldwork on time.

The major delaying factor in the fieldwork was the collection of rags on the line strung between manholes when the line was left in place for more than one day. The collection of rags made it very difficult to pull the probe through the pipe. The line cannot be strung downstream while the pipe is plugged. An effective method of stringing the line a day or two ahead of plugging and electro-scanning the pipe section so that it does not collect rags would considerably reduce the fieldwork time.

The use of two pipe plugging systems significantly reduced the time to fill each section of pipe and is highly recommended for any further electro-scanning projects. Also the plugging of the downstream outlet of the manholes was effective in not only enabling the plugs to be set in the pipe without the need of man entry but also allowing the backed-up water to be released more gradually.

Failure of the electro-scan equipment due to an abraded cable and water leakage caused a field operations delay of one and half days and the use of the S50 probe instead of the S100 probe. A repeat electro-scan of pipe section D14-008 showed that this did not significantly degrade the results.

6.2 Results

Although the electro-scans showed that all of the pipe sections had anomalies associated with joints there was considerable variation between the amplitude of these anomalies and therefore the potential leakage of the joints.

The anomaly analysis shows that pipe sections D14-008, D14-007, D14-002, D13-003, D13-002, C13-008, C13-004 and B12-019 to B12-001 have the largest leak potential. It is possible that the repair of these pipe sections would reduce infiltration to an acceptable level.

There were a number of anomalies with a maximum greater than 10 (off-scale); for example at 320-ft on pipe section D14-008. Targeted spot repair of these locations may also significantly reduce infiltration.

If you require any further information regarding the above project please contact the undersigned

For and on behalf of
LEAK BUSTERS, INC

R. J. HARRIS

7. ADDENDUM: CCTV LOGS

Following the submission of the sewer electro-scans to CM2H Hill, the logs of the CCTV inspection were supplied to Leak Busters Inc. The CCTV defect identification codes were added to the sewer electro-scans shown in Appendix A. A list of the codes used in the logs supplied is shown in the table below.

Code	Description	Observation Category			
		General	Maintenance	Structural	I/I
AMH	Manhole	x			
CS	Crack Spiral			x	x
DSC	Deposits Settled Compacted		x		
ID	Infil Dripper				x
IR	Infil Runner				x
IS	Infil Stain				x
ISSRH	Intruding Sealing Ring Hanging				x
IW	Infil Weeper				x
MSA	Abandoned Survey	x			
MWL	Water Level	x			
MWLS	Water Level Sag		x		

The "I/I" CCTV defects observed are shown in the table below. Also shown is where the CCTV defects coincide with electro-scan anomalies taking into account the apparent distance discrepancies often shown by the CCTV logs.

For pipe section C13-004 there was no coincidence between the CCTV defects and the electro-scan anomalies. However if it is assumed that the CCTV inspection was carried out in the upstream direction then there is good coincidence between the CCTV log and the electro-scan.

The CCTV shows relatively few defects especially when compared with the number of anomalies shown by the electro-scans. This is to be expected, as the most of the electro-scan anomalies are associated with joints that CCTV cannot see into.

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Pipe Section Name	Downstream MH	MH Dist.	Pipe Diam.	CCTV Defects		Coincidence
(Upstream MH)	Total	5887		Distance	Code	with ES
D14-008 S100	D14-007	378	30			
D14-007 S100	D14-006	422	30	210.55	ISSRH	yes
				234.35	IW	
D14-006 S100	D14-005	230	30			
D14-005 S100	D14-004	312	30			
D14-022	D14-002	289	42			
D14-002	D14-025	326	42			
D14-025	D14-001	173	42			
D14-001	D14-023	184	42			
D13-003	D13-002	289	30	187.05	IW	yes
D13-002	D13-001	391	42			
D13-001	D13-010	219	42			
C13-010	C13-009	213	30	206.6	IR	yes
C13-009	C13-008	282	30	192.15	IW	yes
				272.25	ID	yes
C13-008	C13-007	328	42			
C13-005	C13-004	331	30	197.65	IS	yes
				229.9	IW	yes
C13-004	C13-003	507	30	166.1	IW	yes
				174.3	ID	yes
				184.05	CS	yes
				405.45	IW	yes
C13-003	C13-011	240	42			
C13-011	C13-002	455	42	318.3	ISSRH	yes
B12-019 to B12-001 Invert	B12-001	318	54			

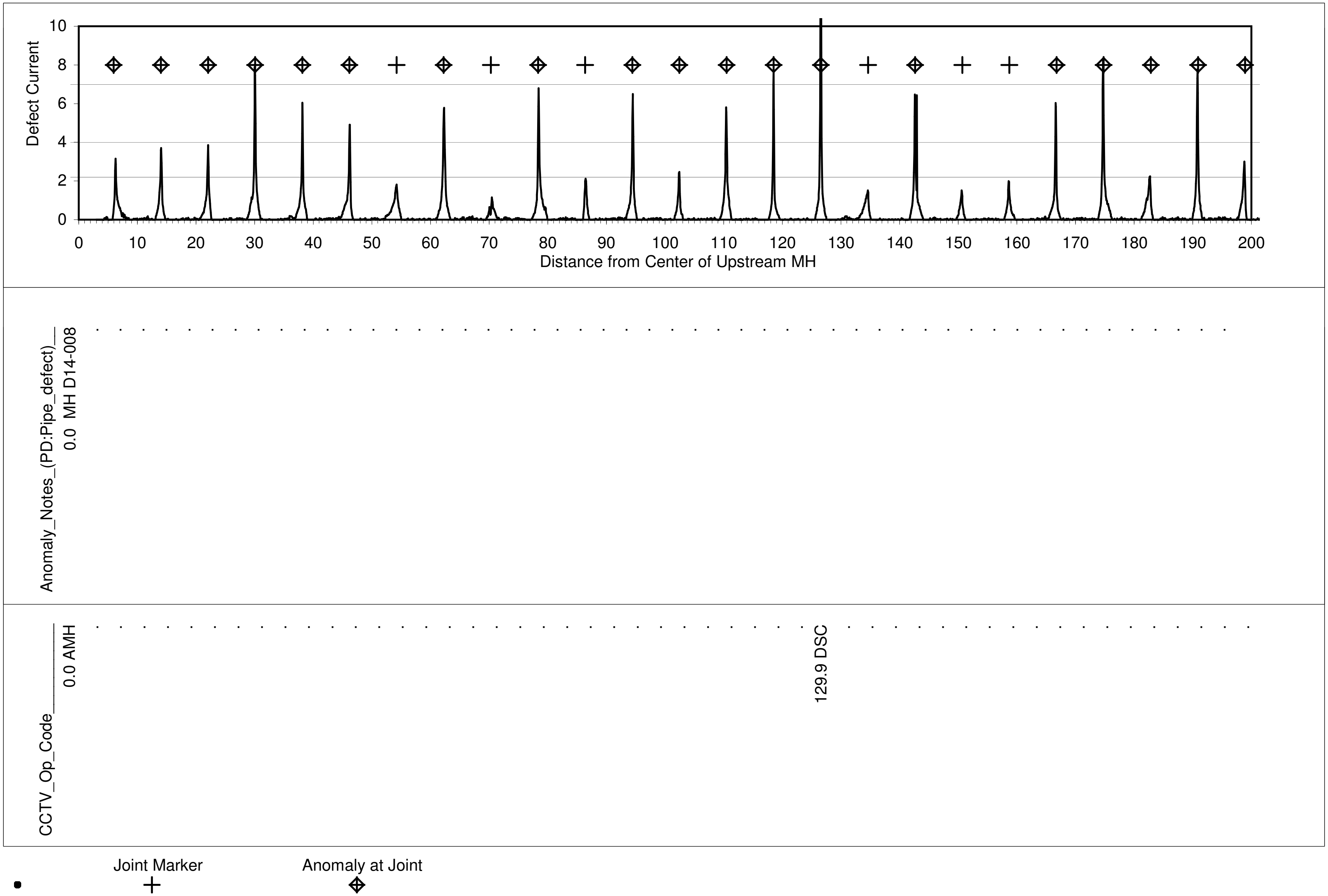
APPENDIX A

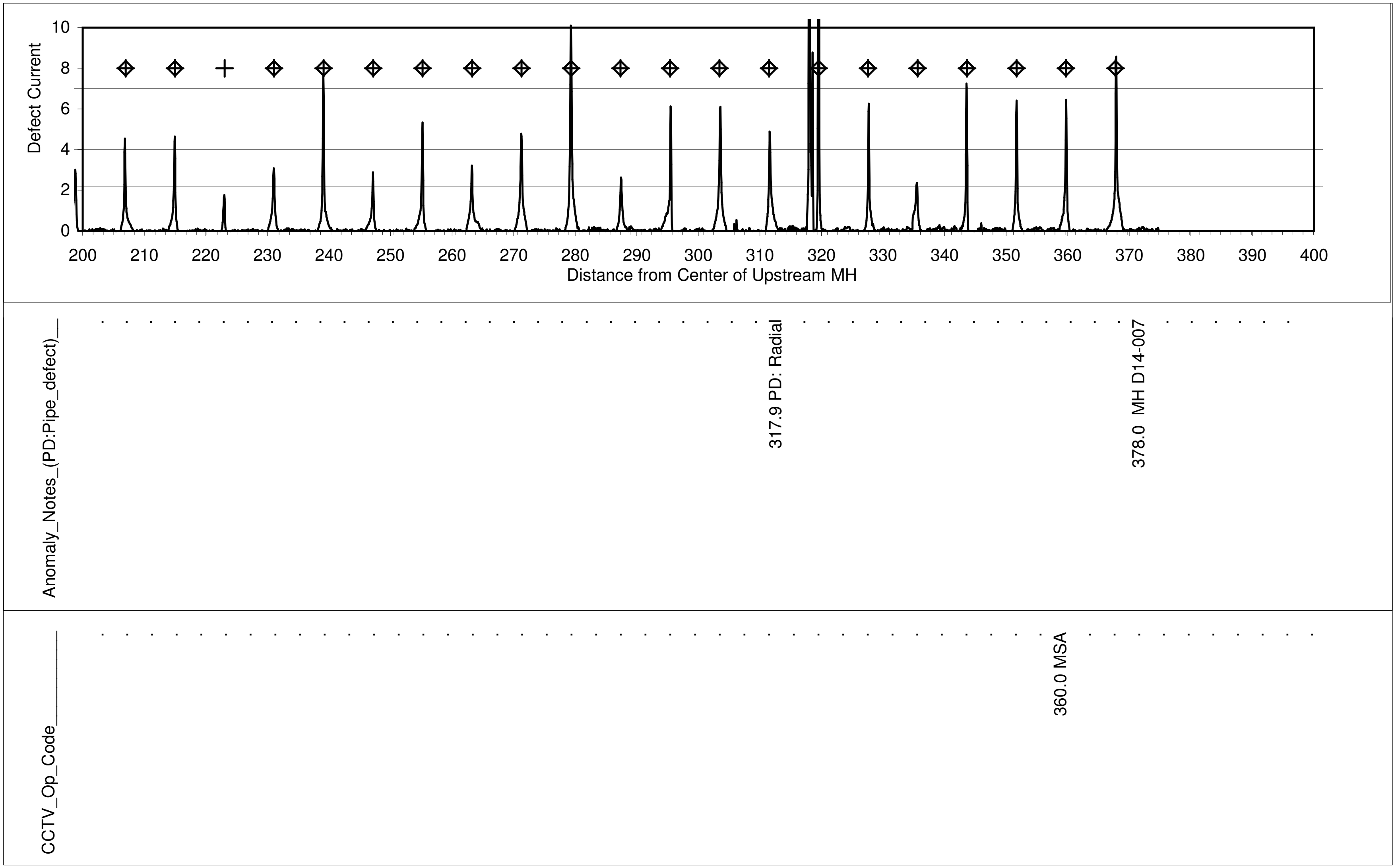
Sewer Electro-Scans - Pipe Full

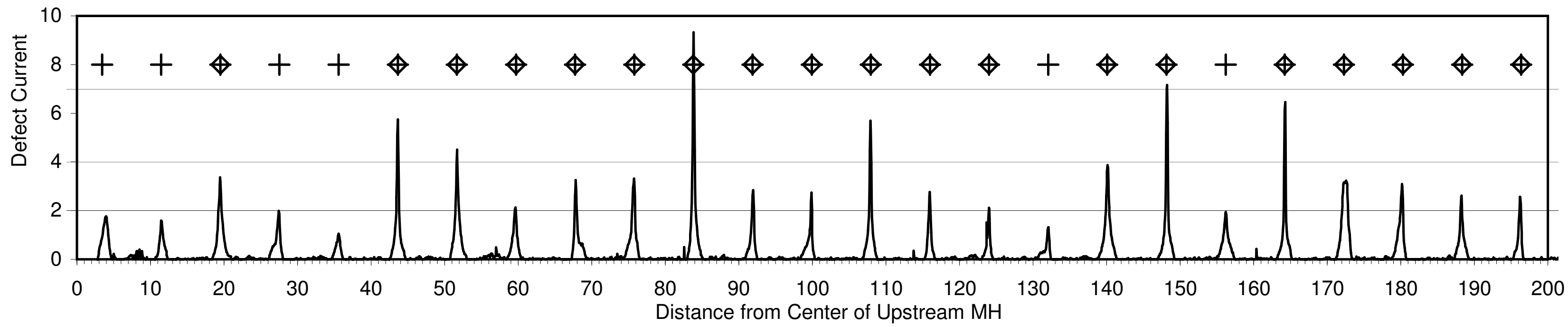
and

CCTV Inspection Logs

(See Addendum)


Defect Current
Distance from Center of Upstream MH
Anomaly_Notes_(PD:Pipe_defect)__
0.0 MH D14-008
CCTV_Op_Code______
0.0 AMH
129.9 DSC
Joint Marker
Anomaly at Joint

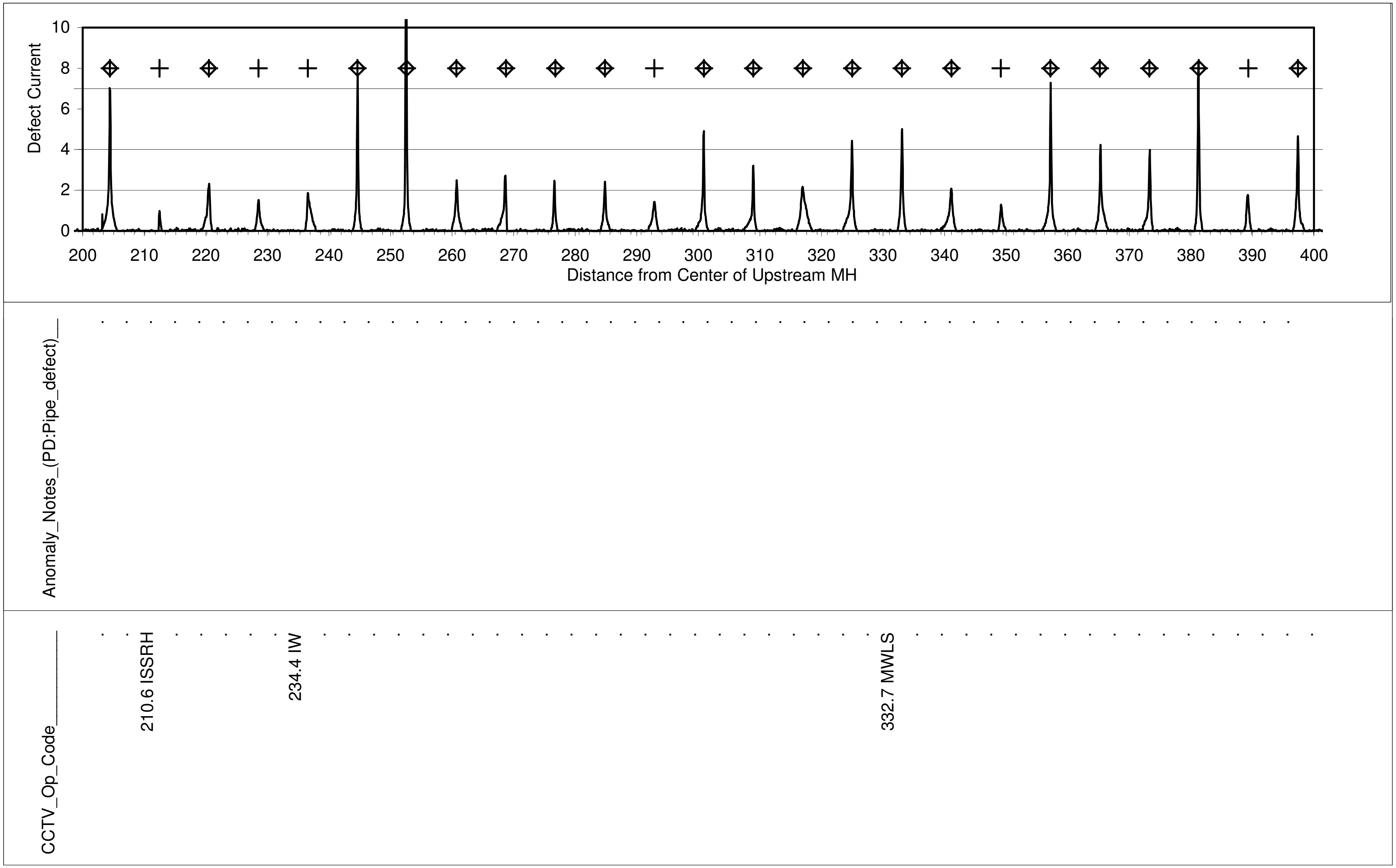

Defect Current
10
8
6
4
2
0
200
210
220
230
240
250
260
270
280
290
300
310
320
330
340
350
360
370
380
390
400
Distance from Center of Upstream MH
Anomaly_Notes_(PD:Pipe_defect)
317.9 PD: Radial
378.0 MH D14-007
CCTV_Op_Code
360.0 MSA

