Submittal 109-A
Amended Acoustic Monitoring Report
Spec Section 01 57 19.24 00
Paragraph 1.4

Naval Base Kitsap – Bangor WA
Repairs to Bents 8, 9, & 10
Capstan Support & Walkway
Demolish Fragmentation Barrier, Walkway, Piles & Misc Repairs
N44255-07-D-2012 TO 0007

Manson Construction Co.

5209 East Marginal Way South

Seattle, WA 98134

2/15/2013

February 14, 2013

Jayme Newbigging, P.E.
Manson Construction and Engineering Company
5209 East Marginal Way South
Seattle, WA 98134

Re: In-water and Airborne Acoustic Monitoring
Concrete Chipping for Removal of Concrete Piles, September 18-19, 2012
Explosives Handling Wharf No. 1 Pile Replacement Project
Naval Base Kitsap, Bangor, Washington RMDT Job No. 11F35b

Dear Ms. Newbigging,

This report presents in-water and airborne sound level measurements collected during construction activity at the project referenced above. Robert Miner Dynamic Testing, Inc. (RMDT) completed these measurements at your request.

The scope of the field work completed by RMDT consisted primarily of in-water sound level measurements at a distance of approximately 10 m from the piles being chipped with an air-powered "jack-hammer' operating in-water near the mud-line. Additional field work included measurement of ambient in-water sound levels approximately 33 m from the work area, in-water sounds at distance greater than 33 m during chipping, and airborne sound levels during chipping. The scope of the analysis and reporting work consisted of analysis and presentation of in-water measurements in terms of 10-second RMS levels and certain analyses of sound spectra, and presentation of the airborne sound levels.

FIELD DETAILS

Chipping Hammer

The air-powered reciprocating hammer used for chipping was reported to be a "Jumbo Rivet Buster" with a 200 mm stroke and it was a hand-held unit operated manually by one diver. Compressed air was supplied to the hammer by a 50 mm OD hose, approximately 60 m long, connected to compressor providing 970 kPa (140 psi) at the compressor-end of the hose. The compressor was located on the existing EHW 1 pier structure.

Concrete Piles

The piles being chipped for removal were 61 mm (24") octagonal prestressed concrete piles. The chipping occurred near the mud-line where the water depth was approximately 17 to 20 m. After the pile was chipped to remove concrete the upper pile section was separated from the lower section by a combination of in-water cutting of steel strands in the pile and rocking or "working" the pile back and forth using cable rigging between top of the pile and a barge mounted crane. Once the steel strand was severed the piles were lofted onto a nearby barge.

Measurement Sequence

Field measurements occurred on September 18 & 19, 2012 during chipping on nine different piles. We monitored the chipping operations on seven piles with hydrophones approximately 10 m from the pile. We also monitored chipping on 2 piles with hydrophones located at greater distances for the purpose of evaluating acoustic spreading loss.

The individual piles are referenced by a numbering sequence which was used by Hart Crowser and provided to RMDT for common reference purposes. Table 1 gives a summary of the series of tests. For additional information on the piles and removal details please refer to submitals prepared by other project participants.

Measurement Equipment

In-water sound levels were measured with Reson Type 4033 units with integral cable connected to a solid state charge converter and an integrating sound level meter. The charge converters were Model 422E12 (10.0 mV/pC) manufactured by PCB Piezontronics, Inc. The integrating sound level meters were Brüel & Kjær 2270 units having constant current line drive circuitry to power a charge converter and piezoelectric hydrophone. The Brüel & Kjær 2270 meter operated with a sampling rate of approximately 44kHz, and provided coverage for sound frequencies up to 20 kHz. Additional recordings of the signals from the hydrophones and charge converters were collected using a Brüel & Kjær Photon 4 channel signal analyzer. The Photon typically recorded with real-time sampling rate greater than 48 kHz and the Photon recordings enabled replay and data quality evaluation.

The equipment field configuration allowed direct field verification of proper function and calibration by means of a calibrated piston-phone sound source. Each measurement day the configuration and instrument settings were checked using our GRAS Model 42AC piston-phone with a hydrophone adaptor manufactured to accommodate the Reson 4033 hydrophones. The 42AC piston-phone was field checked, in turn, using a Class 1 Sound Level Meter with a ½" microphone. All recording equipment was manned by an RMDT field engineer during all data collection, with initial and daily calibration tests using the piston-phone.

Airborne sound levels were measured with a PCB model 377B02 ½" Class-1 free field pre-polarized condenser microphone connected to a preamplifier (PRM831) and a Larson Davis LD 831 integrating sound level meter sampling at a rate of 48 kHz and provided broadband coverage for the required range of 10 Hz to 20 kHz.. This instrument assembly was subject to initial and daily field confirmation of calibration using a Gras Model 42AC piston-phone with an adaptor for a ½" microphone.

Measurement Procedure

During monitoring of seven piles sound levels were measured at a distance of approximately 10 m laterally from the pile being chipped. Two Reson 4033 hydrophones were deployed and monitored; one was positioned approximately 1 m above the mud-line and one was positioned mid way between the mud-line and the water surface. The water depth was typically between 17 and 20 m such that the mid-depth hydrophone was 8.5 to 10 m below the water surface. Figure A1 in Appendix A depicts the site and the position of the hydrophones relative to the piles. For the purpose of evaluating attenuation with distance, further monitoring was completed at distances of 20 and 30 m northward along the outboard side of the existing EHW1 structure. The microphone which measured airborne sound was located at the level of the exisiting EHW1 pier and postioned over the water on the side of the pier. Thus the airborne sound measurements were collected 4 to 8 m above the water surface, depending on the tide.

The position of each hydrophone was maintained using a line extending upward from a small steel anchor, with the hydrophones and associated signal cable raised or lowered on that anchor line. The steel anchor and anchor line were typically deployed from the existing walkway so as to make possible an unobstructed “line of sight” between the pile and each hydrophone, with minimal potential reflecting or blocking surfaces in-water within a distance of at least 20 m of the hydrophone. The anchor was deployed so-as to rest approximately 2 m beyond the edge of the walkway and the hydrophone at mid column depth was thus approximately 1 from the edge of the walkway.

ANALYSIS DETAILS

During field use the Brüel & Kjær 2270 units logged the values of the peak un-weighted sound level, Lzpeak, and the un-weighted Root Mean Square values, Lzeq, at one second intervals. These logged values are the basis for results given in this report and calculation of such results is discussed further below.

The *Peak Sound Pressure Level*, Lzpeak, is the peak “instantaneous” level obtained from the maximum excursion (either positive or negative) from the ambient pressure. Although the pressure is quantified in units such as Pascals or psi, sound level descriptors, such as Lzpeak and RMS are typically expressed using the non-dimensional and logarithmic decibel scale. The formula for converting a measured peak pressure to the Lzpeak metric is given below:

$$\text{Lzpeak} = 20 \text{ Log}(p/p_{ref}),$$

where p is the measured peak in Pascals (Pa) divided by a customary reference pressure, p_{ref}. For sound in water 1 µPa is the customary reference pressure. Thus, signals for which the peak pressure is 1000, 3163, or 10,000 Pa would have Peak metric values of 180 dB, 190 dB, or 200 dB, respectively. For this calculation the “peak” pressure is the peak of the absolute value of measured pressures.

The *Root Mean Square Sound Pressure Level* for a selected time period is the integral of the square of the varying pressure values within that period, divided by the length of the time period. This root mean square value is then converted to dB re: 1µPa. Field data from the hydrophones was collected to obtain RMS values at 1 second intervals such that results for any larger time period could be computed from the field data. This report presents the RMS values for 10 second intervals, $RMS_{10\ sec}$, as requested by the Navy. The 10 second RMS values were computed by appropriate linear and logarithmic operations on the results for 1 second intervals. Such operations involved converting the 1 second data from dB back to pressure units (Pa squared-seconds), averaging ten sequential values, dividing by p_{ref} squared, and then taking the square root of that result, with final conversion to dB. This process provides a direct and correct calculation of $RMS_{10\ sec}$ from a series of ten sequential $RMS_{1\ sec}$ values.

Airborne sound measurements were converted to dB using the standard 20µPa reference pressure. The LD 831 SLM directly recorded a variety of sound descriptors including an A-weighted and an un-weighted Leq for a 60 second interval, and an un-weighted peak value, Lzpeak, with an impulse detector.

PRESENTATION OF MEASUREMENT RESULTS

In-water Sound Levels During Concrete Chipping

Figures 1, 2 and 3 present plots of in-water sound pressure measured during in-water chipping on Pile 102 on September 19. Figure 1 presents 10 seconds of measurements and the individual strikes of the air hammer may be observed. Based on the data in Figure 1 the apparent hammer blow rate is approximately 640 strikes per minute, or approximately 11 Hz. Figure 2 presents an expanded view for a period of 1 second wherein the character and sequence of individual strikes can be further observed. Figure 3 present a single hammer strike with a more expanded time scale.

The primary sound descriptor derived from the pressure measurements is the RMS calculation for a 10 second period, per Navy specification. Appendix A contains Session Logs for the RMS sound levels measured at a 10 m lateral distance during chipping on seven piles. One Session Log is given for each hydrophone postion (mid-depth and 1 m above the mud-line) and each of the seven piles. Figure 4 is a typical Session Log and is for Pile 105 as recorded on September 18. The sound descriptors included in the Session Logs include the RMS for a 10 second interval, and the Peak value, Lzpeak, both as described above. The Session Logs include data for times when the chipping hammer was not active; tabular inserts on the Session Logs summarize sound descriptors for times with the chipping hammer active and inactive. RMS sound levels for the seven piles monitored at a 10 m distance are summarized in Table 2 for the mid-depth postion and in Table 3 for the postition 1 m above the mud-line. Considering the data for a 10 m distance the average RMS value was 141 dB at mid depth and 143 dB near the mud-line. The average duration of chipping was approximately 14 minutes per pile.

Table 2 also includes the result for Piles 100 and 96 for which the sound levels were monitored at lateral spacings of 30 and 20 m, respectively. These results at lateral distances greater than 10 m are for the hydrophone at the mid-column depth

Figure 5 presents the apparent RMS acoustic spreading loss for the the available data. This spreading loss analysis was completed using the seven data sets at a 10 m location, one data set at 20 m, and one data set at 30 m.

Ambient Sound Levels In-water

Figures 6 and 7 present ambient (background) sound levels measured on September 18 during a period of relative inactivity. This time was apparently a lunch break for the construction crew, but some activity occurred during this time. These ambient measurements were made at a location approximately 10 m from the last pile chipped and removed and are thus for a location near and partially surrounded by construction equipment, including an operating derrick barge. During this period the in-water RMS level measured at mid-depth averaged 129 dB with a standard deviation of 6 dB. Measured 1 m above the mud-line the average RMS level was 130 dB and the standard deviation was 5 dB.

Sound Frequency Spectra

Figure 8 presents in-water sound frequency spectra in the form of one-third octave band plots for the period of time depicted in Figure 7, which was the contractors lunch break on September 18, 2012. Figure 9 present a one-third octave band plot for chipping activity on Pile 102.

Airborne Sound Levels During In-water Chipping

Figure 10 is a time history (Session Log) for the airborne sound level descriptors measured on September 19, 2012 over a time period during which Piles 108, 106, 102 and 99 were chipped and removed. Table 4 summarizes the airborne sound descriptors for the same period of approximately 248 minutes duration and separately lists the average sound descriptor values for only the periods when chipping was occurring. During this 248 minute interval the total time for chipping was approximately 80 minutes. Considering the 80 minutes with chipping the average un-weighted and A-weighted Leq levels were 87.5 and 69.2 dB, respectively. For the entire 248 minute period the un-weighted and A-weighted Leq levels averaged 84.4 and 67.1 dB, and were thus 2 to 3 dB lower than during chipping.

DISCUSSION AND SUMMARY OF MEASUREMENT RESULTS

In-water Sound Levels at 10 m

In-water sound levels were measured over a period of two days while seven piles were chipped with a manually operated air-powered chipping hammer. At a distance of approximately 10 m from the pile the RMS sound levels averaged 141 and 143 dB for locations at mid-depth and 1 m above the mud-line, respectively. This RMS sound level is approximately 12 to 14 dB above the measured RMS ambient level of 129 db for this location and time period.

Acoustic Spreading Loss

The apparent acoustic spreading loss for in-water chipping at this project was depicted in Figure 5, which shows the measurements at distances of 10, 20 and 30 m. The measured spreading loss close to the pile (less than 30 m) was 10.4 dB per log cycle of distance. For a spreading loss of 10.4 dB per log cycle of distance, the levels projected for mid-de-depth at 100 and 300 m are 132 and 127 dB, respectively. However, this spreading loss of 10.4 dB per log cycle is based on data with relatively shallow and constant water depth and is less than the rate of approximately 15 dB per log cycle computed for vibratory pile extraction at EHW1. The more extensive results available for such prior work, including our report dated April 27, 2012 may be more applicable for larger distances and for spreading into increasing water depths.

Use of the practical spreading loss rate of 15 dB per log cycle of distance results in estimate of in-water RMS levels of 127 dB at 100 m. Because average mid-depth ambient noise levels was 129 dB for the present work, it is our opinion that in-water RMS levels attenuated to the local ambient noise level at distances of 100 to 300 m, subject to bathymetry and other factors effecting net attenuation.

Ambient Sound Levels In-water

Because relatively modest sound levels were expected for chipping operations the hydrophones used for this work were more sensitive than those used by RMDT for monitoring vibratory pile extraction. Our change from Reson 4013 to 4033 hydrophones was also expected to improve the reliability of our characterization of ambient sound levels. However, the average ambient RMS sound level of 129 dB during this work is similar to ambient RMS sound levels of 124 to 134 dB measured by RMDT during October 2011 at this site. In both cases the measurements occurred within the WRA and near floating construction equipment during periods of relative inactivity. The construction equipment included occasional diver support skiffs with small outboard motors operating within 5 to 30 m, a working derrick barge at approximately 30 to 40 m distance, and Navy security craft within 70 m. The wind was variable during the period of our measurements, and wind waves on the water surface were estimated to be 0.2 to 0.4 m, with few whitecaps observed within 150 m of the measurement location.

The frequency spectra for in-water ambient sound levels (Figure 8) and for concrete chipping (Figure 9) contain relative peaks near frequencies of 60, 120 and 180 Hz. Such peaks may result directly or indirectly from construction-related or facility-related equipment using 60 Hz AC electrical power. Our measurement equipment was directly powered by isolated 12 DC batteries such that our top-side recording equipment would not produce 60 Hz noise, or noise at multiples of that frequency. If the observed relative peaks at 60, 120, and 180 Hz are indirect effects of AC power and thus do not reflect actual in-water sound, the net effect would be to increase the apparent levels for both chipping and ambient sound. However, the relative peaks at 60, 120 and 180 dB are modest departures from the adjacent levels considering the full broadband energy, and it is our opinion their net effect on the overall RMS levels does not materially alter the results regarding chipping levels at 10 m or the spreading loss.

Airborne Sound Levels

The average un-weighted (linear) and A-weighted airborne Leq values measured at a lateral distance of 10 m from the in-water chipping were 87.5 and 69.2 dB. These Leq levels are 2 to 3 dB larger than the overall average computed for a period of over 4 hours that included about 40 minutes of in-water chipping. It is our opinion that the slight difference between chipping and the overall average is primarily due to the fact that the trailer mounted air-compressor used to power the chipping was typically not operating unless chipping was ongoing. Our personal observation on site was that the sound of in-water chipping was fairly faint or soft while standing on the existing pier nearby, and was barely noticeable by hearing if one was near other activity or any operating machinery. However, a reliable sensation or awareness of the chipping appeared to be provided by sense of touch or vibration while standing on the existing pier within a maximum distance of 150 to 300 m of the chipping

It was a pleasure to work with Manson Construction Company and all the other participants on this project. Please do not hesitate to contact us if you have any questions for us regarding the work we performed for this report.

Sincerely,

Robert F. Miner, P.E.
Principal

Andrew Banas
Staff Engineer

Robert Miner Dynamic Testing, Inc.

Table 1. Summary of Events Monitored In-water			
Pile Name	Date	Duration of Chipping	Lateral Distance from Chipping
Pile 107	9-18-2012	7:03	10 m
Pile 105	9-18-2012	13:57	10 m
Pile 111	9-18-2012	9:20	10 m
Pile 108	9-19-2012	20:48	10 m
Pile 106	9-19-2012	30:48	10 m
Pile 102	9-19-2012	8:26	10 m
Pile 99	9-19-2012	11:47	10 m
Pile 100	9-19-2012	7:20	30 m
Pile 96	9-19-2012	12:35	20 m

Table 2. Summary of In-water Sound Levels, Pile Chipping, Mid-Water Depth					
Pile Name	Chipping Duration	RMS_{10} dB		Peak 10 Second Interval (Lzpeak) dB	
	(minutes)	Average (dB)	Standard Deviation	Average (dB)	Standard Deviation
Pile 107 (10 m)	7:03	143	2.3	167	3.5
Pile 105 (10 m)	13:57	136	6.9	160	12.6
Pile 111 (10 m)	9:20	141	4.0	168	7.5
Pile 108 (10 m)	20:48	143	6.3	172	8.2
Pile 106 (10 m)	30:48	139	9.3	165	12.5
Pile 102 (10 m)	8:26	140	5.8	166	7.6
Pile 99 (10 m)	11:47	146	3.2	172	2.2
Overall Average		**141**	**5**	**167**	**8**
Pile 100 (30 m)	7:20	136	2.1	156	2.3
Pile 96 (20 m)	12:35	138	2.6	164	5.4

Note for all sound metrics during concrete chipping:
The tabulated duration of driving generally excludes periods when the air hammer was stopped or paused for any reason. Statistics for the RMS and Peak metrics also generally exclude such interruptions, and are for the time periods used to sum up the duration value. This applies to Tables 1, 2 and 3.

