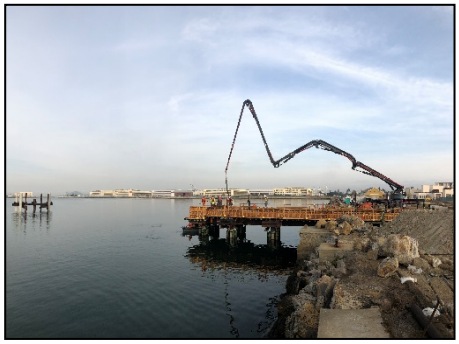

H. T. HARVEY & ASSOCIATES
Ecological Consultants
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Alameda Point Seaplane Lagoon Ferry Terminal Incidental Harassment Authorization Marine Mammal Monitoring Report

Project #3333-14

Prepared for:

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February 19, 2020

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Section 1. Introduction

Per the requirements of the National Marine Fisheries Service (NMFS) August 20, 2019 Incidental Harassment Authorization (IHA) for the Alameda Seaplane Lagoon Ferry Terminal Project, H. T. Harvey & Associates and Illingworth and Rodkin, Inc. have conducted marine mammal monitoring and acoustic monitoring, respectively, in support of Project pile driving activities. Conditions of the IHA are as follows:

- Marine mammal species authorized for take under the IHA are: the gray whale (*Eschrichtius robustus*), harbor porpoise (*Phocoena phocoena*), bottlenose dolphin (*Tursiops truncates*), California sea lion (*Zalophus californianus*), northern fur seal (*Callorhinus ursinus*), northern elephant seal (*Mirounga angustirostris*), and harbor seal (*Phoca vitulina*).
- Table 1 provides the authorized number of takes per species and stock.
- The taking, by serious injury or death, of any marine mammal species was prohibited.
- The taking, by Level A or Level B harassment, of any marine mammal species not listed above was prohibited.
- The project was to conduct a maximum of 24 working days associated with vibratory and impact pile driving and removal.

Table 1. Number of Takes per Species and Stock Authorized by the IHA

Species	Stock (N_{EST})	Level A Harassment	Level B Harassment	Percent of Stock
Gray Whale (*Eschrichtius robustus*)	Eastern North Pacific (26,960)	0	7	<1%
Bottlenose Dolphin (*Tursiops truncatus*)	California Coastal (453)	0	48	10.596%
Harbor Porpoise (*Phocoena phocoena*)	San Francisco-Russian River (9,886)	0	27	<1%
Harbor Seal (*Phoca vitulina*)	California (30,968)	6	615	<2%
Northern Elephant Seal (*Mirounga angustirostris*)	California Breeding (179,000)	0	5	<1%
California Sea Lion (*Zalophus californianus*)	U.S. (257,606)	0	25	<1%
Northern Fur Seal (*Callorhinus ursinus*)	Eastern DPS, California (20,000)	0	3	<1%

This report provides a summary of the marine mammal and acoustic monitoring effort for purposes of documentation of compliance with requirements of the IHA.

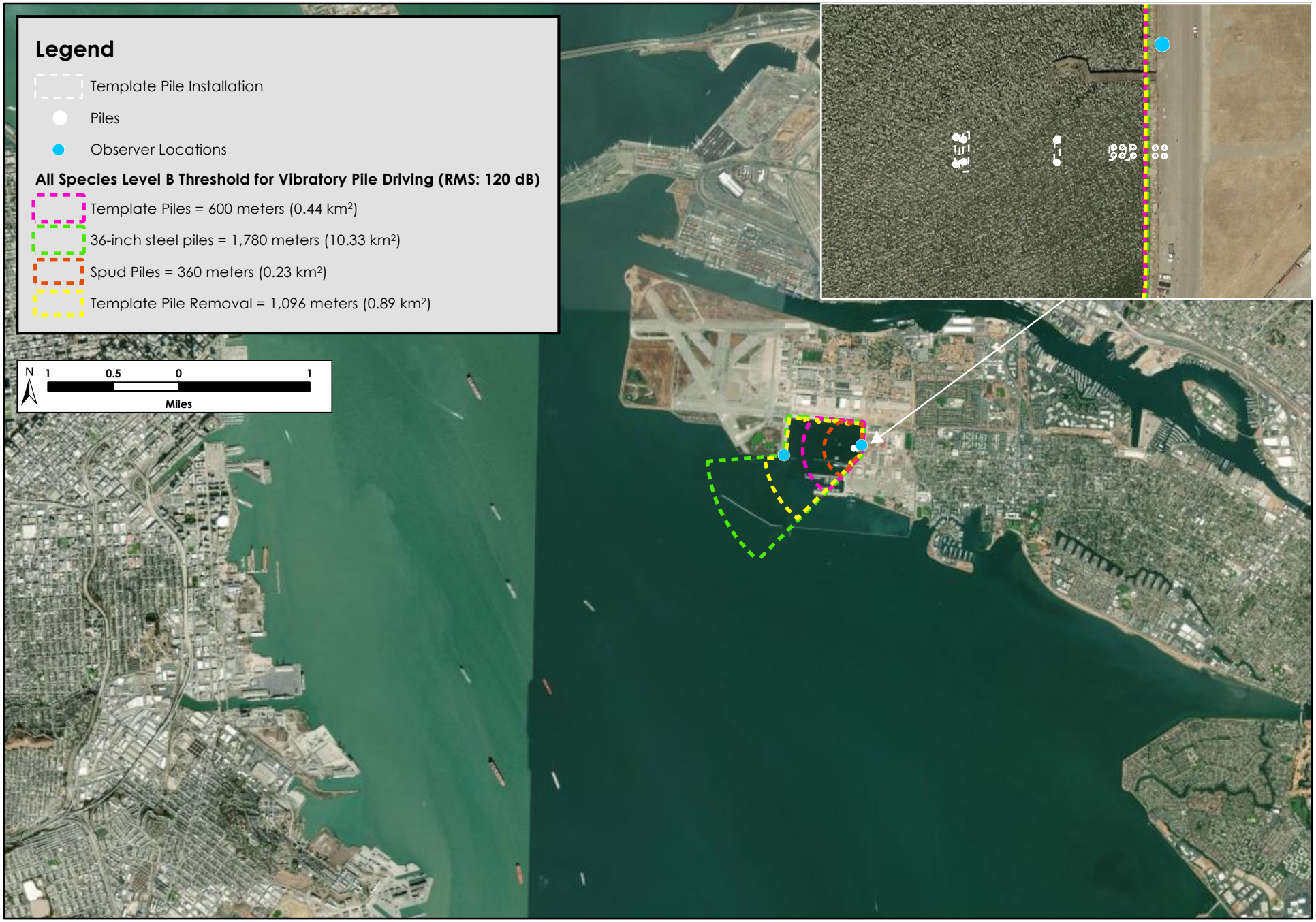
Section 2. Methods

All marine mammal monitoring was conducted by NMFS-approved protected species observers (PSOs) Heather Barrett, Stephen Peterson, Sharon Hsu, and Scott Terrill. The PSOs had no other assigned tasks during the monitoring periods. Per email and phone correspondence with NMFS biologist Stephanie Egger, one PSO was present to monitor all impact pile driving activities (for which the Level A and B harassment zones were limited to areas within the Alameda Seaplane Lagoon) and two PSOs were present to monitor all vibratory pile driving activities (for which the Level B harassment zone extended outside of Alameda Seaplane Lagoon). The PSO locations are shown on Figure 1, and a summary of the monitoring effort for all 20 days of pile driving activities is provided in Table 2.

Table 2. Summary of Monitoring Effort for Pile Driving Activities

Date	Pile Driving Method	Lead PSO	Second PSO
9/5/2019	Vibratory	Heather Barrett	Stephen Peterson
9/6/2019	Vibratory	Heather Barrett	Stephen Peterson
9/9/2019	Impact	Heather Barrett	N/A
9/10/2019	Impact	Heather Barrett	Stephen Peterson
9/11/2019	Vibratory and Impact	Heather Barrett	Stephen Peterson
9/12/2019	Impact	Heather Barrett	Stephen Peterson
9/13/2019	Impact	Heather Barrett	N/A
9/16/2019	Impact	Heather Barrett	N/A
10/25/2019	Vibratory	Heather Barrett	Sharon Hsu
10/26/2019	Vibratory	Heather Barrett	Sharon Hsu
10/28/2019	Vibratory	Heather Barrett	Stephen Peterson
10/29/2019	Vibratory	Heather Barrett	Stephen Peterson
10/31/2019	Vibratory	Heather Barrett	Sharon Hsu
11/5/2019	Vibratory	Stephen Peterson	Scott Terrill
11/18/2019	Vibratory	Heather Barrett	Scott Terrill
11/19/2019	Vibratory	Heather Barrett	Stephen Peterson
11/21/2019	Vibratory	Heather Barrett	Sharon Hsu
11/22/2019	Vibratory	Heather Barrett	Sharon Hsu
11/25/2019	Vibratory	Heather Barrett	Stephen Peterson

Methods for hydroacoustic monitoring are provided in Appendix A.



N:\Projects3300\3333-01\14\Reports\Incidental Harassment\Fig 1. Protected Species Observer Locations for Vibratory Pile Driving v2.mxd

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Figure 1. Protected Species Observer Locations and Revised Level B Acoustic Thresholds for Vibratory Pile Driving

Alameda Point Seaplane Lagoon Ferry Terminal Application for
Incidental Harassment Authorization for Marine Mammals (3333-14)
February 2020

Section 3. Results

3.1 Daily Monitoring and Pile Driving Activities

Pile driving activities were initiated on September 5, 2019 and completed on November 25, 2019. A total of 20 days of pile driving activities occurred during this period, which is within the 24 days of pile driving activities permitted by the IHA. A total of six 36-inch steel piles and six 24-inch concrete piles were installed; the installation of each pile consisted of the installation and removal of a spud pile, followed by the installation of the steel/concrete pile. In addition, a total of 18 temporary 14-inch steel H-type piles were installed and removed during the construction process.

Table 3 provides a summary of the dates and times of pile driving work, daily weather conditions, and pile driving activities. On each day, PSOs monitored marine mammal activity 30 minutes prior to and 30 minutes following all pile driving activities. Pile driving started and stopped frequently throughout each day; PSOs were in constant communication with construction crews to ensure that monitoring occurred for 30 minutes prior to and following each start/stop in compliance with the IHA.

Table 3 Daily Monitoring, Weather, and Construction Activities

Monitoring Date	Start Time	End Time	Arrival Weather and Water Conditions1,2	Departure Weather and Water Conditions	Summary of Pile Driving Activities
9/5/2019	7:45	16:15	Wind Speed: 5 mph Cloud Cover: 90% Visibility: 1 km Sea State (Beaufort Scale): 1	Wind Speed: 10 mph Cloud Cover: 5% Visibility: 1 km Sea State (Beaufort Scale): 4	Installation and removal of one spud pile with a vibratory driver
9/6/2019	6:45	15:15	Wind Speed: 5 mph Cloud cover: 90% Visibility: 1 km Sea State (Beaufort Scale): 1	Wind Speed: 10 mph Cloud Cover: 30% Visibility: 1 km Sea State (Beaufort Scale): 4	Installation and removal of one spud pile with a vibratory driver
9/9/2019	6:45	16:30	Wind Speed: 5 mph Cloud Cover: 10% Visibility: 1 km Sea State (Beaufort Scale): 1	Wind Speed: 15 mph Cloud Cover: 5% Visibility: 1 km Sea State (Beaufort Scale): 4	Installation of one 24-inch concrete pile with an impact driver
9/10/2019	6:20	16:15	Wind: 5 mph Cloud Cover: 10% Visibility: 1 km Sea State (Beaufort Scale): 1	Wind Speed: 15 mph Cloud Cover: 5% Visibility: 1 km Sea State (Beaufort Scale): 4	Installation of one 24-inch concrete pile with an impact driver
9/11/2019	6:45	18:15	Wind Speed: 2 mph Cloud Cover: 0% Visibility: 1 km Sea State (Beaufort Scale): 1	Wind Speed: 5 mph Cloud Cover: 0% Visibility: 300 m Sea State (Beaufort Scale): 3	Installation and removal of one spud pile with a vibratory driver, and installation of one 24-inch concrete pile with an impact driver
9/12/2019	7:15	12:45	Wind Speed: 2 mph Cloud Cover: 10% Visibility: 1 km Sea State (Beaufort Scale): 1	Wind Speed: 5 mph Cloud Cover: 0% Visibility: 1 km Sea State (Beaufort Scale): 2	Installation of one 24-inch concrete pile with an impact driver
9/13/2019	7:45	20:15	Wind Speed: 1 mph Cloud Cover: 0% Visibility: 1 km Sea State (Beaufort Scale): 1	Wind Speed: 5 mph Cloud Cover: 0% Visibility: 300 m Sea State (Beaufort Scale): 3	Installation of two 24-inch concrete piles with an impact driver

Monitoring Date	Start Time	End Time	Arrival Weather and Water Conditions1,2	Departure Weather and Water Conditions	Summary of Pile Driving Activities
9/16/2019	7:15	9:45	Wind Speed: 5 mph Cloud Cover: 70% Visibility: 600 m Sea State (Beaufort Scale): 2	Wind Speed: 5 mph Cloud Cover: 70% Visibility: 600 m Sea State (Beaufort Scale): 2	Installation of one 24-inch concrete pile with an impact driver
10/25/2019	9:15	17:00	Wind Speed: 0 mph Cloud Cover: 10% Visibility: 1 km Sea State (Beaufort Scale): 1	Wind Speed: 5 mph Cloud Cover: 0% Visibility: 500 m Sea State (Beaufort Scale): 2	Installation of temporary H-piles with a vibratory driver
10/26/2019	7:00	13:45	Wind Speed: 0 mph Cloud Cover: 0% Visibility: 1 km Sea State (Beaufort Scale): 1	Wind: 5 mph Cloud Cover: 0% Visibility: 1 km Sea State (Beaufort Scale): 2	Installation of temporary H-piles with a vibratory driver
10/28/2019	9:45	17:00	Wind Speed: 5 mph Cloud Cover: 0% Visibility: 1 km Sea State (Beaufort Scale): 2	Wind Speed: 5 mph Cloud Cover: 0% Visibility: 1 km Sea State (Beaufort Scale): 2	Installation and removal of two spud piles with a vibratory driver
10/29/2019	7:15	16:30	Wind Speed: 5 mph Cloud Cover: 0% Visibility: 1 km Sea State (Beaufort Scale): 1	Wind Speed: 5 mph Cloud Cover: 0% Visibility: 1 km Sea State (Beaufort Scale): 2	Installation of one 36-inch steel pile with a vibratory driver
10/31/2019	7:45	13:15	Wind Speed: 1 mph Cloud Cover: 0% Visibility: 1 km Sea State (Beaufort Scale): 1	Wind Speed: 5 mph Cloud Cover: 0% Visibility: 1 km Sea State (Beaufort Scale): 2	Installation of one 36-inch steel pile with a vibratory driver
11/5/2019	7:58	18:30	Wind Speed: 1 mph Cloud Cover: 10% Visibility: 1 km Sea State (Beaufort Scale): 1	Wind Speed: 5 mph Cloud Cover: 0% Visibility: 1 km Sea State (Beaufort Scale): 2	Installation and removal of two spud piles with a vibratory driver, and installation of two 36-inch steel piles with a vibratory driver

Monitoring Date	Start Time	End Time	Arrival Weather and Water Conditions[1,2]	Departure Weather and Water Conditions	Summary of Pile Driving Activities
11/18/2019	10:45	16:30	Wind Speed: 5 mph Cloud Cover: 10% Visibility: 1 km Sea State (Beaufort Scale): 2	Wind: 5 mph Cloud Cover: 0% Visibility: 1 km Sea State (Beaufort Scale): 2	Removal of temporary H-piles with a vibratory driver
11/19/2019	8:45	15:30	Wind Speed: 5 mph Cloud Cover: 0% Visibility: 1 km Sea State (Beaufort Scale): 2	Wind Speed: 10 mph Cloud Cover: 0% Visibility: 500 m Sea State (Beaufort Scale): 3	Installation of temporary H-piles with a vibratory driver
11/21/2019	6:45	13:00	Wind Speed: 5 mph Cloud Cover: 0% Visibility: 1 km Sea State (Beaufort Scale): 2	Wind Speed: 5 mph Cloud Cover: 0% Visibility: 1 km Sea State (Beaufort Scale): 2	Installation and removal of three spud piles with a vibratory driver Installation of one 36-inch steel pile with a vibratory driver
11/22/2019	7:15	11:00	Wind Speed: 2 mph Cloud Cover: 0% Visibility: 1 km Sea state (Beaufort scale): 1	Wind Speed: 2 mph Cloud Cover: 0% Visibility: 1 km Sea State (Beaufort Scale): 5	Installation of one 36-inch steel pile with a vibratory driver
11/25/2019	10:30	12:30	Wind Speed: 15 mph Cloud Cover: 0% Visibility: 500 m Sea State (Beaufort Scale): 3	Wind Speed: 15 mph Cloud Cover: 0% Visibility: 500 m Sea State (Beaufort Scale): 3	Removal of temporary H-piles with a vibratory driver

[1] mph = miles per hour; m = meter; km = kilometer

[2] Beaufort Sea State

0 – wave height 0 feet, sea is like a mirror

1 – wave height <0.5 foot, ripples with the appearance of scales but without foam crests

2 – wave height 0.5–1 foot; small wavelets, crests have glassy appearance and do not break

3 – wave height 2–3 feet; large wavelets, crests begin to break, foam of glassy appearance

4 –wave height 3–5 feet; small waves, frequent white caps

3.2 Marine Mammal Observations and Take Estimates

The only two marine mammal species observed by the PSOs during monitoring were harbor seal and California sea lion. No gray whales, harbor porpoises, bottlenose dolphins, northern fur seals, northern elephant seals, or marine mammal species not listed on the IHA were observed during the monitoring activities. No individuals of any species were present within the Level A harassment area for impact or vibratory pile driving during the course of the monitoring work, and no Level A take of any marine mammal species occurred.

PSOs regularly observed 1–2 harbor seals within the Level B harassment area during the course of the monitoring. Monitors were able to identify individual animals by the color and pattern of their pelage. There were two distinct harbor seals seen repeatedly, a dark morph and a light morph individual. In addition, an individual California sea lion was observed within the Level B harassment area during vibratory pile driving on one occasion.

A summary of marine mammal observations during the course of the monitoring work is provided in Table 4, and a summary of observations of Level B take of individuals is provided in Table 5. The monitoring documented a total of 14 Level B takes of harbor seals and one Level B take of a California sea lion.

Based on the results of the acoustic monitoring, the distances to acoustic thresholds for Level B take of marine mammal species did not extend outside of the breakwater for the installation and removal of spud piles and 14-inch steel H-type piles (Table 6). As a result, any Level B takes that occurred during this work would have been observed by the PSOs positioned around the lagoon (Figure 1), and are accounted for in the counts of Level B takes provided above. The 1,780-meter (m) distance to the acoustic threshold for Level B take of marine mammal species did extend outside of the breakwater for the 36-inch steel piles (Table 6) (Figure 1). Because the PSOs would not have been able to observe all marine mammals present within this area during vibratory pile driving work, we have applied a correction factor to estimate the number of takes of marine mammals within this area based on the results of the acoustic monitoring.