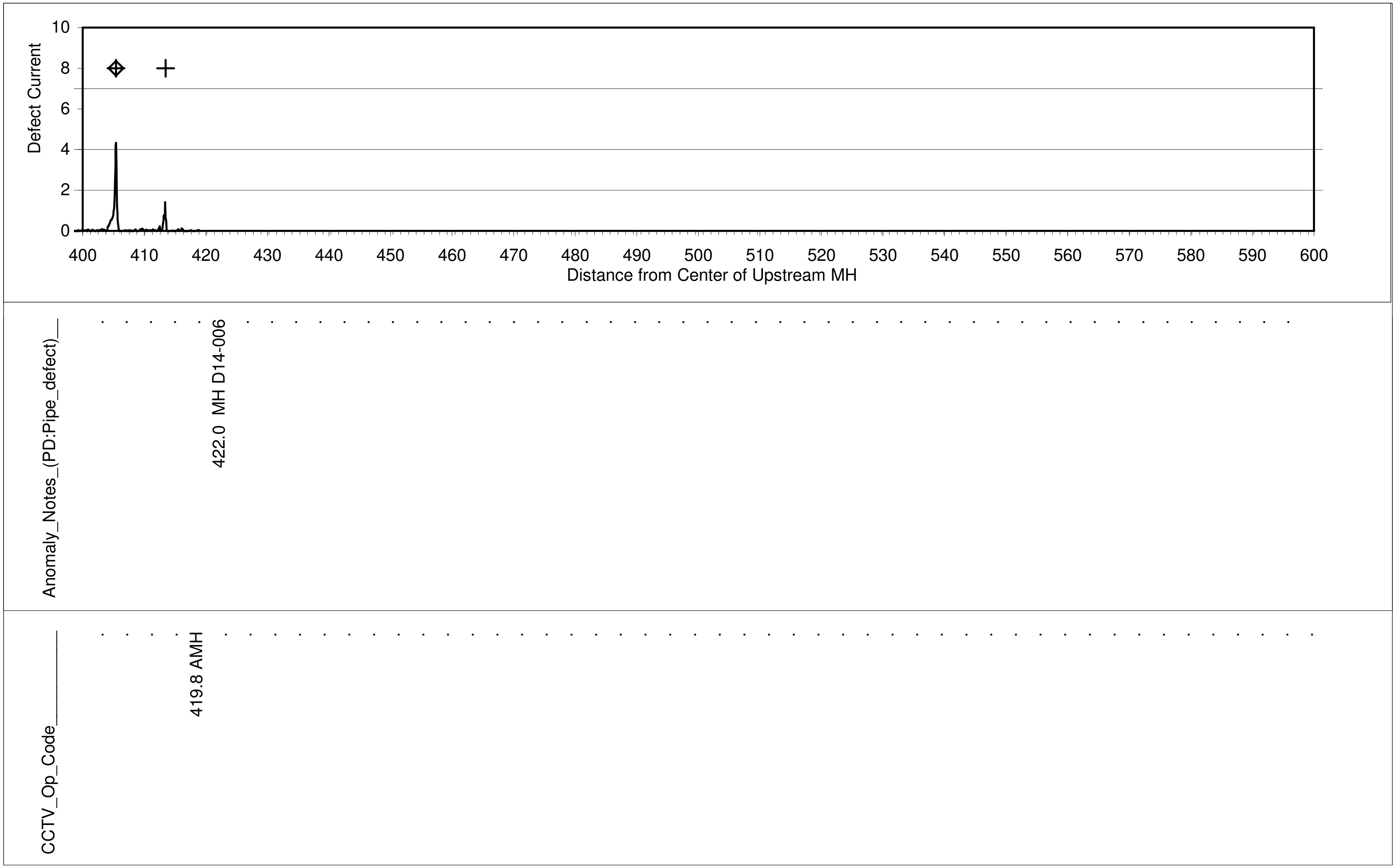


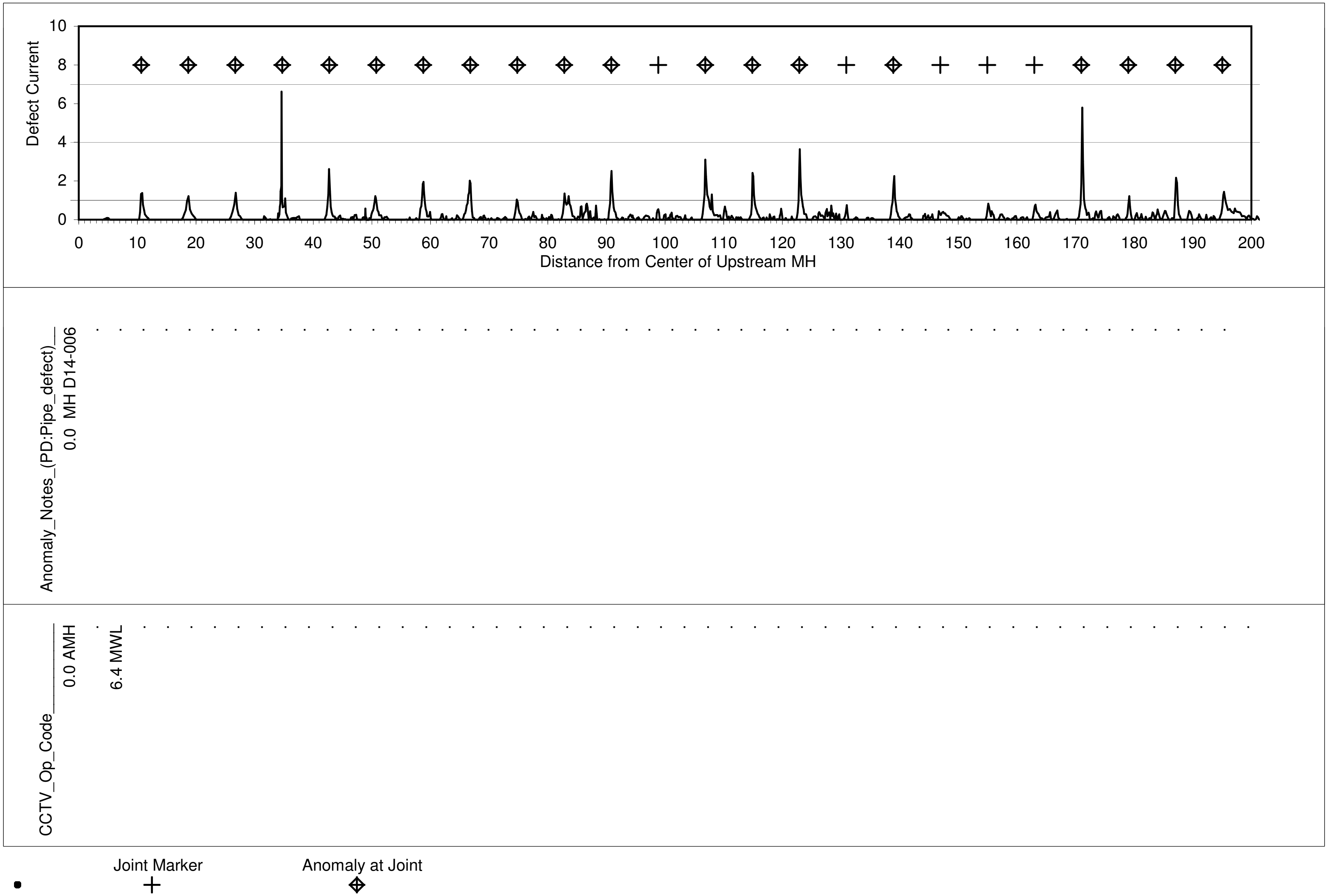
Anomaly_Notes_(PD:Pipe_defect)__
0.0 MH D14-007

CCTV_Op_Code______
2.2 AMH
11.1 MWL
78.9 MWLS

Joint Marker +
Anomaly at Joint ◈


Defect Current
Distance from Center of Upstream MH
0
2
4
6
8
10
200
210
220
230
240
250
260
270
280
290
300
310
320
330
340
350
360
370
380
390
400
Anomaly_Notes_(PD:Pipe_defect)
CCTV_Op_Code
210.6 ISSRH
234.4 IW
332.7 MWLS

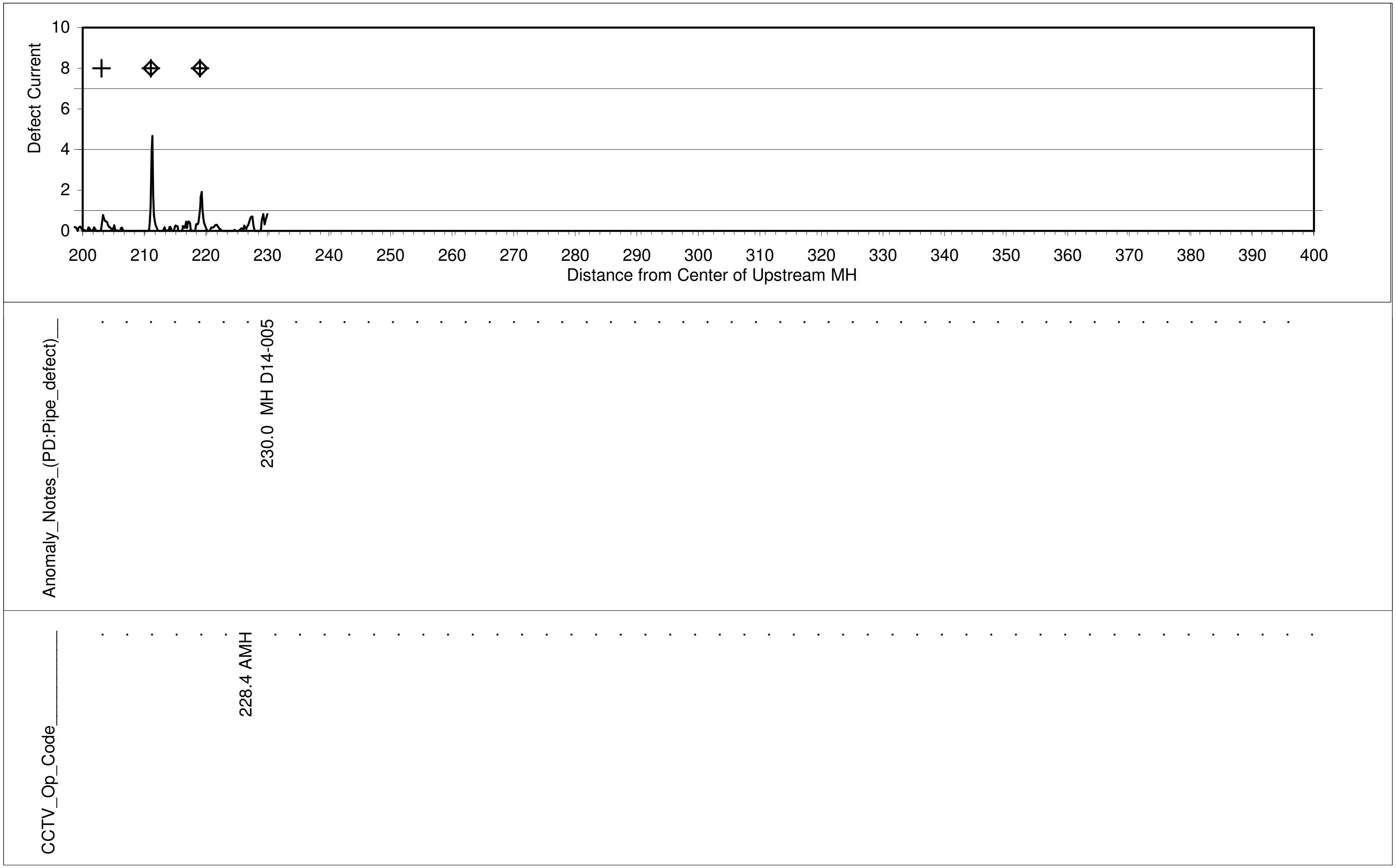

Defect Current
10
8
6
4
2
0
400 410 420 430 440 450 460 470 480 490 500 510 520 530 540 550 560 570 580 590 600
Distance from Center of Upstream MH
Anomaly_Notes_(PD:Pipe_defect)
422.0 MH D14-006
CCTV_Op_Code
419.8 AMH



Scan by: Leak Busters Inc
Job No.: Olathe-01

Utility: City of Olathe

Sewer Name: D14-006 S100


Defect Current
10
8
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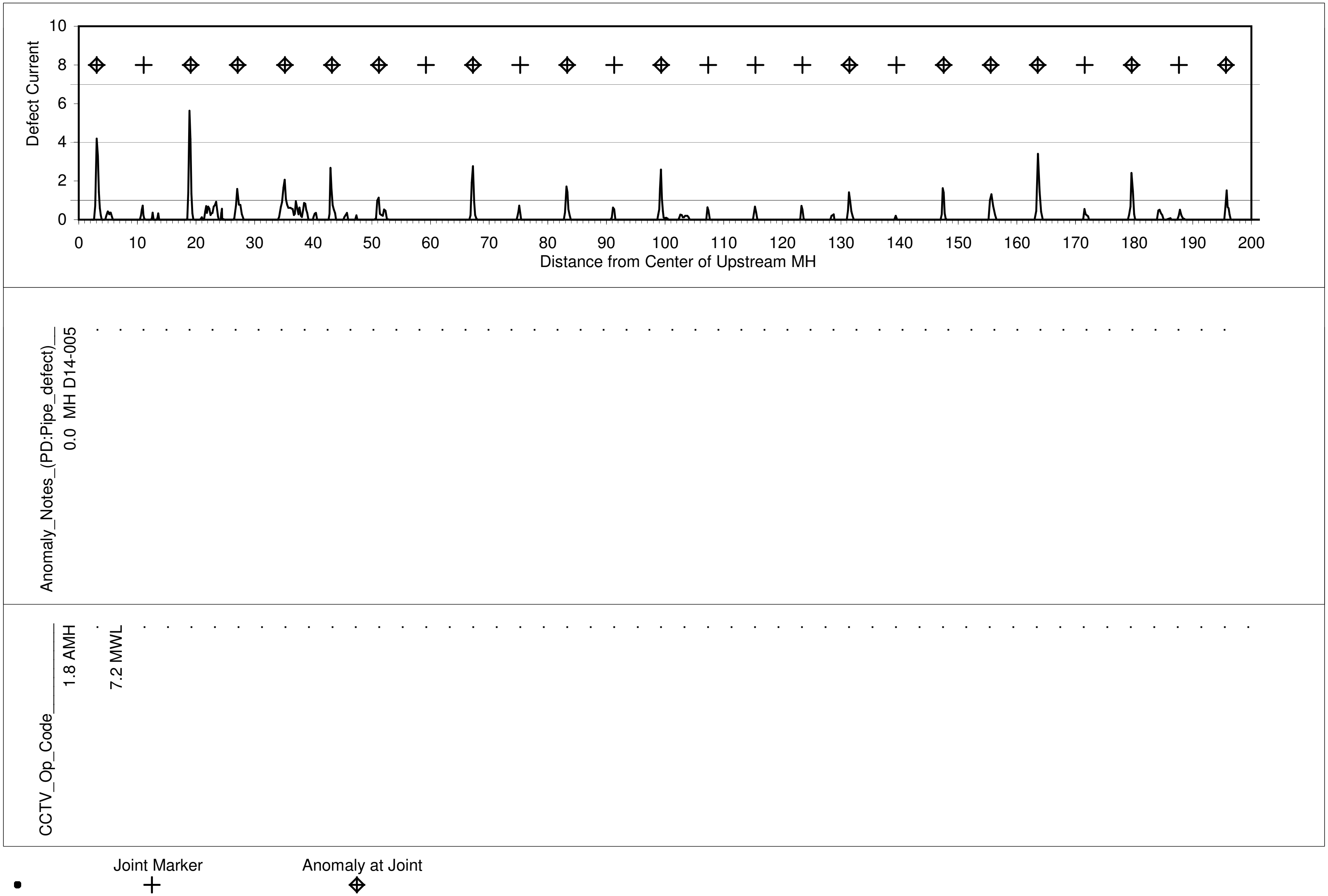
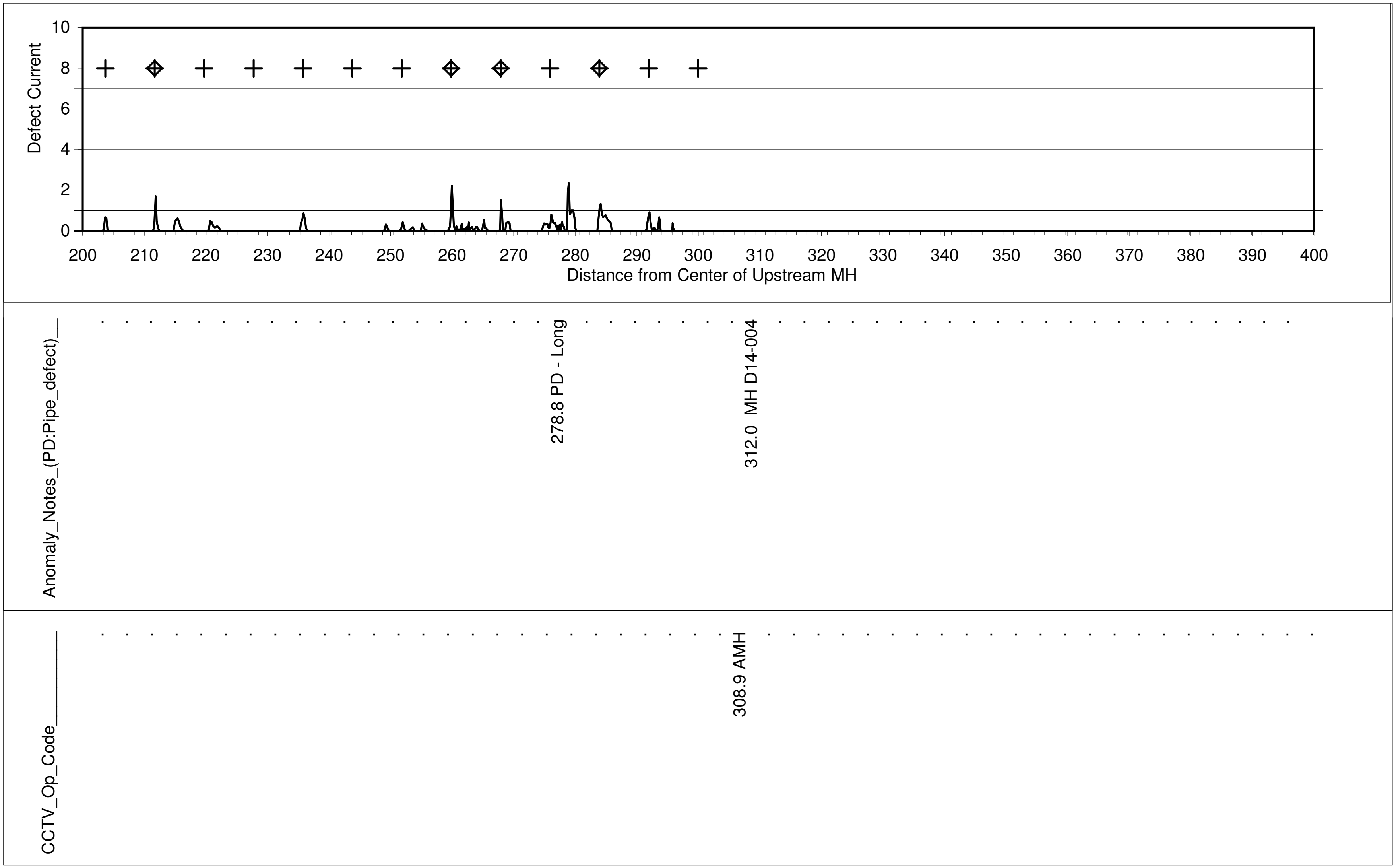
4
2
0
200
210
220
230
240
250
260
270
280
290
300
310
320
330
340
350
360
370
380
390
400
Distance from Center of Upstream MH
Anomaly_Notes_(PD:Pipe_defect)
230.0 MH D14-005
CCTV_Op_Code
228.4 AMH

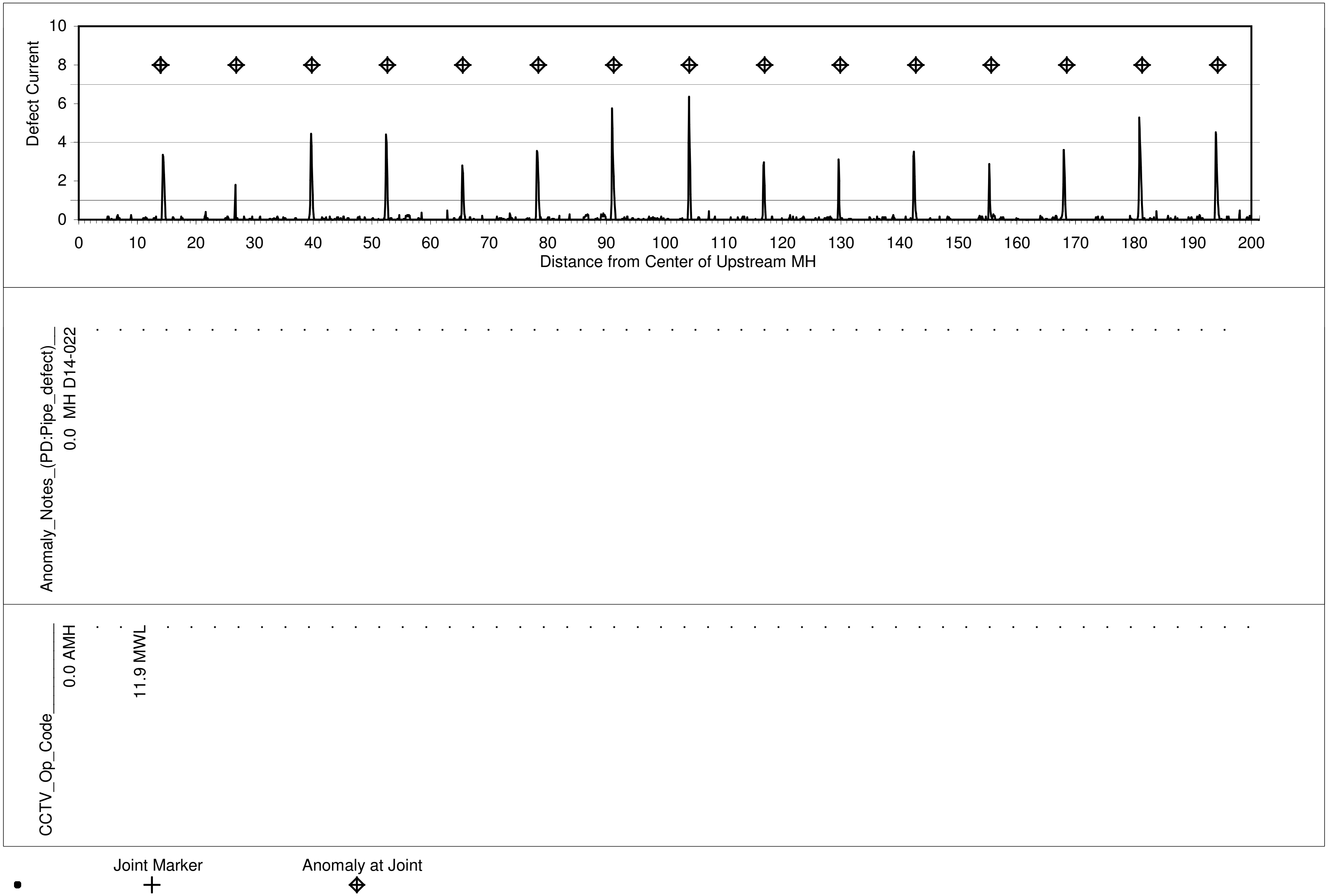

Defect Current
10
8
6
4
2
0
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
Distance from Center of Upstream MH
Anomaly_Notes_(PD:Pipe_defect)__
0.0 MH D14-005
CCTV_Op_Code______
1.8 AMH
7.2 MWL
Joint Marker
Anomaly at Joint


