EXPLOTECH

Specialists in Explosives, Blasting and Vibration
Consulting Engineers

July 30, 2018

Dragados-Tomlinson Joint Venture
5597 Power Road
Ottawa, Ontario
K1G 3N4

Attention: Mr. Kevin Stadelmann

Re: Interim Weekly Vibration Monitoring Report – July 23 to July 29, 2018
Combined Sewage Storage Tunnel (CSST) – Site 5 Operations

Dear Mr. Stadelmann,

Attached please find the interim weekly summary report detailing the results of the vibration monitoring program developed and implemented as part of the construction operations for the Combined Sewage Storage Tunnel (CSST) Project – Site 5 Operations in Ottawa, Ontario. This monitoring program was initiated on March 31, 2017 and has been recording vibrations generated as a result of the construction equipment in order to confirm predicable levels and to guard against possible adverse impacts on the surrounding structures.

A full time on-site Vibration Monitoring Program is currently implemented to delineate vibration intensities experienced at a representative sampling of structures around the Site 5 construction areas as a result of the construction equipment in operation. The monitoring instruments installed consist of Instantel tri-directional digital seismographs capable of measuring vibration intensities up to 254mm/s at a frequency response of 2 – 250Hz or 1 – 315Hz depending on the installation. The units are programmed to measure all vibration levels continuously at a sampling rate of 1024 samples per second. Following each five minute interval, the units review the 307,200 measured vibrations and permanently records the peak particle velocity for that time interval while deleting all subordinate vibration intensities. This process is repeated for all subsequent five minute time intervals thereby providing maximum vibration intensities experienced at the monitored areas throughout the day.

Such a configuration permits continuous monitoring of vibration levels and provides complete coverage of all vibrations, construction induced or otherwise, experienced at the monitored structure. Events recorded under this program mode are marked by an "H" on the vibrations summary report. As an additional analytical tool, the seismographs are configured to record a more detailed waveform in the event that vibration intensities exceeded a pre-set trigger of 4mm/s. This feature permits advanced analysis in the event that anomalous elevated readings are recorded. Events recorded under this program mode are marked by a "W" on the vibrations summary report.

As per the Contract Specification 02482, Subsection 1.5.1.1, the following threshold, response and shutdown values are observed at Site 5:

Project Threshold, Response and Shutdown Values			
Description of Event	**Threshold Value (PPV)**	**Response Value (PPV)**	**Shutdown Value (PPV)**
Continuous/ Intermittent Source	4mm/s	6mm/s	7mm/s
Transient Source	5mm/s	8mm/s	9mm/s
Blasting	10mm/s	16mm/s	20mm/s

The monitoring locations itemized below were installed for the following sites on the listed days and remain installed during the construction operations:

Site 5A/5B

- **141/151 Stanley Avenue** – Installed on March 31, 2017
- **IOS Shaft IOS Location** (Borehole and Surface) – Installed on Oct 13, 2017
- **IOS Shaft 5A Location** (Borehole and Surface) – Removed on May 3, 2018

Site 5C

- **54 Queen Victoria Street** – Installed on March 31, 2017
- **51 Queen Victoria Street** – Installed on April 11, 2017
- **55 Queen Victoria Street** – Installed on January 12, 2018
- **50 Queen Victoria Street** – Installed on January 12, 2018

The following readings generated at Site 5 monitoring locations exceeded the 4mm/s trigger level during the interim monitoring period:

Vibration Readings Exceeding 4mm/s During Interim Monitoring Period						
Ref. Event #	**Location**	**Date**	**Time**	**Velocity (mm/s)**	**Cause of Event**	**Applicable Project Limit Exceeded**
Site 5A/5B						
1 to 2	151 Stanley Avenue	July 23, 2018	16:51 to 17:10	**Up to 7.366**	**RF / Power Spikes**	N/A – Not Construction Related
3 to 25	IOS Shaft IOS – Borehole	July 26, 2018	15:06 to 23:56	**Up to 8.509**	**RF / Power Spikes**	N/A – Not Construction Related
26 to 27	151 Stanley Avenue	July 26, 2018	15:44 to 22:46	**Up to 5.461**	**RF / Power Spikes**	N/A – Not Construction Related
28 to 49	IOS Shaft IOS – Borehole	July 27, 2018	00:06 to 21:14	**Up to 36.45**	**RF / Power Spikes**	N/A – Not Construction Related
50 to 51	151 Stanley Avenue	July 27, 2018	15:14 to 15:29	**Up to 27.81**	**RF / Power Spikes**	N/A – Not Construction Related
52 to 57	IOS Shaft IOS – Borehole	July 28, 2018	8:25 to 18:03	**Up to 7.493**	**RF / Power Spikes**	N/A – Not Construction Related