For the purpose of the correction factor, we assume that the PSOs would have observed all marine mammals within the 1.84 square kilometer (km) area within the breakwater; this leaves an 8.49 square-km area outside of the breakwater where the PSO would not have been able to observe any Level B harassment that occurred. Based on the densities of marine mammal species in the San Francisco Bay provided in the project's IHA Application (H. T. Harvey & Associates 2019), we estimate that the Project may have resulted in the following Level B takes under the MMPA due to 5 days of vibratory pile driving activities for the 36-inch steel piles in addition to the Level B takes observed within the breakwater by the PSOs:

- Given the estimated number of harbor seals present within the San Francisco Bay (3.957 individuals per square km), the number of additional harbor seals that would be subject to Level B harassment would be up to 167.97 individuals. Rounding up to whole numbers, vibratory pile driving of 36-inch steel template piles potentially resulted in Level B harassment of up to 168 additional harbor seals.

Table 4. Summary of Marine Mammal Observations

Date	Time	Number of Animals	Species	Age/Sex	Pile Driving Activities	Distance/Bearing to Pile Location	Behavior Pattern and Direction of Travel
9/5/19	14:39–14:54	1	Harbor Seal	Adult/Unknown	None	120 m south	Breath at surface, direction unknown
	14:55–14:57	1	Harbor Seal	Adult/Unknown	Vibratory	250 m south	Same seal, swimming north
	15:01–15:17	1	Harbor Seal	Adult/Unknown	Vibratory	250 m south	Same seal, swimming north
9/6/19	9:12–9:36	1	Harbor Seal	Adult/Unknown	Vibratory	100 m southeast	Breath at surface, sniffing, stationary
	9:36–10:04	2	Harbor Seal	Adults/Unknown	Vibratory	200 m southeast 1 km east	(at 200 m) Breath at surface, sniffing, stationary (at 1 km) Breath at surface, stationary
	10:04–10:13	2	Harbor Seal	Adults/Unknown	Vibratory	150 m east 1 km east	(at 150 m) Breath at surface, sniffing, stationary (at 1 km) Breath at surface, stationary
9/9/19	8:19–10:30	1	Harbor Seal	Adult/Unknown	None	120 m southeast	Swimming, diving, foraging, and patrolling, swimming towards northwest corner of the lagoon
9/10/19	8:00–9:13	1	Harbor Seal	Adult/Unknown	None	120–150 m southeast	Swimming, surfacing, and patrolling in the northwest corner of the lagoon
9/11/19	7:20–7:50	2	Harbor Seal	Adults/Unknown	None	100 m east ≥1 km east	(at 100 m) Swimming and surfacing within the western portion of the lagoon, traveling southwest (at 1 km) Swimming and surfacing, moving west farther out into the Bay
	7:50–8:57	2	Harbor Seal	Adults/Unknown	None	≥500 m east ≥1 km northeast	(at ≥500 m) Swimming and surfacing within the western portion of the lagoon, traveling southwest (at ≥1 km) Swimming and surfacing, moving west farther out into the Bay
	8:57–9:13	2	Harbor Seal	Adults/Unknown	Vibratory	≥500 m east ≥1 km northeast	(at ≥500 m) Swimming and surfacing within the western portion of the lagoon, traveling southwest (at ≥1 km) Swimming and surfacing, moving west farther out into the Bay
	9:13–9:55	1	Harbor Seal	Adult/Unknown	None	≥700 m northeast	Swimming and surfacing within the western portion of the lagoon, traveling northwest

Date	Time	Number of Animals	Species	Age/Sex	Pile Driving Activities	Distance/Bearing to Pile Location	Behavior Pattern and Direction of Travel
9/12/19	8:03–10:05	1	Harbor Seal	Adult/Unknown	None	450 m east/southeast	Periodically swimming, sniffing, and diving throughout lagoon, no specific travel direction
	10:07–10:13	1	Harbor Seal	Adult/Unknown	None	100–500 m east/southeast	Foraging within lagoon, consuming a captured fish, no specific travel direction
	10:15–10:52	1	Harbor Seal	Adult/Unknown	None	100–500 m east/southeast	Periodically swimming, sniffing, and diving throughout lagoon, no specific travel direction
	10:52–11:17	1	Harbor Seal	Adult/Unknown	None	40–50 m east/southeast	Swimming towards work area and diving under barge, no specific travel direction
	11:20–11:46	1	Harbor Seal	Adult/Unknown	Impact	100–500 m east/southeast	Confirmed 100 m from barge, swimming away from work area to the northwest
9/13/19	8:00–8:30	3	Harbor Seal	Adults/Unknown	None	100–700 m east/southeast	Swimming, sniffing, and diving throughout the lagoon, no specific travel direction
	8:30–9:45	3	Harbor Seal	Adults/Unknown	None	100–700 m east/southeast	Swimming, sniffing, and diving throughout the lagoon, no specific travel direction
	9:45–11:05	1	Harbor Seal	Adult/Unknown	None	100–700 m east/southeast	Swimming, sniffing, and diving throughout the lagoon, no specific travel direction
	11:06–12:11	1	Harbor Seal	Adult/Unknown	Impact	120–700 m east/southeast	Looking and diving, moving west/northwest away from the work area
10/25/19	9:45–10:15	1	Harbor Seal	Adult/Unknown	None	700 m southeast	Breath at surface, direction of travel unknown
	10:15–11:30	2	Harbor Seal (1) California Sea Lion (1)	Adult/Unknown Adult/Male	None	400 m east/southeast 1 km	(at 400 m) Swimming, no specific travel direction (at 1 km) Swimming away from work area to the southwest
	11:30–11:41	2	Harbor Seal	Adults/Unknown	None	10–30 m	Breath at surface and diving near the work area, no specific travel direction
	11:41–12:02	2	Harbor Seal	Adults/Unknown	Vibratory	50–400 m	Confirmed >50 m from pile and moving away from work area to the west
10/26/19	7:30–8:00	2	Harbor Seal	Adults/Unknown	None	200–800 m east/southeast	Swimming and patrolling, no specific travel direction
	8:00–9:00	2	Harbor Seal	Adults/Unknown	None	200–800 m east/southeast	Swimming and patrolling, no specific travel direction

Date	Time	Number of Animals	Species	Age/Sex	Pile Driving Activities	Distance/Bearing to Pile Location	Behavior Pattern and Direction of Travel
	9:00–9:12	1	Harbor Seal	Adult/Unknown	None	200–500 m east/southeast	Breathing at surface at various locations, no specific travel direction
	9:13	1	Harbor Seal	Adult/Unknown	Vibratory	≥500 m east/southeast	Breathing at surface, no specific travel direction
	9:14–9:53	1	Harbor Seal	Adult/Unknown	None	≥700 m northeast	Breathing at surface, heading southwest out of lagoon
	9:59–11:07	1	Harbor Seal	Adult/Unknown	None	20–80 m south	Swimming at the surface on the north side of the barge, no specific direction of travel
	11:08–11:18	1	Harbor Seal	Adult/Unknown	Vibratory	50 m south	Swimming with a captured fish north of the barge
	11:19–12:09	1	Harbor Seal	Adult/Unknown	None	20–100 m north	Swimming under barge and south of barge
	12:10–12:18	1	Harbor Seal	Adult/Unknown	Vibratory	100 m south	Confirmed 100 m from work area, swimming north of barge
	12:19–12:59	1	Harbor Seal	Adult/Unknown	None	15–700 m east/southeast	Diving under barge towards pile
	13:00–13:12	1	Harbor Seal	Adult/Unknown	Vibratory	100–700 m east/southeast	Confirmed on west side of lagoon 100 m from work area, swimming away from the work area
10/28/19	10:00–10:30	1	Harbor Seal	Adult/Unknown	None	1 km	Swimming east outside of lagoon
	10:30–15:40	1	Harbor Seal	Adult/Unknown	None	500 m	Taking breath at center of lagoon, direction of travel unknown, not observed again
10/29/19	7:30–8:00	1	Harbor Seal	Adult/Unknown	None	1 km northeast	Swimming southwest outside of lagoon
	8:00–14:24	1	Harbor Seal	Adult/Unknown	None	30–300 m northeast	Swimming south along rock wall near mouth of lagoon
10/31/19	8:00–9:30	2	Harbor Seal	Adult/Unknown	None	300 m east	(at 300 m) Swimming in lagoon
						610 m northeast	(at 610 m) Outside of lagoon, swimming east
	8:30–11:25	1	Harbor Seal	Adult/Unknown	None	50 m south	Swimming in lagoon, seal approaches barge at 50 m and swims north over 100 m
	11:26–12:52	1	Harbor Seal	Adult/Unknown	None	350-500 m southeast	Same harbor seal observed swimming in lagoon
11/5/19	14:18	1	Harbor Seal	Adult/Unknown	None	300 m east	Swimming and spyhopping, traveling west
	14:46	1	Harbor Seal	Adult/Unknown	Vibratory	30 m south	Surfacing and diving, traveling north

Date	Time	Number of Animals	Species	Age/Sex	Pile Driving Activities	Distance/Bearing to Pile Location	Behavior Pattern and Direction of Travel
11/18/19	12:45–13:15	1	Harbor Seal	Adult/Unknown	None	200 m east/southeast	Sniffing and breathing, swimming west
	13:41–13:58	1	Harbor Seal	Adult/Unknown	Vibratory	550 m east/southeast	Swimming west, not seen again
	15:33–16:07	1	California Sea Lion	Adult/Male	Vibratory	50 m south	Foraging, captured a fish, swam away to the north
	16:08–16:45	1	California Sea Lion	Adult/Male	None	50 m south	Foraging/diving, heading north
11/19/19	14:09–15:02	2	Harbor Seal	Adults/Unknown	Vibratory	1 km northeast 300 m east/southeast	(at 1 km) Outside of lagoon swimming south (at 300 m) Sniffing in lagoon, heading west
	15:03–15:30	1	Harbor Seal	Adult/Unknown	None	550 m east	Swimming west
11/22/19	7:30–8:00	1	Harbor Seal	Adult/Unknown	None	1 km northeast	Swimming west
	8:00–9:40	1	Harbor Seal	Adult/Unknown	None	1 km northeast	Swimming southeast
	9:40–10:16	1	Harbor Seal	Adult/Unknown	Vibratory	1 km northeast	Swimming southeast
	10:17–11:00	1	Harbor Seal	Adult/Unknown	None	1 km northeast	Swimming southeast

Table 5. Take Estimates

Date	Species	Pile and Driver Type	Observations	Level A Threshold	Level B Threshold	Take Estimate
9/5/19	Harbor Seal	Spud piles, vibratory hammer	1 individual observed several times at 250 m	7.9 m	21.5 km	Level B take of 1 harbor seal
9/6/19	Harbor Seal	Spud piles, vibratory hammer	2 individuals observed, one at 150–200 m and one at 1 km	7.9 m	21.3 km	Level B take of 2 harbor seals
9/11/19	Harbor Seal	Spud piles, vibratory hammer	2 individual observed, one at ≥500 m and one at ≥1 km			Level B take of 2 harbor seals
9/12/19	Harbor Seal	24-inch concrete piles, impact hammer	1 individual observed at 100–500 m	28.5 m	39.8 m	None
9/13/19	Harbor Seal	24-inch concrete piles, impact hammer	1 individual observed at 120–700 m	28.5 m	39.8 m	None

Date	Species	Pile and Driver Type	Observations	Level A Threshold	Level B Threshold	Take Estimate
10/25/19	Harbor Seal	Template piles, vibratory hammer (installation)	2 individuals observed at 50–400 m	0.9 m	2.2 km	Level B take of 2 harbor seals
10/26/19	Harbor Seal	Template piles, vibratory hammer (installation)	2 individuals observed at ≥500 m, 50 m, 100 m, and 100–700 m	0.9 m	2.2 km	Level B take of 2 harbor seals
11/5/19	Harbor Seal	Spud and steel piles, vibratory hammer	1 individual observed at 30 m	7.9 m	21.3 km	Level B take of 1 harbor seal
11/18/19	Harbor Seal	Template piles, vibratory hammer (removal)	1 individual observed at 550 m	0.9 m	2.2 km	Level B take of 1 harbor seal
11/18/19	California Sea Lion	Template piles, vibratory hammer (removal)	1 individual observed at 50 m	0.9 m	2.2 km	Level B take of 1 California sea lion
11/19/19	Harbor Seal	Template piles, vibratory hammer (installation)	2 individuals observed at 1 km and 300 m	0.9 m	2.2 km	Level B take of 2 harbor seals
11/22/19	Harbor Seal	36-inch steel pile, vibratory hammer	1 individual observed at 1 km	7.9 m	21.3 km	Level B take of 1 harbor seal

Table 6. Revised Distances to Level B NMFS Acoustic Thresholds for Vibratory Pile Driving

		Distance to Threshold				
Species	**Threshold[1]**	Spud Piles	24-inch Concrete Piles	14-inch Steel H-Type Piles (Installation)	14-inch Steel H-Type Piles (Removal)	36-inch Steel Piles
All Species	RMS: 120 dB	360 m	215 m	600 m	1,096 m	1,780 m

[1] RMS = root mean square sound pressure level

- Given the estimated number of number of California sea lions present within the San Francisco Bay (0.161 individuals per square km), the number of additional California sea lions that would be subject to Level B harassment would be up to 6.83 individuals. Rounding up to whole numbers, vibratory pile driving of 36-inch steel template piles potentially resulted in Level B harassment of up to 7 additional California sea lions.
- Given the estimated number of number of harbor porpoises present within the San Francisco Bay (0.167 individuals per square km), the number of additional harbor porpoises that would be subject to Level B harassment would be up to 7.09 individuals. Rounding up to whole numbers, vibratory pile driving of 36-inch steel template piles potentially resulted in Level B harassment of up to 8 additional harbor porpoises.
- It is assumed that up to one northern elephant seal may occur in the San Francisco Bay in the Project vicinity on up to 20% of pile driving days (i.e., up to 1 individuals in 5 days). Thus, vibratory pile driving of 36-inch steel template piles potentially resulted in Level B harassment of up to 1 additional northern elephant seal.
- It is assumed that up to 1.3 gray whales could occur in the San Francisco Bay in the Project vicinity during 5 days of pile driving activities. Rounding up to whole numbers, vibratory pile driving of 36-inch steel template piles potentially resulted in the Level B harassment of up to 2 additional gray whales.
- It is assumed that up to one northern fur seal may occur in the San Francisco Bay in the Project vicinity on up to 10% of pile driving days (i.e., up to 0.5 individuals in 5 days). Rounding up to whole numbers, vibratory pile driving of 36-inch steel template piles resulted in Level B harassment of up to 1 additional northern fur seal.
- It is assumed that up to 1.5 bottlenose dolphins may occur in the San Francisco Bay in the Project vicinity on all pile driving days (i.e., up to 7.5 individuals in 5 days). Rounding up to whole numbers, vibratory pile driving of 36-inch steel template piles resulted in Level B harassment of up to 8 additional bottlenose dolphins.

In summary, we estimate that the Project resulted in Level B take of marine mammal species, as follows:

- 14 observed Level B takes of harbor seals and up to 168 additional Level B takes of harbor seals, for a total of **up to 182 Level B takes of harbor seals**.
- One observed Level B take of California sea lions and up to 7 additional Level B takes of California sea lions, for a total of **up to 8 Level B takes of California sea lions**.
- No observed Level B takes of harbor porpoises and up to 8 additional Level B takes of harbor porpoises, for a total of **up to 8 Level B takes of harbor porpoises**.
- No observed Level B takes of northern elephant seals and up to 1 additional Level B take of northern elephant seals, for a total of **up to 1 Level B take of a northern elephant seal**.
- No observed Level B takes of gray whales and up to 2 additional Level B take of gray whales, for a total of **up to 2 Level B takes of gray whales**.

- No observed Level B takes of northern fur seals and up to 1 additional take of a northern fur seal, for a total of **up to 1 Level B take of a northern fur seal**.
- No observed Level B takes of bottlenose dolphins and up to 8 additional takes of bottlenose dolphins, for a total of **up to 8 Level B takes of bottlenose dolphins**.

All of these take estimates are well below those authorized by the IHA.

3.3 Mitigation Measures Implemented

IHA mitigation measures were implemented on the following occasions to minimize take of marine mammals:

- On September 12, 2019, from 10:52–11:17 a.m., a harbor seal was observed swimming towards the work area and diving under the barge approximately 50 m from the pile to be driven. The PSO contacted the contractors and recommended a standby of pile driving activities until she could confirm that the animal was moving away from the work area. At 11:20 a.m. the harbor seal was observed 100 m to the north of the work area, and the PSO notified the contractor that no harbor seals were within the Level A shutdown zone. At this time, the crew initiated impact pile driving.
- On October 25, 2019, from 11:30–11:41 a.m., two harbor seals were observed swimming within 10 m of the pile to be driven. The PSO contacted the contractors and recommended a standby of pile driving activities until she could confirm that the animal was confirmed to be outside of the Level A area. At 11:41 a.m. the animals were sighted more than 50 m from the work area, moving away from the pile to be driven, and the PSO notified the contractor that no harbor seals were within the Level A shutdown zone. At this time, the crew initiated vibratory pile driving.
- On October 26, 2019, from 9:59–11:07 a.m., a harbor seal was observed 20–80 m from the work area, and eventually approached and dove beneath the Project barge. The PSO contacted the contractors and recommended a standby of pile driving activities until she could confirm that the animal was moving away from the work area. At 11:08 a.m. the animal was observed 50 m from the work area, moving away from the pile to be driven with a fish in its mouth, and the PSO notified the contractor that no harbor seals were within the Level A shutdown zone. At this time, the crew initiated vibratory pile driving.
- On October 26, 2019, from 11:19–12:09 a.m., a harbor seal was observed 20–100 m from the work area, and eventually approached the barge as the crew was preparing to initiate vibratory work. The PSO contacted the contractors and recommended a standby of pile driving activities until she could confirm that the animal was moving away from the work area. At 12:10 a.m. the harbor seal was observed in the center of the lagoon 100 m from the work area, and the PSO notified the contractor that no harbor seals were within the Level A shutdown zone. At this time, the crew initiated vibratory pile driving.
- On November 18, 2019, from 3:33–16:07 p.m., a California sea lion was observed 50 m from the work area diving and catching fish. The PSO contacted the contractors and recommended a standby of pile driving activities until she could confirm that the animal was moving away from the work area. At 16:08

the sea lion was observed more than 50 m from the work area in the lagoon, moving away from the work area, , and the PSO notified the contractor that no sea lions were within the Level A shutdown zone. At this time, the crew initiated vibratory pile driving.

3.4 Documentation of Injured and Dead Marine Mammals Observed

No injured or dead marine mammals were observed during the course of the Project.

3.5 Hydroacoustic Monitoring Results

Results of the hydroacoustic monitoring are provided in Appendix A.

Appendix A. Pile Driving Noise Measurements for the Alameda Seaplane Lagoon Ferry Terminal

PILE DRIVING NOISE MEASUREMENTS FOR THE ALAMEDA SEAPLANE LAGOON FERRY TERMINAL

Alameda, California

December 2019

♦ ♦ ♦

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Introduction

H. T. Harvey & Associates contracted with Illingworth & Rodkin, Inc. (I&R) to conduct underwater sound measurements during the pile driving portion of the new Seaplane Lagoon Ferry Terminal at Alameda Point in Alameda, California. A total of six pile installations were monitored along with two pile removal operations and two exploratory spud pile operations. There were two 24-inch concrete piles installed with an A.P.E. D70-52 diesel impact hammer; two 36-inch steel piles installed with a A.P.E. King Kong vibratory hammer; two H-Piles installed with a A.P.E. King Kong vibratory hammer; two spud pile operations using the A.P.E. King Kong vibratory hammer; and finally the removal of three H-Piles using the A.P.E. King Kong vibratory hammer. The measurement of underwater sounds was conducted at various distance from the pile driving operation, ranging from 10 m (m) to 700 m.

