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# LA DOTD NE Louisiana Lidar

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## Executive Summary

The primary purpose of this project was to develop a consistent and accurate surface elevation dataset derived from high-accuracy Light Detection and Ranging (lidar) technology for the Louisiana Department of Transportation and Development (LA DOTD) NE Louisiana Lidar Project.

## PROJECT AREA

The lidar data were processed and classified according to project specifications. Detailed breaklines and bare-earth Digital Elevation Models (DEMs) were produced for the project area. Data was formatted according to tiles with each tile covering an area of 1500m by 1500m. A total of 7523 tiles were produced for the project encompassing an area of approximately 6198 sq. miles.

## THE PROJECT TEAM

LA DOTD acquired and initially post-processed all lidar data. LA DOTD along with assistance from Dewberry completed LAS classification, all lidar products, breakline production, Digital Elevation Model (DEM) production, and quality assurance.

LA DOTD completed ground surveying in-house for the project and delivered surveyed checkpoints. Their task was to acquire surveyed checkpoints for the project to use in independent testing of the vertical accuracy of the lidar-derived surface model. We also verified the GPS base station coordinates used during lidar data acquisition to ensure that the base station coordinates were accurate. Please see Appendix A and Appendix B to view the separate Survey Report that was created for this portion of the project.

## SURVEY AREA

The project area addressed by this report falls within the Louisiana parishes of Caldwell, East Carroll, Franklin, La Salle, Madison, Morehouse, Ouachita, Richland, Tensas, Union, and West Carroll.

## DATE OF SURVEY

The lidar aerial acquisition was conducted from 11/27/2017 - 09/12/2019.

## COORDINATE REFERENCE SYSTEM

Data produced for the project were delivered in the following reference system.

**Horizontal Datum:** The horizontal datum for the project is North American Datum of 1983 with the 2011 Adjustment (NAD 83 (2011))
**Vertical Datum:** The Vertical datum for the project is North American Vertical Datum of 1988 (NAVD88)
**Coordinate System:** UTM Zone 15
**Units:** Horizontal units are in meters, Vertical units are in meters.
**Geiod Model:** Geoid12B (Geoid 12B was used to convert ellipsoid heights to orthometric heights).

## LIDAR VERTICAL ACCURACY

For the LA DOTD Amite Watershed Lidar Project, the tested $RMSE_z$ of the classified lidar data for checkpoints in non-vegetated terrain equaled **4.5 cm** compared with the 10 cm specification; and the NVA of the classified lidar data computed using $RMSE_z$ x 1.9600 was equal to **8.7 cm**, compared with the 19.6 cm specification.

For the NE Louisiana Lidar, the tested VVA of the classified lidar data computed using the 95$^{th}$ percentile was equal to **20.1 cm,** compared with the 29.4 cm specification.

Additional accuracy information and statistics for the classified lidar data, raw swath data, and bare earth DEM data are found in the following sections of this report.

## PROJECT DELIVERABLES

The deliverables for the project are listed below.

1. Classified Point Cloud Data (Tiled)
2. Bare Earth Surface (Raster DEM – IMG Format)
3. Intensity Images (8-bit gray scale, tiled, GeoTIFF format)
4. Breakline Data (File GDB)
5. Independent Survey Checkpoint Data (Report, Photos, & Points)
6. Calibration Points
7. Metadata
8. Project Report (Acquisition, Processing, QC)
9. Project Extents, Including a shapefile derived from the lidar deliverable

## PROJECT TILING FOOTPRINT

Seven thousand five-hundred fifty-five (7,523) tiles were delivered for the project. Each tile's extent is 1,500 meters by 1,500 meters (see Appendix C for a complete listing of delivered tiles).

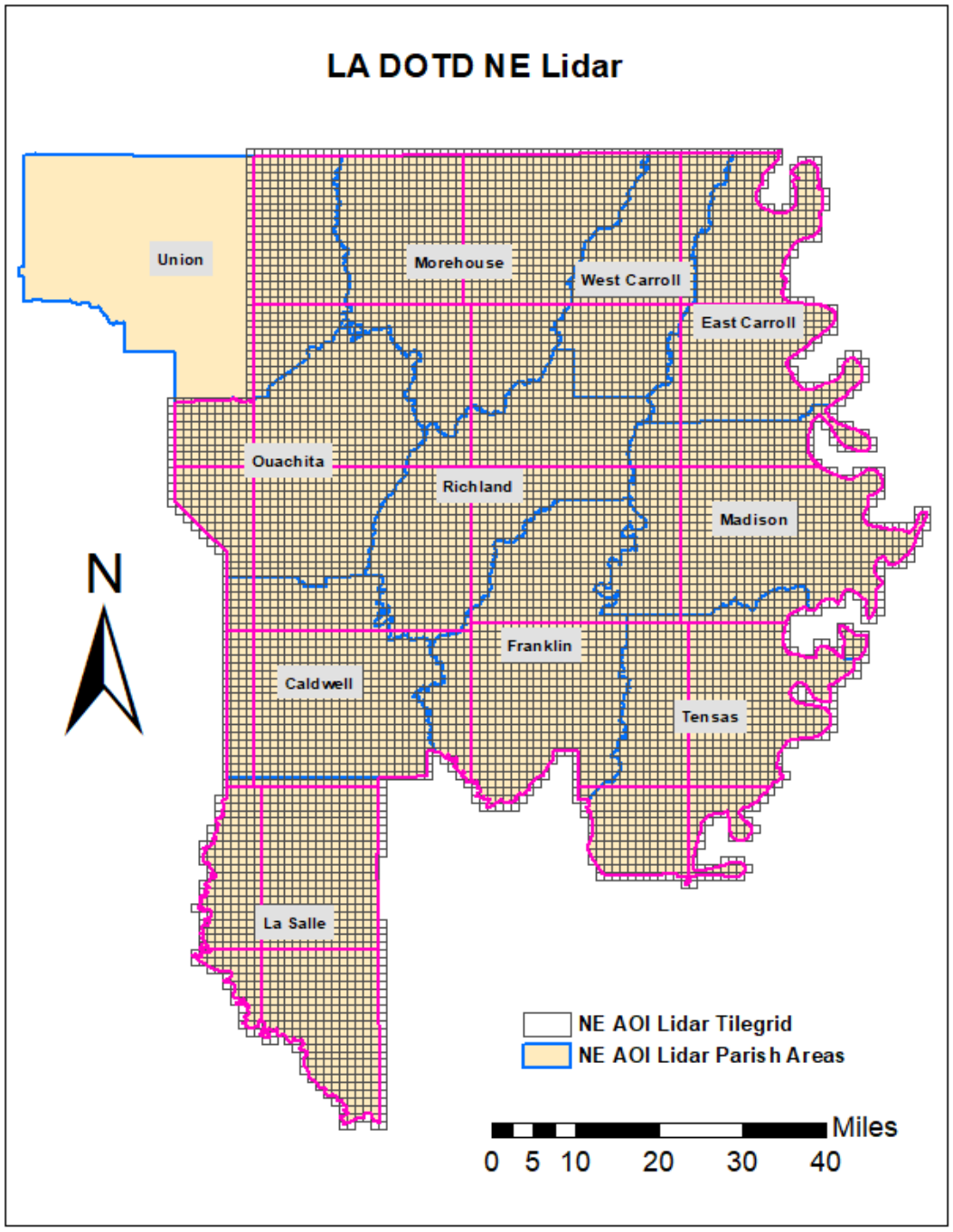


Figure 1 - Project Map

# Lidar Acquisition Report

LA DOTD completed all lidar acquisition and calibration activities.

Dewberry received calibrated swath data from LA DOTD to compete all lidar derived products.

## LIDAR ACQUISITION DETAILS

LA DOTD completed 1262 flight lines for the project area as a series of parallel flight lines with cross flightlines for the purposes of quality control. In order to reduce any margin for error in the flight plan, LA DOTD followed FEMA's Appendix A "guidelines" for flight planning and, at a minimum, includes the following criteria:

- A digital flight line layout using LEICA MISSION PRO flight design software for direct integration into the aircraft flight navigation system.
- Planned flight lines; flight line numbers; and coverage area.
- Lidar coverage extended by a predetermined margin beyond all project borders to ensure necessary over-edge coverage appropriate for specific task order deliverables.
- Local restrictions related to air space and any controlled areas have been investigated so that required permissions can be obtained in a timely manner with respect to schedule. Additionally, LA DOTD will file our flight plans as required by local Air Traffic Control (ATC) prior to each mission.

LA DOTD monitored weather and atmospheric conditions and conducted lidar missions only when no conditions exist below the sensor that will affect the collection of data. These conditions include leaf-off for hardwoods to the extent possible, no snow, rain, fog, smoke, mist and low clouds. Lidar systems are active sensors, not requiring light, thus missions may be conducted during night hours when weather restrictions do not prevent collection. LA DOTD accesses reliable weather sites and indicators (webcams) to establish the highest probability for successful collection in order to position our sensor to maximize successful data acquisition.

LA DOTD closely monitored the weather, checking all sources for forecasts multiple times daily. As soon as weather conditions were conducive to acquisition, the aircraft mobilized to the project site to begin data collection. Once on site, the acquisition team took responsibility for weather analysis.

LA DOTD lidar sensor calibrated at a designated site located at the Baton Rouge Airport in Baton Rouge, Louisiana and are checked and adjusted every time the sensor is re-installed in the aircraft.

## LIDAR SYSTEM PARAMETERS

LA DOTD operated a Beechcraft King Air (Tail # N904HB) outfitted with a LEICA ALS80 LiDAR system. Table 1 illustrates LA DOTD system parameters for lidar acquisition for standard acquisition utilized on every block of this project AOI.

| Item | Parameter |
|---|---|
| System | Leica ALS-80 HP |

| Item | Parameter |
|---|---|
| Altitude (AGL meters) | 1200 |
| Approx. Flight Speed (knots) | 160 |
| Scanner Pulse Rate (kHz) | 669 |
| Scan Frequency (hz) | 59.7 |
| Pulse Duration of the Scanner (nanoseconds) | 9 |
| Pulse Width of the Scanner (m) | 0.32 |
| Swath width (m) | 613.4 |
| Central Wavelength of the Sensor Laser (nanometers) | 1064 |
| Did the Sensor Operate with Multiple Pulses in The Air? (yes/no) | yes |
| Beam Divergence (milliradians) | 0.22 |
| Nominal Swath Width on the Ground (m) | 1252.54 |
| Swath Overlap (%) | 30 |
| Total Sensor Scan Angle (degree) | 28 |
| Computed Down Track spacing (m) per beam | 0.69 |
| Computed Cross Track Spacing (m) per beam | 0.32 |
| Nominal Pulse Spacing (single swath), (m) | 0.27 |
| Nominal Pulse Density (single swath) (ppsm), (m) | 13.26 |
| Aggregate NPS (m) (if ANPS was designed to be met through single coverage, ANPS and NPS will be equal) | 0.33 |
| Aggregate NPD (m) (if ANPD was designed to be met through single coverage, ANPD and NPD will be equal) | 9.18 |
| Maximum Number of Returns per Pulse | 7 |

**Table 1: LA DOTD lidar system parameters for standard flight plan**

Table 2 illustrates system parameters that were used on 4 blocks to densify the data where there was very dense agricultural vegetation growing at the time of the initial acquisition. It was determined that minimal temporal differences would be expected, and additional data could be acquired at a lower density on the select blocks. When combined with the initial acquisition data, this would meet the required density specification. This method was used in blocks 16NW, 16NE, 29SW, and 29NW.

| Item | Parameter |
|---|---|
| System | Leica ALS-80 HP |
| Altitude (AGL meters) | 1383 |
| Approx. Flight Speed (knots) | 160 |
| Scanner Pulse Rate (kHz) | 535 |
| Scan Frequency (hz) | 52 |
| Pulse Duration of the Scanner (nanoseconds) | 9 |
| Pulse Width of the Scanner (m) | 0.36 |
| Swath width (m) | 1093.82 |
| Central Wavelength of the Sensor Laser (nanometers) | 1064 |
| Did the Sensor Operate with Multiple Pulses in The Air? (yes/no) | yes |
| Beam Divergence (milliradians) | 0.22 |

| Item | Parameter |
|---|---|
| Nominal Swath Width on the Ground (m) | 1252.54 |
| Swath Overlap (%) | 25 |
| Total Sensor Scan Angle (degree) | 40 |
| Computed Down Track spacing (m) per beam | 0.63 |
| Computed Cross Track Spacing (m) per beam | 0.79 |
| Nominal Pulse Spacing (single swath), (m) | 0.41 |
| Nominal Pulse Density (single swath) (ppsm), (m) | 5.94 |
| Aggregate NPS (m) (if ANPS was designed to be met through single coverage, ANPS and NPS will be equal) | 0.33 |
| Aggregate NPD (m) (if ANPD was designed to be met through single coverage, ANPD and NPD will be equal) | 9.18 |
| Maximum Number of Returns per Pulse | 7 |

**Table 2: LA DOTD lidar system parameters for densification flight plan used only on blocks 16NW, 16NE, 29SW, and 29NW.**

## ACQUISITION PREPARATION AND FLIGHTLINES REVIEW PROCEDURES

Prior to any mission, the flight crew loaded the flight plans and validated the flight parameters. The pilot in command contacted air traffic control and coordinated flight pattern requirements. Lidar acquisition began immediately upon notification that control base stations were in place. During flight operations, the flight crew monitored weather and atmospheric conditions. Lidar missions were flown only when no condition existed below the sensor that would affect the collection of data. The pilot constantly monitored the aircraft course, position, pitch, roll, and yaw of the aircraft. The sensor operator monitored the sensor, the status of PDOPs, and performed the first Q/C review during acquisition. The flight crew constantly reviewed weather and cloud locations. Any flight lines impacted by unfavorable conditions were marked as invalid and re-flown immediately or at an optimal time.

## LIDAR CONTROL

The coordinates of all used base stations are provided in the table below. All control and calibration points are also provided in shapefile format as part of the final deliverables.

| Name | NAD83(2011) UTM 15 | | Orthometric Ht (NAVD88 Geoid12B, m) |
|---|---|---|---|
| | Easting X (m) | Northing Y (m) | |
| 11_NE_BASE | 548121.367 | 3483559.434 | 59.089 |
| 12_NE_BASE | 548164.85 | 3545654.435 | 74.871 |
| 12_SE_BASE | 547635.269 | 3515688.96 | 33.275 |
| 13_NE_BASE | 552125.28 | 3607775.52 | 75.021 |
| 13_SE_BASE | 550970.531 | 3574942.397 | 52.089 |
| 15_SE_BASE | 631319.026 | 3639548.927 | 28.134 |
| 15_SW_BASE | 590528.113 | 3638863.661 | 21.204 |
| 16_NE_BASE | 632786.358 | 3609831.042 | 26.689 |

| | | | |
|---|---|---|---|
| 16_NW_BASE | 589207.2 | 3607796.948 | 22.733 |
| 16_SE_BASE | 632276.169 | 3577480.681 | 27.509 |
| 16_SW_BASE | 585964.314 | 3577341.199 | 22.256 |
| 17_NE_BASE | 629921.499 | 3546158.212 | 22.438 |
| 17_NW_BASE | 595080.162 | 3545712.235 | 19.101 |
| 17_SE_BASE | 634159.693 | 3514465.303 | 19.9 |
| 17_SW_BASE | 592575.803 | 3516344.129 | 39.869 |
| 18_NW_BASE | 585712.26 | 3482273.079 | 18.252 |
| 27_NW_BASE | 666479.984 | 3550453.353 | 21.158 |
| 27_SW_BASE | 654626.396 | 3521117.826 | 22.772 |
| 28_NW_BASE | 670496.784 | 3608312.136 | 27.356 |
| 28_SW_BASE | 675971.435 | 3582663.006 | 27.121 |
| 29_SW_BASE | 665915.31 | 3642451.091 | 32.598 |

**Table 3 – Base stations used to control lidar acquisition**

## AIRBORN GPS KINEMATIC

Airborne GPS data was processed using the Inertial Explorer software suite. Flights were flown with a minimum of 13 satellites in view (12° above the horizon) and with a PDOP of better than 3. Distances from base station to aircraft were kept to a maximum of 70 km.

For all flights, the GPS data can be classified as excellent, with GPS residuals of no larger than 10 cm being recorded.

GPS processing reports and GPS figures for each mission are included in Appendix A, while flightlogs are available in Appendix B.

## GENERATION AND CALIBRATION OF LASER POINTS (RAW DATA)

The initial step of calibration is to verify availability and status of all needed GPS and Laser data against field notes and compile any data if not complete.

Subsequently the mission points are output using Leica Cloud Pro, initially with default values from Leica or the last mission calibrated for the system. TerraMatch software was utilized for LiDAR calibration, assessment of calibration validity, and assessment of point cloud alignment to control. If a calibration error greater than specification is observed within the mission, the roll, pitch and scanner scale corrections that need to be applied are calculated. The missions with the new calibration values are regenerated and validated internally once again to ensure quality.

Data collected by the lidar unit is reviewed for completeness, acceptable density and to make sure all data is captured without errors or corrupted values. In addition, all GPS, aircraft trajectory, mission information, and ground control files are reviewed and logged into a database.

On a project level, a supplementary coverage check is carried out to ensure no data voids unreported by Field Operations are present.

## RELATIVE ACCURACY

The initial points for each mission calibration are inspected for flight line errors, flight line overlap, slivers or gaps in the data, point data minimums, or issues with the lidar unit or GPS. Roll, pitch and scanner scale are optimized during the calibration process until the relative accuracy is met.

Relative accuracy and internal quality are checked using at least 3 regularly spaced QC blocks in which points from all lines are loaded and inspected. Vertical differences between ground surfaces of each line are displayed. Color scale is adjusted so that errors greater than the specifications are flagged. Cross sections are visually inspected across each block to validate point to point, flight line to flight line and mission to mission agreement.

For this project the specifications used are as follow:
Relative accuracy <= 6 cm maximum difference within individual swaths and <=8 cm RMSDz between adjacent and overlapping swaths.

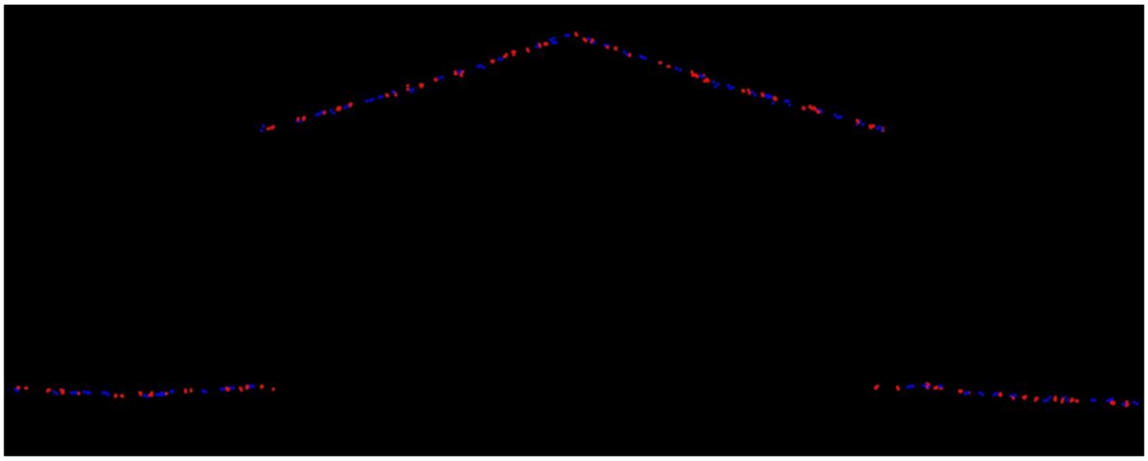

**Figure 2 – Profile views showing correct roll and pitch adjustments.**

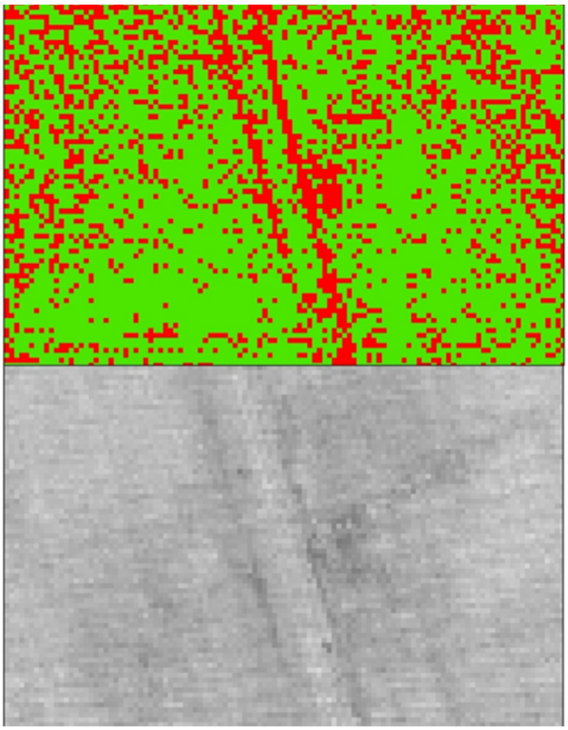

**Figure 3- Relative accuracy of swath data over road and pasture. Top view illustrates green points representing elevation offsets between adjacent points that are within 6 cm. Red points represent elevation offsets greater than 6 cm. Bottom view shows lidar intensity image of the road.**

A different set of QC blocks are generated for final review after all transformations have been applied.

## PRELIMINARY VERTICAL ACCURACY ASSESSMENT

A preliminary $RMSE_z$ error check is performed at this stage of the project life cycle in the raw lidar dataset against GPS static and kinematic data and compared to $RMSE_z$ project specifications. The lidar data is examined in non-vegetated, flat areas away from breaks. Lidar ground points for each flight line generated by an automatic classification routine are used.

Prior to classification, Dewberry assisted LA DOTD to review the elevation data to ensure it met Non-vegetated Vertical Accuracy (NVA) requirements ($RMSE_z \leq 10$ cm and $Accuracy_z$ at the 95% confidence level ≤ 19.6 cm) when compared to static and kinematic GPS checkpoints. Below is a summary for the test:

The calibrated LA DOTD NE Lidar Project dataset was tested to .089 m vertical accuracy at 95% confidence level based on $RMSE_z$ (0.0367 m x 1.9600) when compared to 70 GPS static check points.

