

**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	<b>115.2</b>	
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>59</b>	<b>54</b>	<b>44</b>	<b>40</b>	<b>38</b>	<b>37</b>	<b>31</b>	<b>19</b>	<b>-23</b>	<b>40.8</b>	<b>47.2</b>

  

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>53</b>	<b>48</b>	<b>38</b>	<b>28</b>	<b>26</b>	<b>25</b>	<b>17</b>	<b>7</b>	<b>-25</b>	<b>30.3</b>	<b>36.7</b>

  

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

**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	<b>115.2</b>	
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>59</b>	<b>54</b>	<b>44</b>	<b>40</b>	<b>38</b>	<b>37</b>	<b>31</b>	<b>19</b>	<b>-23</b>	<b>40.8</b>	<b>47.2</b>

  

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>53</b>	<b>48</b>	<b>38</b>	<b>28</b>	<b>26</b>	<b>25</b>	<b>17</b>	<b>7</b>	<b>-25</b>	<b>30.3</b>	<b>36.7</b>

  

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

**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	<b>115.2</b>	
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>55</b>	<b>52</b>	<b>41</b>	<b>40</b>	<b>40</b>	<b>39</b>	<b>35</b>	<b>18</b>	<b>-44</b>	<b>42.8</b>	<b>49.2</b>

  

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>38</b>	<b>33</b>	<b>18</b>	<b>10</b>	<b>6</b>	<b>2</b>	<b>-15</b>	<b>-57</b>	<b>-206</b>	<b>10.8</b>	<b>17.2</b>

  

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

**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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>48</b>	<b>42</b>	<b>27</b>	<b>25</b>	<b>21</b>	<b>17</b>	<b>4</b>	<b>-29</b>	<b>-152</b>	<b>23.2</b>	<b>29.6</b>

  

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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>50</b>	<b>45</b>	<b>33</b>	<b>24</b>	<b>22</b>	<b>21</b>	<b>12</b>	<b>-2</b>	<b>-46</b>	<b>25.7</b>	<b>32.1</b>

  

<b>Combined Entry and Exit Contribution at Receiver</b>		<b>27.6</b>	<b>34.0</b>
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	<b>115.2</b>	
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>58</b>	<b>55</b>	<b>46</b>	<b>44</b>	<b>44</b>	<b>44</b>	<b>41</b>	<b>29</b>	<b>-15</b>	<b>47.6</b>	<b>54.0</b>

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>47</b>	<b>44</b>	<b>33</b>	<b>26</b>	<b>25</b>	<b>25</b>	<b>17</b>	<b>-1</b>	<b>-59</b>	<b>28.4</b>	<b>34.8</b>

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

**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	<b>115.2</b>	
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>54</b>	<b>50</b>	<b>38</b>	<b>37</b>	<b>36</b>	<b>34</b>	<b>29</b>	<b>10</b>	<b>-58</b>	<b>38.3</b>	<b>44.7</b>

  

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>51</b>	<b>48</b>	<b>39</b>	<b>31</b>	<b>30</b>	<b>31</b>	<b>25</b>	<b>12</b>	<b>-26</b>	<b>34.1</b>	<b>40.5</b>

  

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

**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	<b>115.2</b>	
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>63</b>	<b>60</b>	<b>53</b>	<b>49</b>	<b>50</b>	<b>50</b>	<b>48</b>	<b>40</b>	<b>12</b>	<b>54.0</b>	<b>60.4</b>

  

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>56</b>	<b>54</b>	<b>47</b>	<b>39</b>	<b>39</b>	<b>40</b>	<b>37</b>	<b>29</b>	<b>9</b>	<b>44.0</b>	<b>50.4</b>

  

<b>Combined Entry and Exit Contribution at Receiver</b>		<b>54.4</b>	<b>60.8</b>
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	<b>115.2</b>	
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			
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>58</b>	<b>54</b>	<b>45</b>	<b>43</b>	<b>42</b>	<b>42</b>	<b>38</b>	<b>25</b>	<b>-22</b>	<b>45.4</b>	<b>51.8</b>

  

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>58</b>	<b>56</b>	<b>49</b>	<b>40</b>	<b>40</b>	<b>41</b>	<b>37</b>	<b>31</b>	<b>14</b>	<b>45.0</b>	<b>51.4</b>

  

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



**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	<b>115.2</b>	
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>63</b>	<b>60</b>	<b>53</b>	<b>50</b>	<b>50</b>	<b>50</b>	<b>48</b>	<b>41</b>	<b>15</b>	<b>54.6</b>	<b>61.0</b>

  

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>47</b>	<b>42</b>	<b>29</b>	<b>21</b>	<b>19</b>	<b>17</b>	<b>7</b>	<b>-10</b>	<b>-66</b>	<b>22.5</b>	<b>28.9</b>

  

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

**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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>51</b>	<b>45</b>	<b>31</b>	<b>29</b>	<b>26</b>	<b>22</b>	<b>12</b>	<b>-13</b>	<b>-104</b>	<b>27.9</b>	<b>34.3</b>

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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>52</b>	<b>50</b>	<b>41</b>	<b>34</b>	<b>34</b>	<b>35</b>	<b>30</b>	<b>19</b>	<b>-15</b>	<b>38.0</b>	<b>44.4</b>