Defect Current
Distance from Center of Upstream MH
Anomaly_Notes_(PD:Pipe_defect)
278.8 PD - Long
312.0 MH D14-004
CCTV_Op_Code
308.9 AMH

SEWER ELECTRO-SCAN
Cedar Creek Stream Crossings

Client: CH2M Hill Reference No.: PO 945755

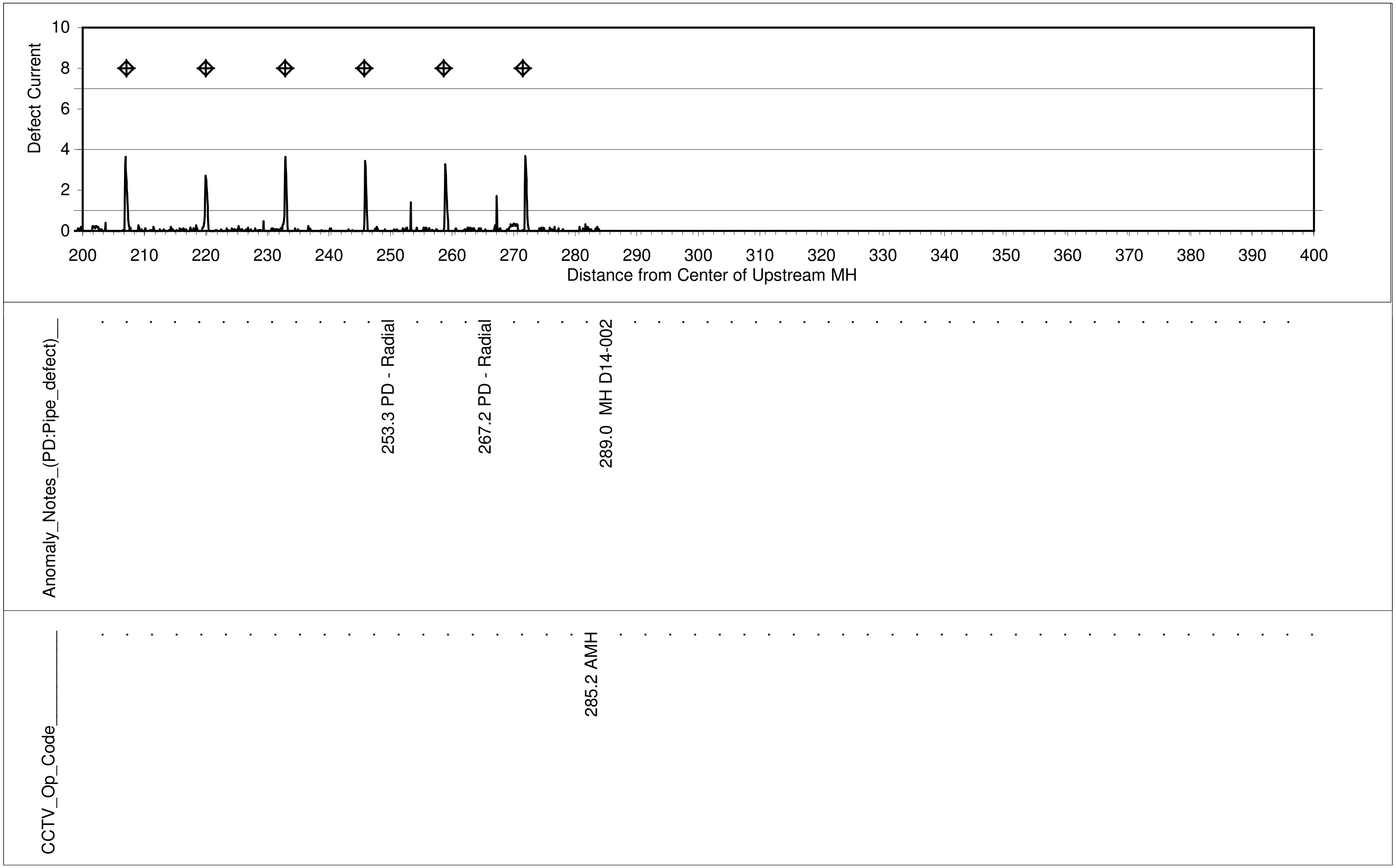
Report Date: 8 Aug 2011



Scan by: Leak Busters Inc
Job No.: Olathe-01

Utility: City of Olathe

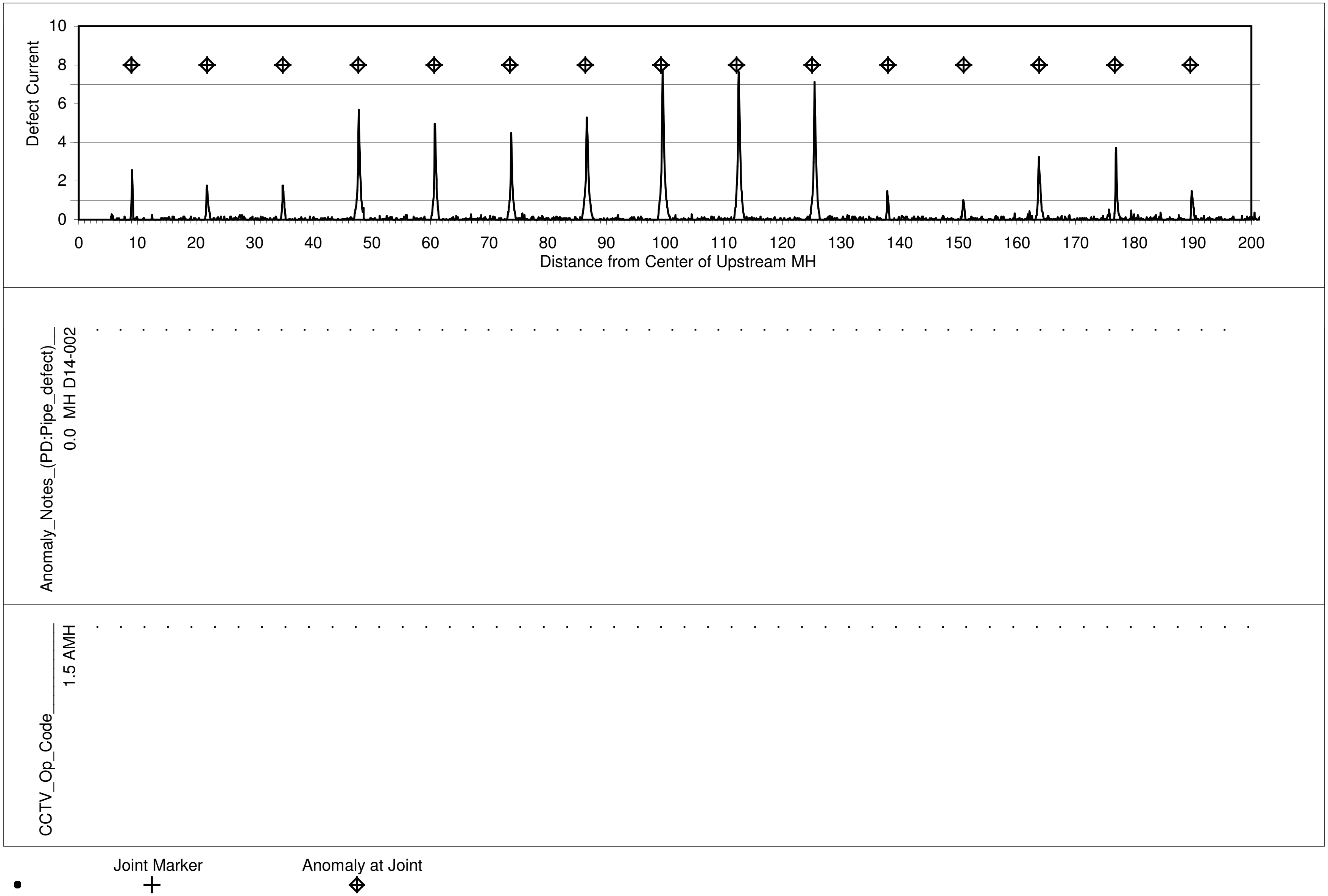
Sewer Name: D14-022


Defect Current
10
8
6
4
2
0
200 210 220 230 240 250 260 270 280 290 300 310 320 330 340 350 360 370 380 390 400
Distance from Center of Upstream MH
Anomaly_Notes_(PD:Pipe_defect)
253.3 PD - Radial
267.2 PD - Radial
289.0 MH D14-002
CCTV_Op_Code
285.2 AMH

SEWER ELECTRO-SCAN
Cedar Creek Stream Crossings

Client: CH2M Hill Reference No.: PO 945755

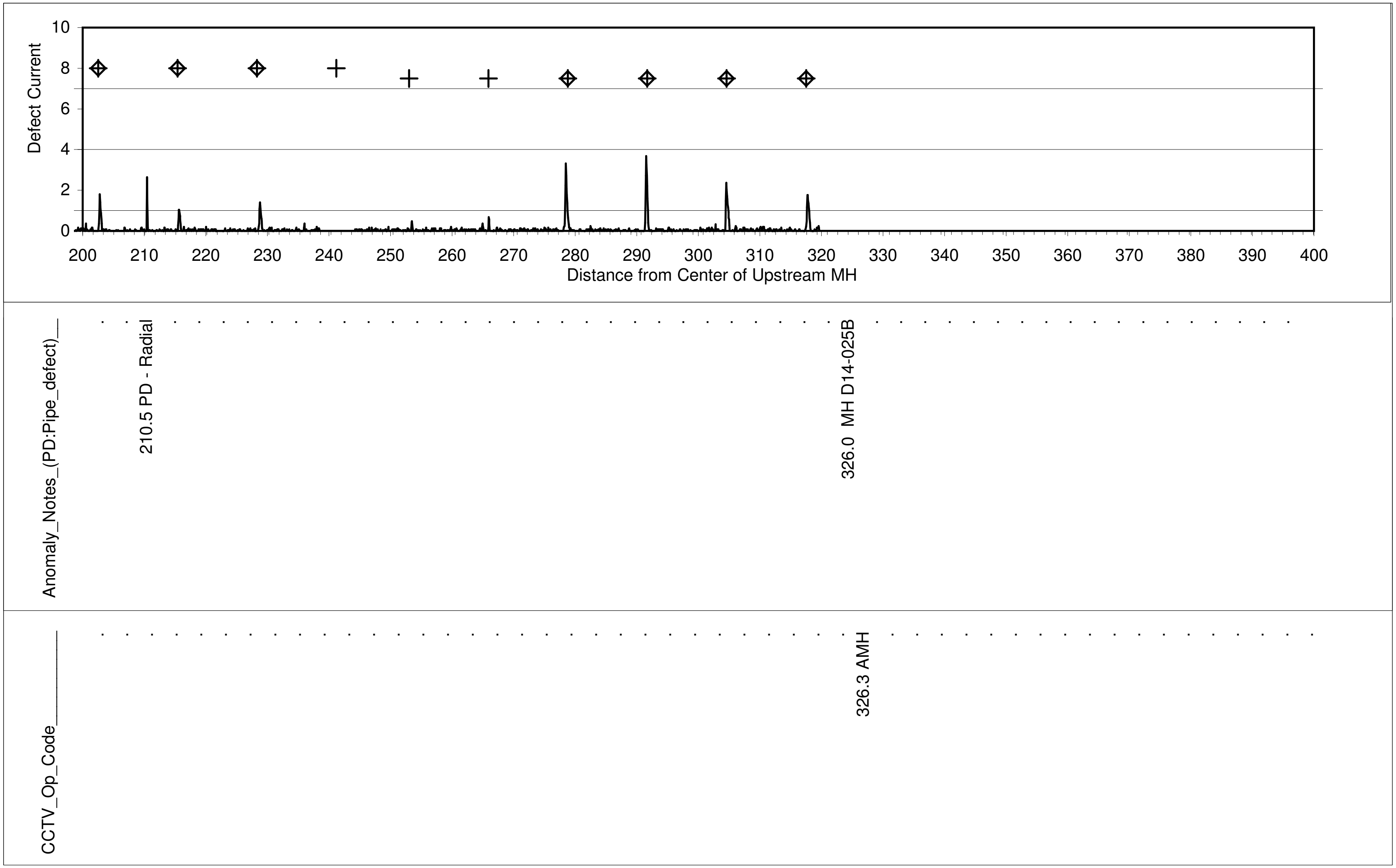
Report Date: 8 Aug 2011



Scan by: Leak Busters Inc
Job No.: Olathe-01

Utility: City of Olathe

Sewer Name: D14-002


10
8
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4
2
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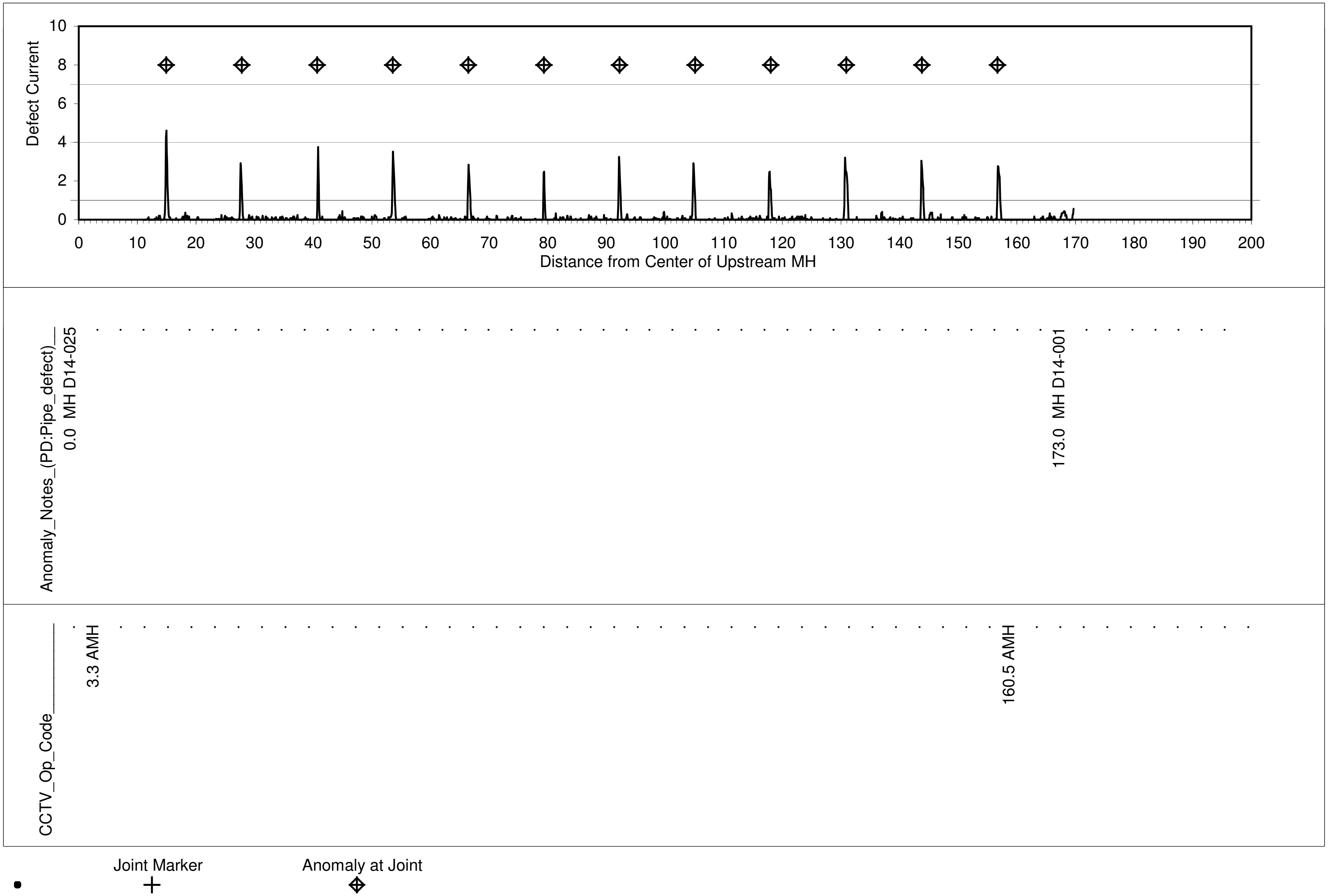
Defect Current
200
210
220
230
240
250
260
270
280
290
300
310
320
330
340
350
360
370
380
390
400
Distance from Center of Upstream MH
Anomaly_Notes_(PD:Pipe_defect)
210.5 PD - Radial
326.0 MH D14-025B
CCTV_Op_Code
326.3 AMH