Table 3. Summary of In-water Sound Levels, Pile Chipping, 1 m above Mud-Line					
Pile Name	Chipping Duration (minutes)	RMS_{10} dB		Peak 10 Second Interval (Lzpeak) dB	
		Average (dB)	Standard Deviation	Average (dB)	Standard Deviation
Pile 107 (10 m)	7:03	146	2.8	171	2.8
Pile 105 (10 m)	13:57	137	8.0	163	14.2
Pile 111 (10 m)	9:20	144	5.6	173	9.0
Pile 108 (10 m)	20:48	144	9.0	172	13.8
Pile 106 (10 m)	30:48	139	9.8	164	14.8
Pile 102 (10 m)	8:26	145	4.1	170	5.8
Pile 99 (10 m)	11:47	149	3.8	174	4.1
Overall Average		**143**	**6**	**170**	**9**

Note for all sound metrics during concrete chipping:
The tabulated duration of driving generally excludes periods when the air hammer was stopped or paused for any reason. Statistics for the RMS and Peak metrics also generally exclude such interruptions, and are for the time periods used to sum up the duration value. This applies to Tables 1, 2 and 3.

Table 4. Summary of Air Borne Sound Levels During In-water Concrete Chipping							
Event	Duration Minutes	Unweighted Leq, dB		A-Weighted Leq, dB		Unweighted Peak Level, dB	
		Average	St. Dev.	Average	St. Dev.	Average	St. Dev.
Pile 108 (10 m)	23	90.3	2.7	70.4	1.8	99.3	2.5
Pile 106 (10 m)	34	88.1	3.0	69.2	1.7	98.5	3.8
Pile 102 (10 m)	10	89.1	0.3	74.4	2.2	103.6	3.3
Pile 99 (10 m)	13	82.5	1.2	62.6	1.6	98.1	1.7
Avg. Chipping at 10 m	**20**	**87.5**	**1.8**	**69.2**	**1.8**	**99.9**	**2.8**
Avg. Overall at 10 m	**248**	**84.4**	**7.2**	**67.1**	**6.8**	**99.2**	**6.4**
Pile 100 (30 m)	10	90.5	1.6	63.6	1.4	105.8	2.2
Pile 96 (20 m)	14	80.1	1.4	64.4	1.0	97.0	3.2

Note: The tabulated averages for individual piles include only the time periods for which the chipping hammer was reported to be active. The tabulated Avg. Overall covers a 248 minute period during which the chipping hammer was both active and inactive.

Table 1. Summary of Events Monitored Underwater			
Pile Name	Date	Duration of Chipping	Lateral Distance from Chipping
Pile 107	9-18-2012	7:03	10 m
Pile 105	9-18-2012	13:57	10 m
Pile 111	9-18-2012	9:20	10 m
Pile 108	9-19-2012	20:48	10 m
Pile 106	9-19-2012	30:48	10 m
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Pile 100	9-19-2012	7:20	30 m
Pile 96	9-19-2012	12:35	20 m

Table 2. Summary of Underwater Sound Levels, Pile Chipping, Mid-Water Depth					
Pile Name	Chipping Duration (minutes)	RMS_{10} dB		Peak 10 Second Interval (Lzpeak) dB	
		Average (dB)	Standard Deviation	Average (dB)	Standard Deviation
Pile 107 (10 m)	7:03	143	2.3	167	3.5
Pile 105 (10 m)	13:57	136	6.9	160	12.6
Pile 111 (10 m)	9:20	141	4.0	168	7.5
Pile 108 (10 m)	20:48	143	6.3	172	8.2
Pile 106 (10 m)	30:48	139	9.3	165	12.5
Pile 102 (10 m)	8:26	140	5.8	166	7.6
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Overall Average		**141**	**5**	**167**	**8**
Pile 100 (30 m)	7:20	136	2.1	156	2.3
Pile 96 (20 m)	12:35	138	2.6	164	5.4

Note for all sound metrics during concrete chipping:
The tabulated duration of driving generally excludes periods when the air hammer was stopped or paused for any reason. Statistics for the RMS and Peak metrics also generally exclude such interruptions, and are for the time periods used to sum up the duration value. This applies to Tables 1, 2 and 3.

Table 3. Summary of Underwater Sound Levels, Pile Chipping, 1 m above Mud-Line

Pile Name	Chipping Duration (minutes)	RMS_{10} dB		Peak 10 Second Interval (Lzpeak) dB	
		Average (dB)	Standard Deviation	Average (dB)	Standard Deviation
Pile 107 (10 m)	7:03	146	2.8	171	2.8
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Overall Average		**143**	**6**	**170**	**9**

Note for all sound metrics during concrete chipping:
The tabulated duration of driving generally excludes periods when the air hammer was stopped or paused for any reason. Statistics for the RMS and Peak metrics also generally exclude such interruptions, and are for the time periods used to sum up the duration value. This applies to Tables 1, 2 and 3.

Table 4. Summary of Air Borne Sound Levels During Underwater Concrete Chipping

Event	Duration Minutes	Unweighted Leq, dB		A-Weighted Leq, dB		Unweighted Peak Level, dB	
		Average	St. Dev.	Average	St. Dev.	Average	St. Dev.
Pile 108 (10 m)	23	90.3	2.7	70.4	1.8	99.3	2.5
Pile 106 (10 m)	34	88.1	3.0	69.2	1.7	98.5	3.8
Pile 102 (10 m)	10	89.1	0.3	74.4	2.2	103.6	3.3
Pile 99 (10 m)	13	82.5	1.2	62.6	1.6	98.1	1.7
Avg. Chipping at 10 m	**20**	**87.5**	**1.8**	**69.2**	**1.8**	**99.9**	**2.8**
Avg. Overall at 10 m	**248**	**84.4**	**7.2**	**67.1**	**6.8**	**99.2**	**6.4**
Pile 100 (30 m)	10	90.5	1.6	63.6	1.4	105.8	2.2
Pile 96 (20 m)	14	80.1	1.4	64.4	1.0	97.0	3.2

Note: The tabulated averages for individual piles include only the time periods for which the chipping hammer was reported to be active. The tabulated Avg. Overall covers a 248 minute period during which the chipping hammer was both active and inactive.

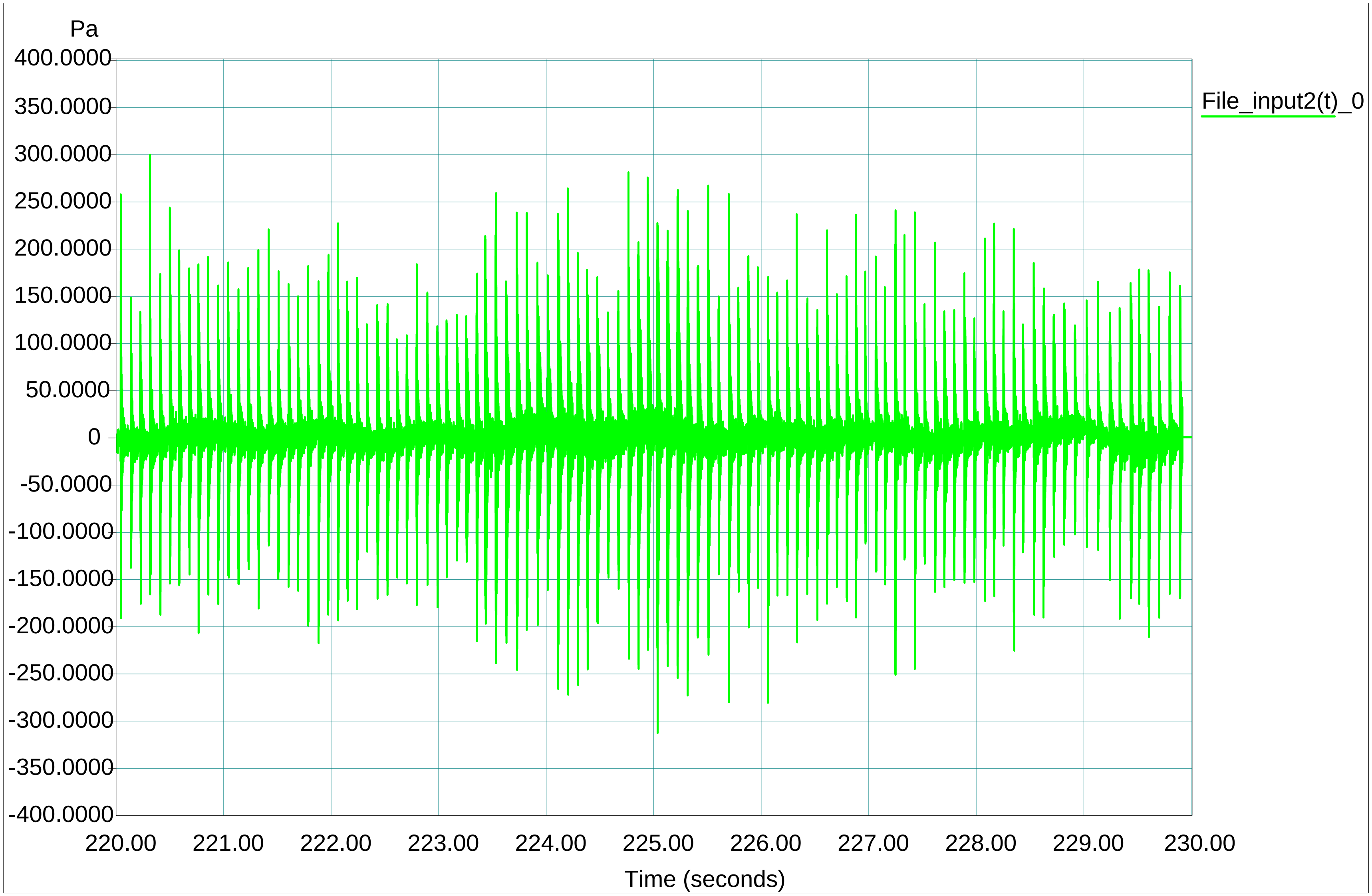


Figure 1. Time History of Underwater Sound Pressure Measurement for a 10 second period within Concrete Chipping for Pile 102, September 19, 2012

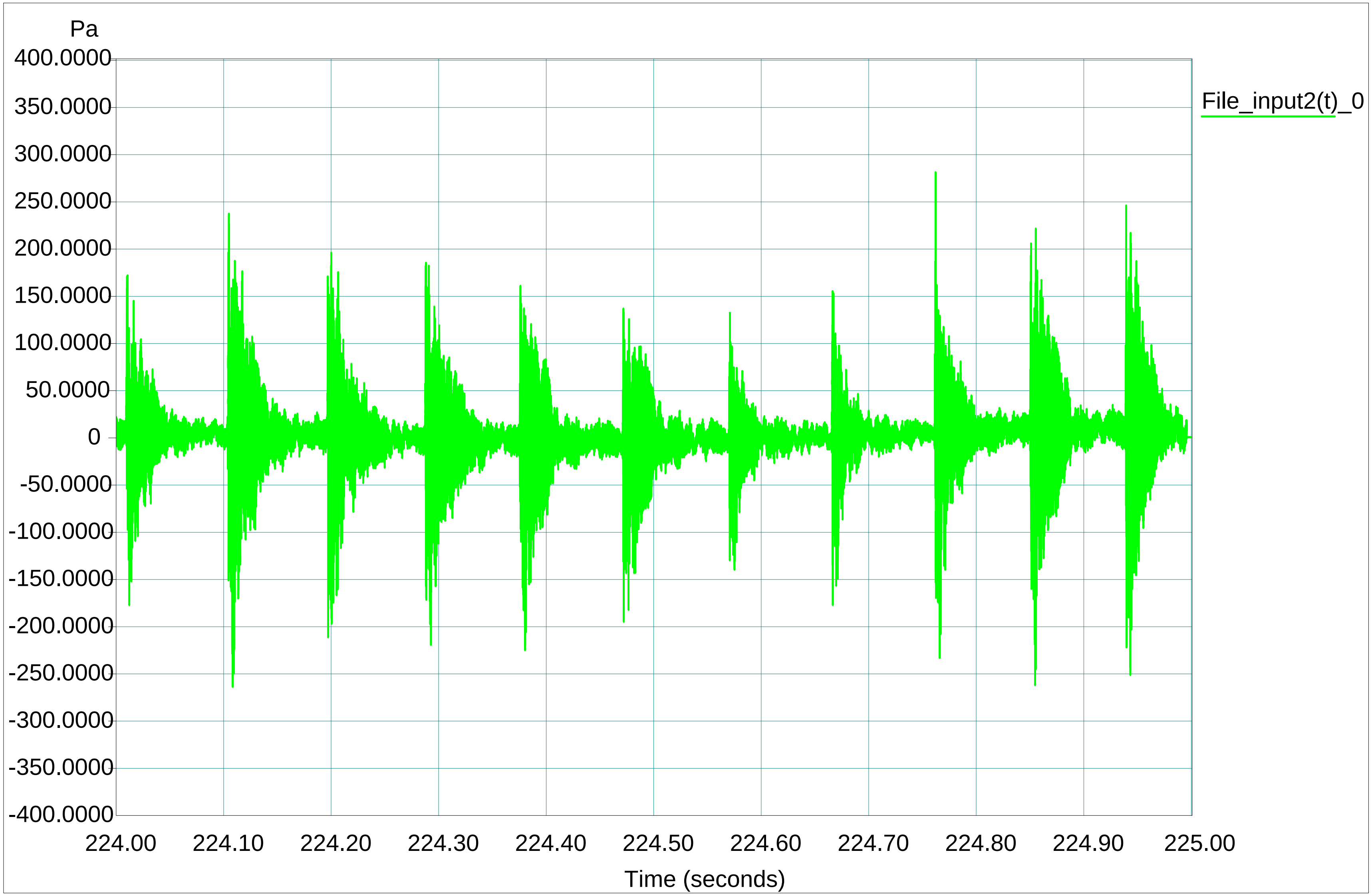


Figure 2. Time History of Underwater Sound Pressure Measurement for a 1 second period within Concrete Chipping for Pile 102, September 19, 2012

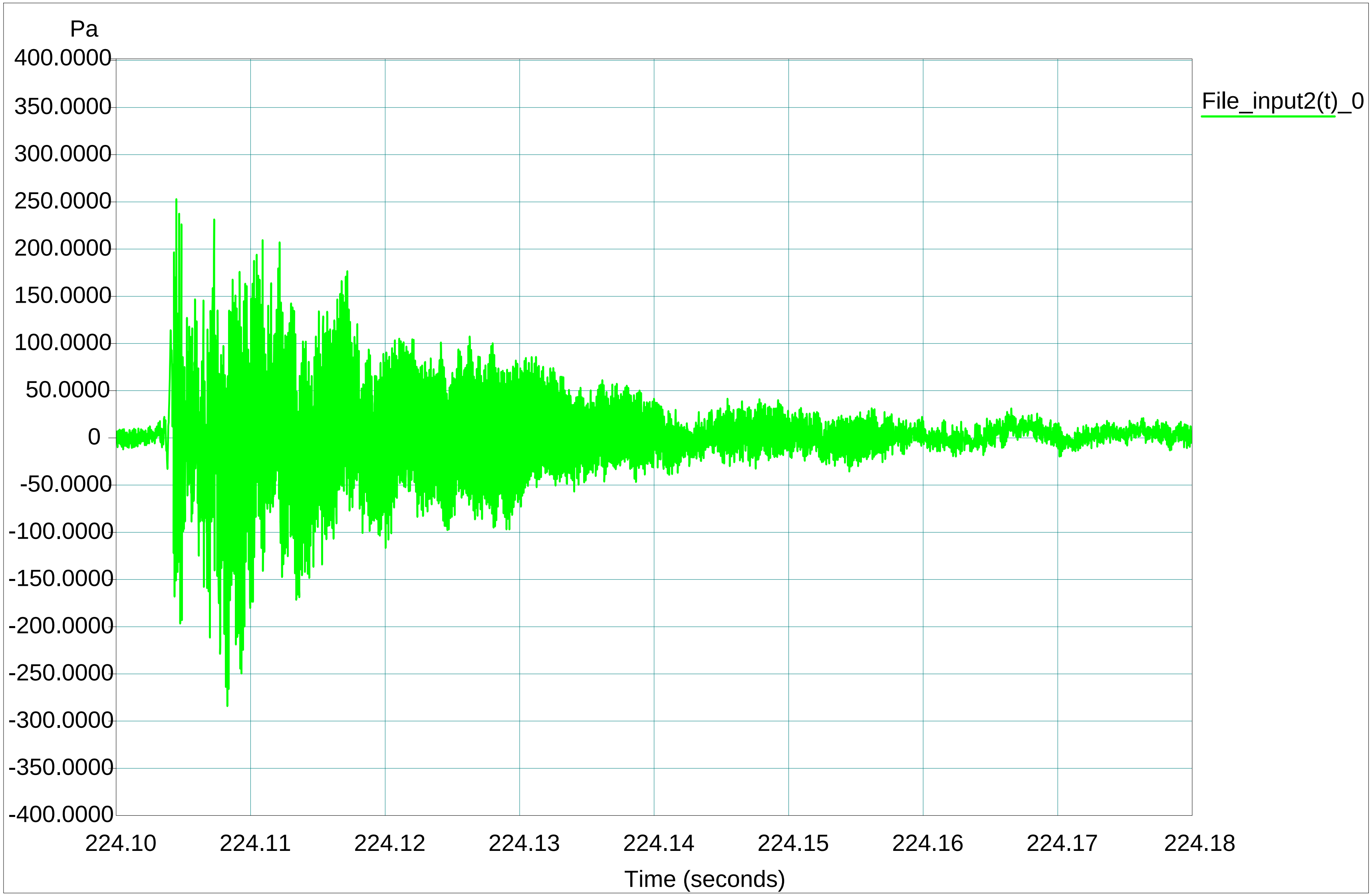
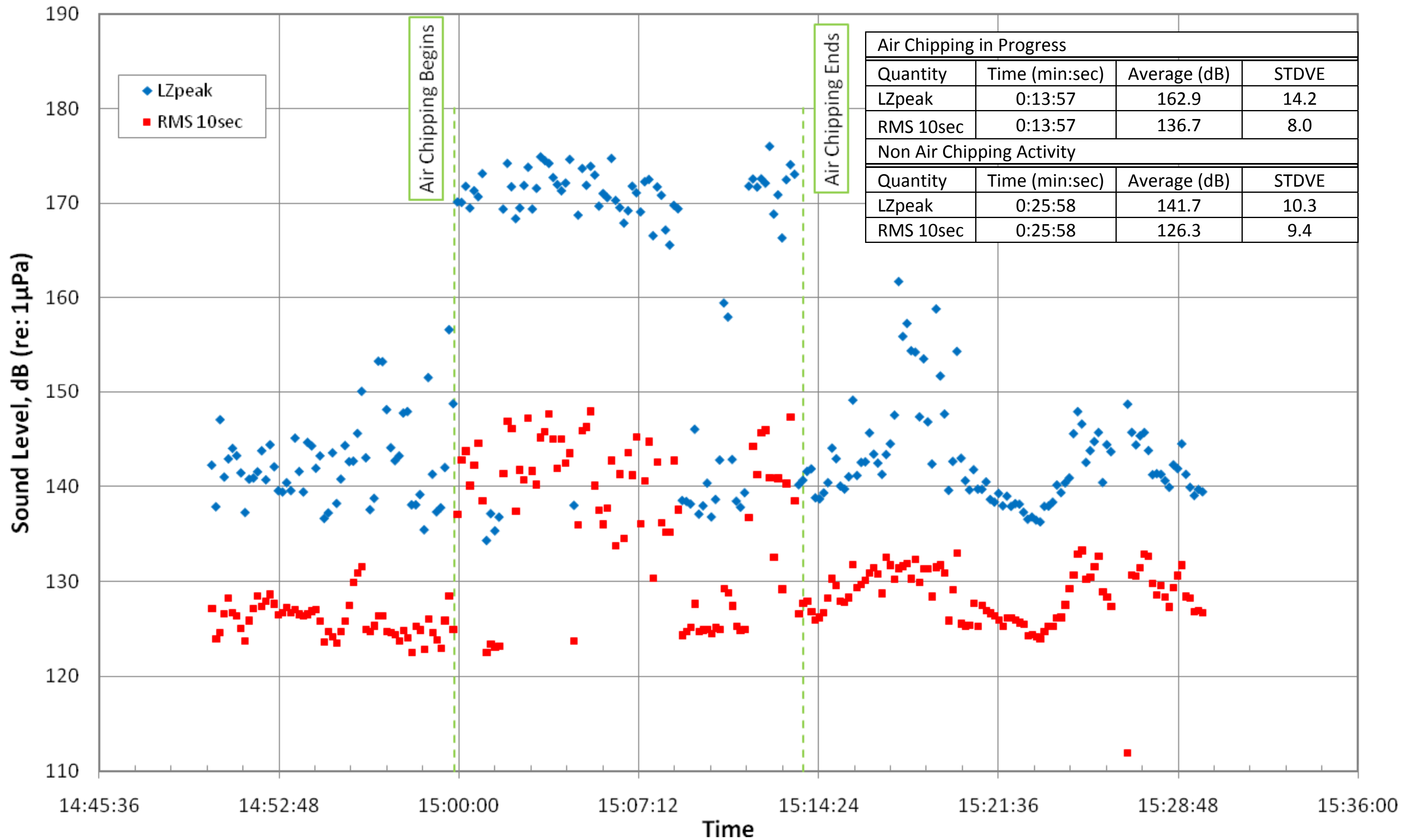