<b>Combined Entry and Exit Contribution at Receiver</b>		<b>38.4</b>	<b>44.8</b>
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	<b>115.2</b>	
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>69</b>	<b>66</b>	<b>60</b>	<b>57</b>	<b>57</b>	<b>57</b>	<b>56</b>	<b>52</b>	<b>35</b>	<b>61.9</b>	<b>68.3</b>

  

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>48</b>	<b>44</b>	<b>32</b>	<b>24</b>	<b>22</b>	<b>21</b>	<b>12</b>	<b>-3</b>	<b>-54</b>	<b>25.6</b>	<b>32.0</b>

  

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

**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	<b>115.2</b>	
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	-87	-101	-101	-151		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>56</b>	<b>49</b>	<b>35</b>	<b>31</b>	<b>29</b>	<b>28</b>	<b>21</b>	<b>5</b>	<b>-53</b>	<b>32.4</b>	<b>38.8</b>

  

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>55</b>	<b>50</b>	<b>40</b>	<b>29</b>	<b>28</b>	<b>28</b>	<b>21</b>	<b>12</b>	<b>-14</b>	<b>32.6</b>	<b>39.0</b>

  

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

**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	<b>115.2</b>	
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 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-60	-60	-66	-69	-68	-65	-67	-77	-115		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>58</b>	<b>55</b>	<b>46</b>	<b>45</b>	<b>44</b>	<b>44</b>	<b>41</b>	<b>29</b>	<b>-17</b>	<b>47.8</b>	<b>54.2</b>

  

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	<b>103.2</b>	
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 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-59	-59	-64	-68	-66	-64	-65	-74	-104		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>51</b>	<b>49</b>	<b>41</b>	<b>34</b>	<b>34</b>	<b>34</b>	<b>30</b>	<b>18</b>	<b>-16</b>	<b>37.8</b>	<b>44.2</b>

  

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

**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	<b>115.2</b>	
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>53</b>	<b>50</b>	<b>39</b>	<b>38</b>	<b>38</b>	<b>36</b>	<b>31</b>	<b>11</b>	<b>-65</b>	<b>40.0</b>	<b>46.4</b>

  

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>52</b>	<b>50</b>	<b>41</b>	<b>34</b>	<b>34</b>	<b>35</b>	<b>30</b>	<b>19</b>	<b>-14</b>	<b>38.1</b>	<b>44.5</b>

  

<b>Combined Entry and Exit Contribution at Receiver</b>		<b>42.2</b>	<b>48.6</b>
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>69</b>	<b>66</b>	<b>60</b>	<b>57</b>	<b>57</b>	<b>57</b>	<b>56</b>	<b>52</b>	<b>35</b>	<b>61.9</b>	<b>68.3</b>

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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>48</b>	<b>45</b>	<b>34</b>	<b>27</b>	<b>26</b>	<b>25</b>	<b>18</b>	<b>3</b>	<b>-47</b>	<b>29.1</b>	<b>35.5</b>

<b>Combined Entry and Exit Contribution at Receiver</b>		<b>61.9</b>	<b>68.3</b>
	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	<b>115.2</b>	
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>54</b>	<b>50</b>	<b>39</b>	<b>38</b>	<b>37</b>	<b>35</b>	<b>29</b>	<b>11</b>	<b>-55</b>	<b>39.0</b>	<b>45.4</b>

  

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>49</b>	<b>47</b>	<b>38</b>	<b>31</b>	<b>31</b>	<b>32</b>	<b>26</b>	<b>13</b>	<b>-31</b>	<b>35.1</b>	<b>41.5</b>

  

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



**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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>68</b>	<b>65</b>	<b>59</b>	<b>55</b>	<b>56</b>	<b>56</b>	<b>54</b>	<b>50</b>	<b>32</b>	<b>60.4</b>	<b>66.8</b>

  

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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>51</b>	<b>46</b>	<b>35</b>	<b>25</b>	<b>23</b>	<b>22</b>	<b>13</b>	<b>0</b>	<b>-39</b>	<b>27.1</b>	<b>33.5</b>

  

<b>Combined Entry and Exit Contribution at Receiver</b>		<b>60.4</b>	<b>66.8</b>
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	<b>115.2</b>	
	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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>58</b>	<b>54</b>	<b>45</b>	<b>43</b>	<b>42</b>	<b>41</b>	<b>37</b>	<b>26</b>	<b>-18</b>	<b>45.2</b>	<b>51.6</b>

  

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	<b>103.2</b>	
425	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	-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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>60</b>	<b>58</b>	<b>53</b>	<b>44</b>	<b>45</b>	<b>46</b>	<b>42</b>	<b>37</b>	<b>24</b>	<b>49.5</b>	<b>55.9</b>

  

<b>Combined Entry and Exit Contribution at Receiver</b>		<b>50.9</b>	<b>57.3</b>
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	<b>115.2</b>	
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>60</b>	<b>56</b>	<b>48</b>	<b>45</b>	<b>45</b>	<b>44</b>	<b>41</b>	<b>31</b>	<b>-5</b>	<b>48.1</b>	<b>54.5</b>

