

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-01N: Sound Levels for HDD Crossing at Highway 151, Entry NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
1400	Geometrical Divergence	-64	-64	-64	-64	-64	-64	-64	-64	-64		
500	Additional Attenuation by Foliage and/or Land Contour	-1	-3	-5	-6	-8	-9	-12	-14	-18		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-2	-4	-12	-41		
	Ground Effect	5	5	0	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-59	-61	-68	-74	-74	-72	-77	-87	-121		
	Calculated Entry Equipment Contribution at NSA	59	54	44	40	38	37	31	19	-23	40.8	47.2

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.7

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
1025	Geometrical Divergence	-61	-61	-61	-61	-61	-61	-61	-61	-61		
920	Additional Attenuation by Foliage and/or Land Contour	-1	-4	-6	-8	-10	-12	-16	-18	-24		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-3	-9	-30		
	Ground Effect	5	5	0	-5	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-57	-60	-67	-74	-74	-73	-78	-85	-113		
	Calculated Exit Equipment Contribution at NSA	53	48	38	28	26	25	17	7	-25	30.3	36.7

Combined Entry and Exit Contribution at Receiver		41.2	47.6
Existing Ambient Sound Level		43.7	50.1
Combined HDD Contribution and Ambient Sound Level		45.6	52.0
Predicted Temporary Increase During HDD Activities		1.9	1.9

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-01X: Sound Levels for HDD Crossing at Highway 151, Exit NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
1400	Geometrical Divergence	-64	-64	-64	-64	-64	-64	-64	-64	-64		
500	Additional Attenuation by Foliage and/or Land Contour	-1	-3	-5	-6	-8	-9	-12	-14	-18		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-2	-4	-12	-41		
	Ground Effect	5	5	0	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-59	-61	-68	-74	-74	-72	-77	-87	-121		
	Calculated Entry Equipment Contribution at NSA	59	54	44	40	38	37	31	19	-23	40.8	47.2

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.7

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
1025	Geometrical Divergence	-61	-61	-61	-61	-61	-61	-61	-61	-61		
920	Additional Attenuation by Foliage and/or Land Contour	-1	-4	-6	-8	-10	-12	-16	-18	-24		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-3	-9	-30		
	Ground Effect	5	5	0	-5	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-57	-60	-67	-74	-74	-73	-78	-85	-113		
	Calculated Exit Equipment Contribution at NSA	53	48	38	28	26	25	17	7	-25	30.3	36.7

Combined Entry and Exit Contribution at Receiver		41.2	47.6
Existing Ambient Sound Level		43.7	50.1
Combined HDD Contribution and Ambient Sound Level		45.6	52.0
Predicted Temporary Increase During HDD Activities		1.9	1.9

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-02N: Sound Levels for HDD Crossing at Indian Fork, Entry NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
2575	Geometrical Divergence	-69	-69	-69	-69	-69	-69	-69	-69	-69		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-2	-3	-7	-22	-76		
	Ground Effect	6	6	-2	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-63	-63	-71	-74	-72	-70	-73	-88	-142		
	Calculated Entry Equipment Contribution at NSA	55	52	41	40	40	39	35	18	-44	42.8	49.2

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.7

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
6625	Geometrical Divergence	-77	-77	-77	-77	-77	-77	-77	-77	-77		
2900	Additional Attenuation by Foliage and/or Land Contour	-1	-4	-6	-8	-10	-12	-16	-18	-24		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	-1	-2	-5	-9	-19	-56	-195		
	Ground Effect	6	6	-3	-4	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-72	-75	-87	-92	-94	-96	-110	-149	-294		
	Calculated Exit Equipment Contribution at NSA	38	33	18	10	6	2	-15	-57	-206	10.8	17.2

Combined Entry and Exit Contribution at Receiver		42.8	49.2
Existing Ambient Sound Level		43.1	49.5
Combined HDD Contribution and Ambient Sound Level		46.0	52.4
Predicted Temporary Increase During HDD Activities		2.9	2.9

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-02X: Sound Levels for HDD Crossing at Indian Fork, Exit NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.8

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)								Total, dB(A)	Total, dB(A) Ldn	
		31.5	63	125	250	500	1000	2000	4000			8000
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
5200	Geometrical Divergence	-75	-75	-75	-75	-75	-75	-75	-75	-75		
3300	Additional Attenuation by Foliage and/or Land Contour	-1	-4	-6	-8	-10	-12	-16	-18	-24		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	-1	-2	-4	-7	-15	-44	-153		
	Ground Effect	6	6	-3	-5	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-70	-73	-85	-89	-91	-92	-104	-135	-250		
	Calculated Entry Equipment Contribution at NSA	48	42	27	25	21	17	4	-29	-152	23.2	29.6

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.8

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)								Total, dB(A)	Total, dB(A) Ldn	
		31.5	63	125	250	500	1000	2000	4000			8000
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
1600	Geometrical Divergence	-65	-65	-65	-65	-65	-65	-65	-65	-65		
850	Additional Attenuation by Foliage and/or Land Contour	-1	-4	-6	-8	-10	-12	-16	-18	-24		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-2	-5	-14	-47		
	Ground Effect	5	5	-1	-5	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-60	-63	-72	-78	-78	-77	-83	-94	-134		
	Calculated Exit Equipment Contribution at NSA	50	45	33	24	22	21	12	-2	-46	25.7	32.1

Combined Entry and Exit Contribution at Receiver		27.6	34.0
Existing Ambient Sound Level		58.7	65.1
Combined HDD Contribution and Ambient Sound Level		58.7	65.1
Predicted Temporary Increase During HDD Activities		0.0	0.0

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-03N: Sound Levels for HDD Crossing at Sandy Creek, Entry NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
1700	Geometrical Divergence	-65	-65	-65	-65	-65	-65	-65	-65	-65		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-2	-5	-14	-50		
	Ground Effect	5	5	0	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-60	-60	-66	-70	-68	-65	-67	-77	-113		
	Calculated Entry Equipment Contribution at NSA	58	55	46	44	44	44	41	29	-15	47.6	54.0

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
2500	Geometrical Divergence	-69	-69	-69	-69	-69	-69	-69	-69	-69		
200	Additional Attenuation by Foliage and/or Land Contour	0	-1	-2	-2	-3	-4	-5	-5	-7		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-2	-3	-7	-21	-74		
	Ground Effect	6	6	-2	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-63	-64	-72	-76	-75	-73	-78	-93	-147		
	Calculated Exit Equipment Contribution at NSA	47	44	33	26	25	25	17	-1	-59	28.4	34.8

Combined Entry and Exit Contribution at Receiver		47.7	54.1
Existing Ambient Sound Level		51.4	57.8
Combined HDD Contribution and Ambient Sound Level		52.9	59.3
Predicted Temporary Increase During HDD Activities		1.5	1.5

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-03X: Sound Levels for HDD Crossing at Sandy Creek, Exit NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.7

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
2800	Geometrical Divergence	-70	-70	-70	-70	-70	-70	-70	-70	-70		
170	Additional Attenuation by Foliage and/or Land Contour	0	-1	-2	-2	-3	-3	-4	-5	-6		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-2	-4	-8	-24	-83		
	Ground Effect	6	6	-2	-4	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-64	-65	-74	-77	-76	-75	-79	-96	-156		
	Calculated Entry Equipment Contribution at NSA	54	50	38	37	36	34	29	10	-58	38.3	44.7

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
1550	Geometrical Divergence	-64	-64	-64	-64	-64	-64	-64	-64	-64		
170	Additional Attenuation by Foliage and/or Land Contour	0	-1	-2	-2	-3	-3	-4	-5	-6		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-2	-4	-13	-46		
	Ground Effect	5	5	0	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-59	-60	-66	-71	-70	-67	-70	-80	-114		
	Calculated Exit Equipment Contribution at NSA	51	48	39	31	30	31	25	12	-26	34.1	40.5

Combined Entry and Exit Contribution at Receiver		39.7	46.1
Existing Ambient Sound Level		31.5	37.9
Combined HDD Contribution and Ambient Sound Level		40.3	46.7
Predicted Temporary Increase During HDD Activities		8.8	8.8

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-04N: Sound Levels for HDD Crossing at Interstate 77, Entry NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.4

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
950	Geometrical Divergence	-60	-60	-60	-60	-60	-60	-60	-60	-60		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-3	-8	-28		
	Ground Effect	5	5	1	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-55	-55	-59	-65	-62	-59	-60	-66	-86		
	Calculated Entry Equipment Contribution at NSA	63	60	53	49	50	50	48	40	12	54.0	60.4

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
780	Geometrical Divergence	-59	-59	-59	-59	-59	-59	-59	-59	-59		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-2	-7	-23		
	Ground Effect	5	5	1	-4	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-54	-54	-58	-63	-61	-58	-58	-63	-79		
	Calculated Exit Equipment Contribution at NSA	56	54	47	39	39	40	37	29	9	44.0	50.4

Combined Entry and Exit Contribution at Receiver		54.4	60.8
Existing Ambient Sound Level		50.1	56.5
Combined HDD Contribution and Ambient Sound Level		55.8	62.2
Predicted Temporary Increase During HDD Activities		5.7	5.7

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-04X: Sound Levels for HDD Crossing at Interstate 77, Exit NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.4

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
1800	Geometrical Divergence	-66	-66	-66	-66	-66	-66	-66	-66	-66		
100	Additional Attenuation by Foliage and/or Land Contour	0	-1	-1	-1	-2	-2	-2	-3	-4		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-2	-5	-15	-53		
	Ground Effect	5	5	0	-4	-1	3	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-60	-61	-67	-71	-70	-70	-81	-120			
	Calculated Entry Equipment Contribution at NSA	58	54	45	43	42	42	38	25	-22	45.4	51.8

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
575	Geometrical Divergence	-56	-56	-56	-56	-56	-56	-56	-56	-56		
100	Additional Attenuation by Foliage and/or Land Contour	0	-1	-1	-1	-2	-2	-2	-3	-4		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-2	-5	-17		
	Ground Effect	4	4	1	-4	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-52	-52	-56	-62	-60	-57	-58	-61	-74		
	Calculated Exit Equipment Contribution at NSA	58	56	49	40	40	41	37	31	14	45.0	51.4

Combined Entry and Exit Contribution at Receiver		48.2	54.6
Existing Ambient Sound Level		50.1	56.5
Combined HDD Contribution and Ambient Sound Level		52.3	58.7
Predicted Temporary Increase During HDD Activities		2.2	2.2

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-05N: Sound Levels for HDD Crossing at Tuscarawas River, Entry NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
875	Geometrical Divergence	-60	-60	-60	-60	-60	-60	-60	-60	-60		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-2	-7	-26		
	Ground Effect	5	5	1	-4	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-55	-55	-59	-64	-62	-59	-60	-65	-83		
	Calculated Entry Equipment Contribution at NSA	63	60	53	50	50	50	48	41	15	54.6	61.0

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.8

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
2200	Geometrical Divergence	-68	-68	-68	-68	-68	-68	-68	-68	-68		
1780	Additional Attenuation by Foliage and/or Land Contour	-1	-4	-6	-8	-10	-12	-16	-18	-24		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-2	-3	-6	-19	-65		
	Ground Effect	6	6	-2	-5	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-63	-66	-76	-81	-81	-81	-88	-102	-154		
	Calculated Exit Equipment Contribution at NSA	47	42	29	21	19	17	7	-10	-66	22.5	28.9

Combined Entry and Exit Contribution at Receiver		54.6	61.0
Existing Ambient Sound Level		42.2	48.6
Combined HDD Contribution and Ambient Sound Level		54.8	61.2
Predicted Temporary Increase During HDD Activities		12.6	12.6