The following are the final statistics for the GPS checkpoints used by LA DOTD to internally verify vertical accuracy.

| Point ID | NAD83(2011) UTM Zone 15N | | NAVD88 (Geoid 12B) | | DeltaZ |
|---|---|---|---|---|---|
| | Easting X (m) | Northing Y (m) | Z-Survey (m) | Z-LiDAR (m) | |
| 11_NE_NVA-36 | 566045.779 | 3494887.969 | 20.475 | 20.490 | 0.015 |
| 11_NE_NVA-37 | 568863.385 | 3491485.945 | 16.233 | 16.190 | -0.043 |
| 11_NE_NVA-38 | 570883.471 | 3486802.584 | 19.939 | 19.970 | 0.031 |
| 11_NE_NVA-5 | 570564.349 | 3498812.515 | 26.099 | 26.080 | -0.019 |
| 12_NE_NVA-10 | 569265.036 | 3552408.625 | 60.302 | 60.350 | 0.048 |
| 12_NE_NVA-15 | 569829.051 | 3542069.451 | 48.722 | 48.730 | 0.008 |
| 12_NE_NVA-20 | 568486.734 | 3535032.471 | 26.653 | 26.670 | 0.017 |
| 12_NE_NVA-25 | 568080.741 | 3544358.009 | 49.436 | 49.450 | 0.014 |
| 12_NE_NVA-26 | 570308.982 | 3559909.435 | 48.467 | 48.470 | 0.003 |
| 12_NE_NVA-33 | 570268.681 | 3540226.252 | 28.096 | 28.020 | -0.076 |
| 12_NE_NVA-34 | 567739.834 | 3530327.122 | 25.215 | 25.210 | -0.005 |
| 12_SE_NVA-10 | 568214.370 | 3516140.040 | 46.473 | 46.490 | 0.017 |
| 12_SE_NVA-15 | 569493.826 | 3509214.866 | 53.532 | 53.570 | 0.038 |
| 12_SE_NVA-20 | 571081.981 | 3499802.149 | 50.457 | 50.420 | -0.037 |
| 12_SE_NVA-22 | 569498.762 | 3527855.643 | 40.613 | 40.660 | 0.047 |
| 12_SE_NVA-25 | 564945.458 | 3519052.329 | 33.302 | 33.300 | -0.002 |
| 12_SE_NVA-27 | 565905.065 | 3522128.057 | 40.018 | 40.000 | -0.018 |
| 12_SE_NVA-30 | 562848.999 | 3512505.068 | 21.438 | 21.410 | -0.028 |
| 12_SE_NVA-31 | 565691.646 | 3510832.575 | 44.473 | 44.490 | 0.017 |
| 12_SE_NVA-5 | 567963.133 | 3524393.098 | 27.786 | 27.790 | 0.004 |
| 12_SE_NVA-9 | 560290.011 | 3517523.067 | 23.740 | 23.790 | 0.050 |
| 13_NE_NVA-19 | 556916.625 | 3604572.379 | 34.044 | 34.010 | -0.034 |

| | | | | | |
|---|---|---|---|---|---|
| 13_NE_NVA-26 | 557542.016 | 3600941.380 | 30.514 | 30.500 | -0.014 |
| 13_NE_NVA-27 | 565595.108 | 3598998.742 | 49.715 | 49.730 | 0.015 |
| 13_NE_NVA-28 | 570056.193 | 3601231.970 | 49.129 | 49.110 | -0.019 |
| 13_NE_NVA-34 | 560970.169 | 3593270.720 | 64.720 | 64.700 | -0.020 |
| 13_NE_NVA-35 | 568590.571 | 3596919.847 | 36.822 | 36.880 | 0.058 |
| 13_NE_NVA-36 | 565766.196 | 3604441.620 | 27.202 | 27.180 | -0.022 |
| 13_NE_NVA-37 | 556856.018 | 3595222.590 | 81.275 | 81.280 | 0.005 |
| 13_NE_NVA-38 | 566196.069 | 3593414.437 | 70.562 | 70.550 | -0.012 |
| 13_SE_NVA-10 | 568183.257 | 3580848.669 | 74.831 | 74.790 | -0.041 |
| 13_SE_NVA-3 | 562480.341 | 3586457.495 | 33.699 | 33.700 | 0.001 |
| 13_SE_NVA-38 | 566437.324 | 3591880.521 | 50.254 | 50.260 | 0.006 |
| 13_SE_NVA-39 | 561256.928 | 3591677.412 | 46.714 | 46.700 | -0.014 |
| 13_SE_NVA-4 | 566236.522 | 3589144.301 | 34.492 | 34.500 | 0.008 |
| 13_SE_NVA-40 | 557973.588 | 3586463.362 | 76.011 | 76.000 | -0.011 |
| 13_SE_NVA-5 | 570268.955 | 3589166.837 | 33.731 | 33.750 | 0.019 |
| 13_SE_NVA-6 | 566767.668 | 3585807.480 | 52.807 | 52.790 | -0.017 |
| 13_SE_NVA-8 | 570035.762 | 3569227.627 | 64.928 | 64.900 | -0.028 |
| 13_SE_NVA-9 | 570500.805 | 3576271.975 | 58.382 | 58.390 | 0.008 |
| 15_SE_NVA-1 | 613747.450 | 3650490.258 | 39.814 | 39.850 | 0.036 |
| 15_SE_NVA-10 | 628390.997 | 3637881.086 | 28.119 | 28.110 | -0.009 |
| 15_SE_NVA-11 | 637643.904 | 3649322.904 | 30.348 | 30.350 | 0.002 |
| 15_SE_NVA-12 | 651784.756 | 3650605.737 | 32.583 | 32.620 | 0.037 |
| 15_SE_NVA-13 | 644811.556 | 3638311.554 | 30.515 | 30.560 | 0.045 |
| 15_SE_NVA-14 | 638703.136 | 3629291.522 | 29.594 | 29.520 | -0.074 |
| 15_SE_NVA-15 | 648586.274 | 3629490.380 | 38.859 | 38.750 | -0.109 |
| 15_SE_NVA-16 | 643393.356 | 3641377.893 | 30.203 | 30.270 | 0.067 |
| 15_SE_NVA-17 | 640160.938 | 3639897.232 | 28.968 | 29.030 | 0.062 |
| 15_SE_NVA-18 | 634623.579 | 3631432.151 | 29.733 | 29.710 | -0.023 |
| 15_SE_NVA-19 | 620219.892 | 3626431.852 | 29.587 | 29.520 | -0.067 |
| 15_SE_NVA-2 | 611804.116 | 3644086.655 | 31.483 | 31.460 | -0.023 |
| 15_SE_NVA-20 | 611620.493 | 3627460.407 | 27.907 | 27.840 | -0.067 |
| 15_SE_NVA-21 | 612560.029 | 3639077.271 | 47.033 | 47.000 | -0.033 |
| 15_SE_NVA-22 | 621940.657 | 3646030.184 | 32.173 | 32.230 | 0.057 |
| 15_SE_NVA-23 | 641058.926 | 3635608.593 | 29.868 | 29.910 | 0.042 |
| 15_SE_NVA-24 | 627271.865 | 3632956.631 | 27.912 | 27.990 | 0.078 |
| 15_SE_NVA-25 | 620070.605 | 3639572.984 | 31.674 | 31.700 | 0.026 |
| 15_SE_NVA-26 | 616767.884 | 3649506.999 | 46.453 | 46.470 | 0.017 |
| 15_SE_NVA-27 | 649024.643 | 3643731.238 | 31.806 | 31.900 | 0.094 |
| 15_SE_NVA-28 | 650918.105 | 3627474.149 | 33.521 | 33.440 | -0.081 |
| 15_SE_NVA-29 | 634723.763 | 3624995.909 | 28.250 | 28.230 | -0.020 |
| 15_SE_NVA-3 | 618981.426 | 3643981.131 | 32.295 | 32.290 | -0.005 |

| | | | | | |
|---|---|---|---|---|---|
| 15_SE_NVA-30 | 633641.298 | 3643211.594 | 28.767 | 28.730 | -0.037 |
| 15_SE_NVA-31 | 626868.579 | 3641013.192 | 28.833 | 28.970 | 0.137 |
| 15_SE_NVA-32 | 625264.360 | 3629731.525 | 28.414 | 28.410 | -0.004 |
| 15_SE_NVA-33 | 613387.388 | 3647640.308 | 38.212 | 38.190 | -0.022 |
| 15_SE_NVA-4 | 611840.015 | 3625429.569 | 26.463 | 26.440 | -0.023 |
| 15_SE_NVA-5 | 622093.220 | 3633107.126 | 30.696 | 30.710 | 0.014 |
| 15_SE_NVA-6 | 616615.492 | 3636428.406 | 30.114 | 30.170 | 0.056 |
| 15_SE_NVA-7 | 625362.111 | 3651020.820 | 33.004 | 33.000 | -0.004 |
| 15_SE_NVA-8 | 628385.221 | 3644338.240 | 28.894 | 28.920 | 0.026 |
| 15_SE_NVA-9 | 637307.175 | 3646901.929 | 30.794 | 30.790 | -0.004 |
| 15_SW_NVA-1 | 572709.964 | 3652551.403 | 35.259 | 35.270 | 0.011 |
| 15_SW_NVA-10 | 575802.182 | 3646941.949 | 37.531 | 37.530 | -0.001 |
| 15_SW_NVA-11 | 571085.157 | 3644939.316 | 54.773 | 54.770 | -0.003 |
| 15_SW_NVA-12 | 591794.710 | 3644050.196 | 20.746 | 20.780 | 0.034 |
| 15_SW_NVA-13 | 603619.422 | 3643365.782 | 37.078 | 37.020 | -0.058 |
| 15_SW_NVA-14 | 606366.912 | 3641365.301 | 38.675 | 38.670 | -0.005 |
| 15_SW_NVA-15 | 602001.336 | 3637712.460 | 29.126 | 29.130 | 0.004 |
| 15_SW_NVA-16 | 579324.318 | 3641132.138 | 35.750 | 35.720 | -0.030 |
| 15_SW_NVA-17 | 579757.937 | 3638323.397 | 41.026 | 41.080 | 0.054 |
| 15_SW_NVA-18 | 570856.397 | 3641671.351 | 57.371 | 57.370 | -0.001 |
| 15_SW_NVA-19 | 571150.840 | 3640495.438 | 59.349 | 59.390 | 0.041 |
| 15_SW_NVA-2 | 575036.956 | 3650780.140 | 30.427 | 30.440 | 0.013 |
| 15_SW_NVA-20 | 605062.344 | 3633395.391 | 38.726 | 38.730 | 0.004 |
| 15_SW_NVA-21 | 599901.396 | 3632415.951 | 28.703 | 28.690 | -0.013 |
| 15_SW_NVA-22 | 598432.068 | 3629616.305 | 28.389 | 28.390 | 0.001 |
| 15_SW_NVA-23 | 601297.982 | 3628501.134 | 35.280 | 35.250 | -0.030 |
| 15_SW_NVA-24 | 580953.197 | 3625510.292 | 40.830 | 40.830 | 0.000 |
| 15_SW_NVA-25 | 580400.976 | 3630650.150 | 40.024 | 40.060 | 0.036 |
| 15_SW_NVA-26 | 577111.374 | 3631861.576 | 54.638 | 54.640 | 0.002 |
| 15_SW_NVA-27 | 584770.696 | 3635414.375 | 23.699 | 23.760 | 0.061 |
| 15_SW_NVA-28 | 570597.385 | 3635910.978 | 59.485 | 59.530 | 0.045 |
| 15_SW_NVA-29 | 571214.139 | 3629122.054 | 56.195 | 56.270 | 0.075 |
| 15_SW_NVA-3 | 580448.407 | 3652049.813 | 24.254 | 24.270 | 0.016 |
| 15_SW_NVA-30 | 572525.358 | 3626620.985 | 22.130 | 22.140 | 0.010 |
| 15_SW_NVA-31 | 597301.937 | 3624809.529 | 28.211 | 28.200 | -0.011 |
| 15_SW_NVA-32 | 606886.254 | 3625591.867 | 51.122 | 51.080 | -0.042 |
| 15_SW_NVA-33 | 594538.551 | 3636020.796 | 24.259 | 24.270 | 0.011 |
| 15_SW_NVA-4 | 594515.680 | 3651365.262 | 27.619 | 27.650 | 0.031 |
| 15_SW_NVA-5 | 597815.078 | 3652559.121 | 33.879 | 33.990 | 0.111 |
| 15_SW_NVA-6 | 600624.546 | 3648532.802 | 38.961 | 39.020 | 0.059 |
| 15_SW_NVA-7 | 609851.631 | 3650494.088 | 38.743 | 38.760 | 0.017 |
| 15_SW_NVA-8 | 607196.519 | 3645662.220 | 42.888 | 42.920 | 0.032 |
| 15_SW_NVA-9 | 596654.951 | 3645541.109 | 33.156 | 33.150 | -0.006 |
| 16_NE_NVA-1 | 611640.566 | 3623635.927 | 25.447 | 25.460 | 0.013 |

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|---|---|---|---|---|---|
| 16_NE_NVA-10 | 638793.415 | 3616972.310 | 29.182 | 29.220 | 0.038 |
| 16_NE_NVA-11 | 649466.239 | 3612451.268 | 28.427 | 28.500 | 0.073 |
| 16_NE_NVA-12 | 614477.962 | 3609652.754 | 26.933 | 27.060 | 0.127 |
| 16_NE_NVA-13 | 623918.771 | 3607112.228 | 26.915 | 26.910 | -0.005 |
| 16_NE_NVA-14 | 637971.492 | 3610217.881 | 28.027 | 28.020 | -0.007 |
| 16_NE_NVA-15 | 642056.178 | 3605968.087 | 28.524 | 28.560 | 0.036 |
| 16_NE_NVA-16 | 651749.213 | 3609303.153 | 26.655 | 26.700 | 0.045 |
| 16_NE_NVA-17 | 644265.246 | 3613354.873 | 30.891 | 30.900 | 0.009 |
| 16_NE_NVA-18 | 623198.099 | 3616796.423 | 29.096 | 29.150 | 0.054 |
| 16_NE_NVA-19 | 644850.599 | 3616593.179 | 31.538 | 31.620 | 0.082 |
| 16_NE_NVA-2 | 613981.792 | 3619239.294 | 26.555 | 26.590 | 0.035 |
| 16_NE_NVA-20 | 628766.393 | 3609654.949 | 27.695 | 27.700 | 0.005 |
| 16_NE_NVA-21 | 616476.774 | 3602250.693 | 25.308 | 25.330 | 0.022 |
| 16_NE_NVA-22 | 624953.122 | 3603946.522 | 26.716 | 26.750 | 0.034 |
| 16_NE_NVA-23 | 633109.348 | 3603223.544 | 25.935 | 26.000 | 0.065 |
| 16_NE_NVA-24 | 641109.332 | 3601281.242 | 27.922 | 27.920 | -0.002 |
| 16_NE_NVA-25 | 652635.957 | 3604639.482 | 26.980 | 26.920 | -0.060 |
| 16_NE_NVA-26 | 612130.828 | 3594444.479 | 25.364 | 25.330 | -0.034 |
| 16_NE_NVA-27 | 622458.432 | 3598254.189 | 25.987 | 26.060 | 0.073 |
| 16_NE_NVA-28 | 628934.014 | 3597570.647 | 26.274 | 26.270 | -0.004 |
| 16_NE_NVA-29 | 640513.647 | 3596887.149 | 26.267 | 26.320 | 0.053 |
| 16_NE_NVA-3 | 621785.383 | 3621326.584 | 29.660 | 29.720 | 0.060 |
| 16_NE_NVA-30 | 647688.082 | 3595546.507 | 25.689 | 25.670 | -0.019 |
| 16_NE_NVA-31 | 651738.005 | 3597380.064 | 25.822 | 25.830 | 0.008 |
| 16_NE_NVA-32 | 646917.175 | 3601229.739 | 25.843 | 25.890 | 0.047 |
| 16_NE_NVA-33 | 616674.370 | 3598369.701 | 25.727 | 25.760 | 0.033 |
| 16_NE_NVA-34 | 635112.673 | 3597705.621 | 26.347 | 26.340 | -0.007 |
| 16_NE_NVA-35 | 628871.071 | 3602411.728 | 26.973 | 27.000 | 0.027 |
| 16_NE_NVA-36 | 635160.478 | 3593766.211 | 26.863 | 26.930 | 0.067 |
| 16_NE_NVA-4 | 634709.908 | 3621747.507 | 28.548 | 28.540 | -0.008 |
| 16_NE_NVA-5 | 646878.516 | 3623488.203 | 32.606 | 32.630 | 0.024 |
| 16_NE_NVA-6 | 651229.096 | 3619125.035 | 25.492 | 25.510 | 0.018 |
| 16_NE_NVA-7 | 615387.177 | 3616439.841 | 26.022 | 26.060 | 0.038 |
| 16_NE_NVA-8 | 617528.965 | 3613092.605 | 28.173 | 28.210 | 0.037 |
| 16_NE_NVA-9 | 628709.493 | 3615244.510 | 26.946 | 27.050 | 0.104 |
| 16_NW_NVA-1 | 572996.597 | 3620636.628 | 52.587 | 52.570 | -0.017 |
| 16_NW_NVA-10 | 585668.165 | 3614710.291 | 24.728 | 24.740 | 0.012 |
| 16_NW_NVA-11 | 591549.501 | 3616119.087 | 25.942 | 25.960 | 0.018 |
| 16_NW_NVA-12 | 599855.081 | 3613548.283 | 30.723 | 30.740 | 0.017 |
| 16_NW_NVA-14 | 610890.135 | 3617448.499 | 22.984 | 22.950 | -0.034 |
| 16_NW_NVA-15 | 573747.369 | 3610800.355 | 18.871 | 18.940 | 0.069 |
| 16_NW_NVA-16 | 579314.510 | 3607058.857 | 24.474 | 24.440 | -0.034 |
| 16_NW_NVA-17 | 585986.383 | 3606615.799 | 23.089 | 23.150 | 0.061 |
| 16_NW_NVA-18 | 592032.877 | 3608842.777 | 28.744 | 28.760 | 0.016 |

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|---|---|---|---|---|---|
| 16_NW_NVA-19 | 597018.892 | 3607112.817 | 25.558 | 25.600 | 0.042 |
| 16_NW_NVA-2 | 577642.982 | 3620320.959 | 25.486 | 25.500 | 0.014 |
| 16_NW_NVA-20 | 603716.917 | 3610346.967 | 22.870 | 22.860 | -0.010 |
| 16_NW_NVA-21 | 610200.769 | 3605577.076 | 22.942 | 23.010 | 0.068 |
| 16_NW_NVA-22 | 572759.785 | 3600963.823 | 50.657 | 50.700 | 0.043 |
| 16_NW_NVA-23 | 575880.045 | 3601794.661 | 39.859 | 39.910 | 0.051 |
| 16_NW_NVA-24 | 583066.784 | 3601536.977 | 24.112 | 24.100 | -0.012 |
| 16_NW_NVA-25 | 590715.404 | 3599490.275 | 25.109 | 25.130 | 0.021 |
| 16_NW_NVA-26 | 595112.659 | 3603950.347 | 28.827 | 28.830 | 0.003 |
| 16_NW_NVA-27 | 606174.063 | 3605528.260 | 19.821 | 19.820 | -0.001 |
| 16_NW_NVA-28 | 611312.227 | 3598986.489 | 24.098 | 24.100 | 0.002 |
| 16_NW_NVA-29 | 571497.787 | 3595560.929 | 24.247 | 24.280 | 0.033 |
| 16_NW_NVA-3 | 584876.481 | 3621743.293 | 30.090 | 30.130 | 0.040 |
| 16_NW_NVA-30 | 576160.972 | 3597382.420 | 42.859 | 42.880 | 0.021 |
| 16_NW_NVA-31 | 583686.261 | 3594191.874 | 22.712 | 22.720 | 0.008 |
| 16_NW_NVA-32 | 589296.421 | 3597918.706 | 23.123 | 23.130 | 0.007 |
| 16_NW_NVA-33 | 594459.237 | 3595106.653 | 21.042 | 21.040 | -0.002 |
| 16_NW_NVA-35 | 610278.050 | 3594354.764 | 23.827 | 23.800 | -0.027 |
| 16_NW_NVA-4 | 590105.081 | 3620806.596 | 28.170 | 28.140 | -0.030 |
| 16_NW_NVA-5 | 596137.146 | 3623900.770 | 27.514 | 27.590 | 0.076 |
| 16_NW_NVA-6 | 600733.436 | 3620047.804 | 43.722 | 43.720 | -0.002 |
| 16_NW_NVA-7 | 608684.907 | 3621674.643 | 25.876 | 25.820 | -0.056 |
| 16_NW_NVA-8 | 571148.731 | 3613659.736 | 18.080 | 18.060 | -0.020 |
| 16_NW_NVA-9 | 577304.996 | 3614691.018 | 30.854 | 30.850 | -0.004 |
| 16_SE_NVA-1 | 611987.482 | 3592894.033 | 24.967 | 24.990 | 0.023 |
| 16_SE_NVA-10 | 648277.711 | 3589070.383 | 24.412 | 24.410 | -0.002 |
| 16_SE_NVA-11 | 640942.397 | 3573820.427 | 23.897 | 23.860 | -0.037 |
| 16_SE_NVA-12 | 633878.699 | 3578198.054 | 27.236 | 27.290 | 0.054 |
| 16_SE_NVA-13 | 647771.670 | 3570470.281 | 22.940 | 22.950 | 0.010 |
| 16_SE_NVA-14 | 639478.310 | 3579999.635 | 27.305 | 27.310 | 0.005 |
| 16_SE_NVA-15 | 644013.213 | 3576789.097 | 24.294 | 24.290 | -0.004 |
| 16_SE_NVA-16 | 649104.833 | 3584079.468 | 23.339 | 23.340 | 0.001 |
| 16_SE_NVA-17 | 643698.336 | 3562273.212 | 18.601 | 18.540 | -0.061 |
| 16_SE_NVA-18 | 640272.123 | 3565602.750 | 22.233 | 22.250 | 0.017 |
| 16_SE_NVA-19 | 639203.227 | 3569395.119 | 22.988 | 23.020 | 0.032 |
| 16_SE_NVA-2 | 614818.821 | 3592964.249 | 24.161 | 24.200 | 0.039 |
| 16_SE_NVA-20 | 634695.908 | 3562285.300 | 22.513 | 22.560 | 0.047 |
| 16_SE_NVA-21 | 633031.095 | 3568145.072 | 27.219 | 27.210 | -0.009 |
| 16_SE_NVA-22 | 629850.995 | 3573841.581 | 25.755 | 25.700 | -0.055 |
| 16_SE_NVA-23 | 619851.865 | 3562710.293 | 22.232 | 22.250 | 0.018 |
| 16_SE_NVA-24 | 612154.385 | 3562924.029 | 20.642 | 20.700 | 0.058 |
| 16_SE_NVA-25 | 618005.553 | 3569801.275 | 22.026 | 22.080 | 0.054 |
| 16_SE_NVA-26 | 623894.201 | 3568573.387 | 23.101 | 23.140 | 0.039 |
| 16_SE_NVA-27 | 612778.642 | 3575851.293 | 20.196 | 20.220 | 0.024 |