Terminology

Various technical terms used in this report are defined in the Glossary of Terms in *Appendix A*. Sound pressure is the instantaneous absolute positive or negative pressure and is presented in this report as a decibel referenced as 1 micro Pascal (dB re 1 µPa). While several noise metrics are used to describe sounds in the environment, the root-mean-square (RMS) sound pressure level is an appropriate descriptor to describe measured sounds from pile driving activity. The RMS sound pressure level is presented in dB re 1 µPa and is averaged over a defined time period in a stated frequency range or band. The appropriate time period to average for the RMS computation varies by the type of sound (e.g., pulsed or continuous). The average sound level during the measurement period is also computed to be the equivalent average sound pressure level (Leq). Sound Exposure Level (SEL) is proportionally equivalent to the time integral of the pressure squared and is also described in this report in terms of dB re 1 μPa^2 sec over the duration of a sound event. Sounds were measured over the frequency range of 20 to 20,000 Hz.

Methods and Equipment

Measurements were made in the Seaplane Lagoon (*Figure 3*) in approximately 5 m of water depth. Atmospheric and oceanic conditions ranged from relatively calm, with no wind or current, to high wind speeds up to 10-15 knots (7-8 m/s) and very rough water (waves approximately 0.3-0.6 m high).

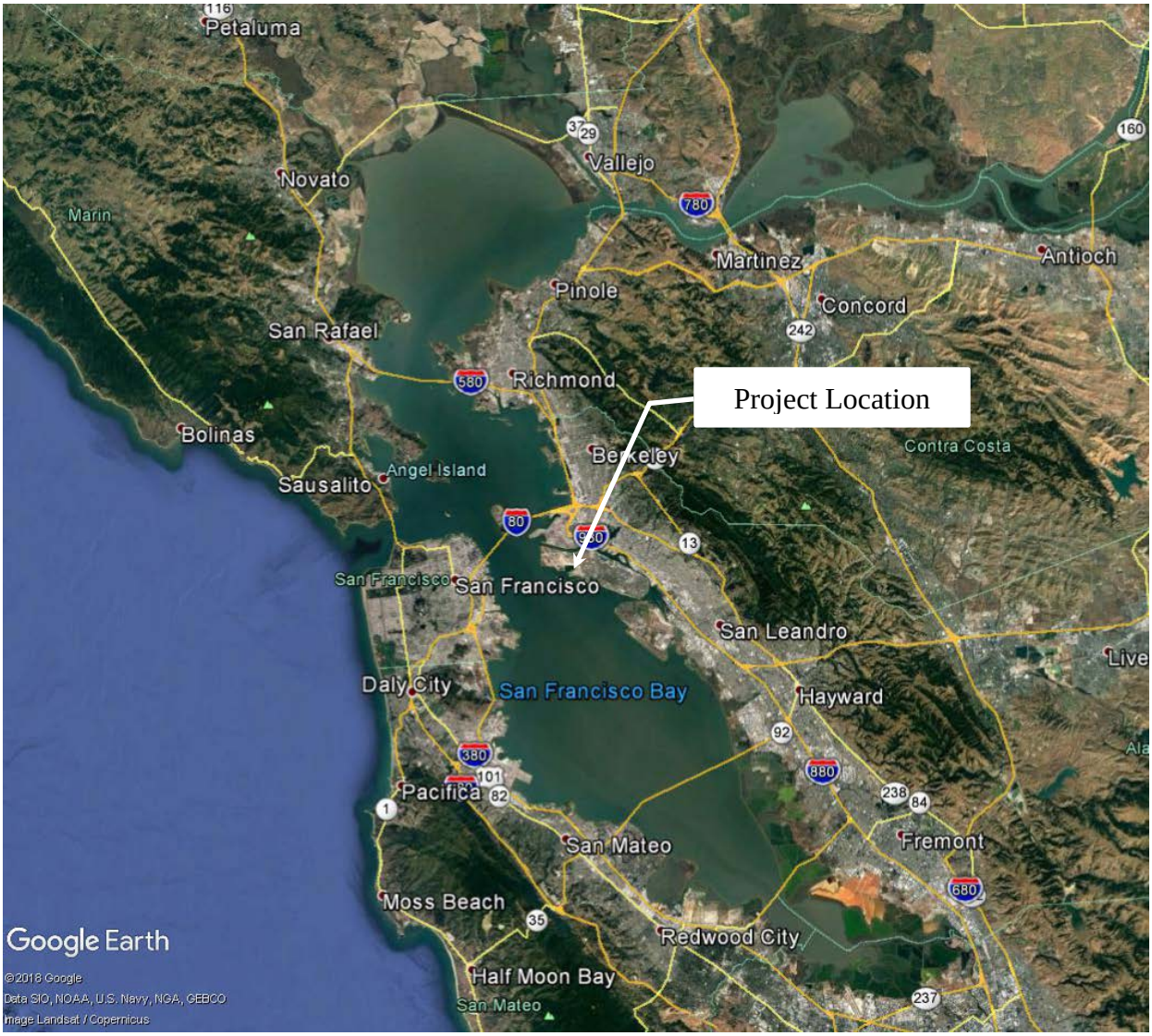

Figure 1. Project Site Location

Figure 2. Project Site Map and Monitoring Locations

Three methods were used to collect underwater sound measurements at various positions in relation to the SBPs. The first method consisted of an autonomous unit that was equipped with hydrophone, signal processing equipment and digital audio recorder. The unit was attached to an anchor and buoy and deployed at depth of 5 m, as depicted in *Figure 3*a. The autonomous unit consisted of a RESON TC4013 hydrophone with PCB in-line charge amplifier (Model 422E13), PCB Multi Gain Signal Conditioner (Model 480M122), and a Roland Model R-05 Solid State Recorder (see *Figure 3b*). The Roland recorders were set to a sampling rate of 96,000 samples per second. These units were deployed all the monitoring days.

The second method consisted of live measurements from a small aluminum boat. The hydrophone used during this sampling was deployed at a depth of 5 m. The boat was anchored at a set distance while the pile driving occurred.

The third method consisted of unmanned measurements on the pile driving derrick (barge). The hydrophone used during this sampling was deployed at a depth of 3 m.

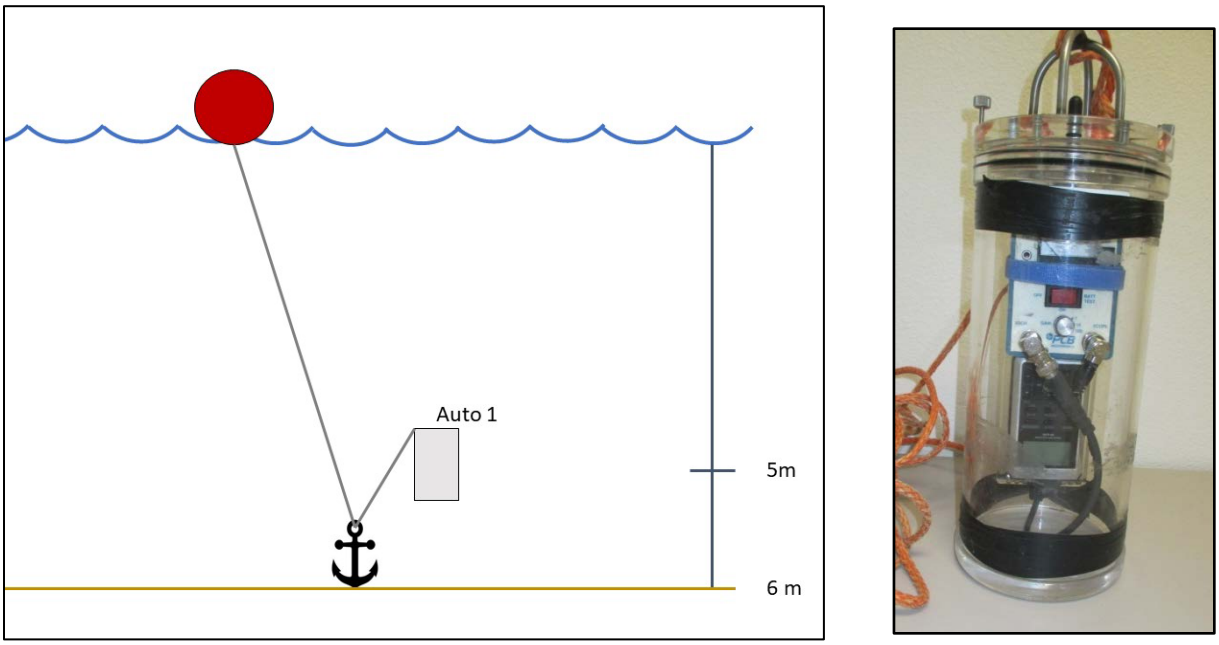

Figure 3. a) Positioning of autonomous hydrophone units in the water column b) Autonomous hydrophone system configuration

Live measurements were made using RESON Model TC-4033 hydrophones. The hydrophone signal was fed through into a Larson Davis Model 831 Precision Sound Level Meter (LDL 831). The LDL 831 system provided live displays of the Leq values.

MEASUREMENT RESULTS

The recorded signals were first examined to identify pulses at various measurement positions. The peak, SEL, pulse duration, and RMS values were identified for these pulses. These data were used to provide a broad description of the far-field sound environment.

Time history plots of all the pile driving events are included in *Appendix B***.** Samples of the 1/3 octave band spectra for pile installation at all monitoring positions are included in *Appendix C*.

Spud Pile

On September 5 and 6, 2019, underwater sound monitoring was performed during the vibratory spudding operation to clear pilot holes for the impact driving of two concrete piles (3A and 3B). Measurements were made at distances of 10 m, 700 m from the pile 3B spudding operation on September 5th and of 10 m, 100 m from the pile 3A spudding operation on September 6th. The water depth was approximately 3 m at the pile. At the ten-meter position the water depth was 3.0 m; at 100-m and 700-m locations the water depth was approximately 6 m. The hydrophones were placed at mid water depth at both locations. Winds were a large factor for both days at the distant measurement positions. The background levels were higher due to the movement of the raft and the waves hitting the raft. Spudding for Pile 3B was completed on September 5, 2019 and the driving

was extremely difficult with a total of 2,566 blows to install the pile, they were not able to install it to the final tip elevation. On September 10, 2019 during the driving of Pile 3B 1,282 blows were used to install the pile to the same depth as Pile 3A.

A A.P.E. King Kong Vibratory hammer was used to conduct the spudding operations and a bubble ring was not required. There was a lot of starting and stopping during the spudding as there were several dense layers of material that required additional time to penetrate. On September 5th, when the raft was positioned at 700 m, the noise from the spudding operation was not discernible above the background noise. On September 6th the distant location was moved to 100 m to capture the noise from the spudding operation.

Table 1 shows the levels measured at both locations and Table 2 shows the distances to the interim criteria. Figures 1 through 3, in *Appendix B* show a graphical representation of sound levels for each pile driving activity. Calculations in the sound level meter generally rely on one-second time intervals to compute metrics.

Table 1 – Measured Data from the Spudding Operation on September 5 and 6, 2019

Pile Type	Duration (Seconds)	Distance	Peak	RMS		SEL	
			dB re: 1µPa	dB re: 1µPa		dB re: 1µPa	
			Maximum	Median	Range	Median	Range
3B 09/05/2019	1429	10 m	186	160	150-175	159	149-174
		700 m	--[1]	--[1]	--[1]	--[1]	--[1]
3A 09/6/2019	858	10 m	177	160	147-169	159	146-168
		100 m	155	128	114-140	128	116-139
3B 09/06/2019	372	10 m	176	162	149-169	162	147-168
		100 m	155	135	125-143	135	126-144

Table 2: Calculated Distances to Thresholds from the Spudding Operation on September 5 and 6, 2019

Threshold	Calculated distance to threshold	
Pile Id	3A	3B
206 dB Peak	<10 m	<10 m
120 dB RMS (Level B Marine Mammal Harassment Zone)	240 m	360 m

Concrete Piles

On September 9 and 10, 2019, underwater sound monitoring was performed during the impact driving of two concrete piles (3A and 3B). Measurements were made at distances of 10 m, 100 m from the pile being installed. The water depth was approximately 3 m at the pile. At the 10-m position the water depth was 3.0 m; at the 100-m location the water depth was approximately 6 m. The hydrophones were placed at mid water depth at both locations. Winds were a large factor at the 100-m measurement position, nearly capsizing the raft. The background levels were higher due to the movement of the raft and the waves hitting the raft on September 9, 2019. On September 10,

2019 an attempt was made to anchor a larger boat, rather than possibly having the raft capsize; this proved to have a different set of problems as it was difficult to anchor the boat and part of the drive was not captured. Pile 3A was installed on September 9, 2019 and the driving was extremely difficult with a total of 2,566 blows to install the pile; they were not able to install it to the final tip elevation. On September 10, 2019 during the driving of Pile 3B 1,282 blows were used to install the pile to the same depth as Pile 3A. Requirements from the NMFS BO are summarized below:

Table 3 shows the levels measured at both locations and Table 4 shows the distances to the interim criteria. Figures 4 through 7, in *Appendix B* show a graphical representation of sound levels for each pile driving activity.

Table 3: Summary of Measured Sound Levels for September 9 and 10, 2019

Pile Type	Pile Strikes	Distance	Peak	RMS		SEL		Cumulative SEL
			dB re: 1µPa	dB re: 1µPa		dB re: 1µPa		dB re: 1µPa^2-sec
			Maximum	Median	Range	Median	Range	
3A 09/09/2019	2,566	10 m	193	178	171-180	166	154-172	200
		100 m	177	165	158-168	153	141-156	187
3B 09/10/2019	1,282	10 m	189	170	157-178	164	146-171	198
		100 m	181	166	151-171	154	150-159	185

[1] This calculation assumes that single strike SELs < 150 dB do not accumulate to cause injury (Effective Quiet).

Table 4: Calculated Distances to Thresholds.

Threshold	Calculated distance to threshold	
Pile Id	3A	3B
206 dB Peak	<10 m	<10 m
187 dB Cumulative SEL	101 m	64 m
183 dB Cumulative SEL	158 m	118 m
150 dB RMS (Fish Harassment Zone)	1,000 m	1,000 m
160 dB RMS (Level B Marine Mammal Zone)	215 m	215 m

H-Pile installation

On October 25, 2019, underwater sound monitoring was performed during the vibratory installation of two H-Piles for the driving template. Measurements were made at distances of 10-11 m, 140-150 m and 600 m from the pile being installed. The water depth was approximately 3 m at the pile. At the 10-m position the water depth was 3.0 m; at the 140-/150-m location the water depth was approximately 6 m, and at the 600-m location the water depth was approximately 6 m. The hydrophones were placed at mid water depth at both locations. Winds were a not an issue; the driving duration was 476 seconds for the first H-pile and 245 seconds for the second H-pile.

Table 5 shows the levels measured at both locations and Table 6 shows the distances to the interim criteria. Figures 8 through 13, in *Appendix B* show a graphical representation of sound levels for each pile driving activity.

Table 5: Summary of Measured Sound Levels for October 25, 2019

Pile Type	Duration (Seconds)	Distance	Peak	RMS		SEL	
			dB re: 1µPa	dB re: 1µPa		dB re: 1µPa	
			Maximum	Median	Range	Median	Range
1st H-Pile	476	11 m	180	156	139-168	156	135-168
		150 m	162	136	118-151	136	118-149
		600 m	149	120	112-134	120	112-134
2nd H-Pile	245	10 m	174	164	151-168	164	145-168
		140 m	159	143	129-153	143	130-153
		600 m	144	118	112-130	118	112-130

Table 6: Calculated Distances to Thresholds.

Threshold	Calculated distance to threshold	
Pile Id	1st H-Pile	2nd H-Pile
206 dB Peak	<10 m	<10 m
120 dB RMS (Level B Marine Mammal Zone)	600 m	500 m

36-inch Steel Pile

On October 29th and 30th, 2019, underwater sound monitoring was performed during the Vibratory driving of two 36-inch steel piles. On October 29th measurements were made at distances of 10 m, 260 m and 660 m from the pile being installed. The water depth was approximately 3 m at the pile. At the 10-m position the water depth was 3.0 m; at the 260-m location the water depth was approximately 6 m, and at the 660-m location the water was 6 m deep. The hydrophones were placed at mid water depth at both locations. Requirements from the NMFS BO are summarized below:

Table 7 shows the levels measured at both locations and Table 8 shows the distances to the interim criteria. Figures 14 through 19, in *Appendix B* show a graphical representation of sound levels for each pile driving activity.

Table 7: Summary of Measured Sound Levels for October 29, 2019

Pile Type	Duration (Seconds)	Distance	Peak	RMS		SEL	
			dB re: 1µPa	dB re: 1µPa		dB re: 1µPa	
			Maximum	Median	Range	Median	Range
36-inch pile 10/ 29/2019	2,839	10 m	203	165	150-181	165	149-181
		260 m	177	141	121-159	141	121-158
		660 m	162	128	112-146	128	112-145

36-inch pile 10/ 31/2019	2,118	10 m	200	167	145-178	167	167-178
		230 m	182	143	143-156	143	143-156
		660 m	160	129	112-142	129	129-142

Table 8: Calculated Distances to Thresholds.

Threshold	Calculated distance to threshold	
Pile Id	1st H-Pile	2nd H-Pile
206 dB Peak	<10 m	<10 m
120 dB RMS (Level B Marine Mammal Zone)	1,570 m	1,780 m

H-Pile Removal

On November 18, 2019, underwater sound monitoring was performed during the vibratory removal of three H-piles. Measurements were made at distances of 10-20 m, 120 m and 660 m from the pile being removed. The water depth was approximately 3 m at the pile. At the 10-m position the water depth was 3.0 m; at the 120-m location the water depth was approximately 6 m, and at the 660-m location the water depth was approximately 6 m. The hydrophones were placed at mid water depth at both locations. Winds were a not an issue; the removal duration ranged from 37 seconds to 126 seconds for the piles removed. Requirements from the NMFS BO are summarized below:

Table 9 shows the levels measured at both locations and Table 10 shows the distances to the interim criteria. Figures 20 through 21, in *Appendix B* show a graphical representation of sound levels for each pile driving activity.

Table 9: Summary of Measured Sound Levels for November 18, 2019

Pile Type	Duration (Seconds)	Distance	Peak	RMS		SEL	
			dB re: 1µPa	dB re: 1µPa		dB re: 1µPa	
			Maximum	Median	Range	Median	Range
1st H-Pile	42	16 m	172	162	150-168	161	150-167
		120 m	156	145	125-150	143	122-149
		660 m	--[1]	--[1]	--[1]	--[1]	--[1]
2nd H-Pile	37	20 m	170	160	146-165	159	148-164
		120 m	153	141	129-147	140	129-145
		66 m	--[1]	--[1]	--[1]	--[1]	--[1]
3rd H-Pile	126	10 m	174	154	146-165	153	144-162
		120 m	152	131	125-144	130	119-143
		660 m	--[1]	--[1]	--[1]	--[1]	--[1]

[1] – Levels were less than background levels

Table 10: Calculated Distances to Thresholds.

Threshold	Calculated distance to threshold	
Pile Id	1st H-Pile	2nd H-Pile
206 dB Peak	<10 m	<10 m
120 dB RMS (Level B Marine Mammal Zone)	1,096 m	585 m

Appendix A

Glossary of Technical Terms

Ambient sound – Normal background sound in the environment that has no distinguishable sources.

Ambient sound level – The background sound pressure level at a given location, normally specified as a reference level to study a new intrusive sound source.

Amplitude – The maximum deviation between the sound pressure and the ambient pressure.