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>56</b>	<b>54</b>	<b>47</b>	<b>39</b>	<b>39</b>	<b>40</b>	<b>36</b>	<b>29</b>	<b>8</b>	<b>43.8</b>	<b>50.2</b>

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

**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 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-59	-59	-65	-70	-68	-66	-69	-77	-108		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>59</b>	<b>56</b>	<b>47</b>	<b>44</b>	<b>44</b>	<b>43</b>	<b>39</b>	<b>29</b>	<b>-10</b>	<b>47.0</b>	<b>53.4</b>

  

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 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-51	-51	-54	-59	-57	-54	-54	-57	-67		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>59</b>	<b>57</b>	<b>51</b>	<b>43</b>	<b>43</b>	<b>44</b>	<b>41</b>	<b>35</b>	<b>21</b>	<b>48.1</b>	<b>54.5</b>

  

<b>Combined Entry and Exit Contribution at Receiver</b>		<b>50.6</b>	<b>57.0</b>
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>74</b>	<b>71</b>	<b>65</b>	<b>61</b>	<b>61</b>	<b>61</b>	<b>59</b>	<b>56</b>	<b>43</b>	<b>65.7</b>	<b>72.1</b>

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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>42</b>	<b>37</b>	<b>24</b>	<b>17</b>	<b>14</b>	<b>11</b>	<b>-1</b>	<b>-28</b>	<b>-118</b>	<b>17.2</b>	<b>23.6</b>

<b>Combined Entry and Exit Contribution at Receiver</b>		<b>65.7</b>	<b>72.1</b>
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	<b>115.2</b>	
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 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-67	-69	-79	-83	-83	-83	-91	-112	-190		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>51</b>	<b>46</b>	<b>33</b>	<b>31</b>	<b>29</b>	<b>26</b>	<b>17</b>	<b>-6</b>	<b>-92</b>	<b>30.7</b>	<b>37.1</b>

  

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>55</b>	<b>53</b>	<b>46</b>	<b>38</b>	<b>38</b>	<b>39</b>	<b>35</b>	<b>27</b>	<b>5</b>	<b>42.9</b>	<b>49.3</b>

  

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

**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	<b>115.2</b>	
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>68</b>	<b>65</b>	<b>59</b>	<b>55</b>	<b>56</b>	<b>56</b>	<b>54</b>	<b>50</b>	<b>32</b>	<b>60.4</b>	<b>66.8</b>

  

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>50</b>	<b>48</b>	<b>39</b>	<b>32</b>	<b>32</b>	<b>33</b>	<b>27</b>	<b>15</b>	<b>-26</b>	<b>36.0</b>	<b>42.4</b>

  

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

**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	<b>115.2</b>	
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>60</b>	<b>57</b>	<b>49</b>	<b>47</b>	<b>47</b>	<b>47</b>	<b>44</b>	<b>34</b>	<b>-1</b>	<b>50.6</b>	<b>56.9</b>

  

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>61</b>	<b>59</b>	<b>54</b>	<b>45</b>	<b>46</b>	<b>47</b>	<b>43</b>	<b>38</b>	<b>26</b>	<b>50.6</b>	<b>57.0</b>

  

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



**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	<b>115.2</b>	
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>72</b>	<b>69</b>	<b>63</b>	<b>60</b>	<b>61</b>	<b>60</b>	<b>59</b>	<b>56</b>	<b>42</b>	<b>65.3</b>	<b>71.7</b>

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>50</b>	<b>48</b>	<b>38</b>	<b>31</b>	<b>30</b>	<b>30</b>	<b>25</b>	<b>12</b>	<b>-28</b>	<b>34.0</b>	<b>40.4</b>

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

**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	<b>115.2</b>	
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>57</b>	<b>52</b>	<b>42</b>	<b>39</b>	<b>38</b>	<b>37</b>	<b>32</b>	<b>18</b>	<b>-33</b>	<b>40.8</b>	<b>47.2</b>

  

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>57</b>	<b>54</b>	<b>48</b>	<b>39</b>	<b>40</b>	<b>41</b>	<b>37</b>	<b>30</b>	<b>10</b>	<b>44.4</b>	<b>50.8</b>

  

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

**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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>57</b>	<b>54</b>	<b>45</b>	<b>43</b>	<b>43</b>	<b>43</b>	<b>39</b>	<b>27</b>	<b>-20</b>	<b>46.6</b>	<b>53.0</b>

  

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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>44</b>	<b>39</b>	<b>26</b>	<b>19</b>	<b>16</b>	<b>14</b>	<b>3</b>	<b>-20</b>	<b>-94</b>	<b>19.4</b>	<b>25.8</b>

  

<b>Combined Entry and Exit Contribution at Receiver</b>		<b>46.6</b>	<b>53.0</b>
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			
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>54</b>	<b>48</b>	<b>35</b>	<b>32</b>	<b>30</b>	<b>27</b>	<b>18</b>	<b>-1</b>	<b>-69</b>	<b>31.6</b>	<b>38.0</b>

  

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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>52</b>	<b>50</b>	<b>41</b>	<b>34</b>	<b>34</b>	<b>35</b>	<b>30</b>	<b>19</b>	<b>-14</b>	<b>38.1</b>	<b>44.5</b>

  