58 to 60	151 Stanley Avenue	July 29, 2018	10:23 to 18:54	**Up to 9.525**	**RF / Power Spikes**	N/A – Not Construction Related
61 to 84	IOS Shaft IOS – Borehole	July 29, 2018	15:03 to 21:22	**Up to 12.57**	**RF / Power Spikes**	N/A – Not Construction Related
85	IOS Shaft IOS – Borehole	July 29, 2018	3:54	**Up to 6.350**	**RF / Power Spikes**	N/A – Not Construction Related
Site 5C						
86	50 Queen Victoria Street	July 26, 2018	9:35	**36.83**	**RF / Power Spikes**	N/A – Not Construction Related
87	55 Queen Victoria Street	July 26, 2018	15:44	**4.699**	**Localized Impact**	N/A – Not Construction Related

All recorded Histogram summaries and Waveform details for Site 5 are available for reference at anytime on the www.constructionvibrations.com website. A summary list is attached to this interim report for reference. Should you have any questions or concerns related to the information contained herein or the monitoring program undertaken, please do not hesitate to contact the undersigned at your leisure.

Kindest regards,

Mitch Malcomson, P.Eng.

CSST - Site 5
M7550A DTJV
July 23, 2018 to July 29, 2018

Event Report: Event List - z:\to be archived\2 csst temp folders\site 5

Type	Serial No.	Date/Time	Tran Peak (mm/s)	Vert Peak (mm/s)	Long Peak (mm/s)	PVS1 (mm/s)	Tran2 Peak (mm/s)	Vert2 Peak (mm/s)	Long2 Peak (mm/s)	PVS2 (mm/s)	Mic Peak (dB)	Description
W	BE20059	Jul 23 /18 16:51:13	1.397	0.635	0.254	1.403	1.016	0.635	7.366	7.393	<88L	Site 5AB - 141+151 Stanley Aven
W	BE20059	Jul 23 /18 17:10:41	0.635	0.508	0.254	0.684	4.826	0.635	0.762	4.882	<88L	Site 5AB - 141+151 Stanley Aven
W	BE22085	Jul 26 /18 09:35:35	7.874	36.83	6.604	37.76	***	***	***	***	***	Site 5C - 50 Queen Victoria Stree
W	BE16212	Jul 26 /18 15:06:21	4.826	3.048	5.715	8.077	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 26 /18 15:21:25	0.381	0.381	6.477	6.483	0.381	0.254	0.381	0.421	***	Site 5A - IOS Shaft IOS Location
W	BE18786	Jul 26 /18 15:44:38	4.699	2.667	1.651	5.126	***	***	***	***	***	Site 5C - 55 Queen Victoria Stree
W	BE16212	Jul 26 /18 18:45:07	0.381	1.651	6.350	6.561	0.381	0.381	0.254	0.475	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 26 /18 18:52:39	0.381	4.318	1.016	4.436	0.381	0.254	0.254	0.475	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 26 /18 19:02:18	0.381	2.921	3.937	4.909	0.381	0.254	0.381	0.458	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 26 /18 19:44:18	5.207	1.905	4.572	7.186	0.381	0.254	0.254	0.440	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 26 /18 21:33:56	1.143	4.191	3.429	5.534	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 26 /18 21:47:39	1.143	4.191	2.286	4.909	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 26 /18 21:57:31	1.524	3.937	2.159	4.742	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 26 /18 22:05:11	0.381	4.191	1.270	4.387	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 26 /18 22:10:25	1.016	3.937	2.159	4.492	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 26 /18 22:20:23	8.128	0.889	2.286	8.490	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 26 /18 22:23:26	4.445	1.524	2.540	4.969	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 26 /18 22:27:22	0.381	8.509	1.270	8.518	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 26 /18 22:32:42	7.874	3.810	1.016	8.806	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE20059	Jul 26 /18 22:35:22	5.461	1.143	0.254	5.581	1.397	1.016	3.429	3.840	91.5L	Site 5AB - 141+151 Stanley Aven
W	BE16212	Jul 26 /18 22:37:36	1.270	1.143	7.366	7.437	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 26 /18 22:39:49	2.413	1.270	5.715	6.019	0.381	0.254	0.254	0.381	***	Site 5A - IOS Shaft IOS Location
W	BE20059	Jul 26 /18 22:46:46	1.397	0.762	0.254	1.397	4.445	0.508	0.635	4.476	<88L	Site 5AB - 141+151 Stanley Aven