Background level – Similar to ambient sound level with the exception that is a composite of all sound measured during the construction period minus the pile removal.

Decibel (dB) – A customary scale most commonly used for reporting levels of sound. A difference of 10 dB corresponds to a factor of 10 in sound power. A unit describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure. The reference pressure for water is 1 microPascal, and for air it is 20 microPascals (the threshold of healthy human auditory sensitivity).

Fast, Slow, and Impulse – Most sound level meters have two conventional time weightings, F = Fast and S = Slow with time constants of 125 milliseconds (ms) and 1,000 ms, respectively. Some also have I = Impulse time weighting, which is a quasi-peak detection characteristic with rapid rise time (35 ms) and a much slower 1.5-second decay.

- F = 125 ms up and down
- S = 1 second up and down
- I = 35 ms while the signal level is increasing or 1,500 ms while the signal level is decreasing.

Frequency – The number of complete pressure fluctuations per second above and below atmospheric pressure, measured in cycles per second (Hertz [Hz]). Normal human hearing is between 20 and 20,000 Hz. Infrasonic sounds are below 20 Hz and ultrasonic sounds are above 20,000 Hz.

Frequency spectrum – The distribution of frequencies that comprise a sound.

Hertz (Hz) – The units of frequency where 1 Hz equals 1 cycle per second.

Kilohertz (kHz) – 1,000 Hz

L_{eq} – *Equivalent Average Sound Pressure Level (or Energy-Averaged Sound Level).* The decibel level of a constant noise source that would have the same total acoustical energy over the same time interval as the actual time-varying noise condition being measured or estimated. Leq values must be associated with an explicit or implicit averaging time in order to have practical meaning. The use of A-weighted, C-weighted, or Z-weighted (flat) decibel units sometimes is indicated by LA_{eq}, LC_{eq}, or LZ_{eq}, respectively

LZ_{eq} – Z-weighted, Leq, sound pressure level.

LZ_{max} – Maximum Sound Pressure level during a measurement period or a noise event.

LZ_{peak} – Z-weighted peak sound pressure level.

microPascal (µPa) – The Pascal (symbol Pa) is the SI unit of pressure. It is equivalent to one Newton per square meter. There are 1,000,000 microPascals in one Pascal.

Peak sound pressure level (L_{PEAK}) – The largest absolute value of the instantaneous sound pressure. This pressure is expressed in decibels (referenced to a pressure of 1 μPa for water and 20 μPa for air) or in units of pressure, such as μPa or Pounds per Square Inch.

Root mean square (RMS) sound pressure level – Decibel measure of the square root of mean square (RMS) pressure. For impulses, the average of the squared pressures over the time that comprise that portion of the waveform containing 90 percent of the sound energy of the impulse.

SLM – Sound level meter.

Sound – Small disturbances in a fluid from ambient conditions through which energy is transferred away from a source by progressive fluctuations of pressure (or sound waves).

Sound exposure – The integral over all time of the square of the sound pressure of a transient waveform.

Sound exposure level (SEL) – The time integral of frequency-weighted squared instantaneous sound pressures. Proportionally equivalent to the time integral of the pressure squared. Sound energy associated with an acoustical event is characterized by the SEL. SEL is the constant sound level in one second, which has the same amount of acoustic energy as the original time-varying sound (i.e., the total energy of an event). SEL is calculated by summing the cumulative pressure squared over the time of the event ($1\mu Pa^2$-sec**)**.

Sound pressure level (SPL) – An expression of the sound pressure using the decibel (dB) scale and the standard reference pressures of 1 μPa for water and 20 μPa for air when addressing human concerns. Sound pressure is the sound force per unit area, usually expressed in microPascals (or microNewtons per square meter), where 1 Pascal is the pressure resulting from a force of 1 Newton exerted over an area of 1 square meter. The SPL is expressed in dB as one or 20 times the logarithm to the base 10 of the ratio between the pressure exerted by the sound to a reference sound pressure. SPL is the quantity directly measured by a sound level meter.

Z-weighted – Z-weighting is a flat frequency response of 10 Hz to 20 kHz ±1.5 dB. This response replaces the older "Linear" or "Unweighted" responses as these did not define the frequency range over which a sound level meter would be linear.

A-Weighted - The sound pressure level in decibels as measured on a sound level meter using the A-weighting filter network. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise

Appendix B

Time History
Plots

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Figure 1 – September 5, 2019 Spudding Operation at 10 m

