

C-4.1 Report on Nominal Pulse Spacing (NPS)

The USGS Lidar Base Specification Version 1.3 states: "Assessment and reporting of the NPS are made against single swath, single instrument, first-return-only data, including only the geometrically usable part of the swath and excluding acceptable data voids. Higher net densities of lidar point measurements are being achieved more often by flying multiple passes of the lidar instrument over the project area or flying with large amounts (greater than [$>$] 50 percent) of overlap between swaths, creating a need for a new term to describe total pulse density without being confused with NPS and NPD. This specification will use the terms aggregate nominal pulse spacing (ANPS) and aggregate nominal pulse density (ANPD) to describe the net overall pulse spacing and density, respectively. The required ANPS and ANPD by QL are listed in Table 1. Dependent on the local terrain and land cover conditions in a project, a greater pulse density may be required on specific projects."

Table 1. Aggregate nominal pulse spacing and density.

[QL, quality level; pls/m², pulses per square meter; m, meter; \leq , less than or equal to; \geq , greater than or equal to]

Quality level	Aggregate nominal pulse spacing (m)	Aggregate nominal pulse density (pls/m ²)
QL0	≤ 0.35	≥ 8.0
QL1	≤ 0.35	≥ 8.0
QL2	≤ 0.71	≥ 2.0
QL3	≤ 1.41	≥ 0.5

The purpose of this section is to report on the lidar point density and nominal point spacing by LAS file. Averages by files (not including overlap), project boundary polygons (including overlap), and aggregate project boundary polygons (including overlap) are reported.

[Data Source - Y:\Mapping\Projects\65220171_USGS-TX_West_Texas\Production\Final_Client_Deliverables\Lot9_utm13\point_cloud\Swaths](Y:\Mapping\Projects\65220171_USGS-TX_West_Texas\Production\Final_Client_Deliverables\Lot9_utm13\point_cloud\Swaths)

Quality level tested: QL2

File	Number of First Returns	Area	Point Density	NPS
CS_02002.las	17,489,357	5,004,816	3.495/0.325	0.535/1.755
CS_02029.las	90,397,052	29,825,936	3.031/0.282	0.574/1.883
CS_02038.las	365,129,079	128,793,728	2.835/0.263	0.594/1.949
CS_02067.las	48,561,558	16,961,184	2.863/0.266	0.591/1.939

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File	Number of First Returns	Area	Point Density	NPS
CS_02070.las	94,473,330	30,263,152	3.122/0.290	0.566/1.857
CS_02087.las	547,712,918	194,972,768	2.809/0.261	0.597/1.959
CS_02097.las	5,170	1,296	3.989/0.371	0.501/1.644
CS_02112.las	1,696,908	554,128	3.062/0.284	0.571/1.873
CS_02113.las	85,464,252	24,819,568	3.443/0.320	0.539/1.768
CS_02115.las	750,890,635	232,690,096	3.227/0.300	0.557/1.827
CS_02117.las	727,908,407	235,292,352	3.094/0.287	0.569/1.867
CS_02122.las	94,322,556	30,910,736	3.051/0.283	0.572/1.877
CS_02123.las	93,809,737	29,748,000	3.153/0.293	0.563/1.847
CS_02125.las	51,986,287	16,862,176	3.083/0.286	0.570/1.870
CS_02126.las	85,479,660	30,522,608	2.801/0.260	0.598/1.962
CS_02129.las	90,735,872	30,970,768	2.930/0.272	0.584/1.916
CS_02137.las	10,510,799	2,759,520	3.809/0.354	0.512/1.680
CS_02146.las	536,673,010	194,946,592	2.753/0.256	0.603/1.978
CS_02163.las	563,855	181,200	3.112/0.289	0.567/1.860
CS_02170.las	83,142,382	29,160,288	2.851/0.265	0.592/1.942
CS_02175.las	8,219,779	2,625,984	3.130/0.291	0.565/1.854
CS_02176.las	87,213,113	28,201,136	3.093/0.287	0.569/1.867
CS_02178.las	162,399,100	52,124,928	3.116/0.289	0.567/1.860
CS_02180.las	745,800,536	230,416,640	3.237/0.301	0.556/1.824
CS_02186.las	85,312,582	29,778,864	2.865/0.266	0.591/1.939
CS_02187.las	90,630,673	29,843,424	3.037/0.282	0.574/1.883
CS_02188.las	86,434,047	30,345,696	2.848/0.265	0.593/1.946
CS_02189.las	91,643,519	29,150,656	3.144/0.292	0.564/1.850
CS_02193.las	95,113,925	29,719,152	3.200/0.297	0.559/1.834
CS_02197.las	87,163,967	30,120,992	2.894/0.269	0.588/1.929
CS_02214.las	556,848,854	194,491,840	2.863/0.266	0.591/1.939
CS_02215.las	560,230,770	195,191,904	2.870/0.267	0.590/1.936
CS_02240.las	91,785,535	28,919,200	3.174/0.295	0.561/1.841
CS_02245.las	16,272,711	5,159,488	3.154/0.293	0.563/1.847
CS_02247.las	113,060,415	32,155,504	3.516/0.327	0.533/1.749
CS_02251.las	719,443,350	229,385,200	3.136/0.291	0.565/1.854
CS_02257.las	92,242,653	30,254,032	3.049/0.283	0.573/1.880