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|---|---|---|---|---|---|
| 16_SE_NVA-28 | 615740.212 | 3585353.392 | 22.227 | 22.200 | -0.027 |
| 16_SE_NVA-29 | 632362.844 | 3590335.717 | 27.466 | 27.420 | -0.046 |
| 16_SE_NVA-3 | 616293.298 | 3591525.114 | 23.707 | 23.720 | 0.013 |
| 16_SE_NVA-30 | 624272.682 | 3580758.576 | 24.101 | 24.100 | -0.001 |
| 16_SE_NVA-31 | 641673.244 | 3592434.465 | 28.681 | 28.660 | -0.021 |
| 16_SE_NVA-32 | 623293.224 | 3576287.721 | 24.522 | 24.590 | 0.068 |
| 16_SE_NVA-33 | 628382.125 | 3564455.718 | 24.370 | 24.380 | 0.010 |
| 16_SE_NVA-34 | 616257.624 | 3562981.652 | 19.319 | 19.340 | 0.021 |
| 16_SE_NVA-35 | 623000.425 | 3587767.629 | 24.296 | 24.330 | 0.034 |
| 16_SE_NVA-36 | 630328.952 | 3568436.184 | 25.750 | 25.760 | 0.010 |
| 16_SE_NVA-37 | 637631.904 | 3584700.906 | 27.442 | 27.470 | 0.028 |
| 16_SE_NVA-4 | 633530.469 | 3592715.434 | 27.704 | 27.690 | -0.014 |
| 16_SE_NVA-5 | 649386.847 | 3593243.210 | 25.457 | 25.400 | -0.057 |
| 16_SE_NVA-6 | 641814.970 | 3586408.558 | 27.180 | 27.190 | 0.010 |
| 16_SE_NVA-7 | 629244.646 | 3586008.279 | 25.856 | 25.910 | 0.054 |
| 16_SE_NVA-8 | 619726.896 | 3589340.815 | 23.866 | 23.760 | -0.106 |
| 16_SE_NVA-9 | 636220.442 | 3579918.411 | 34.537 | 34.590 | 0.053 |
| 16_SW_NVA-1 | 575865.849 | 3590928.664 | 22.663 | 22.650 | -0.013 |
| 16_SW_NVA-10 | 583610.457 | 3585246.159 | 22.147 | 22.170 | 0.023 |
| 16_SW_NVA-11 | 588857.437 | 3583777.135 | 20.050 | 20.070 | 0.020 |
| 16_SW_NVA-12 | 597281.677 | 3584024.791 | 20.324 | 20.370 | 0.046 |
| 16_SW_NVA-13 | 603538.706 | 3583011.781 | 23.038 | 23.000 | -0.038 |
| 16_SW_NVA-14 | 609851.359 | 3585373.779 | 23.736 | 23.670 | -0.066 |
| 16_SW_NVA-15 | 573205.731 | 3576689.491 | 61.510 | 61.540 | 0.030 |
| 16_SW_NVA-16 | 576426.698 | 3579740.951 | 37.085 | 37.070 | -0.015 |
| 16_SW_NVA-17 | 584175.285 | 3579691.283 | 22.494 | 22.460 | -0.034 |
| 16_SW_NVA-18 | 585855.124 | 3573632.994 | 21.321 | 21.380 | 0.059 |
| 16_SW_NVA-19 | 599221.972 | 3574660.563 | 21.351 | 21.460 | 0.109 |
| 16_SW_NVA-2 | 576162.352 | 3586839.549 | 29.289 | 29.290 | 0.001 |
| 16_SW_NVA-20 | 606404.877 | 3576464.605 | 20.900 | 21.000 | 0.100 |
| 16_SW_NVA-21 | 610468.476 | 3576501.831 | 21.671 | 21.710 | 0.039 |
| 16_SW_NVA-22 | 570621.016 | 3574085.667 | 48.660 | 48.760 | 0.100 |
| 16_SW_NVA-23 | 575057.365 | 3572212.292 | 52.686 | 52.680 | -0.006 |
| 16_SW_NVA-24 | 585214.728 | 3569050.571 | 19.819 | 19.870 | 0.051 |
| 16_SW_NVA-25 | 594517.262 | 3573190.383 | 20.177 | 20.180 | 0.003 |
| 16_SW_NVA-26 | 595575.044 | 3568318.496 | 18.860 | 18.930 | 0.070 |
| 16_SW_NVA-27 | 607161.942 | 3569403.668 | 22.364 | 22.360 | -0.004 |
| 16_SW_NVA-28 | 611699.352 | 3572510.843 | 22.395 | 22.360 | -0.035 |
| 16_SW_NVA-29 | 571587.366 | 3565018.087 | 65.588 | 65.640 | 0.052 |
| 16_SW_NVA-3 | 584195.474 | 3590477.552 | 23.658 | 23.640 | -0.018 |
| 16_SW_NVA-30 | 576102.033 | 3566290.324 | 58.844 | 58.850 | 0.006 |
| 16_SW_NVA-31 | 583941.966 | 3565518.102 | 21.526 | 21.570 | 0.044 |
| 16_SW_NVA-32 | 591970.294 | 3562525.811 | 18.905 | 18.540 | -0.365 |
| 16_SW_NVA-33 | 595642.429 | 3567111.807 | 20.414 | 20.410 | -0.004 |

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| 16_SW_NVA-34 | 598829.788 | 3561909.750 | 17.525 | 17.530 | 0.005 |
| 16_SW_NVA-35 | 609708.418 | 3564590.028 | 22.070 | 21.960 | -0.110 |
| 16_SW_NVA-4 | 590742.819 | 3587736.166 | 19.457 | 19.420 | -0.037 |
| 16_SW_NVA-5 | 601854.072 | 3589403.768 | 19.759 | 19.700 | -0.059 |
| 16_SW_NVA-6 | 607087.043 | 3589417.931 | 23.858 | 23.800 | -0.058 |
| 16_SW_NVA-7 | 611581.400 | 3592968.875 | 24.828 | 24.800 | -0.028 |
| 16_SW_NVA-9 | 577593.344 | 3581637.652 | 27.334 | 27.350 | 0.016 |
| 17_NE_NVA-1 | 612275.690 | 3557652.238 | 21.840 | 21.840 | 0.000 |
| 17_NE_NVA-10 | 627663.700 | 3552439.053 | 24.098 | 24.170 | 0.072 |
| 17_NE_NVA-11 | 632955.033 | 3551561.578 | 21.924 | 21.970 | 0.046 |
| 17_NE_NVA-12 | 642343.774 | 3551388.625 | 21.145 | 21.200 | 0.055 |
| 17_NE_NVA-13 | 645801.201 | 3551197.510 | 21.279 | 21.260 | -0.019 |
| 17_NE_NVA-14 | 651264.643 | 3554716.227 | 22.144 | 22.110 | -0.034 |
| 17_NE_NVA-15 | 613472.492 | 3546398.531 | 21.093 | 21.160 | 0.067 |
| 17_NE_NVA-16 | 618822.611 | 3545010.308 | 19.575 | 19.570 | -0.005 |
| 17_NE_NVA-17 | 626596.736 | 3546959.382 | 22.397 | 22.450 | 0.053 |
| 17_NE_NVA-18 | 632742.234 | 3546051.288 | 18.958 | 18.920 | -0.038 |
| 17_NE_NVA-19 | 637070.491 | 3548811.599 | 19.696 | 19.710 | 0.014 |
| 17_NE_NVA-2 | 619957.623 | 3561845.434 | 22.516 | 22.520 | 0.004 |
| 17_NE_NVA-20 | 643871.257 | 3547855.632 | 18.749 | 18.780 | 0.031 |
| 17_NE_NVA-21 | 652589.442 | 3545393.104 | 21.843 | 21.860 | 0.017 |
| 17_NE_NVA-22 | 612498.801 | 3538875.349 | 19.837 | 19.810 | -0.027 |
| 17_NE_NVA-23 | 622969.808 | 3537117.404 | 21.137 | 21.180 | 0.043 |
| 17_NE_NVA-24 | 627133.402 | 3539767.251 | 22.494 | 22.560 | 0.066 |
| 17_NE_NVA-25 | 635100.622 | 3539233.312 | 20.870 | 20.870 | 0.000 |
| 17_NE_NVA-26 | 639286.413 | 3541218.077 | 17.314 | 17.410 | 0.096 |
| 17_NE_NVA-27 | 645159.022 | 3538767.080 | 20.225 | 20.250 | 0.025 |
| 17_NE_NVA-28 | 651796.748 | 3538224.655 | 21.439 | 21.380 | -0.059 |
| 17_NE_NVA-29 | 613430.211 | 3534952.218 | 19.199 | 19.300 | 0.101 |
| 17_NE_NVA-3 | 631338.975 | 3555963.321 | 28.461 | 28.510 | 0.049 |
| 17_NE_NVA-30 | 621292.421 | 3533056.621 | 19.585 | 19.580 | -0.005 |
| 17_NE_NVA-32 | 633624.533 | 3534720.515 | 18.054 | 18.140 | 0.086 |
| 17_NE_NVA-33 | 637694.998 | 3534179.228 | 19.764 | 19.740 | -0.024 |
| 17_NE_NVA-34 | 647826.281 | 3533322.322 | 21.065 | 21.110 | 0.045 |
| 17_NE_NVA-35 | 652038.563 | 3536215.336 | 21.328 | 21.270 | -0.058 |
| 17_NE_NVA-4 | 637939.090 | 3561380.786 | 22.436 | 22.390 | -0.046 |
| 17_NE_NVA-5 | 644250.605 | 3561738.426 | 20.326 | 20.390 | 0.064 |
| 17_NE_NVA-6 | 650447.969 | 3557568.862 | 22.840 | 22.850 | 0.010 |
| 17_NE_NVA-7 | 622081.805 | 3555719.714 | 21.808 | 21.900 | 0.092 |
| 17_NE_NVA-8 | 614258.724 | 3552877.941 | 20.862 | 20.900 | 0.038 |
| 17_NE_NVA-9 | 622148.590 | 3552003.095 | 22.538 | 22.600 | 0.062 |
| 17_NW_NVA-1 | 610751.315 | 3560815.822 | 19.866 | 19.880 | 0.014 |
| 17_NW_NVA-10 | 596549.181 | 3561179.594 | 20.447 | 20.440 | -0.007 |
| 17_NW_NVA-11 | 585451.550 | 3561228.764 | 20.890 | 20.940 | 0.050 |

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| 17_NW_NVA-12 | 575047.627 | 3560568.725 | 40.217 | 40.240 | 0.023 |
| 17_NW_NVA-13 | 578625.731 | 3560628.890 | 52.746 | 52.770 | 0.024 |
| 17_NW_NVA-14 | 576456.386 | 3557085.664 | 51.615 | 51.600 | -0.015 |
| 17_NW_NVA-15 | 585864.495 | 3550548.069 | 64.011 | 64.010 | -0.001 |
| 17_NW_NVA-16 | 590786.967 | 3555860.765 | 19.477 | 19.450 | -0.027 |
| 17_NW_NVA-17 | 597841.507 | 3558200.475 | 19.386 | 19.430 | 0.044 |
| 17_NW_NVA-18 | 590813.850 | 3550288.933 | 20.482 | 20.480 | -0.002 |
| 17_NW_NVA-19 | 586786.416 | 3557037.034 | 19.467 | 19.470 | 0.003 |
| 17_NW_NVA-2 | 612168.787 | 3539468.305 | 20.016 | 20.030 | 0.014 |
| 17_NW_NVA-20 | 578594.325 | 3553660.329 | 63.114 | 63.070 | -0.044 |
| 17_NW_NVA-21 | 577257.116 | 3555797.944 | 48.921 | 48.930 | 0.009 |
| 17_NW_NVA-22 | 578672.694 | 3548117.414 | 58.502 | 58.540 | 0.038 |
| 17_NW_NVA-23 | 579325.161 | 3538300.545 | 37.910 | 37.930 | 0.020 |
| 17_NW_NVA-24 | 586401.526 | 3542788.773 | 62.097 | 62.100 | 0.003 |
| 17_NW_NVA-25 | 584672.803 | 3545726.540 | 47.293 | 47.320 | 0.027 |
| 17_NW_NVA-26 | 572512.150 | 3555989.858 | 44.623 | 44.600 | -0.023 |
| 17_NW_NVA-27 | 573770.861 | 3561485.796 | 60.735 | 60.730 | -0.005 |
| 17_NW_NVA-28 | 572508.272 | 3539012.138 | 30.073 | 30.140 | 0.067 |
| 17_NW_NVA-29 | 571396.078 | 3531797.210 | 44.349 | 44.450 | 0.101 |
| 17_NW_NVA-3 | 611842.893 | 3543085.969 | 19.827 | 19.860 | 0.033 |
| 17_NW_NVA-30 | 573208.109 | 3549543.485 | 41.381 | 41.390 | 0.009 |
| 17_NW_NVA-31 | 574909.613 | 3531005.049 | 51.356 | 51.380 | 0.024 |
| 17_NW_NVA-32 | 584741.358 | 3534379.407 | 44.504 | 44.540 | 0.036 |
| 17_NW_NVA-33 | 588872.843 | 3537592.478 | 51.833 | 51.830 | -0.003 |
| 17_NW_NVA-36 | 600558.488 | 3533931.117 | 19.518 | 19.550 | 0.032 |
| 17_NW_NVA-37 | 598758.833 | 3537959.178 | 19.481 | 19.520 | 0.039 |
| 17_NW_NVA-38 | 596212.153 | 3559150.258 | 19.275 | 19.310 | 0.035 |
| 17_NW_NVA-39 | 605066.782 | 3545495.308 | 18.966 | 19.000 | 0.034 |
| 17_NW_NVA-4 | 611115.104 | 3546763.572 | 21.091 | 21.160 | 0.069 |
| 17_NW_NVA-40 | 580178.902 | 3543811.943 | 39.559 | 39.610 | 0.051 |
| 17_NW_NVA-41 | 584791.617 | 3530656.159 | 54.385 | 54.390 | 0.005 |
| 17_NW_NVA-5 | 606649.941 | 3548880.291 | 19.237 | 19.270 | 0.033 |
| 17_NW_NVA-6 | 598170.999 | 3549467.785 | 19.419 | 19.450 | 0.031 |
| 17_NW_NVA-7 | 608198.083 | 3554426.511 | 20.896 | 20.900 | 0.004 |
| 17_NW_NVA-8 | 596645.070 | 3543480.677 | 19.082 | 19.060 | -0.022 |
| 17_NW_NVA-9 | 609406.389 | 3558443.458 | 20.568 | 20.600 | 0.032 |
| 17_SE_NVA-12 | 643980.846 | 3522367.157 | 19.332 | 19.310 | -0.022 |
| 17_SE_NVA-13 | 649622.398 | 3520050.851 | 19.627 | 19.600 | -0.027 |
| 17_SE_NVA-14 | 653210.969 | 3522552.236 | 21.007 | 21.040 | 0.033 |
| 17_SE_NVA-19 | 639938.944 | 3515814.836 | 19.796 | 19.810 | 0.014 |
| 17_SE_NVA-21 | 651324.385 | 3519332.134 | 19.793 | 19.810 | 0.017 |
| 17_SE_NVA-36 | 635709.387 | 3530405.025 | 19.501 | 19.530 | 0.029 |
| 17_SE_NVA-37 | 647883.005 | 3526568.391 | 19.629 | 19.570 | -0.059 |
| 17_SE_NVA-38 | 635513.133 | 3521102.700 | 20.373 | 20.310 | -0.063 |

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|---|---|---|---|---|---|
| 17_SE_NVA-4 | 634636.183 | 3528588.482 | 22.427 | 22.380 | -0.047 |
| 17_SE_NVA-5 | 640101.972 | 3526354.897 | 18.881 | 18.860 | -0.021 |
| 17_SE_NVA-6 | 644452.103 | 3530521.882 | 18.651 | 18.580 | -0.071 |
| 17_SE_NVA-7 | 653649.957 | 3528900.033 | 21.058 | 21.030 | -0.028 |
| 17_SW_NVA-1 | 571640.040 | 3529882.533 | 46.818 | 46.810 | -0.008 |
| 17_SW_NVA-10 | 589669.476 | 3519997.068 | 59.936 | 59.890 | -0.046 |
| 17_SW_NVA-11 | 592987.862 | 3520437.855 | 53.838 | 53.870 | 0.032 |
| 17_SW_NVA-15 | 571591.332 | 3511888.617 | 42.531 | 42.550 | 0.019 |
| 17_SW_NVA-16 | 579379.068 | 3513392.129 | 42.980 | 42.930 | -0.050 |
| 17_SW_NVA-17 | 584428.215 | 3515913.037 | 53.075 | 53.100 | 0.025 |
| 17_SW_NVA-18 | 592695.515 | 3513881.609 | 36.796 | 36.720 | -0.076 |
| 17_SW_NVA-2 | 575653.380 | 3528217.701 | 36.792 | 36.800 | 0.008 |
| 17_SW_NVA-22 | 573113.637 | 3507991.032 | 31.064 | 31.130 | 0.066 |
| 17_SW_NVA-23 | 580344.980 | 3506600.419 | 61.564 | 61.520 | -0.044 |
| 17_SW_NVA-24 | 586635.726 | 3508967.256 | 66.682 | 66.700 | 0.018 |
| 17_SW_NVA-25 | 590650.034 | 3511768.489 | 64.820 | 64.810 | -0.010 |
| 17_SW_NVA-29 | 573586.026 | 3502109.386 | 55.209 | 55.210 | 0.001 |
| 17_SW_NVA-3 | 585608.908 | 3530381.442 | 51.896 | 51.940 | 0.044 |
| 17_SW_NVA-30 | 577927.583 | 3504165.054 | 64.289 | 64.290 | 0.001 |
| 17_SW_NVA-31 | 585511.871 | 3504138.012 | 63.145 | 63.180 | 0.035 |
| 17_SW_NVA-32 | 592259.474 | 3499505.641 | 22.089 | 22.100 | 0.011 |
| 17_SW_NVA-36 | 584893.745 | 3523518.402 | 69.470 | 69.490 | 0.020 |
| 17_SW_NVA-38 | 589322.352 | 3528571.168 | 72.565 | 72.580 | 0.015 |
| 17_SW_NVA-39 | 591750.109 | 3506281.585 | 60.927 | 60.860 | -0.067 |
| 17_SW_NVA-8 | 573944.712 | 3519503.357 | 46.652 | 46.650 | -0.002 |
| 17_SW_NVA-9 | 576742.395 | 3521227.802 | 50.115 | 50.110 | -0.005 |
| 18_NW_NVA-1 | 579101.418 | 3491880.217 | 56.758 | 56.750 | -0.008 |
| 18_NW_NVA-2 | 584076.614 | 3494501.382 | 25.939 | 25.900 | -0.039 |
| 18_NW_NVA-21 | 571673.029 | 3496146.535 | 49.189 | 49.160 | -0.029 |
| 18_NW_NVA-23 | 581097.088 | 3497150.024 | 48.229 | 48.230 | 0.001 |
| 18_NW_NVA-24 | 592321.349 | 3487941.519 | 18.102 | 18.110 | 0.008 |
| 18_NW_NVA-26 | 576420.895 | 3488260.197 | 35.791 | 35.800 | 0.009 |
| 18_NW_NVA-28 | 575406.222 | 3485848.910 | 27.063 | 27.060 | -0.003 |
| 18_NW_NVA-3 | 592366.020 | 3497347.359 | 19.622 | 19.500 | -0.122 |
| 18_NW_NVA-31 | 583873.636 | 3480311.501 | 18.349 | 18.350 | 0.001 |
| 18_NW_NVA-36 | 575875.643 | 3499094.022 | 65.613 | 65.480 | -0.133 |
| 18_NW_NVA-37 | 572253.129 | 3492597.695 | 23.292 | 23.290 | -0.002 |
| 18_NW_NVA-38 | 593113.236 | 3495587.065 | 18.510 | 18.520 | 0.010 |
| 18_NW_NVA-39 | 593836.084 | 3489198.751 | 17.906 | 18.050 | 0.144 |
| 18_NW_NVA-40 | 589536.575 | 3480008.820 | 18.486 | 18.530 | 0.044 |
| 18_NW_NVA-41 | 593922.086 | 3473847.081 | 13.931 | 13.770 | -0.161 |
| 18_NW_NVA-42 | 583488.186 | 3473520.841 | 13.899 | 13.850 | -0.049 |
| 18_NW_NVA-43 | 590077.757 | 3473330.928 | 13.324 | 13.200 | -0.124 |
| 18_NW_NVA-44 | 594198.391 | 3469215.294 | 13.924 | 13.920 | -0.004 |