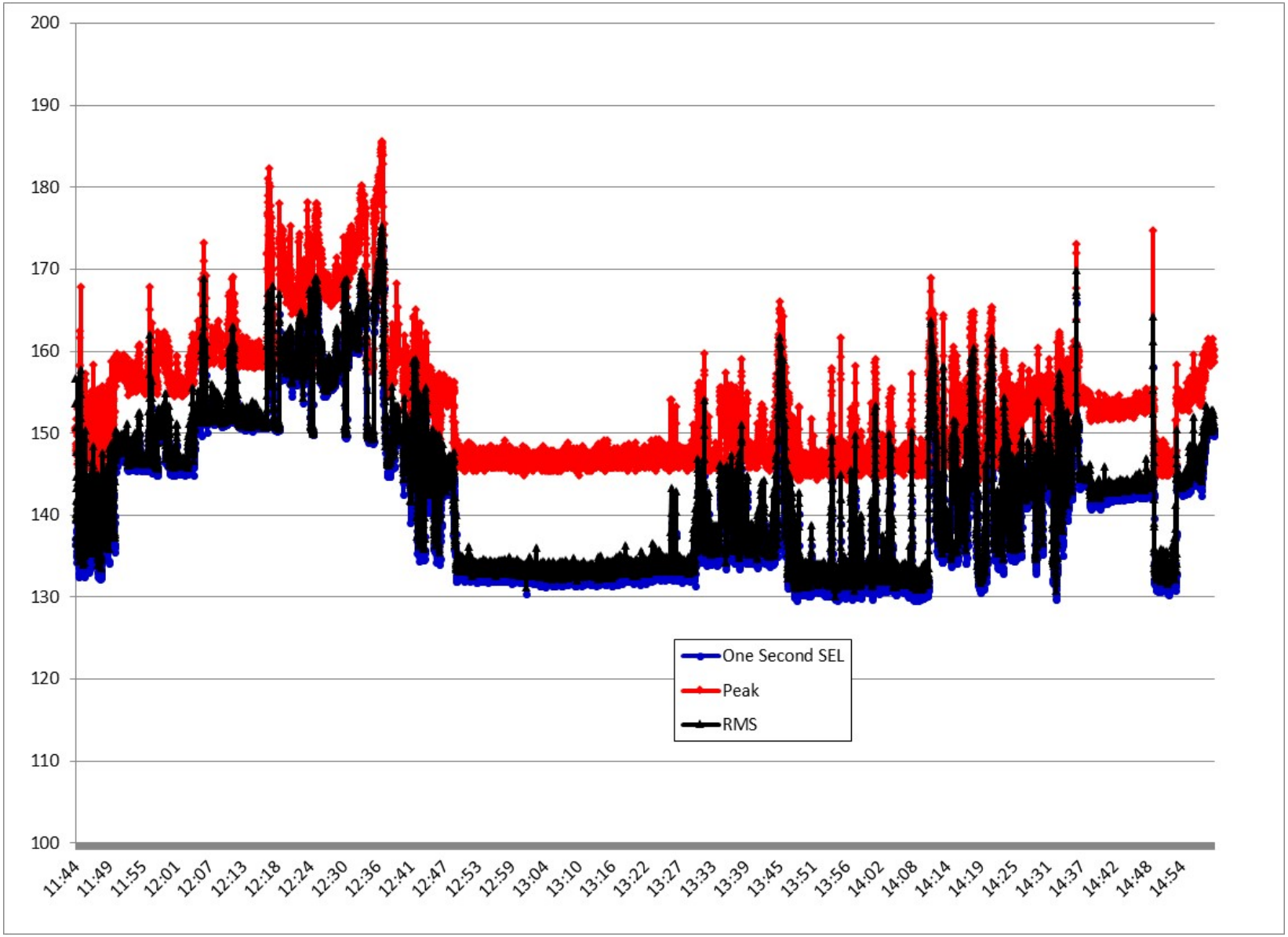


Figure 2 – September 5, 2019 Spudding Operation at 700 m

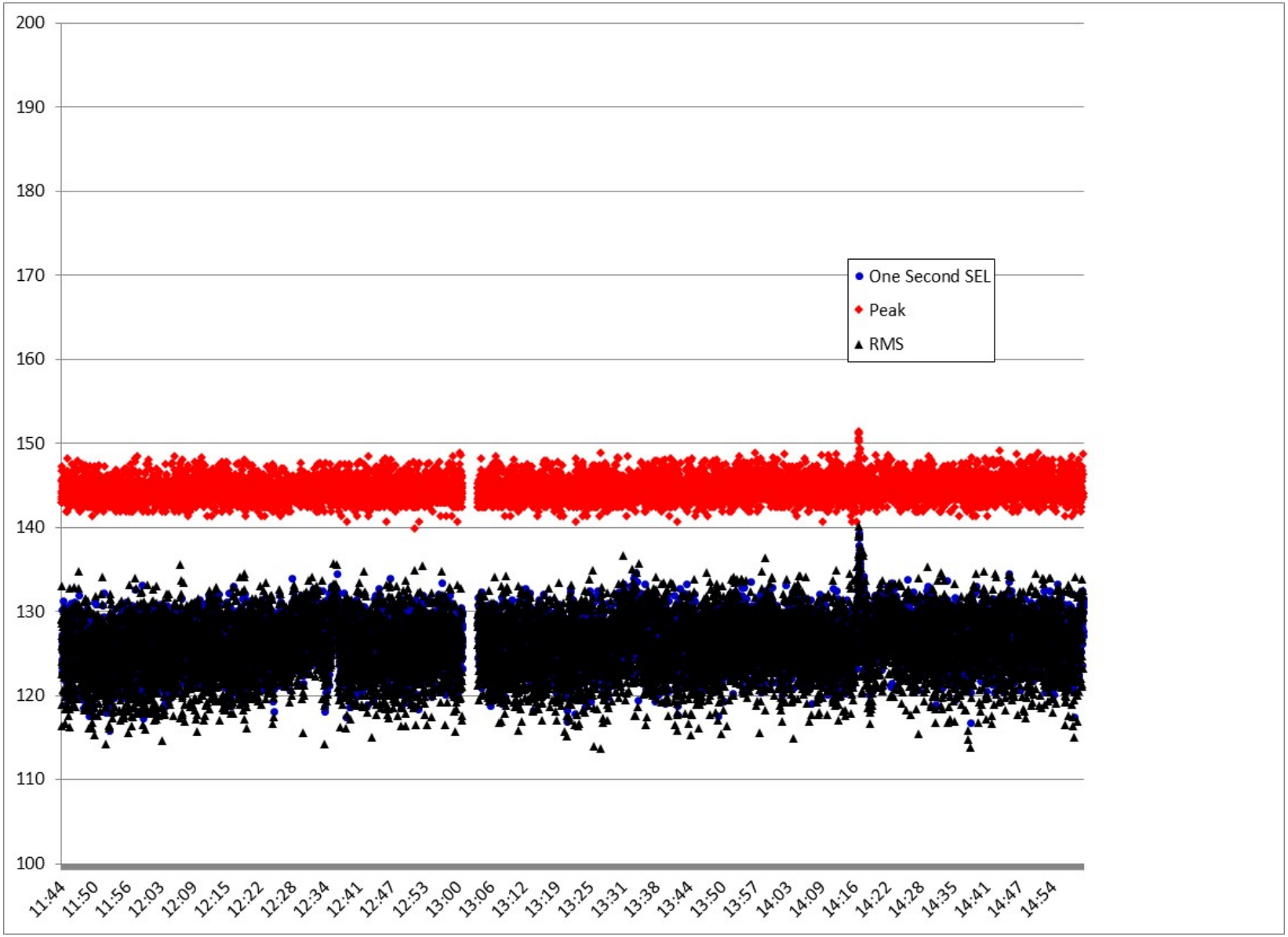


Figure 3 September 6, 2019 Spudding Operation RMS levels at 10 m and 100 m

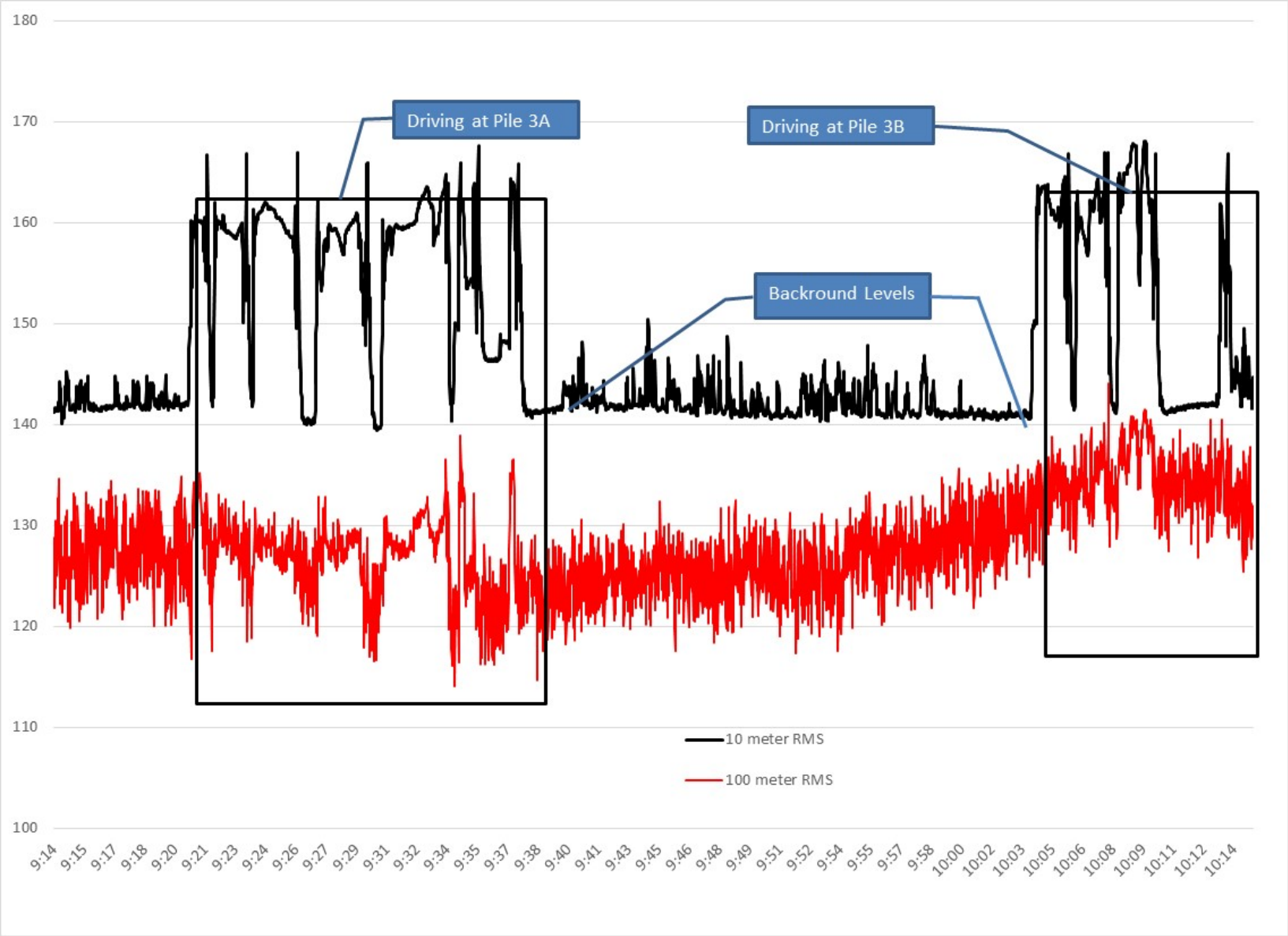


Figure 4 – September 9, 2019 Concrete Pile 3A Installation at 10 m

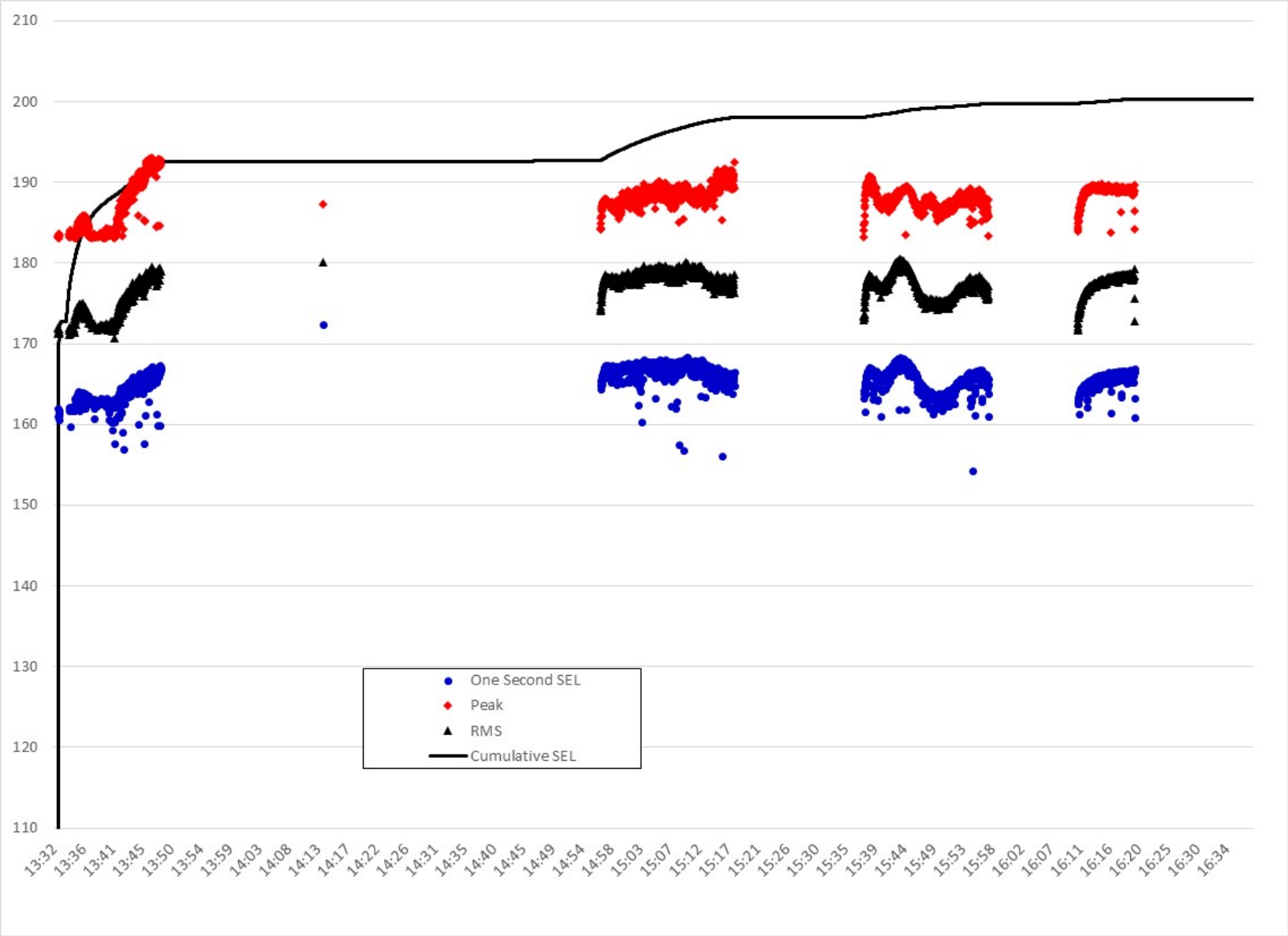


Figure 5 – September 9, 2019 Concrete Pile 3A Installation at 100 m

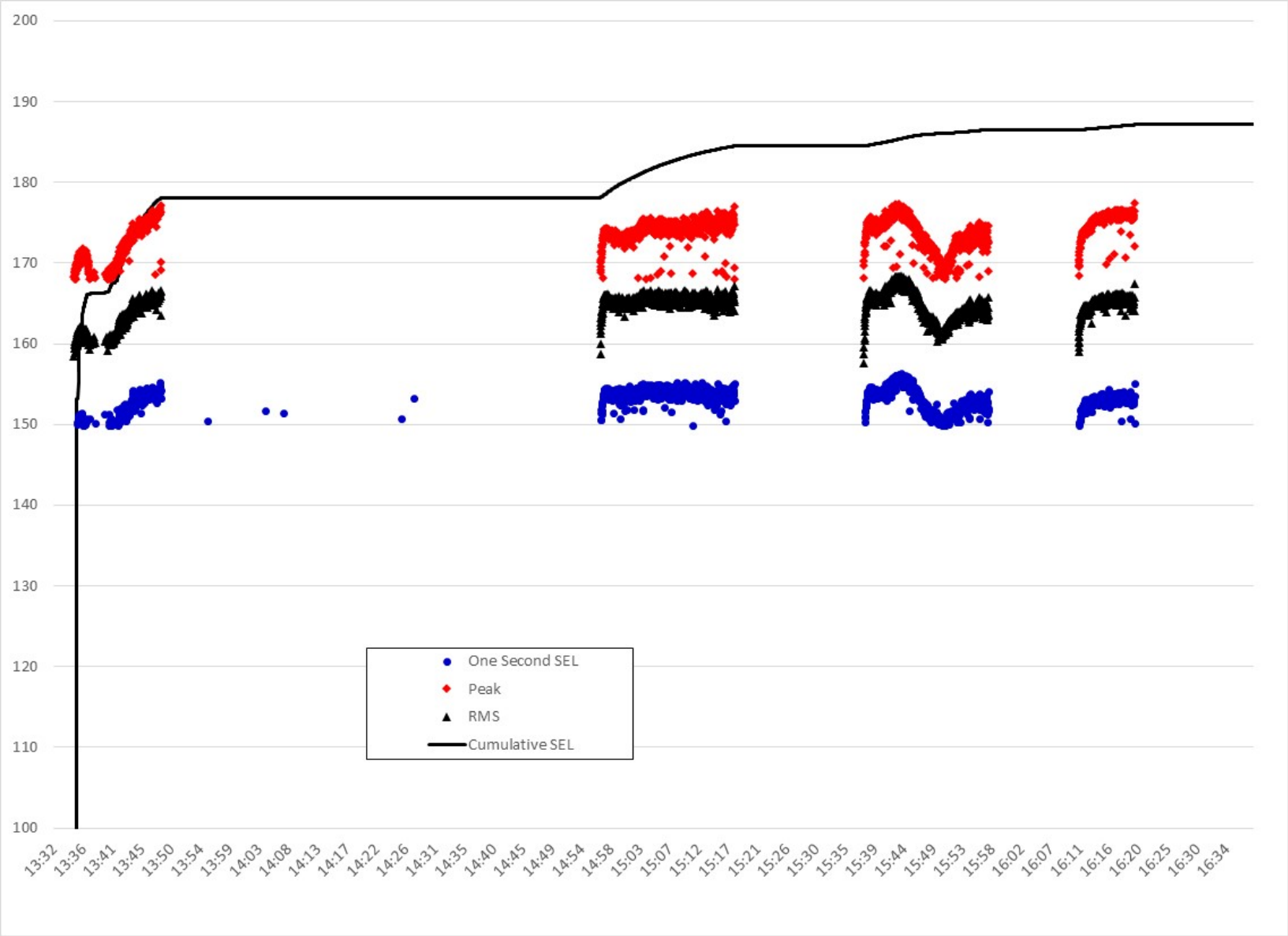


Figure 6 - September 10, 2019 Concrete Pile 3B Installation at 10 m

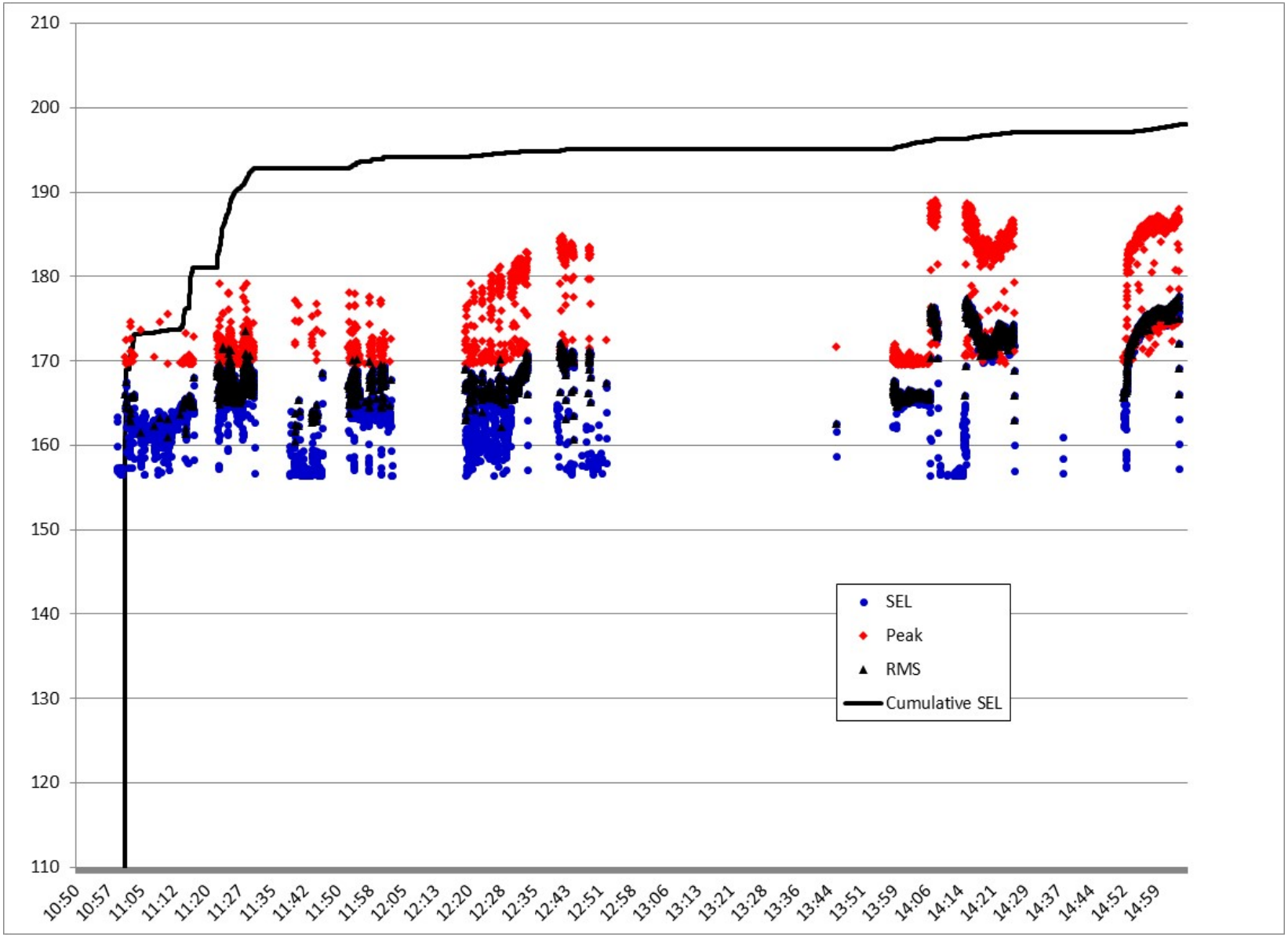


Figure 7 - September 10, 2019 Concrete Pile 3B Installation at 100 m