Figure 3. Time History of Underwater Sound Pressure Measurement one strike of the chipping hammer during Concrete Chipping for Pile 102, September 19, 2012



Air Chipping in Progress			
Quantity	Time (min:sec)	Average (dB)	STDVE
LZpeak	0:13:57	162.9	14.2
RMS 10sec	0:13:57	136.7	8.0
Non Air Chipping Activity			
Quantity	Time (min:sec)	Average (dB)	STDVE
LZpeak	0:25:58	141.7	10.3
RMS 10sec	0:25:58	126.3	9.4

Figure 4. Session Log For Concrete Chipping, Pile 105, 1 M Above Mud-Line, September 18, 2012

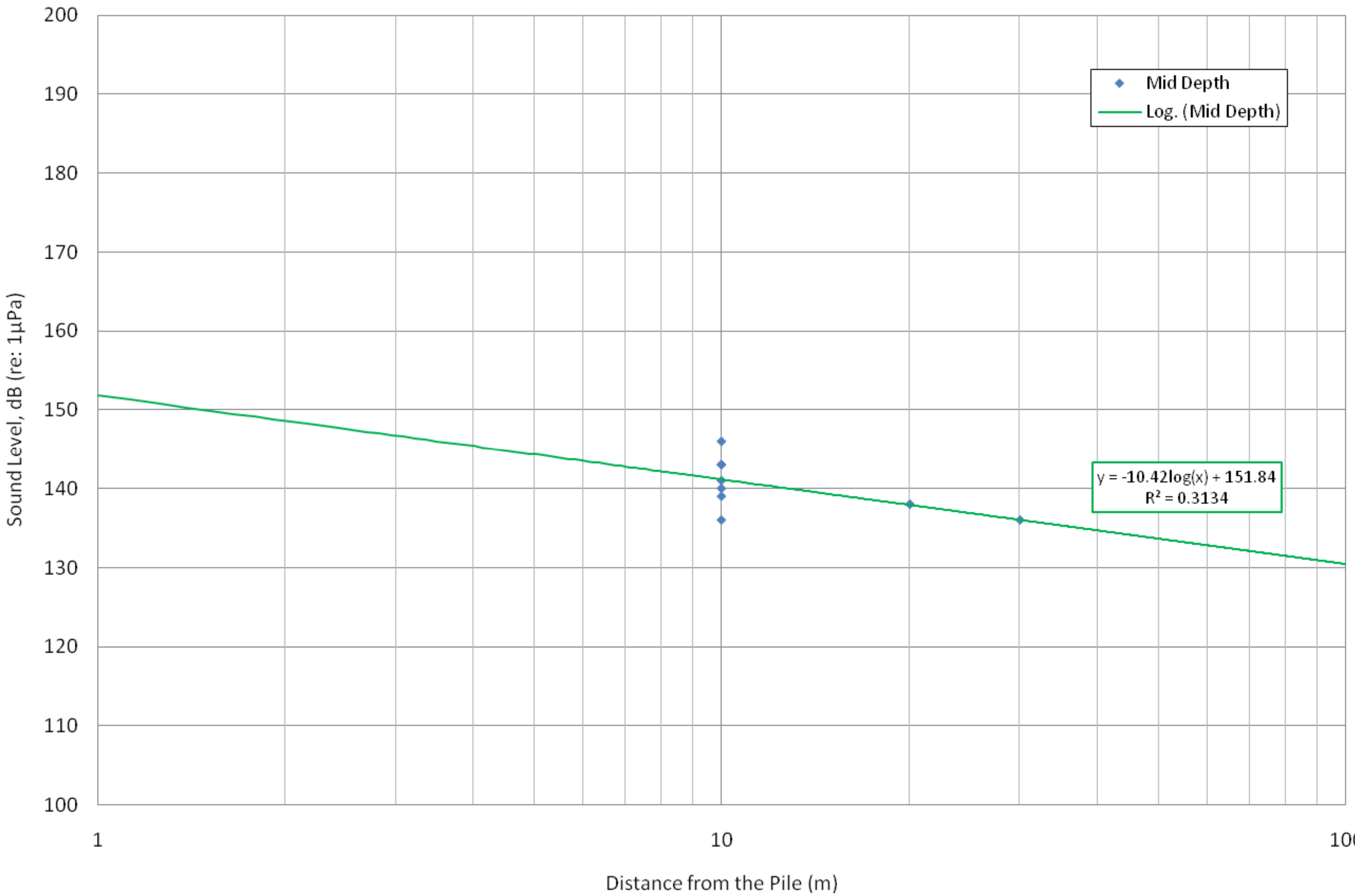


Figure 5. Acoustic Spreading Loss (RMS), Concrete Piles, Chipping Hammer, Mid-Water Depth

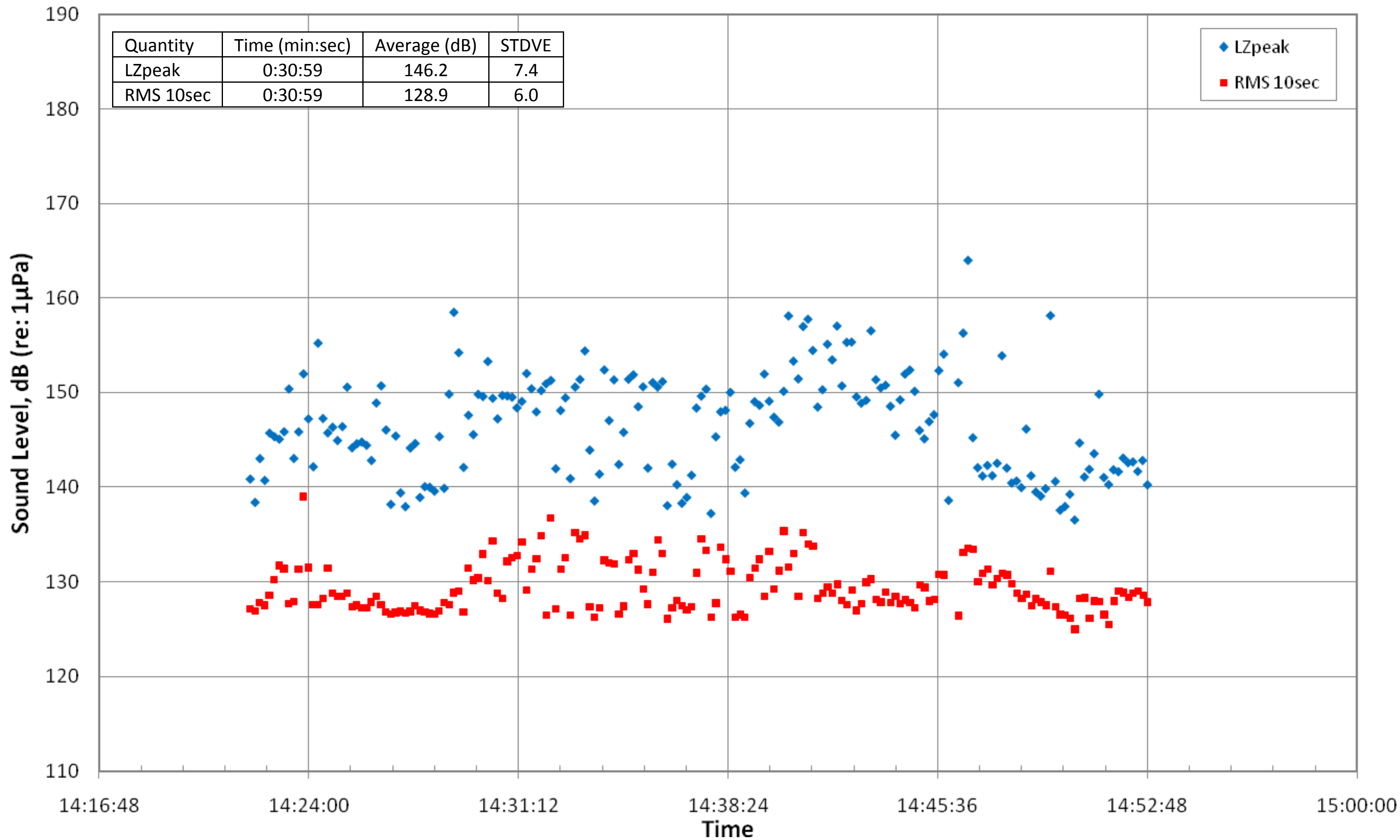


Figure 6. Continuous Ambient Sound Levels, September 18, 2012 during contractors "Lunch Break," Mid-Water Depth

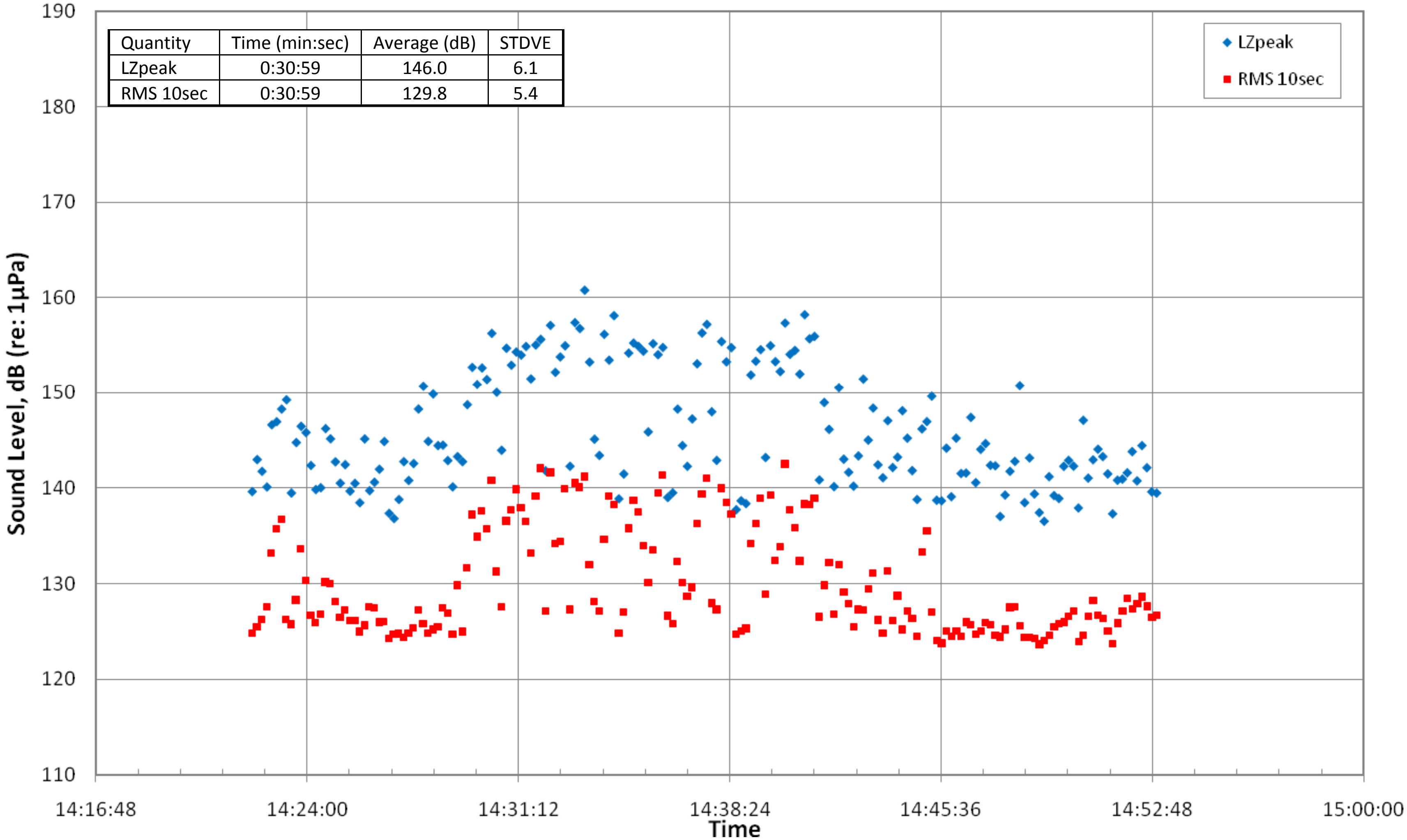


Figure 7. Continuous Ambient Sound Levels, September 18, 2012 during contractors “Lunch Break,” 1-M Above Mud-Line