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|---|---|---|---|---|---|
| 18_NW_NVA-6 | 573484.697 | 3488861.534 | 26.783 | 26.730 | -0.053 |
| 18_NW_NVA-7 | 587728.212 | 3484496.154 | 18.728 | 18.680 | -0.048 |
| 27_NW_NVA-1 | 653455.815 | 3559353.776 | 23.193 | 23.200 | 0.007 |
| 27_NW_NVA-10 | 659894.064 | 3548896.237 | 23.184 | 23.140 | -0.044 |
| 27_NW_NVA-11 | 668586.612 | 3546254.567 | 24.772 | 24.750 | -0.022 |
| 27_NW_NVA-12 | 675250.575 | 3544668.584 | 23.847 | 23.830 | -0.017 |
| 27_NW_NVA-13 | 656900.466 | 3539905.400 | 21.335 | 21.330 | -0.005 |
| 27_NW_NVA-14 | 664782.970 | 3543988.889 | 22.314 | 22.320 | 0.006 |
| 27_NW_NVA-15 | 665346.666 | 3538111.518 | 23.238 | 23.190 | -0.048 |
| 27_NW_NVA-16 | 671477.097 | 3540043.528 | 23.880 | 23.900 | 0.020 |
| 27_NW_NVA-17 | 669502.234 | 3555228.508 | 23.808 | 23.820 | 0.012 |
| 27_NW_NVA-18 | 654034.095 | 3534433.457 | 20.566 | 20.550 | -0.016 |
| 27_NW_NVA-19 | 662132.436 | 3534861.908 | 21.876 | 21.900 | 0.024 |
| 27_NW_NVA-2 | 660645.761 | 3561855.831 | 22.467 | 22.450 | -0.017 |
| 27_NW_NVA-20 | 668412.241 | 3534586.767 | 23.549 | 23.580 | 0.031 |
| 27_NW_NVA-3 | 666971.037 | 3559817.405 | 25.199 | 25.210 | 0.011 |
| 27_NW_NVA-4 | 671737.952 | 3558809.298 | 32.105 | 32.080 | -0.025 |
| 27_NW_NVA-5 | 655963.719 | 3552004.177 | 21.530 | 21.500 | -0.030 |
| 27_NW_NVA-6 | 660988.729 | 3555110.181 | 22.758 | 22.750 | -0.008 |
| 27_NW_NVA-7 | 666366.128 | 3550729.737 | 24.553 | 24.530 | -0.023 |
| 27_NW_NVA-9 | 653517.342 | 3544604.138 | 22.264 | 22.250 | -0.014 |
| 27_SW_NVA-1 | 659194.328 | 3530832.998 | 20.388 | 20.390 | 0.002 |
| 27_SW_NVA-2 | 661020.574 | 3530218.553 | 19.634 | 19.640 | 0.006 |
| 27_SW_NVA-3 | 665985.914 | 3530551.091 | 21.156 | 21.220 | 0.064 |
| 27_SW_NVA-4 | 655325.942 | 3528797.435 | 21.531 | 21.530 | -0.001 |
| 27_SW_NVA-5 | 656871.982 | 3528972.744 | 19.834 | 19.820 | -0.014 |
| 27_SW_NVA-6 | 655268.172 | 3526597.084 | 20.841 | 20.820 | -0.021 |
| 27_SW_NVA-7 | 654222.129 | 3524549.547 | 20.640 | 20.600 | -0.040 |
| 27_SW_NVA-8 | 653770.763 | 3522013.326 | 21.662 | 21.610 | -0.052 |
| 28_NW_NVA-1 | 652410.553 | 3622417.422 | 25.952 | 25.920 | -0.032 |
| 28_NW_NVA-10 | 663832.245 | 3616918.075 | 27.101 | 27.060 | -0.041 |
| 28_NW_NVA-11 | 670419.269 | 3617113.216 | 30.706 | 30.690 | -0.016 |
| 28_NW_NVA-12 | 674224.819 | 3619562.675 | 30.512 | 30.500 | -0.012 |
| 28_NW_NVA-13 | 654219.011 | 3612908.079 | 27.066 | 27.060 | -0.006 |
| 28_NW_NVA-14 | 656610.157 | 3609416.870 | 27.200 | 27.220 | 0.020 |
| 28_NW_NVA-15 | 665632.314 | 3609733.847 | 26.072 | 26.100 | 0.028 |
| 28_NW_NVA-16 | 670533.560 | 3613817.546 | 29.348 | 29.340 | -0.008 |
| 28_NW_NVA-17 | 671587.789 | 3608337.332 | 27.882 | 28.000 | 0.118 |
| 28_NW_NVA-18 | 652687.338 | 3602149.202 | 26.266 | 26.270 | 0.004 |
| 28_NW_NVA-19 | 660725.056 | 3612200.688 | 24.585 | 24.640 | 0.055 |
| 28_NW_NVA-2 | 661015.151 | 3621716.683 | 28.189 | 28.210 | 0.021 |
| 28_NW_NVA-20 | 671929.715 | 3610726.437 | 27.942 | 27.880 | -0.062 |
| 28_NW_NVA-21 | 658178.707 | 3603725.745 | 23.509 | 23.530 | 0.021 |
| 28_NW_NVA-22 | 664048.062 | 3604758.331 | 25.184 | 25.280 | 0.096 |

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|---|---|---|---|---|---|
| 28_NW_NVA-23 | 670497.269 | 3606363.157 | 27.415 | 27.460 | 0.045 |
| 28_NW_NVA-24 | 671824.231 | 3601500.548 | 26.448 | 26.480 | 0.032 |
| 28_NW_NVA-25 | 675627.824 | 3604563.631 | 27.681 | 27.690 | 0.009 |
| 28_NW_NVA-26 | 653757.626 | 3599820.305 | 26.334 | 26.380 | 0.046 |
| 28_NW_NVA-27 | 661067.416 | 3596921.467 | 24.930 | 24.920 | -0.010 |
| 28_NW_NVA-28 | 666687.622 | 3597337.548 | 25.188 | 25.200 | 0.012 |
| 28_NW_NVA-29 | 673979.977 | 3594844.855 | 25.618 | 25.590 | -0.028 |
| 28_NW_NVA-3 | 662208.284 | 3621103.953 | 27.860 | 27.880 | 0.020 |
| 28_NW_NVA-30 | 675639.569 | 3596757.278 | 27.466 | 27.480 | 0.014 |
| 28_NW_NVA-4 | 670564.987 | 3624925.264 | 30.071 | 30.070 | -0.001 |
| 28_NW_NVA-5 | 670546.321 | 3620054.433 | 29.256 | 29.240 | -0.016 |
| 28_NW_NVA-6 | 676949.037 | 3620825.294 | 40.542 | 40.520 | -0.022 |
| 28_NW_NVA-7 | 653739.842 | 3619202.837 | 26.244 | 26.320 | 0.076 |
| 28_NW_NVA-8 | 658070.159 | 3615435.203 | 27.886 | 27.920 | 0.034 |
| 28_NW_NVA-9 | 659801.542 | 3619455.381 | 27.458 | 27.480 | 0.022 |
| 28_SW_NVA-1 | 668061.469 | 3567971.652 | 25.991 | 25.990 | -0.001 |
| 28_SW_NVA-10 | 681531.448 | 3576973.791 | 27.160 | 27.140 | -0.020 |
| 28_SW_NVA-11 | 676331.772 | 3574194.647 | 26.523 | 26.530 | 0.007 |
| 28_SW_NVA-12 | 686035.814 | 3578728.059 | 28.029 | 28.040 | 0.011 |
| 28_SW_NVA-13 | 689215.307 | 3573508.578 | 34.114 | 34.140 | 0.026 |
| 28_SW_NVA-14 | 681500.051 | 3569261.761 | 33.568 | 33.580 | 0.012 |
| 28_SW_NVA-15 | 673758.970 | 3564887.836 | 33.088 | 33.120 | 0.032 |
| 28_SW_NVA-16 | 663161.776 | 3569545.059 | 23.866 | 23.890 | 0.024 |
| 28_SW_NVA-17 | 688036.992 | 3576794.379 | 25.787 | 25.770 | -0.017 |
| 28_SW_NVA-18 | 695026.328 | 3579000.823 | 35.893 | 35.910 | 0.017 |
| 28_SW_NVA-19 | 689774.844 | 3579335.590 | 26.508 | 26.500 | -0.008 |
| 28_SW_NVA-2 | 666544.121 | 3562767.704 | 26.111 | 26.150 | 0.039 |
| 28_SW_NVA-20 | 686161.805 | 3582463.970 | 27.563 | 27.580 | 0.017 |
| 28_SW_NVA-21 | 686155.832 | 3587167.699 | 36.422 | 36.410 | -0.012 |
| 28_SW_NVA-22 | 676764.775 | 3585477.862 | 25.611 | 25.610 | -0.001 |
| 28_SW_NVA-23 | 681625.701 | 3581667.516 | 27.938 | 27.910 | -0.028 |
| 28_SW_NVA-24 | 673149.262 | 3591272.747 | 25.216 | 25.170 | -0.046 |
| 28_SW_NVA-25 | 666984.023 | 3576621.370 | 24.172 | 24.210 | 0.038 |
| 28_SW_NVA-26 | 670789.035 | 3587020.838 | 26.321 | 26.320 | -0.001 |
| 28_SW_NVA-27 | 653441.294 | 3589497.651 | 25.142 | 25.170 | 0.028 |
| 28_SW_NVA-28 | 662359.619 | 3581412.518 | 22.360 | 22.360 | 0.000 |
| 28_SW_NVA-29 | 654451.290 | 3575430.932 | 23.421 | 23.420 | -0.001 |
| 28_SW_NVA-3 | 654346.765 | 3563089.537 | 22.300 | 22.350 | 0.050 |
| 28_SW_NVA-30 | 657529.450 | 3585655.117 | 24.146 | 24.170 | 0.024 |
| 28_SW_NVA-31 | 664735.377 | 3593588.925 | 23.915 | 23.880 | -0.035 |
| 28_SW_NVA-32 | 656746.804 | 3592437.671 | 24.212 | 24.240 | 0.028 |
| 28_SW_NVA-4 | 655027.175 | 3563994.836 | 22.035 | 22.060 | 0.025 |
| 28_SW_NVA-5 | 689137.557 | 3569291.724 | 34.017 | 34.050 | 0.033 |
| 28_SW_NVA-6 | 675673.489 | 3569719.866 | 26.176 | 26.180 | 0.004 |

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|---|---|---|---|---|---|
| 28_SW_NVA-7 | 658808.836 | 3562928.984 | 23.165 | 23.170 | 0.005 |
| 28_SW_NVA-8 | 684859.359 | 3572815.592 | 23.707 | 23.790 | 0.083 |
| 28_SW_NVA-9 | 680289.937 | 3578101.255 | 26.622 | 26.630 | 0.008 |
| 29_SW_NVA-1 | 652292.290 | 3650704.550 | 35.081 | 35.160 | 0.079 |
| 29_SW_NVA-10 | 673795.674 | 3642217.920 | 33.566 | 33.580 | 0.014 |
| 29_SW_NVA-11 | 652908.093 | 3636955.864 | 34.581 | 34.630 | 0.049 |
| 29_SW_NVA-12 | 666294.102 | 3636137.702 | 32.441 | 32.420 | -0.021 |
| 29_SW_NVA-14 | 677432.114 | 3640319.603 | 35.233 | 35.180 | -0.053 |
| 29_SW_NVA-15 | 652616.319 | 3631555.847 | 28.658 | 28.630 | -0.028 |
| 29_SW_NVA-16 | 659601.313 | 3632265.070 | 27.918 | 27.900 | -0.018 |
| 29_SW_NVA-17 | 669198.041 | 3631972.869 | 31.284 | 31.380 | 0.096 |
| 29_SW_NVA-18 | 652342.298 | 3627291.760 | 26.680 | 26.730 | 0.050 |
| 29_SW_NVA-19 | 662207.779 | 3625820.044 | 28.507 | 28.530 | 0.023 |
| 29_SW_NVA-2 | 658965.608 | 3651630.987 | 39.363 | 39.350 | -0.013 |
| 29_SW_NVA-20 | 665417.914 | 3628609.219 | 28.487 | 28.510 | 0.023 |
| 29_SW_NVA-21 | 670727.514 | 3625900.812 | 42.131 | 42.130 | -0.001 |
| 29_SW_NVA-22 | 657949.842 | 3640292.705 | 29.646 | 29.700 | 0.054 |
| 29_SW_NVA-3 | 665841.633 | 3651591.994 | 34.406 | 34.480 | 0.074 |
| 29_SW_NVA-4 | 652667.346 | 3646671.351 | 34.378 | 34.370 | -0.008 |
| 29_SW_NVA-5 | 658311.647 | 3646782.357 | 35.320 | 35.330 | 0.010 |
| 29_SW_NVA-6 | 666052.503 | 3648363.077 | 33.381 | 33.450 | 0.069 |
| 29_SW_NVA-7 | 652954.625 | 3641840.592 | 36.412 | 36.360 | -0.052 |
| 29_SW_NVA-8 | 661642.085 | 3643614.365 | 29.411 | 29.520 | 0.109 |
| 29_SW_NVA-9 | 668328.608 | 3642305.312 | 34.134 | 34.170 | 0.036 |

Table 4 – Non-Vegetated Accuracy GPS Points

| 100 % of Totals | # of Points | RMSEz (m) NVA Spec=0.1 m | NVA at 95% Spec=0.196 m | Mean (m) | Std Dev (m) | Min (m) | Max (m) |
|---|---|---|---|---|---|---|---|
| Non-Vegetated Terrain | 483 | 0.046 | 0.089 | 0.008 | 0.045 | -0.365 | 0.144 |

Table 5 – Non-Vegetated Vertical Accuracy Results

Overall the calibrated lidar data products collected by LA DOTD meet or exceed the requirements set out in the Statement of Work. The quality control requirements of LA DOTD quality management program were adhered to throughout the acquisition stage for this project to ensure product quality.

# Lidar Processing & Qualitative Assessment

## INITIAL PROCESSING

Once the calibrated swath data are available, LA DOTD and Dewberry perform several validations on the dataset prior to starting full-scale production on the project. These validations include vertical accuracy of the swath data, inter-swath (between swath) relative

accuracy validation, intra-swath (within a single swath) relative accuracy validation, verification of horizontal alignment between swaths, and confirmation of point density and spatial distribution. This initial assessment is used to determine if the data are suitable for full-scale production. Addressing issues at this stage allows the data to be corrected while imposing the least disruption possible on the overall production workflow and overall schedule.

### Final Swath Vertical Accuracy Assessment

LA DOTD tested the vertical accuracy of the non-vegetated terrain swath data prior to additional processing. LA DOTD tested the vertical accuracy of the swath data using the four-hundred eighty-three non-vegetated (open terrain and urban) independent survey check points. The vertical accuracy is tested by comparing survey checkpoints in non-vegetated terrain to a triangulated irregular network (TIN) that is created from the raw swath points. Only checkpoints in non-vegetated terrain can be tested against raw swath data because the data has not undergone classification techniques to remove vegetation, buildings, and other artifacts from the ground surface. Checkpoints are always compared to interpolated surfaces from the lidar point cloud because it is unlikely that a survey checkpoint will be located at the location of a discrete lidar point. LA DOTD and Dewberry typically uses LP360 software to test the swath lidar vertical accuracy, Terrascan software to test the classified lidar vertical accuracy, and Esri ArcMap to test the DEM vertical accuracy so that three different software programs are used to validate the vertical accuracy for each project. Project specifications require a NVA of 19.6 cm based on the $RMSE_z$ (10 cm) x 1.96. The dataset for the LA DOTD NE Lidar Project satisfies this criteria. This raw lidar swath data set was tested to meet ASPRS Positional Accuracy Standards for Digital Geospatial Data (2014) for a 10 cm $RMSE_z$ Vertical Accuracy Class. Actual NVA accuracy was found to be $RMSE_z$ = 4.5 cm, equating to +/- 8.7 cm at 95% confidence level. The table below shows all calculated statistics for the raw swath data.

| 100 % of Totals | # of Points | $RMSE_z$ NVA Spec=0.10 m | NVA –Non-vegetated Vertical Accuracy ($RMSE_z$ x 1.9600) Spec=0.196 m | Mean (m) | Median (m) | Skew | Std Dev (m) | Min (m) | Max (m) | Kurtosis |
|---|---|---|---|---|---|---|---|---|---|---|
| Non-Vegetated Terrain | 483 | 0.045 | 0.087 | 0.002 | 0.003 | -1.148 | 0.045 | -0.365 | 0.144 | 9.836 |

Table 6- NVA at 95% Confidence Level for Raw Swaths

Three checkpoints were removed from the raw swath vertical accuracy testing due to their location outside the project boundary. Only non-vegetated terrain checkpoints are used to test the raw swath data because the raw swath data has not been classified to remove vegetation, structures, and other above ground features from the ground classification. Table 4, below, provides the coordinates for these.

| Point ID | NAD83(2011) UTM 15 | | NAVD88 (Geoid 12B) | Lidar Z (m) | Delta Z | AbsDeltaZ |
|---|---|---|---|---|---|---|
| | Easting X (m) | Northing Y (m) | Survey Z (m) | | | |
| 27_NW_NVA-8 | 677570.140 | 3555018.838 | 23.243 | Outside | -23.243 | 23.243 |
| 27_NW_VVA-10 | 667043.907 | 3532228.088 | 22.045 | Outside | -22.045 | 22.045 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 27_NW_VVA-2 | 672286.366 | 3561626.903 | 25.225 | Outside | -25.225 | 25.225 |

**Table 7- Checkpoints removed from raw swath vertical accuracy testing.**

## Inter-Swath (Between Swath) Relative Accuracy

LA DOTD verified inter-swath or between swath relative accuracy of the dataset by creating Delta-Z (DZ) orthos. According to the SOW, USGS Lidar Base Specifications v1.2, and ASPRS Positional Accuracy Standards for Digital Geospatial Data, 10 cm Vertical Accuracy Class or QL2 data must meet inter-swath relative accuracy of 8 cm RMSDz or less with maximum differences less than 16 cm. These measurements are to be taken in non-vegetated and flat open terrain using single or only returns from all classes. Measurements are calculated in the DZ orthos on 1-meter pixels or cell sizes. Areas in the dataset where overlapping flight lines are within 8 cm of each other within each pixel are colored green, areas in the dataset where overlapping flight lines have elevation differences in each pixel between 8 cm to 16 cm are colored yellow, and areas in the dataset where overlapping flight lines have elevation differences in each pixel greater than 16 cm are colored red. Pixels that do not contain points from overlapping flight lines are colored according to their intensity values. Areas of vegetation and steep slopes (slopes with 16 cm or more of valid elevation change across 1 linear meter) are expected to appear yellow or red in the DZ orthos. If the project area is heavily vegetated, LA DOTD may also create DZ Orthos from the initial ground classification only, while keeping all other parameters consistent. This allows review of the ground classification relative accuracy beneath vegetation and to ensure flight line ridges or other issues do not exist in the final classified data.

Flat, open areas are expected to be green in the DZ orthos. Large or continuous sections of yellow or red pixels can indicate the data was not calibrated correctly or that there were issues during acquisition that could affect the usability of the data, especially when these yellow/red sections follow the flight lines and not the terrain or areas of vegetation. The DZ orthos for LA DOTD NE Lidar Project were thoroughly reviewed to ensure this project meets inter-swath relative accuracy specifications.

## Intra-Swath (Within a Single Swath) Relative Accuracy

LA DOTD verifies the intra-swath or within swath relative accuracy by using ArcMap and visual reviews. ArcMap is used to calculate the maximum difference of all points within each 1-meter pixel/cell size of each swath. Dewberry analysts then identify planar surfaces acceptable for repeatability testing and analysts review the QTM results in those areas. According to the SOW, USGS Lidar Base Specifications v1.2, and ASPRS Positional Accuracy Standards for Digital Geospatial Data, 10 cm Vertical Accuracy Class or QL1 data must meet intra-swath relative accuracy of 6 cm maximum difference or less. This project meets intra-swath relative accuracy specifications.

## Horizontal Alignment

To ensure horizontal alignment between adjacent or overlapping flight lines, LA DOTD uses TerraScan scripting and visual reviews. Scripting is used to create files similar to DZ orthos for each swath but this process highlights planar surfaces, such as roof tops. In particular, horizontal shifts or misalignments between swaths on roof tops and other elevated planar surfaces are highlighted. Visual reviews of these features, including additional profile verifications, are used to confirm the results of this process. The image below shows an example

of the horizontal alignment between swaths for LA DOTD NE Lidar Project; no horizontal alignment issues were identified.

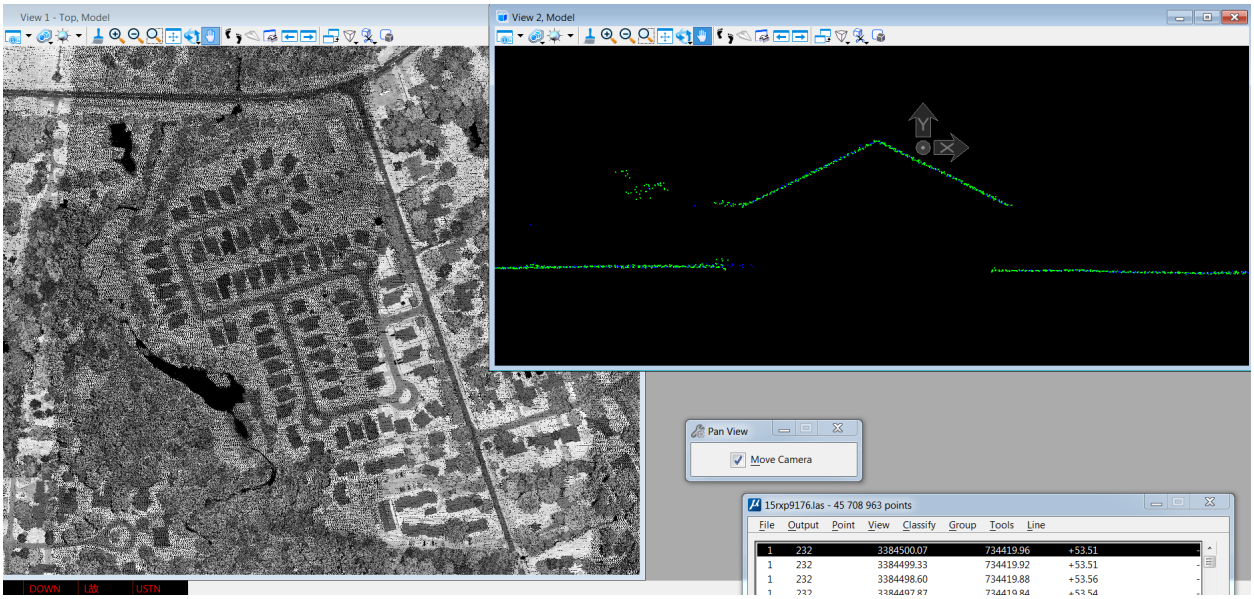



**Figure 4– Horizontal Alignment. Two separate flight lines differentiated by color (Green/Blue) are shown in this profile. There is no visible offset between these two flight lines. No horizontal alignment issues were identified.**

### Point Density and Spatial Distribution

The required Aggregate Nominal Point Spacing (ANPS) for this project is no greater than 0.35 meters, which equates to an Aggregate Nominal Point Density (ANPD) of 9 points per square meter or greater. Density calculations were performed using first return data only located in the geometrically usable center portion (typically ~90%) of each swath. By utilizing statistics, the project area was determined to have an ANPS of 0.4 meters or an ANPD of 10.41 points per square meter which satisfies the project requirements. A visual review of a 1-square meter density grid reveals that there are some 1-meter cells that do not contain 9 points per square meter (red areas) due to large areas of water. Most 1-sqaure meter cells contain at least 9 points per square meter (green areas) and when density is viewed/analyzed by representative 1-square kilometer areas (to account for the irregular spacing of lidar point clouds), density passes with no issues.

The spatial distribution of points must be uniform and free of clustering. This specification is tested by creating a grid with cell sizes equal to the design NPS*2. ArcGIS tools are then used to calculate the number of first return points of each swath within each grid cell. At least 90% of the cells must contain 1 lidar point, excluding acceptable void areas such as water or low NIR reflectivity features, i.e. some asphalt and roof composition materials. This project passes spatial distribution requirements.

## DATA CLASSIFICATION AND EDITING

Once the calibration, absolute swath vertical accuracy, and relative accuracy of the data was confirmed, LA DOTD and Dewberry utilized a variety of software suites for data processing. The data was processed using GeoCue and TerraScan software. The initial step is the setup of the

GeoCue project, which is done by importing a project defined tile boundary index encompassing the entire project area. The acquired 3D laser point clouds, in LAS binary format, were imported into the GeoCue project and tiled according to the project tile grid. Once tiled, the laser points were classified using a proprietary routine in TerraScan. This routine classifies any obvious low outliers in the dataset to class 7 and high outliers in the dataset to class 18. Points along flight line edges that are geometrically unusable are identified as withheld and classified to a separate class so that they will not be used in the initial ground algorithm. After points that could negatively affect the ground are removed from class 1, the ground layer is extracted from this remaining point cloud. The ground extraction process encompassed in this routine takes place by building an iterative surface model.

