

C-2 Report on Multiple Discrete Returns

The USGS Lidar Base Specification Version 2.1 states: "Deriving and delivering multiple discrete returns are required in all conventional lidar data collection efforts. Data collection shall be capable of at least three returns per pulse. Full waveform collection is acceptable and is promoted; however, full waveform data are regarded as supplemental information."

The purpose of this section is to report on the presence and quantities of lidar returns in the LAS data. Empty return columns can indicate a collection or processing problem dealing with lidar return attribute information.

[Data Source - Y:\Mapping\Projects\6522048201_ISGS_Wabash_and_Embaras\Production\Final_Client_Deliverables\Swath](#)

| File | First return | Second return | Third return | Other returns | Total points |
|-----------|--------------|---------------|--------------|---------------|--------------|
| 00108.las | 138,913,272 | 1,374,274 | 368,391 | 58,272 | 140,714,209 |
| 00110.las | 410,714,610 | 86,502,148 | 39,592,230 | 11,517,228 | 548,326,216 |
| 00111.las | 97,786,902 | 4,621,190 | 1,094,816 | 136,253 | 103,639,161 |
| 00112.las | 505,453,200 | 19,118,538 | 5,470,521 | 890,774 | 530,933,033 |
| 00113.las | 51,461,316 | 1,021,017 | 284,113 | 54,455 | 52,820,901 |
| 00114.las | 635,377,500 | 22,388,150 | 5,866,230 | 855,183 | 664,487,063 |
| 00115.las | 829,922,652 | 26,050,856 | 7,444,387 | 1,219,571 | 864,637,466 |
| 00116.las | 648,120,528 | 20,340,875 | 6,269,116 | 1,135,807 | 675,866,326 |
| 00117.las | 862,683,308 | 33,696,506 | 10,916,752 | 2,033,384 | 909,329,950 |
| 00118.las | 668,822,695 | 26,154,095 | 8,383,434 | 1,534,444 | 704,894,668 |
| 00119.las | 788,669,947 | 33,911,759 | 10,721,497 | 1,964,604 | 835,267,807 |
| 00120.las | 675,347,690 | 32,025,282 | 9,905,741 | 1,787,229 | 719,065,942 |
| 00121.las | 789,794,715 | 59,898,306 | 19,094,046 | 3,689,578 | 872,476,645 |
| 00122.las | 652,246,764 | 66,118,518 | 21,650,447 | 4,383,343 | 744,399,072 |
| 00123.las | 793,296,448 | 70,256,914 | 22,235,280 | 4,342,712 | 890,131,354 |
| 00125.las | 652,647,365 | 43,330,304 | 14,021,418 | 2,745,346 | 712,744,433 |
| 00126.las | 785,847,262 | 39,710,287 | 13,273,898 | 2,662,466 | 841,493,913 |
| 00127.las | 661,248,523 | 38,638,756 | 12,838,793 | 2,526,778 | 715,252,850 |
| 00128.las | 781,612,782 | 50,105,088 | 16,209,666 | 3,057,120 | 850,984,656 |
| 00129.las | 713,345,434 | 38,970,489 | 10,278,579 | 1,520,388 | 764,114,890 |
| 00130.las | 59,911,725 | 4,937,202 | 1,369,035 | 203,943 | 66,421,905 |
| 00132.las | 738,142,140 | 51,214,587 | 14,929,970 | 2,513,979 | 806,800,676 |
| 00133.las | 726,085,127 | 45,354,208 | 13,048,261 | 2,196,103 | 786,683,699 |
| 00134.las | 739,111,139 | 44,111,400 | 12,967,856 | 2,231,746 | 798,422,141 |
| 00135.las | 735,185,317 | 43,113,269 | 12,114,717 | 1,925,108 | 792,338,411 |