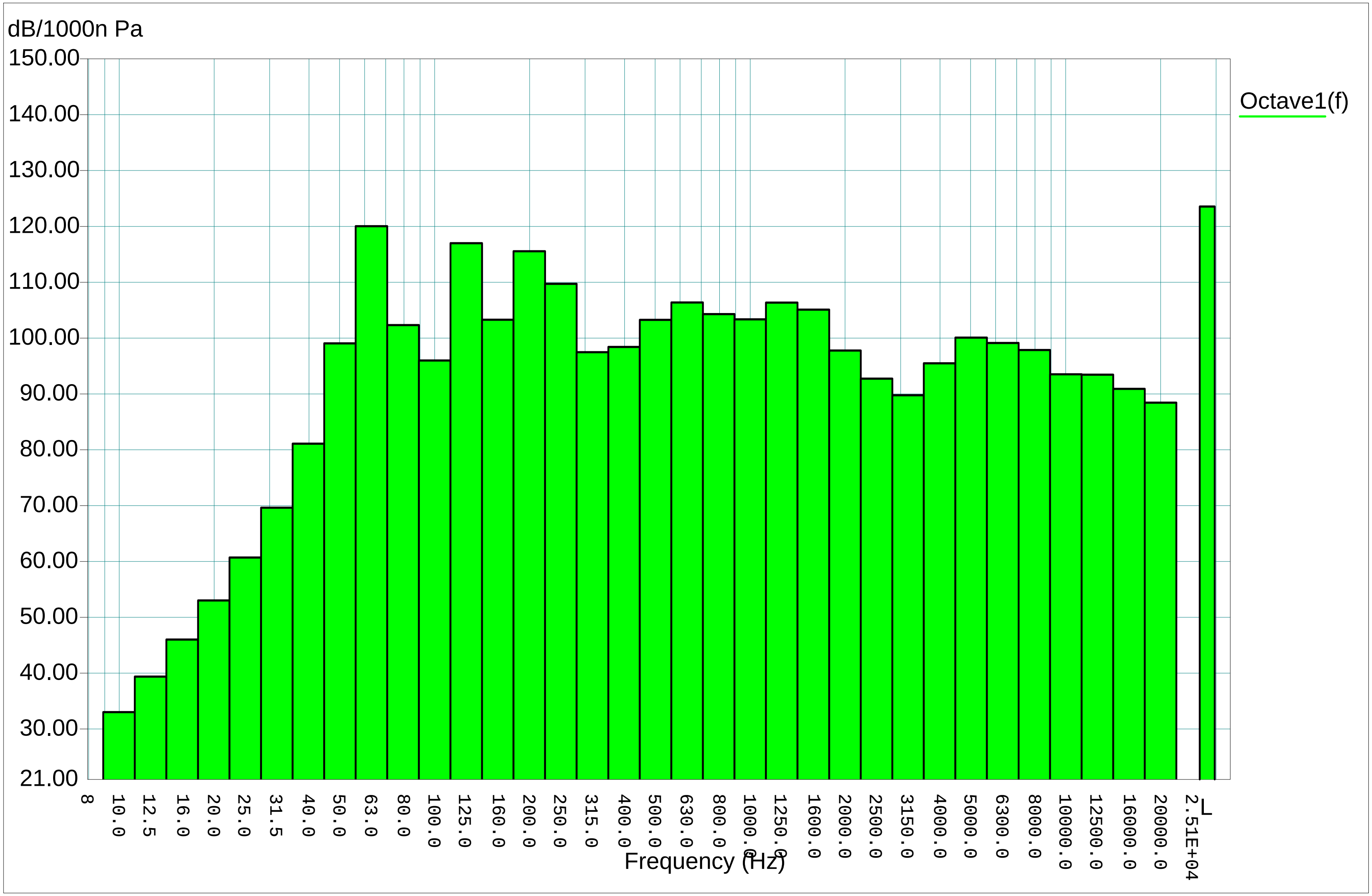


Figure 8. Frequency Spectra for Ambient Sound Levels, One-third Octave Bands, 1 m above Mud-line, "Lunch Break" September 18, 2012

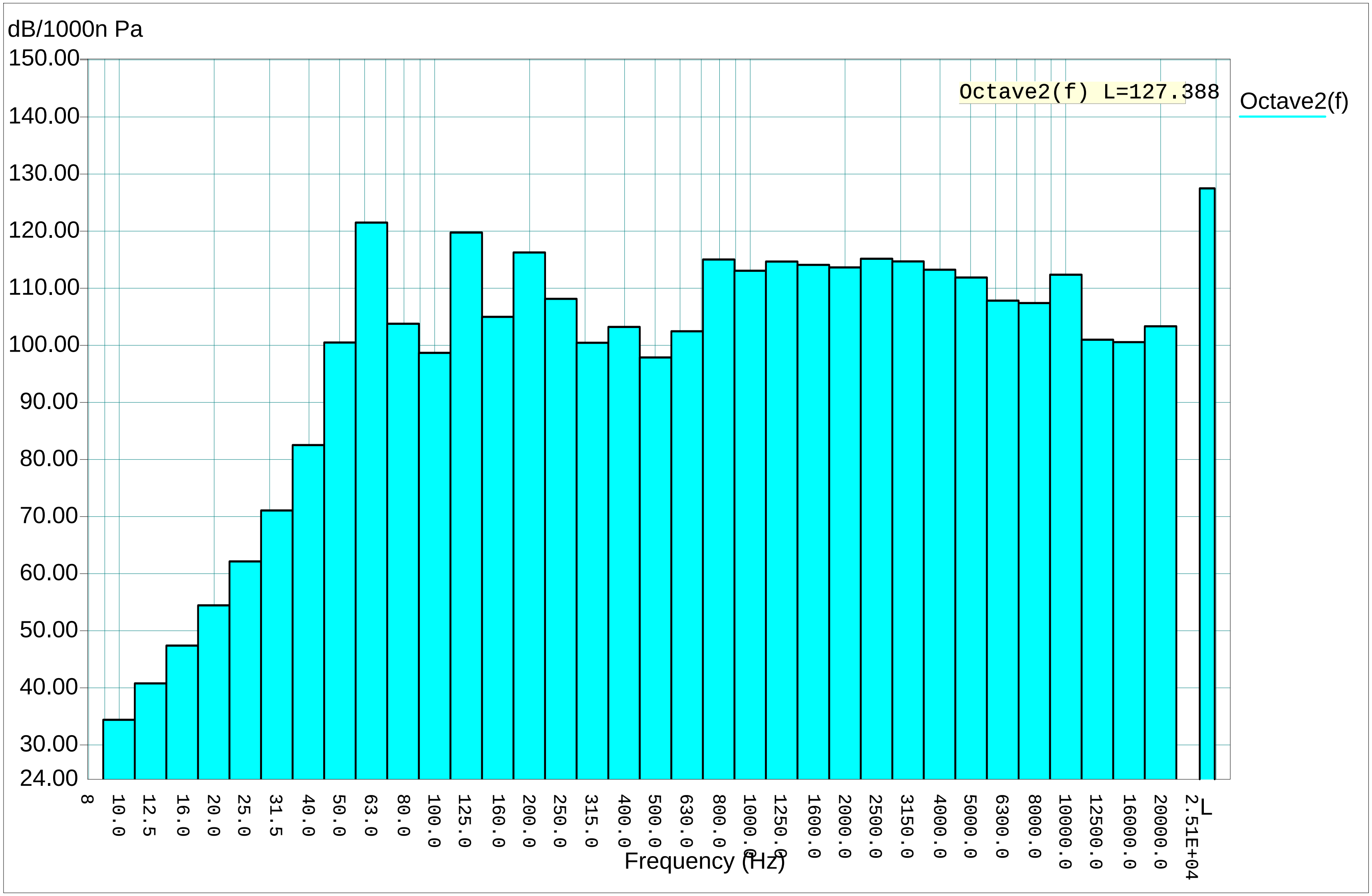


Figure 9. Frequency Spectra for Concrete Chipping of Pile 102, One-third Octave Bands, Mid-Water Depth

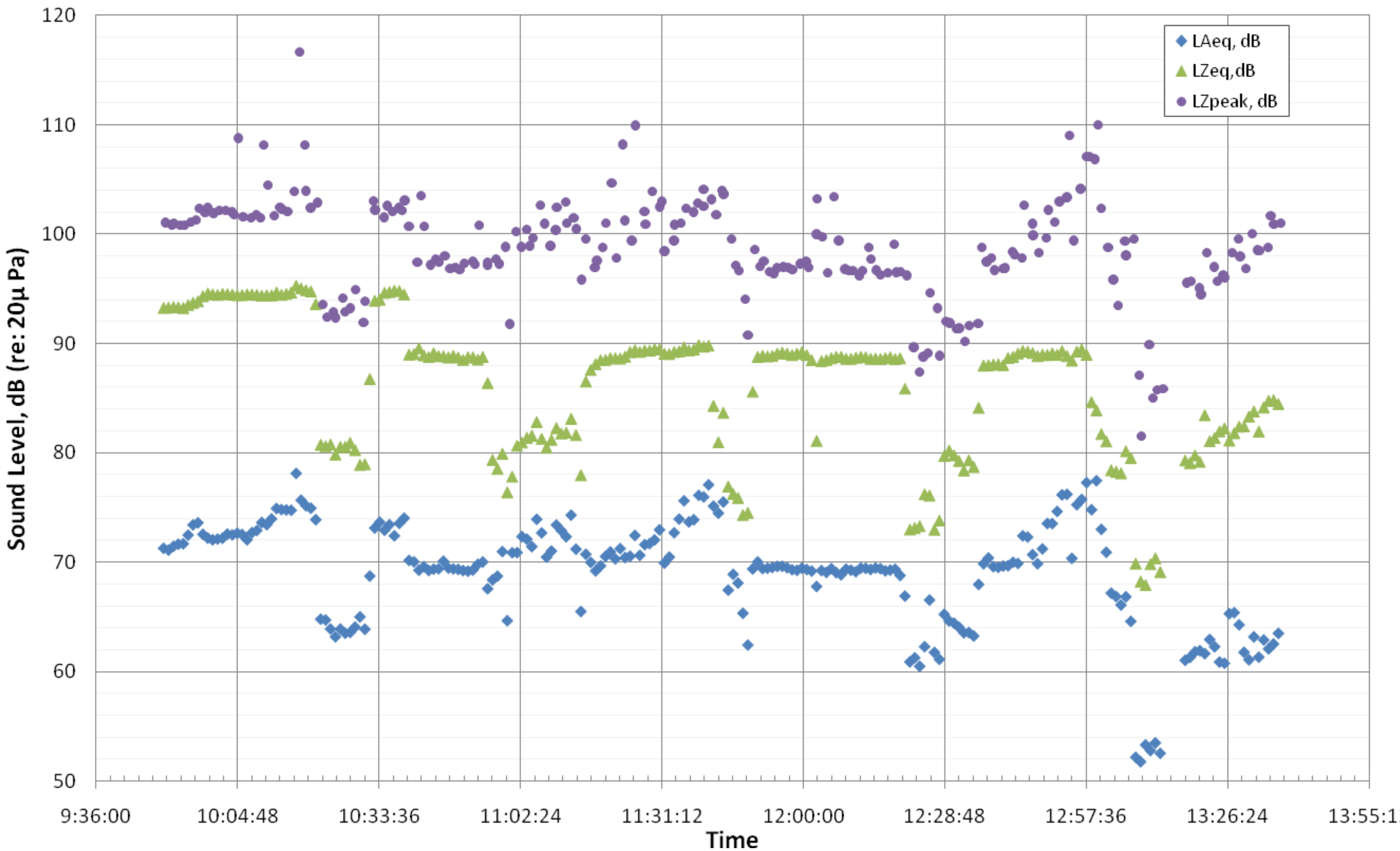


Figure 10: Time History of Airborne Sounds as Piles 108, 106, 102 and 99 were chipped and removed.

Appendix A

Session Logs including
Sound Pressure Metrics for a
Ten Second RMS Integration Period:

Underwater Concrete Chipping
with Air Hammer

EHW & WW CONCRETE PILES

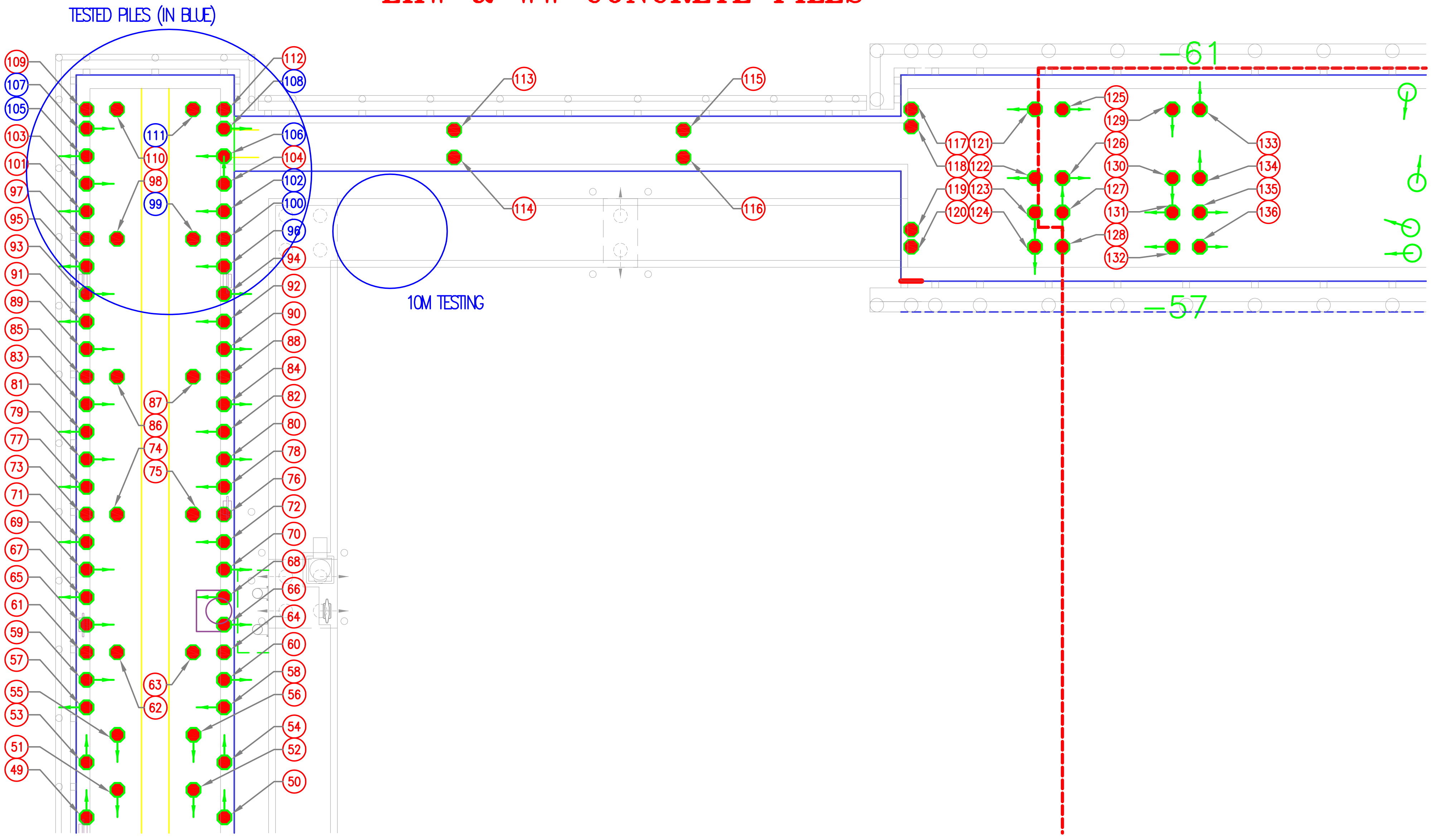
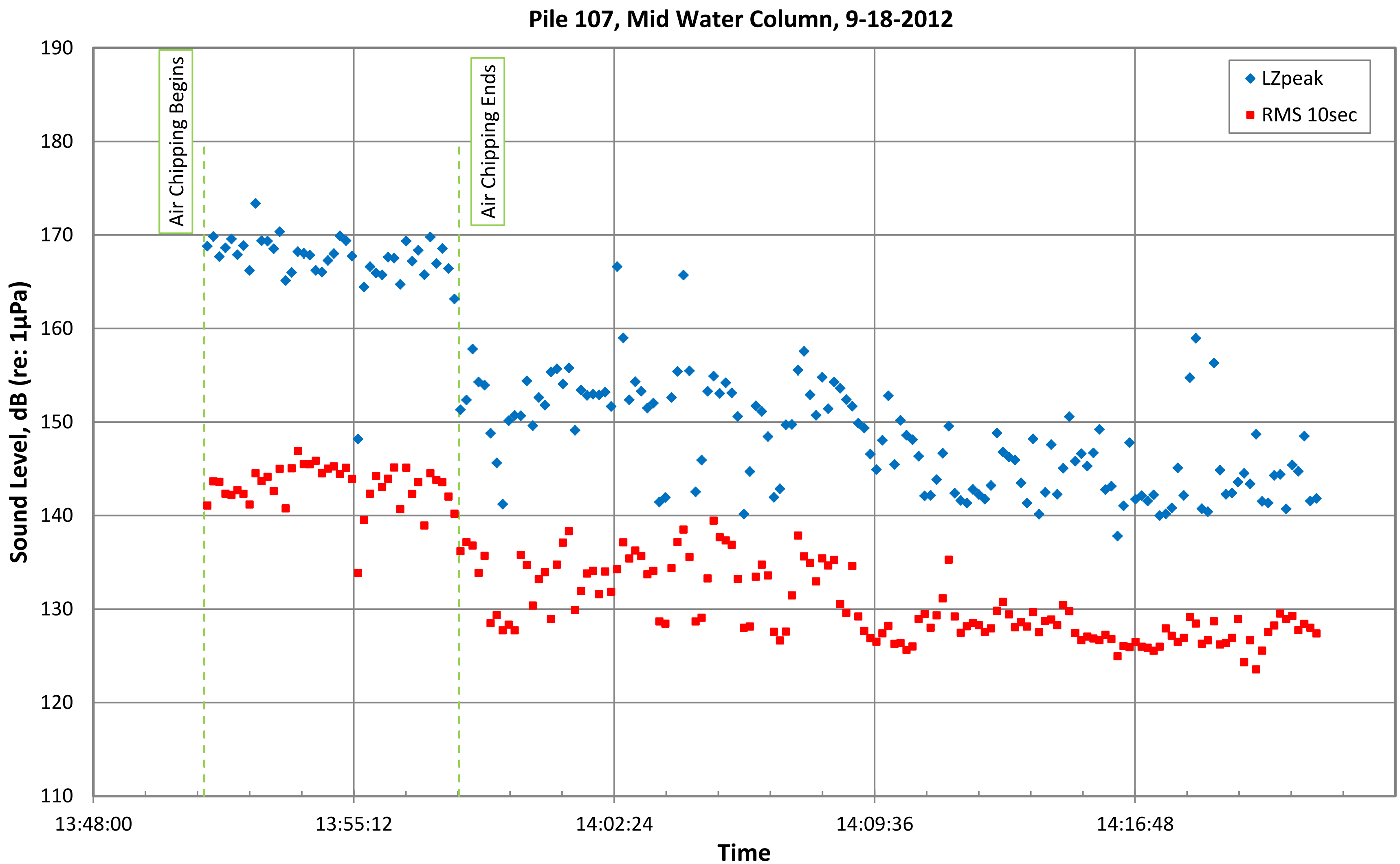