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-05X: Sound Levels for HDD Crossing at Tuscarawas River, Exit NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
3700	Geometrical Divergence	-72	-72	-72	-72	-72	-72	-72	-72	-72		
1450	Additional Attenuation by Foliage and/or Land Contour	-1	-4	-6	-8	-10	-12	-16	-18	-24		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-3	-5	-11	-31	-109		
	Ground Effect	6	6	-2	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-67	-70	-81	-85	-86	-87	-96	-119	-202		
	Calculated Entry Equipment Contribution at NSA	51	45	31	29	26	22	12	-13	-104	27.9	34.3

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
1425	Geometrical Divergence	-64	-64	-64	-64	-64	-64	-64	-64	-64		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-2	-4	-12	-42		
	Ground Effect	5	5	0	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-58	-58	-64	-68	-66	-63	-65	-73	-103		
	Calculated Exit Equipment Contribution at NSA	52	50	41	34	34	35	30	19	-15	38.0	44.4

Combined Entry and Exit Contribution at Receiver		38.4	44.8
Existing Ambient Sound Level		43.3	49.7
Combined HDD Contribution and Ambient Sound Level		44.5	50.9
Predicted Temporary Increase During HDD Activities		1.2	1.2

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-06N: Sound Levels for HDD Crossing at Stream at Hwy 241, Entry NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
400	Geometrical Divergence	-53	-53	-53	-53	-53	-53	-53	-53	-53		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-1	-3	-12		
	Ground Effect	4	4	1	-4	-2	1	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-49	-49	-52	-57	-55	-52	-52	-54	-63		
	Calculated Entry Equipment Contribution at NSA	69	66	60	57	57	57	56	52	35	61.9	68.3

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.8

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
2000	Geometrical Divergence	-67	-67	-67	-67	-67	-67	-67	-67	-67		
500	Additional Attenuation by Foliage and/or Land Contour	-1	-3	-5	-6	-8	-9	-12	-14	-18		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-3	-6	-17	-59		
	Ground Effect	6	6	-2	-5	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-62	-64	-73	-78	-78	-77	-83	-95	-142		
	Calculated Exit Equipment Contribution at NSA	48	44	32	24	22	21	12	-3	-54	25.6	32.0

Combined Entry and Exit Contribution at Receiver		61.9	68.3
Existing Ambient Sound Level		58.9	65.3
Combined HDD Contribution and Ambient Sound Level		63.7	70.1
Predicted Temporary Increase During HDD Activities		4.8	4.8

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-06X: Sound Levels for HDD Crossing at Stream at Hwy 241, Exit NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.8	0.8

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
2075	Geometrical Divergence	-67	-67	-67	-67	-67	-67	-67	-67	-67		
1700	Additional Attenuation by Foliage and/or Land Contour	-1	-4	-6	-8	-10	-12	-16	-18	-24		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-3	-6	-18	-61		
	Ground Effect	6	6	-3	-7	-4	1	2	2	2		
	- Total Attenuation per ISO 9613-2 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-62	-66	-77	-83	-83	-81	-87	-101	-151		
	Calculated Entry Equipment Contribution at NSA	56	49	35	31	29	28	21	5	-53	32.4	38.8

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.8	0.8

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
825	Geometrical Divergence	-59	-59	-59	-59	-59	-59	-59	-59	-59		
560	Additional Attenuation by Foliage and/or Land Contour	-1	-3	-5	-7	-9	-10	-14	-15	-20		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-2	-7	-24		
	Ground Effect	5	5	-1	-7	-4	1	1	1	1		
	- Total Attenuation per ISO 9613-2 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-55	-58	-65	-73	-72	-70	-74	-80	-102		
	Calculated Exit Equipment Contribution at NSA	55	50	40	29	28	28	21	12	-14	32.6	39.0

Combined Entry and Exit Contribution at Receiver		35.5	41.9
Existing Ambient Sound Level		47.6	54.0
Combined HDD Contribution and Ambient Sound Level		47.9	54.3
Predicted Temporary Increase During HDD Activities		0.3	0.3

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-07N: Sound Levels for HDD Crossing at Prairie Lane, Entry NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.2

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)										Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000			
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2		
1775	Geometrical Divergence	-66	-66	-66	-66	-66	-66	-66	-66	-66			
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0			
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-2	-5	-15	-52			
	Ground Effect	5	5	0	-3	-1	3	3	3	3			
	- Total Attenuation per ISO 9613-2 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-60	-60	-66	-69	-68	-65	-67	-77	-115			
	Calculated Entry Equipment Contribution at NSA	58	55	46	45	44	44	41	29	-17	47.8	54.2	

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)										Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000			
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2		
1450	Geometrical Divergence	-64	-64	-64	-64	-64	-64	-64	-64	-64			
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0			
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-2	-4	-12	-43			
	Ground Effect	5	5	0	-4	-1	2	3	3	3			
	- Total Attenuation per ISO 9613-2 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-59	-59	-64	-68	-66	-64	-65	-74	-104			
	Calculated Exit Equipment Contribution at NSA	51	49	41	34	34	34	30	18	-16	37.8	44.2	

Combined Entry and Exit Contribution at Receiver		48.2	54.6
Existing Ambient Sound Level		40.7	47.1
Combined HDD Contribution and Ambient Sound Level		48.9	55.3
Predicted Temporary Increase During HDD Activities		8.2	8.2

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-07X: Sound Levels for HDD Crossing at Prairie Lane, Exit NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
3225	Geometrical Divergence	-71	-71	-71	-71	-71	-71	-71	-71	-71		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-2	-4	-9	-27	-95		
	Ground Effect	6	6	-2	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-65	-65	-73	-76	-74	-73	-77	-95	-163		
	Calculated Entry Equipment Contribution at NSA	53	50	39	38	38	36	31	11	-65	40.0	46.4

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
1400	Geometrical Divergence	-64	-64	-64	-64	-64	-64	-64	-64	-64		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-2	-4	-12	-41		
	Ground Effect	5	5	0	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-58	-58	-64	-68	-66	-63	-65	-73	-102		
	Calculated Exit Equipment Contribution at NSA	52	50	41	34	34	35	30	19	-14	38.1	44.5

Combined Entry and Exit Contribution at Receiver		42.2	48.6
Existing Ambient Sound Level		40.5	46.9
Combined HDD Contribution and Ambient Sound Level		44.4	50.8
Predicted Temporary Increase During HDD Activities		3.9	3.9

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-08N: Sound Levels for HDD Crossing at Railroad, Entry NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
400	Geometrical Divergence	-53	-53	-53	-53	-53	-53	-53	-53	-53		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-1	-3	-12		
	Ground Effect	4	4	1	-4	-2	1	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-49	-49	-52	-57	-55	-52	-52	-54	-63		
	Calculated Entry Equipment Contribution at NSA	69	66	60	57	57	57	56	52	35	61.9	68.3

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
2025	Geometrical Divergence	-67	-67	-67	-67	-67	-67	-67	-67	-67		
300	Additional Attenuation by Foliage and/or Land Contour	0	-2	-3	-4	-5	-5	-7	-8	-11		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-3	-6	-17	-60		
	Ground Effect	6	6	-1	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-62	-63	-71	-75	-74	-73	-77	-89	-135		
	Calculated Exit Equipment Contribution at NSA	48	45	34	27	26	25	18	3	-47	29.1	35.5

Combined Entry and Exit Contribution at Receiver		61.9	68.3
	Existing Ambient Sound Level	35.8	42.2
	Combined HDD Contribution and Ambient Sound Level	61.9	68.3
	Predicted Temporary Increase During HDD Activities	26.1	26.1

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-08X: Sound Levels for HDD Crossing at Railroad, Exit NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.4

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
2700	Geometrical Divergence	-69	-69	-69	-69	-69	-69	-69	-69	-69		
200	Additional Attenuation by Foliage and/or Land Contour	0	-1	-2	-2	-3	-4	-5	-5	-7		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-2	-4	-8	-23	-80		
	Ground Effect	6	6	-1	-4	-1	3	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-64	-65	-73	-76	-75	-74	-79	-95	-153		
	Calculated Entry Equipment Contribution at NSA	54	50	39	38	37	35	29	11	-55	39.0	45.4

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.4

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
1900	Geometrical Divergence	-66	-66	-66	-66	-66	-66	-66	-66	-66		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-3	-5	-16	-56		
	Ground Effect	5	5	-1	-4	-1	3	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-61	-61	-67	-71	-69	-66	-69	-79	-119		
	Calculated Exit Equipment Contribution at NSA	49	47	38	31	31	32	26	13	-31	35.1	41.5

Combined Entry and Exit Contribution at Receiver		40.5	46.9
Existing Ambient Sound Level		41.3	47.7
Combined HDD Contribution and Ambient Sound Level		43.9	50.3
Predicted Temporary Increase During HDD Activities		2.6	2.6

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-09N: Sound Levels for HDD Crossing at S Columbus Rd, Entry NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)										Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000			
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2		
475	Geometrical Divergence	-54	-54	-54	-54	-54	-54	-54	-54	-54			
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0			
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-1	-4	-14			
	Ground Effect	4	4	1	-4	-2	2	2	2	2			
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-50	-50	-53	-59	-56	-53	-54	-56	-66			
	Calculated Entry Equipment Contribution at NSA	68	65	59	55	56	56	54	50	32	60.4	66.8	

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.8

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)										Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000			
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2		
1400	Geometrical Divergence	-64	-64	-64	-64	-64	-64	-64	-64	-64			
840	Additional Attenuation by Foliage and/or Land Contour	-1	-4	-6	-8	-10	-12	-16	-18	-24			
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-2	-4	-12	-41			
	Ground Effect	5	5	-1	-5	-2	1	2	2	2			
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-59	-62	-70	-77	-77	-76	-82	-92	-127			
	Calculated Exit Equipment Contribution at NSA	51	46	35	25	23	22	13	0	-39	27.1	33.5	

Combined Entry and Exit Contribution at Receiver		60.4	66.8
Existing Ambient Sound Level		57.6	64.0
Combined HDD Contribution and Ambient Sound Level		62.2	68.6
Predicted Temporary Increase During HDD Activities		4.6	4.6

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-09X: Sound Levels for HDD Crossing at S Columbus Rd, Exit NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
	Geometrical Divergence	-65	-65	-65	-65	-65	-65	-65	-65	-65		
1650	Additional Attenuation by Foliage and/or Land Contour	0	-1	-1	-2	-2	-3	-4	-4	-5		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-2	-5	-14	-49		
	Ground Effect	5	5	0	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-60	-61	-67	-71	-70	-68	-71	-80	-116		
	Calculated Entry Equipment Contribution at NSA	58	54	45	43	42	41	37	26	-18	45.2	51.6

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
	Geometrical Divergence	-53	-53	-53	-53	-53	-53	-53	-53	-53		
425	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-1	-4	-13		
	Ground Effect	4	4	1	-4	-2	1	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-50	-50	-52	-58	-55	-52	-53	-55	-64		
	Calculated Exit Equipment Contribution at NSA	60	58	53	44	45	46	42	37	24	49.5	55.9

Combined Entry and Exit Contribution at Receiver		50.9	57.3
	Existing Ambient Sound Level	53.9	60.3
	Combined HDD Contribution and Ambient Sound Level	55.7	62.1
	Predicted Temporary Increase During HDD Activities	1.8	1.8

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-10N: Sound Levels for HDD Crossing at US Hwy 30, Entry NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.4