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File	Number of First Returns	Area	Point Density	NPS
CS_02258.las	96,882,750	31,845,328	3.042/0.283	0.573/1.880
CS_02259.las	107,713,723	28,681,232	3.756/0.349	0.516/1.693
CS_02260.las	91,732,222	28,604,320	3.207/0.298	0.558/1.831
CS_02264.las	82,705,196	29,272,448	2.825/0.262	0.595/1.952
CS_02268.las	82,054,602	29,202,592	2.810/0.261	0.597/1.959
CS_02277.las	145,802,238	37,712,000	3.866/0.359	0.509/1.670
CS_02287.las	541,455,762	192,706,480	2.810/0.261	0.597/1.959
CS_02288.las	552,646,535	195,062,000	2.833/0.263	0.594/1.949
CS_02310.las	83,371,877	29,077,584	2.867/0.266	0.591/1.939
CS_02313.las	23,573,190	7,588,560	3.106/0.289	0.567/1.860
CS_02315.las	120,061,417	39,055,392	3.074/0.286	0.570/1.870
CS_02318.las	712,243,049	224,826,128	3.168/0.294	0.562/1.844
CS_02324.las	86,306,386	29,553,328	2.920/0.271	0.585/1.919
CS_02325.las	90,552,454	29,507,536	3.069/0.285	0.571/1.873
CS_02327.las	88,571,866	29,264,672	3.027/0.281	0.575/1.886
CS_02331.las	94,045,987	29,699,840	3.167/0.294	0.562/1.844
CS_02334.las	630,617,123	207,135,440	3.044/0.283	0.573/1.880
CS_02344.las	136,684,601	47,971,600	2.849/0.265	0.592/1.942
CS_02346.las	372,406,548	129,027,136	2.886/0.268	0.589/1.932
CS_02353.las	103,721,570	35,589,536	2.914/0.271	0.586/1.923
CS_02354.las	551,645,760	195,973,552	2.815/0.262	0.596/1.955
CS_02358.las	547,113,394	194,251,744	2.817/0.262	0.596/1.955
CS_02365.las	43,053,056	13,351,360	3.225/0.300	0.557/1.827
CS_02369.las	86	16	5.375/0.499	0.431/1.414
CS_02370.las	616,644,529	207,631,648	2.970/0.276	0.580/1.903
CS_02373.las	88,397,329	29,233,856	3.024/0.281	0.575/1.886
CS_02376.las	38,785,367	11,808,496	3.285/0.305	0.552/1.811
CS_02378.las	156,663,939	44,151,296	3.548/0.330	0.531/1.742
CS_02387.las	97,001,264	29,631,264	3.274/0.304	0.553/1.814
CS_02388.las	92,560,457	29,752,800	3.111/0.289	0.567/1.860
CS_02390.las	91,715,581	28,297,952	3.241/0.301	0.555/1.821
CS_02394.las	86,698,322	30,323,680	2.859/0.266	0.591/1.939
CS_02396.las	646,926,696	210,826,560	3.069/0.285	0.571/1.873