<b>Combined Entry and Exit Contribution at Receiver</b>		<b>39.0</b>	<b>45.4</b>
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	<b>115.2</b>	
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 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-54	-54	-58	-64	-61	-58	-59	-64	-81		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>64</b>	<b>61</b>	<b>54</b>	<b>50</b>	<b>51</b>	<b>51</b>	<b>49</b>	<b>42</b>	<b>17</b>	<b>55.2</b>	<b>61.6</b>

  

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	<b>103.2</b>	
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 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-59	-60	-66	-72	-70	-69	-72	-81	-113		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>51</b>	<b>48</b>	<b>39</b>	<b>30</b>	<b>30</b>	<b>29</b>	<b>23</b>	<b>11</b>	<b>-25</b>	<b>33.2</b>	<b>39.6</b>

  

<b>Combined Entry and Exit Contribution at Receiver</b>		<b>55.2</b>	<b>61.6</b>
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	<b>115.2</b>	
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>58</b>	<b>54</b>	<b>44</b>	<b>41</b>	<b>40</b>	<b>39</b>	<b>34</b>	<b>22</b>	<b>-23</b>	<b>42.9</b>	<b>49.3</b>

  

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>56</b>	<b>54</b>	<b>47</b>	<b>38</b>	<b>39</b>	<b>40</b>	<b>36</b>	<b>28</b>	<b>6</b>	<b>43.2</b>	<b>49.6</b>

  

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

**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	<b>115.2</b>	
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 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-61	-64	-75	-81	-81	-79	-85	-97	-141		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>57</b>	<b>51</b>	<b>37</b>	<b>33</b>	<b>31</b>	<b>30</b>	<b>23</b>	<b>9</b>	<b>-43</b>	<b>34.1</b>	<b>40.5</b>

  

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	<b>103.2</b>	
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 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-65	-68	-80	-85	-85	-84	-91	-108	-171		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>45</b>	<b>40</b>	<b>25</b>	<b>17</b>	<b>15</b>	<b>14</b>	<b>4</b>	<b>-16</b>	<b>-83</b>	<b>19.5</b>	<b>25.9</b>

  

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

**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	<b>115.2</b>	
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 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-62	-65	-74	-79	-79	-78	-84	-98	-147		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>56</b>	<b>50</b>	<b>38</b>	<b>35</b>	<b>33</b>	<b>31</b>	<b>24</b>	<b>8</b>	<b>-49</b>	<b>35.3</b>	<b>41.7</b>

  

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	<b>103.2</b>	
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 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-58	-61	-68	-75	-75	-74	-80	-88	-120		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>52</b>	<b>47</b>	<b>37</b>	<b>27</b>	<b>25</b>	<b>24</b>	<b>15</b>	<b>4</b>	<b>-32</b>	<b>28.8</b>	<b>35.2</b>

  

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



**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	<b>115.2</b>	
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>65</b>	<b>61</b>	<b>55</b>	<b>51</b>	<b>52</b>	<b>50</b>	<b>50</b>	<b>44</b>	<b>20</b>	<b>56.1</b>	<b>62.5</b>

  

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>47</b>	<b>44</b>	<b>34</b>	<b>27</b>	<b>27</b>	<b>26</b>	<b>19</b>	<b>2</b>	<b>-53</b>	<b>29.8</b>	<b>36.2</b>

  

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

**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	<b>115.2</b>	
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>65</b>	<b>61</b>	<b>55</b>	<b>51</b>	<b>52</b>	<b>50</b>	<b>50</b>	<b>44</b>	<b>20</b>	<b>56.1</b>	<b>62.5</b>

  

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>47</b>	<b>44</b>	<b>34</b>	<b>27</b>	<b>27</b>	<b>26</b>	<b>19</b>	<b>2</b>	<b>-53</b>	<b>29.8</b>	<b>36.2</b>

  

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

**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	<b>115.2</b>	
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 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-55	-55	-59	-63	-61	-59	-60	-65	-84		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>63</b>	<b>60</b>	<b>53</b>	<b>51</b>	<b>51</b>	<b>50</b>	<b>48</b>	<b>41</b>	<b>14</b>	<b>54.6</b>	<b>61.0</b>

  

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	<b>103.2</b>	
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 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-68	-68	-76	-78	-77	-76	-82	-107	-197		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>42</b>	<b>40</b>	<b>29</b>	<b>24</b>	<b>23</b>	<b>22</b>	<b>13</b>	<b>-15</b>	<b>-109</b>	<b>25.3</b>	<b>31.7</b>

  

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

**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	<b>115.2</b>	
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>52</b>	<b>49</b>	<b>38</b>	<b>38</b>	<b>37</b>	<b>36</b>	<b>30</b>	<b>9</b>	<b>-70</b>	<b>39.4</b>	<b>45.8</b>

  

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>54</b>	<b>52</b>	<b>44</b>	<b>36</b>	<b>36</b>	<b>37</b>	<b>33</b>	<b>24</b>	<b>-3</b>	<b>40.6</b>	<b>47.0</b>

  

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

**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	<b>115.2</b>	
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>57</b>	<b>54</b>	<b>45</b>	<b>43</b>	<b>43</b>	<b>42</b>	<b>39</b>	<b>26</b>	<b>-22</b>	<b>46.2</b>	<b>52.6</b>