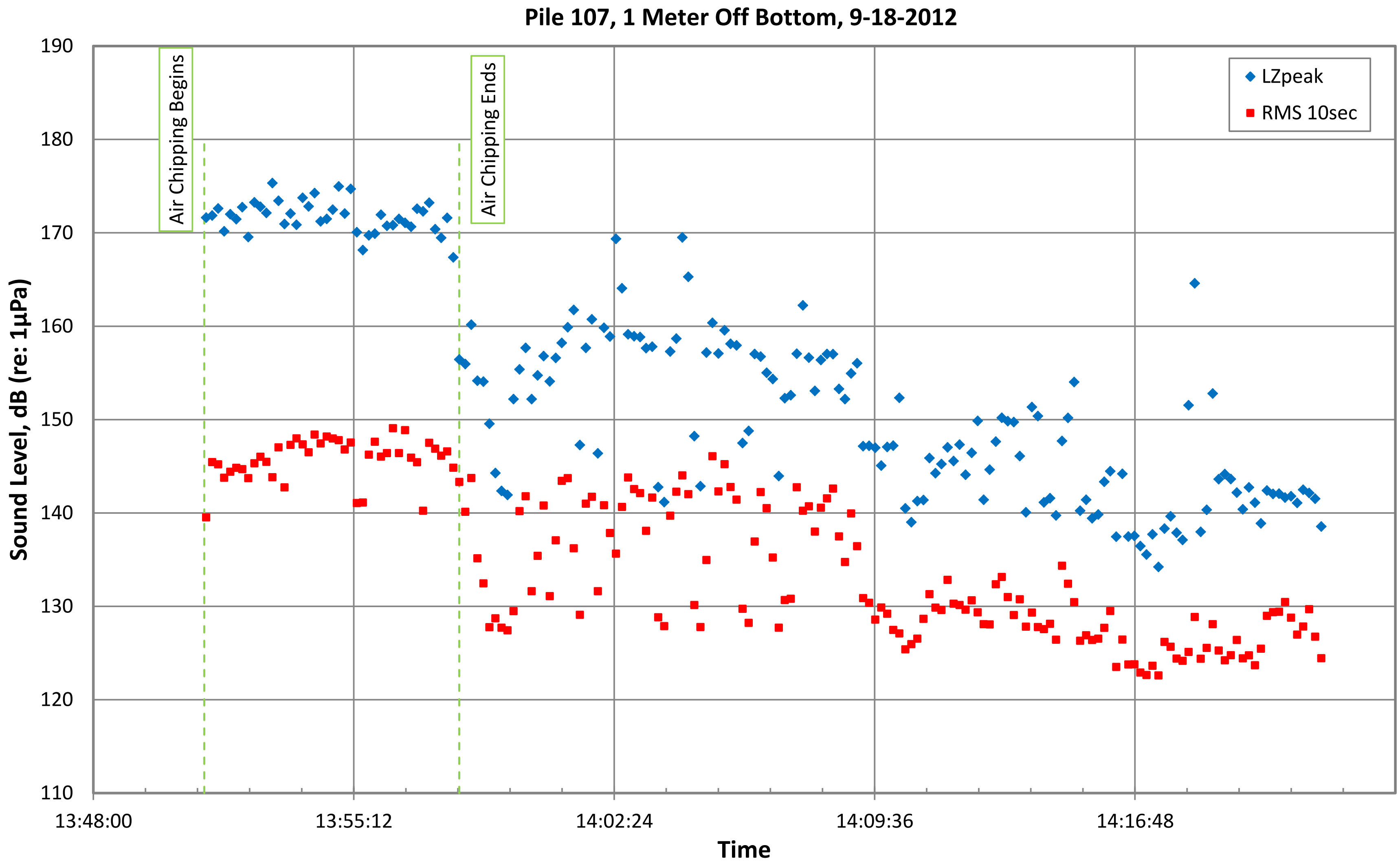
FIGURE A-1



Air Chipping in Progress			
Quantity	Time (min:sec)	Average (dB)	STDVE
LZpeak	0:07:03	167.3	3.5
RMS 10sec	0:07:03	143.2	2.3

Non Air Chipping Activity			
Quantity	Time (min:sec)	Average (dB)	STDVE
LZpeak	0:23:49	148.1	5.6
RMS 10sec	0:23:49	130.3	3.8

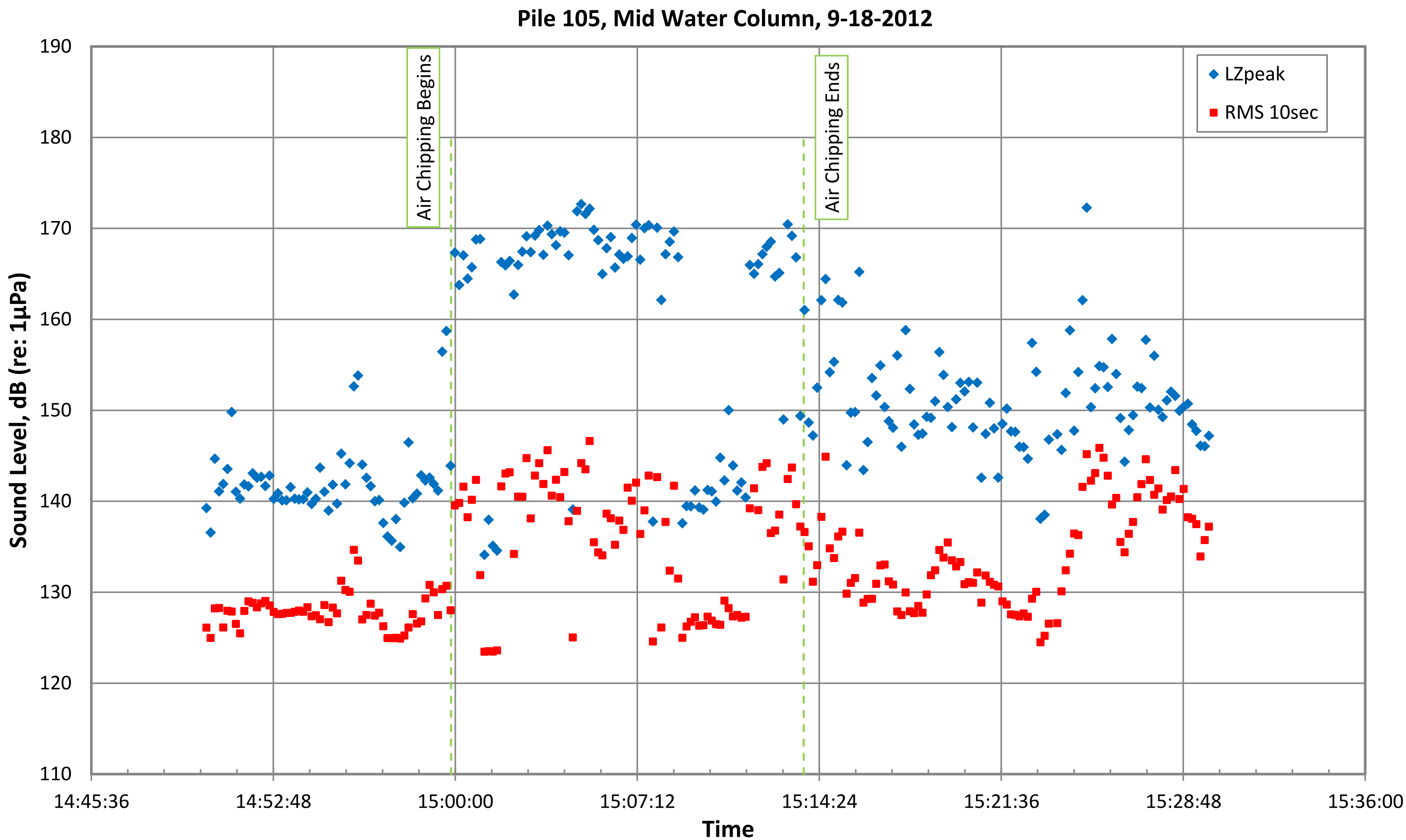
Input: 120918 003a



Air Chipping in Progress			
Quantity	Time (min:sec)	Average (dB)	STDVE
LZpeak	0:07:03	171.4	2.8
RMS 10sec	0:07:03	145.7	2.2

Non Air Chipping Activity			
Quantity	Time (min:sec)	Average (dB)	STDVE
LZpeak	0:23:49	148.9	8.0
RMS 10sec	0:23:49	132.0	6.4

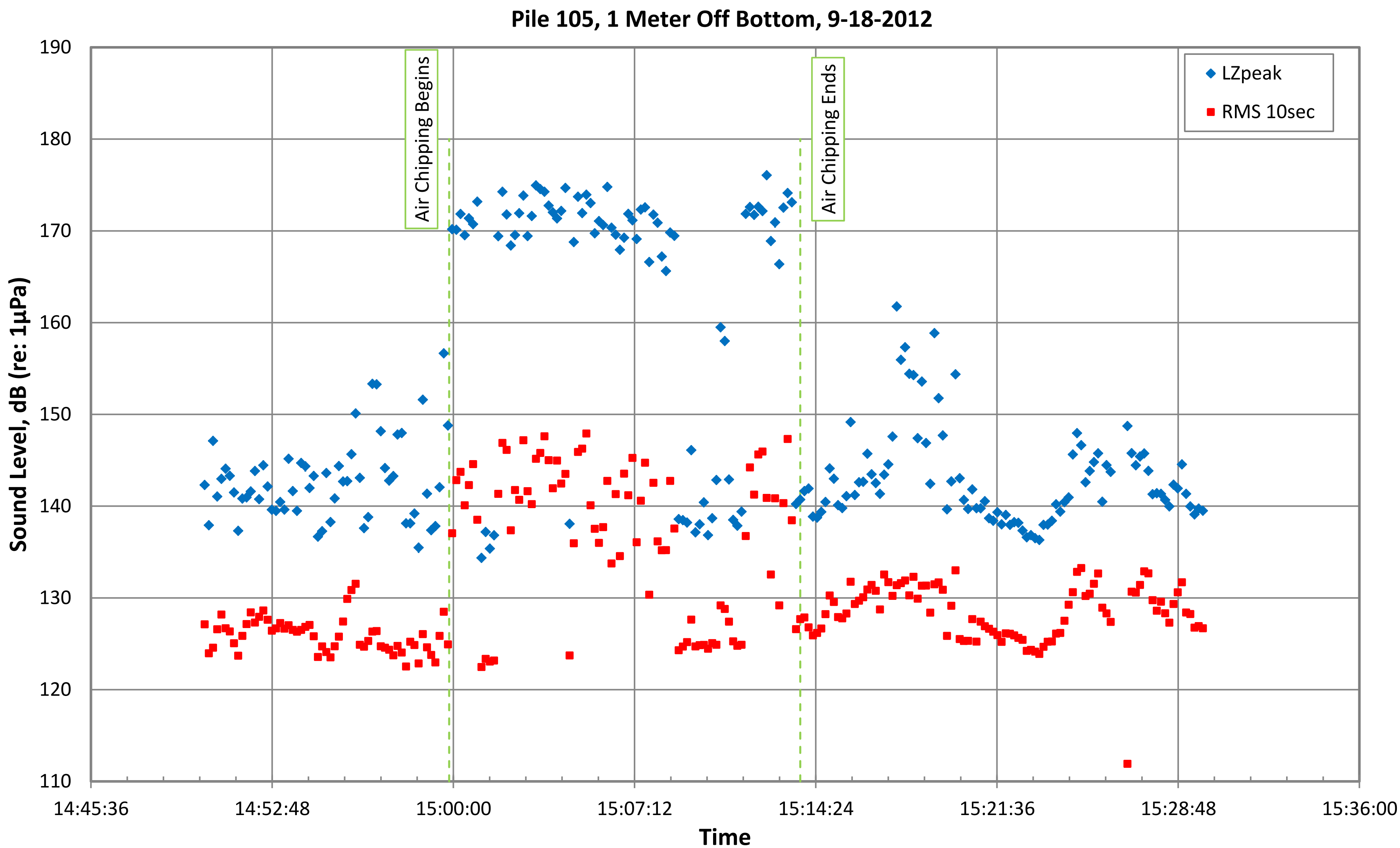
Input: 120918 004a



Air Chipping in Progress			
Quantity	Time (min:sec)	Average (dB)	STDVE
LZpeak	0:13:57	160.0	12.6
RMS 10sec	0:13:57	136.0	6.9

Non Air Chipping Activity			
Quantity	Time (min:sec)	Average (dB)	STDVE
LZpeak	0:25:58	147.3	8.8
RMS 10sec	0:25:58	131.4	7.7

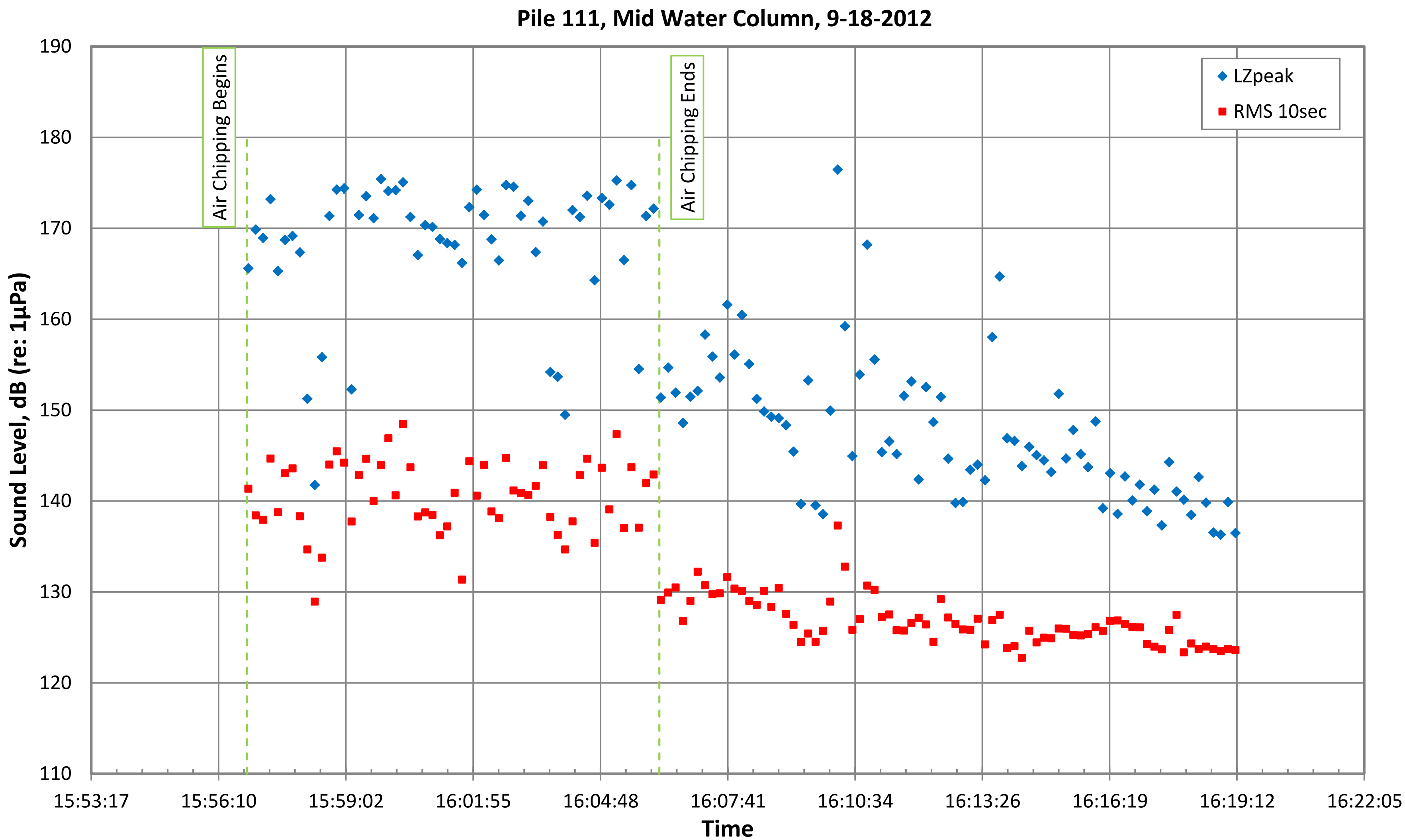
Input: 120918 003b



Air Chipping in Progress			
Quantity	Time (min:sec)	Average (dB)	STDVE
LZpeak	0:13:57	162.9	14.2
RMS 10sec	0:13:57	136.7	8.0

Non Air Chipping Activity			
Quantity	Time (min:sec)	Average (dB)	STDVE
LZpeak	0:25:58	141.7	10.3
RMS 10sec	0:25:58	126.3	9.4