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
1275	Geometrical Divergence	-63	-63	-63	-63	-63	-63	-63	-63	-63		
150	Additional Attenuation by Foliage and/or Land Contour	0	-1	-1	-2	-2	-3	-4	-4	-5		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-2	-4	-11	-38		
	Ground Effect	5	5	1	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-58	-59	-64	-69	-67	-65	-67	-75	-103		
	Calculated Entry Equipment Contribution at NSA	60	56	48	45	45	44	41	31	-5	48.1	54.5

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
800	Geometrical Divergence	-59	-59	-59	-59	-59	-59	-59	-59	-59		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-2	-7	-24		
	Ground Effect	5	5	1	-4	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-54	-54	-58	-63	-61	-58	-59	-63	-80		
	Calculated Exit Equipment Contribution at NSA	56	54	47	39	39	40	36	29	8	43.8	50.2

Combined Entry and Exit Contribution at Receiver		49.5	55.9
Existing Ambient Sound Level		39.1	45.5
Combined HDD Contribution and Ambient Sound Level		49.9	56.3
Predicted Temporary Increase During HDD Activities		10.8	10.8

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-10X: Sound Levels for HDD Crossing at US Hwy 30, Exit NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.4

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
1425	Geometrical Divergence	-64	-64	-64	-64	-64	-64	-64	-64	-64		
150	Additional Attenuation by Foliage and/or Land Contour	0	-1	-1	-2	-2	-3	-4	-4	-5		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-2	-4	-12	-42		
	Ground Effect	5	5	0	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-59	-59	-65	-70	-68	-66	-69	-77	-108		
	Calculated Entry Equipment Contribution at NSA	59	56	47	44	44	43	39	29	-10	47.0	53.4

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
500	Geometrical Divergence	-55	-55	-55	-55	-55	-55	-55	-55	-55		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-1	-4	-15		
	Ground Effect	4	4	1	-4	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-51	-51	-54	-59	-57	-54	-54	-57	-67		
	Calculated Exit Equipment Contribution at NSA	59	57	51	43	43	44	41	35	21	48.1	54.5

Combined Entry and Exit Contribution at Receiver		50.6	57.0
Existing Ambient Sound Level		49.6	56.0
Combined HDD Contribution and Ambient Sound Level		53.1	59.5
Predicted Temporary Increase During HDD Activities		3.5	3.5

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-11N: Sound Levels for HDD Crossing at County Road 1675, Entry NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.8	0.7

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)								Total, dB(A)	Total, dB(A) Ldn	
		31.5	63	125	250	500	1000	2000	4000			8000
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
200	Geometrical Divergence	-47	-47	-47	-47	-47	-47	-47	-47	-47		
100	Additional Attenuation by Foliage and/or Land Contour	0	-1	-1	-1	-2	-2	-2	-3	-4		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	0	0	-1	-2	-6		
	Ground Effect	3	3	0	-5	-3	1	1	1	1		
	- Total Attenuation per ISO 9613-2 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-44	-44	-47	-53	-51	-48	-49	-50	-55		
	Calculated Entry Equipment Contribution at NSA	74	71	65	61	61	61	59	56	43	65.7	72.1

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)								Total, dB(A)	Total, dB(A) Ldn	
		31.5	63	125	250	500	1000	2000	4000			8000
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
3800	Geometrical Divergence	-72	-72	-72	-72	-72	-72	-72	-72	-72		
1000	Additional Attenuation by Foliage and/or Land Contour	-1	-4	-6	-8	-10	-12	-16	-18	-24		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-3	-5	-11	-32	-112		
	Ground Effect	6	6	-2	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-68	-71	-81	-85	-86	-87	-96	-120	-206		
	Calculated Exit Equipment Contribution at NSA	42	37	24	17	14	11	-1	-28	-118	17.2	23.6

Combined Entry and Exit Contribution at Receiver		65.7	72.1
	Existing Ambient Sound Level	36.1	42.5
	Combined HDD Contribution and Ambient Sound Level	65.7	72.1
	Predicted Temporary Increase During HDD Activities	29.6	29.6

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-11X: Sound Levels for HDD Crossing at County Road 1675, Exit NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.6

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
3475	Geometrical Divergence	-71	-71	-71	-71	-71	-71	-71	-71	-71		
500	Additional Attenuation by Foliage and/or Land Contour	-1	-3	-5	-6	-8	-9	-12	-14	-18		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-2	-5	-10	-29	-103		
	Ground Effect	6	6	-2	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-67	-69	-79	-83	-83	-83	-91	-112	-190		
	Calculated Entry Equipment Contribution at NSA	51	46	33	31	29	26	17	-6	-92	30.7	37.1

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
875	Geometrical Divergence	-60	-60	-60	-60	-60	-60	-60	-60	-60		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-2	-7	-26		
	Ground Effect	5	5	1	-4	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-55	-55	-59	-64	-62	-59	-60	-65	-83		
	Calculated Exit Equipment Contribution at NSA	55	53	46	38	38	39	35	27	5	42.9	49.3

Combined Entry and Exit Contribution at Receiver		43.2	49.6
Existing Ambient Sound Level		66.0	72.4
Combined HDD Contribution and Ambient Sound Level		66.0	72.5
Predicted Temporary Increase During HDD Activities		0.0	0.1

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-12N: Sound Levels for HDD Crossing at Interstate 71, Entry NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
475	Geometrical Divergence	-54	-54	-54	-54	-54	-54	-54	-54	-54		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-1	-4	-14		
	Ground Effect	4	4	1	-4	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-50	-50	-53	-59	-56	-53	-54	-56	-66		
	Calculated Entry Equipment Contribution at NSA	68	65	59	55	56	56	54	50	32	60.4	66.8

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.4

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
1750	Geometrical Divergence	-66	-66	-66	-66	-66	-66	-66	-66	-66		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-2	-5	-15	-52		
	Ground Effect	5	5	0	-4	-1	3	3	3	3		
	- Total Attenuation per ISO 9613-2 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-60	-60	-66	-70	-68	-65	-68	-77	-114		
	Calculated Exit Equipment Contribution at NSA	50	48	39	32	32	33	27	15	-26	36.0	42.4

Combined Entry and Exit Contribution at Receiver		60.4	66.8
	Existing Ambient Sound Level	57.9	64.3
	Combined HDD Contribution and Ambient Sound Level	62.3	68.8
	Predicted Temporary Increase During HDD Activities	4.4	4.5

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-12X: Sound Levels for HDD Crossing at Interstate 71, Exit NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.4

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
1325	Geometrical Divergence	-63	-63	-63	-63	-63	-63	-63	-63	-63		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-2	-4	-11	-39		
	Ground Effect	5	5	0	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-58	-58	-63	-67	-65	-62	-64	-72	-99		
	Calculated Entry Equipment Contribution at NSA	60	57	49	47	47	47	44	34	-1	50.6	56.9

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
375	Geometrical Divergence	-52	-52	-52	-52	-52	-52	-52	-52	-52		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	0	0	-1	-3	-11		
	Ground Effect	3	3	1	-4	-2	1	2	2	2		
	- Total Attenuation per ISO 9613-2 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-49	-49	-51	-57	-54	-51	-52	-54	-62		
	Calculated Exit Equipment Contribution at NSA	61	59	54	45	46	47	43	38	26	50.6	57.0

Combined Entry and Exit Contribution at Receiver		53.6	60.0
Existing Ambient Sound Level		57.4	63.8
Combined HDD Contribution and Ambient Sound Level		58.9	65.3
Predicted Temporary Increase During HDD Activities		1.5	1.5

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-13N: Sound Levels for HDD Crossing at US Hwy 42, Entry NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
275	Geometrical Divergence	-49	-49	-49	-49	-49	-49	-49	-49	-49		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	0	0	-1	-2	-8		
	Ground Effect	3	3	1	-4	-2	1	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-46	-46	-49	-54	-51	-49	-49	-50	-56		
	Calculated Entry Equipment Contribution at NSA	72	69	63	60	61	60	59	56	42	65.3	71.7

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
1625	Geometrical Divergence	-65	-65	-65	-65	-65	-65	-65	-65	-65		
150	Additional Attenuation by Foliage and/or Land Contour	0	-1	-1	-2	-2	-3	-4	-4	-5		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-2	-5	-14	-48		
	Ground Effect	5	5	0	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-60	-60	-67	-71	-70	-68	-70	-80	-116		
	Calculated Exit Equipment Contribution at NSA	50	48	38	31	30	30	25	12	-28	34.0	40.4

Combined Entry and Exit Contribution at Receiver		65.3	71.7
Existing Ambient Sound Level		53.7	60.1
Combined HDD Contribution and Ambient Sound Level		65.6	72.0
Predicted Temporary Increase During HDD Activities		11.9	11.9

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-13X: Sound Levels for HDD Crossing at US Hwy 42, Exit NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.6

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
1900	Geometrical Divergence	-66	-66	-66	-66	-66	-66	-66	-66	-66		
300	Additional Attenuation by Foliage and/or Land Contour	0	-2	-3	-4	-5	-5	-7	-8	-11		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-3	-5	-16	-56		
	Ground Effect	5	5	-1	-4	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-61	-63	-70	-75	-74	-72	-76	-88	-131		
	Calculated Entry Equipment Contribution at NSA	57	52	42	39	38	37	32	18	-33	40.8	47.2

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
750	Geometrical Divergence	-58	-58	-58	-58	-58	-58	-58	-58	-58		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-2	-6	-22		
	Ground Effect	5	5	1	-4	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-53	-54	-57	-63	-60	-57	-58	-62	-78		
	Calculated Exit Equipment Contribution at NSA	57	54	48	39	40	41	37	30	10	44.4	50.8

Combined Entry and Exit Contribution at Receiver		46.0	52.4
	Existing Ambient Sound Level	49.5	55.9
	Combined HDD Contribution and Ambient Sound Level	51.1	57.5
	Predicted Temporary Increase During HDD Activities	1.6	1.6

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-14N: Sound Levels for HDD Crossing at Black Fork Mohican River, Entry NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
1850	Geometrical Divergence	-66	-66	-66	-66	-66	-66	-66	-66	-66		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-2	-5	-16	-55		
	Ground Effect	5	5	-1	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-61	-61	-67	-71	-69	-66	-69	-79	-118		
	Calculated Entry Equipment Contribution at NSA	57	54	45	43	43	43	39	27	-20	46.6	53.0

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.6

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
3050	Geometrical Divergence	-70	-70	-70	-70	-70	-70	-70	-70	-70		
1000	Additional Attenuation by Foliage and/or Land Contour	-1	-4	-6	-8	-10	-12	-16	-18	-24		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-2	-4	-9	-26	-90		
	Ground Effect	6	6	-2	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-66	-69	-79	-83	-84	-84	-92	-112	-182		
	Calculated Exit Equipment Contribution at NSA	44	39	26	19	16	14	3	-20	-94	19.4	25.8

Combined Entry and Exit Contribution at Receiver		46.6	53.0
Existing Ambient Sound Level		37.9	44.3
Combined HDD Contribution and Ambient Sound Level		47.2	53.6
Predicted Temporary Increase During HDD Activities		9.3	9.3

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-14X: Sound Levels for HDD Crossing at Black Fork Mohican River, Exit NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.6

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
2600	Geometrical Divergence	-69	-69	-69	-69	-69	-69	-69	-69	-69		
1000	Additional Attenuation by Foliage and/or Land Contour	-1	-4	-6	-8	-10	-12	-16	-18	-24		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-2	-3	-7	-22	-77		
	Ground Effect	6	6	-2	-4	-2	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-64	-67	-77	-82	-82	-90	-107	-167			
	Calculated Entry Equipment Contribution at NSA	54	48	35	32	30	27	18	-1	-69	31.6	38.0