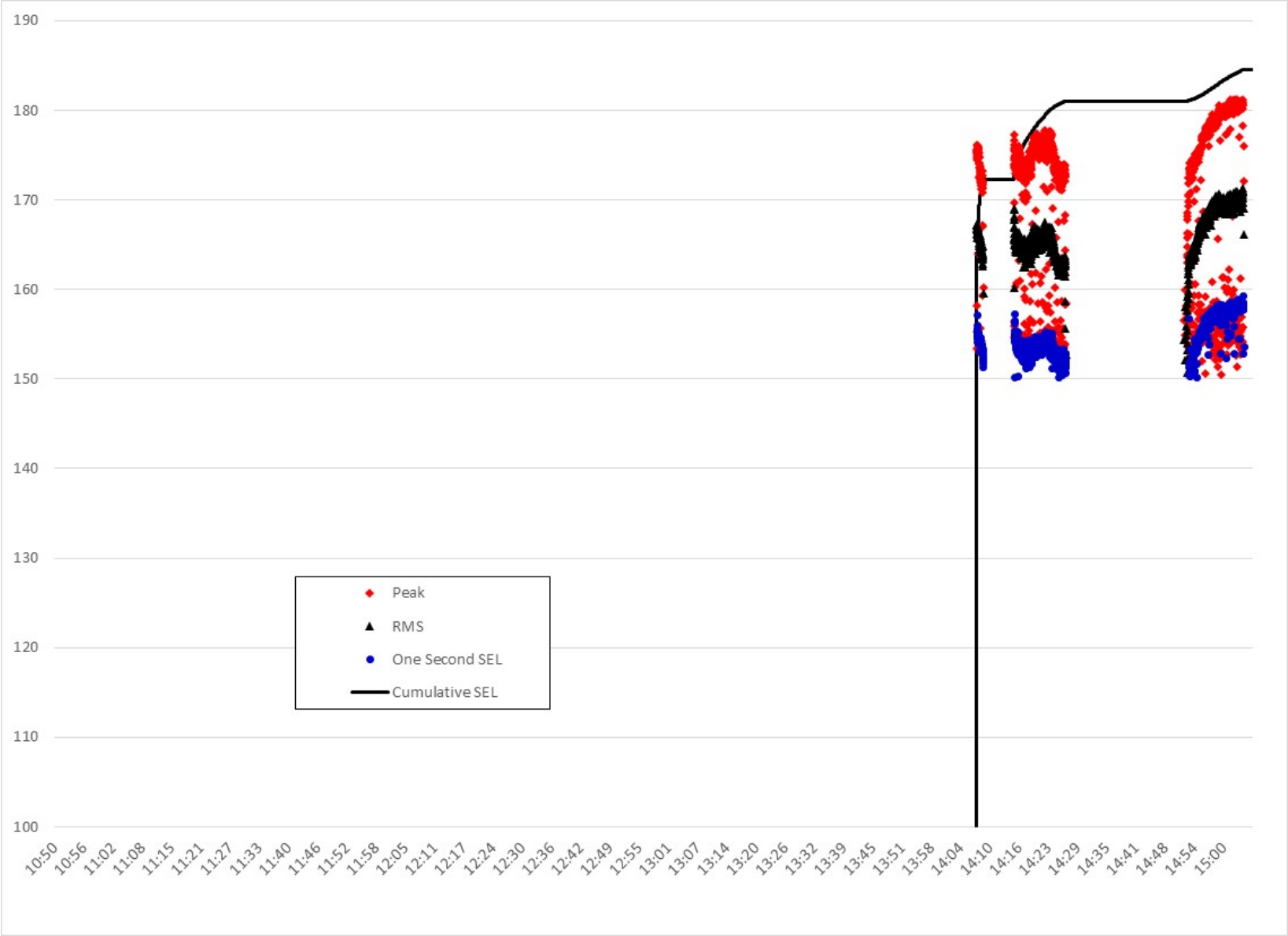


Figure 8– October 25, 2019 1st H-Pile Installation at 11 m

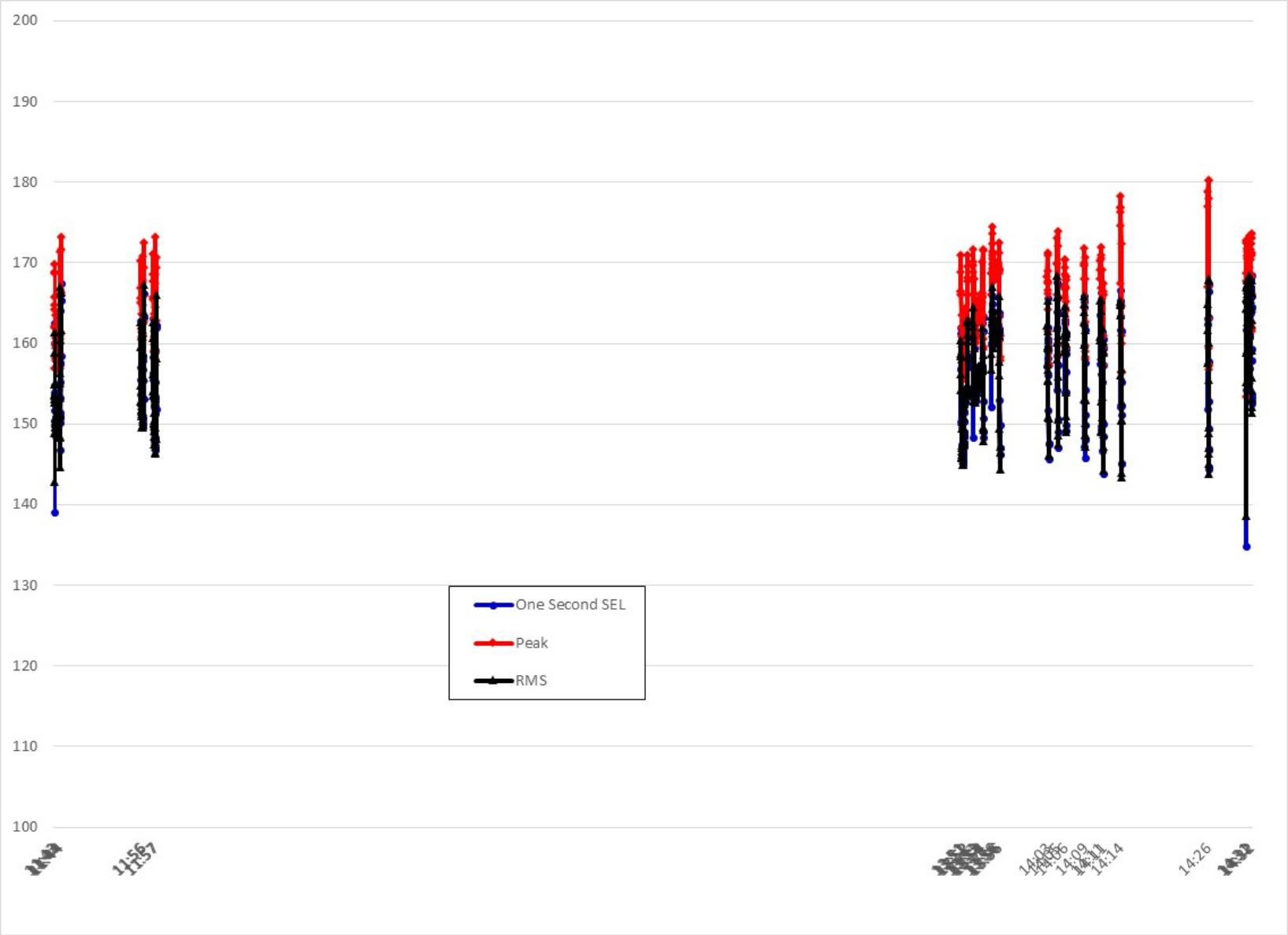


Figure 9 - October 25, 2019 1st H-Pile Installation at 150 m

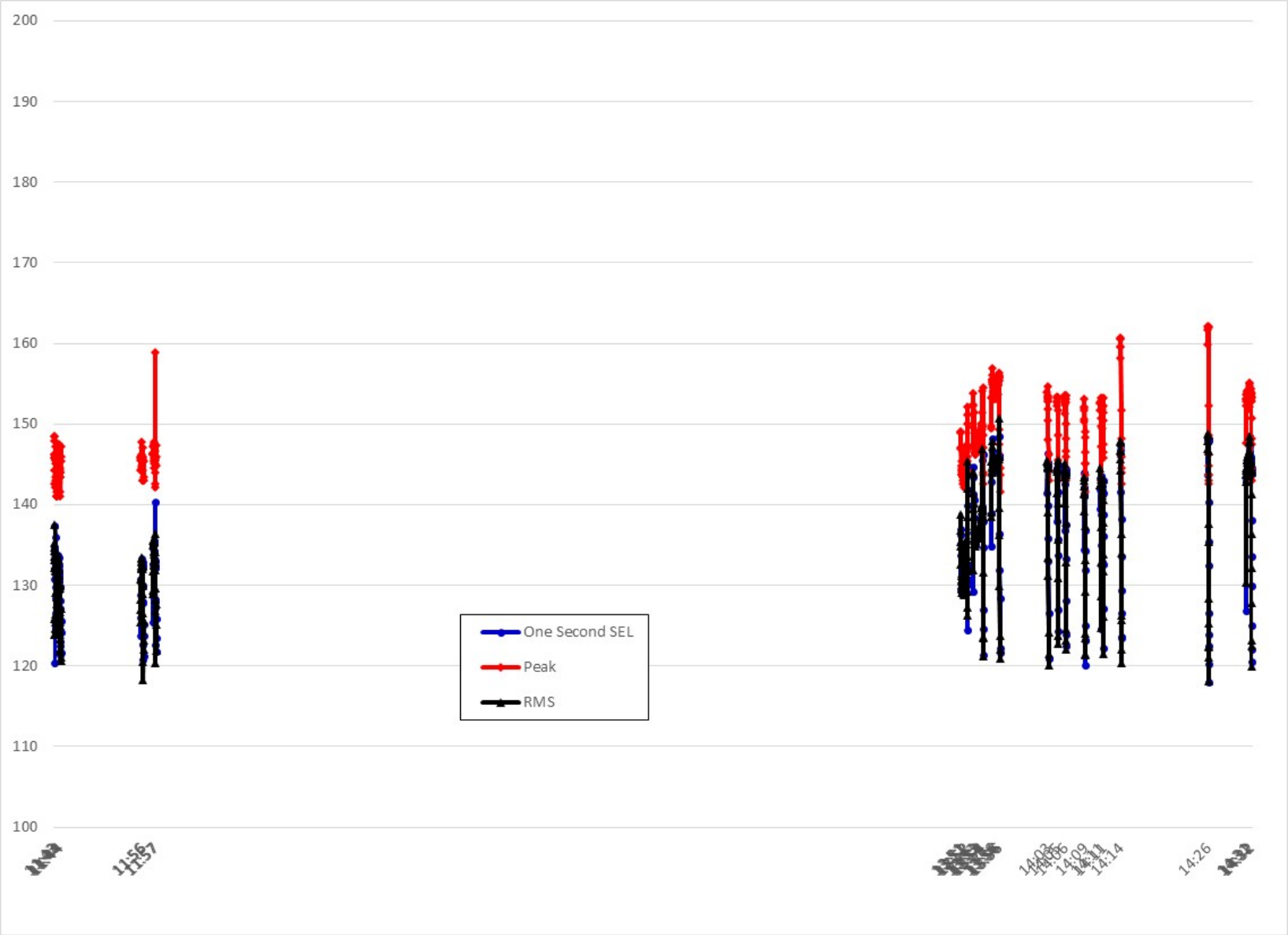


Figure 10 - October 25, 2019 1st H-Pile Installation at 600 m

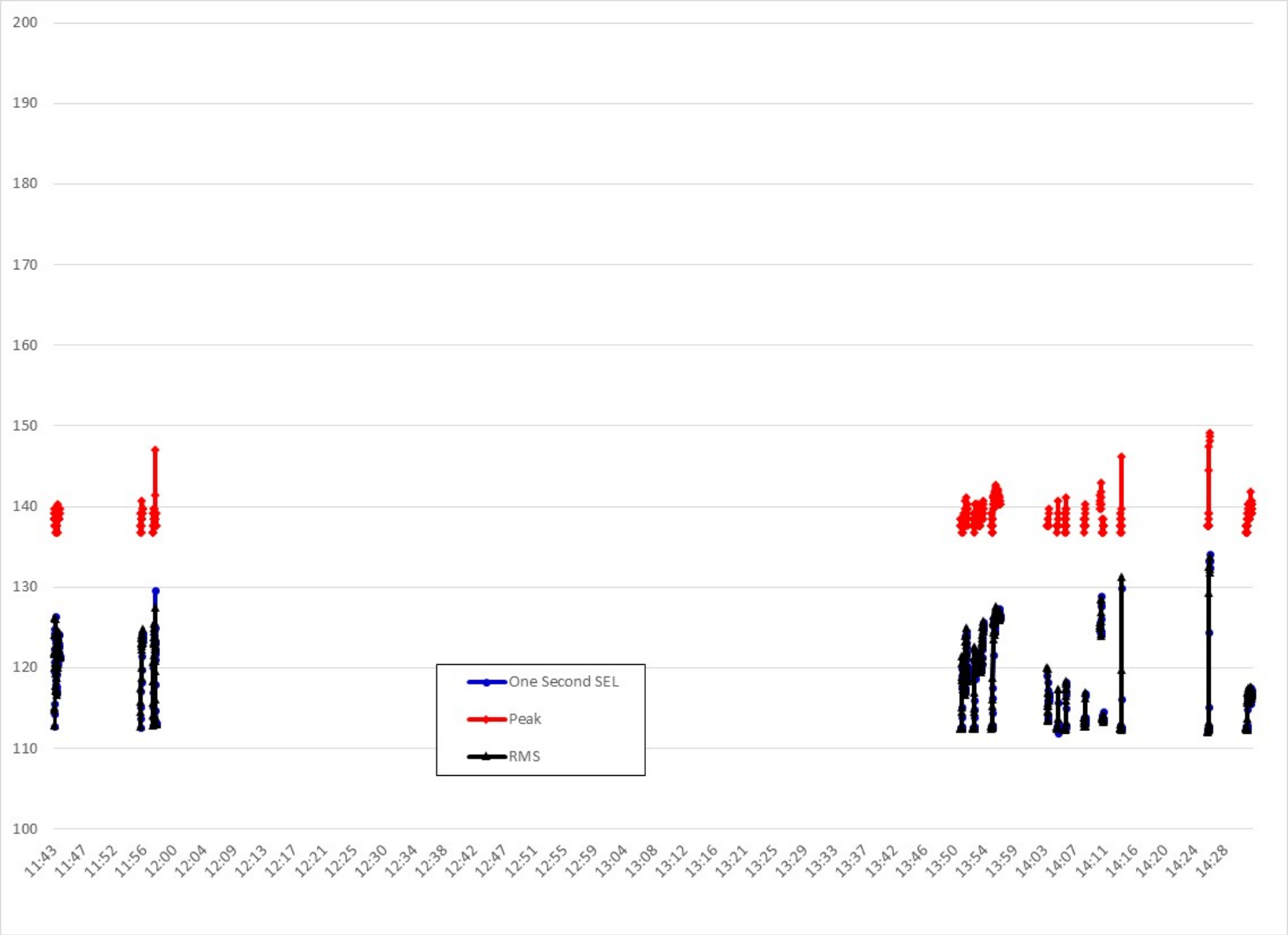


Figure 11 – October 25, 2019 2nd H-Pile Installation at 10 m

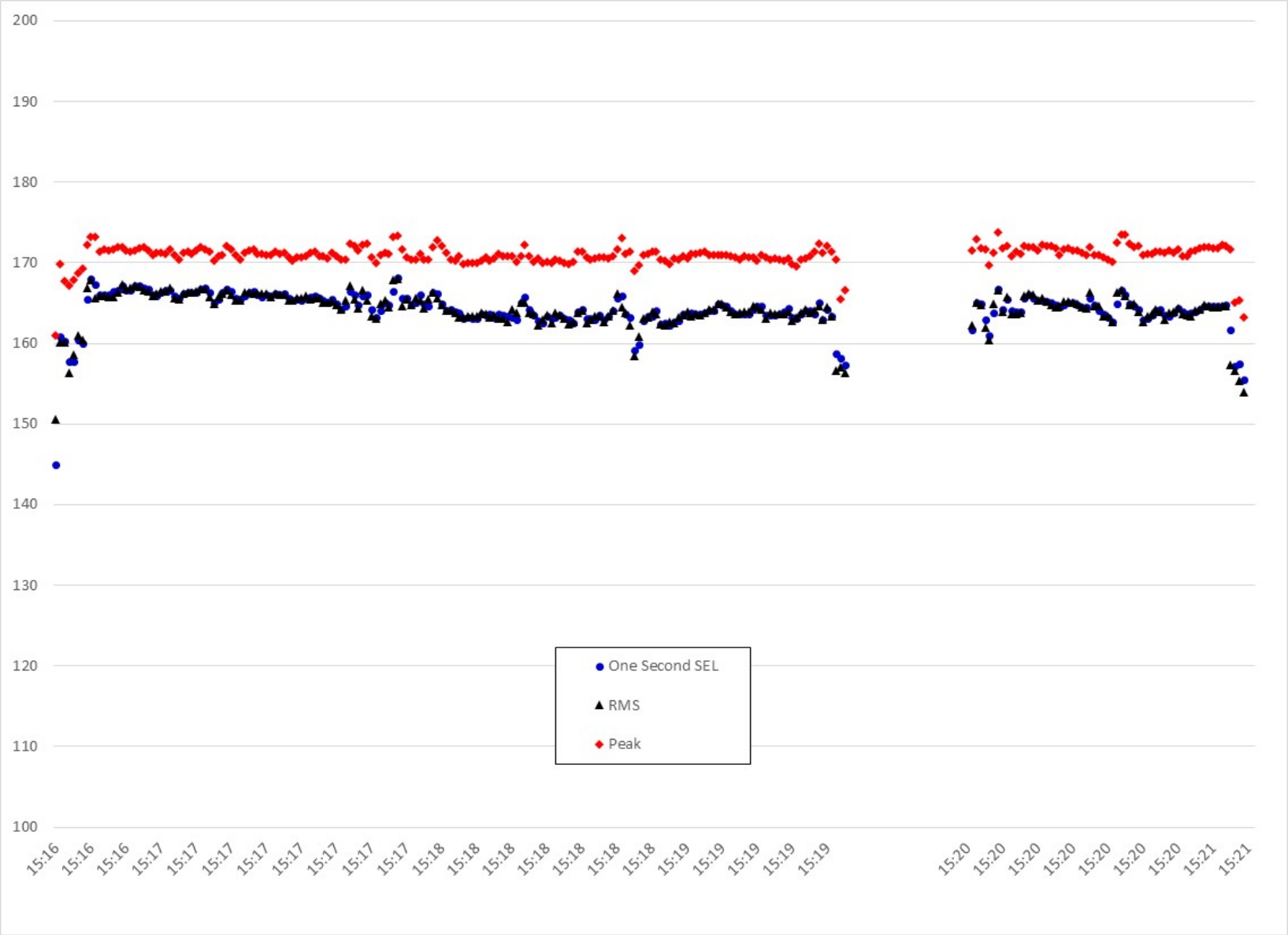


Figure 12 - October 25, 2019 2nd H-Pile Installation at 140 m

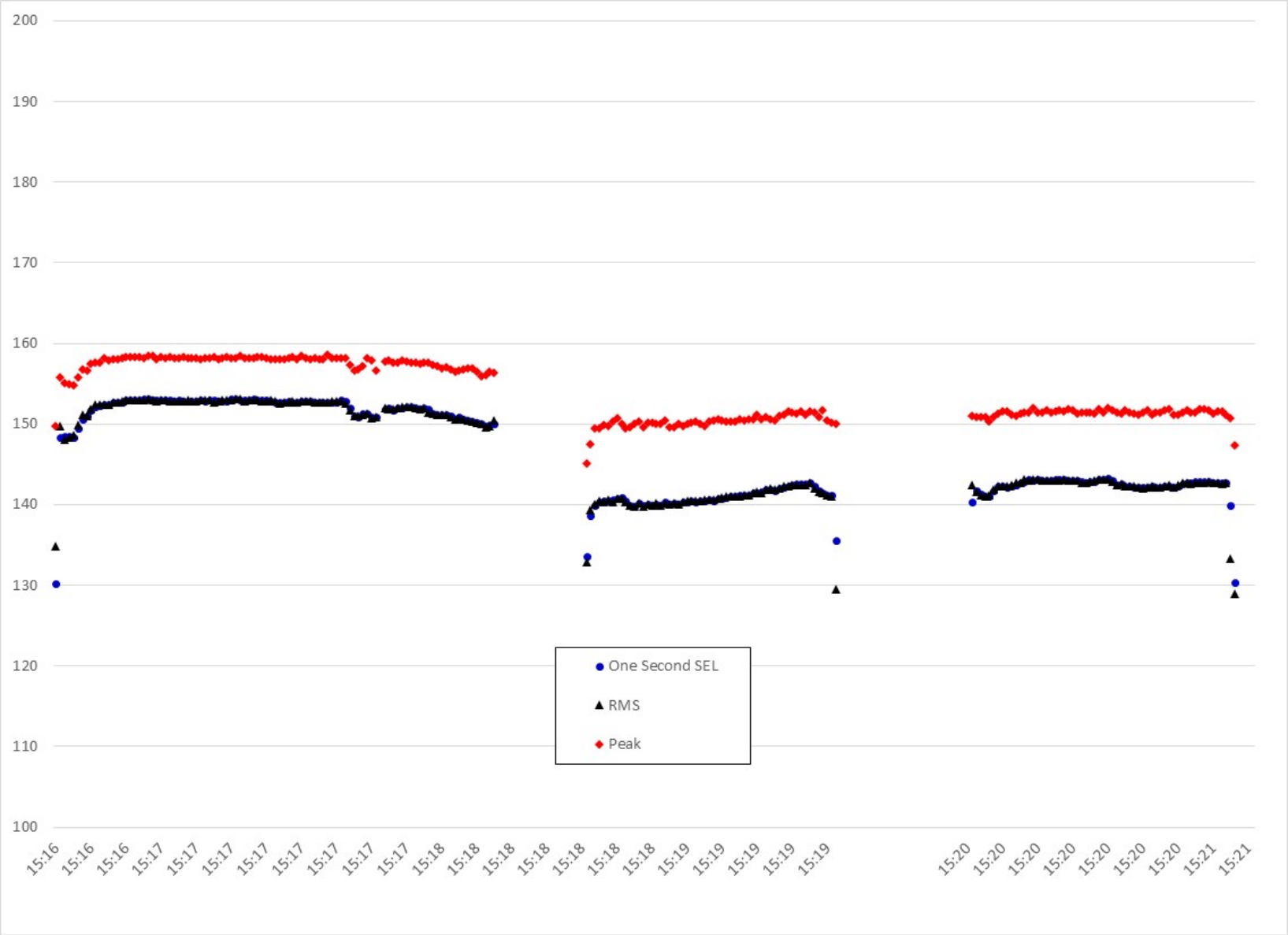


Figure 13 - October 25, 2019 2nd H-Pile Installation at 600 m

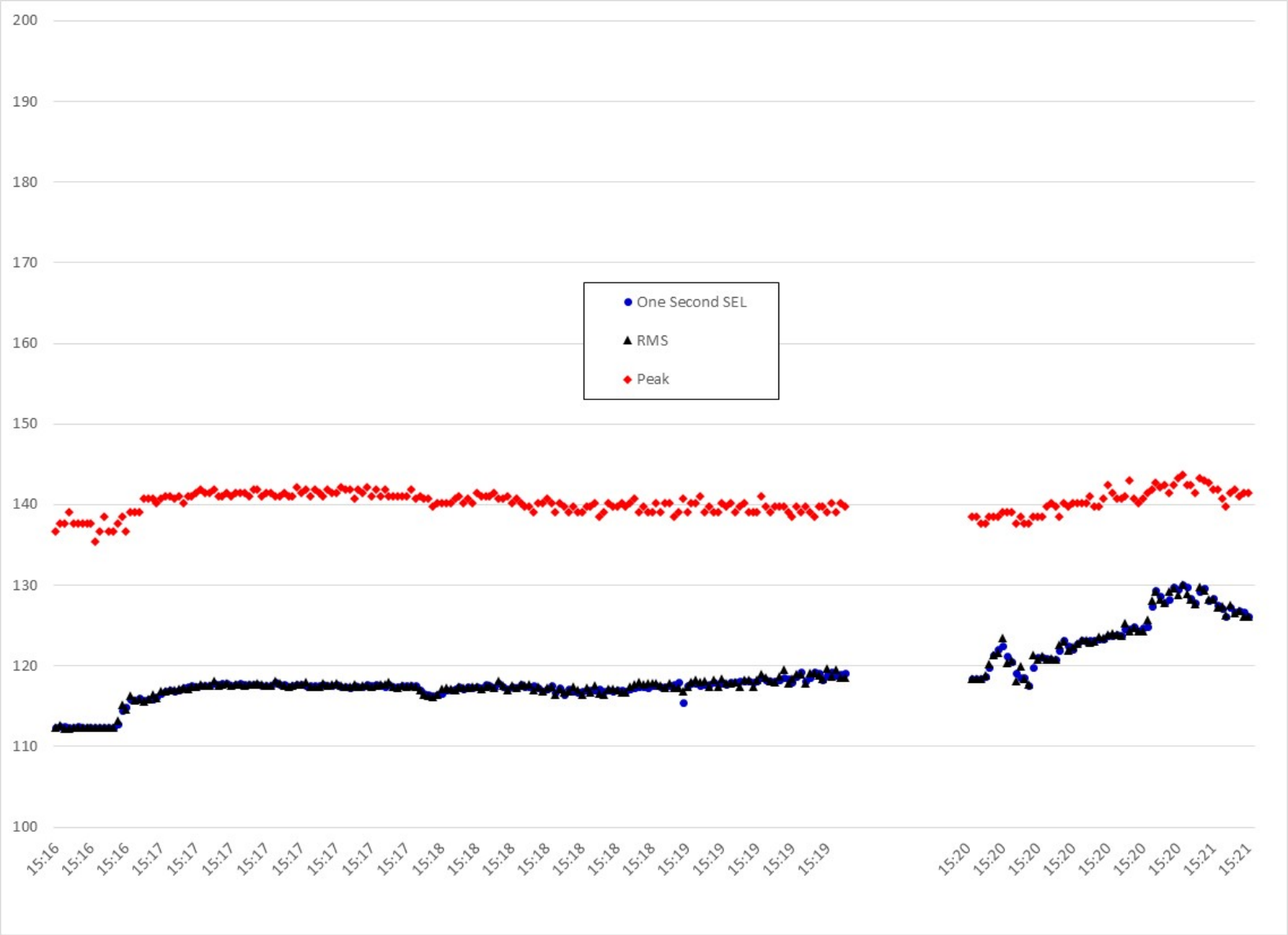