W	BE16212	Jul 26 /18 22:48:50	2.794	2.667	5.461	6.689	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 26 /18 22:55:00	6.604	5.334	4.699	8.937	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 26 /18 22:58:18	1.651	0.381	4.318	4.320	0.381	0.254	0.254	0.381	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 26 /18 23:14:37	4.699	5.334	2.159	7.429	0.381	0.254	0.254	0.381	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 26 /18 23:56:41	5.207	0.635	1.524	5.462	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 27 /18 00:06:30	0.381	1.270	5.207	5.373	0.381	0.254	0.254	0.381	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 27 /18 14:00:05	4.953	1.397	1.524	5.367	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 27 /18 14:35:24	4.318	1.905	3.048	5.618	0.381	0.254	0.254	0.421	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 27 /18 14:44:03	4.953	1.778	2.540	5.843	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 27 /18 14:50:40	4.572	3.048	3.175	6.346	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 27 /18 14:56:58	1.524	8.890	0.635	8.913	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 27 /18 15:01:10	8.382	6.350	5.588	10.07	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 27 /18 15:04:09	36.45	15.24	13.46	41.74	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 27 /18 15:07:35	5.588	0.889	2.032	5.947	0.381	0.254	0.254	0.421	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 27 /18 15:11:05	4.572	3.810	3.429	6.869	0.381	0.254	0.381	0.421	***	Site 5A - IOS Shaft IOS Location
W	BE20059	Jul 27 /18 15:14:59	4.191	1.270	0.381	4.216	24.89	12.83	27.81	37.80	112.6L	Site 5AB - 141+151 Stanley Aven
W	BE16212	Jul 27 /18 15:18:15	4.064	0.635	2.286	4.670	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 27 /18 15:21:18	4.318	2.667	1.905	4.708	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 27 /18 15:24:50	0.508	5.207	1.651	5.464	0.381	0.254	0.381	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 27 /18 15:28:00	6.096	2.413	4.191	6.587	0.381	0.254	0.254	0.458	***	Site 5A - IOS Shaft IOS Location
W	BE20059	Jul 27 /18 15:29:37	1.016	1.016	0.254	1.047	4.699	15.75	18.92	25.06	102.8L	Site 5AB - 141+151 Stanley Aven
W	BE16212	Jul 27 /18 15:36:27	1.270	5.080	2.794	5.454	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 27 /18 15:52:06	5.080	2.032	1.270	5.617	0.381	0.254	0.254	0.421	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 27 /18 15:56:28	0.762	5.207	0.508	5.232	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 27 /18 16:05:02	7.493	2.413	2.921	8.396	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 27 /18 16:20:52	0.508	0.508	4.064	4.098	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 27 /18 18:17:11	2.159	3.937	0.381	4.497	0.381	0.254	0.254	0.421	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 27 /18 18:28:47	1.016	6.096	1.397	6.336	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 27 /18 20:40:07	4.191	2.921	2.286	5.597	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 27 /18 21:07:53	8.382	3.048	2.921	9.385	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 27 /18 21:14:45	3.683	4.064	0.889	5.556	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 28 /18 08:25:14	0.508	0.508	4.572	4.600	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 28 /18 15:30:28	1.270	1.778	4.191	4.639	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 28 /18 17:36:08	1.524	4.191	4.572	6.387	0.381	0.254	0.254	0.421	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 28 /18 18:00:52	0.381	0.508	7.493	7.510	0.381	0.254	0.254	0.421	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 28 /18 18:03:50	4.572	3.556	4.826	7.539	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 28 /18 18:34:23	1.778	5.969	1.905	6.267	0.381	0.254	0.381	0.475	***	Site 5A - IOS Shaft IOS Location
W	BE20059	Jul 29 /18 10:23:00	2.286	9.525	3.683	9.750	0.889	0.508	0.635	0.898	95.9L	Site 5AB - 141+151 Stanley Aven
W	BE16212	Jul 29 /18 15:03:42	0.889	1.778	5.461	5.812	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 29 /18 15:54:04	0.381	5.080	0.635	5.121	0.381	0.381	0.254	0.458	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 29 /18 16:16:11	3.937	1.016	0.889	4.162	0.381	0.254	0.254	0.440	***	Site 5A - IOS Shaft IOS Location