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
1400	Geometrical Divergence	-64	-64	-64	-64	-64	-64	-64	-64	-64		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-2	-4	-12	-41		
	Ground Effect	5	5	0	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-58	-58	-64	-68	-66	-63	-65	-73	-102		
	Calculated Exit Equipment Contribution at NSA	52	50	41	34	34	35	30	19	-14	38.1	44.5

Combined Entry and Exit Contribution at Receiver		39.0	45.4
Existing Ambient Sound Level		43.5	49.9
Combined HDD Contribution and Ambient Sound Level		44.8	51.2
Predicted Temporary Increase During HDD Activities		1.3	1.3

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-15N: Sound Levels for HDD Crossing at County Road 12, Entry NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
825	Geometrical Divergence	-59	-59	-59	-59	-59	-59	-59	-59	-59		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-2	-7	-24		
	Ground Effect	5	5	1	-4	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-54	-54	-58	-64	-61	-58	-59	-64	-81		
	Calculated Entry Equipment Contribution at NSA	64	61	54	50	51	51	49	42	17	55.2	61.6

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
1425	Geometrical Divergence	-64	-64	-64	-64	-64	-64	-64	-64	-64		
280	Additional Attenuation by Foliage and/or Land Contour	0	-2	-3	-3	-4	-5	-7	-8	-10		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-2	-4	-12	-42		
	Ground Effect	5	5	0	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-59	-60	-66	-72	-70	-69	-72	-81	-113		
	Calculated Exit Equipment Contribution at NSA	51	48	39	30	30	29	23	11	-25	33.2	39.6

Combined Entry and Exit Contribution at Receiver		55.2	61.6
Existing Ambient Sound Level		37.4	43.8
Combined HDD Contribution and Ambient Sound Level		55.3	61.7
Predicted Temporary Increase During HDD Activities		17.9	17.9

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-15X: Sound Levels for HDD Crossing at County Road 12, Exit NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
1650	Geometrical Divergence	-65	-65	-65	-65	-65	-65	-65	-65	-65		
280	Additional Attenuation by Foliage and/or Land Contour	0	-2	-3	-3	-4	-5	-7	-8	-10		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-2	-5	-14	-49		
	Ground Effect	5	5	0	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-60	-61	-68	-73	-72	-70	-74	-84	-121		
	Calculated Entry Equipment Contribution at NSA	58	54	44	41	40	39	34	22	-23	42.9	49.3

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
850	Geometrical Divergence	-59	-59	-59	-59	-59	-59	-59	-59	-59		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-2	-7	-25		
	Ground Effect	5	5	1	-4	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-54	-54	-58	-64	-61	-58	-59	-64	-82		
	Calculated Exit Equipment Contribution at NSA	56	54	47	38	39	40	36	28	6	43.2	49.6

Combined Entry and Exit Contribution at Receiver		46.1	52.5
	Existing Ambient Sound Level	42.7	49.1
	Combined HDD Contribution and Ambient Sound Level	47.7	54.1
	Predicted Temporary Increase During HDD Activities	5.0	5.0

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-16N: Sound Levels for HDD Crossing at Honey Creek, Entry NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.8	0.7

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
1800	Geometrical Divergence	-66	-66	-66	-66	-66	-66	-66	-66	-66		
1075	Additional Attenuation by Foliage and/or Land Contour	-1	-4	-6	-8	-10	-12	-16	-18	-24		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-2	-5	-15	-53		
	Ground Effect	5	5	-3	-7	-4	1	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-61	-64	-75	-81	-81	-79	-85	-97	-141		
	Calculated Entry Equipment Contribution at NSA	57	51	37	33	31	30	23	9	-43	34.1	40.5

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.8	0.7

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
2700	Geometrical Divergence	-69	-69	-69	-69	-69	-69	-69	-69	-69		
1000	Additional Attenuation by Foliage and/or Land Contour	-1	-4	-6	-8	-10	-12	-16	-18	-24		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-2	-4	-8	-23	-80		
	Ground Effect	6	6	-4	-7	-4	1	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-65	-68	-80	-85	-85	-84	-91	-108	-171		
	Calculated Exit Equipment Contribution at NSA	45	40	25	17	15	14	4	-16	-83	19.5	25.9

Combined Entry and Exit Contribution at Receiver		34.2	40.6
Existing Ambient Sound Level		37.3	43.7
Combined HDD Contribution and Ambient Sound Level		39.0	45.4
Predicted Temporary Increase During HDD Activities		1.7	1.7

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-16X: Sound Levels for HDD Crossing at Honey Creek, Exit NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.7

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
2100	Geometrical Divergence	-67	-67	-67	-67	-67	-67	-67	-67	-67		
550	Additional Attenuation by Foliage and/or Land Contour	-1	-3	-5	-7	-8	-10	-13	-15	-20		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-2	-3	-6	-18	-62		
	Ground Effect	6	6	-2	-4	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-62	-65	-74	-79	-79	-78	-84	-98	-147		
	Calculated Entry Equipment Contribution at NSA	56	50	38	35	33	31	24	8	-49	35.3	41.7

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.7

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
1200	Geometrical Divergence	-62	-62	-62	-62	-62	-62	-62	-62	-62		
740	Additional Attenuation by Foliage and/or Land Contour	-1	-4	-6	-8	-10	-12	-16	-18	-24		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-2	-3	-10	-35		
	Ground Effect	5	5	0	-5	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-58	-61	-68	-75	-75	-74	-80	-88	-120		
	Calculated Exit Equipment Contribution at NSA	52	47	37	27	25	24	15	4	-32	28.8	35.2

Combined Entry and Exit Contribution at Receiver		36.2	42.6
Existing Ambient Sound Level		39.1	45.5
Combined HDD Contribution and Ambient Sound Level		40.9	47.3
Predicted Temporary Increase During HDD Activities		1.8	1.8

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-17N: Sound Levels for HDD Crossing at Sandusky River, Entry NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
750	Geometrical Divergence	-58	-58	-58	-58	-58	-58	-58	-58	-58		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-2	-6	-22		
	Ground Effect	5	5	1	-4	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-53	-54	-57	-63	-60	-57	-58	-62	-78		
	Calculated Entry Equipment Contribution at NSA	65	61	55	51	52	50	50	44	20	56.1	62.5

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
2375	Geometrical Divergence	-68	-68	-68	-68	-68	-68	-68	-68	-68		
150	Additional Attenuation by Foliage and/or Land Contour	0	-1	-1	-2	-2	-3	-4	-4	-5		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-2	-3	-7	-20	-70		
	Ground Effect	6	6	-1	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-63	-64	-71	-75	-73	-72	-76	-90	-141		
	Calculated Exit Equipment Contribution at NSA	47	44	34	27	27	26	19	2	-53	29.8	36.2

Combined Entry and Exit Contribution at Receiver		56.1	62.5
Existing Ambient Sound Level		52.6	59.0
Combined HDD Contribution and Ambient Sound Level		57.7	64.1
Predicted Temporary Increase During HDD Activities		5.1	5.1

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-17X: Sound Levels for HDD Crossing at Sandusky River, Exit NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
750	Geometrical Divergence	-58	-58	-58	-58	-58	-58	-58	-58	-58		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-2	-6	-22		
	Ground Effect	5	5	1	-4	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-53	-54	-57	-63	-60	-57	-58	-62	-78		
	Calculated Entry Equipment Contribution at NSA	65	61	55	51	52	50	50	44	20	56.1	62.5

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
2375	Geometrical Divergence	-68	-68	-68	-68	-68	-68	-68	-68	-68		
150	Additional Attenuation by Foliage and/or Land Contour	0	-1	-1	-2	-2	-3	-4	-4	-5		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-2	-3	-7	-20	-70		
	Ground Effect	6	6	-1	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-63	-64	-71	-75	-73	-72	-76	-90	-141		
	Calculated Exit Equipment Contribution at NSA	47	44	34	27	27	26	19	2	-53	29.8	36.2

Combined Entry and Exit Contribution at Receiver		56.1	62.5
Existing Ambient Sound Level		52.6	59.0
Combined HDD Contribution and Ambient Sound Level		57.7	64.1
Predicted Temporary Increase During HDD Activities		5.1	5.1

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-18N: Sound Levels for HDD Crossing at Interstate 75, Entry NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.4	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
900	Geometrical Divergence	-60	-60	-60	-60	-60	-60	-60	-60	-60		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-3	-8	-27		
	Ground Effect	5	5	1	-3	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-55	-55	-59	-63	-61	-59	-60	-65	-84		
	Calculated Entry Equipment Contribution at NSA	63	60	53	51	51	50	48	41	14	54.6	61.0

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.4

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
4300	Geometrical Divergence	-73	-73	-73	-73	-73	-73	-73	-73	-73		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-3	-6	-12	-37	-127		
	Ground Effect	6	6	-2	-4	-1	3	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-68	-68	-76	-78	-77	-76	-82	-107	-197		
	Calculated Exit Equipment Contribution at NSA	42	40	29	24	23	22	13	-15	-109	25.3	31.7

Combined Entry and Exit Contribution at Receiver		54.6	61.0
Existing Ambient Sound Level		41.4	47.8
Combined HDD Contribution and Ambient Sound Level		54.8	61.2
Predicted Temporary Increase During HDD Activities		13.4	13.4

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-18X: Sound Levels for HDD Crossing at Interstate 75, Exit NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)								Total, dB(A)	Total, dB(A) Ldn	
		31.5	63	125	250	500	1000	2000	4000			8000
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
3375	Geometrical Divergence	-71	-71	-71	-71	-71	-71	-71	-71	-71		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-2	-4	-10	-29	-100		
	Ground Effect	6	6	-2	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-66	-66	-74	-76	-75	-73	-78	-97	-168		
	Calculated Entry Equipment Contribution at NSA	52	49	38	38	37	36	30	9	-70	39.4	45.8

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)								Total, dB(A)	Total, dB(A) Ldn	
		31.5	63	125	250	500	1000	2000	4000			8000
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
1100	Geometrical Divergence	-62	-62	-62	-62	-62	-62	-62	-62	-62		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-3	-9	-32		
	Ground Effect	5	5	1	-4	-2	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-56	-56	-61	-66	-64	-61	-62	-68	-91		
	Calculated Exit Equipment Contribution at NSA	54	52	44	36	36	37	33	24	-3	40.6	47.0

Combined Entry and Exit Contribution at Receiver		43.1	49.5
Existing Ambient Sound Level		39.4	45.8
Combined HDD Contribution and Ambient Sound Level		44.6	51.0
Predicted Temporary Increase During HDD Activities		5.2	5.2

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-18AN: Sound Levels for HDD Crossing at State Hwy 109, Entry NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
1925	Geometrical Divergence	-66	-66	-66	-66	-66	-66	-66	-66	-66		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-3	-5	-16	-57		
	Ground Effect	5	5	-1	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-61	-61	-67	-71	-69	-67	-69	-80	-120		
	Calculated Entry Equipment Contribution at NSA	57	54	45	43	43	42	39	26	-22	46.2	52.6

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
4000	Geometrical Divergence	-73	-73	-73	-73	-73	-73	-73	-73	-73		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-3	-5	-11	-34	-118		
	Ground Effect	6	6	-2	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-67	-67	-75	-78	-77	-76	-81	-104	-188		
	Calculated Exit Equipment Contribution at NSA	43	41	30	24	23	22	14	-12	-100	26.0	32.4

Combined Entry and Exit Contribution at Receiver		46.2	52.6
Existing Ambient Sound Level		48.0	54.4
Combined HDD Contribution and Ambient Sound Level		50.2	56.6
Predicted Temporary Increase During HDD Activities		2.2	2.2