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>43</b>	<b>41</b>	<b>30</b>	<b>24</b>	<b>23</b>	<b>22</b>	<b>14</b>	<b>-12</b>	<b>-100</b>	<b>26.0</b>	<b>32.4</b>

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

**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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>56</b>	<b>53</b>	<b>42</b>	<b>41</b>	<b>41</b>	<b>40</b>	<b>36</b>	<b>21</b>	<b>-36</b>	<b>44.0</b>	<b>50.4</b>

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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>61</b>	<b>59</b>	<b>53</b>	<b>45</b>	<b>45</b>	<b>46</b>	<b>43</b>	<b>38</b>	<b>25</b>	<b>50.0</b>	<b>56.4</b>

<b>Combined Entry and Exit Contribution at Receiver</b>		<b>51.0</b>	<b>57.4</b>
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	<b>115.2</b>	
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>62</b>	<b>57</b>	<b>48</b>	<b>44</b>	<b>43</b>	<b>42</b>	<b>38</b>	<b>29</b>	<b>-4</b>	<b>46.3</b>	<b>52.7</b>

  

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>59</b>	<b>57</b>	<b>51</b>	<b>42</b>	<b>43</b>	<b>44</b>	<b>40</b>	<b>35</b>	<b>19</b>	<b>47.7</b>	<b>54.1</b>

  

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

**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	<b>115.2</b>		
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			
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>62</b>	<b>57</b>	<b>48</b>	<b>44</b>	<b>43</b>	<b>42</b>	<b>38</b>	<b>29</b>	<b>-4</b>	<b>46.3</b>	<b>52.7</b>	

  

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	<b>103.2</b>		
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			
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>59</b>	<b>57</b>	<b>51</b>	<b>42</b>	<b>43</b>	<b>44</b>	<b>40</b>	<b>35</b>	<b>19</b>	<b>47.7</b>	<b>54.1</b>	

  

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



**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	<b>115.2</b>	
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>67</b>	<b>63</b>	<b>56</b>	<b>52</b>	<b>52</b>	<b>52</b>	<b>49</b>	<b>44</b>	<b>23</b>	<b>56.1</b>	<b>62.5</b>

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>45</b>	<b>40</b>	<b>28</b>	<b>20</b>	<b>17</b>	<b>15</b>	<b>5</b>	<b>-16</b>	<b>-84</b>	<b>20.8</b>	<b>27.2</b>

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

**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	<b>115.2</b>	
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>54</b>	<b>48</b>	<b>36</b>	<b>33</b>	<b>30</b>	<b>27</b>	<b>19</b>	<b>1</b>	<b>-66</b>	<b>32.3</b>	<b>38.7</b>

  

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>57</b>	<b>53</b>	<b>45</b>	<b>35</b>	<b>35</b>	<b>35</b>	<b>29</b>	<b>22</b>	<b>1</b>	<b>38.9</b>	<b>45.3</b>

  

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

**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	<b>115.2</b>	
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>60</b>	<b>57</b>	<b>48</b>	<b>46</b>	<b>46</b>	<b>46</b>	<b>43</b>	<b>33</b>	<b>-4</b>	<b>49.7</b>	<b>56.1</b>

  

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>44</b>	<b>39</b>	<b>25</b>	<b>18</b>	<b>15</b>	<b>13</b>	<b>1</b>	<b>-22</b>	<b>-99</b>	<b>18.7</b>	<b>25.1</b>

  

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

**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	<b>115.2</b>	
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>58</b>	<b>52</b>	<b>41</b>	<b>37</b>	<b>35</b>	<b>33</b>	<b>26</b>	<b>14</b>	<b>-32</b>	<b>37.4</b>	<b>43.8</b>

  

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>55</b>	<b>53</b>	<b>46</b>	<b>37</b>	<b>38</b>	<b>39</b>	<b>35</b>	<b>27</b>	<b>3</b>	<b>42.4</b>	<b>48.8</b>

  

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

**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	<b>115.2</b>	
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 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-57	-58	-64	-69	-68	-66	-69	-76	-101		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>61</b>	<b>57</b>	<b>48</b>	<b>45</b>	<b>44</b>	<b>43</b>	<b>39</b>	<b>30</b>	<b>-3</b>	<b>46.9</b>	<b>53.3</b>

  

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	<b>103.2</b>	
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 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-67	-70	-80	-84	-85	-85	-94	-115	-193		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>43</b>	<b>38</b>	<b>25</b>	<b>18</b>	<b>15</b>	<b>13</b>	<b>1</b>	<b>-23</b>	<b>-105</b>	<b>18.5</b>	<b>24.9</b>

  

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

**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	<b>115.2</b>	
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>55</b>	<b>52</b>	<b>41</b>	<b>40</b>	<b>40</b>	<b>39</b>	<b>35</b>	<b>18</b>	<b>-43</b>	<b>42.9</b>	<b>49.3</b>

  

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>56</b>	<b>53</b>	<b>45</b>	<b>35</b>	<b>35</b>	<b>35</b>	<b>30</b>	<b>21</b>	<b>-1</b>	<b>38.9</b>	<b>45.3</b>

  