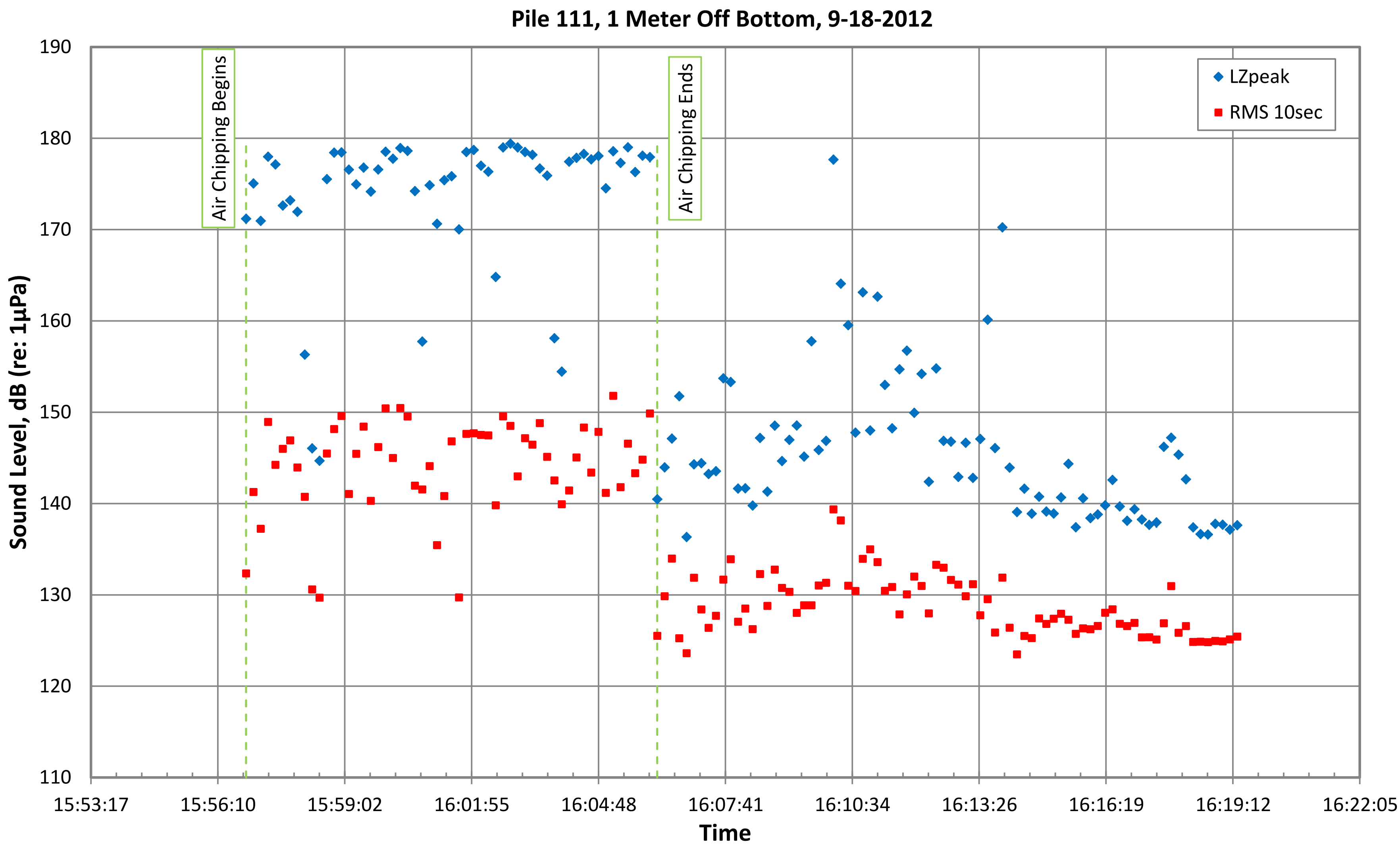
Input: 120918 004b



Air Chipping in Progress			
Quantity	Time (min:sec)	Average (dB)	STDVE
LZpeak	0:09:20	168.2	7.5
RMS 10sec	0:09:20	140.5	4.0

Non Air Chipping Activity			
Quantity	Time (min:sec)	Average (dB)	STDVE
LZpeak	0:13:09	147.5	7.7
RMS 10sec	0:13:09	126.9	2.6

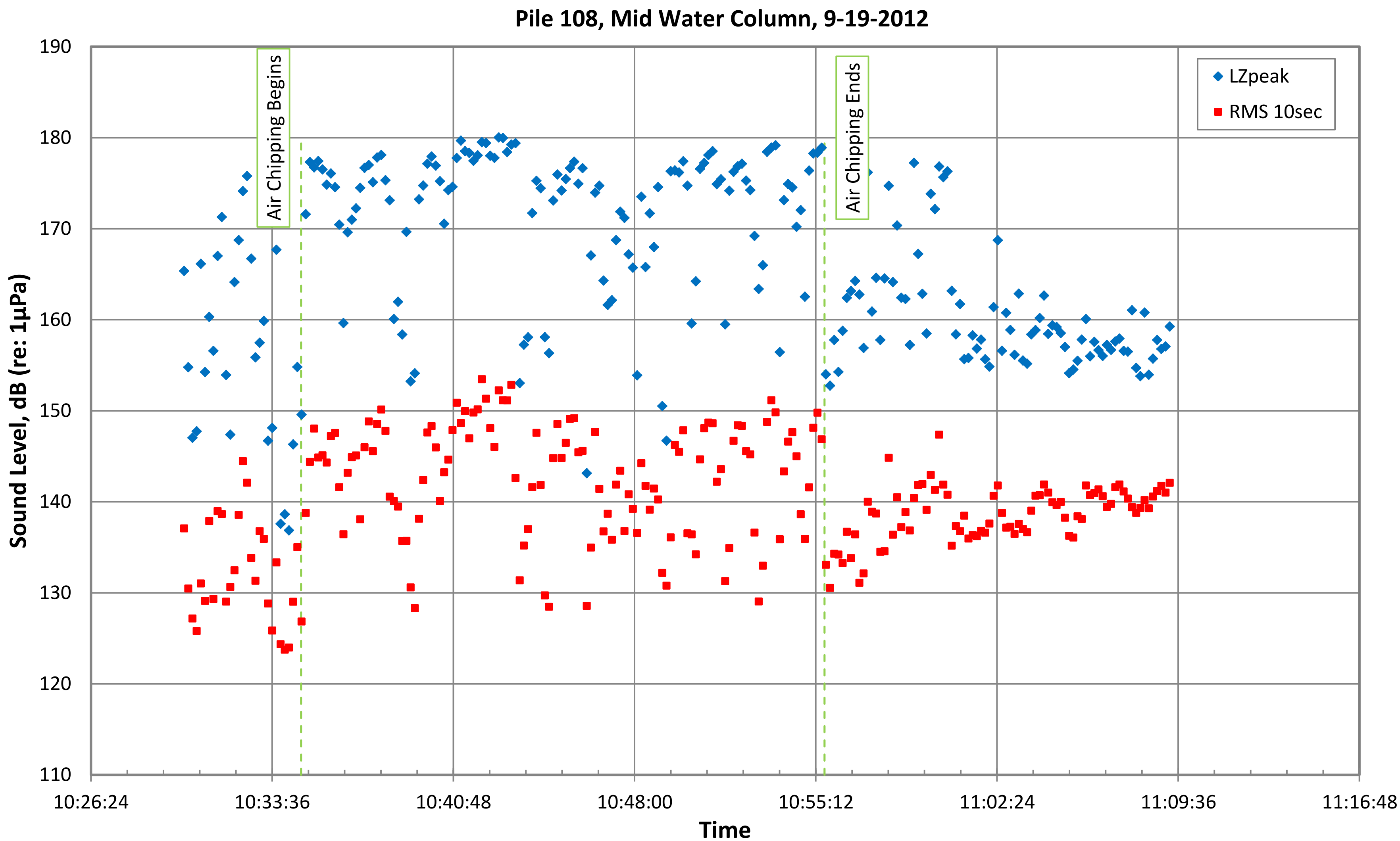
Input: 120918 004



Air Chipping in Progress			
Quantity	Time (min:sec)	Average (dB)	STDVE
LZpeak	0:09:20	173.1	9.0
RMS 10sec	0:09:20	143.8	5.6

Non Air Chipping Activity			
Quantity	Time (min:sec)	Average (dB)	STDVE
LZpeak	0:13:09	145.9	8.2
RMS 10sec	0:13:09	128.8	3.3

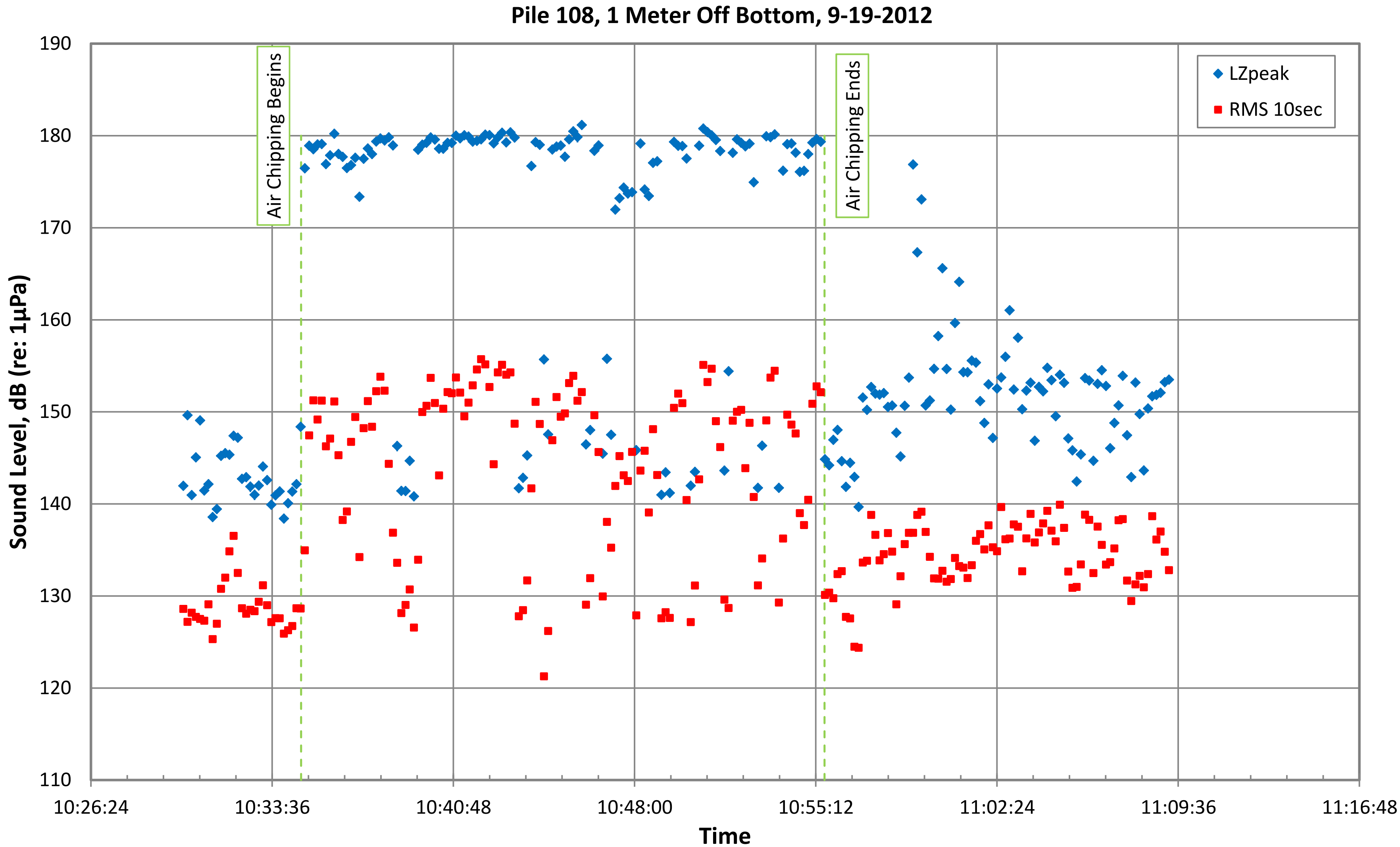
Input: 120918 005



Air Chipping in Progress			
Quantity	Time (min:sec)	Average (dB)	STDVE
LZpeak	0:20:48	171.5	8.2
RMS 10sec	0:20:48	142.8	6.3

Non Air Chipping Activity			
Quantity	Time (min:sec)	Average (dB)	STDVE
LZpeak	0:18:26	159.5	7.6
RMS 10sec	0:18:26	137.1	4.7

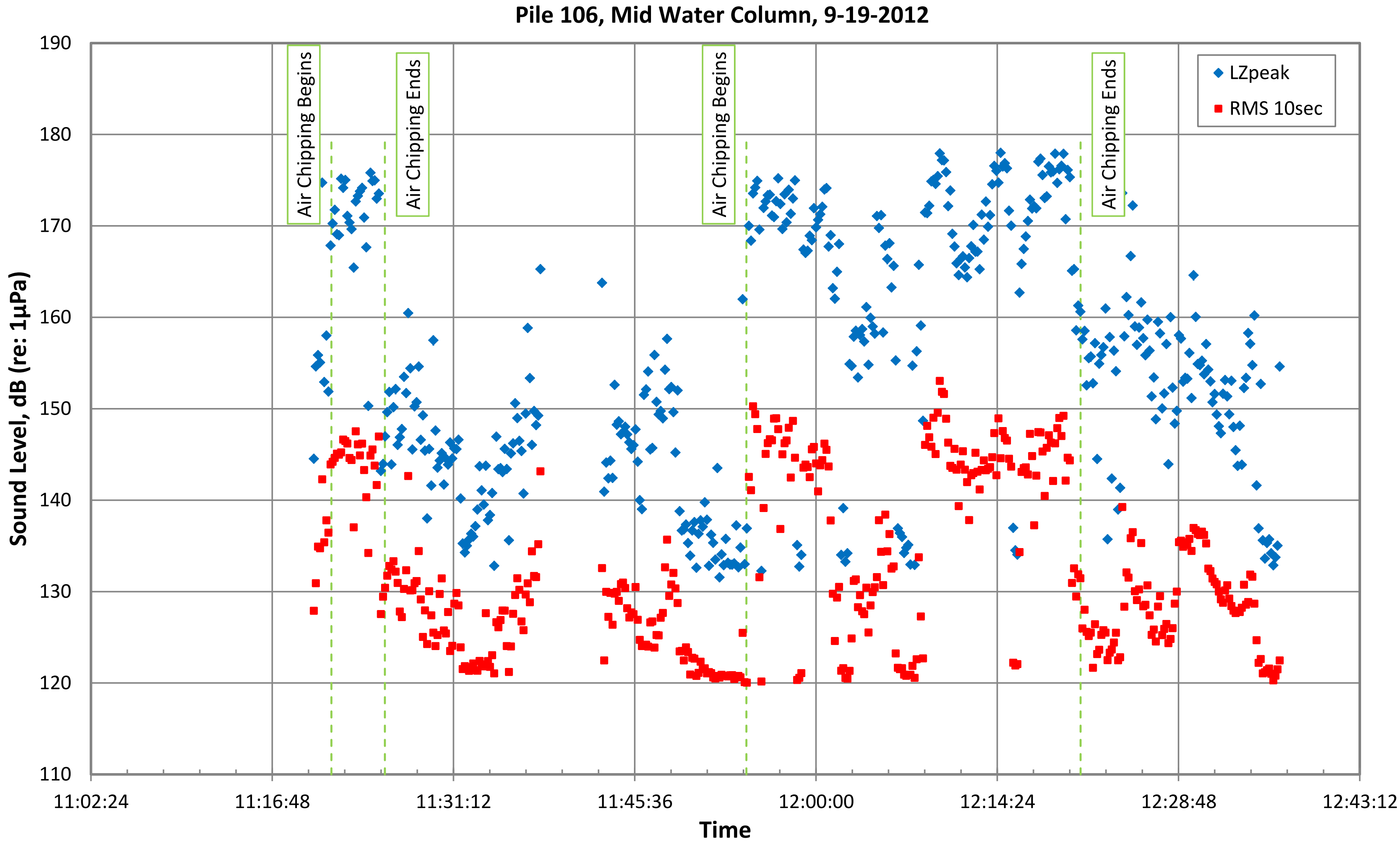
Input: 120919 001a



Air Chipping in Progress			
Quantity	Time (min:sec)	Average (dB)	STDVE
LZpeak	0:20:48	171.5	13.8
RMS 10sec	0:20:48	144.3	9.0

Non Air Chipping Activity			
Quantity	Time (min:sec)	Average (dB)	STDVE
LZpeak	0:18:26	149.5	6.7
RMS 10sec	0:18:26	133.0	4.0

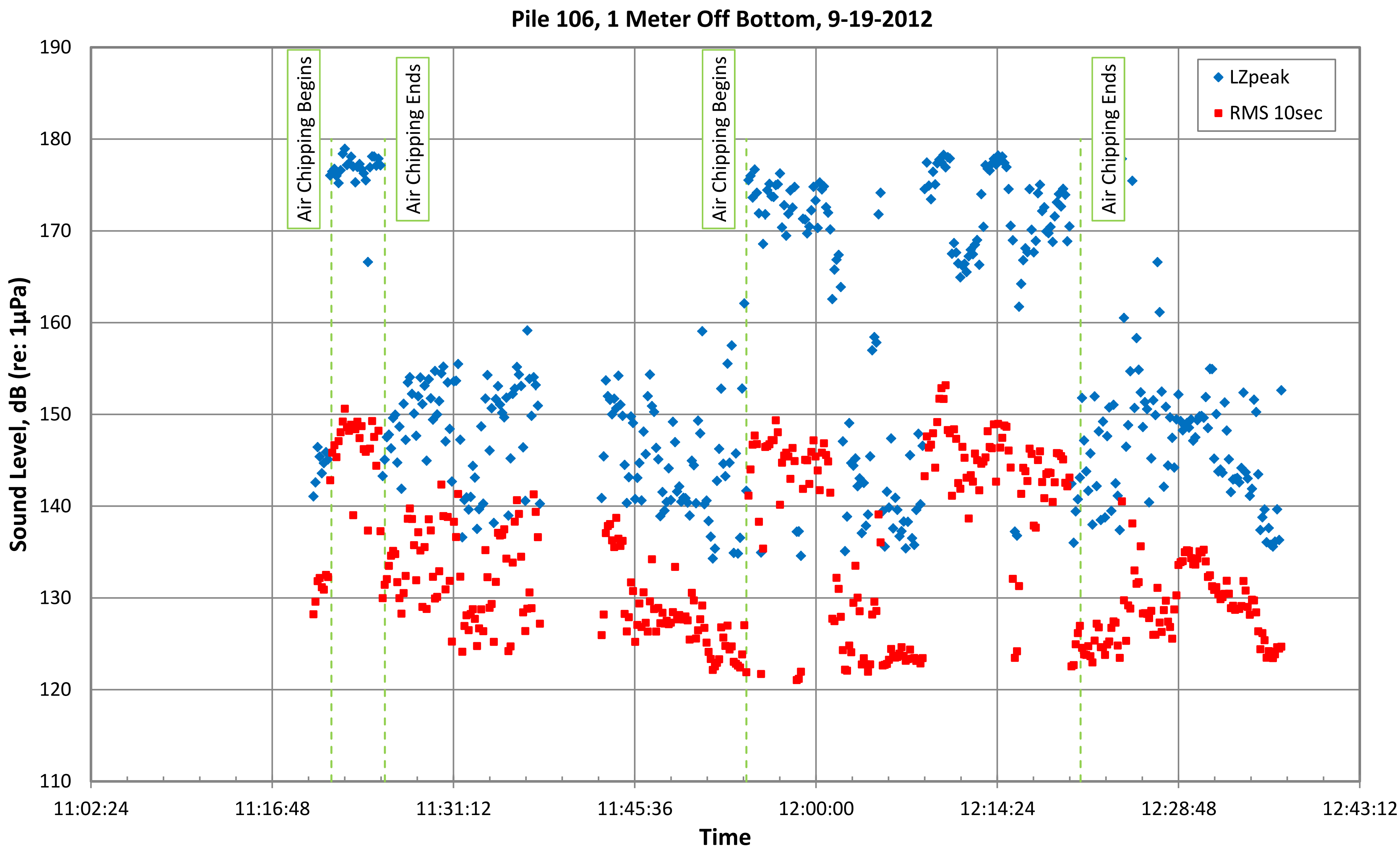
Input: 120919 001a



Air Chipping in Progress			
Quantity	Time (min:sec)	Average (dB)	STDVE
LZpeak	0:30:48	165.4	12.5
RMS 10sec	0:30:48	138.9	9.3