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-18AX: Sound Levels for HDD Crossing at State Hwy 109, Exit NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
2325	Geometrical Divergence	-68	-68	-68	-68	-68	-68	-68	-68	-68		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-2	-3	-7	-20	-69		
	Ground Effect	6	6	-1	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-62	-62	-70	-73	-71	-69	-72	-85	-134		
	Calculated Entry Equipment Contribution at NSA	56	53	42	41	41	40	36	21	-36	44.0	50.4

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
400	Geometrical Divergence	-53	-53	-53	-53	-53	-53	-53	-53	-53		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-1	-3	-12		
	Ground Effect	4	4	1	-4	-2	1	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-49	-49	-52	-57	-55	-52	-52	-54	-63		
	Calculated Exit Equipment Contribution at NSA	61	59	53	45	45	46	43	38	25	50.0	56.4

Combined Entry and Exit Contribution at Receiver		51.0	57.4
	Existing Ambient Sound Level	51.7	58.1
	Combined HDD Contribution and Ambient Sound Level	54.4	60.8
	Predicted Temporary Increase During HDD Activities	2.7	2.7

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-19N: Sound Levels for HDD Crossing at Road 15, Entry NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.6

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
1025	Geometrical Divergence	-61	-61	-61	-61	-61	-61	-61	-61	-61		
350	Additional Attenuation by Foliage and/or Land Contour	-1	-2	-3	-4	-5	-6	-9	-10	-13		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-3	-9	-30		
	Ground Effect	5	5	0	-4	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-56	-58	-64	-70	-69	-67	-70	-77	-102		
	Calculated Entry Equipment Contribution at NSA	62	57	48	44	43	42	38	29	-4	46.3	52.7

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
525	Geometrical Divergence	-55	-55	-55	-55	-55	-55	-55	-55	-55		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-1	-4	-15		
	Ground Effect	4	4	1	-4	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-51	-51	-54	-60	-57	-54	-55	-57	-69		
	Calculated Exit Equipment Contribution at NSA	59	57	51	42	43	44	40	35	19	47.7	54.1

Combined Entry and Exit Contribution at Receiver		50.1	56.5
Existing Ambient Sound Level		35.7	42.1
Combined HDD Contribution and Ambient Sound Level		50.2	56.6
Predicted Temporary Increase During HDD Activities		14.5	14.5

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-19X: Sound Levels for HDD Crossing at Road 15, Exit NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.6

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)										Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000			
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2		
1025	Geometrical Divergence	-61	-61	-61	-61	-61	-61	-61	-61	-61			
350	Additional Attenuation by Foliage and/or Land Contour	-1	-2	-3	-4	-5	-6	-9	-10	-13			
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-3	-9	-30			
	Ground Effect	5	5	0	-4	-2	2	2	2	2			
	- Total Attenuation per ISO 9613-2 (includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-56	-58	-64	-70	-69	-67	-70	-77	-102			
	Calculated Entry Equipment Contribution at NSA	62	57	48	44	43	42	38	29	-4	46.3	52.7	

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)										Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000			
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2		
525	Geometrical Divergence	-55	-55	-55	-55	-55	-55	-55	-55	-55			
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0			
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-1	-4	-15			
	Ground Effect	4	4	1	-4	-2	2	2	2	2			
	- Total Attenuation per ISO 9613-2 (includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-51	-51	-54	-60	-57	-54	-55	-57	-69			
	Calculated Exit Equipment Contribution at NSA	59	57	51	42	43	44	40	35	19	47.7	54.1	

Combined Entry and Exit Contribution at Receiver		50.1	56.5
Existing Ambient Sound Level		35.7	42.1
Combined HDD Contribution and Ambient Sound Level		50.2	56.6
Predicted Temporary Increase During HDD Activities		14.5	14.5

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-20N: Sound Levels for HDD Crossing at Maumee River, Entry NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
550	Geometrical Divergence	-55	-55	-55	-55	-55	-55	-55	-55	-55		
150	Additional Attenuation by Foliage and/or Land Contour	0	-1	-1	-2	-2	-3	-4	-4	-5		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-2	-5	-16		
	Ground Effect	4	4	1	-4	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-51	-52	-56	-62	-60	-57	-59	-62	-75		
	Calculated Entry Equipment Contribution at NSA	67	63	56	52	52	52	49	44	23	56.1	62.5

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
2750	Geometrical Divergence	-69	-69	-69	-69	-69	-69	-69	-69	-69		
650	Additional Attenuation by Foliage and/or Land Contour	-1	-4	-6	-8	-10	-12	-16	-18	-24		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-2	-4	-8	-23	-81		
	Ground Effect	6	6	-2	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-65	-68	-77	-82	-83	-83	-90	-108	-172		
	Calculated Exit Equipment Contribution at NSA	45	40	28	20	17	15	5	-16	-84	20.8	27.2

Combined Entry and Exit Contribution at Receiver		56.1	62.5
Existing Ambient Sound Level		36.0	42.4
Combined HDD Contribution and Ambient Sound Level		56.1	62.5
Predicted Temporary Increase During HDD Activities		20.1	20.1

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-ML-P4-20X: Sound Levels for HDD Crossing at Maumee River, Exit NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
2500	Geometrical Divergence	-69	-69	-69	-69	-69	-69	-69	-69	-69		
1130	Additional Attenuation by Foliage and/or Land Contour	-1	-4	-6	-8	-10	-12	-16	-18	-24		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-2	-3	-7	-21	-74		
	Ground Effect	6	6	-2	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-64	-67	-76	-81	-82	-82	-89	-105	-164		
	Calculated Entry Equipment Contribution at NSA	54	48	36	33	30	27	19	1	-66	32.3	38.7

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.6	0.7

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
650	Geometrical Divergence	-57	-57	-57	-57	-57	-57	-57	-57	-57		
350	Additional Attenuation by Foliage and/or Land Contour	-1	-2	-3	-4	-5	-6	-9	-10	-13		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-2	-6	-19		
	Ground Effect	5	5	0	-5	-3	1	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-53	-55	-60	-67	-65	-63	-66	-70	-87		
	Calculated Exit Equipment Contribution at NSA	57	53	45	35	35	35	29	22	1	38.9	45.3

Combined Entry and Exit Contribution at Receiver		39.8	46.2
Existing Ambient Sound Level		35.9	42.3
Combined HDD Contribution and Ambient Sound Level		41.3	47.7
Predicted Temporary Increase During HDD Activities		5.4	5.4

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-MK-P4-21N: Sound Levels for HDD Crossing at Hudson Lake, Entry NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
1400	Geometrical Divergence	-64	-64	-64	-64	-64	-64	-64	-64	-64		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-2	-4	-12	-41		
	Ground Effect	5	5	0	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-58	-58	-64	-68	-66	-63	-65	-73	-102		
	Calculated Entry Equipment Contribution at NSA	60	57	48	46	46	46	43	33	-4	49.7	56.1

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.7

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
3200	Geometrical Divergence	-71	-71	-71	-71	-71	-71	-71	-71	-71		
1000	Additional Attenuation by Foliage and/or Land Contour	-1	-4	-6	-8	-10	-12	-16	-18	-24		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-2	-4	-9	-27	-94		
	Ground Effect	6	6	-3	-4	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-66	-69	-80	-84	-85	-85	-94	-114	-187		
	Calculated Exit Equipment Contribution at NSA	44	39	25	18	15	13	1	-22	-99	18.7	25.1

Combined Entry and Exit Contribution at Receiver		49.7	56.1
Existing Ambient Sound Level		43.1	49.5
Combined HDD Contribution and Ambient Sound Level		50.6	57.0
Predicted Temporary Increase During HDD Activities		7.5	7.5

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-MK-P4-21X: Sound Levels for HDD Crossing at Hudson Lake, Exit NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.6

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
1500	Geometrical Divergence	-64	-64	-64	-64	-64	-64	-64	-64	-64		
775	Additional Attenuation by Foliage and/or Land Contour	-1	-4	-6	-8	-10	-12	-16	-18	-24		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-2	-4	-13	-44		
	Ground Effect	5	5	0	-4	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-60	-63	-71	-77	-77	-76	-82	-92	-130		
	Calculated Entry Equipment Contribution at NSA	58	52	41	37	35	33	26	14	-32	37.4	43.8

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
925	Geometrical Divergence	-60	-60	-60	-60	-60	-60	-60	-60	-60		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-3	-8	-27		
	Ground Effect	5	5	1	-4	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-55	-55	-59	-65	-62	-59	-60	-65	-85		
	Calculated Exit Equipment Contribution at NSA	55	53	46	37	38	39	35	27	3	42.4	48.8

Combined Entry and Exit Contribution at Receiver		43.6	50.0
Existing Ambient Sound Level		33.5	39.9
Combined HDD Contribution and Ambient Sound Level		44.0	50.4
Predicted Temporary Increase During HDD Activities		10.5	10.5

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-MK-P4-22N: Sound Levels for HDD Crossing at State Road 52, Entry NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
1075	Geometrical Divergence	-61	-61	-61	-61	-61	-61	-61	-61	-61		
300	Additional Attenuation by Foliage and/or Land Contour	0	-2	-3	-4	-5	-5	-7	-8	-11		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-3	-9	-32		
	Ground Effect	5	5	1	-4	-2	2	3	3	3		
	- Total Attenuation per ISO 9613-2 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-57	-58	-64	-69	-68	-66	-69	-76	-101		
	Calculated Entry Equipment Contribution at NSA	61	57	48	45	44	43	39	30	-3	46.9	53.3

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
3400	Geometrical Divergence	-71	-71	-71	-71	-71	-71	-71	-71	-71		
2000	Additional Attenuation by Foliage and/or Land Contour	-1	-4	-6	-8	-10	-12	-16	-18	-24		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-2	-5	-10	-29	-100		
	Ground Effect	6	6	-2	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-67	-70	-80	-84	-85	-85	-94	-115	-193		
	Calculated Exit Equipment Contribution at NSA	43	38	25	18	15	13	1	-23	-105	18.5	24.9

Combined Entry and Exit Contribution at Receiver		46.9	53.3
Existing Ambient Sound Level		38.2	44.6
Combined HDD Contribution and Ambient Sound Level		47.5	53.9
Predicted Temporary Increase During HDD Activities		9.3	9.3

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-MK-P4-22X: Sound Levels for HDD Crossing at State Road 52, Exit NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
2550	Geometrical Divergence	-69	-69	-69	-69	-69	-69	-69	-69	-69		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-2	-3	-7	-22	-75		
	Ground Effect	6	6	-2	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-63	-63	-71	-74	-72	-70	-73	-88	-141		
	Calculated Entry Equipment Contribution at NSA	55	52	41	40	40	39	35	18	-43	42.9	49.3

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.6

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
750	Geometrical Divergence	-58	-58	-58	-58	-58	-58	-58	-58	-58		
300	Additional Attenuation by Foliage and/or Land Contour	0	-2	-3	-4	-5	-5	-7	-8	-11		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-2	-6	-22		
	Ground Effect	5	5	1	-4	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-54	-55	-60	-67	-65	-63	-65	-71	-89		
	Calculated Exit Equipment Contribution at NSA	56	53	45	35	35	35	30	21	-1	38.9	45.3

Combined Entry and Exit Contribution at Receiver		44.4	50.8
Existing Ambient Sound Level		45.1	51.5
Combined HDD Contribution and Ambient Sound Level		47.8	54.1
Predicted Temporary Increase During HDD Activities		2.7	2.6

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-MK-P4-23N: Sound Levels for HDD Crossing at Tiplady Road, Entry NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
325	Geometrical Divergence	-51	-51	-51	-51	-51	-51	-51	-51	-51		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	0	0	-1	-3	-10		
	Ground Effect	3	3	1	-4	-2	1	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-48	-48	-50	-55	-53	-50	-50	-52	-59		
	Calculated Entry Equipment Contribution at NSA	70	67	62	59	59	58	58	54	39	63.7	70.1