This surface model is generated using three main parameters: building size, iteration angle and iteration distance. The initial model is based on low points being selected by a "roaming window" with the assumption that these are the ground points. The size of this roaming window is determined by the building size parameter. The low points are triangulated and the remaining points are evaluated and subsequently added to the model if they meet the iteration angle and distance constraints. This process is repeated until no additional points are added within iterations. A second critical parameter is the maximum terrain angle constraint, which determines the maximum terrain angle allowed within the classification model.

Each tile was then imported into Terrascan and a surface model was created to examine the ground classification. Analysts visually reviewed the ground surface model and corrected errors in the ground classification such as vegetation, buildings, and bridges that were present following the initial processing conducted by LA DOTD or Dewberry. Analysts employ 3D visualization techniques to view the point cloud at multiple angles and in profile to ensure that non-ground points are removed from the ground classification. Bridge decks are classified to class 17 using bridge breaklines compiled by analysts. After the ground classification corrections were completed, the dataset was processed through a water classification routine that utilizes breaklines compiled to automatically classify hydro features. The water classification routine selects ground points within the breakline polygons and automatically classifies them as class 9, water. During this water classification routine, points that are within 1x NPS or less of the hydrographic features are moved to class 10, an ignored ground due to breakline proximity. Overage points are then identified in Terrascan and GeoCue is used to set the overlap bit for the overage points and the withheld bit is set on the withheld points previously identified in Terrascan before the ground classification routine was performed.

The lidar tiles were classified to the following classification schema:

- Class 1 = Unclassified, used for all other features that do not fit into the Classes 2, 7, 9, 10, 17, or 18, including vegetation, buildings, etc.
- Class 2 = Bare-Earth Ground
- Class 7 = Low Noise
- Class 8 = Model Key Points
- Class 9 = Water, points located within collected breaklines
- Class 10 = Ignored Ground due to breakline proximity
- Class 17 = Bridge Decks

- Class 18 = High Noise

After manual classification, the LAS tiles were peer reviewed and then underwent a final QA/QC. After the final QA/QC and corrections, all headers, appropriate point data records, and variable length records, including spatial reference information, are updated in GeoCue software and then verified using proprietary Dewberry tools.

# Lidar Qualitative Assessment

Dewberry assisted LA DOTD to develop qualitative assessment utilizing a combination of statistical analysis and interpretative methodology or visualization to assess the quality of the data for a bare-earth digital terrain model (DTM). This includes creating pseudo image products such as lidar orthos produced from the intensity returns, Triangular Irregular Network (TIN)'s, Digital Elevation Models (DEM) and 3-dimensional models as well as reviewing the actual point cloud data. This process looks for anomalies in the data, areas where man-made structures or vegetation points may not have been classified properly to produce a bare-earth model, and other classification errors. This report will present representative examples where the lidar and post processing had issues as well as examples of where the lidar performed well.

## VISUAL REVIEW

The following sections describe common types of issues identified in lidar data and the results of the visual review for LA DOTD NE Lidar Project.

### Artifacts

Artifacts are caused by the misclassification of ground points and usually represent vegetation and/or man-made structures. The artifacts identified are usually low-lying structures, such as porches or low vegetation used as landscaping in neighborhoods and other developed areas. These low-lying features are extremely difficult for the automated algorithms to detect as non-ground and must be removed manually. The vast majority of these features have been removed but a small number of these features are still in the ground classification. The limited numbers of features remaining in the ground are usually 0.3 meters or less above the actual ground surface and should not negatively impact the usability of the dataset.

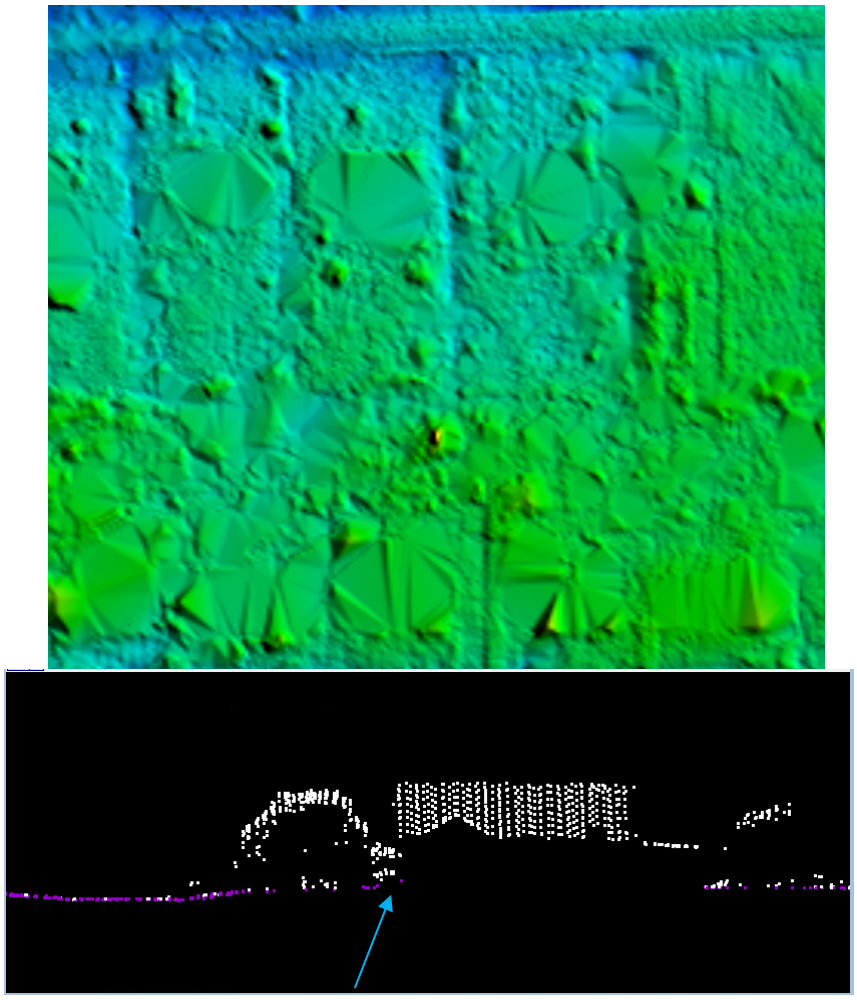


**Figure 5 – Profile with points colored by class (class 1=white, class 2=purple) is shown in the bottom view and a TIN of the surface is shown in the top view. The arrow identifies low vegetation points. A limited number of these small features are still classified as ground but do not impact the usability of the dataset.**

## Bridge Removal Artifacts

The DEM surface models are created from TINs or Terrains. TIN and Terrain models create continuous surfaces from the inputs. Because a continuous surface is being created, the TIN or Terrain will use interpolation to continue the surface beneath the bridge where no lidar data was acquired. Locations where bridges were removed will generally contain less detail in the bare-earth surface because these areas are interpolated.

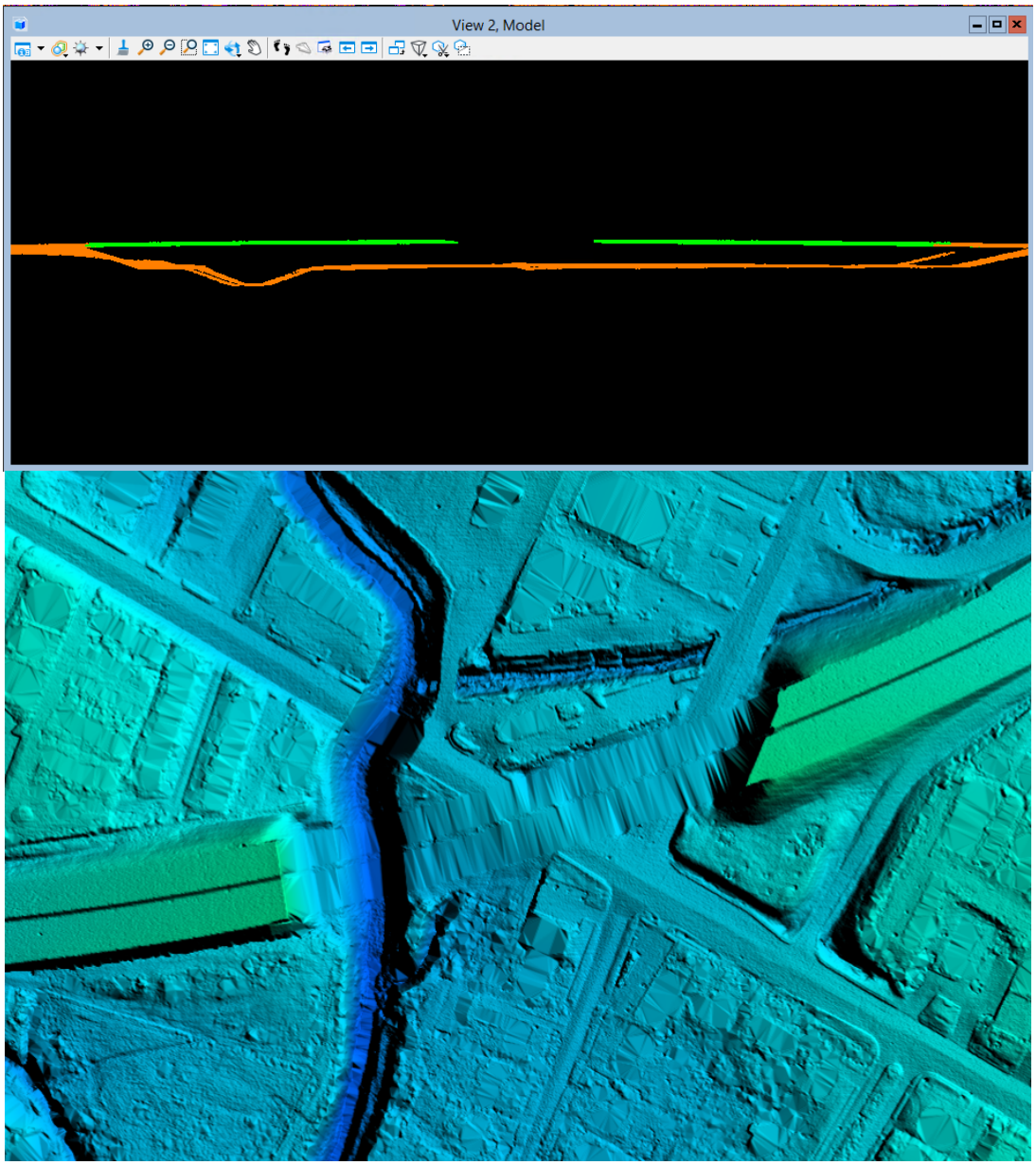



**Figure 6 –The DEM in the bottom view shows an area where a bridge has been removed from ground. The surface model must make a continuous model and in order to do so, points are connected through interpolation. This results in less detail where the surface must be interpolated. The profile in the top view shows the lidar points of this particular feature colored by class. All bridge points have been removed from ground (brown) and have been moved to class 17 bridge deck (green).**

## Culverts and Bridges

Bridges have been removed from the bare earth surface while culverts remain in the bare earth surface. In instances where it is difficult to determine if the feature is a culvert or bridge, such as with some small bridges, Dewberry erred on assuming they would be culverts especially if they are on secondary or tertiary roads. Below is an example of a culvert that has been left in the ground surface.

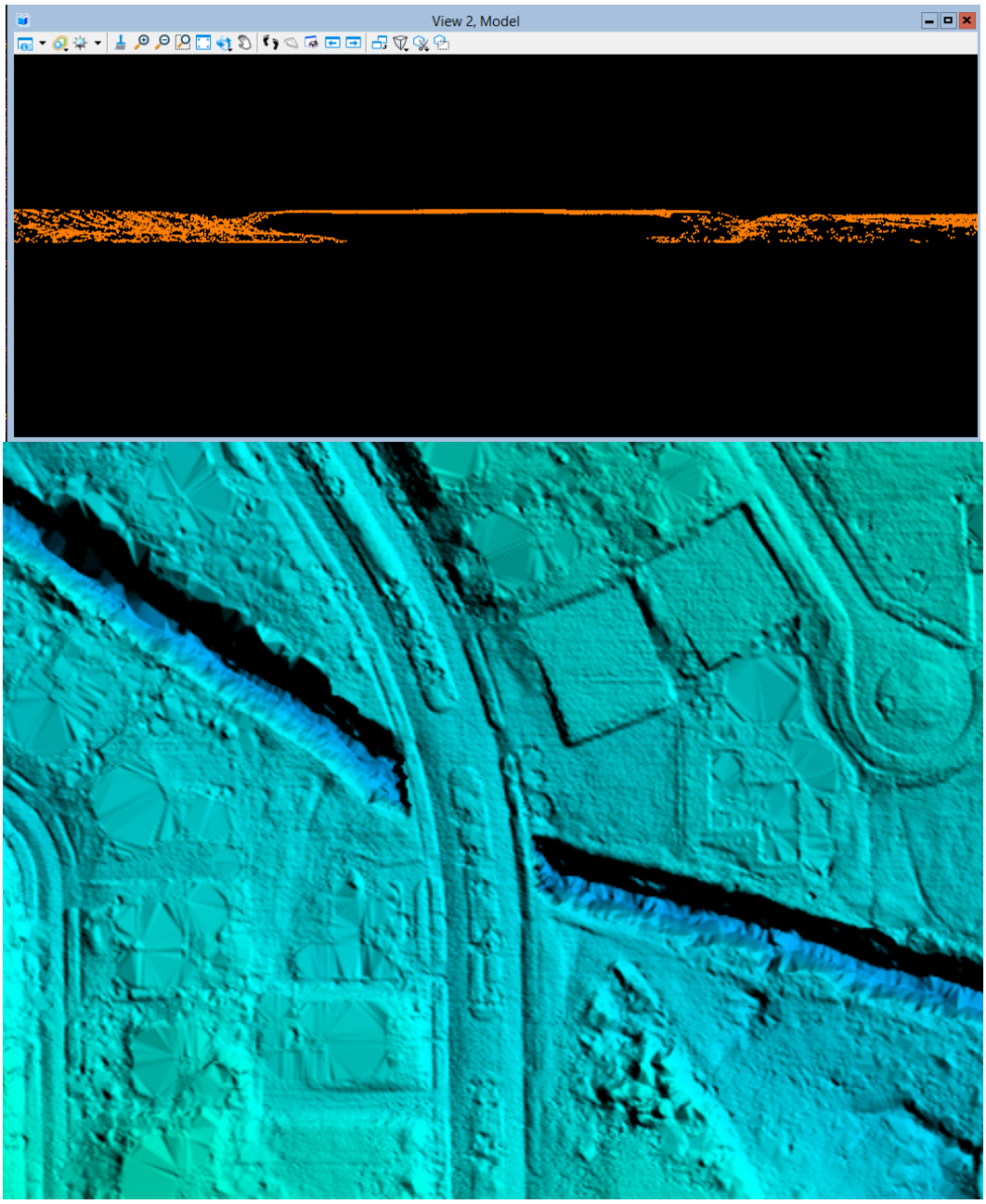
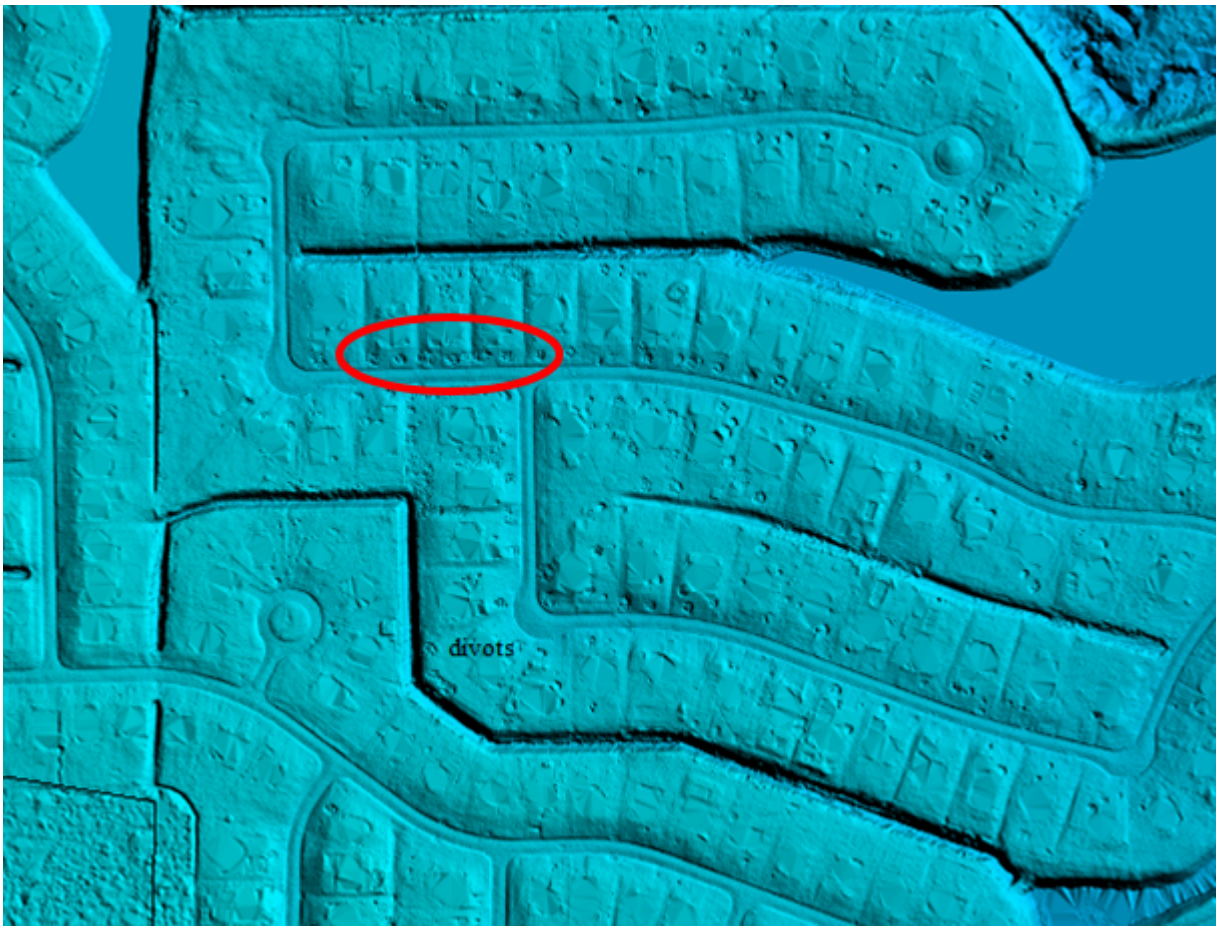
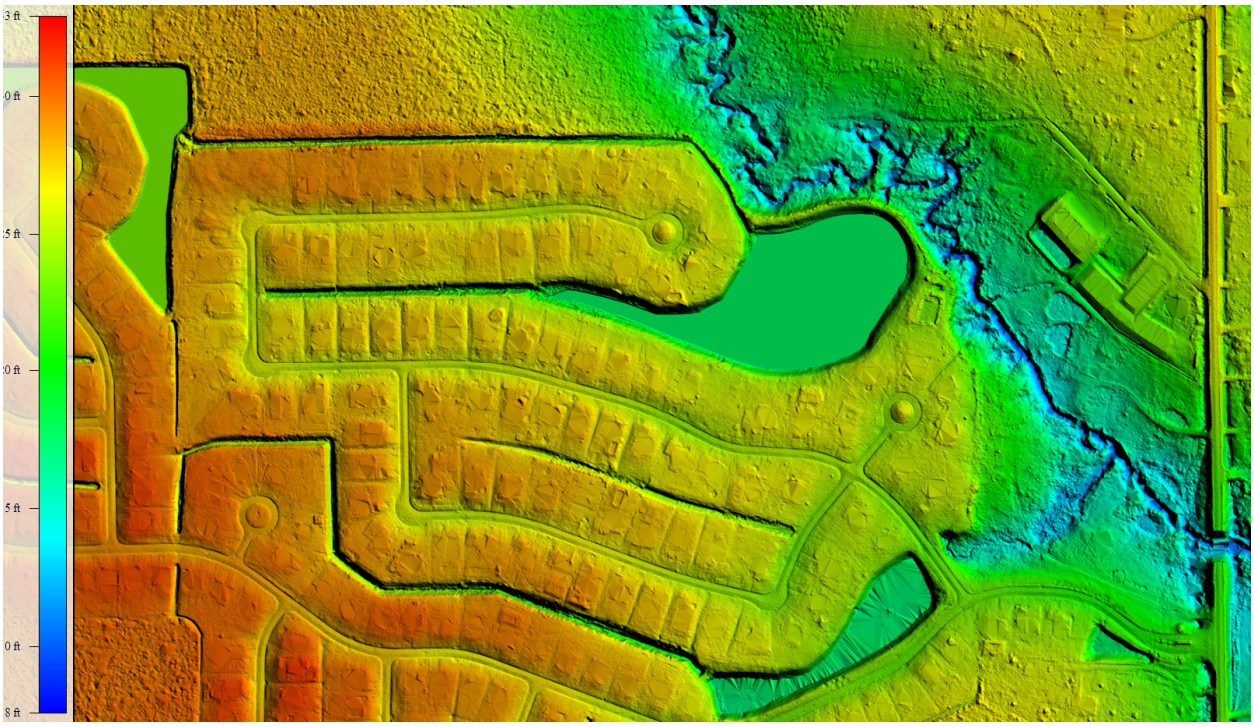



**Figure 7–The DEM in the bottom view shows an area where a culvert has been left in the bare earth surface. The top view shows a profile with culvert area left as ground points colored in brown. Bridges have been removed from the bare earth surface and classified to class 17.**

## Divots

Divots caused by sensor issues beneath single standing trees were found throughout this data. A series of macros were run to help remove these divots along with manual fixes, however some of these divots still remain in areas where no lidar points were available to accurately model the ground beneath the tree.


divots



**Figures 9–The DEM in the top view shows an area with divots left in the bare earth surface. In the intensity and color imagery, single trees can easily be seen in the area above where the divots appear. The DEM in the bottom view shows the same subdivision where the majority of these divots were able to be removed with during the editing process.**

## Elevation Change Within Breaklines

While water bodies are flattened in the final DEMs, other features such as linear hydrographic features can have significant changes in elevation within a small distance. In linear hydrographic features, this is often due to the presence of a structure that affects flow such as a dam or spillway. Dewberry has reviewed the DEMs to ensure that changes in elevation are shown from bank to bank. These changes are often shown as steps to reduce the presence of artifacts while ensuring consistent downhill flow. An example is shown below.