Non Air Chipping Activity			
Quantity	Time (min:sec)	Average (dB)	STDVE
LZpeak	0:49:08	149.3	10.3
RMS 10sec	0:49:08	128.7	6.4

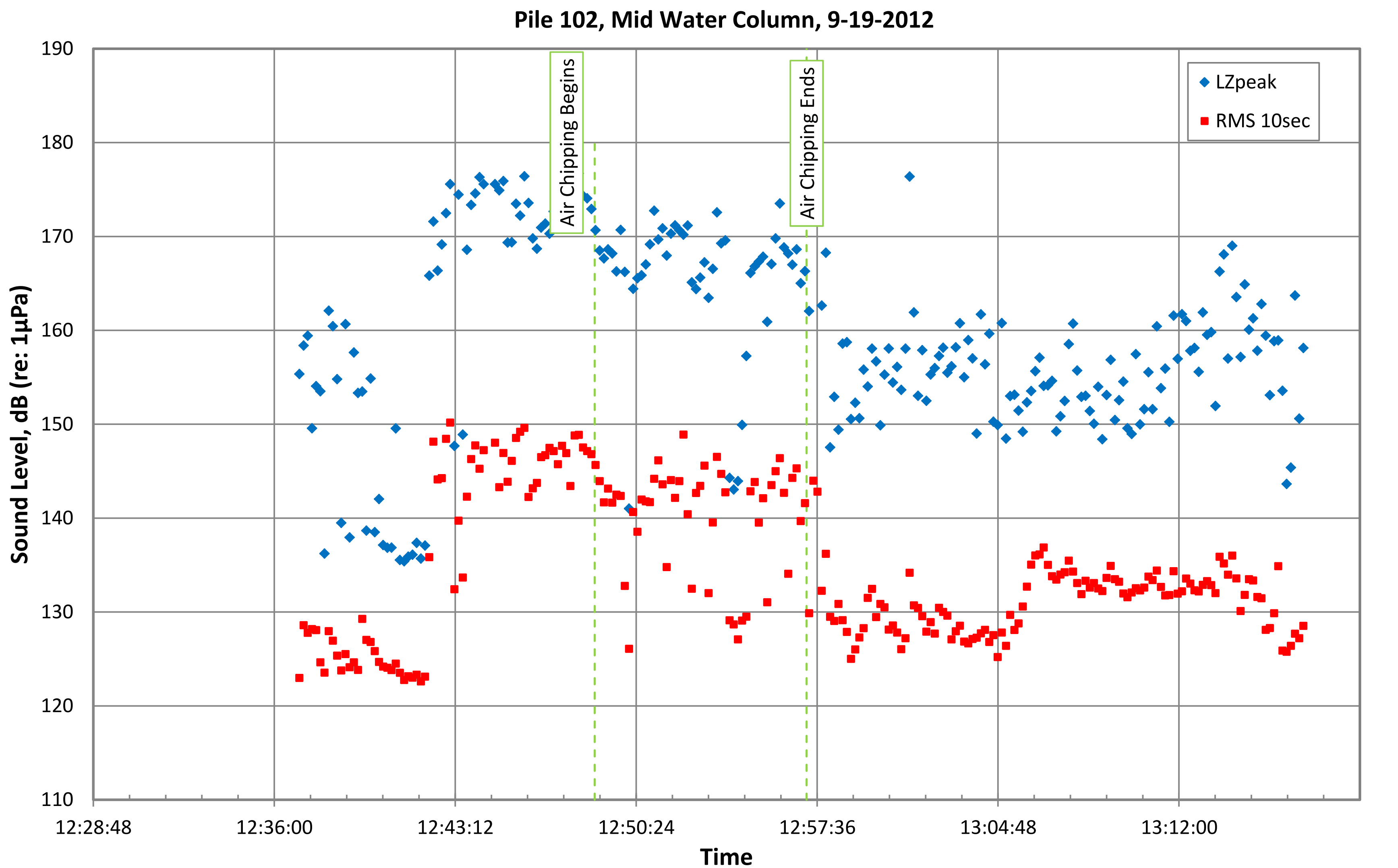
Input: 120919 001b



Air Chipping in Progress			
Quantity	Time (min:sec)	Average (dB)	STDVE
LZpeak	0:30:48	164.3	14.8
RMS 10sec	0:30:48	138.9	9.8

Non Air Chipping Activity			
Quantity	Time (min:sec)	Average (dB)	STDVE
LZpeak	0:49:08	149.2	9.8
RMS 10sec	0:49:08	131.1	6.2

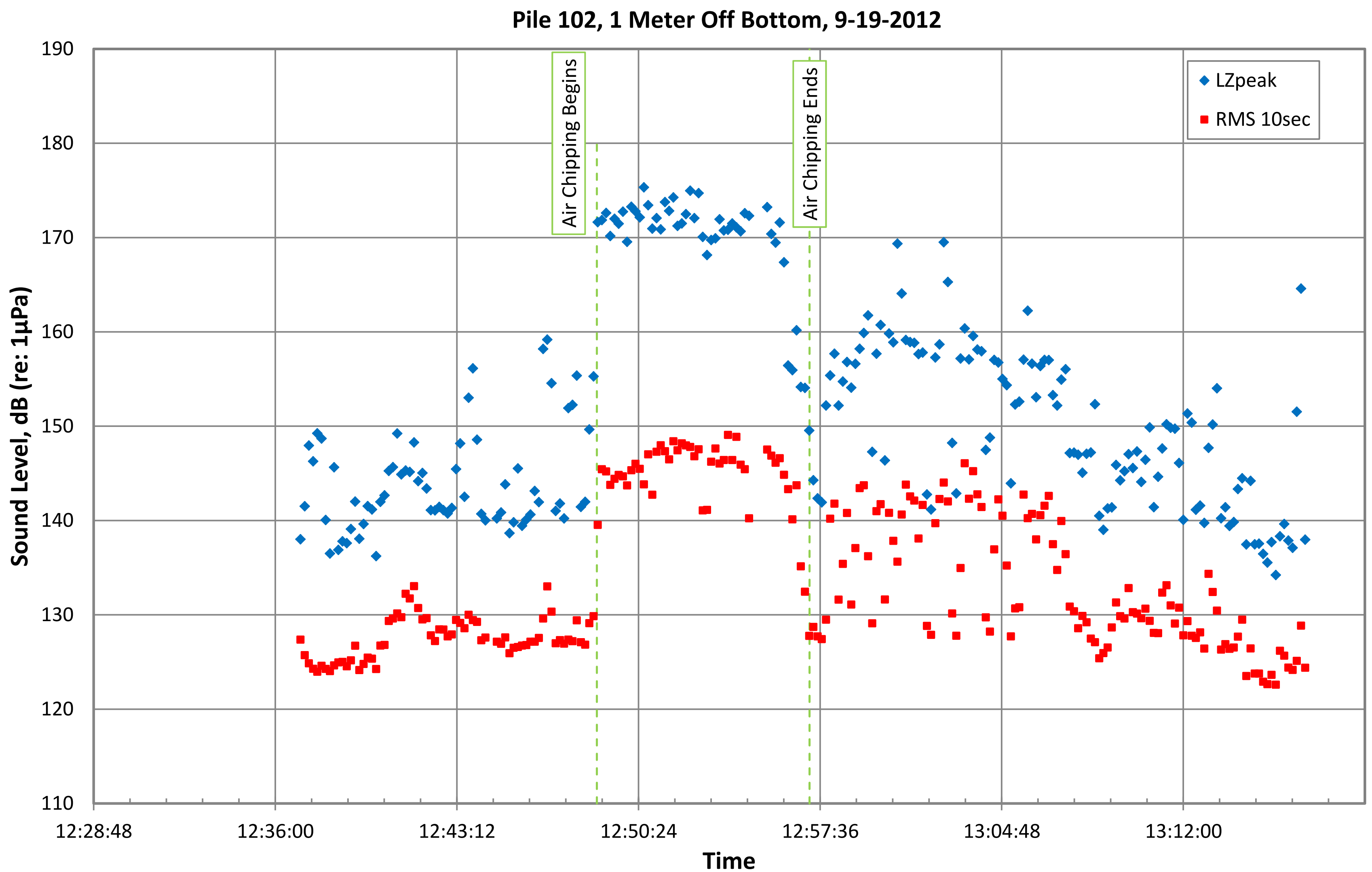
Input: 120919 001b



Air Chipping in Progress			
Quantity	Time (min:sec)	Average (dB)	STDVE
LZpeak	0:08:26	165.5	7.6
RMS 10sec	0:08:26	140.2	5.8

Non Air Chipping Activity			
Quantity	Time (min)	Average (dB)	STDVE
LZpeak	0:31:31	157.9	10.3
RMS 10sec	0:31:31	133.3	7.4

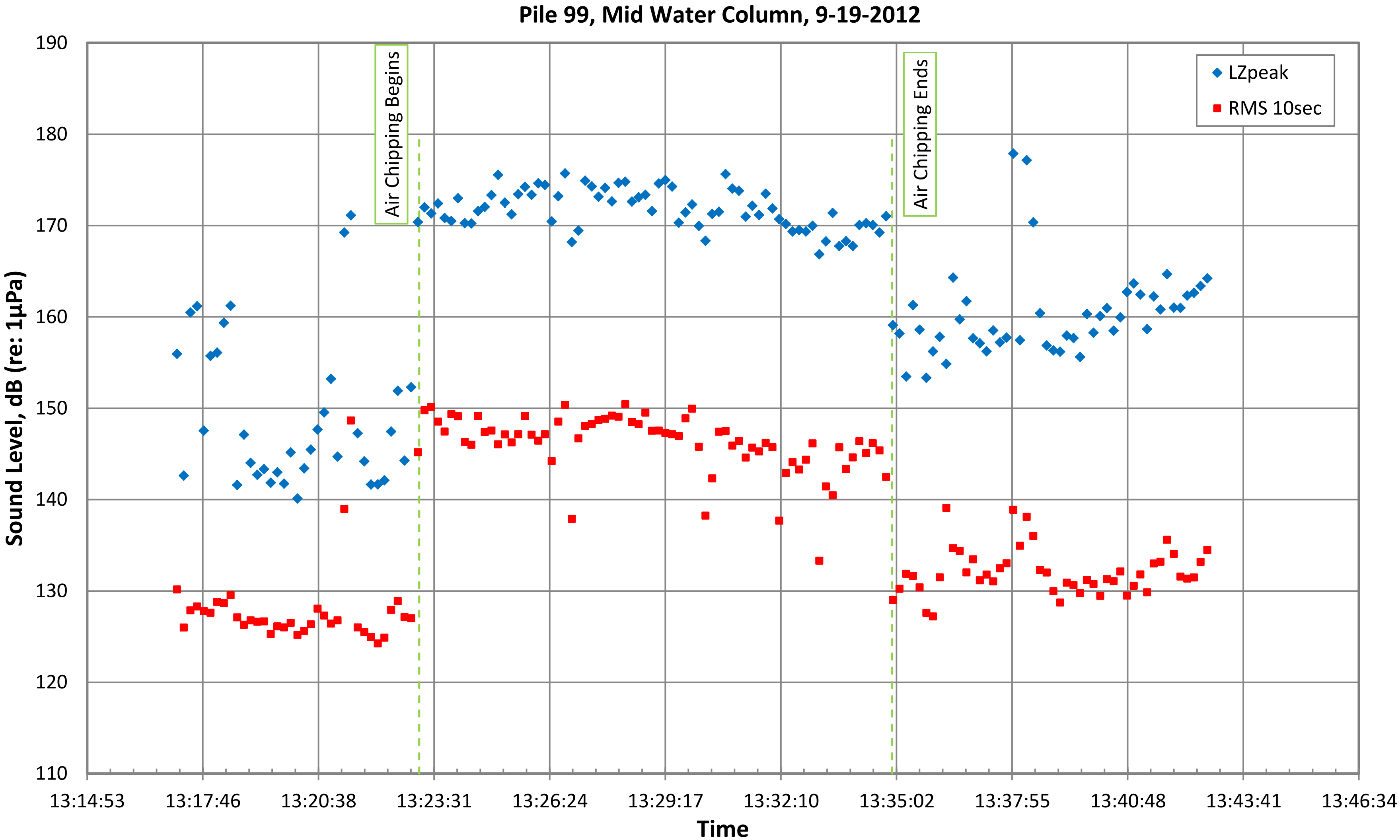
Input: 120919 002b



Air Chipping in Progress			
Quantity	Time (min:sec)	Average (dB)	STDVE
LZpeak	0:08:26	169.6	5.8
RMS 10sec	0:08:26	144.7	4.1

Non Air Chipping Activity			
Quantity	Time (min)	Average (dB)	STDVE
LZpeak	0:31:31	147.7	7.7
RMS 10sec	0:31:31	130.8	5.9

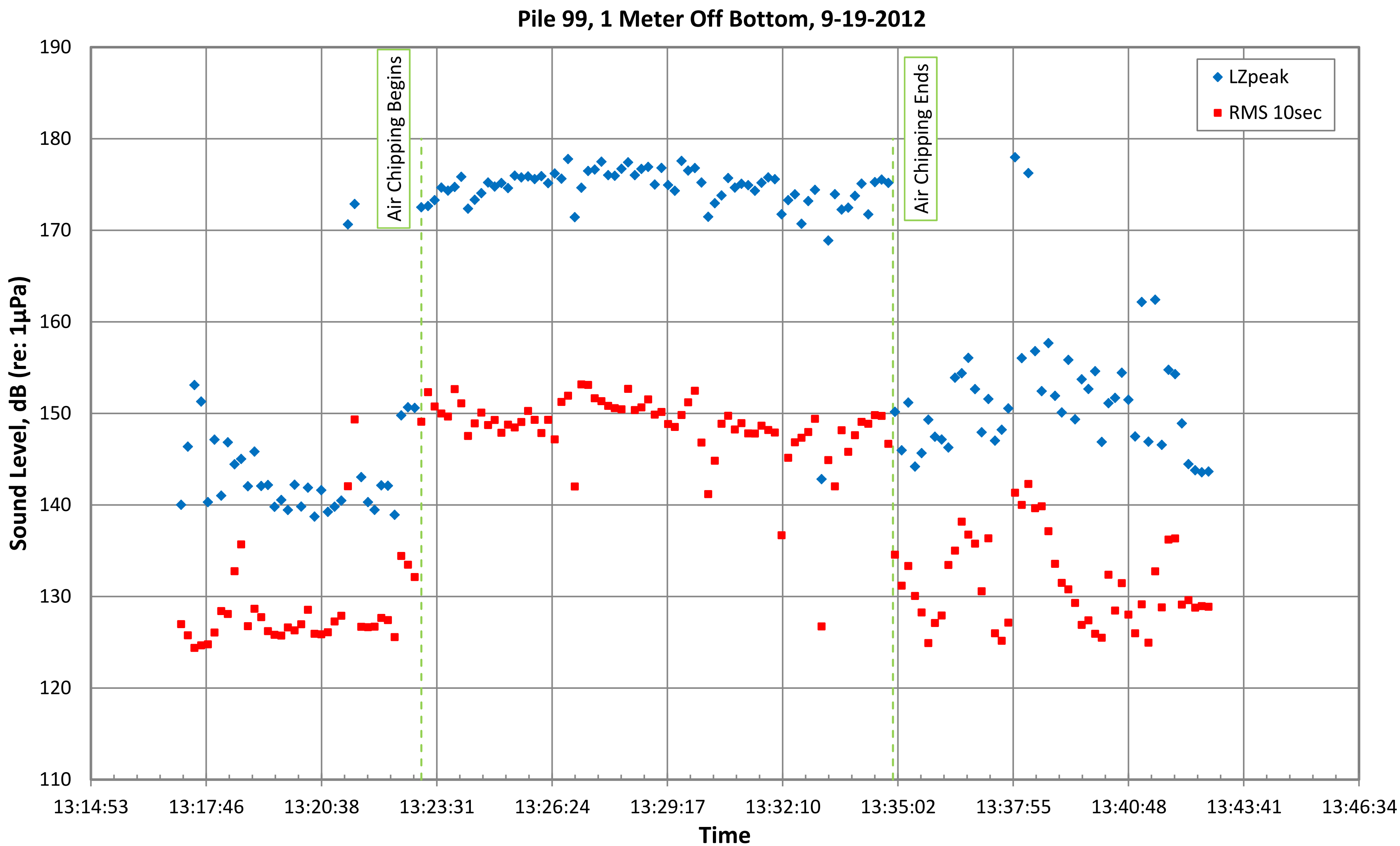
Input: 120919 002



Air Chipping in Progress			
Quantity	Time (min:sec)	Average (dB)	STDVE
LZpeak	0:11:47	171.8	2.2
RMS 10sec	0:11:47	146.2	3.2