<b>Combined Entry and Exit Contribution at Receiver</b>		<b>44.4</b>	<b>50.8</b>
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	<b>115.2</b>		
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			
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>70</b>	<b>67</b>	<b>62</b>	<b>59</b>	<b>59</b>	<b>58</b>	<b>58</b>	<b>54</b>	<b>39</b>	<b>63.7</b>	<b>70.1</b>	

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	<b>103.2</b>		
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			
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>50</b>	<b>48</b>	<b>38</b>	<b>32</b>	<b>32</b>	<b>32</b>	<b>27</b>	<b>14</b>	<b>-28</b>	<b>35.4</b>	<b>41.8</b>	

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

**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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>54</b>	<b>48</b>	<b>36</b>	<b>33</b>	<b>30</b>	<b>27</b>	<b>19</b>	<b>2</b>	<b>-62</b>	<b>32.4</b>	<b>38.8</b>

  

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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>59</b>	<b>57</b>	<b>51</b>	<b>42</b>	<b>43</b>	<b>44</b>	<b>40</b>	<b>35</b>	<b>19</b>	<b>47.7</b>	<b>54.1</b>

  

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



**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	<b>115.2</b>	
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>63</b>	<b>60</b>	<b>53</b>	<b>50</b>	<b>50</b>	<b>50</b>	<b>48</b>	<b>41</b>	<b>14</b>	<b>54.3</b>	<b>60.7</b>

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>47</b>	<b>45</b>	<b>35</b>	<b>29</b>	<b>29</b>	<b>29</b>	<b>23</b>	<b>5</b>	<b>-51</b>	<b>32.2</b>	<b>38.6</b>

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

**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	<b>115.2</b>		
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			
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>55</b>	<b>52</b>	<b>42</b>	<b>41</b>	<b>41</b>	<b>40</b>	<b>35</b>	<b>19</b>	<b>-43</b>	<b>43.4</b>	<b>49.8</b>	

  

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	<b>103.2</b>		
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			
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>63</b>	<b>61</b>	<b>55</b>	<b>48</b>	<b>48</b>	<b>48</b>	<b>45</b>	<b>41</b>	<b>30</b>	<b>52.5</b>	<b>58.9</b>	

  

<b>Combined Entry and Exit Contribution at Receiver</b>		<b>53.0</b>	<b>59.4</b>
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>65</b>	<b>61</b>	<b>55</b>	<b>51</b>	<b>52</b>	<b>50</b>	<b>50</b>	<b>44</b>	<b>20</b>	<b>56.1</b>	<b>62.5</b>

  

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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>49</b>	<b>45</b>	<b>33</b>	<b>24</b>	<b>23</b>	<b>23</b>	<b>15</b>	<b>0</b>	<b>-44</b>	<b>27.0</b>	<b>33.4</b>

  

<b>Combined Entry and Exit Contribution at Receiver</b>		<b>56.1</b>	<b>62.5</b>
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 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-62	-64	-72	-77	-77	-76	-82	-94	-140		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>56</b>	<b>51</b>	<b>40</b>	<b>37</b>	<b>35</b>	<b>33</b>	<b>26</b>	<b>12</b>	<b>-42</b>	<b>37.1</b>	<b>43.5</b>

  

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 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-49	-51	-55	-62	-60	-57	-59	-62	-73		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>61</b>	<b>57</b>	<b>50</b>	<b>40</b>	<b>40</b>	<b>41</b>	<b>36</b>	<b>30</b>	<b>15</b>	<b>44.5</b>	<b>50.9</b>

  

<b>Combined Entry and Exit Contribution at Receiver</b>		<b>45.2</b>	<b>51.6</b>
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	<b>115.2</b>	
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>72</b>	<b>69</b>	<b>63</b>	<b>60</b>	<b>61</b>	<b>60</b>	<b>59</b>	<b>56</b>	<b>42</b>	<b>65.3</b>	<b>71.7</b>

  

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>48</b>	<b>45</b>	<b>35</b>	<b>28</b>	<b>27</b>	<b>26</b>	<b>19</b>	<b>4</b>	<b>-45</b>	<b>29.9</b>	<b>36.3</b>

  

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

**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	<b>115.2</b>	
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>56</b>	<b>53</b>	<b>44</b>	<b>42</b>	<b>42</b>	<b>41</b>	<b>38</b>	<b>24</b>	<b>-28</b>	<b>45.2</b>	<b>51.6</b>

  

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>58</b>	<b>56</b>	<b>50</b>	<b>41</b>	<b>42</b>	<b>43</b>	<b>39</b>	<b>33</b>	<b>16</b>	<b>46.4</b>	<b>52.8</b>

  

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

**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	<b>115.2</b>	
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>62</b>	<b>58</b>	<b>50</b>	<b>45</b>	<b>44</b>	<b>43</b>	<b>39</b>	<b>31</b>	<b>0</b>	<b>47.5</b>	<b>53.9</b>

  

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>46</b>	<b>41</b>	<b>29</b>	<b>22</b>	<b>20</b>	<b>18</b>	<b>8</b>	<b>-11</b>	<b>-77</b>	<b>22.8</b>	<b>29.2</b>

  

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

**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 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-68	-71	-82	-86	-87	-88	-98	-122	-211		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>50</b>	<b>44</b>	<b>30</b>	<b>28</b>	<b>25</b>	<b>21</b>	<b>10</b>	<b>-16</b>	<b>-113</b>	<b>26.7</b>	<b>33.1</b>