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File	Number of First Returns	Area	Point Density	NPS
CS_02404.las	208,427,120	58,632,208	3.555/0.330	0.530/1.739
CS_02407.las	426,913,155	128,965,056	3.310/0.308	0.550/1.804
CS_02417.las	541,373,315	193,619,568	2.796/0.260	0.598/1.962
CS_02425.las	230,038,441	76,909,088	2.991/0.278	0.578/1.896
CS_02431.las	569,168,651	206,200,656	2.760/0.256	0.602/1.975
CS_02436.las	48,886,764	16,079,296	3.040/0.282	0.574/1.883
CS_02438.las	146,870,277	49,720,736	2.954/0.274	0.582/1.909
CS_02446.las	85,810,605	29,002,352	2.959/0.275	0.581/1.906
CS_02447.las	89,006,706	29,579,312	3.009/0.280	0.576/1.890
CS_02450.las	30,210,026	10,440,912	2.893/0.269	0.588/1.929
CS_02454.las	612,568,256	210,416,752	2.911/0.270	0.586/1.923
CS_02463.las	192,968,606	67,474,352	2.860/0.266	0.591/1.939
CS_02465.las	58,946,429	22,250,448	2.649/0.246	0.614/2.014
CS_02466.las	375,947,615	131,662,704	2.855/0.265	0.592/1.942
CS_02474.las	551,553,697	195,932,896	2.815/0.262	0.596/1.955
CS_02475.las	536,469,512	193,300,544	2.775/0.258	0.600/1.969
CS_02483.las	314,549,565	103,833,584	3.029/0.281	0.575/1.886
CS_02488.las	612,225,951	207,098,880	2.956/0.275	0.582/1.909
CS_02491.las	84,324,125	29,636,288	2.845/0.264	0.593/1.946
CS_02494.las	59,301,979	18,241,136	3.251/0.302	0.555/1.821
CS_02496.las	178,204,729	52,556,912	3.391/0.315	0.543/1.781
CS_02505.las	98,326,877	28,989,440	3.392/0.315	0.543/1.781
CS_02506.las	92,931,613	29,547,200	3.145/0.292	0.564/1.850
CS_02511.las	406,508,960	136,524,320	2.978/0.277	0.580/1.903
CS_02512.las	640,809,882	211,252,064	3.033/0.282	0.574/1.883
CS_02513.las	605,085,847	211,899,232	2.856/0.265	0.592/1.942
CS_02517.las	592,509,311	210,053,920	2.821/0.262	0.595/1.952
CS_02520.las	231,221,102	75,831,024	3.049/0.283	0.573/1.880
CS_02522.las	476,684,246	149,556,224	3.187/0.296	0.560/1.837
CS_02523.las	379,619,081	131,268,544	2.892/0.269	0.588/1.929
CS_02530.las	541,744,203	195,793,136	2.767/0.257	0.601/1.972
CS_02531.las	392,047,538	147,538,320	2.657/0.247	0.613/2.011
CS_02539.las	312,732,391	104,937,392	2.980/0.277	0.579/1.900

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File	Number of First Returns	Area	Point Density	NPS
CS_02544.las	565,201,743	205,183,696	2.755/0.256	0.603/1.978
CS_02547.las	89,541,035	29,596,016	3.025/0.281	0.575/1.886
CS_02550.las	62,839,047	20,908,960	3.005/0.279	0.577/1.893
CS_02552.las	154,783,586	53,432,160	2.897/0.269	0.588/1.929
CS_02553.las	86,038,723	29,637,552	2.903/0.270	0.587/1.926
CS_02555.las	146,035,456	45,460,320	3.212/0.298	0.558/1.831
CS_02561.las	85,455,163	28,725,728	2.975/0.276	0.580/1.903
CS_02562.las	88,295,324	29,400,064	3.003/0.279	0.577/1.893
CS_02566.las	90,673,657	29,672,640	3.056/0.284	0.572/1.877
CS_02567.las	610,546,808	181,127,904	3.371/0.313	0.545/1.788
CS_02569.las	617,221,414	211,638,800	2.916/0.271	0.586/1.923
CS_02573.las	637,177,613	213,366,288	2.986/0.277	0.579/1.900
CS_02577.las	441,395,685	153,223,088	2.881/0.268	0.589/1.932
CS_02578.las	213,855,005	76,523,264	2.795/0.260	0.598/1.962
CS_02584.las	560,404,107	196,108,688	2.858/0.266	0.592/1.942
CS_02585.las	46,721,461	13,422,432	3.481/0.323	0.536/1.759
CS_02589.las	593,220,874	190,764,688	3.110/0.289	0.567/1.860
CS_02592.las	311,616,379	104,023,008	2.996/0.278	0.578/1.896
CS_02599.las	8,564,763	3,013,648	2.842/0.264	0.593/1.946
CS_02602.las	67,930,986	20,555,168	3.305/0.307	0.550/1.804
CS_02604.las	498,014,683	147,452,208	3.377/0.314	0.544/1.785
CS_02605.las	86,247,855	29,778,912	2.896/0.269	0.588/1.929
CS_02607.las	139,525,527	46,862,944	2.977/0.277	0.580/1.903
CS_02613.las	92,662,972	29,230,432	3.170/0.295	0.562/1.844
CS_02614.las	90,927,777	29,573,984	3.075/0.286	0.570/1.870
CS_02617.las	84,417,162	29,615,568	2.850/0.265	0.592/1.942
CS_02618.las	613,756,078	206,580,736	2.971/0.276	0.580/1.903
CS_02619.las	614,877,695	211,267,744	2.910/0.270	0.586/1.923
CS_02620.las	615,446,784	212,655,584	2.894/0.269	0.588/1.929
CS_02624.las	615,877,652	213,678,672	2.882/0.268	0.589/1.932
CS_02628.las	481,801,885	156,767,632	3.073/0.285	0.570/1.870
CS_02629.las	2,125,318	285,360	7.448/0.692	0.366/1.201
CS_02634.las	546,216,761	194,177,616	2.813/0.261	0.596/1.955