SEWER ELECTRO-SCAN
Cedar Creek Stream Crossings

Client: CH2M Hill Reference No.: PO 945755

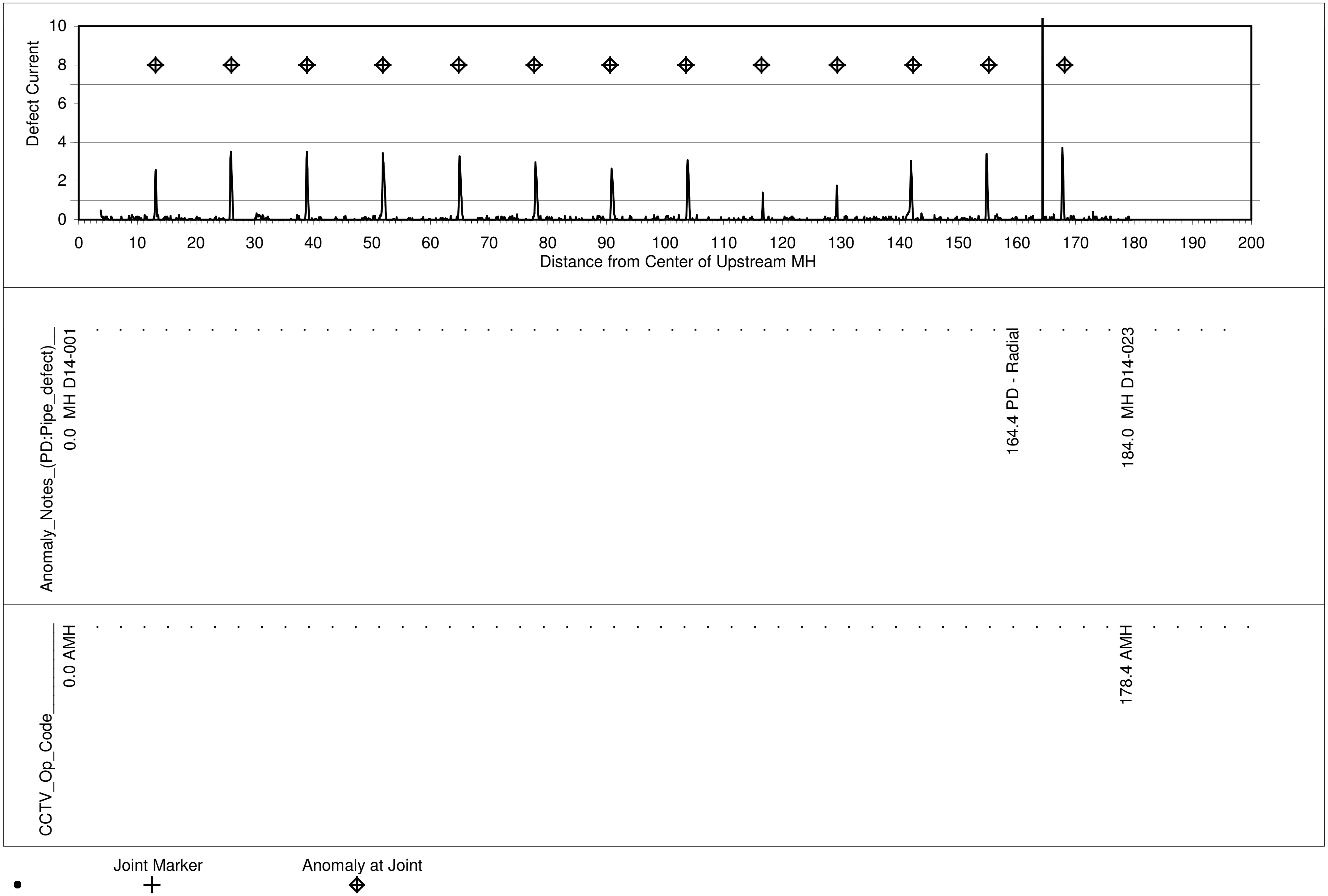
Report Date: 8 Aug 2011



Scan by: Leak Busters Inc
Job No.: Olathe-01

Utility: City of Olathe

Sewer Name: D14-025



Scan by: Leak Busters Inc
Job No.: Olathe-01

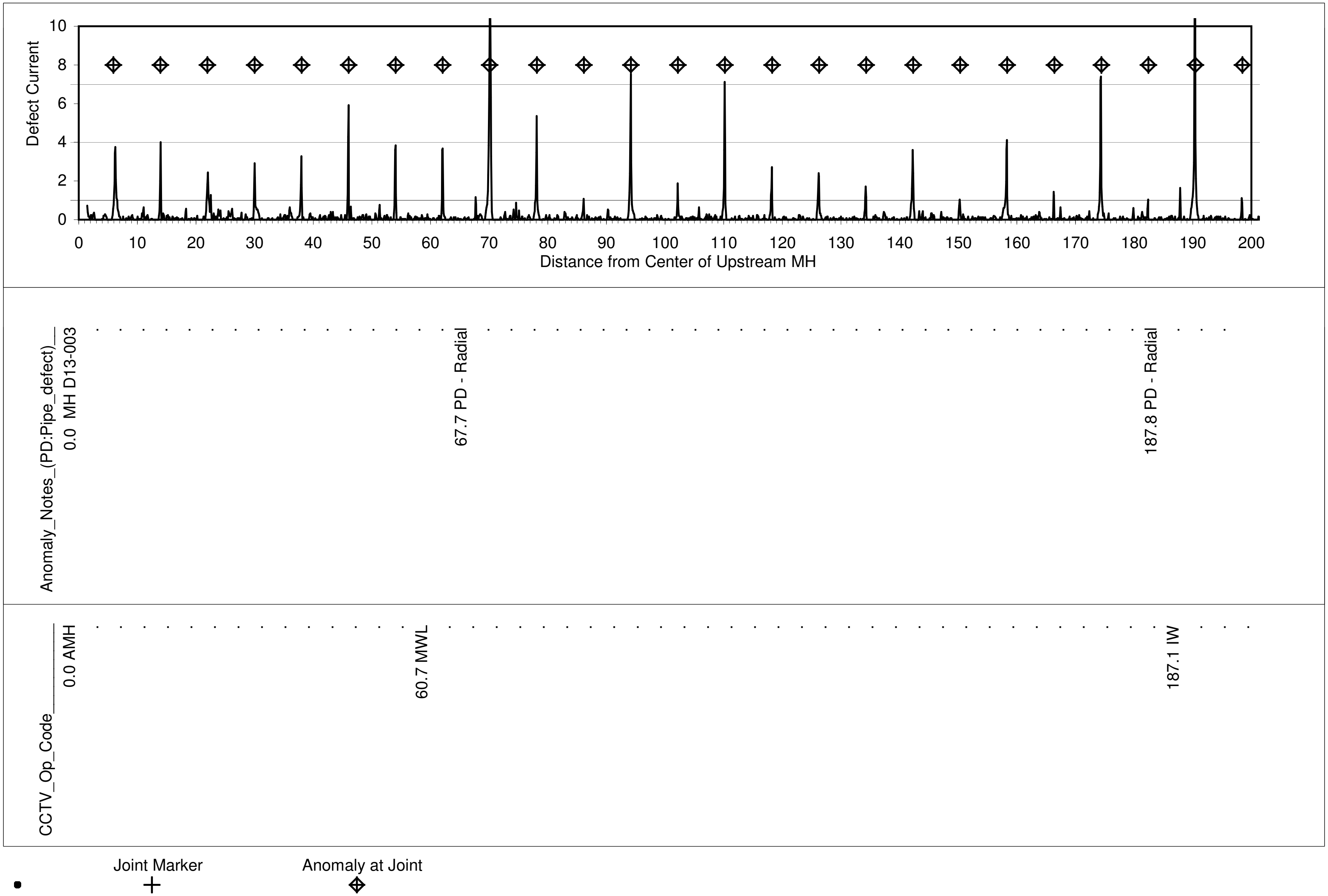
Utility: City of Olathe

Sewer Name: D14-001

SEWER ELECTRO-SCAN
Cedar Creek Stream Crossings

Client: CH2M Hill Reference No.: PO 945755

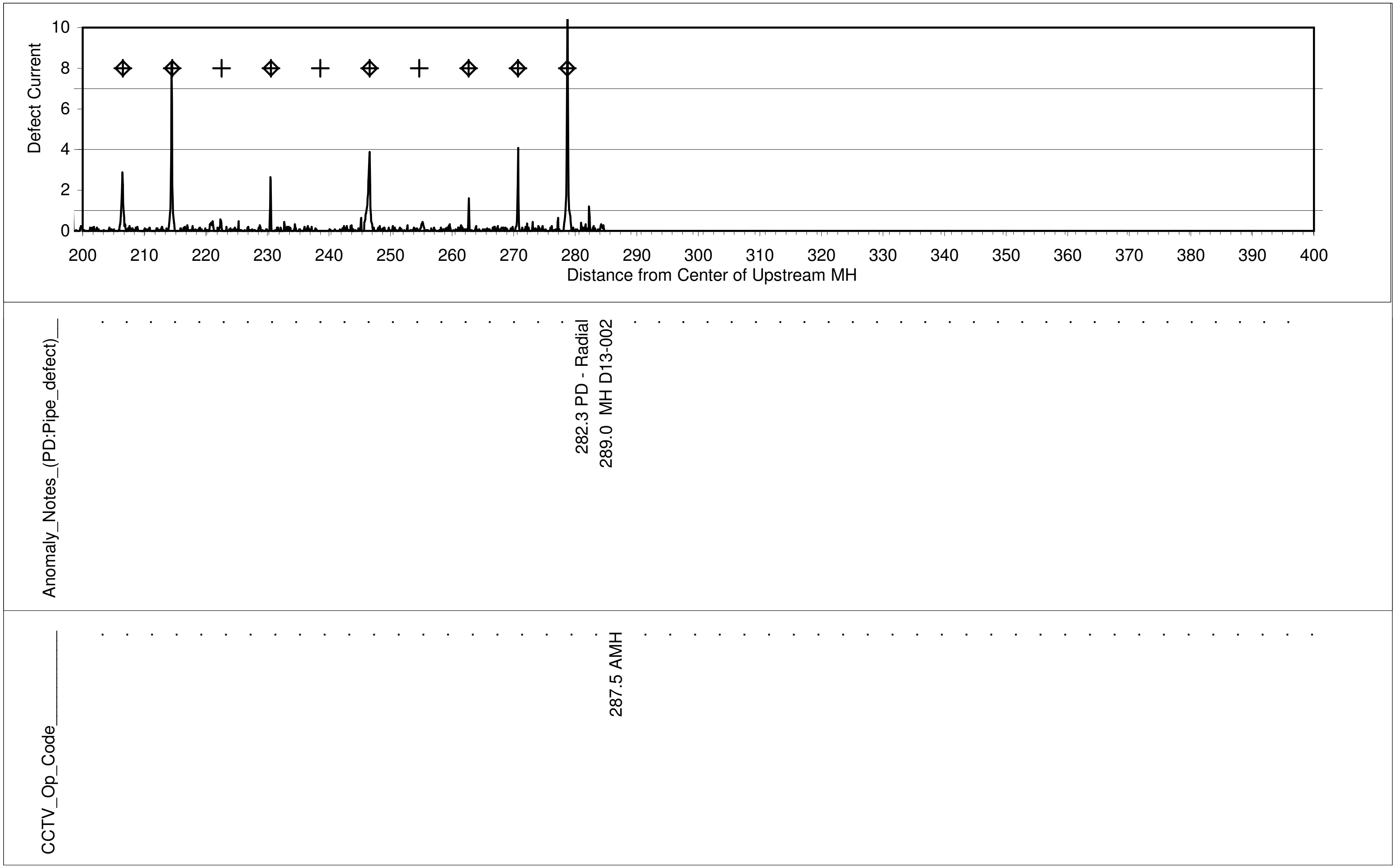
Report Date: 8 Aug 2011



Scan by: Leak Busters Inc
Job No.: Olathe-01

Utility: City of Olathe

Sewer Name: D13-003


Defect Current
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200
210
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230
240
250
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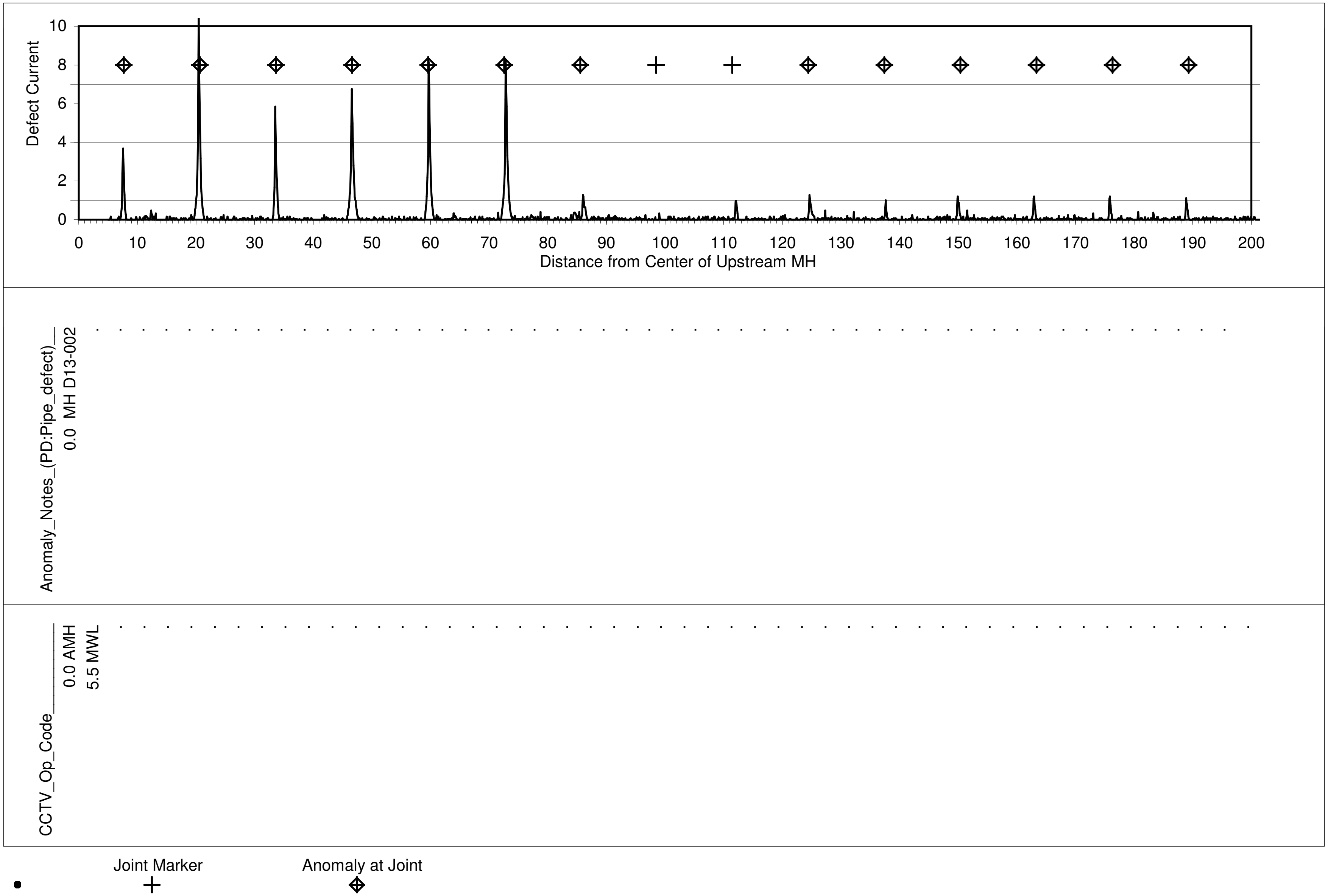
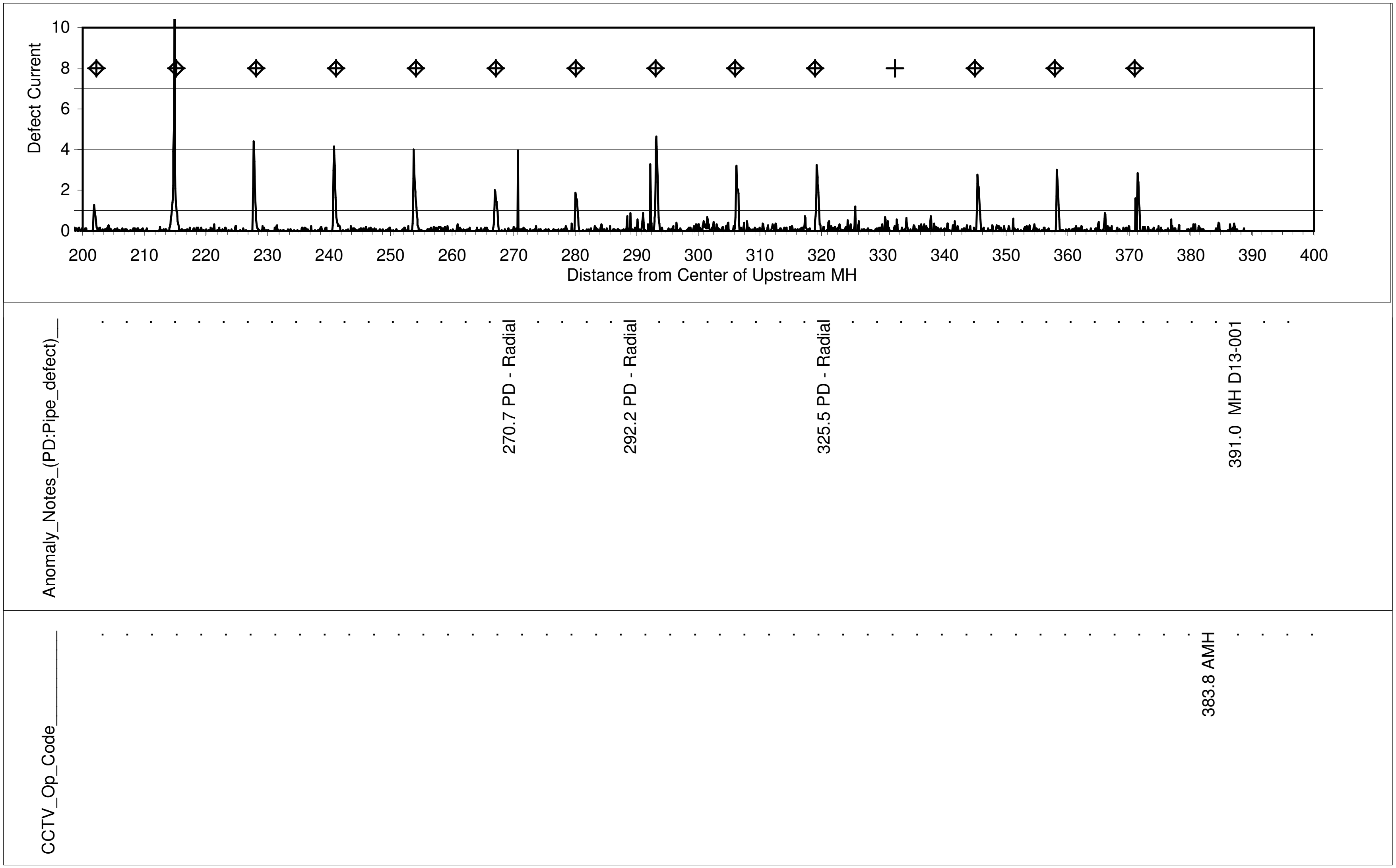
280
290
300
310
320
330
340
350
360
370
380
390
400
Distance from Center of Upstream MH
Anomaly_Notes_(PD:Pipe_defect)
282.3 PD - Radial
289.0 MH D13-002
CCTV_Op_Code
287.5 AMH


Defect Current
10
8
6
4
2
0
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
Distance from Center of Upstream MH
Anomaly_Notes_(PD:Pipe_defect)__
0.0 MH D13-002
CCTV_Op_Code____________
0.0 AMH
5.5 MWL
Joint Marker
Anomaly at Joint


Defect Current
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200
210
220
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240
250
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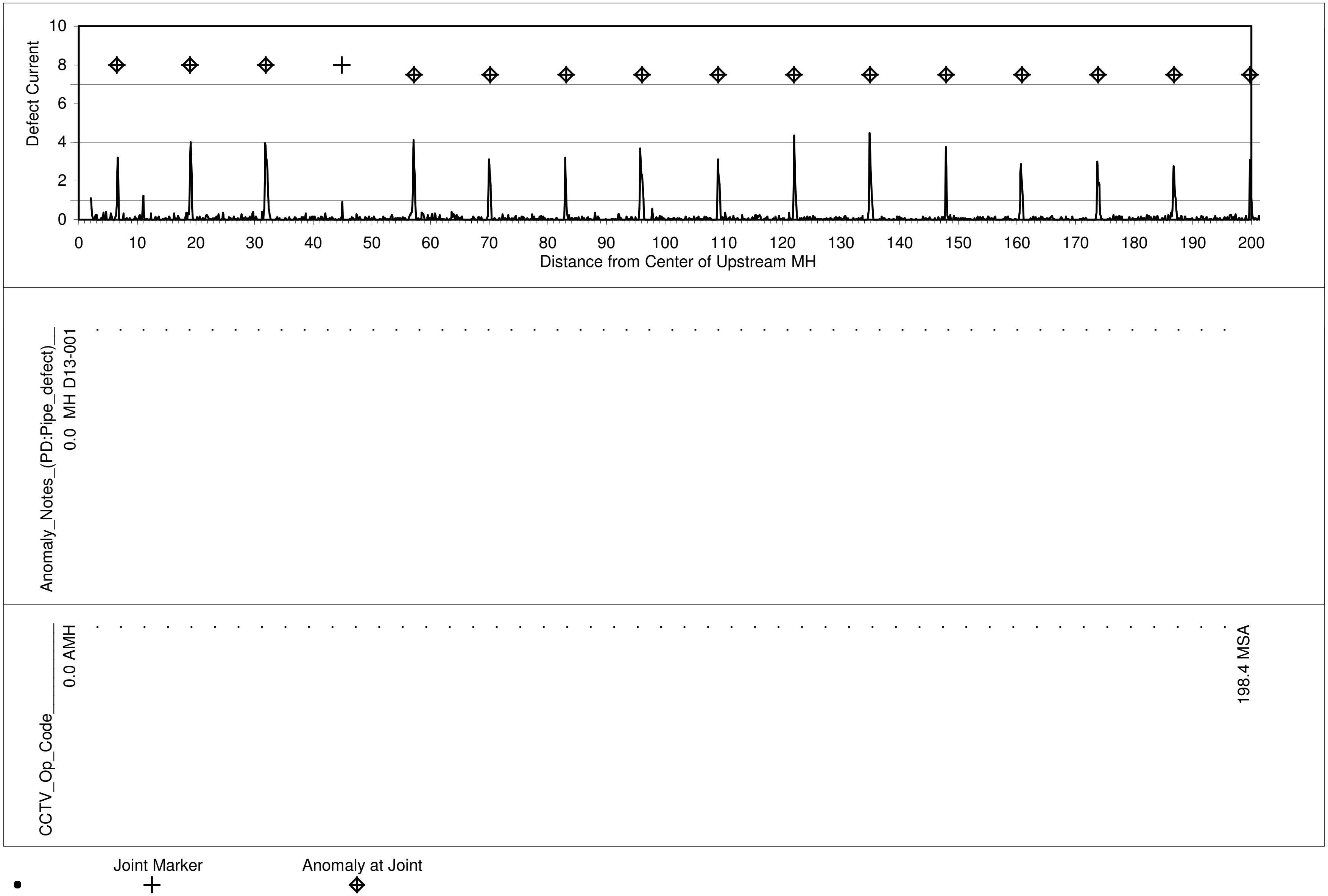
270
280
290
300
310
320
330
340
350
360
370
380
390
400
Distance from Center of Upstream MH
Anomaly_Notes_(PD:Pipe_defect)__
270.7 PD - Radial
292.2 PD - Radial
325.5 PD - Radial
391.0 MH D13-001
CCTV_Op_Code_______
383.8 AMH