  

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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>58</b>	<b>56</b>	<b>50</b>	<b>41</b>	<b>42</b>	<b>43</b>	<b>39</b>	<b>33</b>	<b>16</b>	<b>46.4</b>	<b>52.8</b>

  

<b>Combined Entry and Exit Contribution at Receiver</b>		<b>46.4</b>	<b>52.8</b>
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	<b>115.2</b>	
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>61</b>	<b>57</b>	<b>48</b>	<b>44</b>	<b>44</b>	<b>43</b>	<b>39</b>	<b>30</b>	<b>-4</b>	<b>46.6</b>	<b>53.0</b>

  

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>47</b>	<b>42</b>	<b>30</b>	<b>22</b>	<b>19</b>	<b>18</b>	<b>8</b>	<b>-9</b>	<b>-65</b>	<b>23.0</b>	<b>29.4</b>

  

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

**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 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-63	-66	-75	-80	-80	-80	-87	-101	-151		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>55</b>	<b>49</b>	<b>37</b>	<b>34</b>	<b>32</b>	<b>29</b>	<b>21</b>	<b>5</b>	<b>-53</b>	<b>33.7</b>	<b>40.1</b>

  

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 (Includes Divergence, Additional Attenuation, Absorption, Ground Effect)	-48	-48	-50	-55	-53	-50	-50	-52	-59		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>62</b>	<b>60</b>	<b>55</b>	<b>47</b>	<b>47</b>	<b>48</b>	<b>45</b>	<b>40</b>	<b>29</b>	<b>51.8</b>	<b>58.2</b>

  

<b>Combined Entry and Exit Contribution at Receiver</b>		<b>51.9</b>	<b>58.3</b>
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	<b>115.2</b>	
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	-84	-97	-146			
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>56</b>	<b>50</b>	<b>39</b>	<b>36</b>	<b>34</b>	<b>31</b>	<b>24</b>	<b>9</b>	<b>-48</b>	<b>35.9</b>	<b>42.3</b>

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>50</b>	<b>47</b>	<b>37</b>	<b>28</b>	<b>27</b>	<b>27</b>	<b>20</b>	<b>7</b>	<b>-33</b>	<b>30.8</b>	<b>37.2</b>

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

**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	<b>115.2</b>	
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>51</b>	<b>44</b>	<b>31</b>	<b>28</b>	<b>25</b>	<b>22</b>	<b>11</b>	<b>-14</b>	<b>-107</b>	<b>27.2</b>	<b>33.6</b>

  

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>55</b>	<b>51</b>	<b>42</b>	<b>33</b>	<b>32</b>	<b>32</b>	<b>26</b>	<b>17</b>	<b>-9</b>	<b>36.1</b>	<b>42.5</b>

  

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

**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	<b>115.2</b>		
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 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-56	-58	-65	-72	-71	-70	-74	-81	-106			
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>62</b>	<b>57</b>	<b>47</b>	<b>42</b>	<b>41</b>	<b>39</b>	<b>34</b>	<b>25</b>	<b>-8</b>	<b>43.5</b>	<b>49.9</b>	

  

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	<b>103.2</b>		
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 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-71	-74	-84	-89	-90	-92	-104	-136	-257			
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>39</b>	<b>34</b>	<b>21</b>	<b>13</b>	<b>10</b>	<b>6</b>	<b>-9</b>	<b>-44</b>	<b>-169</b>	<b>13.5</b>	<b>19.9</b>	

  

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

**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	<b>115.2</b>	
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>46</b>	<b>40</b>	<b>26</b>	<b>24</b>	<b>20</b>	<b>14</b>	<b>0</b>	<b>-39</b>	<b>-186</b>	<b>21.6</b>	<b>28.0</b>

  

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>66</b>	<b>64</b>	<b>59</b>	<b>52</b>	<b>52</b>	<b>52</b>	<b>49</b>	<b>45</b>	<b>37</b>	<b>56.5</b>	<b>62.9</b>

  

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

**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	<b>115.2</b>	
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			
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>59</b>	<b>53</b>	<b>42</b>	<b>38</b>	<b>36</b>	<b>33</b>	<b>27</b>	<b>15</b>	<b>-28</b>	<b>38.1</b>	<b>44.5</b>

  

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>53</b>	<b>49</b>	<b>41</b>	<b>32</b>	<b>32</b>	<b>32</b>	<b>26</b>	<b>16</b>	<b>-15</b>	<b>35.7</b>	<b>42.1</b>

  

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

**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	<b>115.2</b>	
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 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-59	-62	-70	-76	-76	-81	-91	-91	-126		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>59</b>	<b>53</b>	<b>42</b>	<b>38</b>	<b>36</b>	<b>33</b>	<b>27</b>	<b>15</b>	<b>-28</b>	<b>38.1</b>	<b>44.5</b>

  

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	<b>103.2</b>	
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 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-57	-59	-64	-70	-68	-66	-69	-76	-103		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>53</b>	<b>49</b>	<b>41</b>	<b>32</b>	<b>32</b>	<b>32</b>	<b>26</b>	<b>16</b>	<b>-15</b>	<b>35.7</b>	<b>42.1</b>