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File	Number of First Returns	Area	Point Density	NPS
CS_02638.las	574,548,248	190,154,240	3.021/0.281	0.575/1.886
CS_02641.las	306,149,289	105,424,592	2.904/0.270	0.587/1.926
CS_02647.las	555,564,815	205,595,040	2.702/0.251	0.608/1.995
CS_02651.las	59,058,287	20,204,304	2.923/0.272	0.585/1.919
CS_02652.las	95,875,093	30,087,488	3.187/0.296	0.560/1.837
CS_02655.las	142,361,894	46,039,632	3.092/0.287	0.569/1.867
CS_02661.las	87,280,965	28,463,776	3.066/0.285	0.571/1.873
CS_02662.las	88,816,169	28,877,248	3.076/0.286	0.570/1.870
CS_02666.las	696,921,153	209,668,288	3.324/0.309	0.548/1.798
CS_02667.las	623,451,378	211,704,112	2.945/0.274	0.583/1.913
CS_02668.las	605,926,290	212,599,088	2.850/0.265	0.592/1.942
CS_02672.las	634,671,853	212,765,216	2.983/0.277	0.579/1.900
CS_02676.las	459,089,400	162,239,344	2.830/0.263	0.594/1.949
CS_02681.las	547,515,832	195,391,936	2.802/0.260	0.597/1.959
CS_02685.las	583,786,708	191,099,680	3.055/0.284	0.572/1.877
CS_02688.las	315,567,222	104,559,072	3.018/0.280	0.576/1.890
CS_02693.las	51,010,963	17,724,208	2.878/0.267	0.589/1.932
CS_02695.las	565,156,234	206,816,704	2.733/0.254	0.605/1.985
CS_02699.las	70,193,398	21,600,000	3.250/0.302	0.555/1.821
CS_02700.las	83,738,088	29,726,384	2.817/0.262	0.596/1.955
CS_02710.las	94,393,014	29,096,336	3.244/0.301	0.555/1.821
CS_02713.las	611,887,588	207,631,504	2.947/0.274	0.583/1.913
CS_02714.las	638,415,693	211,684,320	3.016/0.280	0.576/1.890
CS_02715.las	605,451,356	211,948,256	2.857/0.265	0.592/1.942
CS_02718.las	604,984,453	213,052,208	2.840/0.264	0.593/1.946
CS_02722.las	481,902,242	163,218,656	2.952/0.274	0.582/1.909
CS_02727.las	532,656,256	194,393,760	2.740/0.255	0.604/1.982
CS_02731.las	589,118,733	190,790,208	3.088/0.287	0.569/1.867
CS_02739.las	94,328,844	31,921,280	2.955/0.275	0.582/1.909
CS_02740.las	561,740,665	205,802,064	2.730/0.254	0.605/1.985
CS_02743.las	68,242,966	22,796,800	2.994/0.278	0.578/1.896
CS_02744.las	96,171,852	29,969,392	3.209/0.298	0.558/1.831
CS_02748.las	129,002,306	43,337,104	2.977/0.277	0.580/1.903