Defect Current
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4
2
0
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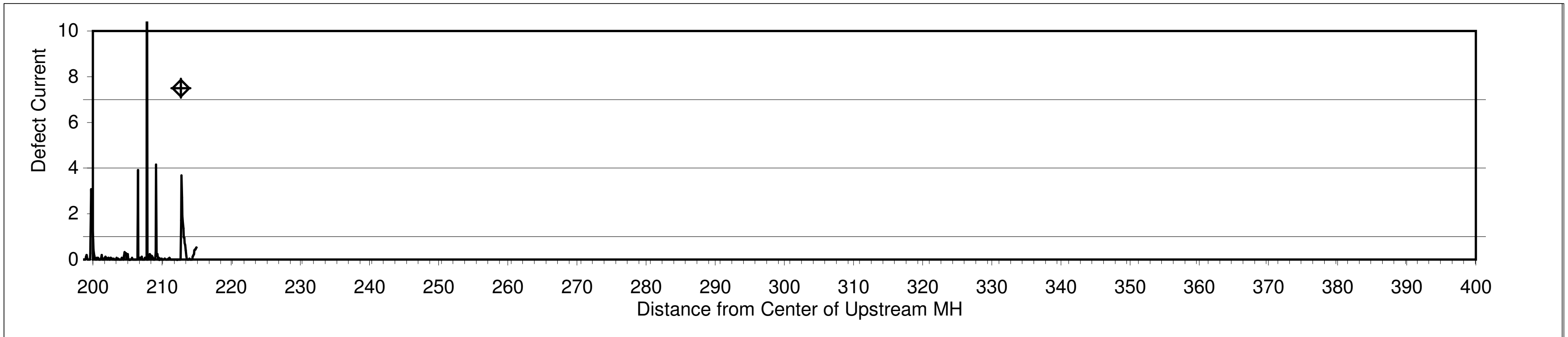
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
Distance from Center of Upstream MH
Anomaly_Notes_(PD:Pipe_defect)__
0.0 MH D13-001
CCTV_Op_Code______
0.0 AMH
198.4 MSA
Joint Marker
Anomaly at Joint


Defect Current
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2
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200
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220
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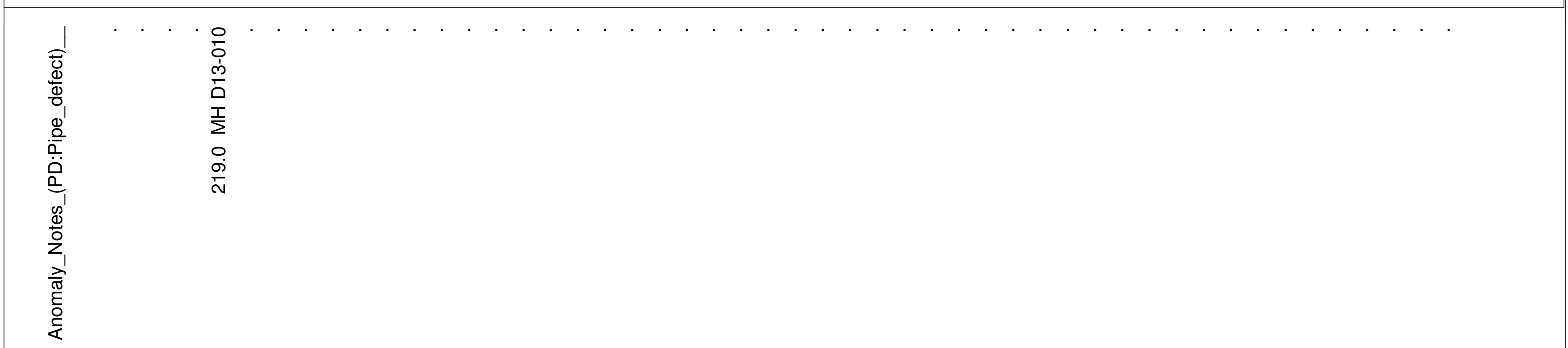
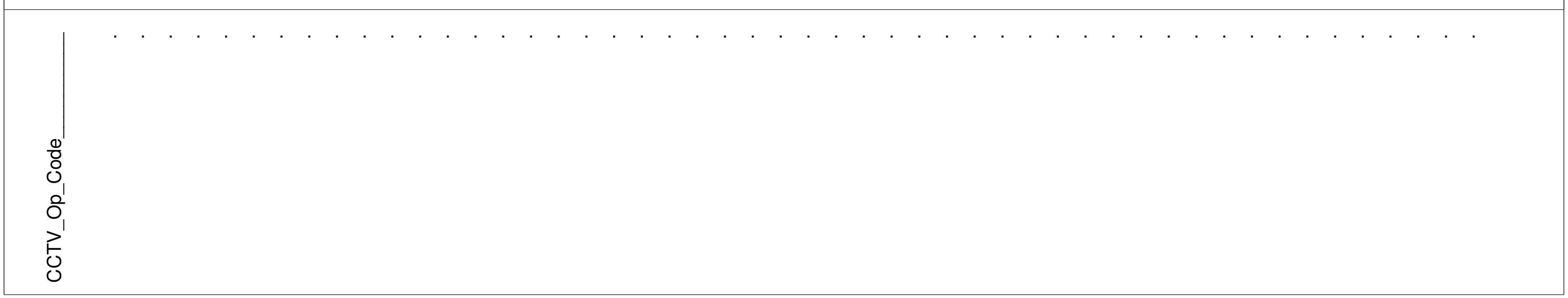
360
370
380
390
400
Distance from Center of Upstream MH

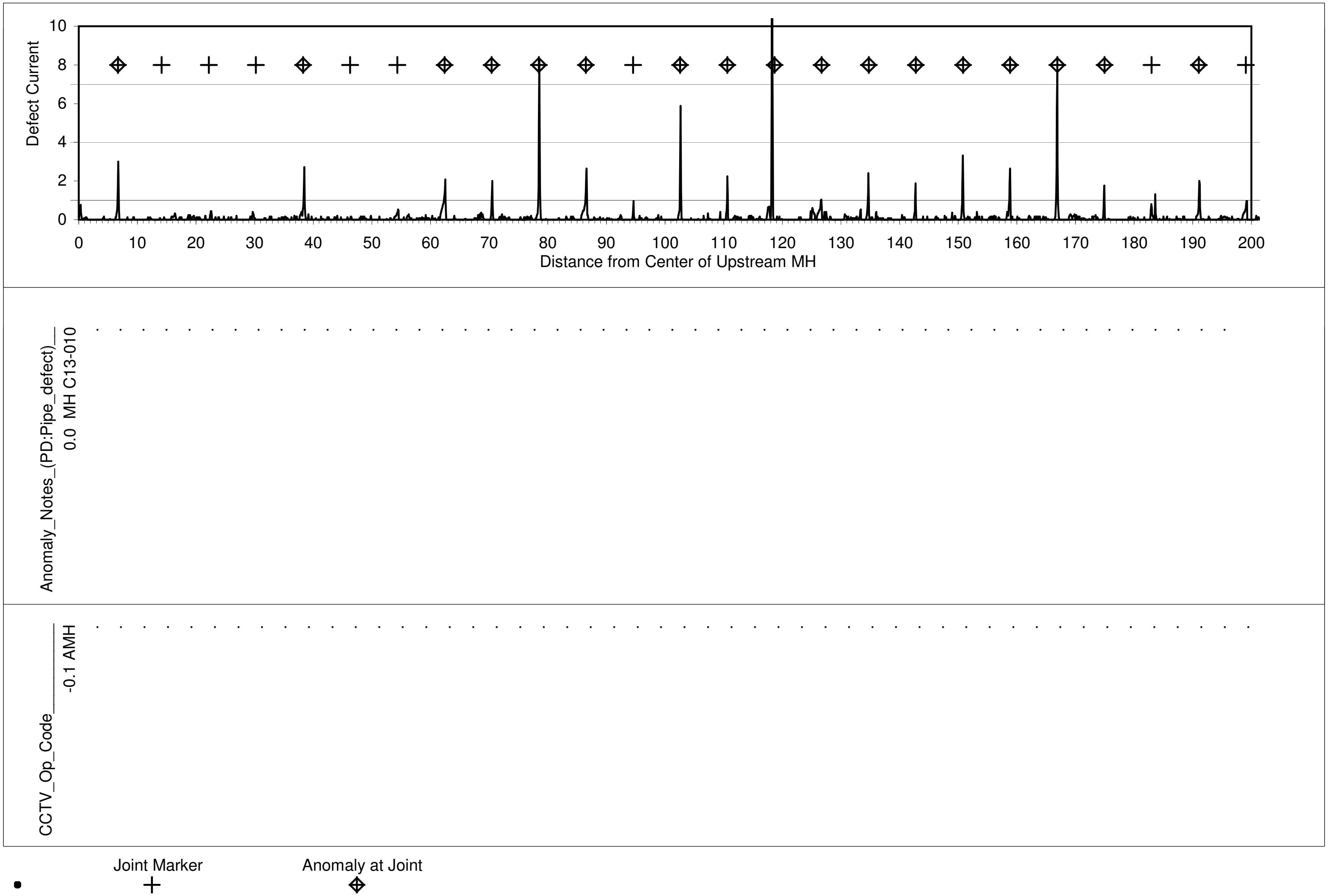

Anomaly_Notes_(PD:Pipe_defect)
219.0 MH D13-010


CCTV_Op_Code

SEWER ELECTRO-SCAN
Cedar Creek Stream Crossings

Client: CH2M Hill Reference No.: PO 945755

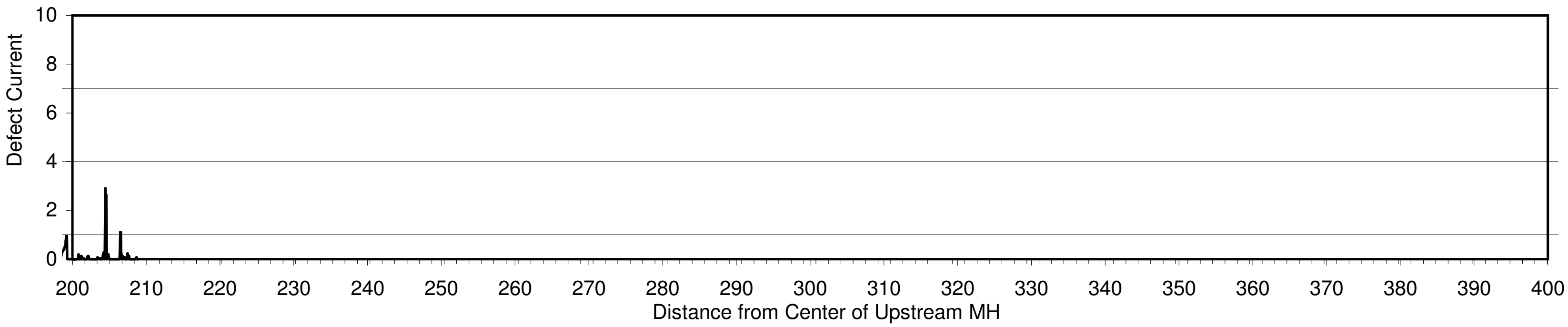
Report Date: 8 Aug 2011



Scan by: Leak Busters Inc
Job No.: Olathe-01

Utility: City of Olathe

Sewer Name: C13-010

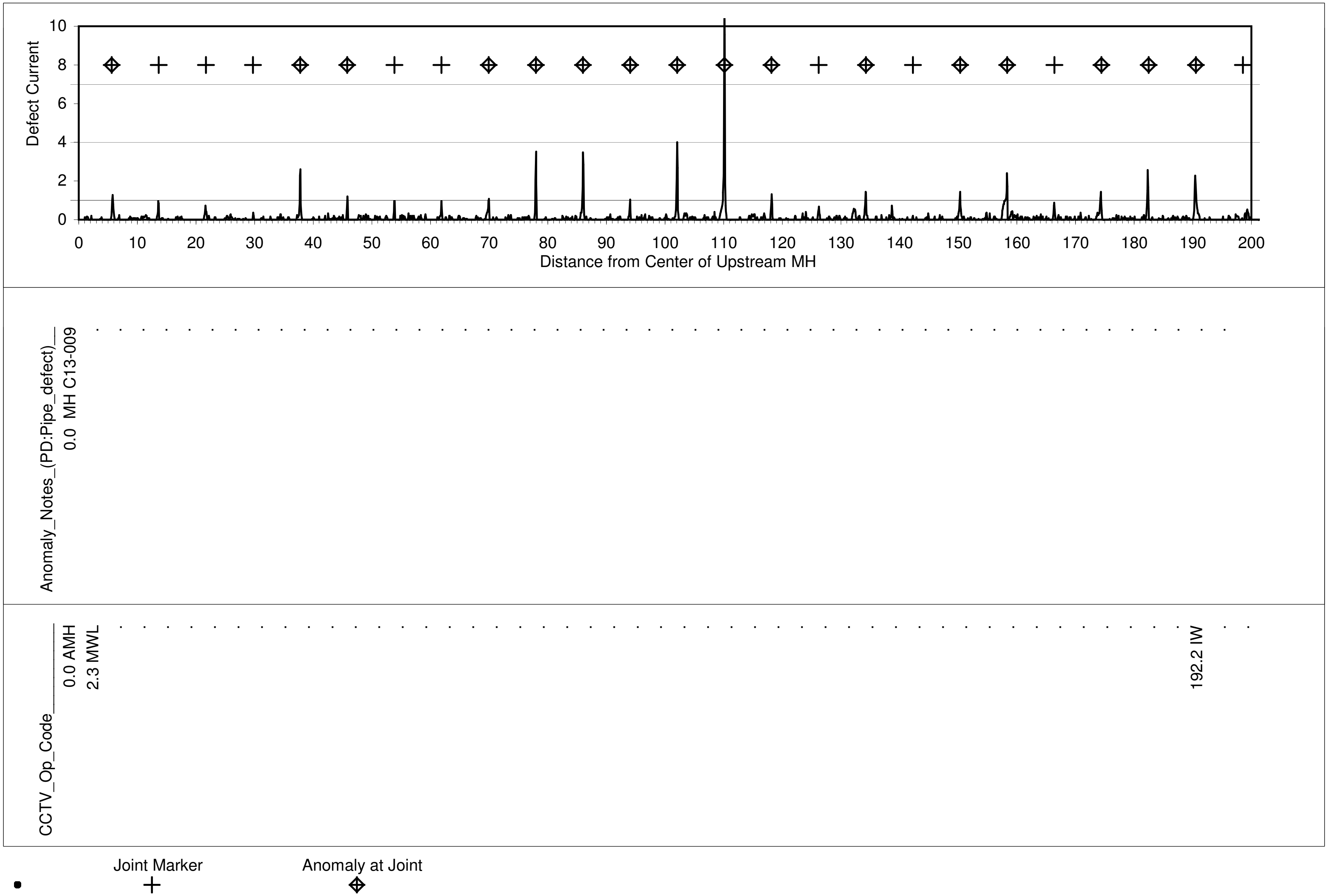


Anomaly_Notes_(PD:Pipe_defect)__

204.5 PD - Radial
206.5 PD - Radial
213.0 MH C13-009

CCTV_Op_Code______

206.6 IR, 208.1 AMH


Defect Current
10
8
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4
2
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0
10
20
30
40
50
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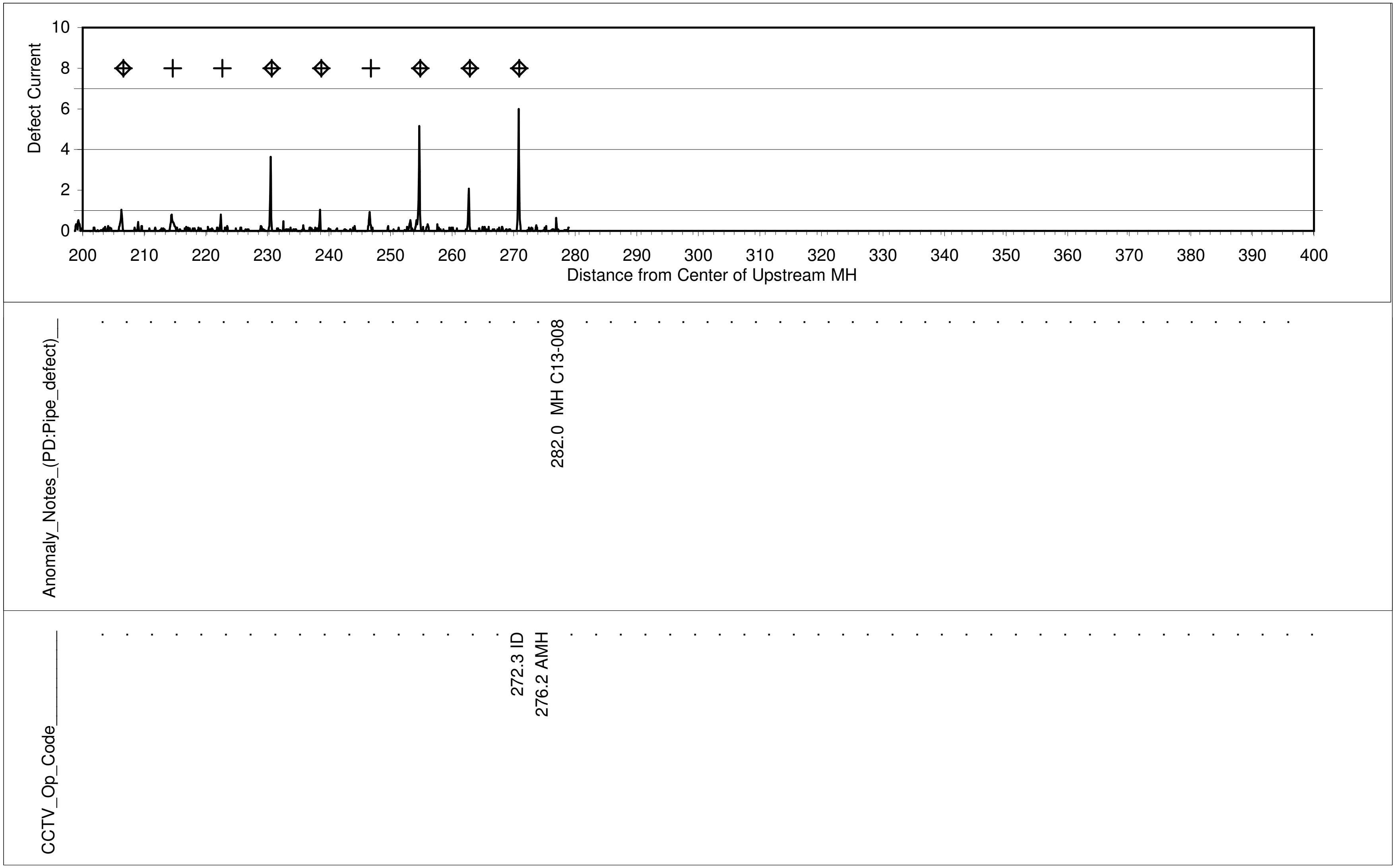
70
80
90
100
110
120
130
140
150
160
170
180
190
200
Distance from Center of Upstream MH
Anomaly_Notes_(PD:Pipe_defect)__
0.0 MH C13-009
CCTV_Op_Code________
0.0 AMH
2.3 MWL
192.2 IW
Joint Marker
Anomaly at Joint