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
1800	Geometrical Divergence	-66	-66	-66	-66	-66	-66	-66	-66	-66		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-2	-5	-15	-53		
	Ground Effect	5	5	-1	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-60	-60	-67	-70	-68	-66	-68	-78	-116		
	Calculated Exit Equipment Contribution at NSA	50	48	38	32	32	32	27	14	-28	35.4	41.8

Combined Entry and Exit Contribution at Receiver		63.7	70.1
Existing Ambient Sound Level		38.0	44.4
Combined HDD Contribution and Ambient Sound Level		63.7	70.1
Predicted Temporary Increase During HDD Activities		25.7	25.7

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-MK-P4-23X: Sound Levels for HDD Crossing at Tiplady Road, Exit NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.7

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
2375	Geometrical Divergence	-68	-68	-68	-68	-68	-68	-68	-68	-68		
1700	Additional Attenuation by Foliage and/or Land Contour	-1	-4	-6	-8	-10	-12	-16	-18	-24		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-2	-3	-7	-20	-70		
	Ground Effect	6	6	-2	-4	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-64	-67	-76	-81	-82	-82	-89	-104	-160		
	Calculated Entry Equipment Contribution at NSA	54	48	36	33	30	27	19	2	-62	32.4	38.8

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
525	Geometrical Divergence	-55	-55	-55	-55	-55	-55	-55	-55	-55		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-1	-4	-15		
	Ground Effect	4	4	1	-4	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-51	-51	-54	-60	-57	-54	-55	-57	-69		
	Calculated Exit Equipment Contribution at NSA	59	57	51	42	43	44	40	35	19	47.7	54.1

Combined Entry and Exit Contribution at Receiver		47.8	54.2
Existing Ambient Sound Level		38.6	45.0
Combined HDD Contribution and Ambient Sound Level		48.3	54.7
Predicted Temporary Increase During HDD Activities		9.7	9.7

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-MK-P4-24N: Sound Levels for HDD Crossing at County Road D32, Entry NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
900	Geometrical Divergence	-60	-60	-60	-60	-60	-60	-60	-60	-60		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-3	-8	-27		
	Ground Effect	5	5	1	-4	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-55	-55	-59	-64	-62	-59	-60	-65	-84		
	Calculated Entry Equipment Contribution at NSA	63	60	53	50	50	50	48	41	14	54.3	60.7

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.3

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
2500	Geometrical Divergence	-69	-69	-69	-69	-69	-69	-69	-69	-69		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-2	-3	-7	-21	-74		
	Ground Effect	6	6	-1	-3	-1	3	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-63	-63	-70	-73	-71	-69	-72	-87	-139		
	Calculated Exit Equipment Contribution at NSA	47	45	35	29	29	29	23	5	-51	32.2	38.6

Combined Entry and Exit Contribution at Receiver		54.3	60.7
Existing Ambient Sound Level		35.3	41.7
Combined HDD Contribution and Ambient Sound Level		54.4	60.8
Predicted Temporary Increase During HDD Activities		19.1	19.1

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-MK-P4-24X: Sound Levels for HDD Crossing at County Road D32, Exit NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.3

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
2550	Geometrical Divergence	-69	-69	-69	-69	-69	-69	-69	-69	-69		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-2	-3	-7	-22	-75		
	Ground Effect	6	6	-1	-3	-1	3	3	3	3		
	- Total Attenuation per ISO 9613-2 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-63	-63	-70	-73	-71	-69	-73	-87	-141		
	Calculated Entry Equipment Contribution at NSA	55	52	42	41	41	40	35	19	-43	43.4	49.8

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
300	Geometrical Divergence	-50	-50	-50	-50	-50	-50	-50	-50	-50		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	0	0	-1	-3	-9		
	Ground Effect	3	3	1	-4	-2	1	2	2	2		
	- Total Attenuation per ISO 9613-2 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-47	-47	-50	-54	-52	-50	-50	-51	-58		
	Calculated Exit Equipment Contribution at NSA	63	61	55	48	48	48	45	41	30	52.5	58.9

Combined Entry and Exit Contribution at Receiver		53.0	59.4
Existing Ambient Sound Level		41.3	47.7
Combined HDD Contribution and Ambient Sound Level		53.3	59.7
Predicted Temporary Increase During HDD Activities		12.0	12.0

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-MK-P4-25N: Sound Levels for HDD Crossing at De Lapp Lane, Entry NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
750	Geometrical Divergence	-58	-58	-58	-58	-58	-58	-58	-58	-58		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-2	-6	-22		
	Ground Effect	5	5	1	-4	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-53	-54	-57	-63	-60	-57	-58	-62	-78		
	Calculated Entry Equipment Contribution at NSA	65	61	55	51	52	50	50	44	20	56.1	62.5

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.7	0.5	0.6

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
1725	Geometrical Divergence	-65	-65	-65	-65	-65	-65	-65	-65	-65		
500	Additional Attenuation by Foliage and/or Land Contour	-1	-3	-5	-6	-8	-9	-12	-14	-18		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-2	-5	-15	-51		
	Ground Effect	5	5	-2	-6	-3	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-61	-63	-72	-78	-77	-75	-80	-92	-132		
	Calculated Exit Equipment Contribution at NSA	49	45	33	24	23	23	15	0	-44	27.0	33.4

Combined Entry and Exit Contribution at Receiver		56.1	62.5
Existing Ambient Sound Level		35.3	41.7
Combined HDD Contribution and Ambient Sound Level		56.1	62.5
Predicted Temporary Increase During HDD Activities		20.8	20.8

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-MK-P4-25X: Sound Levels for HDD Crossing at De Lapp Lane, Exit NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.6

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
1950	Geometrical Divergence	-66	-66	-66	-66	-66	-66	-66	-66	-66		
500	Additional Attenuation by Foliage and/or Land Contour	-1	-3	-5	-6	-8	-9	-12	-14	-18		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-3	-6	-17	-58		
	Ground Effect	6	6	-1	-4	-2	2	3	3	3		
	- Total Attenuation per ISO 9613-2 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-62	-64	-72	-77	-77	-76	-82	-94	-140		
	Calculated Entry Equipment Contribution at NSA	56	51	40	37	35	33	26	12	-42	37.1	43.5

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.7	0.5	0.8

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
375	Geometrical Divergence	-52	-52	-52	-52	-52	-52	-52	-52	-52		
300	Additional Attenuation by Foliage and/or Land Contour	0	-2	-3	-4	-5	-5	-7	-8	-11		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	0	0	-1	-3	-11		
	Ground Effect	3	3	0	-6	-3	1	1	1	1		
	- Total Attenuation per ISO 9613-2 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-49	-51	-55	-62	-60	-57	-59	-62	-73		
	Calculated Exit Equipment Contribution at NSA	61	57	50	40	40	41	36	30	15	44.5	50.9

Combined Entry and Exit Contribution at Receiver		45.2	51.6
Existing Ambient Sound Level		32.8	39.2
Combined HDD Contribution and Ambient Sound Level		45.5	51.9
Predicted Temporary Increase During HDD Activities		12.7	12.7

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-MK-P4-27N: Sound Levels for HDD Crossing at Lake at Vines Road, Entry NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.6

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)										Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000			
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2		
275	Geometrical Divergence	-49	-49	-49	-49	-49	-49	-49	-49	-49			
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0			
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	0	0	-1	-2	-8			
	Ground Effect	3	3	1	-4	-2	1	2	2	2			
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-46	-46	-49	-54	-51	-49	-49	-50	-56			
	Calculated Entry Equipment Contribution at NSA	72	69	63	60	61	60	59	56	42	65.3	71.7	

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)										Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000			
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2		
2025	Geometrical Divergence	-67	-67	-67	-67	-67	-67	-67	-67	-67			
250	Additional Attenuation by Foliage and/or Land Contour	0	-2	-2	-3	-4	-5	-6	-7	-9			
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-3	-6	-17	-60			
	Ground Effect	6	6	-1	-4	-1	2	3	3	3			
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-62	-63	-70	-74	-73	-72	-76	-88	-133			
	Calculated Exit Equipment Contribution at NSA	48	45	35	28	27	26	19	4	-45	29.9	36.3	

Combined Entry and Exit Contribution at Receiver		65.3	71.7
Existing Ambient Sound Level		36.3	42.7
Combined HDD Contribution and Ambient Sound Level		65.3	71.7
Predicted Temporary Increase During HDD Activities		29.0	29.0

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-MK-P4-27X: Sound Levels for HDD Crossing at Lake at Vines Road, Exit NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
2100	Geometrical Divergence	-67	-67	-67	-67	-67	-67	-67	-67	-67		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-2	-3	-6	-18	-62		
	Ground Effect	6	6	-1	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-62	-62	-68	-72	-70	-68	-70	-82	-126		
	Calculated Entry Equipment Contribution at NSA	56	53	44	42	42	41	38	24	-28	45.2	51.6

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
600	Geometrical Divergence	-56	-56	-56	-56	-56	-56	-56	-56	-56		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-2	-5	-18		
	Ground Effect	4	4	1	-4	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-52	-52	-55	-61	-58	-55	-56	-59	-72		
	Calculated Exit Equipment Contribution at NSA	58	56	50	41	42	43	39	33	16	46.4	52.8

Combined Entry and Exit Contribution at Receiver		48.9	55.3
Existing Ambient Sound Level		37.5	43.9
Combined HDD Contribution and Ambient Sound Level		49.2	55.6
Predicted Temporary Increase During HDD Activities		11.7	11.7

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-MK-P4-28N: Sound Levels for HDD Crossing at Jewell Road, Entry NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
925	Geometrical Divergence	-60	-60	-60	-60	-60	-60	-60	-60	-60		
350	Additional Attenuation by Foliage and/or Land Contour	-1	-2	-3	-4	-5	-6	-9	-10	-13		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-3	-8	-27		
	Ground Effect	5	5	1	-4	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-56	-57	-62	-69	-68	-66	-69	-75	-98		
	Calculated Entry Equipment Contribution at NSA	62	58	50	45	44	43	39	31	0	47.5	53.9

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.6

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
2700	Geometrical Divergence	-69	-69	-69	-69	-69	-69	-69	-69	-69		
500	Additional Attenuation by Foliage and/or Land Contour	-1	-3	-5	-6	-8	-9	-12	-14	-18		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-2	-4	-8	-23	-80		
	Ground Effect	6	6	-2	-4	-2	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-64	-67	-76	-80	-80	-80	-87	-103	-165		
	Calculated Exit Equipment Contribution at NSA	46	41	29	22	20	18	8	-11	-77	22.8	29.2

Combined Entry and Exit Contribution at Receiver		47.5	53.9
Existing Ambient Sound Level		40.3	46.7
Combined HDD Contribution and Ambient Sound Level		48.3	54.7
Predicted Temporary Increase During HDD Activities		8.0	8.0

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-MK-P4-28X: Sound Levels for HDD Crossing at Jewell Road, Exit NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.7

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
3950	Geometrical Divergence	-73	-73	-73	-73	-73	-73	-73	-73	-73		
2000	Additional Attenuation by Foliage and/or Land Contour	-1	-4	-6	-8	-10	-12	-16	-18	-24		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-3	-5	-11	-34	-117		
	Ground Effect	6	6	-3	-4	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-68	-71	-82	-86	-87	-88	-98	-122	-211		
	Calculated Entry Equipment Contribution at NSA	50	44	30	28	25	21	10	-16	-113	26.7	33.1