CSST - Site 5
M7550A DTJV
July 23, 2018 to July 29, 2018

Event Report: Event List - z:\to be archived\2 csst temp folders\site 5

Type	Serial No.	Date/Time	Tran Peak (mm/s)	Vert Peak (mm/s)	Long Peak (mm/s)	PVS1 (mm/s)	Tran2 Peak (mm/s)	Vert2 Peak (mm/s)	Long2 Peak (mm/s)	PVS2 (mm/s)	Mic Peak (dB)	Description
W	BE16212	Jul 29 /18 17:00:22	3.175	4.826	1.778	5.520	0.381	0.381	0.254	0.458	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 29 /18 18:26:02	4.191	0.762	0.381	4.277	0.381	0.254	0.381	0.475	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 29 /18 18:28:49	0.508	5.080	2.794	5.799	0.381	0.254	0.381	0.475	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 29 /18 18:33:09	6.350	4.699	2.667	7.909	0.381	0.254	0.254	0.421	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 29 /18 18:36:09	3.048	4.826	5.715	8.077	0.381	0.381	0.254	0.475	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 29 /18 18:44:59	4.318	0.889	1.651	4.666	0.381	0.254	0.254	0.421	***	Site 5A - IOS Shaft IOS Location
W	BE20059	Jul 29 /18 18:46:49	0.889	0.762	0.254	0.898	5.207	0.508	0.762	5.276	<88L	Site 5AB - 141+151 Stanley Aver
W	BE16212	Jul 29 /18 18:48:52	7.112	3.810	4.445	8.573	0.381	0.381	0.381	0.475	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 29 /18 18:54:52	4.826	10.54	5.588	10.55	0.381	0.381	0.254	0.475	***	Site 5A - IOS Shaft IOS Location
W	BE20059	Jul 29 /18 18:54:52	2.921	2.667	0.254	3.188	8.128	2.794	3.048	8.482	<88L	Site 5AB - 141+151 Stanley Aver
W	BE16212	Jul 29 /18 19:01:38	0.508	0.889	5.080	5.096	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 29 /18 19:05:42	0.508	4.953	1.143	5.090	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 29 /18 19:07:47	4.572	2.159	3.302	5.157	0.381	0.254	0.381	0.458	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 29 /18 19:10:49	12.57	12.19	4.953	17.74	0.381	0.254	0.381	0.421	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 29 /18 19:20:18	2.413	1.905	5.461	6.267	0.381	0.254	0.254	0.421	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 29 /18 19:26:28	1.397	7.366	3.683	8.353	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 29 /18 19:35:42	4.064	1.778	2.286	4.665	0.381	0.254	0.254	0.381	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 29 /18 19:42:36	0.381	4.572	3.302	5.645	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 29 /18 19:58:30	0.889	6.858	3.175	7.567	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 29 /18 20:25:53	3.937	1.651	3.556	5.556	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 29 /18 20:36:01	4.318	2.794	0.381	5.149	0.381	0.254	0.254	0.475	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 29 /18 21:22:24	4.699	8.636	5.969	11.50	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location
W	BE16212	Jul 30 /18 03:54:22	6.350	0.381	3.429	7.221	0.381	0.254	0.254	0.402	***	Site 5A - IOS Shaft IOS Location