Non Air Chipping Activity			
Quantity	Time (min:sec)	Average (dB)	STDVE
LZpeak	0:14:04	155.7	8.6
RMS 10sec	0:14:04	130.4	4.3

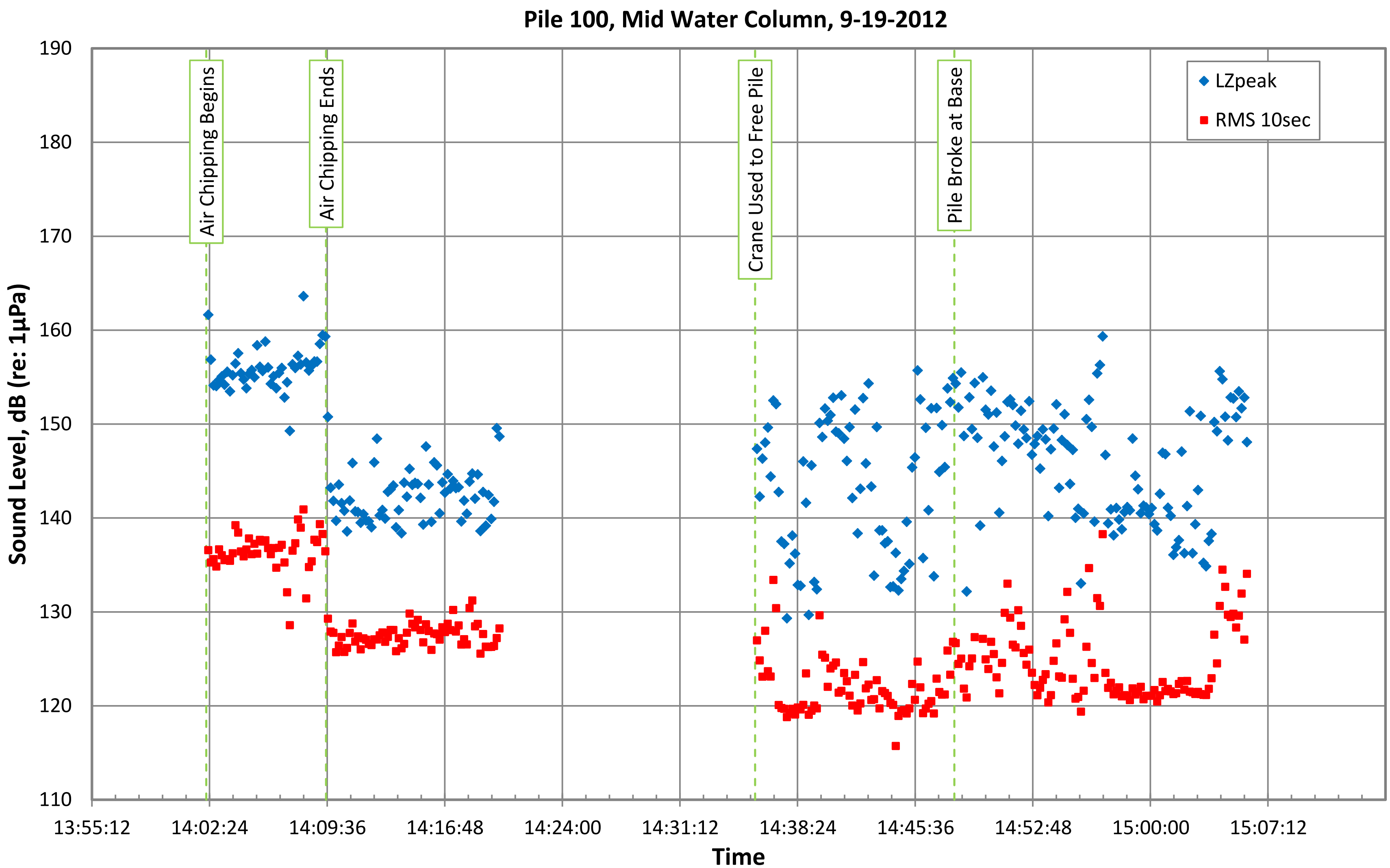
Input: 120919 002b



Air Chipping in Progress			
Quantity	Time (min:sec)	Average (dB)	STDVE
LZpeak	0:11:47	174.3	4.1
RMS 10sec	0:11:47	148.5	3.8

Non Air Chipping Activity			
Quantity	Time (min:sec)	Average (dB)	STDVE
LZpeak	0:14:05	149.1	8.4
RMS 10sec	0:14:05	130.5	5.4

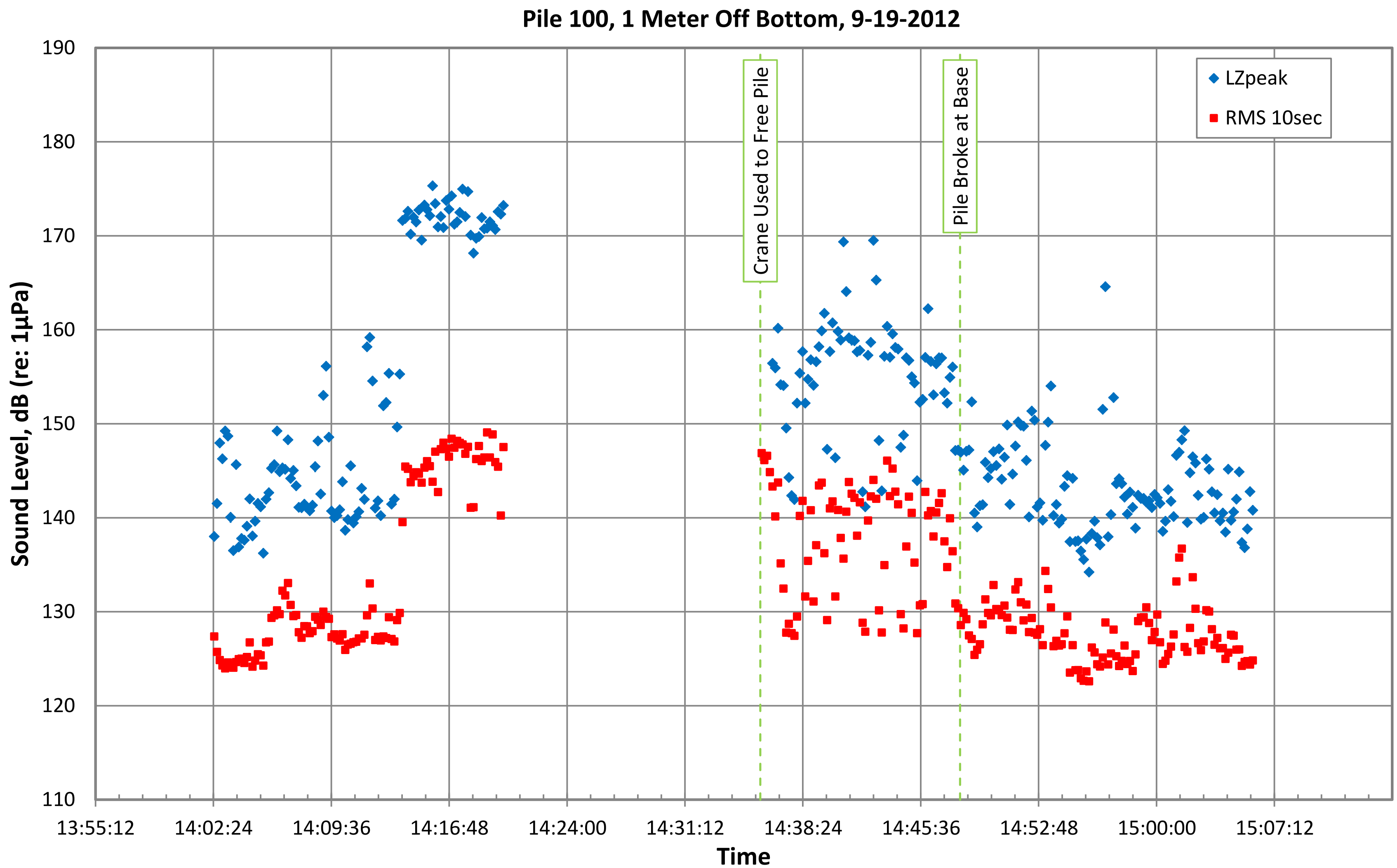
Input: 120919 004b



Air Chipping in Progress			
Quantity	Time (min:sec)	Average (dB)	STDVE
LZpeak	0:07:20	156.0	2.3
RMS 10sec	0:07:20	136.4	2.1

Non Air Chipping Activity			
Quantity	Time (min)	Average (dB)	STDVE
LZpeak	0:28:34	144.8	5.4
RMS 10sec	0:28:34	125.5	4.0

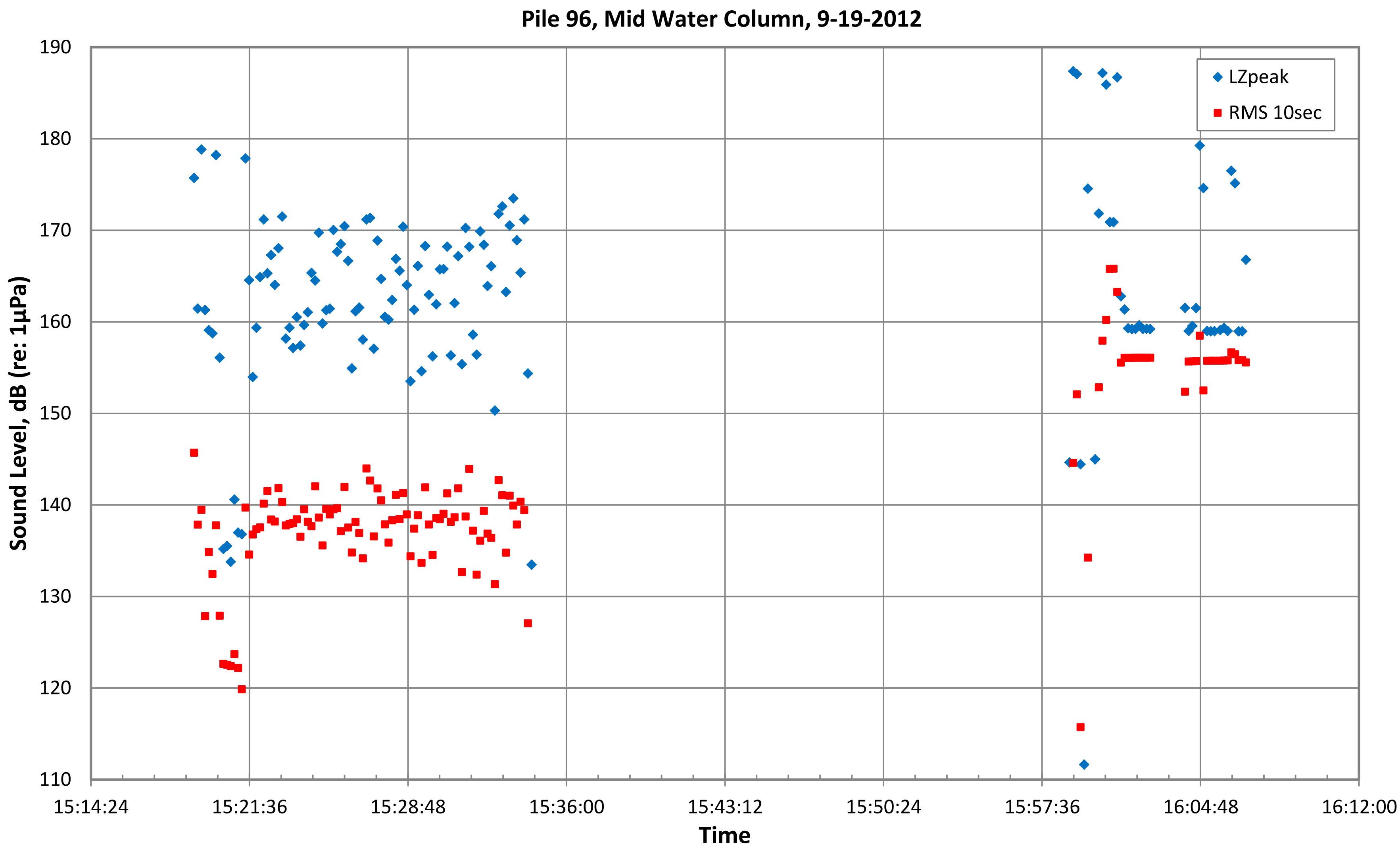
Input: 120919 006



Air Chipping in Progress			
Quantity	Time (min:sec)	Average (dB)	STDVE
LZpeak	0:12:12	155.7	6.8
RMS 10sec	0:12:12	137.6	5.8

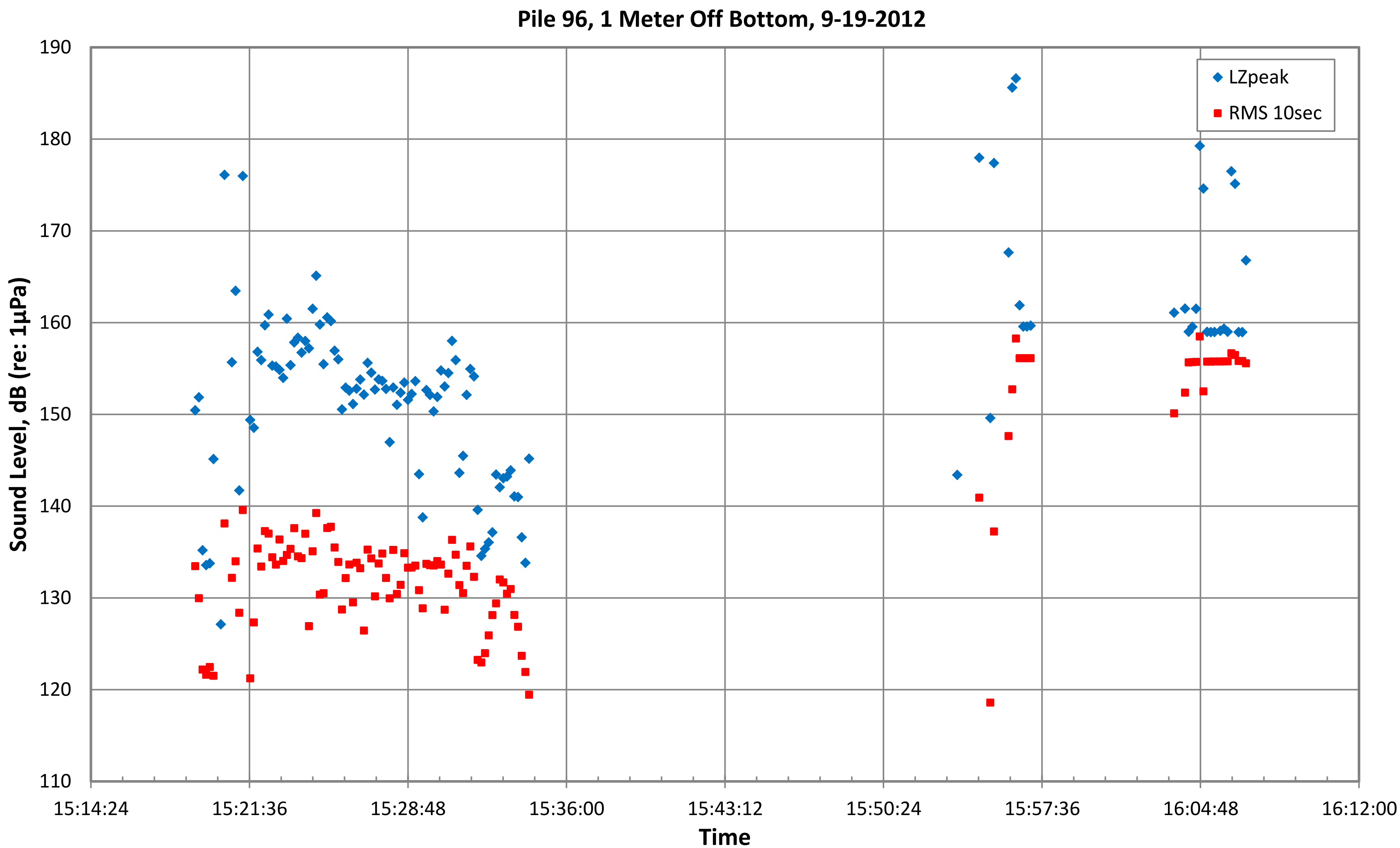
Non Air Chipping Activity			
Quantity	Time (min)	Average (dB)	STDVE
LZpeak	0:30:43	148.6	11.7
RMS 10sec	0:30:43	130.8	7.4

Input: 120919 006



Non Air Chipping Activity			
Quantity	Time (min:sec)	Average (dB)	STDVE
LZpeak	0:46:52	128.0	43.5
RMS 10sec	0:46:52	108.6	39.7

Input: 120919 007b



Non Air Chipping Activity			
Quantity	Time (min:sec)	Average (dB)	STDVE
LZpeak	0:46:52	117.8	39.7
RMS 10sec	0:46:52	101.0	37.6

Input: 120919 007b