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
600	Geometrical Divergence	-56	-56	-56	-56	-56	-56	-56	-56	-56		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-2	-5	-18		
	Ground Effect	4	4	1	-4	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-52	-52	-55	-61	-58	-55	-56	-59	-72		
	Calculated Exit Equipment Contribution at NSA	58	56	50	41	42	43	39	33	16	46.4	52.8

Combined Entry and Exit Contribution at Receiver		46.4	52.8
Existing Ambient Sound Level		37.6	44.0
Combined HDD Contribution and Ambient Sound Level		47.0	53.4
Predicted Temporary Increase During HDD Activities		9.4	9.4

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-SW-P4-38N: Sound Levels for HDD Crossing at Private Road and Middle Island Creek, Entry NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.7

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
1100	Geometrical Divergence	-62	-62	-62	-62	-62	-62	-62	-62	-62		
280	Additional Attenuation by Foliage and/or Land Contour	0	-2	-3	-3	-4	-5	-7	-8	-10		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-3	-9	-32		
	Ground Effect	5	5	0	-5	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-57	-58	-64	-70	-68	-66	-69	-76	-102		
	Calculated Entry Equipment Contribution at NSA	61	57	48	44	44	43	39	30	-4	46.6	53.0

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.7

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
2175	Geometrical Divergence	-67	-67	-67	-67	-67	-67	-67	-67	-67		
640	Additional Attenuation by Foliage and/or Land Contour	-1	-4	-6	-8	-10	-12	-16	-18	-23		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-2	-3	-6	-18	-64		
	Ground Effect	6	6	-2	-4	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-63	-66	-75	-80	-81	-80	-87	-101	-153		
	Calculated Exit Equipment Contribution at NSA	47	42	30	22	19	18	8	-9	-65	23.0	29.4

Combined Entry and Exit Contribution at Receiver		46.6	53.0
Existing Ambient Sound Level		32.0	38.4
Combined HDD Contribution and Ambient Sound Level		46.8	53.2
Predicted Temporary Increase During HDD Activities		14.8	14.8

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-SW-P4-38X: Sound Levels for HDD Crossing at Private Road and Middle Island Creek, Exit NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.7

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
2125	Geometrical Divergence	-67	-67	-67	-67	-67	-67	-67	-67	-67		
650	Additional Attenuation by Foliage and/or Land Contour	-1	-4	-6	-8	-10	-12	-16	-18	-24		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-2	-3	-6	-18	-63		
	Ground Effect	6	6	-2	-4	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-63	-66	-75	-80	-80	-80	-87	-101	-151		
	Calculated Entry Equipment Contribution at NSA	55	49	37	34	32	29	21	5	-53	33.7	40.1

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
325	Geometrical Divergence	-51	-51	-51	-51	-51	-51	-51	-51	-51		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	0	0	-1	-3	-10		
	Ground Effect	3	3	1	-4	-2	1	2	2	2		
	- Total Attenuation per ISO 9613-2 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-48	-48	-50	-55	-53	-50	-50	-52	-59		
	Calculated Exit Equipment Contribution at NSA	62	60	55	47	47	48	45	40	29	51.8	58.2

Combined Entry and Exit Contribution at Receiver		51.9	58.3
Existing Ambient Sound Level		46.0	52.4
Combined HDD Contribution and Ambient Sound Level		52.9	59.3
Predicted Temporary Increase During HDD Activities		6.9	6.9

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-SW-P4-39N: Sound Levels for HDD Crossing at Middle Island Creek, Entry NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
2075	Geometrical Divergence	-67	-67	-67	-67	-67	-67	-67	-67	-67		
550	Additional Attenuation by Foliage and/or Land Contour	-1	-3	-5	-7	-8	-10	-13	-15	-20		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-3	-6	-18	-61		
	Ground Effect	6	6	-1	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-62	-65	-73	-78	-78	-78	-84	-97	-146		
	Calculated Entry Equipment Contribution at NSA	56	50	39	36	34	31	24	9	-48	35.9	42.3

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.6

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
1575	Geometrical Divergence	-65	-65	-65	-65	-65	-65	-65	-65	-65		
350	Additional Attenuation by Foliage and/or Land Contour	-1	-2	-3	-4	-5	-6	-9	-10	-13		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-2	-4	-13	-46		
	Ground Effect	5	5	0	-4	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-60	-61	-68	-74	-73	-71	-75	-85	-121		
	Calculated Exit Equipment Contribution at NSA	50	47	37	28	27	27	20	7	-33	30.8	37.2

Combined Entry and Exit Contribution at Receiver		37.1	43.5
Existing Ambient Sound Level		40.3	46.7
Combined HDD Contribution and Ambient Sound Level		42.0	48.4
Predicted Temporary Increase During HDD Activities		1.7	1.7

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-SW-P4-39X: Sound Levels for HDD Crossing at Middle Island Creek, Exit NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.7

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
3775	Geometrical Divergence	-72	-72	-72	-72	-72	-72	-72	-72	-72		
1400	Additional Attenuation by Foliage and/or Land Contour	-1	-4	-6	-8	-10	-12	-16	-18	-24		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-3	-5	-11	-32	-111		
	Ground Effect	6	6	-3	-4	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-67	-71	-81	-86	-87	-87	-97	-120	-205		
	Calculated Entry Equipment Contribution at NSA	51	44	31	28	25	22	11	-14	-107	27.2	33.6

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.7

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
870	Geometrical Divergence	-59	-59	-59	-59	-59	-59	-59	-59	-59		
375	Additional Attenuation by Foliage and/or Land Contour	-1	-2	-3	-5	-6	-7	-9	-10	-14		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-2	-7	-26		
	Ground Effect	5	5	0	-5	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-55	-57	-63	-69	-68	-66	-69	-75	-97		
	Calculated Exit Equipment Contribution at NSA	55	51	42	33	32	32	26	17	-9	36.1	42.5

Combined Entry and Exit Contribution at Receiver		36.6	43.0
Existing Ambient Sound Level		30.8	37.2
Combined HDD Contribution and Ambient Sound Level		37.6	44.0
Predicted Temporary Increase During HDD Activities		6.8	6.8

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-SW-P4-40N: Sound Levels for HDD Crossing at Ohio River - Sherwood, Entry NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.8

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)										Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000			
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2		
925	Geometrical Divergence	-60	-60	-60	-60	-60	-60	-60	-60	-60			
550	Additional Attenuation by Foliage and/or Land Contour	-1	-3	-5	-7	-8	-10	-13	-15	-20			
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-3	-8	-27			
	Ground Effect	5	5	0	-5	-2	1	2	2	2			
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-56	-58	-65	-72	-71	-70	-74	-81	-106			
	Calculated Entry Equipment Contribution at NSA	62	57	47	42	41	39	34	25	-8	43.5	49.9	

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.4

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)										Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000			
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2		
5450	Geometrical Divergence	-75	-75	-75	-75	-75	-75	-75	-75	-75			
1500	Additional Attenuation by Foliage and/or Land Contour	-1	-4	-6	-8	-10	-12	-16	-18	-24			
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	-1	-2	-4	-7	-16	-46	-161			
	Ground Effect	6	6	-2	-4	-1	3	3	3	3			
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-71	-74	-84	-89	-90	-92	-104	-136	-257			
	Calculated Exit Equipment Contribution at NSA	39	34	21	13	10	6	-9	-44	-169	13.5	19.9	

Combined Entry and Exit Contribution at Receiver		43.5	49.9
	Existing Ambient Sound Level	37.0	43.4
	Combined HDD Contribution and Ambient Sound Level	44.4	50.8
	Predicted Temporary Increase During HDD Activities	7.4	7.4

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-SW-P4-40X: Sound Levels for HDD Crossing at Ohio River - Sherwood, Exit NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
6300	Geometrical Divergence	-77	-77	-77	-77	-77	-77	-77	-77	-77		
2800	Additional Attenuation by Foliage and/or Land Contour	-1	-4	-6	-8	-10	-12	-16	-18	-24		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	-1	-2	-5	-8	-18	-53	-186		
	Ground Effect	6	6	-2	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-77	-75	-86	-90	-92	-95	-108	-145	-284		
	Calculated Entry Equipment Contribution at NSA	46	40	26	24	20	14	0	-39	-186	21.6	28.0

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
200	Geometrical Divergence	-47	-47	-47	-47	-47	-47	-47	-47	-47		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	0	0	-1	-2	-6		
	Ground Effect	3	3	1	-3	-1	1	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-44	-44	-46	-50	-48	-46	-46	-47	-51		
	Calculated Exit Equipment Contribution at NSA	66	64	59	52	52	52	49	45	37	56.5	62.9

Combined Entry and Exit Contribution at Receiver		56.5	62.9
Existing Ambient Sound Level		74.9	81.3
Combined HDD Contribution and Ambient Sound Level		75.0	81.3
Predicted Temporary Increase During HDD Activities		0.1	0.0

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-CL-P4-41N: Sound Levels for HDD Crossing at Captina Creek, Entry NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.7

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
1375	Geometrical Divergence	-63	-63	-63	-63	-63	-63	-63	-63	-63		
950	Additional Attenuation by Foliage and/or Land Contour	-1	-4	-6	-8	-10	-12	-16	-18	-24		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-2	-4	-12	-41		
	Ground Effect	5	5	0	-5	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-59	-62	-70	-76	-76	-81	-91	-126			
	Calculated Entry Equipment Contribution at NSA	59	53	42	38	36	33	27	15	-28	38.1	44.5

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
1200	Geometrical Divergence	-62	-62	-62	-62	-62	-62	-62	-62	-62		
230	Additional Attenuation by Foliage and/or Land Contour	0	-1	-2	-3	-4	-4	-6	-6	-8		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-2	-3	-10	-35		
	Ground Effect	5	5	0	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-57	-59	-64	-70	-68	-66	-69	-76	-103		
	Calculated Exit Equipment Contribution at NSA	53	49	41	32	32	32	26	16	-15	35.7	42.1

Combined Entry and Exit Contribution at Receiver		40.1	46.5
Existing Ambient Sound Level		53.2	59.6
Combined HDD Contribution and Ambient Sound Level		53.4	59.9
Predicted Temporary Increase During HDD Activities		0.2	0.3

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-CL-P4-41X: Sound Levels for HDD Crossing at Captina Creek, Exit NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.7

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
1375	Geometrical Divergence	-63	-63	-63	-63	-63	-63	-63	-63	-63		
950	Additional Attenuation by Foliage and/or Land Contour	-1	-4	-6	-8	-10	-12	-16	-18	-24		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-2	-4	-12	-41		
	Ground Effect	5	5	0	-5	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-59	-62	-70	-76	-76	-81	-91	-126			
	Calculated Entry Equipment Contribution at NSA	59	53	42	38	36	33	27	15	-28	38.1	44.5

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
1200	Geometrical Divergence	-62	-62	-62	-62	-62	-62	-62	-62	-62		
230	Additional Attenuation by Foliage and/or Land Contour	0	-1	-2	-3	-4	-4	-6	-6	-8		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-2	-3	-10	-35		
	Ground Effect	5	5	0	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-57	-59	-64	-70	-68	-66	-69	-76	-103		
	Calculated Exit Equipment Contribution at NSA	53	49	41	32	32	32	26	16	-15	35.7	42.1

Combined Entry and Exit Contribution at Receiver		40.1	46.5
Existing Ambient Sound Level		53.2	59.6
Combined HDD Contribution and Ambient Sound Level		53.4	59.9
Predicted Temporary Increase During HDD Activities		0.2	0.3

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-CL-P4-42N: Sound Levels for HDD Crossing at Interstate 70, Entry NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
1175	Geometrical Divergence	-62	-62	-62	-62	-62	-62	-62	-62	-62		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-2	-3	-10	-35		
	Ground Effect	5	5	0	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-57	-57	-62	-67	-64	-62	-63	-69	-94		
	Calculated Entry Equipment Contribution at NSA	61	58	50	47	48	47	45	37	4	51.6	58.0