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| <u>File</u> | <u>First return</u> | <u>Second return</u> | <u>Third return</u> | <u>Other returns</u> | <u>Total points</u> |
|-------------|---------------------|----------------------|---------------------|----------------------|---------------------|
| 00136.las | 677,841,185 | 43,088,088 | 14,078,368 | 2,804,988 | 737,812,629 |
| 00137.las | 691,545,386 | 59,519,913 | 20,854,978 | 4,573,902 | 776,494,179 |
| 00138.las | 683,069,380 | 54,909,429 | 19,803,628 | 4,705,720 | 762,488,157 |
| 00139.las | 705,230,263 | 67,574,117 | 24,445,449 | 5,519,740 | 802,769,569 |
| 00140.las | 680,933,426 | 84,394,066 | 26,366,886 | 5,234,621 | 796,928,999 |
| 00141.las | 696,653,449 | 96,064,425 | 30,271,846 | 5,839,681 | 828,829,401 |
| 00142.las | 670,653,065 | 85,756,232 | 26,703,759 | 5,030,202 | 788,143,258 |
| 00143.las | 683,099,266 | 91,301,305 | 28,913,623 | 5,548,067 | 808,862,261 |
| 00144.las | 369,912,610 | 9,261,494 | 3,386,226 | 720,094 | 383,280,424 |
| 00146.las | 643,879,875 | 56,812,219 | 15,142,429 | 2,260,082 | 718,094,605 |
| 00147.las | 378,388,578 | 77,199,812 | 21,644,480 | 3,587,826 | 480,820,696 |
| 00148.las | 785,017,941 | 88,335,975 | 28,605,680 | 5,660,608 | 907,620,204 |
| 00149.las | 637,988,136 | 75,883,310 | 26,220,365 | 5,518,459 | 745,610,270 |
| 00150.las | 794,246,624 | 97,672,458 | 32,789,812 | 6,691,558 | 931,400,452 |
| 00151.las | 649,780,973 | 79,150,090 | 25,627,000 | 5,008,593 | 759,566,656 |
| 00152.las | 779,082,280 | 92,944,886 | 30,098,073 | 5,817,736 | 907,942,975 |
| 00153.las | 638,577,536 | 73,253,479 | 23,365,902 | 4,424,710 | 739,621,627 |
| 00154.las | 751,753,461 | 64,041,073 | 19,354,218 | 3,389,345 | 838,538,097 |
| 00155.las | 648,795,662 | 44,414,266 | 13,211,152 | 2,221,459 | 708,642,539 |
| 00156.las | 716,221,269 | 38,043,154 | 11,723,221 | 2,074,193 | 768,061,837 |
| 00158.las | 647,701,395 | 30,460,451 | 9,047,591 | 1,454,604 | 688,664,041 |
| 00159.las | 790,518,568 | 27,132,409 | 8,367,585 | 1,439,240 | 827,457,802 |
| 00160.las | 666,584,685 | 26,293,776 | 8,258,816 | 1,467,109 | 702,604,386 |
| 00161.las | 801,226,726 | 46,360,372 | 14,349,125 | 2,515,473 | 864,451,696 |
| 00162.las | 674,296,923 | 40,618,553 | 12,954,873 | 2,398,892 | 730,269,241 |
| 00163.las | 813,634,745 | 57,390,241 | 19,374,936 | 3,831,754 | 894,231,676 |
| 00165.las | 660,790,932 | 56,013,490 | 15,638,385 | 2,355,582 | 734,798,389 |
| 00166.las | 690,962,409 | 71,211,436 | 21,217,733 | 3,519,101 | 786,910,679 |
| 00167.las | 656,354,005 | 59,793,319 | 19,192,274 | 3,534,847 | 738,874,445 |
| 00168.las | 685,583,071 | 63,169,895 | 21,571,246 | 4,453,339 | 774,777,551 |
| 00169.las | 663,384,266 | 61,634,038 | 21,267,432 | 4,303,768 | 750,589,504 |
| 00170.las | 670,343,839 | 55,743,447 | 18,782,908 | 3,677,765 | 748,547,959 |
| 00171.las | 667,499,798 | 42,593,308 | 15,068,430 | 3,173,107 | 728,334,643 |
| 00172.las | 652,146,442 | 31,712,734 | 11,020,991 | 2,281,748 | 697,161,915 |