Defect Current
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310
320
330
340
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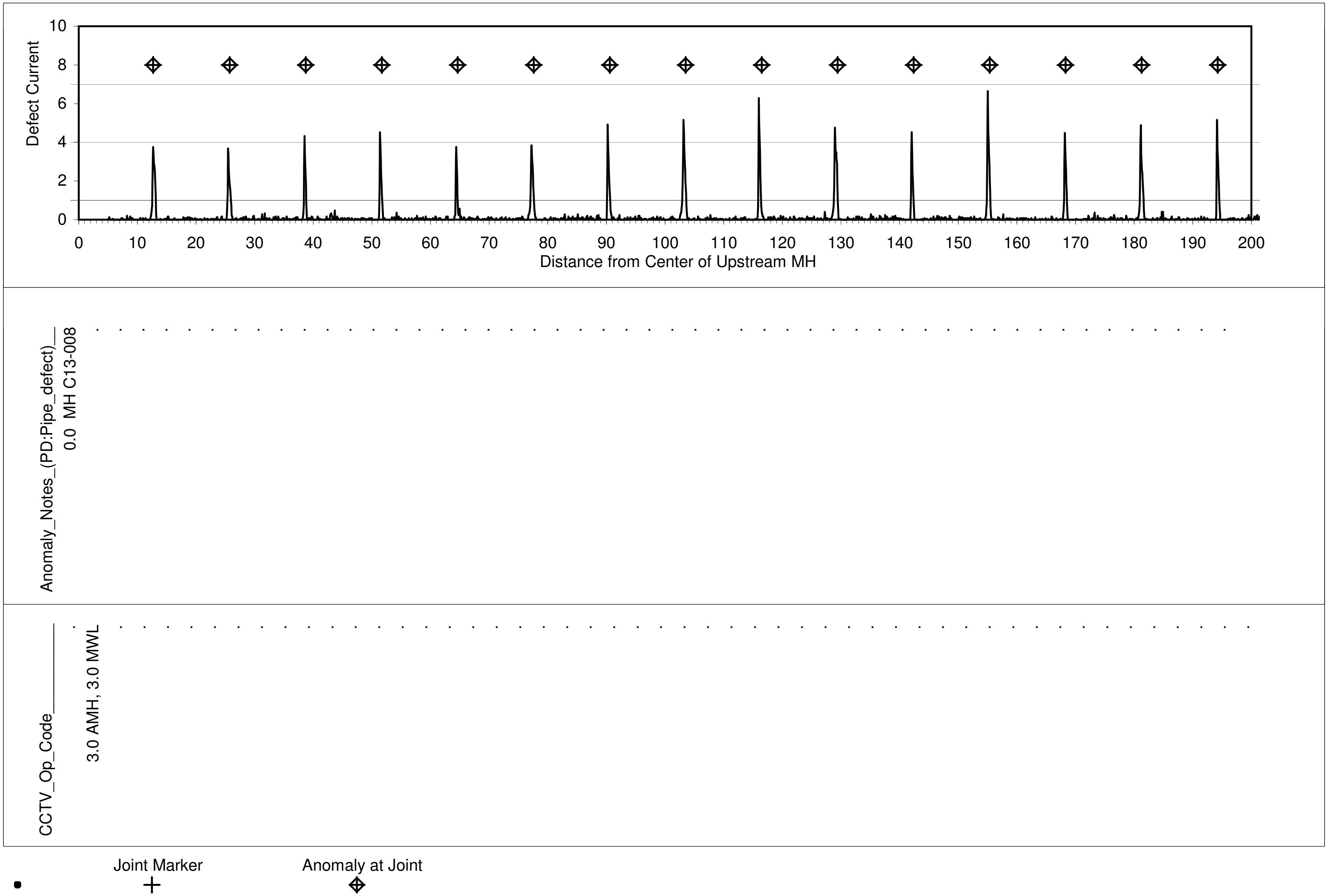
360
370
380
390
400
Distance from Center of Upstream MH
Anomaly_Notes_(PD:Pipe_defect)
282.0 MH C13-008
CCTV_Op_Code
272.3 ID
276.2 AMH

SEWER ELECTRO-SCAN
Cedar Creek Stream Crossings

Client: CH2M Hill Reference No.: PO 945755

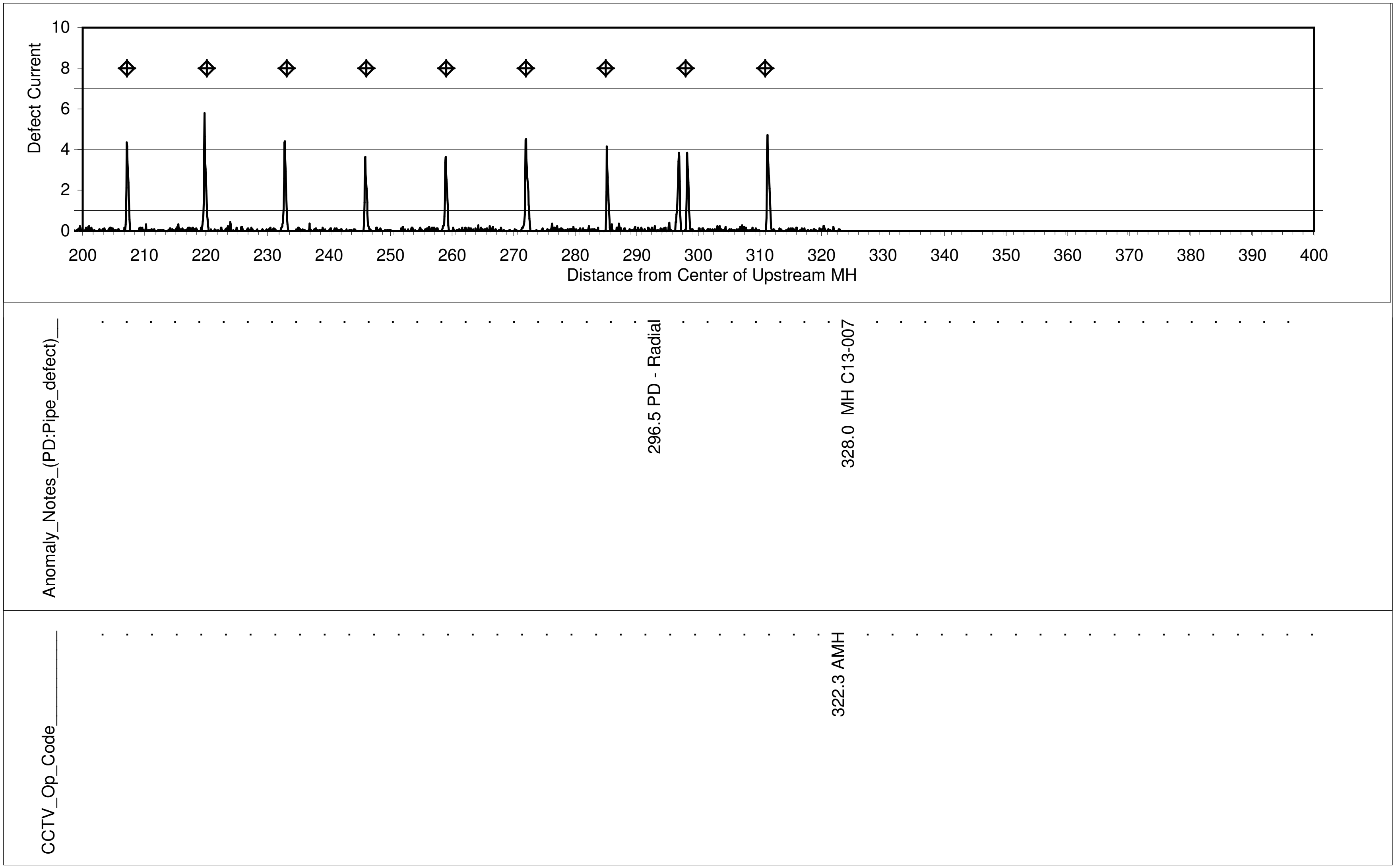
Report Date: 8 Aug 2011



Scan by: Leak Busters Inc
Job No.: Olathe-01

Utility: City of Olathe

Sewer Name: C13-008


Defect Current
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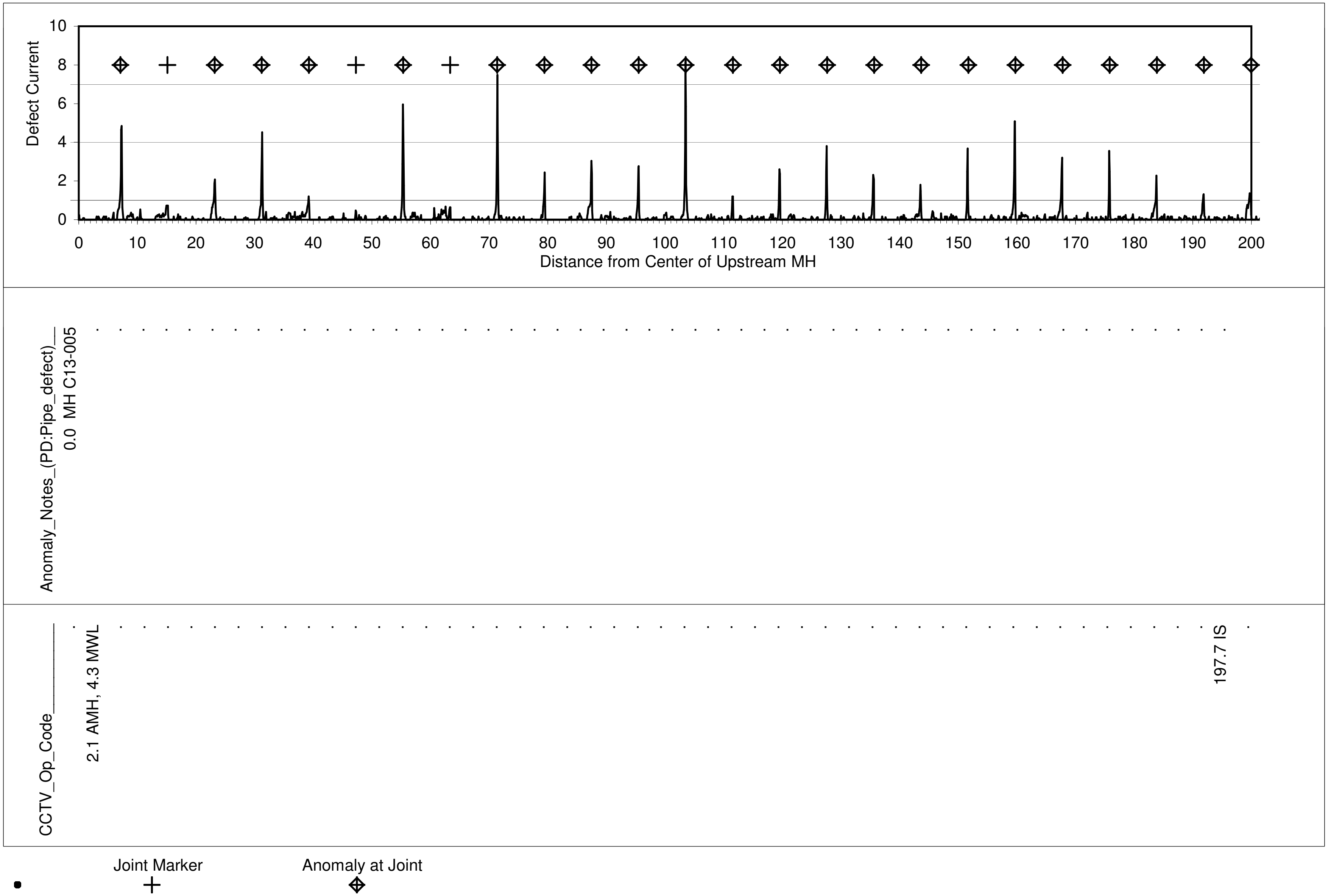
4
2
0
200 210 220 230 240 250 260 270 280 290 300 310 320 330 340 350 360 370 380 390 400
Distance from Center of Upstream MH
Anomaly_Notes_(PD:Pipe_defect)
296.5 PD - Radial
328.0 MH C13-007
CCTV_Op_Code
322.3 AMH


Defect Current
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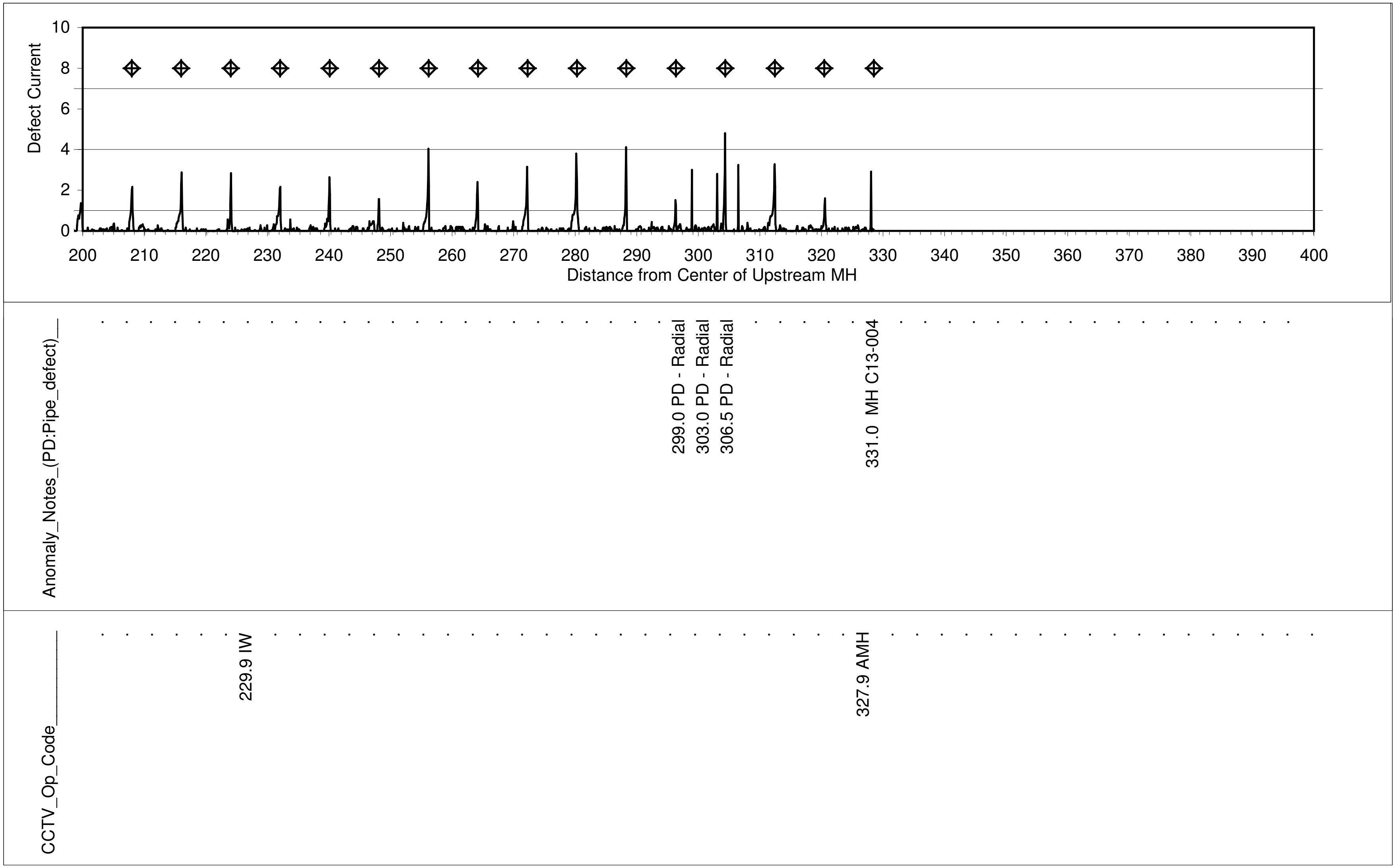
120
130
140
150
160
170
180
190
200
Distance from Center of Upstream MH
Anomaly_Notes_(PD:Pipe_defect)__
0.0 MH C13-005
CCTV_Op_Code________
2.1 AMH, 4.3 MWL
197.7 IS
Joint Marker
Anomaly at Joint