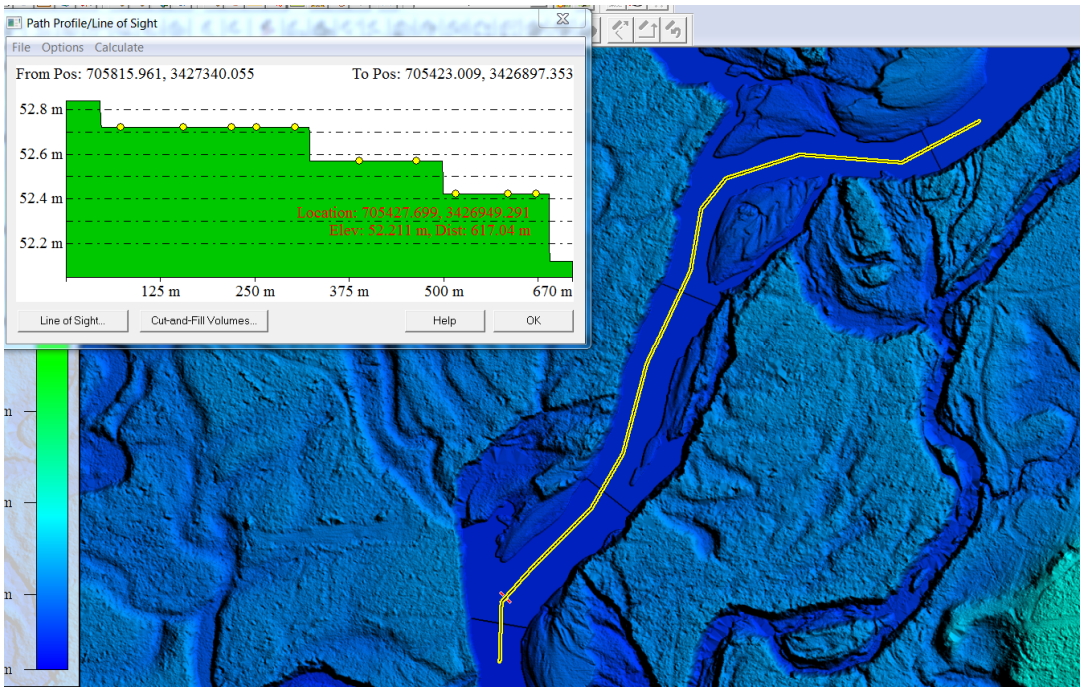



**Figure 10 –Elevation change has been stair stepped. The steps are flat from bank to bank and flow consistently downhill.**

## Marsh Areas

It is sometimes difficult to determine true ground in low wet areas; the lowest points available are used to represent ground. Marsh areas are present within the project area and were not collected with breaklines as they are not open bodies of water. As these areas are not included in the collected breaklines, marsh areas were not flattened in the final DEMs. While low points are used to determine ground in marsh areas, there is often greater variation within the low points due to wet soils that cause greater interpolation between points, and undulating or uneven ground. An example is shown below.

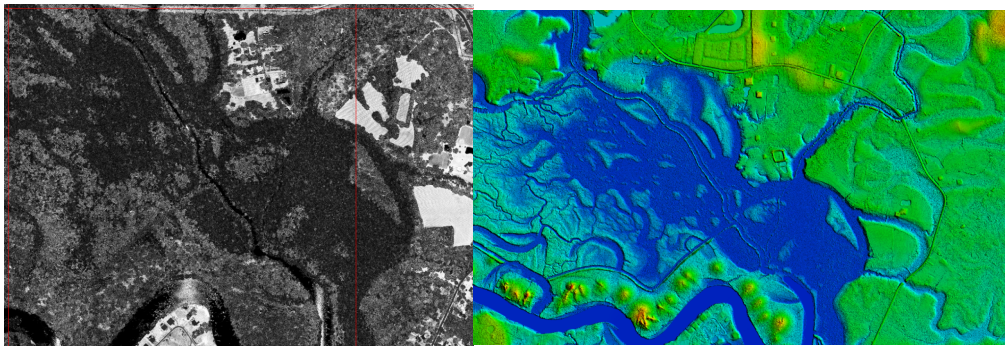


**Figure 11 - The intensity on the left shows a marsh area that was not included in the collected breaklines. The same area is shown in the DEM on the right. Due to wet soils and broken terrain, the point density in marsh areas is sparser than surrounding areas and there is more variation in the low points representing ground.**

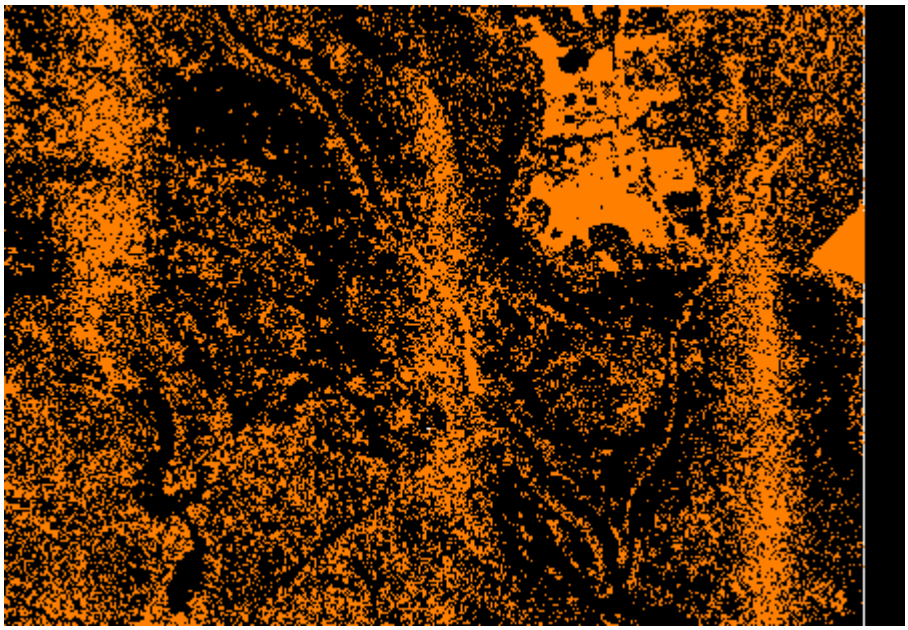


**Figure 12 - The same marsh area shown in the figure above is shown in this image with the points colored by class 2= brown. Though ground points are sparse they are present, indicating that the area is wet but should not be classified as water (class 9). Doing so would strip the detail from this area and result in incorrectly flattening ground as part of the hydro mask.**

## NIR Depressions

Marsh areas within the project contain north-south strips of minimally "depressed" NIR data at nadir. The cause of these artifacts is due to high reflectivity in extremely shallow waters, or high absorption of the NIR wavelength in saturated soils. These depressions are a characteristic of the NIR wavelength and do not negatively impact the overall usability of the data. An example is shown below.

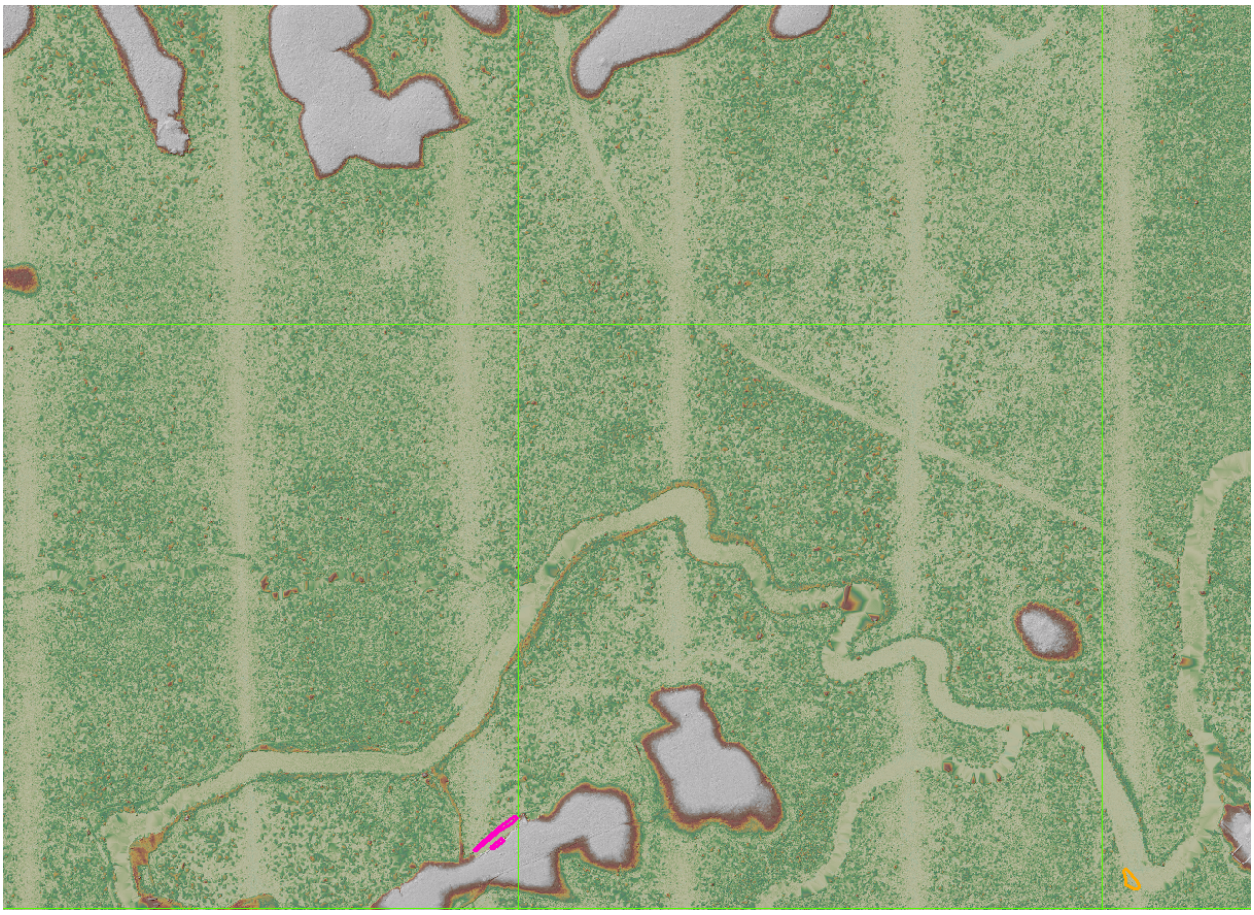


**Figure 13 - The DEM shows strips of minimally depressed NIR data, following a north-south direction. These strips are a characteristic of the NIR wavelength in saturated soils in marshy areas, and do not negatively impact the overall usability of the data.**

## High Water

For the LA DOTD statewide project, each block was flown at different times and data was not integrated with adjacent block data. Temporal differences may be present in the bare earth DEM or hydro features along the tile edge of adjacent blocks. LA DOTD/Dewberry attempted minimize any offset in the bare earth DEMs and to edge match breaklines horizontally and vertically as best as possible between blocks. There may be some bare earth DEM offsets present or breakline features along tile edges that vary greatly from block to block horizontally and vertically due to temporal differences. If possible, LA DOTD/Dewberry ensured breaklines along a block edge were edge matched horizontally and set the elevation of each part of the breakline along the tile edge to the lowest elevation of each part, if within a 3ft tolerance. Some breakline features may have an elevation difference greater than 3 ft between blocks and/or was not possible to edge-match horizontally. All temporal differences will be outlined with a temporal shapefile included with each respective affected block.

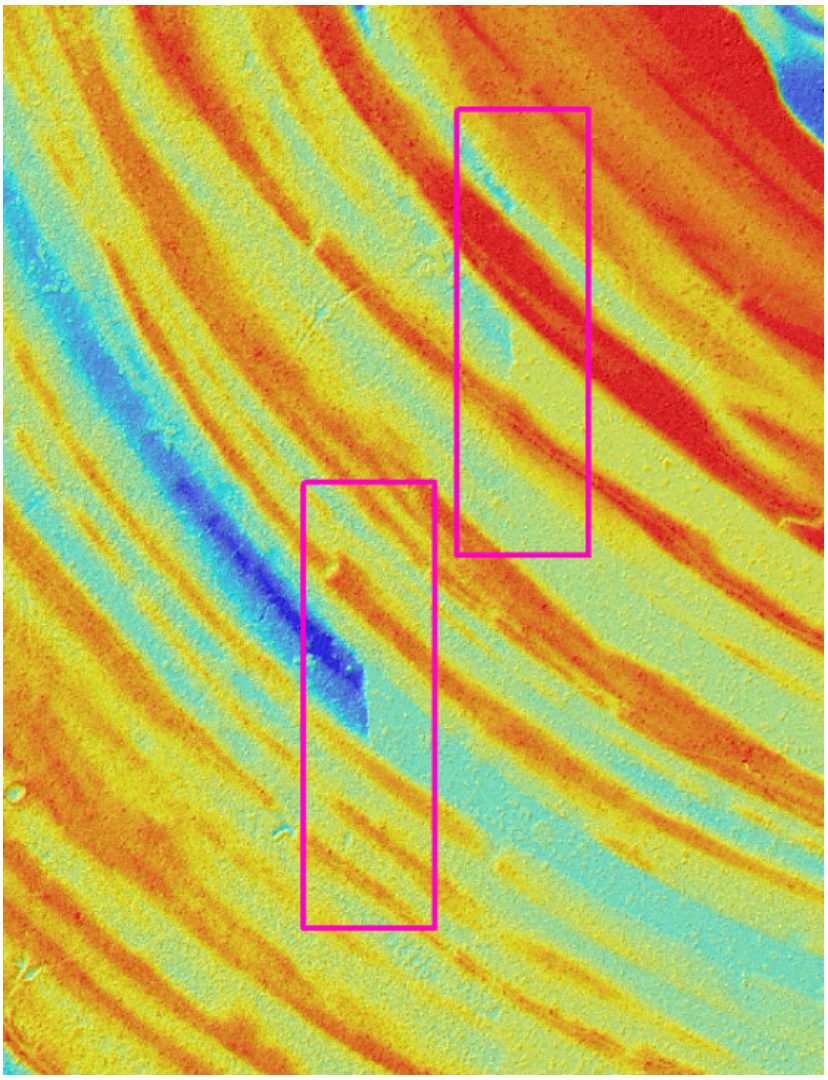


**Figure 14 - The DEM shows temporal differences between acquisition blocks. All temporal differences are identified in a "temporal.shp" shapefile delivered with each block that contains these differences.**

Additionally, at the time of lidar acquisition, water levels throughout the area varied. As a result, there are many buildings, structures, and roads along the shorelines which were flooded during one acquisition and dry during others. Because these features would not normally be hydro-flattened, Dewberry collected the river around these features, where they could be discerned, so they would not be hydro-flattened in these bare earth DEMs either. The exclusion of the flooded features from the breaklines does cause several of these areas to look like artifacts in the water. However, comparing these locations to the intensity imagery will show they are a result of not having ground points on these flooded features but that these areas should not be hydro-flattened as they are not normally part of the riverine system.

## FORMATTING

After the final QA/QC is performed and all corrections have been applied to the dataset, all lidar files are updated to the final format requirements and the final formatting, header information, point data records, and variable length records are verified using Dewberry proprietary tools. The table below lists some of the main lidar header fields that are updated and verified.

| Classified Lidar Formatting | | |
|---|---|---|
| **Parameter** | **Requirement** | **Pass/Fail** |
| LAS Version | 1.4 | Pass |
| Point Data Format | Format 6 | Pass |
| Coordinate Reference System | NAD83 (2011) UTM Zone 15, meters and NAVD88 (Geoid 12B), meters in WKT Format | Pass |
| Global Encoder Bit | Should be set to 17 for Adjusted GPS Time | Pass |
| Time Stamp | Adjusted GPS Time (unique timestamps) | Pass |
| System ID | Should be set to the processing system/software and is set to NIIRS10 for GeoCue software | Pass |
| Multiple Returns | The sensor shall be able to collect multiple returns per pulse and the return numbers are recorded | Pass |
| Intensity | 16 bit intensity values are recorded for each pulse | Pass |
| Classification | Required Classes include:<br>Class 1: Unclassified<br>Class 2: Ground<br>Class 7: Low Noise<br>Class 8: Model Key Points<br>Class 9: Water<br>Class 10: Ignored Ground<br>Class 17: Bridge Decks<br>Class 18: High Noise | Pass |
| Overlap and Withheld Points | Overlap (Overage) and Withheld points are set to the Overlap and Withheld bits | Pass |
| Scan Angle | Recorded for each pulse | Pass |

| | | |
|---|---|---|
| XYZ Coordinates | Unique Easting, Northing, and Elevation coordinates are recorded for each pulse | Pass |

Table 7- Classified Lidar Formatting QC Checklist

# Lidar Positional Accuracy

## BACKGROUND

Dewberry and LA DOTD quantitatively tested the dataset by testing the vertical accuracy of the lidar. The vertical accuracy is tested by comparing the discreet measurement of the survey checkpoints to that of the interpolated value within the three closest lidar points that constitute the vertices of a three-dimensional triangular face of the TIN. Therefore, the end result is that only a small sample of the lidar data is actually tested. However there is an increased level of confidence with lidar data due to the relative accuracy. This relative accuracy in turn is based on how well one lidar point "fits" in comparison to the next contiguous lidar measurement and is verified as part of the initial processing. If the relative accuracy of a dataset is within specifications and the dataset passes vertical accuracy requirements at the location of survey checkpoints, the vertical accuracy results can be applied to the whole dataset with high confidence due to the passing relative accuracy. Typically, the use of LP360 software to test the swath lidar vertical accuracy, Terrascan software to test the classified lidar vertical accuracy, and Esri ArcMap to test the DEM vertical accuracy so that three different software programs are used to validate the vertical accuracy for each project.

We also test the horizontal accuracy of lidar datasets when checkpoints are photo-identifiable in the intensity imagery. Photo-identifiable checkpoints in intensity imagery typically include checkpoints located at the ends of paint stripes on concrete or asphalt surfaces or checkpoints located at 90-degree corners of different reflectivity, e.g. a sidewalk corner adjoining a grass surface. The XY coordinates of checkpoints, as defined in the intensity imagery, are compared to surveyed XY coordinates for each photo-identifiable checkpoint. These differences are used to compute the tested horizontal accuracy of the lidar. As not all projects contain photo-identifiable checkpoints, the horizontal accuracy of the lidar cannot always be tested.

## SURVEY VERTICAL ACCURACY CHECKPOINTS

For the vertical accuracy assessment, eight hundred and fourteen (814) check points were surveyed for the project and are located within bare earth/open terrain, grass/weeds/crops, and forested/fully grown land cover categories. Please see appendix A to view the survey report which details and validates how the survey was completed for this project.

Checkpoints were evenly distributed throughout the project area so as to cover as many flight lines as possible using the “dispersed method” of placement.

All checkpoints surveyed for vertical accuracy testing purposes are listed in the following table.

| Point ID | NAD83(2011) UTM Zone 15N | | NAVD88 (Geoid 12B) | |
|---|---|---|---|---|
| | Easting X (m) | Northing Y (m) | Z-Survey (m) | Z-LiDAR (m) |

| | | | | |
|---|---|---|---|---|
| 11_NE_NVA-36 | 566045.779 | 3494887.969 | 20.475 | 20.510 |
| 11_NE_NVA-37 | 568863.385 | 3491485.945 | 16.233 | 16.190 |
| 11_NE_NVA-38 | 570883.471 | 3486802.584 | 19.939 | 19.960 |
| 11_NE_NVA-5 | 570564.349 | 3498812.515 | 26.099 | 26.080 |
| 12_NE_NVA-10 | 569265.036 | 3552408.625 | 60.302 | 60.330 |
| 12_NE_NVA-15 | 569829.051 | 3542069.451 | 48.722 | 48.730 |
| 12_NE_NVA-20 | 568486.734 | 3535032.471 | 26.653 | 26.670 |
| 12_NE_NVA-25 | 568080.741 | 3544358.009 | 49.436 | 49.450 |
| 12_NE_NVA-26 | 570308.982 | 3559909.435 | 48.467 | 48.480 |
| 12_NE_NVA-33 | 570268.681 | 3540226.252 | 28.096 | 28.020 |
| 12_NE_NVA-34 | 567739.834 | 3530327.122 | 25.215 | 25.210 |
| 12_SE_NVA-10 | 568214.370 | 3516140.040 | 46.473 | 46.490 |
| 12_SE_NVA-15 | 569493.826 | 3509214.866 | 53.532 | 53.570 |
| 12_SE_NVA-20 | 571081.981 | 3499802.149 | 50.457 | 50.420 |
| 12_SE_NVA-22 | 569498.762 | 3527855.643 | 40.613 | 40.650 |
| 12_SE_NVA-25 | 564945.458 | 3519052.329 | 33.302 | 33.300 |
| 12_SE_NVA-27 | 565905.065 | 3522128.057 | 40.018 | 40.000 |
| 12_SE_NVA-30 | 562848.999 | 3512505.068 | 21.438 | 21.410 |
| 12_SE_NVA-31 | 565691.646 | 3510832.575 | 44.473 | 44.490 |
| 12_SE_NVA-5 | 567963.133 | 3524393.098 | 27.786 | 27.790 |
| 12_SE_NVA-9 | 560290.011 | 3517523.067 | 23.740 | 23.790 |
| 13_NE_NVA-19 | 556916.625 | 3604572.379 | 34.044 | 34.010 |
| 13_NE_NVA-26 | 557542.016 | 3600941.380 | 30.514 | 30.500 |
| 13_NE_NVA-27 | 565595.108 | 3598998.742 | 49.715 | 49.730 |
| 13_NE_NVA-28 | 570056.193 | 3601231.970 | 49.129 | 49.130 |
| 13_NE_NVA-34 | 560970.169 | 3593270.720 | 64.720 | 64.660 |
| 13_NE_NVA-35 | 568590.571 | 3596919.847 | 36.822 | 36.880 |
| 13_NE_NVA-36 | 565766.196 | 3604441.620 | 27.202 | 27.180 |
| 13_NE_NVA-37 | 556856.018 | 3595222.590 | 81.275 | 81.280 |
| 13_NE_NVA-38 | 566196.069 | 3593414.437 | 70.562 | 70.550 |
| 13_SE_NVA-10 | 568183.257 | 3580848.669 | 74.831 | 74.790 |
| 13_SE_NVA-3 | 562480.341 | 3586457.495 | 33.699 | 33.700 |
| 13_SE_NVA-38 | 566437.324 | 3591880.521 | 50.254 | 50.260 |
| 13_SE_NVA-39 | 561256.928 | 3591677.412 | 46.714 | 46.670 |
| 13_SE_NVA-4 | 566236.522 | 3589144.301 | 34.492 | 34.470 |
| 13_SE_NVA-40 | 557973.588 | 3586463.362 | 76.011 | 76.000 |
| 13_SE_NVA-5 | 570268.955 | 3589166.837 | 33.731 | 33.740 |
| 13_SE_NVA-6 | 566767.668 | 3585807.480 | 52.807 | 52.790 |
| 13_SE_NVA-8 | 570035.762 | 3569227.627 | 64.928 | 64.900 |