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| File | First return | Second return | Third return | Other returns | Total points |
|-----------|----------------|---------------|---------------|---------------|----------------|
| 00173.las | 32,438,885 | 2,747,723 | 986,637 | 224,985 | 36,398,230 |
| 00174.las | 306,057,593 | 61,222,111 | 27,886,464 | 8,843,172 | 404,009,340 |
| 00175.las | 583,543,181 | 117,861,698 | 55,729,410 | 18,407,661 | 775,541,950 |
| 00176.las | 519,009,996 | 93,966,638 | 43,757,301 | 13,845,940 | 670,579,875 |
| 00177.las | 631,355,067 | 107,882,706 | 50,824,614 | 16,272,600 | 806,334,987 |
| 00178.las | 579,658,965 | 126,295,024 | 59,937,556 | 19,400,123 | 785,291,668 |
| 00179.las | 708,752,777 | 149,819,855 | 69,221,782 | 21,496,808 | 949,291,222 |
| 00180.las | 648,075,042 | 107,147,151 | 48,454,751 | 14,688,168 | 818,365,112 |
| 00181.las | 757,207,351 | 143,695,789 | 66,161,923 | 20,845,789 | 987,910,852 |
| 00182.las | 698,594,129 | 115,534,911 | 52,284,303 | 15,863,641 | 882,276,984 |
| 00183.las | 765,736,024 | 117,408,827 | 54,132,842 | 16,870,551 | 954,148,244 |
| 00184.las | 735,381,135 | 126,912,445 | 60,047,001 | 19,326,614 | 941,667,195 |
| 00185.las | 725,568,027 | 129,588,004 | 56,528,037 | 15,520,444 | 927,204,512 |
| 00187.las | 815,087,854 | 126,011,773 | 54,676,654 | 14,949,645 | 1,010,725,926 |
| 00188.las | 701,236,383 | 90,966,243 | 39,289,109 | 10,873,581 | 842,365,316 |
| 00189.las | 790,505,417 | 101,071,973 | 44,556,582 | 12,665,178 | 948,799,150 |
| 00190.las | 676,538,169 | 107,434,210 | 47,589,684 | 13,599,176 | 845,161,239 |
| 00191.las | 780,361,198 | 141,521,407 | 65,553,809 | 19,619,216 | 1,007,055,630 |
| 00192.las | 669,731,943 | 126,999,483 | 59,702,078 | 18,184,078 | 874,617,582 |
| 00193.las | 768,415,966 | 132,948,235 | 62,006,384 | 18,724,804 | 982,095,389 |
| 00194.las | 669,074,582 | 99,750,921 | 44,967,800 | 12,716,013 | 826,509,316 |
| 00195.las | 742,949,884 | 122,405,307 | 58,049,133 | 17,778,828 | 941,183,152 |
| 00196.las | 315,508,135 | 5,638,884 | 2,470,997 | 716,954 | 324,334,970 |
| 00197.las | 693,741,291 | 90,187,299 | 42,528,096 | 13,115,112 | 839,571,798 |
| 00198.las | 660,591,613 | 78,909,073 | 37,496,641 | 11,808,434 | 788,805,761 |
| 00199.las | 687,897,678 | 68,078,362 | 32,713,800 | 10,316,041 | 799,005,881 |
| 00200.las | 649,217,923 | 64,069,661 | 31,452,927 | 10,263,158 | 755,003,669 |
| 00201.las | 710,355,396 | 53,086,434 | 24,785,125 | 7,319,572 | 795,546,527 |
| 00202.las | 644,563,140 | 36,852,432 | 17,043,496 | 5,076,440 | 703,535,508 |
| Total | 56,832,601,274 | 5,798,725,857 | 2,259,903,550 | 583,556,453 | 65,474,787,134 |