Defect Current
10
8
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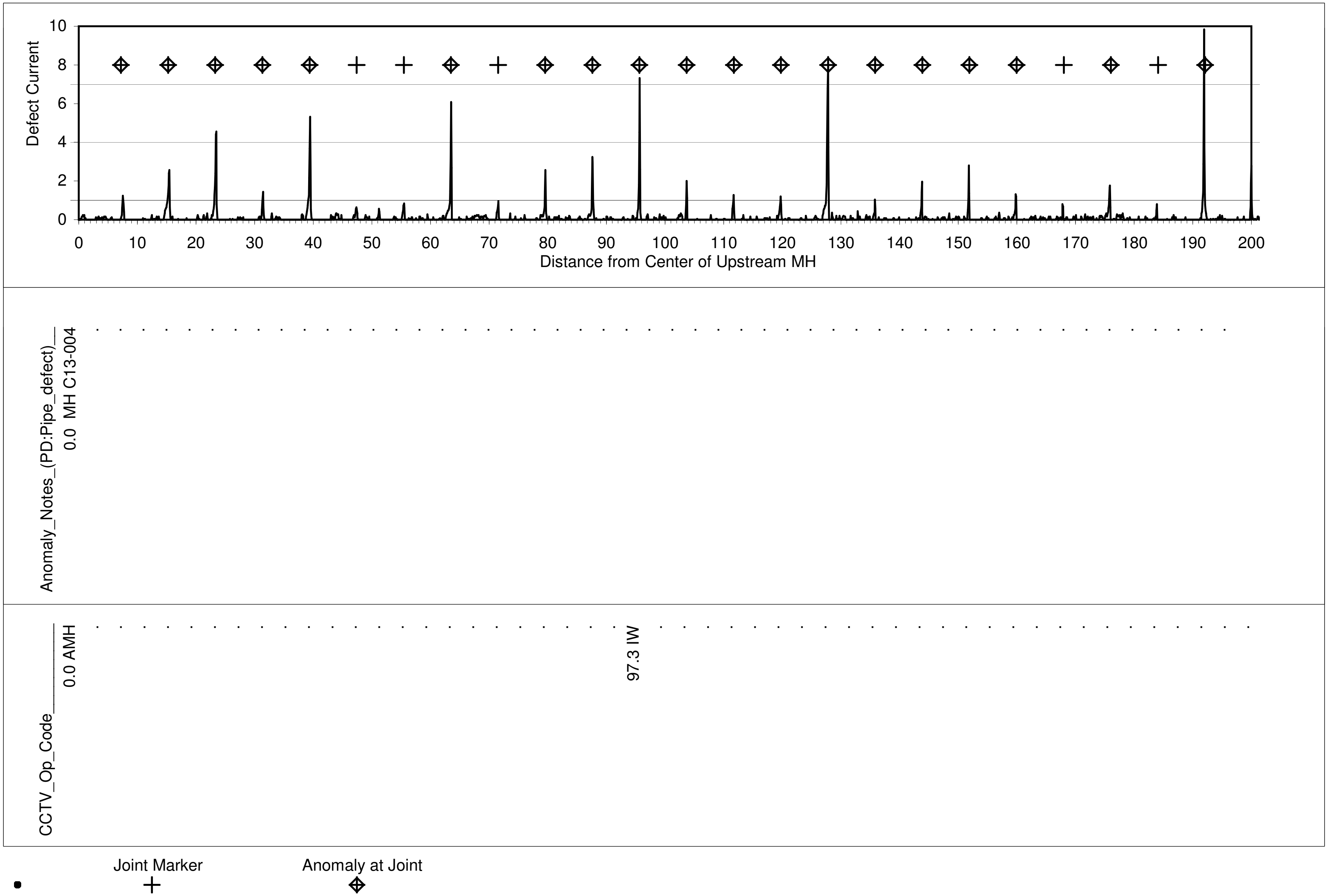
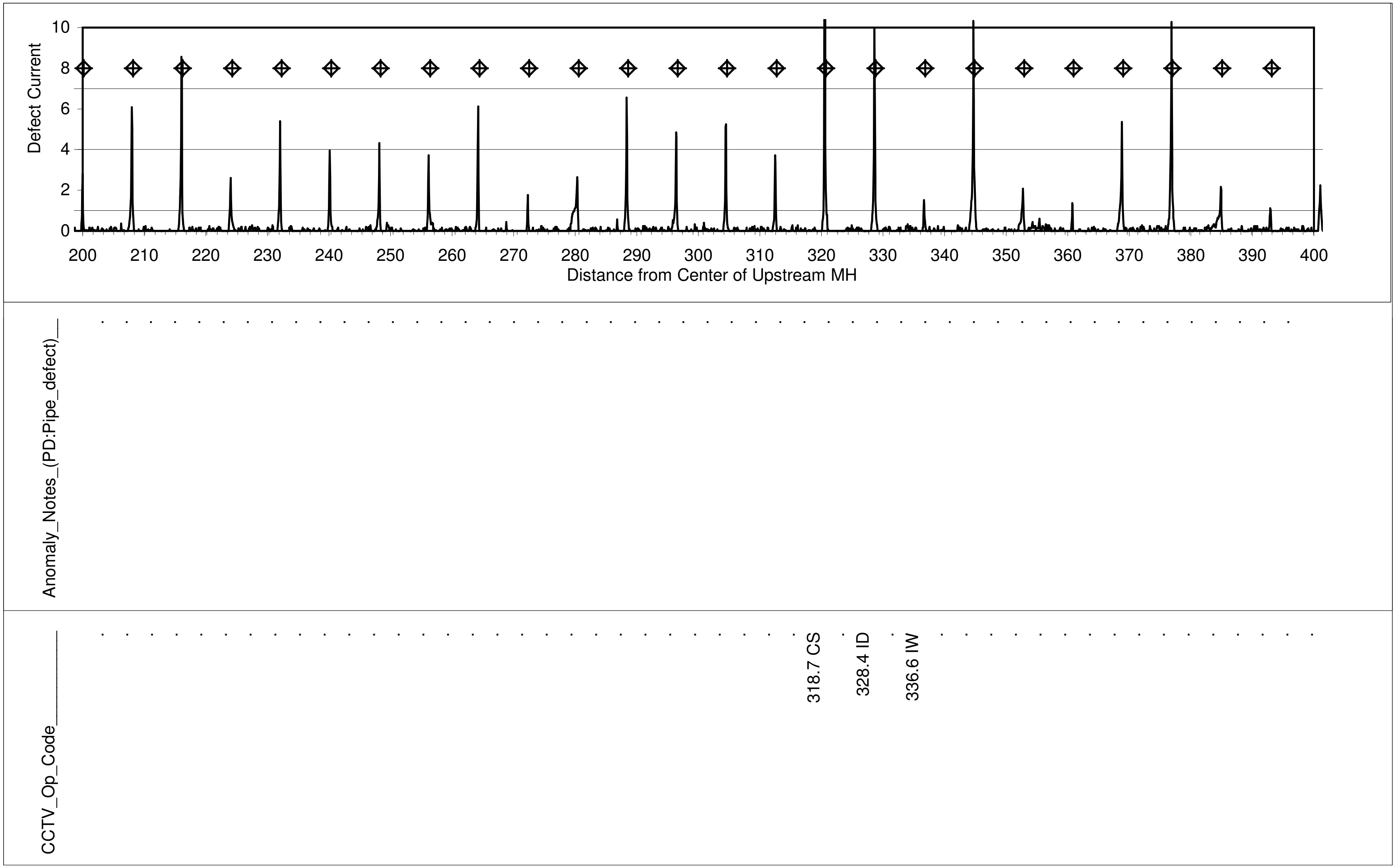
4
2
0
200 210 220 230 240 250 260 270 280 290 300 310 320 330 340 350 360 370 380 390 400
Distance from Center of Upstream MH
Anomaly_Notes_(PD:Pipe_defect)
299.0 PD - Radial
303.0 PD - Radial
306.5 PD - Radial
331.0 MH C13-004
CCTV_Op_Code
229.9 IW
327.9 AMH



Scan by: Leak Busters Inc
Job No.: Olathe-01

Utility: City of Olathe

Sewer Name: C13-004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330
340
350
360
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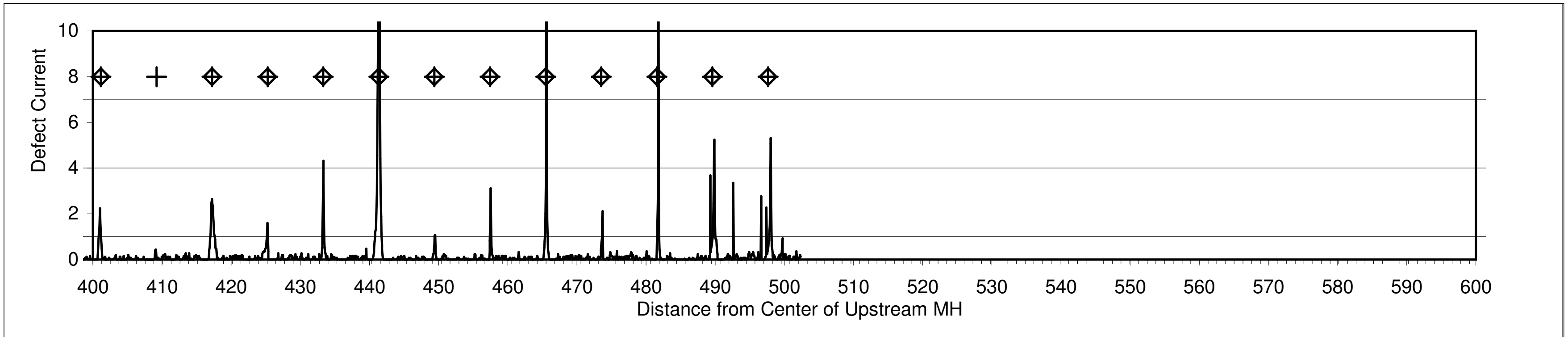
400
Distance from Center of Upstream MH
Anomaly_Notes_(PD:Pipe_defect)
CCTV_Op_Code
318.7 CS
328.4 ID
336.6 IW


Defect Current
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4
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410
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560
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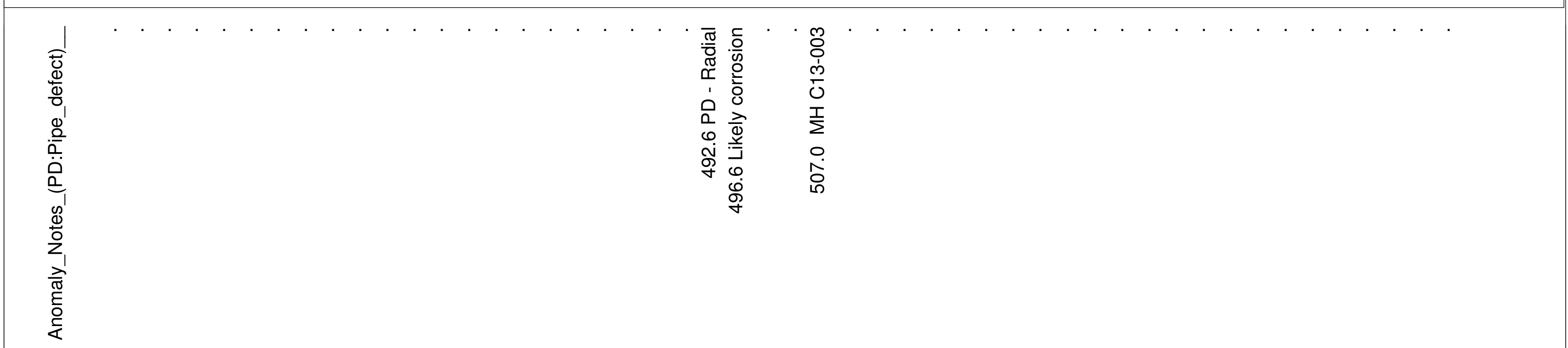
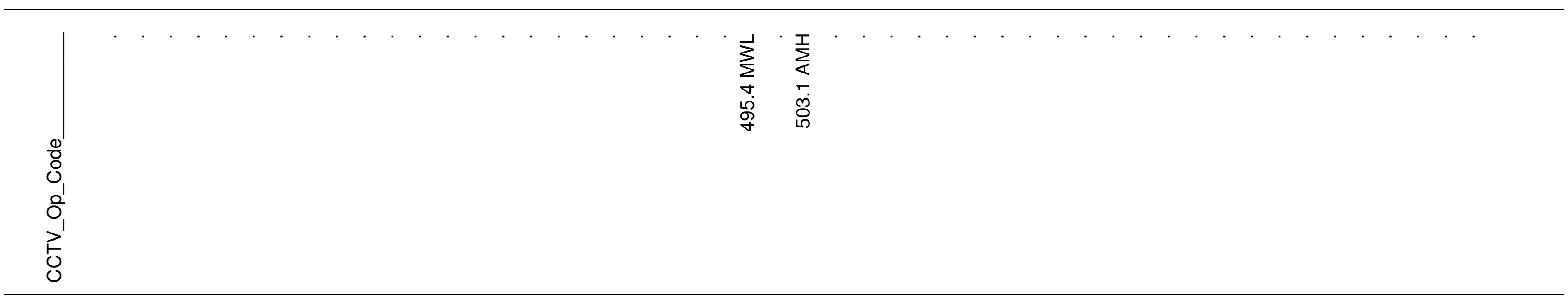
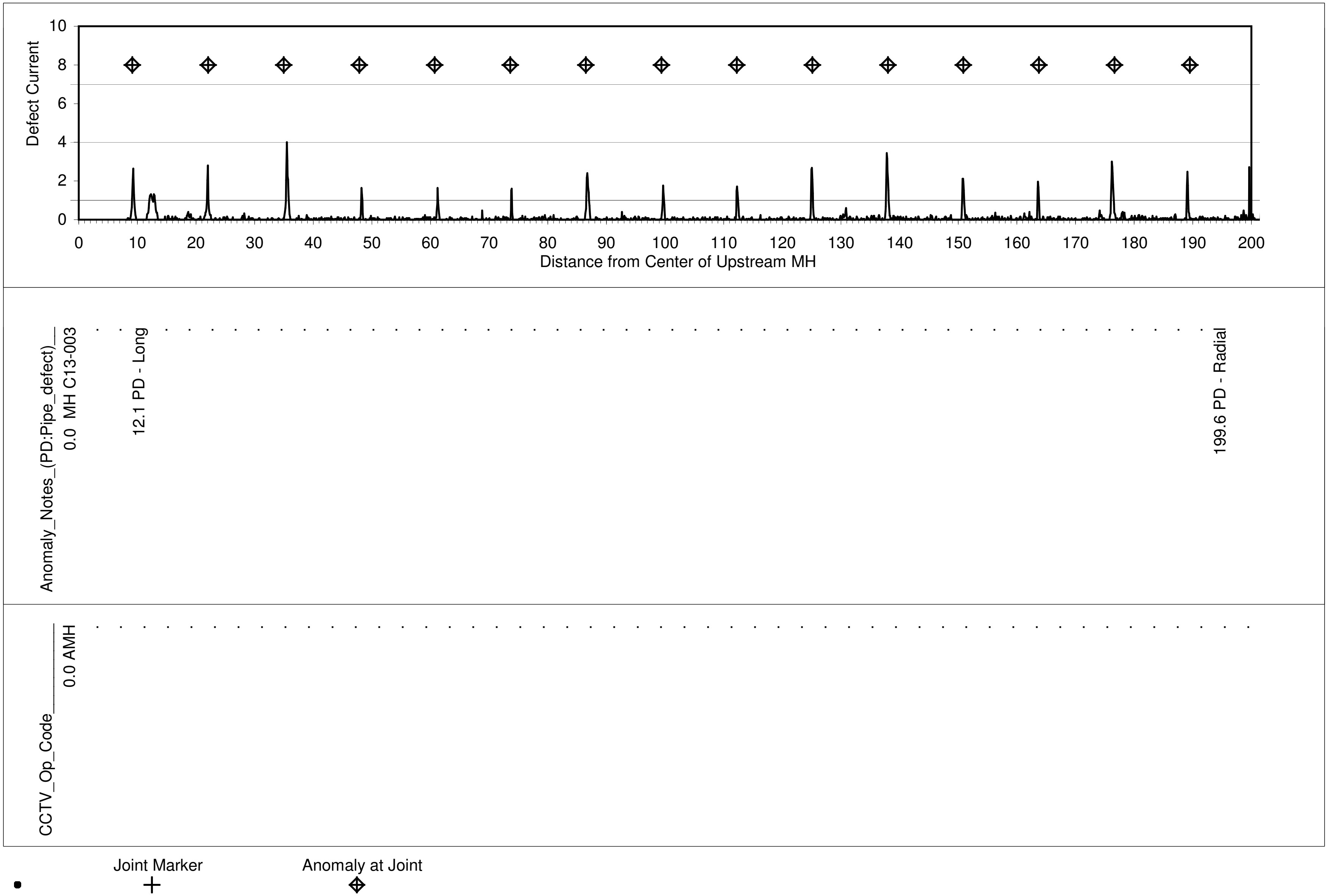
580
590
600
Distance from Center of Upstream MH


Anomaly_Notes_(PD:Pipe_defect)__
492.6 PD - Radial
496.6 Likely corrosion
507.0 MH C13-003


CCTV_Op_Code_______
495.4 MWL
503.1 AMH


Defect Current
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8
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90
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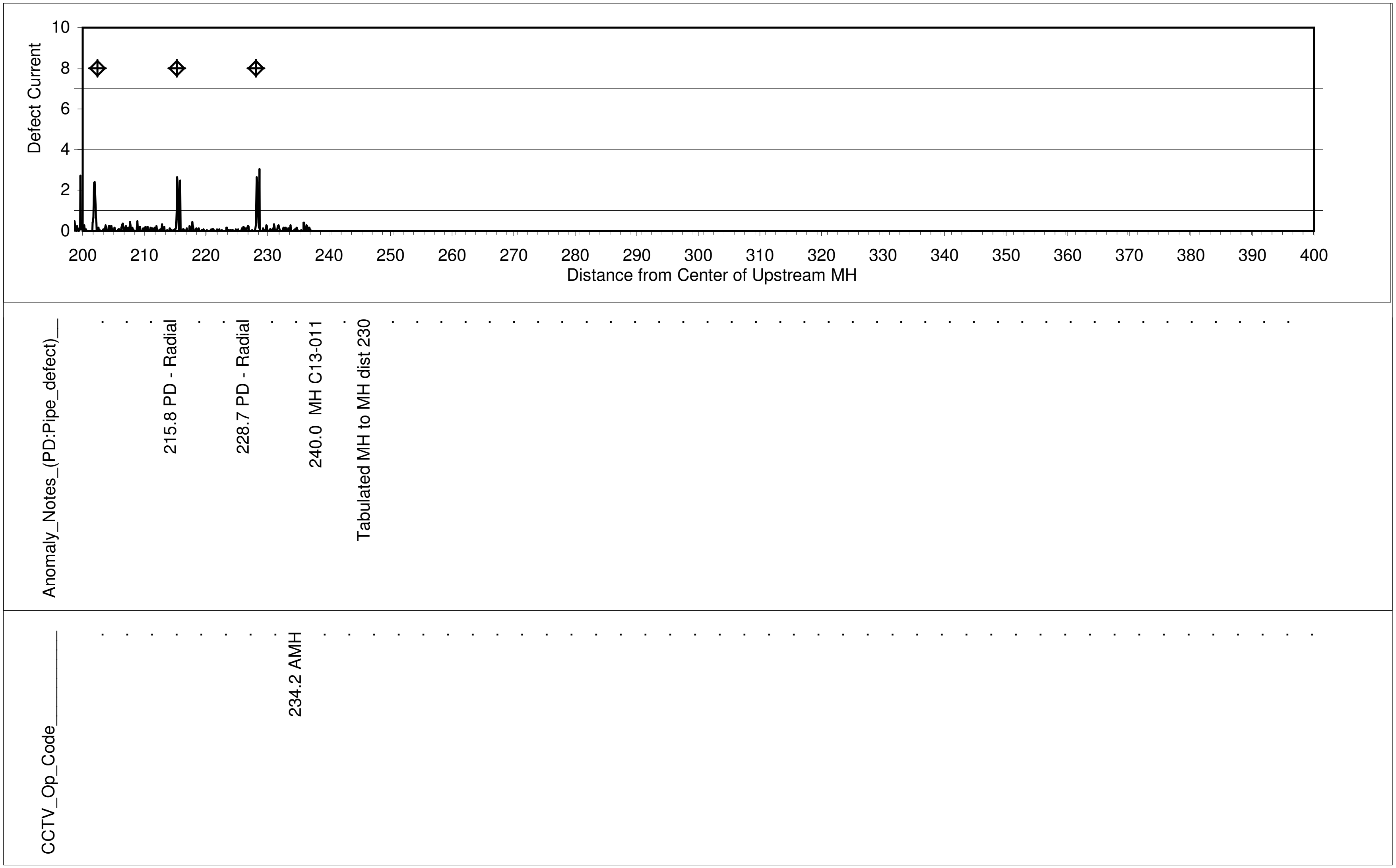
110
120
130
140
150
160
170
180
190
200
Distance from Center of Upstream MH
Anomaly_Notes_(PD:Pipe_defect)__
0.0 MH C13-003
12.1 PD - Long
199.6 PD - Radial
CCTV_Op_Code____
0.0 AMH
Joint Marker
Anomaly at Joint