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File	Number of First Returns	Area	Point Density	NPS
CS_02755.las	86,455,808	28,722,240	3.010/0.280	0.576/1.890
CS_02758.las	687,663,822	209,573,216	3.281/0.305	0.552/1.811
CS_02759.las	625,850,069	211,904,736	2.953/0.274	0.582/1.909
CS_02760.las	642,525,153	212,809,520	3.019/0.280	0.576/1.890
CS_02763.las	633,933,193	213,005,040	2.976/0.276	0.580/1.903
CS_02765.las	227,984,456	82,096,832	2.777/0.258	0.600/1.969
CS_02767.las	465,491,865	159,162,256	2.925/0.272	0.585/1.919
CS_02772.las	552,724,775	193,451,504	2.857/0.265	0.592/1.942
CS_02776.las	573,956,797	190,849,840	3.007/0.279	0.577/1.893
CS_02783.las	49,951,137	17,626,128	2.834/0.263	0.594/1.949
CS_02784.las	574,513,406	202,649,504	2.835/0.263	0.594/1.949
CS_02789.las	82,026,325	29,658,912	2.766/0.257	0.601/1.972
CS_02802.las	612,440,853	211,730,928	2.893/0.269	0.588/1.929
CS_02805.las	605,049,938	210,518,688	2.874/0.267	0.590/1.936
CS_02807.las	280,548,310	88,733,888	3.162/0.294	0.562/1.844
CS_02814.las	532,631,308	193,264,688	2.756/0.256	0.602/1.975
CS_02818.las	402,814,522	132,858,112	3.032/0.282	0.574/1.883
CS_02821.las	154,513,574	55,707,552	2.774/0.258	0.600/1.969
CS_02824.las	53,896,020	18,006,320	2.993/0.278	0.578/1.896
CS_02828.las	47,166,398	17,558,464	2.686/0.250	0.610/2.001
CS_02843.las	648,784,878	212,368,192	3.055/0.284	0.572/1.877
CS_02844.las	622,721,743	212,440,064	2.931/0.272	0.584/1.916
CS_02846.las	628,613,734	202,759,936	3.100/0.288	0.568/1.864
CS_02852.las	529,400,938	193,861,952	2.731/0.254	0.605/1.985
CS_02858.las	533,005,708	186,080,672	2.864/0.266	0.591/1.939
CS_02882.las	328,509,748	104,873,840	3.132/0.291	0.565/1.854
CS_02887.las	532,251,682	192,874,272	2.760/0.256	0.602/1.975
CS_02893.las	526,712,762	184,936,224	2.848/0.265	0.593/1.946
CS_02895.las	532,753,895	195,034,832	2.732/0.254	0.605/1.985
CS_02898.las	39,280,852	17,181,248	2.286/0.212	0.661/2.169
CS_02925.las	29,683,010	10,662,736	2.784/0.259	0.599/1.965
CS_02937.las	313,665,212	110,557,168	2.837/0.264	0.594/1.949
CS_02938.las	500,904,841	169,980,496	2.947/0.274	0.583/1.913

C-4.1 Report on Nominal Pulse Spacing (NPS) - continued

File	Number of First Returns	Area	Point Density	NPS
CS_02957.las	389,342,763	123,770,192	3.146/0.292	0.564/1.850
CS_02983.las	3,695,772	1,015,280	3.640/0.338	0.524/1.719
CS_03027.las	66,993,780	24,194,576	2.769/0.257	0.601/1.972
CS_03041.las	274,338,343	97,528,640	2.813/0.261	0.596/1.955
CS_03042.las	523,822,827	187,677,904	2.791/0.259	0.599/1.965
Average			3.013/0.280	0.576/1.890
			pp Square Meter/ pp Square US Survey Foot	Meter/ US Survey Feet
Lot_9	62,620,158,386	15,691,430,107	3.991/0.371	0.501/1.644
Aggregate	62,620,158,386	15,691,430,107	3.991/0.371	0.501/1.644
			pp Square Meter/ pp Square US Survey Foot	Meter/ US Survey Feet

* - indicates a swath whose NPS and Point Density were brought up to specifications due to the inclusion of one or more re-flight swaths.