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
2950	Geometrical Divergence	-70	-70	-70	-70	-70	-70	-70	-70	-70		
500	Additional Attenuation by Foliage and/or Land Contour	-1	-3	-5	-6	-8	-9	-12	-14	-18		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-2	-4	-8	-25	-87		
	Ground Effect	6	6	-2	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-65	-68	-77	-81	-81	-81	-88	-106	-173		
	Calculated Exit Equipment Contribution at NSA	45	40	28	21	19	17	7	-14	-85	22.1	28.5

Combined Entry and Exit Contribution at Receiver		51.6	58.0
Existing Ambient Sound Level		54.9	61.3
Combined HDD Contribution and Ambient Sound Level		56.6	63.0
Predicted Temporary Increase During HDD Activities		1.7	1.7

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-CL-P4-42X: Sound Levels for HDD Crossing at Interstate 70, Exit NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
3800	Geometrical Divergence	-72	-72	-72	-72	-72	-72	-72	-72	-72		
1700	Additional Attenuation by Foliage and/or Land Contour	-1	-4	-6	-8	-10	-12	-16	-18	-24		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-3	-5	-11	-32	-112		
	Ground Effect	6	6	-2	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-68	-71	-81	-85	-86	-87	-96	-120	-206		
	Calculated Entry Equipment Contribution at NSA	50	44	31	29	26	22	12	-14	-108	27.6	34.0

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.6

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
1400	Geometrical Divergence	-64	-64	-64	-64	-64	-64	-64	-64	-64		
720	Additional Attenuation by Foliage and/or Land Contour	-1	-4	-6	-8	-10	-12	-16	-18	-24		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-2	-4	-12	-41		
	Ground Effect	5	5	0	-4	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-59	-62	-70	-76	-76	-76	-81	-91	-126		
	Calculated Exit Equipment Contribution at NSA	51	46	35	26	24	22	14	1	-38	27.5	33.9

Combined Entry and Exit Contribution at Receiver		30.6	37.0
Existing Ambient Sound Level		50.5	56.9
Combined HDD Contribution and Ambient Sound Level		50.5	56.9
Predicted Temporary Increase During HDD Activities		0.0	0.0

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-BG-P4-44N: Sound Levels for HDD Crossing at Golf Course, Entry NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.7	0.7

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
525	Geometrical Divergence	-55	-55	-55	-55	-55	-55	-55	-55	-55		
250	Additional Attenuation by Foliage and/or Land Contour	0	-2	-2	-3	-4	-5	-6	-7	-9		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-1	-4	-15		
	Ground Effect	4	4	0	-6	-3	1	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-51	-52	-57	-65	-63	-59	-61	-65	-78		
	Calculated Entry Equipment Contribution at NSA	67	63	55	49	49	50	47	41	20	53.8	60.2

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.7	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
2400	Geometrical Divergence	-68	-68	-68	-68	-68	-68	-68	-68	-68		
300	Additional Attenuation by Foliage and/or Land Contour	0	-2	-3	-4	-5	-5	-7	-8	-11		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-2	-3	-7	-20	-71		
	Ground Effect	6	6	-3	-6	-3	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-63	-65	-74	-78	-77	-75	-80	-94	-148		
	Calculated Exit Equipment Contribution at NSA	47	43	31	24	23	23	15	-2	-60	26.6	33.0

Combined Entry and Exit Contribution at Receiver		53.8	60.2
Existing Ambient Sound Level		48.0	54.4
Combined HDD Contribution and Ambient Sound Level		54.8	61.2
Predicted Temporary Increase During HDD Activities		6.8	6.8

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-BG-P4-44X: Sound Levels for HDD Crossing at Golf Course, Exit NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
2450	Geometrical Divergence	-68	-68	-68	-68	-68	-68	-68	-68	-68		
375	Additional Attenuation by Foliage and/or Land Contour	-1	-2	-3	-5	-6	-7	-9	-10	-14		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-2	-3	-7	-21	-72		
	Ground Effect	6	6	-2	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-63	-65	-74	-78	-77	-76	-82	-97	-152		
	Calculated Entry Equipment Contribution at NSA	55	50	38	36	35	33	26	9	-54	36.9	43.3

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.8

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
550	Geometrical Divergence	-55	-55	-55	-55	-55	-55	-55	-55	-55		
430	Additional Attenuation by Foliage and/or Land Contour	-1	-3	-4	-5	-7	-8	-10	-12	-16		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-2	-5	-16		
	Ground Effect	4	4	1	-5	-2	1	2	2	2		
	- Total Attenuation per ISO 9613-2 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-52	-54	-59	-66	-65	-63	-66	-70	-86		
	Calculated Exit Equipment Contribution at NSA	58	54	46	36	35	35	29	22	2	39.3	45.7

Combined Entry and Exit Contribution at Receiver		41.3	47.7
Existing Ambient Sound Level		46.7	53.1
Combined HDD Contribution and Ambient Sound Level		47.8	54.2
Predicted Temporary Increase During HDD Activities		1.1	1.1

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-BG-P4-45N: Sound Levels for HDD Crossing at Ohio River - Burgettstown, Entry NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.6

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
500	Geometrical Divergence	-55	-55	-55	-55	-55	-55	-55	-55	-55		
250	Additional Attenuation by Foliage and/or Land Contour	0	-2	-2	-3	-4	-5	-6	-7	-9		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-1	-4	-15		
	Ground Effect	4	4	1	-4	-2	1	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-51	-52	-56	-62	-61	-58	-60	-64	-77		
	Calculated Entry Equipment Contribution at NSA	67	63	56	52	51	51	48	42	21	54.9	61.3

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
5300	Geometrical Divergence	-75	-75	-75	-75	-75	-75	-75	-75	-75		
450	Additional Attenuation by Foliage and/or Land Contour	-1	-3	-4	-5	-7	-8	-11	-12	-16		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	-1	-2	-4	-7	-15	-45	-156		
	Ground Effect	6	6	-2	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-70	-72	-82	-86	-87	-88	-98	-130	-245		
	Calculated Exit Equipment Contribution at NSA	40	36	23	16	13	10	-3	-38	-157	16.1	22.5

Combined Entry and Exit Contribution at Receiver		54.9	61.3
Existing Ambient Sound Level		56.8	63.2
Combined HDD Contribution and Ambient Sound Level		59.0	65.3
Predicted Temporary Increase During HDD Activities		2.2	2.1

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-BG-P4-45X: Sound Levels for HDD Crossing at Ohio River - Burgettstown, Exit NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
5800	Geometrical Divergence	-76	-76	-76	-76	-76	-76	-76	-76	-76		
1400	Additional Attenuation by Foliage and/or Land Contour	-1	-4	-6	-8	-10	-12	-16	-18	-24		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	-1	-2	-4	-8	-17	-49	-171		
	Ground Effect	6	6	-2	-4	-1	2	3	3	3		
	- Total Attenuation per ISO 9613-2 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-71	-74	-85	-90	-91	-93	-106	-140	-268		
	Calculated Entry Equipment Contribution at NSA	47	41	27	24	21	16	2	-34	-170	22.6	29.0

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.8

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
575	Geometrical Divergence	-56	-56	-56	-56	-56	-56	-56	-56	-56		
500	Additional Attenuation by Foliage and/or Land Contour	-1	-3	-5	-6	-8	-9	-12	-14	-18		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-2	-5	-17		
	Ground Effect	4	4	1	-5	-2	1	2	2	2		
	- Total Attenuation per ISO 9613-2 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-52	-55	-60	-67	-66	-64	-68	-73	-89		
	Calculated Exit Equipment Contribution at NSA	58	53	45	35	34	34	27	19	-1	37.8	44.2

Combined Entry and Exit Contribution at Receiver		37.9	44.3
Existing Ambient Sound Level		46.7	53.1
Combined HDD Contribution and Ambient Sound Level		47.2	53.6
Predicted Temporary Increase During HDD Activities		0.5	0.5

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-MJ-P4-46N: Sound Levels for HDD Crossing at Ohio River - Majorsville, Entry NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.5

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
750	Geometrical Divergence	-58	-58	-58	-58	-58	-58	-58	-58	-58		
0	Additional Attenuation by Foliage and/or Land Contour	0	0	0	0	0	0	0	0	0		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-2	-6	-22		
	Ground Effect	5	5	1	-4	-2	2	2	2	2		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-53	-54	-57	-63	-60	-57	-58	-62	-78		
	Calculated Entry Equipment Contribution at NSA	65	61	55	51	52	52	50	44	20	56.1	62.5

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.5	0.5	0.4

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
3175	Geometrical Divergence	-71	-71	-71	-71	-71	-71	-71	-71	-71		
200	Additional Attenuation by Foliage and/or Land Contour	0	-1	-2	-2	-3	-4	-5	-5	-7		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-2	-4	-9	-27	-94		
	Ground Effect	6	6	-2	-4	-1	3	3	3	3		
	- Total Attenuation per ISO 9613-2 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-65	-66	-75	-78	-77	-76	-82	-100	-169		
	Calculated Exit Equipment Contribution at NSA	45	42	30	24	23	22	13	-8	-81	25.9	32.3

Combined Entry and Exit Contribution at Receiver		56.1	62.5
Existing Ambient Sound Level		67.1	73.5
Combined HDD Contribution and Ambient Sound Level		67.4	73.9
Predicted Temporary Increase During HDD Activities		0.3	0.4

Appendix 9E: Detailed Propagation Calculations for HDD Equipment

Table 9.2-HDD-MJ-P4-46X: Sound Levels for HDD Crossing at Ohio River - Majorsville, Exit NSA

Source		Ground Absorption Coefficient		
Entry		Source	Receiver	Middle
		0.5	0.5	0.3

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Entry Point	118	115	112	114	112	109	108	106	98	115.2	
2325	Geometrical Divergence	-68	-68	-68	-68	-68	-68	-68	-68	-68		
250	Additional Attenuation by Foliage and/or Land Contour	0	-2	-2	-3	-4	-5	-6	-7	-9		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	-1	-2	-3	-7	-20	-69		
	Ground Effect	6	6	-1	-3	-1	3	3	3	3		
	- Total Attenuation per ISO 9613-2 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-63	-64	-71	-75	-74	-73	-77	-91	-142		
	Calculated Entry Equipment Contribution at NSA	55	51	41	39	38	36	31	15	-44	40.1	46.5

Source		Ground Absorption Coefficient		
Exit		Source	Receiver	Middle
		0.6	0.6	0.8

Dist., ft.	Item	SPL or PWL at Octave Center Frequency. (dB at Hz)									Total, dB(A)	Total, dB(A) Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operations at an Exit Point	110	108	105	102	100	98	95	92	88	103.2	
950	Geometrical Divergence	-60	-60	-60	-60	-60	-60	-60	-60	-60		
900	Additional Attenuation by Foliage and/or Land Contour	-1	-4	-6	-8	-10	-12	-16	-18	-24		
	Atmospheric Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-3	-8	-28		
	Ground Effect	5	5	0	-6	-3	1	2	2	2		
	- Total Attenuation per ISO 9613-2 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-56	-59	-67	-75	-74	-72	-77	-85	-111		
	Calculated Exit Equipment Contribution at NSA	54	49	38	27	26	26	18	7	-23	30.3	36.7

Combined Entry and Exit Contribution at Receiver		40.5	46.9
Existing Ambient Sound Level		45.4	51.8
Combined HDD Contribution and Ambient Sound Level		46.6	53.0
Predicted Temporary Increase During HDD Activities		1.2	1.2