SEWER ELECTRO-SCAN
Cedar Creek Stream Crossings

Client: CH2M Hill Reference No.: PO 945755

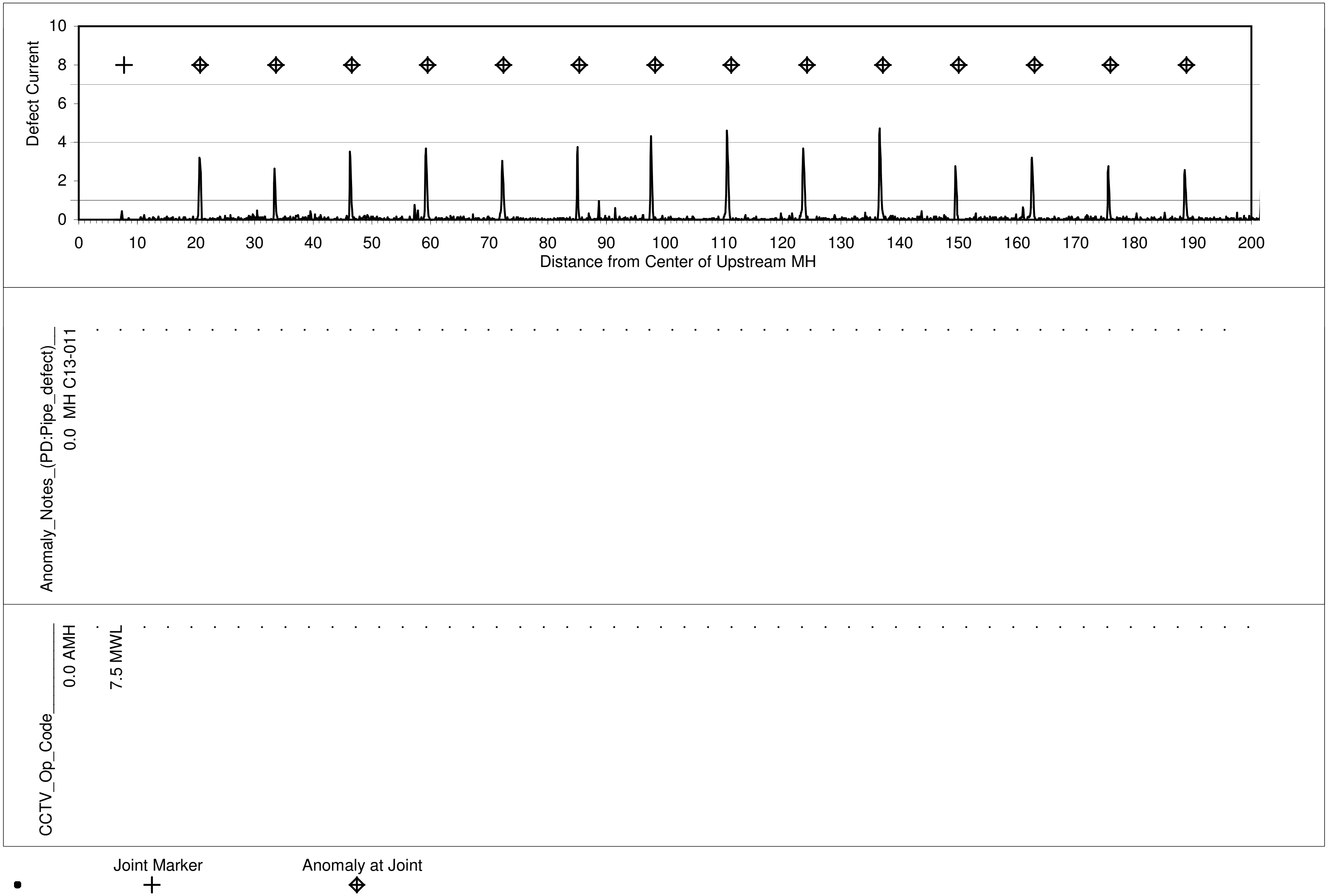
Report Date: 8 Aug 2011

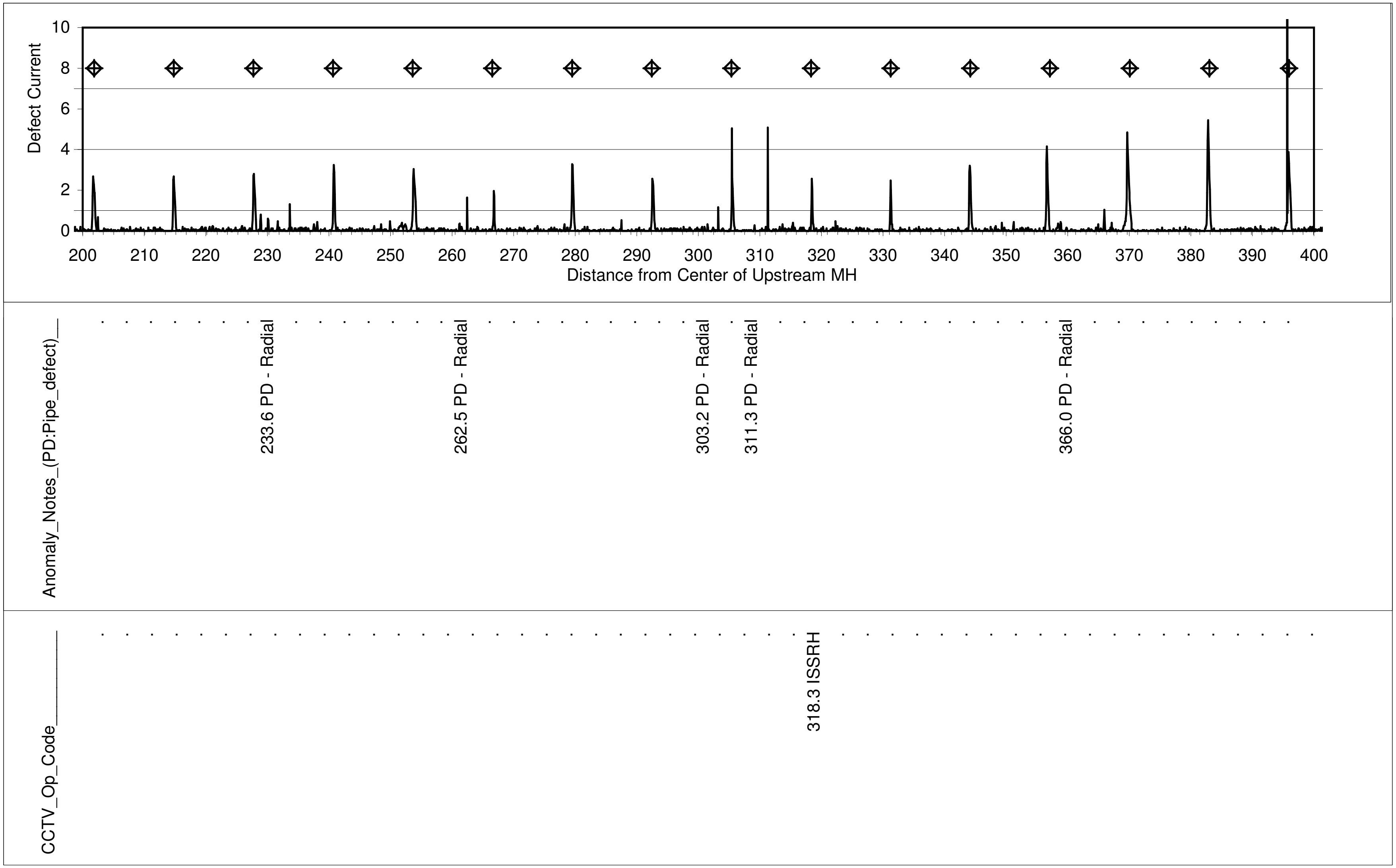


Scan by: Leak Busters Inc
Job No.: Olathe-01

Utility: City of Olathe

Sewer Name: C13-003


Defect Current
10
8
6
4
2
0
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
Distance from Center of Upstream MH
Anomaly_Notes_(PD:Pipe_defect)__
0.0 MH C13-011
CCTV_Op_Code____
0.0 AMH
7.5 MWL
Joint Marker
Anomaly at Joint


Defect Current
10
8
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200
210
220
230
240
250
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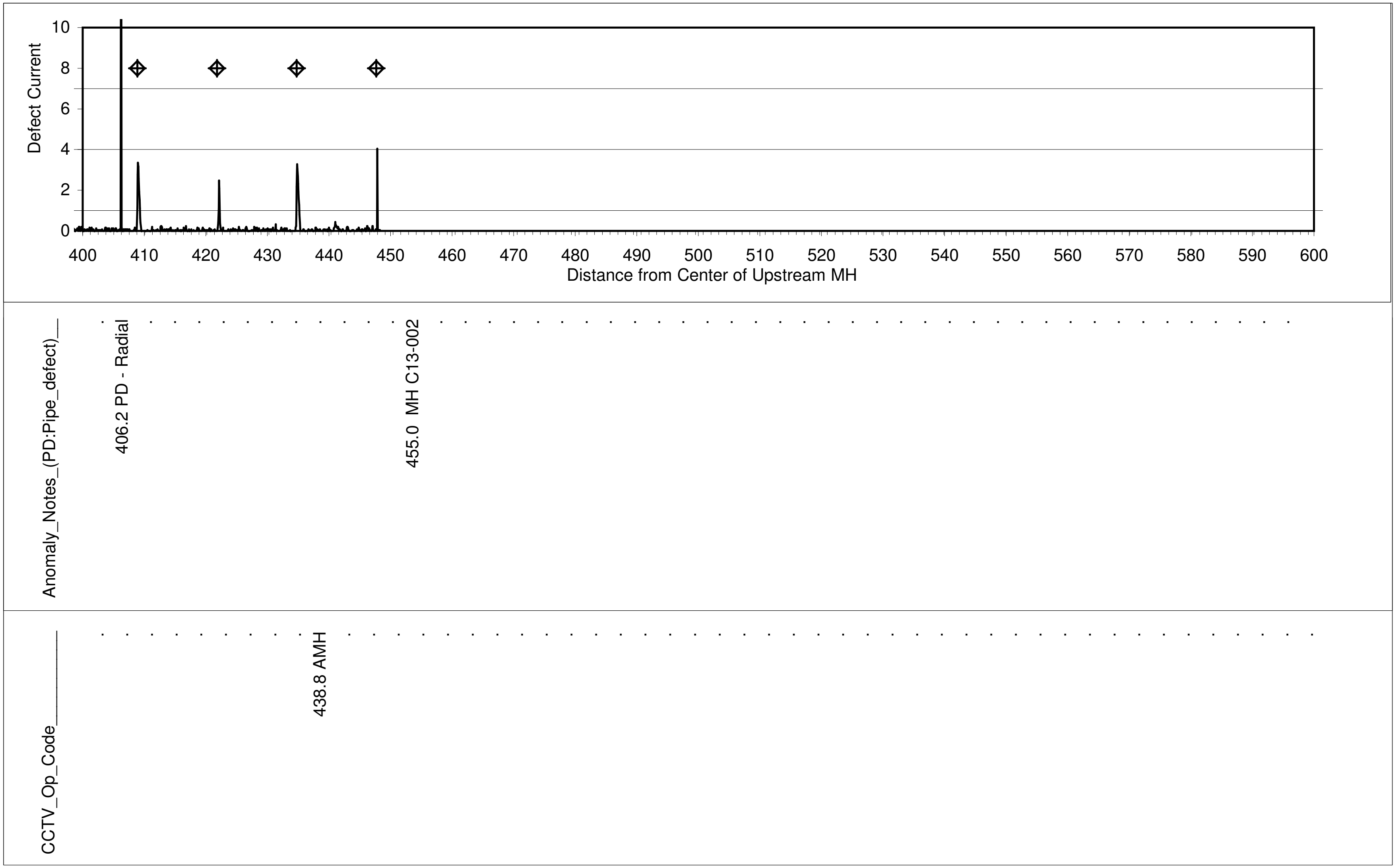
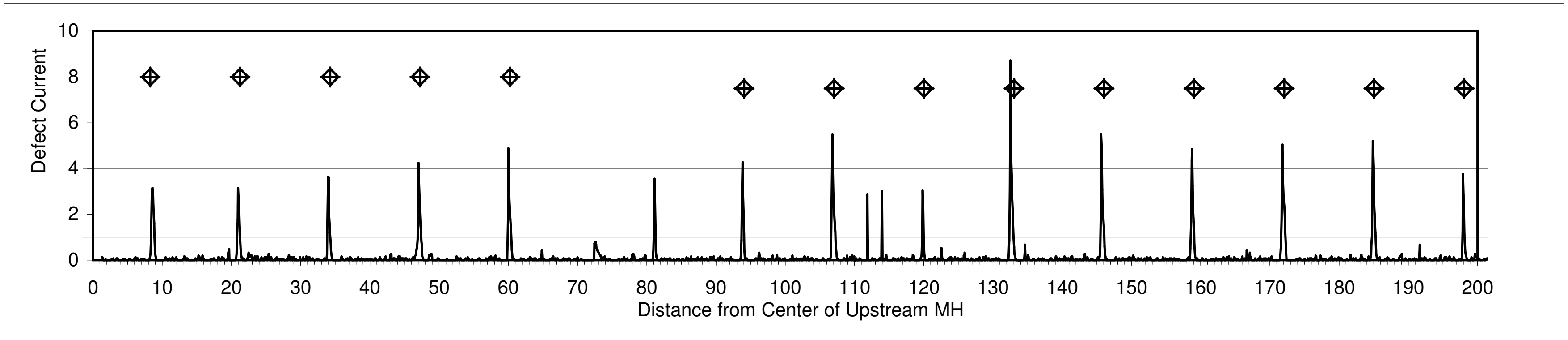
270
280
290
300
310
320
330
340
350
360
370
380
390
400
Distance from Center of Upstream MH
Anomaly_Notes_(PD:Pipe_defect)
233.6 PD - Radial
262.5 PD - Radial
303.2 PD - Radial
311.3 PD - Radial
366.0 PD - Radial
CCTV_Op_Code
318.3 ISSRH

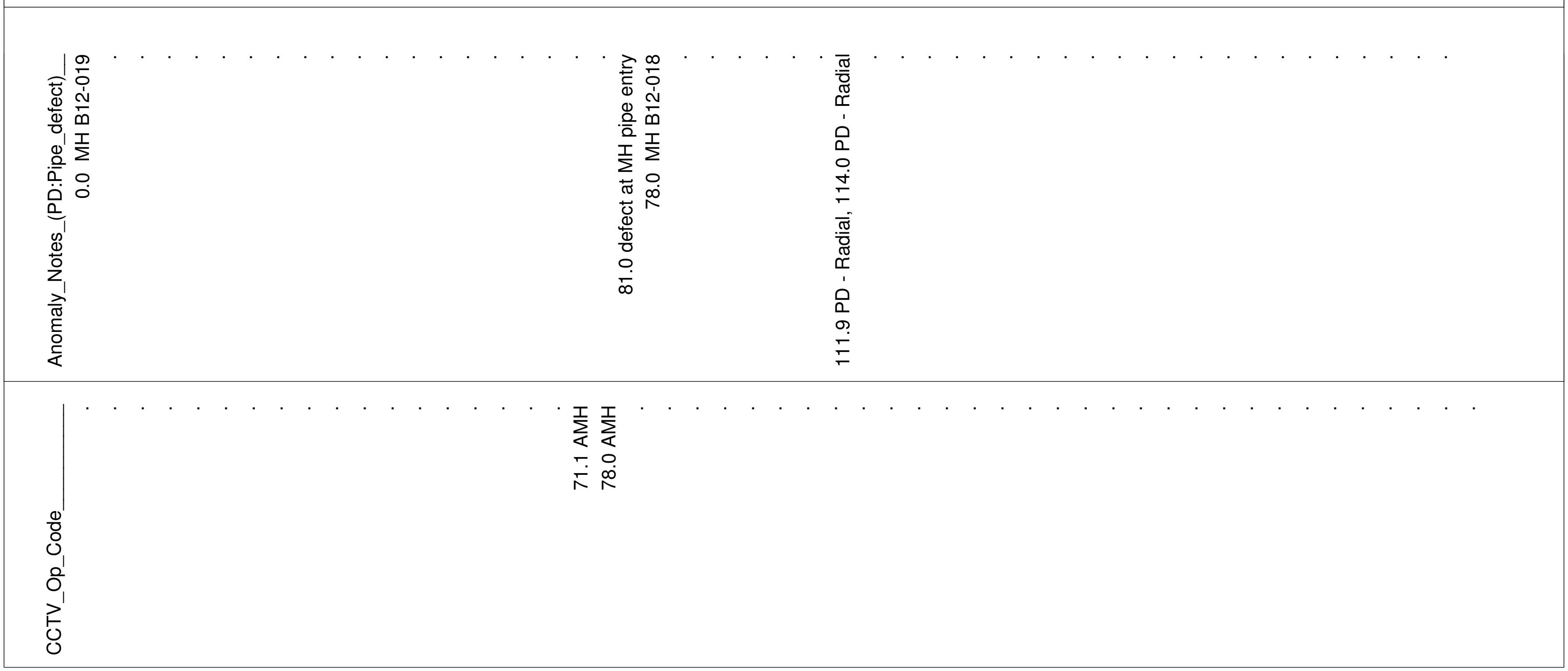

Defect Current
10
8
6
4
2
0
400 410 420 430 440 450 460 470 480 490 500 510 520 530 540 550 560 570 580 590 600
Distance from Center of Upstream MH
Anomaly_Notes_(PD:Pipe_defect)__
406.2 PD - Radial
455.0 MH C13-002
CCTV_Op_Code______
438.8 AMH

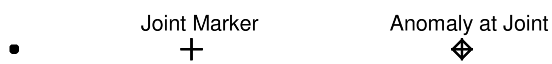
SEWER ELECTRO-SCAN
Cedar Creek Stream Crossings

Client: CH2M Hill Reference No.: PO 945755

Report Date: 8 Aug 2011



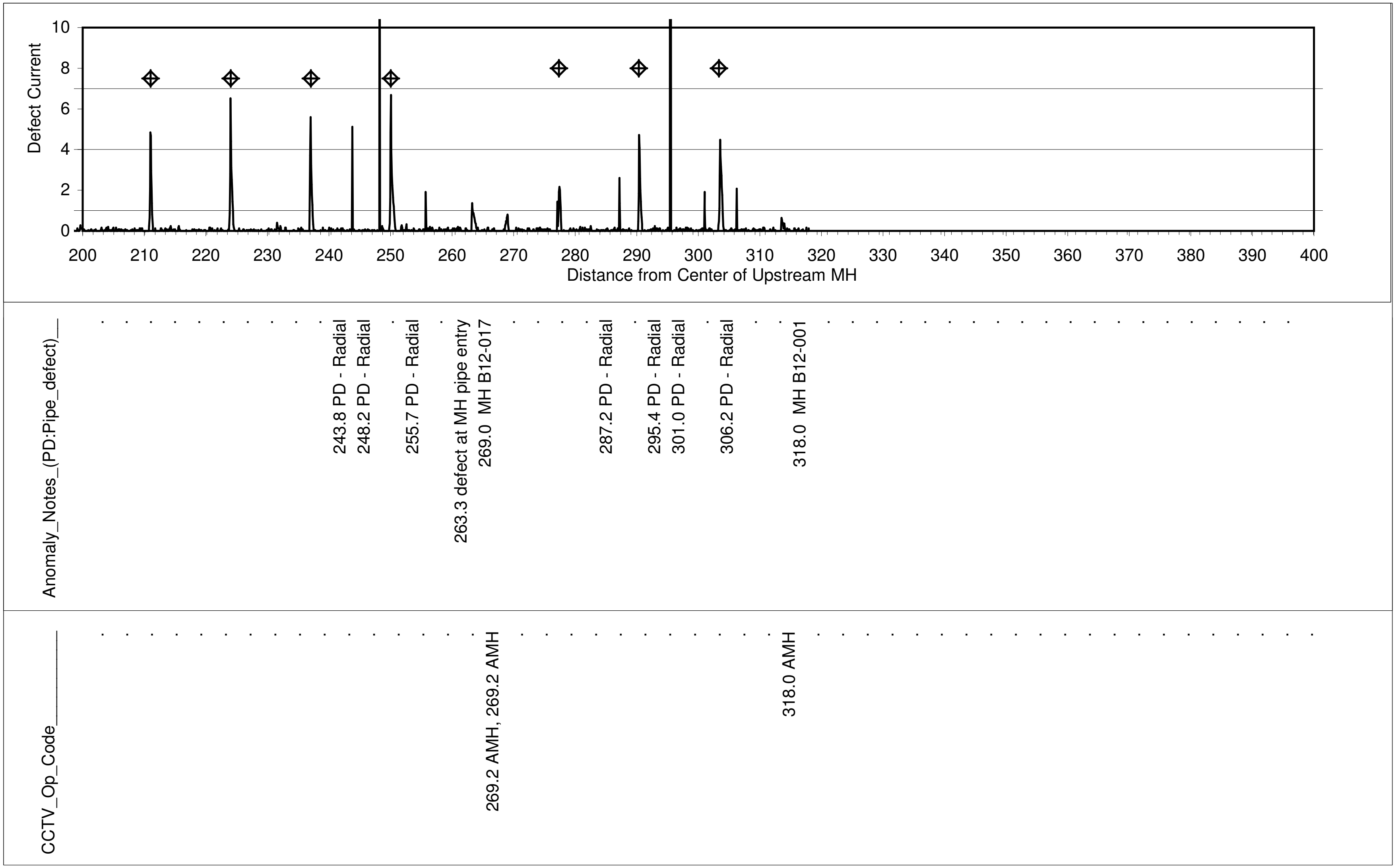




Scan by: Leak Busters Inc
Job No.: Olathe-01

Utility: City of Olathe

Sewer Name: B12-019 to B12-001 Invert


Defect Current
10
8
6
4
2
0
200
210
220
230
240
250
260
270
280
290
300
310
320
330
340
350
360
370
380
390
400
Distance from Center of Upstream MH
Anomaly_Notes_(PD:Pipe_defect)
243.8 PD - Radial
248.2 PD - Radial
255.7 PD - Radial
263.3 defect at MH pipe entry
269.0 MH B12-017
287.2 PD - Radial
295.4 PD - Radial
301.0 PD - Radial
306.2 PD - Radial
318.0 MH B12-001
CCTV_Op_Code
269.2 AMH, 269.2 AMH
318.0 AMH