| | | | | |
|---|---|---|---|---|
| 13_SE_NVA-9 | 570500.805 | 3576271.975 | 58.382 | 58.400 |
| 15_SE_NVA-1 | 613747.450 | 3650490.258 | 39.814 | 39.830 |
| 15_SE_NVA-10 | 628390.997 | 3637881.086 | 28.119 | 28.110 |
| 15_SE_NVA-11 | 637643.904 | 3649322.904 | 30.348 | 30.350 |
| 15_SE_NVA-12 | 651784.756 | 3650605.737 | 32.583 | 32.610 |
| 15_SE_NVA-13 | 644811.556 | 3638311.554 | 30.515 | 30.560 |
| 15_SE_NVA-14 | 638703.136 | 3629291.522 | 29.594 | 29.520 |
| 15_SE_NVA-15 | 648586.274 | 3629490.380 | 38.859 | 38.750 |
| 15_SE_NVA-16 | 643393.356 | 3641377.893 | 30.203 | 30.270 |
| 15_SE_NVA-17 | 640160.938 | 3639897.232 | 28.968 | 29.030 |
| 15_SE_NVA-18 | 634623.579 | 3631432.151 | 29.733 | 29.710 |
| 15_SE_NVA-19 | 620219.892 | 3626431.852 | 29.587 | 29.520 |
| 15_SE_NVA-2 | 611804.116 | 3644086.655 | 31.483 | 31.470 |
| 15_SE_NVA-20 | 611620.493 | 3627460.407 | 27.907 | 27.900 |
| 15_SE_NVA-21 | 612560.029 | 3639077.271 | 47.033 | 47.000 |
| 15_SE_NVA-22 | 621940.657 | 3646030.184 | 32.173 | 32.240 |
| 15_SE_NVA-23 | 641058.926 | 3635608.593 | 29.868 | 29.910 |
| 15_SE_NVA-24 | 627271.865 | 3632956.631 | 27.912 | 27.990 |
| 15_SE_NVA-25 | 620070.605 | 3639572.984 | 31.674 | 31.700 |
| 15_SE_NVA-26 | 616767.884 | 3649506.999 | 46.453 | 46.470 |
| 15_SE_NVA-27 | 649024.643 | 3643731.238 | 31.806 | 31.900 |
| 15_SE_NVA-28 | 650918.105 | 3627474.149 | 33.521 | 33.440 |
| 15_SE_NVA-29 | 634723.763 | 3624995.909 | 28.250 | 28.230 |
| 15_SE_NVA-3 | 618981.426 | 3643981.131 | 32.295 | 32.290 |
| 15_SE_NVA-30 | 633641.298 | 3643211.594 | 28.767 | 28.730 |
| 15_SE_NVA-31 | 626868.579 | 3641013.192 | 28.833 | 28.970 |
| 15_SE_NVA-32 | 625264.360 | 3629731.525 | 28.414 | 28.410 |
| 15_SE_NVA-33 | 613387.388 | 3647640.308 | 38.212 | 38.190 |
| 15_SE_NVA-4 | 611840.015 | 3625429.569 | 26.463 | 26.390 |
| 15_SE_NVA-5 | 622093.220 | 3633107.126 | 30.696 | 30.710 |
| 15_SE_NVA-6 | 616615.492 | 3636428.406 | 30.114 | 30.160 |
| 15_SE_NVA-7 | 625362.111 | 3651020.820 | 33.004 | 33.000 |
| 15_SE_NVA-8 | 628385.221 | 3644338.240 | 28.894 | 28.920 |
| 15_SE_NVA-9 | 637307.175 | 3646901.929 | 30.794 | 30.740 |
| 15_SW_NVA-1 | 572709.964 | 3652551.403 | 35.259 | 35.270 |
| 15_SW_NVA-10 | 575802.182 | 3646941.949 | 37.531 | 37.530 |
| 15_SW_NVA-11 | 571085.157 | 3644939.316 | 54.773 | 54.760 |
| 15_SW_NVA-12 | 591794.710 | 3644050.196 | 20.746 | 20.780 |
| 15_SW_NVA-13 | 603619.422 | 3643365.782 | 37.078 | 37.040 |
| 15_SW_NVA-14 | 606366.912 | 3641365.301 | 38.675 | 38.640 |

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|---|---|---|---|---|
| 15_SW_NVA-15 | 602001.336 | 3637712.460 | 29.126 | 29.130 |
| 15_SW_NVA-16 | 579324.318 | 3641132.138 | 35.750 | 35.720 |
| 15_SW_NVA-17 | 579757.937 | 3638323.397 | 41.026 | 41.060 |
| 15_SW_NVA-18 | 570856.397 | 3641671.351 | 57.371 | 57.350 |
| 15_SW_NVA-19 | 571150.840 | 3640495.438 | 59.349 | 59.380 |
| 15_SW_NVA-2 | 575036.956 | 3650780.140 | 30.427 | 30.440 |
| 15_SW_NVA-20 | 605062.344 | 3633395.391 | 38.726 | 38.730 |
| 15_SW_NVA-21 | 599901.396 | 3632415.951 | 28.703 | 28.690 |
| 15_SW_NVA-22 | 598432.068 | 3629616.305 | 28.389 | 28.390 |
| 15_SW_NVA-23 | 601297.982 | 3628501.134 | 35.280 | 35.250 |
| 15_SW_NVA-24 | 580953.197 | 3625510.292 | 40.830 | 40.830 |
| 15_SW_NVA-25 | 580400.976 | 3630650.150 | 40.024 | 40.060 |
| 15_SW_NVA-26 | 577111.374 | 3631861.576 | 54.638 | 54.640 |
| 15_SW_NVA-27 | 584770.696 | 3635414.375 | 23.699 | 23.760 |
| 15_SW_NVA-28 | 570597.385 | 3635910.978 | 59.485 | 59.530 |
| 15_SW_NVA-29 | 571214.139 | 3629122.054 | 56.195 | 56.250 |
| 15_SW_NVA-3 | 580448.407 | 3652049.813 | 24.254 | 24.270 |
| 15_SW_NVA-30 | 572525.358 | 3626620.985 | 22.130 | 22.140 |
| 15_SW_NVA-31 | 597301.937 | 3624809.529 | 28.211 | 28.200 |
| 15_SW_NVA-32 | 606886.254 | 3625591.867 | 51.122 | 51.080 |
| 15_SW_NVA-33 | 594538.551 | 3636020.796 | 24.259 | 24.270 |
| 15_SW_NVA-4 | 594515.680 | 3651365.262 | 27.619 | 27.630 |
| 15_SW_NVA-5 | 597815.078 | 3652559.121 | 33.879 | 33.990 |
| 15_SW_NVA-6 | 600624.546 | 3648532.802 | 38.961 | 39.040 |
| 15_SW_NVA-7 | 609851.631 | 3650494.088 | 38.743 | 38.780 |
| 15_SW_NVA-8 | 607196.519 | 3645662.220 | 42.888 | 42.910 |
| 15_SW_NVA-9 | 596654.951 | 3645541.109 | 33.156 | 33.150 |
| 16_NE_NVA-1 | 611640.566 | 3623635.927 | 25.447 | 25.440 |
| 16_NE_NVA-10 | 638793.415 | 3616972.310 | 29.182 | 29.220 |
| 16_NE_NVA-11 | 649466.239 | 3612451.268 | 28.427 | 28.450 |
| 16_NE_NVA-12 | 614477.962 | 3609652.754 | 26.933 | 27.060 |
| 16_NE_NVA-13 | 623918.771 | 3607112.228 | 26.915 | 26.910 |
| 16_NE_NVA-14 | 637971.492 | 3610217.881 | 28.027 | 28.010 |
| 16_NE_NVA-15 | 642056.178 | 3605968.087 | 28.524 | 28.560 |
| 16_NE_NVA-16 | 651749.213 | 3609303.153 | 26.655 | 26.660 |
| 16_NE_NVA-17 | 644265.246 | 3613354.873 | 30.891 | 30.900 |
| 16_NE_NVA-18 | 623198.099 | 3616796.423 | 29.096 | 29.140 |
| 16_NE_NVA-19 | 644850.599 | 3616593.179 | 31.538 | 31.620 |
| 16_NE_NVA-2 | 613981.792 | 3619239.294 | 26.555 | 26.590 |
| 16_NE_NVA-20 | 628766.393 | 3609654.949 | 27.695 | 27.700 |
| 16_NE_NVA-21 | 616476.774 | 3602250.693 | 25.308 | 25.330 |

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| 16_NE_NVA-22 | 624953.122 | 3603946.522 | 26.716 | 26.750 |
| 16_NE_NVA-23 | 633109.348 | 3603223.544 | 25.935 | 25.990 |
| 16_NE_NVA-24 | 641109.332 | 3601281.242 | 27.922 | 27.900 |
| 16_NE_NVA-25 | 652635.957 | 3604639.482 | 26.980 | 26.940 |
| 16_NE_NVA-26 | 612130.828 | 3594444.479 | 25.364 | 25.330 |
| 16_NE_NVA-27 | 622458.432 | 3598254.189 | 25.987 | 26.060 |
| 16_NE_NVA-28 | 628934.014 | 3597570.647 | 26.274 | 26.270 |
| 16_NE_NVA-29 | 640513.647 | 3596887.149 | 26.267 | 26.320 |
| 16_NE_NVA-3 | 621785.383 | 3621326.584 | 29.660 | 29.720 |
| 16_NE_NVA-30 | 647688.082 | 3595546.507 | 25.689 | 25.650 |
| 16_NE_NVA-31 | 651738.005 | 3597380.064 | 25.822 | 25.820 |
| 16_NE_NVA-32 | 646917.175 | 3601229.739 | 25.843 | 25.890 |
| 16_NE_NVA-33 | 616674.370 | 3598369.701 | 25.727 | 25.760 |
| 16_NE_NVA-34 | 635112.673 | 3597705.621 | 26.347 | 26.320 |
| 16_NE_NVA-35 | 628871.071 | 3602411.728 | 26.973 | 27.000 |
| 16_NE_NVA-36 | 635160.478 | 3593766.211 | 26.863 | 26.930 |
| 16_NE_NVA-4 | 634709.908 | 3621747.507 | 28.548 | 28.540 |
| 16_NE_NVA-5 | 646878.516 | 3623488.203 | 32.606 | 32.610 |
| 16_NE_NVA-6 | 651229.096 | 3619125.035 | 25.492 | 25.480 |
| 16_NE_NVA-7 | 615387.177 | 3616439.841 | 26.022 | 26.060 |
| 16_NE_NVA-8 | 617528.965 | 3613092.605 | 28.173 | 28.190 |
| 16_NE_NVA-9 | 628709.493 | 3615244.510 | 26.946 | 27.040 |
| 16_NW_NVA-1 | 572996.597 | 3620636.628 | 52.587 | 52.550 |
| 16_NW_NVA-10 | 585668.165 | 3614710.291 | 24.728 | 24.740 |
| 16_NW_NVA-11 | 591549.501 | 3616119.087 | 25.942 | 25.950 |
| 16_NW_NVA-12 | 599855.081 | 3613548.283 | 30.723 | 30.740 |
| 16_NW_NVA-14 | 610890.135 | 3617448.499 | 22.984 | 22.930 |
| 16_NW_NVA-15 | 573747.369 | 3610800.355 | 18.871 | 18.940 |
| 16_NW_NVA-16 | 579314.510 | 3607058.857 | 24.474 | 24.440 |
| 16_NW_NVA-17 | 585986.383 | 3606615.799 | 23.089 | 23.070 |
| 16_NW_NVA-18 | 592032.877 | 3608842.777 | 28.744 | 28.750 |
| 16_NW_NVA-19 | 597018.892 | 3607112.817 | 25.558 | 25.600 |
| 16_NW_NVA-2 | 577642.982 | 3620320.959 | 25.486 | 25.450 |
| 16_NW_NVA-20 | 603716.917 | 3610346.967 | 22.870 | 22.860 |
| 16_NW_NVA-21 | 610200.769 | 3605577.076 | 22.942 | 22.990 |
| 16_NW_NVA-22 | 572759.785 | 3600963.823 | 50.657 | 50.670 |
| 16_NW_NVA-23 | 575880.045 | 3601794.661 | 39.859 | 39.900 |
| 16_NW_NVA-24 | 583066.784 | 3601536.977 | 24.112 | 24.100 |
| 16_NW_NVA-25 | 590715.404 | 3599490.275 | 25.109 | 25.120 |
| 16_NW_NVA-26 | 595112.659 | 3603950.347 | 28.827 | 28.830 |
| 16_NW_NVA-27 | 606174.063 | 3605528.260 | 19.821 | 19.800 |
| 16_NW_NVA-28 | 611312.227 | 3598986.489 | 24.098 | 24.070 |
| 16_NW_NVA-29 | 571497.787 | 3595560.929 | 24.247 | 24.260 |
| 16_NW_NVA-3 | 584876.481 | 3621743.293 | 30.090 | 30.130 |

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| 16_NW_NVA-30 | 576160.972 | 3597382.420 | 42.859 | 42.880 |
| 16_NW_NVA-31 | 583686.261 | 3594191.874 | 22.712 | 22.720 |
| 16_NW_NVA-32 | 589296.421 | 3597918.706 | 23.123 | 23.120 |
| 16_NW_NVA-33 | 594459.237 | 3595106.653 | 21.042 | 21.040 |
| 16_NW_NVA-35 | 610278.050 | 3594354.764 | 23.827 | 23.800 |
| 16_NW_NVA-4 | 590105.081 | 3620806.596 | 28.170 | 28.140 |
| 16_NW_NVA-5 | 596137.146 | 3623900.770 | 27.514 | 27.590 |
| 16_NW_NVA-6 | 600733.436 | 3620047.804 | 43.722 | 43.720 |
| 16_NW_NVA-7 | 608684.907 | 3621674.643 | 25.876 | 25.820 |
| 16_NW_NVA-8 | 571148.731 | 3613659.736 | 18.080 | 18.070 |
| 16_NW_NVA-9 | 577304.996 | 3614691.018 | 30.854 | 30.850 |
| 16_SE_NVA-1 | 611987.482 | 3592894.033 | 24.967 | 24.960 |
| 16_SE_NVA-10 | 648277.711 | 3589070.383 | 24.412 | 24.410 |
| 16_SE_NVA-11 | 640942.397 | 3573820.427 | 23.897 | 23.860 |
| 16_SE_NVA-12 | 633878.699 | 3578198.054 | 27.236 | 27.290 |
| 16_SE_NVA-13 | 647771.670 | 3570470.281 | 22.940 | 22.950 |
| 16_SE_NVA-14 | 639478.310 | 3579999.635 | 27.305 | 27.310 |
| 16_SE_NVA-15 | 644013.213 | 3576789.097 | 24.294 | 24.290 |
| 16_SE_NVA-16 | 649104.833 | 3584079.468 | 23.339 | 23.340 |
| 16_SE_NVA-17 | 643698.336 | 3562273.212 | 18.601 | 18.550 |
| 16_SE_NVA-18 | 640272.123 | 3565602.750 | 22.233 | 22.230 |
| 16_SE_NVA-19 | 639203.227 | 3569395.119 | 22.988 | 23.020 |
| 16_SE_NVA-2 | 614818.821 | 3592964.249 | 24.161 | 24.110 |
| 16_SE_NVA-20 | 634695.908 | 3562285.300 | 22.513 | 22.570 |
| 16_SE_NVA-21 | 633031.095 | 3568145.072 | 27.219 | 27.210 |
| 16_SE_NVA-22 | 629850.995 | 3573841.581 | 25.755 | 25.700 |
| 16_SE_NVA-23 | 619851.865 | 3562710.293 | 22.232 | 22.240 |
| 16_SE_NVA-24 | 612154.385 | 3562924.029 | 20.642 | 20.680 |
| 16_SE_NVA-25 | 618005.553 | 3569801.275 | 22.026 | 22.070 |
| 16_SE_NVA-26 | 623894.201 | 3568573.387 | 23.101 | 23.140 |
| 16_SE_NVA-27 | 612778.642 | 3575851.293 | 20.196 | 20.220 |
| 16_SE_NVA-28 | 615740.212 | 3585353.392 | 22.227 | 22.200 |
| 16_SE_NVA-29 | 632362.844 | 3590335.717 | 27.466 | 27.420 |
| 16_SE_NVA-3 | 616293.298 | 3591525.114 | 23.707 | 23.720 |
| 16_SE_NVA-30 | 624272.682 | 3580758.576 | 24.101 | 24.100 |
| 16_SE_NVA-31 | 641673.244 | 3592434.465 | 28.681 | 28.660 |
| 16_SE_NVA-32 | 623293.224 | 3576287.721 | 24.522 | 24.590 |
| 16_SE_NVA-33 | 628382.125 | 3564455.718 | 24.370 | 24.380 |
| 16_SE_NVA-34 | 616257.624 | 3562981.652 | 19.319 | 19.340 |
| 16_SE_NVA-35 | 623000.425 | 3587767.629 | 24.296 | 24.330 |
| 16_SE_NVA-36 | 630328.952 | 3568436.184 | 25.750 | 25.760 |
| 16_SE_NVA-37 | 637631.904 | 3584700.906 | 27.442 | 27.470 |
| 16_SE_NVA-4 | 633530.469 | 3592715.434 | 27.704 | 27.680 |
| 16_SE_NVA-5 | 649386.847 | 3593243.210 | 25.457 | 25.410 |

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| 16_SE_NVA-6 | 641814.970 | 3586408.558 | 27.180 | 27.190 |
| 16_SE_NVA-7 | 629244.646 | 3586008.279 | 25.856 | 25.900 |
| 16_SE_NVA-8 | 619726.896 | 3589340.815 | 23.866 | 23.760 |
| 16_SE_NVA-9 | 636220.442 | 3579918.411 | 34.537 | 34.590 |
| 16_SW_NVA-1 | 575865.849 | 3590928.664 | 22.663 | 22.650 |
| 16_SW_NVA-10 | 583610.457 | 3585246.159 | 22.147 | 22.170 |
| 16_SW_NVA-11 | 588857.437 | 3583777.135 | 20.050 | 20.070 |
| 16_SW_NVA-12 | 597281.677 | 3584024.791 | 20.324 | 20.340 |
| 16_SW_NVA-13 | 603538.706 | 3583011.781 | 23.038 | 22.990 |
| 16_SW_NVA-14 | 609851.359 | 3585373.779 | 23.736 | 23.670 |
| 16_SW_NVA-15 | 573205.731 | 3576689.491 | 61.510 | 61.540 |
| 16_SW_NVA-16 | 576426.698 | 3579740.951 | 37.085 | 37.070 |
| 16_SW_NVA-17 | 584175.285 | 3579691.283 | 22.494 | 22.460 |
| 16_SW_NVA-18 | 585855.124 | 3573632.994 | 21.321 | 21.380 |
| 16_SW_NVA-19 | 599221.972 | 3574660.563 | 21.351 | 21.460 |
| 16_SW_NVA-2 | 576162.352 | 3586839.549 | 29.289 | 29.290 |
| 16_SW_NVA-20 | 606404.877 | 3576464.605 | 20.900 | 21.000 |
| 16_SW_NVA-21 | 610468.476 | 3576501.831 | 21.671 | 21.710 |
| 16_SW_NVA-22 | 570621.016 | 3574085.667 | 48.660 | 48.650 |
| 16_SW_NVA-23 | 575057.365 | 3572212.292 | 52.686 | 52.670 |
| 16_SW_NVA-24 | 585214.728 | 3569050.571 | 19.819 | 19.860 |
| 16_SW_NVA-25 | 594517.262 | 3573190.383 | 20.177 | 20.180 |
| 16_SW_NVA-26 | 595575.044 | 3568318.496 | 18.860 | 18.930 |
| 16_SW_NVA-27 | 607161.942 | 3569403.668 | 22.364 | 22.360 |
| 16_SW_NVA-28 | 611699.352 | 3572510.843 | 22.395 | 22.330 |
| 16_SW_NVA-29 | 571587.366 | 3565018.087 | 65.588 | 65.640 |
| 16_SW_NVA-3 | 584195.474 | 3590477.552 | 23.658 | 23.610 |
| 16_SW_NVA-30 | 576102.033 | 3566290.324 | 58.844 | 58.850 |
| 16_SW_NVA-31 | 583941.966 | 3565518.102 | 21.526 | 21.560 |
| 16_SW_NVA-32 | 591970.294 | 3562525.811 | 18.905 | 18.540 |
| 16_SW_NVA-33 | 595642.429 | 3567111.807 | 20.414 | 20.410 |
| 16_SW_NVA-34 | 598829.788 | 3561909.750 | 17.525 | 17.520 |
| 16_SW_NVA-35 | 609708.418 | 3564590.028 | 22.070 | 21.950 |
| 16_SW_NVA-4 | 590742.819 | 3587736.166 | 19.457 | 19.420 |
| 16_SW_NVA-5 | 601854.072 | 3589403.768 | 19.759 | 19.690 |
| 16_SW_NVA-6 | 607087.043 | 3589417.931 | 23.858 | 23.800 |
| 16_SW_NVA-7 | 611581.400 | 3592968.875 | 24.828 | 24.780 |
| 16_SW_NVA-9 | 577593.344 | 3581637.652 | 27.334 | 27.350 |
| 17_NE_NVA-1 | 612275.690 | 3557652.238 | 21.840 | 21.840 |
| 17_NE_NVA-10 | 627663.700 | 3552439.053 | 24.098 | 24.170 |
| 17_NE_NVA-11 | 632955.033 | 3551561.578 | 21.924 | 21.970 |
| 17_NE_NVA-12 | 642343.774 | 3551388.625 | 21.145 | 21.200 |
| 17_NE_NVA-13 | 645801.201 | 3551197.510 | 21.279 | 21.250 |
| 17_NE_NVA-14 | 651264.643 | 3554716.227 | 22.144 | 22.110 |