Figure 14 – October 29, 2019 36-inch Steel Pile Installation At 10 m

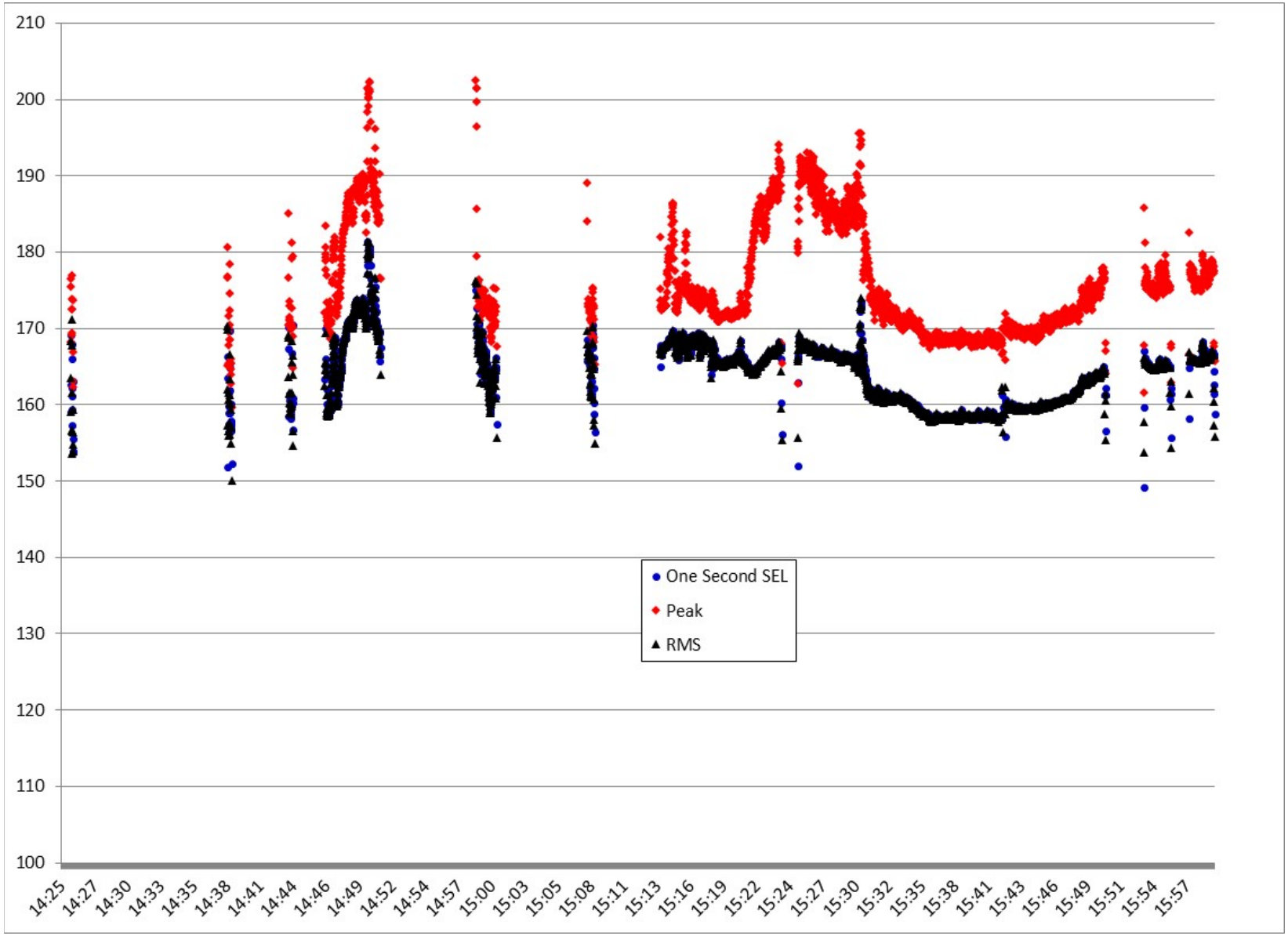


Figure 15 – October 29, 2019 36-inch Steel Pile Installation At 260 m

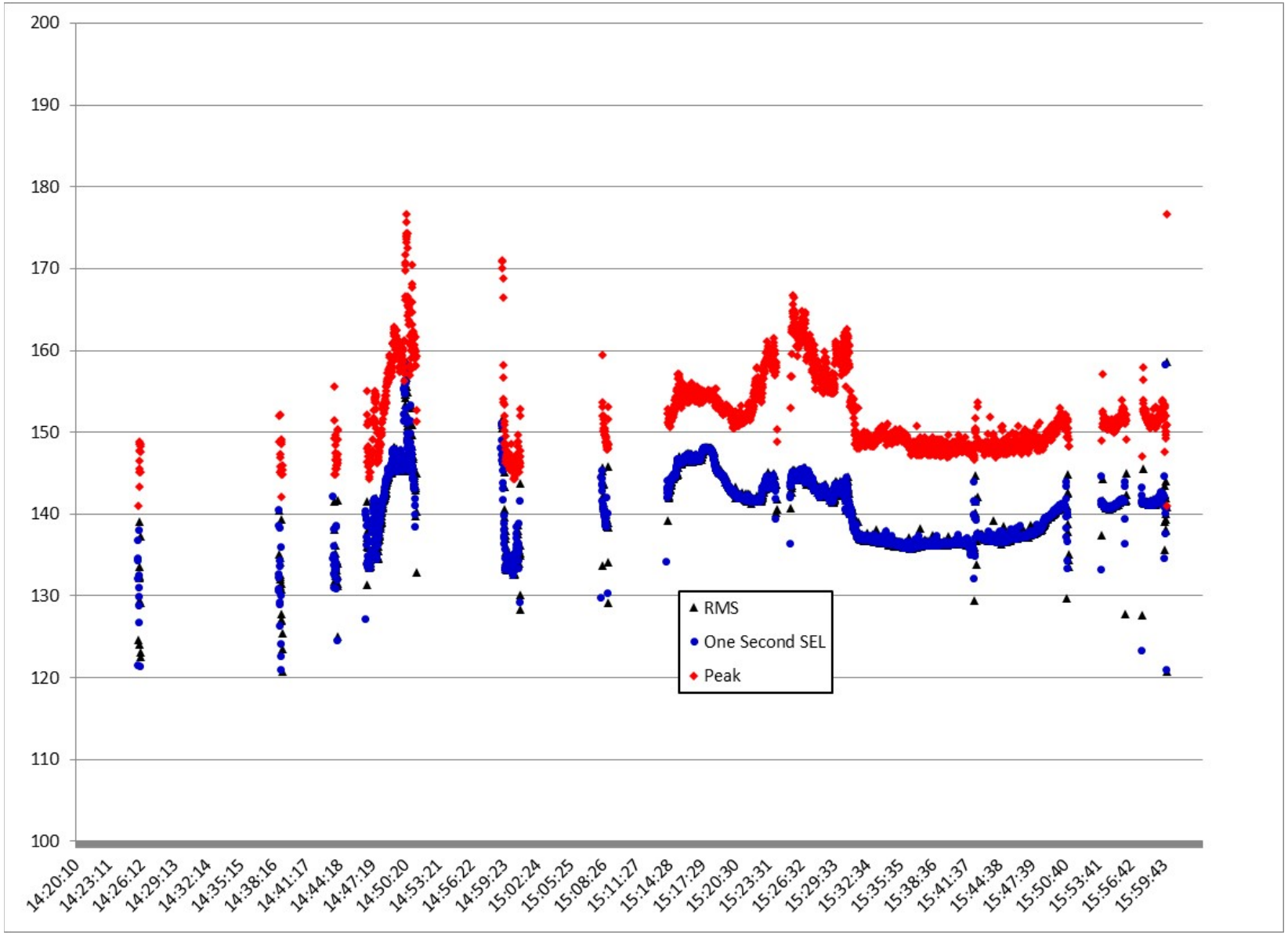


Figure 16 – October 29, 2019 36-inch Steel Pile Installation At 660 m

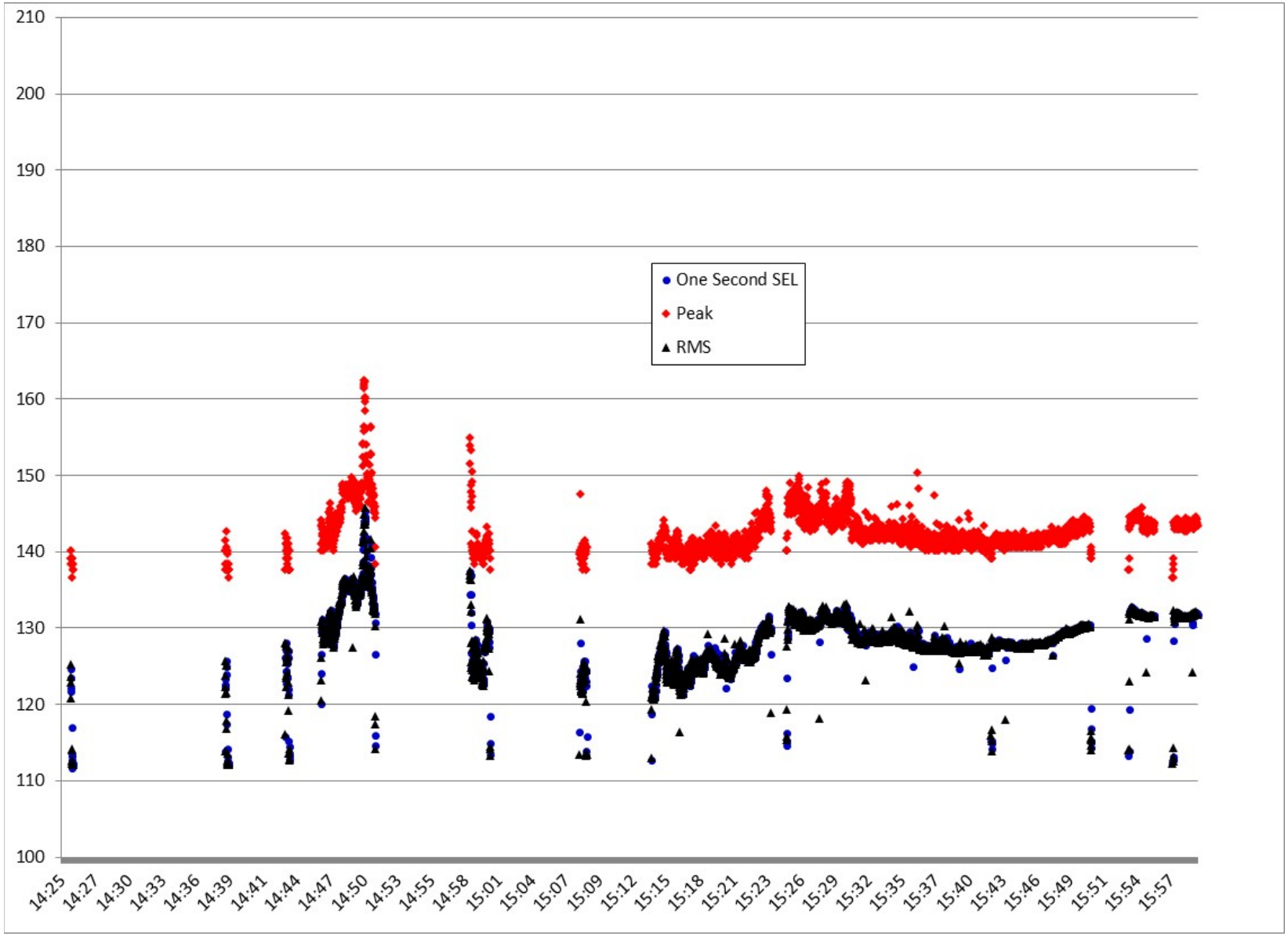


Figure 17 – October 31, 2019 36-inch Steel Pile Installation At 10 m

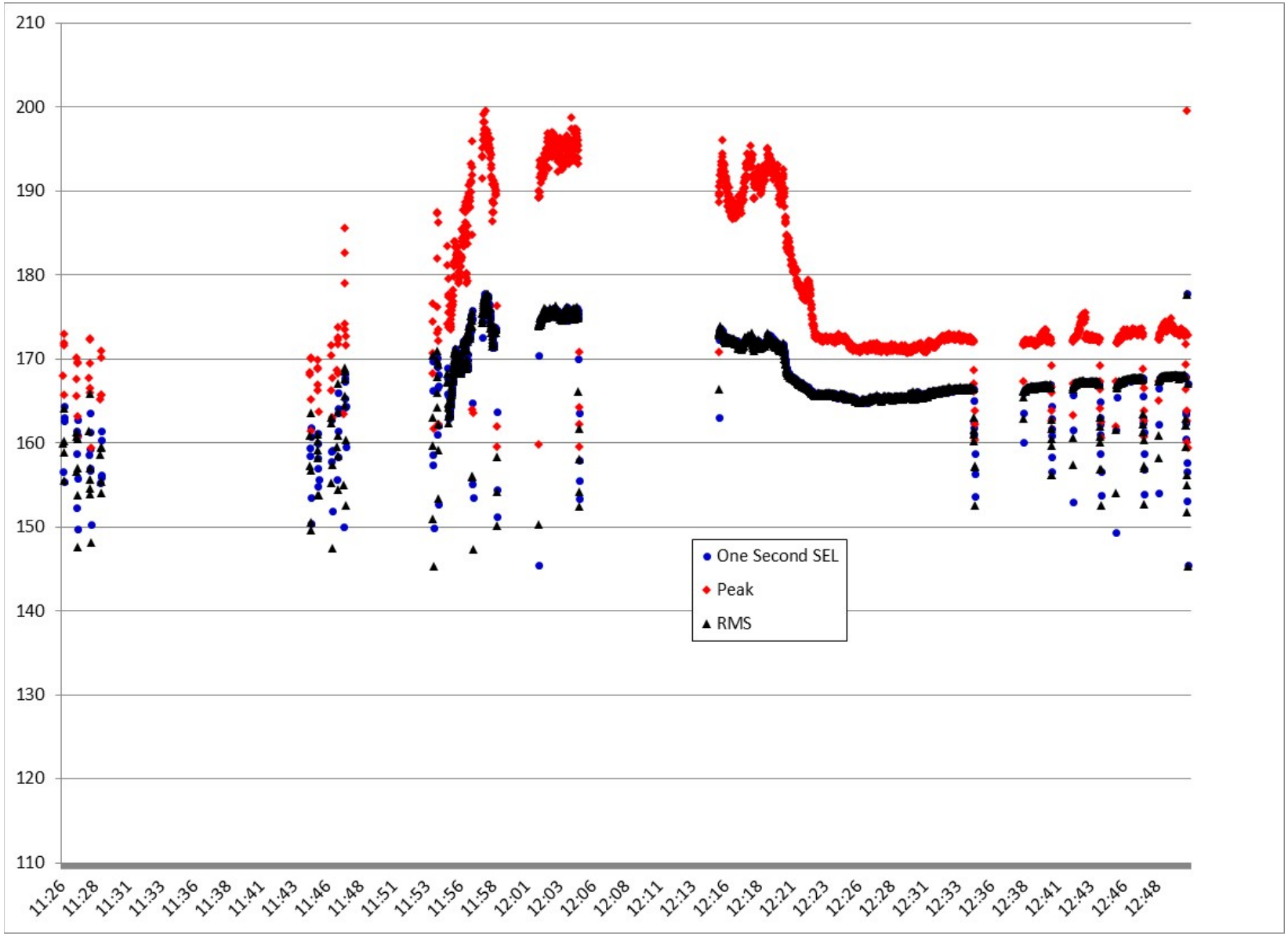


Figure 18 - October 31, 2019 36-inch Steel Pile Installation At 230 m

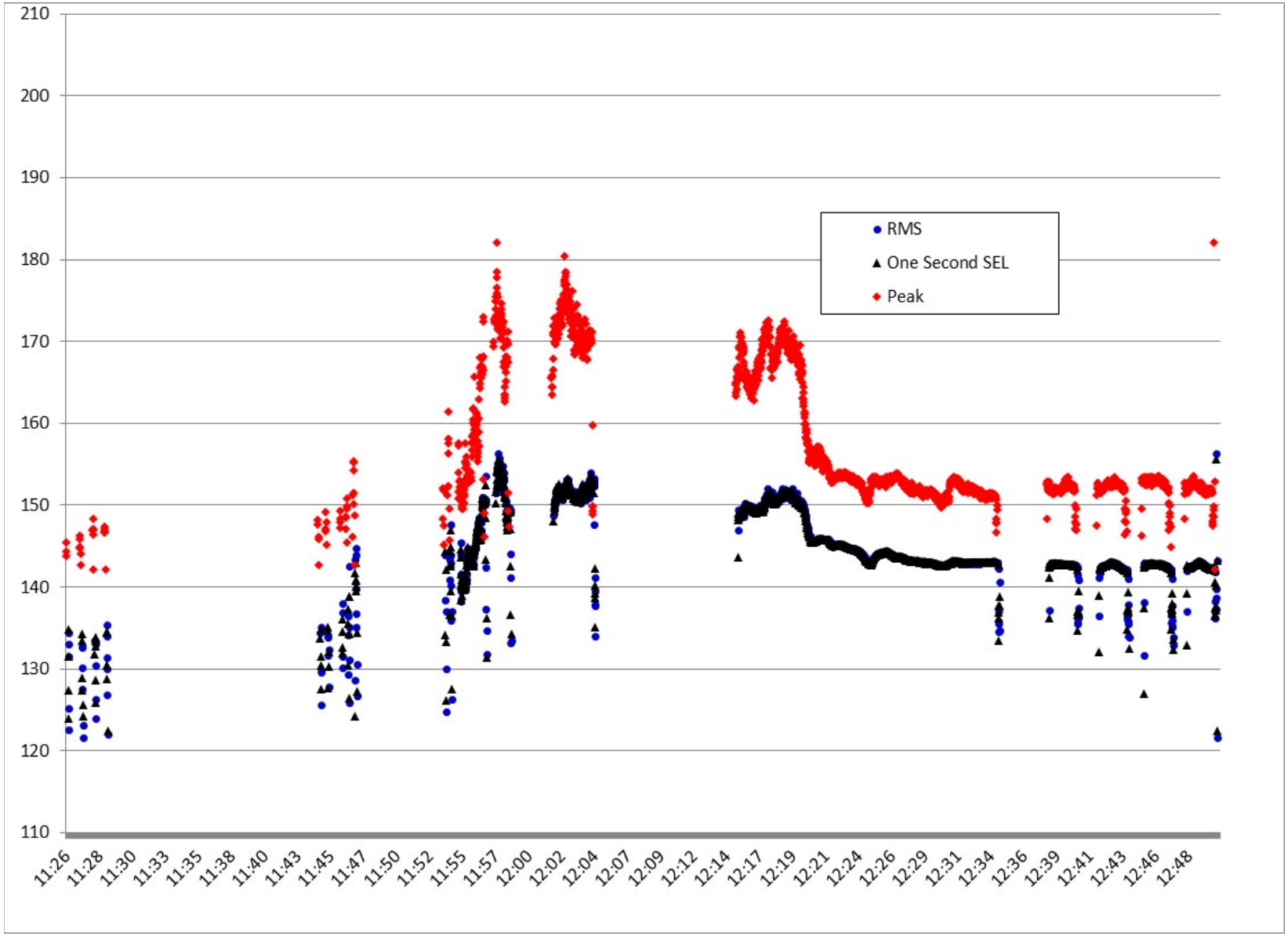


Figure 19 - October 31, 2019 36-inch Steel Pile Installation At 660 m

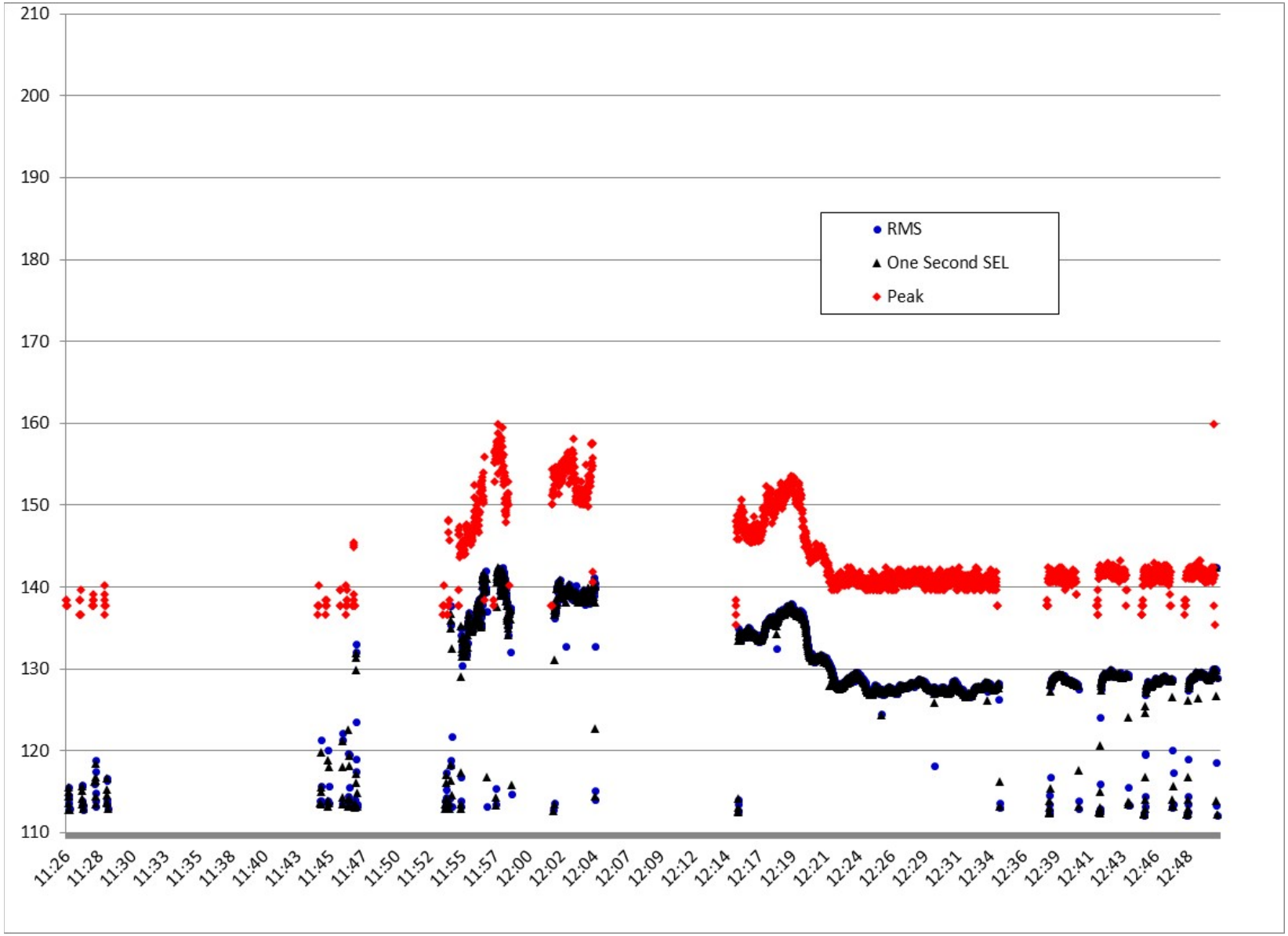