  

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



**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	<b>115.2</b>	
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>61</b>	<b>58</b>	<b>50</b>	<b>47</b>	<b>48</b>	<b>47</b>	<b>45</b>	<b>37</b>	<b>4</b>	<b>51.6</b>	<b>58.0</b>

  

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>45</b>	<b>40</b>	<b>28</b>	<b>21</b>	<b>19</b>	<b>17</b>	<b>7</b>	<b>-14</b>	<b>-85</b>	<b>22.1</b>	<b>28.5</b>

  

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

**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	<b>115.2</b>	
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>50</b>	<b>44</b>	<b>31</b>	<b>29</b>	<b>26</b>	<b>22</b>	<b>12</b>	<b>-14</b>	<b>-108</b>	<b>27.6</b>	<b>34.0</b>

  

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>51</b>	<b>46</b>	<b>35</b>	<b>26</b>	<b>24</b>	<b>22</b>	<b>14</b>	<b>1</b>	<b>-38</b>	<b>27.5</b>	<b>33.9</b>

  

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

**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	<b>115.2</b>	
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 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-51	-52	-57	-65	-63	-59	-61	-65	-78		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>67</b>	<b>63</b>	<b>55</b>	<b>49</b>	<b>49</b>	<b>50</b>	<b>47</b>	<b>41</b>	<b>20</b>	<b>53.8</b>	<b>60.2</b>

  

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	<b>103.2</b>	
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 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-63	-65	-74	-78	-77	-75	-80	-94	-148		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>47</b>	<b>43</b>	<b>31</b>	<b>24</b>	<b>23</b>	<b>23</b>	<b>15</b>	<b>-2</b>	<b>-60</b>	<b>26.6</b>	<b>33.0</b>

  

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

**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	<b>115.2</b>	
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>55</b>	<b>50</b>	<b>38</b>	<b>36</b>	<b>35</b>	<b>33</b>	<b>26</b>	<b>9</b>	<b>-54</b>	<b>36.9</b>	<b>43.3</b>

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>58</b>	<b>54</b>	<b>46</b>	<b>36</b>	<b>35</b>	<b>35</b>	<b>29</b>	<b>22</b>	<b>2</b>	<b>39.3</b>	<b>45.7</b>

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

**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 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-51	-52	-56	-62	-61	-58	-60	-64	-77		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>67</b>	<b>63</b>	<b>56</b>	<b>52</b>	<b>51</b>	<b>51</b>	<b>48</b>	<b>42</b>	<b>21</b>	<b>54.9</b>	<b>61.3</b>

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 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-70	-72	-82	-86	-87	-88	-98	-130	-245		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>40</b>	<b>36</b>	<b>23</b>	<b>16</b>	<b>13</b>	<b>10</b>	<b>-3</b>	<b>-38</b>	<b>-157</b>	<b>16.1</b>	<b>22.5</b>

<b>Combined Entry and Exit Contribution at Receiver</b>		<b>54.9</b>	<b>61.3</b>
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>47</b>	<b>41</b>	<b>27</b>	<b>24</b>	<b>21</b>	<b>16</b>	<b>2</b>	<b>-34</b>	<b>-170</b>	<b>22.6</b>	<b>29.0</b>

  

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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>58</b>	<b>53</b>	<b>45</b>	<b>35</b>	<b>34</b>	<b>34</b>	<b>27</b>	<b>19</b>	<b>-1</b>	<b>37.8</b>	<b>44.2</b>

  

<b>Combined Entry and Exit Contribution at Receiver</b>		<b>37.9</b>	<b>44.3</b>
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	<b>115.2</b>	
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 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-53	-54	-57	-63	-60	-57	-58	-62	-78		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>65</b>	<b>61</b>	<b>55</b>	<b>51</b>	<b>52</b>	<b>52</b>	<b>50</b>	<b>44</b>	<b>20</b>	<b>56.1</b>	<b>62.5</b>

  

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	<b>103.2</b>	
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 <small>(Includes Divergence, Additional Attenuation, Absorption, Ground Effect)</small>	-65	-66	-75	-78	-77	-76	-82	-100	-169		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>45</b>	<b>42</b>	<b>30</b>	<b>24</b>	<b>23</b>	<b>22</b>	<b>13</b>	<b>-8</b>	<b>-81</b>	<b>25.9</b>	<b>32.3</b>

  

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

**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	<b>115.2</b>	
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		
	<b>Calculated Entry Equipment Contribution at NSA</b>	<b>55</b>	<b>51</b>	<b>41</b>	<b>39</b>	<b>38</b>	<b>36</b>	<b>31</b>	<b>15</b>	<b>-44</b>	<b>40.1</b>	<b>46.5</b>

  

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	<b>103.2</b>	
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		
	<b>Calculated Exit Equipment Contribution at NSA</b>	<b>54</b>	<b>49</b>	<b>38</b>	<b>27</b>	<b>26</b>	<b>26</b>	<b>18</b>	<b>7</b>	<b>-23</b>	<b>30.3</b>	<b>36.7</b>

  

<b>Combined Entry and Exit Contribution at Receiver</b>		<b>40.5</b>	<b>46.9</b>
	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