Figure 20– November 18, 2019 H Pile removal at 10 to 16 m

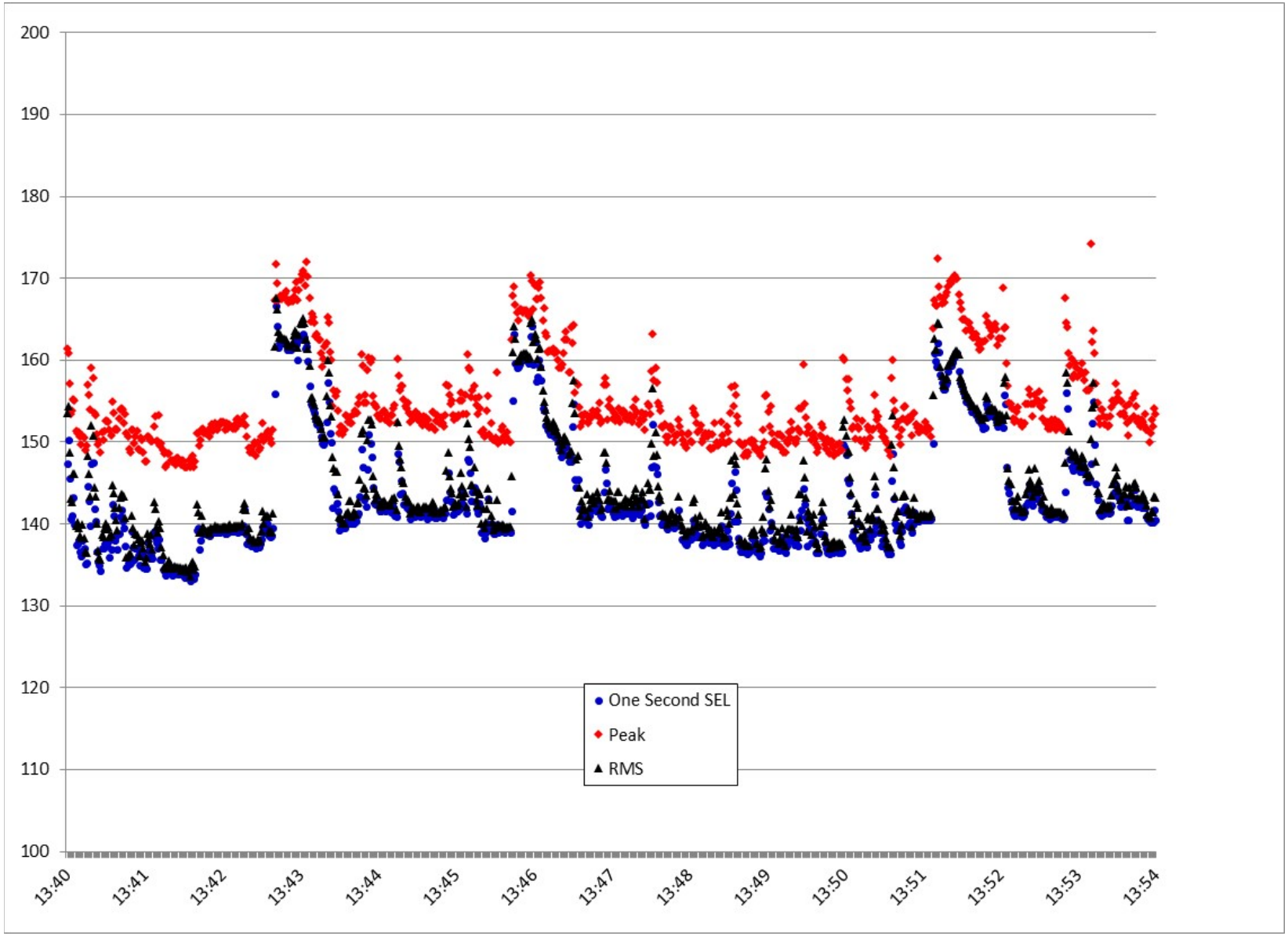
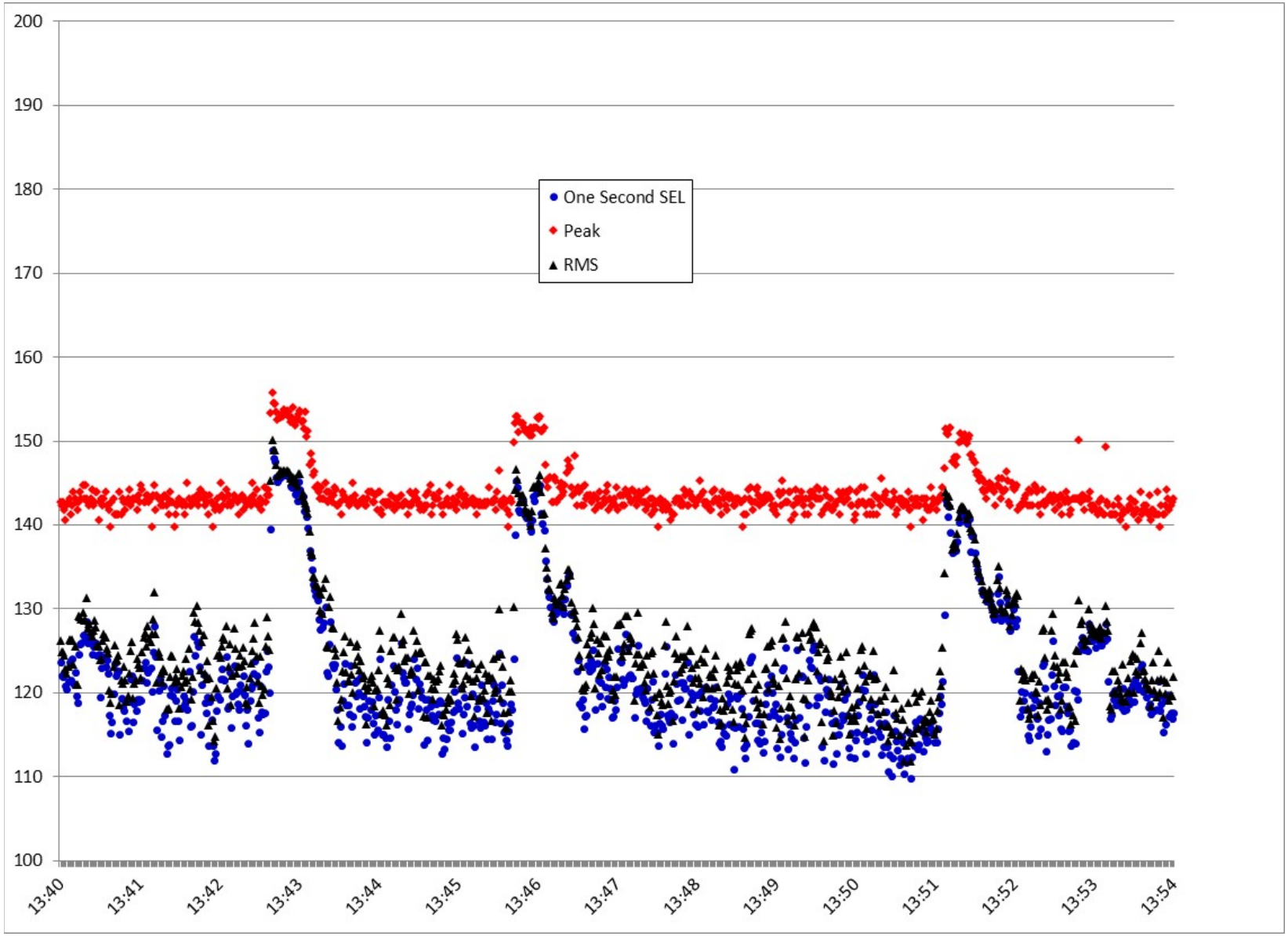


Figure 21 - November 18, 2019 H Pile removal at 120 m



Appendix C

1/3 Octave Band
Spectrum Plots

Figure 1B – Lzeq 1/3 Octave Band Plot of 36-inch Steel Pile Vibrated in at 11 m, 150 m, and 600 m

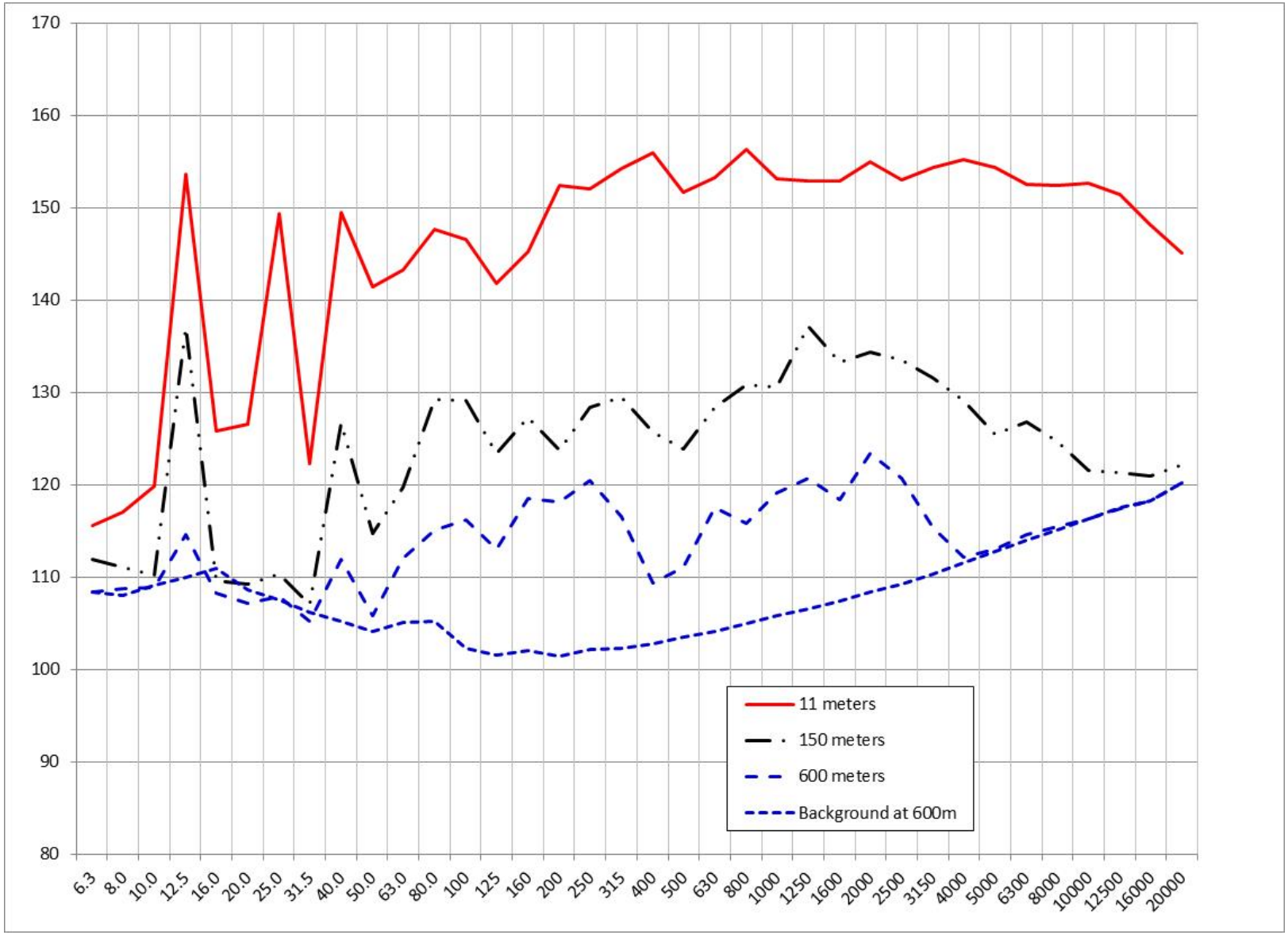


Figure 2B – Lzeq 1/3 Octave Band Plot of Concrete pile installed With an Impact hammer at 10 m and 100 m

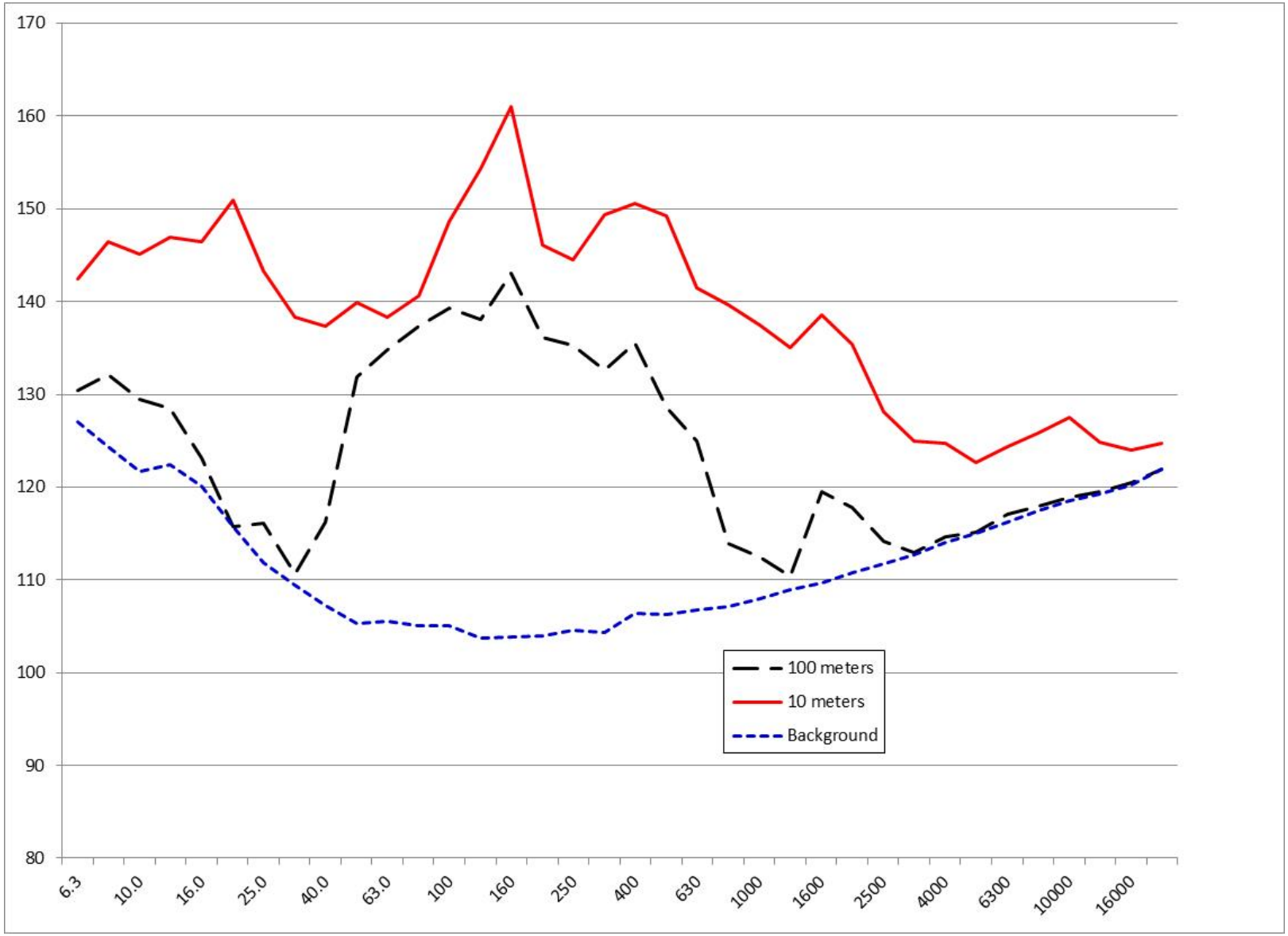
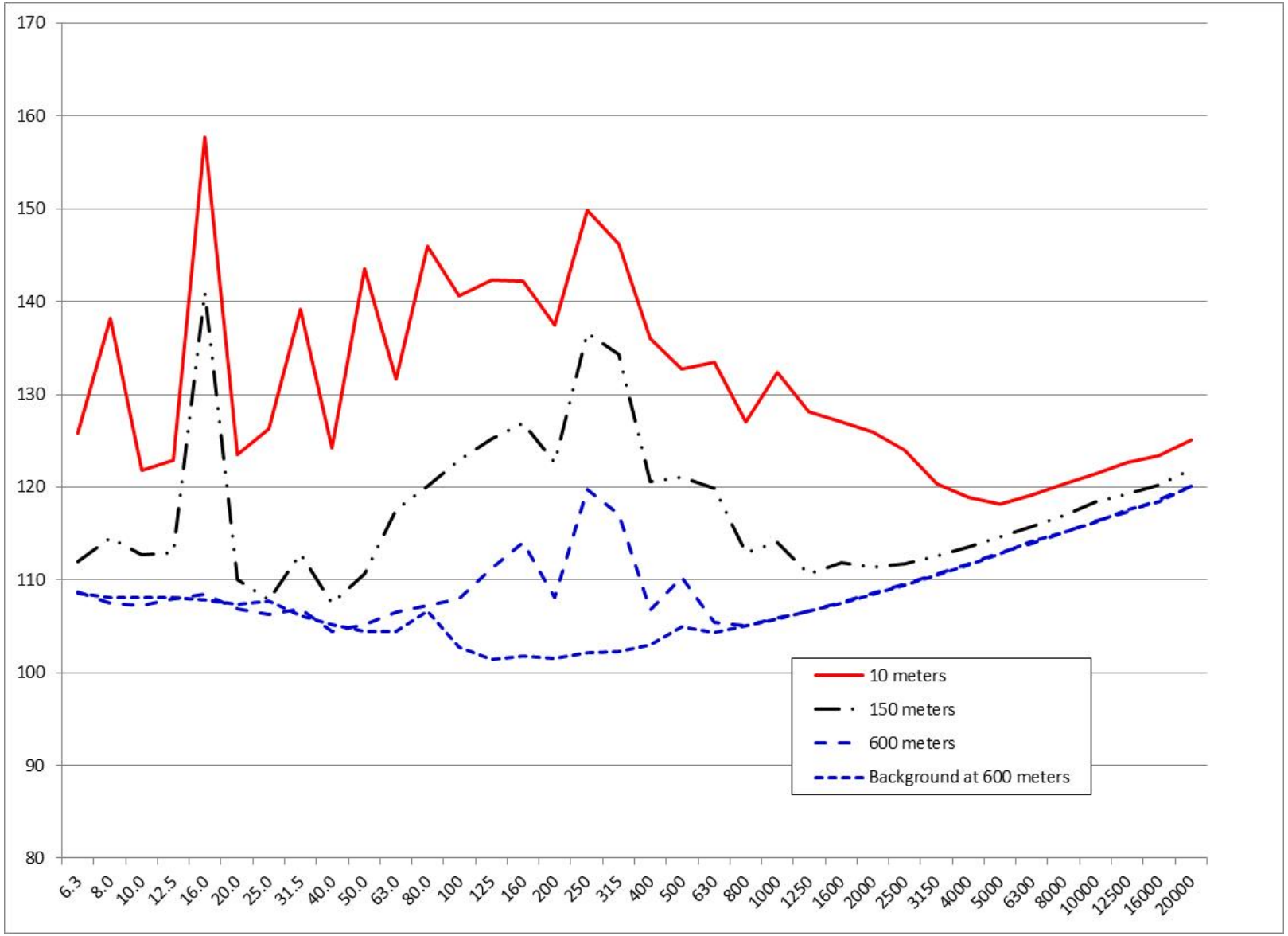



Figure 3B – Lzeq 1/3 Octave Band Plot for vibratory Installation of H-Pile at 10 m, 150 m, and 600 m