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| 17_NE_NVA-15 | 613472.492 | 3546398.531 | 21.093 | 21.160 |
| 17_NE_NVA-16 | 618822.611 | 3545010.308 | 19.575 | 19.570 |
| 17_NE_NVA-17 | 626596.736 | 3546959.382 | 22.397 | 22.450 |
| 17_NE_NVA-18 | 632742.234 | 3546051.288 | 18.958 | 18.920 |
| 17_NE_NVA-19 | 637070.491 | 3548811.599 | 19.696 | 19.700 |
| 17_NE_NVA-2 | 619957.623 | 3561845.434 | 22.516 | 22.530 |
| 17_NE_NVA-20 | 643871.257 | 3547855.632 | 18.749 | 18.780 |
| 17_NE_NVA-21 | 652589.442 | 3545393.104 | 21.843 | 21.860 |
| 17_NE_NVA-22 | 612498.801 | 3538875.349 | 19.837 | 19.790 |
| 17_NE_NVA-23 | 622969.808 | 3537117.404 | 21.137 | 21.180 |
| 17_NE_NVA-24 | 627133.402 | 3539767.251 | 22.494 | 22.530 |
| 17_NE_NVA-25 | 635100.622 | 3539233.312 | 20.870 | 20.870 |
| 17_NE_NVA-26 | 639286.413 | 3541218.077 | 17.314 | 17.410 |
| 17_NE_NVA-27 | 645159.022 | 3538767.080 | 20.225 | 20.250 |
| 17_NE_NVA-28 | 651796.748 | 3538224.655 | 21.439 | 21.380 |
| 17_NE_NVA-29 | 613430.211 | 3534952.218 | 19.199 | 19.300 |
| 17_NE_NVA-3 | 631338.975 | 3555963.321 | 28.461 | 28.510 |
| 17_NE_NVA-30 | 621292.421 | 3533056.621 | 19.585 | 19.580 |
| 17_NE_NVA-32 | 633624.533 | 3534720.515 | 18.054 | 18.140 |
| 17_NE_NVA-33 | 637694.998 | 3534179.228 | 19.764 | 19.740 |
| 17_NE_NVA-34 | 647826.281 | 3533322.322 | 21.065 | 21.100 |
| 17_NE_NVA-35 | 652038.563 | 3536215.336 | 21.328 | 21.270 |
| 17_NE_NVA-4 | 637939.090 | 3561380.786 | 22.436 | 22.390 |
| 17_NE_NVA-5 | 644250.605 | 3561738.426 | 20.326 | 20.390 |
| 17_NE_NVA-6 | 650447.969 | 3557568.862 | 22.840 | 22.850 |
| 17_NE_NVA-7 | 622081.805 | 3555719.714 | 21.808 | 21.900 |
| 17_NE_NVA-8 | 614258.724 | 3552877.941 | 20.862 | 20.900 |
| 17_NE_NVA-9 | 622148.590 | 3552003.095 | 22.538 | 22.600 |
| 17_NW_NVA-1 | 610751.315 | 3560815.822 | 19.866 | 19.880 |
| 17_NW_NVA-10 | 596549.181 | 3561179.594 | 20.447 | 20.440 |
| 17_NW_NVA-11 | 585451.550 | 3561228.764 | 20.890 | 20.900 |
| 17_NW_NVA-12 | 575047.627 | 3560568.725 | 40.217 | 40.240 |
| 17_NW_NVA-13 | 578625.731 | 3560628.890 | 52.746 | 52.770 |
| 17_NW_NVA-14 | 576456.386 | 3557085.664 | 51.615 | 51.600 |
| 17_NW_NVA-15 | 585864.495 | 3550548.069 | 64.011 | 64.010 |
| 17_NW_NVA-16 | 590786.967 | 3555860.765 | 19.477 | 19.450 |
| 17_NW_NVA-17 | 597841.507 | 3558200.475 | 19.386 | 19.420 |
| 17_NW_NVA-18 | 590813.850 | 3550288.933 | 20.482 | 20.480 |
| 17_NW_NVA-19 | 586786.416 | 3557037.034 | 19.467 | 19.470 |
| 17_NW_NVA-2 | 612168.787 | 3539468.305 | 20.016 | 20.030 |
| 17_NW_NVA-20 | 578594.325 | 3553660.329 | 63.114 | 63.070 |
| 17_NW_NVA-21 | 577257.116 | 3555797.944 | 48.921 | 48.930 |
| 17_NW_NVA-22 | 578672.694 | 3548117.414 | 58.502 | 58.540 |
| 17_NW_NVA-23 | 579325.161 | 3538300.545 | 37.910 | 37.930 |

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| 17_NW_NVA-24 | 586401.526 | 3542788.773 | 62.097 | 62.100 |
| 17_NW_NVA-25 | 584672.803 | 3545726.540 | 47.293 | 47.320 |
| 17_NW_NVA-26 | 572512.150 | 3555989.858 | 44.623 | 44.600 |
| 17_NW_NVA-27 | 573770.861 | 3561485.796 | 60.735 | 60.720 |
| 17_NW_NVA-28 | 572508.272 | 3539012.138 | 30.073 | 30.140 |
| 17_NW_NVA-29 | 571396.078 | 3531797.210 | 44.349 | 44.440 |
| 17_NW_NVA-3 | 611842.893 | 3543085.969 | 19.827 | 19.860 |
| 17_NW_NVA-30 | 573208.109 | 3549543.485 | 41.381 | 41.390 |
| 17_NW_NVA-31 | 574909.613 | 3531005.049 | 51.356 | 51.380 |
| 17_NW_NVA-32 | 584741.358 | 3534379.407 | 44.504 | 44.540 |
| 17_NW_NVA-33 | 588872.843 | 3537592.478 | 51.833 | 51.830 |
| 17_NW_NVA-36 | 600558.488 | 3533931.117 | 19.518 | 19.550 |
| 17_NW_NVA-37 | 598758.833 | 3537959.178 | 19.481 | 19.490 |
| 17_NW_NVA-38 | 596212.153 | 3559150.258 | 19.275 | 19.310 |
| 17_NW_NVA-39 | 605066.782 | 3545495.308 | 18.966 | 19.000 |
| 17_NW_NVA-4 | 611115.104 | 3546763.572 | 21.091 | 21.160 |
| 17_NW_NVA-40 | 580178.902 | 3543811.943 | 39.559 | 39.570 |
| 17_NW_NVA-41 | 584791.617 | 3530656.159 | 54.385 | 54.270 |
| 17_NW_NVA-5 | 606649.941 | 3548880.291 | 19.237 | 19.270 |
| 17_NW_NVA-6 | 598170.999 | 3549467.785 | 19.419 | 19.450 |
| 17_NW_NVA-7 | 608198.083 | 3554426.511 | 20.896 | 20.900 |
| 17_NW_NVA-8 | 596645.070 | 3543480.677 | 19.082 | 19.080 |
| 17_NW_NVA-9 | 609406.389 | 3558443.458 | 20.568 | 20.600 |
| 17_SE_NVA-12 | 643980.846 | 3522367.157 | 19.332 | 19.310 |
| 17_SE_NVA-13 | 649622.398 | 3520050.851 | 19.627 | 19.600 |
| 17_SE_NVA-14 | 653210.969 | 3522552.236 | 21.007 | 21.020 |
| 17_SE_NVA-19 | 639938.944 | 3515814.836 | 19.796 | 19.810 |
| 17_SE_NVA-21 | 651324.385 | 3519332.134 | 19.793 | 19.810 |
| 17_SE_NVA-36 | 635709.387 | 3530405.025 | 19.501 | 19.510 |
| 17_SE_NVA-37 | 647883.005 | 3526568.391 | 19.629 | 19.570 |
| 17_SE_NVA-38 | 635513.133 | 3521102.700 | 20.373 | 20.320 |
| 17_SE_NVA-4 | 634636.183 | 3528588.482 | 22.427 | 22.380 |
| 17_SE_NVA-5 | 640101.972 | 3526354.897 | 18.881 | 18.860 |
| 17_SE_NVA-6 | 644452.103 | 3530521.882 | 18.651 | 18.580 |
| 17_SE_NVA-7 | 653649.957 | 3528900.033 | 21.058 | 21.030 |
| 17_SW_NVA-1 | 571640.040 | 3529882.533 | 46.818 | 46.810 |
| 17_SW_NVA-10 | 589669.476 | 3519997.068 | 59.936 | 59.890 |
| 17_SW_NVA-11 | 592987.862 | 3520437.855 | 53.838 | 53.840 |
| 17_SW_NVA-15 | 571591.332 | 3511888.617 | 42.531 | 42.550 |
| 17_SW_NVA-16 | 579379.068 | 3513392.129 | 42.980 | 42.930 |
| 17_SW_NVA-17 | 584428.215 | 3515913.037 | 53.075 | 53.080 |
| 17_SW_NVA-18 | 592695.515 | 3513881.609 | 36.796 | 36.700 |
| 17_SW_NVA-2 | 575653.380 | 3528217.701 | 36.792 | 36.800 |
| 17_SW_NVA-22 | 573113.637 | 3507991.032 | 31.064 | 31.130 |

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|---|---|---|---|---|
| 17_SW_NVA-23 | 580344.980 | 3506600.419 | 61.564 | 61.510 |
| 17_SW_NVA-24 | 586635.726 | 3508967.256 | 66.682 | 66.660 |
| 17_SW_NVA-25 | 590650.034 | 3511768.489 | 64.820 | 64.810 |
| 17_SW_NVA-29 | 573586.026 | 3502109.386 | 55.209 | 55.210 |
| 17_SW_NVA-3 | 585608.908 | 3530381.442 | 51.896 | 51.930 |
| 17_SW_NVA-30 | 577927.583 | 3504165.054 | 64.289 | 64.270 |
| 17_SW_NVA-31 | 585511.871 | 3504138.012 | 63.145 | 63.180 |
| 17_SW_NVA-32 | 592259.474 | 3499505.641 | 22.089 | 22.100 |
| 17_SW_NVA-36 | 584893.745 | 3523518.402 | 69.470 | 69.490 |
| 17_SW_NVA-38 | 589322.352 | 3528571.168 | 72.565 | 72.580 |
| 17_SW_NVA-39 | 591750.109 | 3506281.585 | 60.927 | 60.860 |
| 17_SW_NVA-8 | 573944.712 | 3519503.357 | 46.652 | 46.650 |
| 17_SW_NVA-9 | 576742.395 | 3521227.802 | 50.115 | 50.100 |
| 18_NW_NVA-1 | 579101.418 | 3491880.217 | 56.758 | 56.750 |
| 18_NW_NVA-2 | 584076.614 | 3494501.382 | 25.939 | 25.890 |
| 18_NW_NVA-21 | 571673.029 | 3496146.535 | 49.189 | 49.160 |
| 18_NW_NVA-23 | 581097.088 | 3497150.024 | 48.229 | 48.230 |
| 18_NW_NVA-24 | 592321.349 | 3487941.519 | 18.102 | 18.110 |
| 18_NW_NVA-26 | 576420.895 | 3488260.197 | 35.791 | 35.800 |
| 18_NW_NVA-28 | 575406.222 | 3485848.910 | 27.063 | 27.060 |
| 18_NW_NVA-3 | 592366.020 | 3497347.359 | 19.622 | 19.500 |
| 18_NW_NVA-31 | 583873.636 | 3480311.501 | 18.349 | 18.350 |
| 18_NW_NVA-36 | 575875.643 | 3499094.022 | 65.613 | 65.490 |
| 18_NW_NVA-37 | 572253.129 | 3492597.695 | 23.292 | 23.290 |
| 18_NW_NVA-38 | 593113.236 | 3495587.065 | 18.510 | 18.520 |
| 18_NW_NVA-39 | 593836.084 | 3489198.751 | 17.906 | 18.050 |
| 18_NW_NVA-40 | 589536.575 | 3480008.820 | 18.486 | 18.510 |
| 18_NW_NVA-41 | 593922.086 | 3473847.081 | 13.931 | 13.770 |
| 18_NW_NVA-42 | 583488.186 | 3473520.841 | 13.899 | 13.850 |
| 18_NW_NVA-43 | 590077.757 | 3473330.928 | 13.324 | 13.200 |
| 18_NW_NVA-44 | 594198.391 | 3469215.294 | 13.924 | 13.890 |
| 18_NW_NVA-6 | 573484.697 | 3488861.534 | 26.783 | 26.720 |
| 18_NW_NVA-7 | 587728.212 | 3484496.154 | 18.728 | 18.680 |
| 27_NW_NVA-1 | 653455.815 | 3559353.776 | 23.193 | 23.190 |
| 27_NW_NVA-10 | 659894.064 | 3548896.237 | 23.184 | 23.140 |
| 27_NW_NVA-11 | 668586.612 | 3546254.567 | 24.772 | 24.740 |
| 27_NW_NVA-12 | 675250.575 | 3544668.584 | 23.847 | 23.810 |
| 27_NW_NVA-13 | 656900.466 | 3539905.400 | 21.335 | 21.330 |
| 27_NW_NVA-14 | 664782.970 | 3543988.889 | 22.314 | 22.320 |
| 27_NW_NVA-15 | 665346.666 | 3538111.518 | 23.238 | 23.190 |
| 27_NW_NVA-16 | 671477.097 | 3540043.528 | 23.880 | 23.900 |
| 27_NW_NVA-17 | 669502.234 | 3555228.508 | 23.808 | 23.820 |
| 27_NW_NVA-18 | 654034.095 | 3534433.457 | 20.566 | 20.550 |
| 27_NW_NVA-19 | 662132.436 | 3534861.908 | 21.876 | 21.900 |

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|---|---|---|---|---|
| 27_NW_NVA-2 | 660645.761 | 3561855.831 | 22.467 | 22.440 |
| 27_NW_NVA-20 | 668412.241 | 3534586.767 | 23.549 | 23.580 |
| 27_NW_NVA-3 | 666971.037 | 3559817.405 | 25.199 | 25.220 |
| 27_NW_NVA-4 | 671737.952 | 3558809.298 | 32.105 | 32.080 |
| 27_NW_NVA-5 | 655963.719 | 3552004.177 | 21.530 | 21.500 |
| 27_NW_NVA-6 | 660988.729 | 3555110.181 | 22.758 | 22.750 |
| 27_NW_NVA-7 | 666366.128 | 3550729.737 | 24.553 | 24.530 |
| 27_NW_NVA-9 | 653517.342 | 3544604.138 | 22.264 | 22.230 |
| 27_SW_NVA-1 | 659194.328 | 3530832.998 | 20.388 | 20.390 |
| 27_SW_NVA-2 | 661020.574 | 3530218.553 | 19.634 | 19.640 |
| 27_SW_NVA-3 | 665985.914 | 3530551.091 | 21.156 | 21.220 |
| 27_SW_NVA-4 | 655325.942 | 3528797.435 | 21.531 | 21.530 |
| 27_SW_NVA-5 | 656871.982 | 3528972.744 | 19.834 | 19.820 |
| 27_SW_NVA-6 | 655268.172 | 3526597.084 | 20.841 | 20.820 |
| 27_SW_NVA-7 | 654222.129 | 3524549.547 | 20.640 | 20.600 |
| 27_SW_NVA-8 | 653770.763 | 3522013.326 | 21.662 | 21.610 |
| 28_NW_NVA-1 | 652410.553 | 3622417.422 | 25.952 | 25.900 |
| 28_NW_NVA-10 | 663832.245 | 3616918.075 | 27.101 | 27.020 |
| 28_NW_NVA-11 | 670419.269 | 3617113.216 | 30.706 | 30.690 |
| 28_NW_NVA-12 | 674224.819 | 3619562.675 | 30.512 | 30.500 |
| 28_NW_NVA-13 | 654219.011 | 3612908.079 | 27.066 | 27.060 |
| 28_NW_NVA-14 | 656610.157 | 3609416.870 | 27.200 | 27.200 |
| 28_NW_NVA-15 | 665632.314 | 3609733.847 | 26.072 | 26.100 |
| 28_NW_NVA-16 | 670533.560 | 3613817.546 | 29.348 | 29.340 |
| 28_NW_NVA-17 | 671587.789 | 3608337.332 | 27.882 | 28.000 |
| 28_NW_NVA-18 | 652687.338 | 3602149.202 | 26.266 | 26.270 |
| 28_NW_NVA-19 | 660725.056 | 3612200.688 | 24.585 | 24.640 |
| 28_NW_NVA-2 | 661015.151 | 3621716.683 | 28.189 | 28.210 |
| 28_NW_NVA-20 | 671929.715 | 3610726.437 | 27.942 | 27.890 |
| 28_NW_NVA-21 | 658178.707 | 3603725.745 | 23.509 | 23.490 |
| 28_NW_NVA-22 | 664048.062 | 3604758.331 | 25.184 | 25.280 |
| 28_NW_NVA-23 | 670497.269 | 3606363.157 | 27.415 | 27.420 |
| 28_NW_NVA-24 | 671824.231 | 3601500.548 | 26.448 | 26.480 |
| 28_NW_NVA-25 | 675627.824 | 3604563.631 | 27.681 | 27.690 |
| 28_NW_NVA-26 | 653757.626 | 3599820.305 | 26.334 | 26.370 |
| 28_NW_NVA-27 | 661067.416 | 3596921.467 | 24.930 | 24.920 |
| 28_NW_NVA-28 | 666687.622 | 3597337.548 | 25.188 | 25.200 |
| 28_NW_NVA-29 | 673979.977 | 3594844.855 | 25.618 | 25.580 |
| 28_NW_NVA-3 | 662208.284 | 3621103.953 | 27.860 | 27.880 |
| 28_NW_NVA-30 | 675639.569 | 3596757.278 | 27.466 | 27.450 |
| 28_NW_NVA-4 | 670564.987 | 3624925.264 | 30.071 | 30.010 |
| 28_NW_NVA-5 | 670546.321 | 3620054.433 | 29.256 | 29.230 |
| 28_NW_NVA-6 | 676949.037 | 3620825.294 | 40.542 | 40.520 |
| 28_NW_NVA-7 | 653739.842 | 3619202.837 | 26.244 | 26.300 |

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|---|---|---|---|---|
| 28_NW_NVA-8 | 658070.159 | 3615435.203 | 27.886 | 27.890 |
| 28_NW_NVA-9 | 659801.542 | 3619455.381 | 27.458 | 27.480 |
| 28_SW_NVA-1 | 668061.469 | 3567971.652 | 25.991 | 25.980 |
| 28_SW_NVA-10 | 681531.448 | 3576973.791 | 27.160 | 27.130 |
| 28_SW_NVA-11 | 676331.772 | 3574194.647 | 26.523 | 26.530 |
| 28_SW_NVA-12 | 686035.814 | 3578728.059 | 28.029 | 28.030 |
| 28_SW_NVA-13 | 689215.307 | 3573508.578 | 34.114 | 34.140 |
| 28_SW_NVA-14 | 681500.051 | 3569261.761 | 33.568 | 33.580 |
| 28_SW_NVA-15 | 673758.970 | 3564887.836 | 33.088 | 33.120 |
| 28_SW_NVA-16 | 663161.776 | 3569545.059 | 23.866 | 23.890 |
| 28_SW_NVA-17 | 688036.992 | 3576794.379 | 25.787 | 25.770 |
| 28_SW_NVA-18 | 695026.328 | 3579000.823 | 35.893 | 35.910 |
| 28_SW_NVA-19 | 689774.844 | 3579335.590 | 26.508 | 26.500 |
| 28_SW_NVA-2 | 666544.121 | 3562767.704 | 26.111 | 26.150 |
| 28_SW_NVA-20 | 686161.805 | 3582463.970 | 27.563 | 27.580 |
| 28_SW_NVA-21 | 686155.832 | 3587167.699 | 36.422 | 36.410 |
| 28_SW_NVA-22 | 676764.775 | 3585477.862 | 25.611 | 25.590 |
| 28_SW_NVA-23 | 681625.701 | 3581667.516 | 27.938 | 27.910 |
| 28_SW_NVA-24 | 673149.262 | 3591272.747 | 25.216 | 25.170 |
| 28_SW_NVA-25 | 666984.023 | 3576621.370 | 24.172 | 24.180 |
| 28_SW_NVA-26 | 670789.035 | 3587020.838 | 26.321 | 26.320 |
| 28_SW_NVA-27 | 653441.294 | 3589497.651 | 25.142 | 25.150 |
| 28_SW_NVA-28 | 662359.619 | 3581412.518 | 22.360 | 22.360 |
| 28_SW_NVA-29 | 654451.290 | 3575430.932 | 23.421 | 23.410 |
| 28_SW_NVA-3 | 654346.765 | 3563089.537 | 22.300 | 22.350 |
| 28_SW_NVA-30 | 657529.450 | 3585655.117 | 24.146 | 24.170 |
| 28_SW_NVA-31 | 664735.377 | 3593588.925 | 23.915 | 23.900 |
| 28_SW_NVA-32 | 656746.804 | 3592437.671 | 24.212 | 24.240 |
| 28_SW_NVA-4 | 655027.175 | 3563994.836 | 22.035 | 22.060 |
| 28_SW_NVA-5 | 689137.557 | 3569291.724 | 34.017 | 34.050 |
| 28_SW_NVA-6 | 675673.489 | 3569719.866 | 26.176 | 26.180 |
| 28_SW_NVA-7 | 658808.836 | 3562928.984 | 23.165 | 23.170 |
| 28_SW_NVA-8 | 684859.359 | 3572815.592 | 23.707 | 23.760 |
| 28_SW_NVA-9 | 680289.937 | 3578101.255 | 26.622 | 26.630 |
| 29_SW_NVA-1 | 652292.290 | 3650704.550 | 35.081 | 35.140 |
| 29_SW_NVA-10 | 673795.674 | 3642217.920 | 33.566 | 33.570 |
| 29_SW_NVA-11 | 652908.093 | 3636955.864 | 34.581 | 34.590 |
| 29_SW_NVA-12 | 666294.102 | 3636137.702 | 32.441 | 32.410 |
| 29_SW_NVA-14 | 677432.114 | 3640319.603 | 35.233 | 35.160 |
| 29_SW_NVA-15 | 652616.319 | 3631555.847 | 28.658 | 28.630 |
| 29_SW_NVA-16 | 659601.313 | 3632265.070 | 27.918 | 27.900 |
| 29_SW_NVA-17 | 669198.041 | 3631972.869 | 31.284 | 31.280 |
| 29_SW_NVA-18 | 652342.298 | 3627291.760 | 26.680 | 26.660 |
| 29_SW_NVA-19 | 662207.779 | 3625820.044 | 28.507 | 28.480 |

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|---|---|---|---|---|
| 29_SW_NVA-2 | 658965.608 | 3651630.987 | 39.363 | 39.350 |
| 29_SW_NVA-20 | 665417.914 | 3628609.219 | 28.487 | 28.490 |
| 29_SW_NVA-21 | 670727.514 | 3625900.812 | 42.131 | 42.130 |
| 29_SW_NVA-22 | 657949.842 | 3640292.705 | 29.646 | 29.670 |
| 29_SW_NVA-3 | 665841.633 | 3651591.994 | 34.406 | 34.410 |
| 29_SW_NVA-4 | 652667.346 | 3646671.351 | 34.378 | 34.350 |
| 29_SW_NVA-5 | 658311.647 | 3646782.357 | 35.320 | 35.270 |
| 29_SW_NVA-6 | 666052.503 | 3648363.077 | 33.381 | 33.370 |
| 29_SW_NVA-7 | 652954.625 | 3641840.592 | 36.412 | 36.350 |
| 29_SW_NVA-8 | 661642.085 | 3643614.365 | 29.411 | 29.520 |
| 29_SW_NVA-9 | 668328.608 | 3642305.312 | 34.134 | 34.170 |
| 11_NE_VVA-26 | 564821.866 | 3498038.337 | 31.432 | 31.440 |
| 11_NE_VVA-27 | 570579.078 | 3491603.277 | 20.804 | 20.850 |
| 11_NE_VVA-5 | 568055.464 | 3493602.817 | 22.513 | 22.560 |
| 12_NE_VVA-10 | 567453.770 | 3552522.757 | 51.692 | 51.700 |
| 12_NE_VVA-15 | 568877.701 | 3547728.306 | 37.250 | 37.280 |
| 12_NE_VVA-19 | 566255.388 | 3537905.970 | 46.902 | 46.910 |
| 12_NE_VVA-20 | 570415.481 | 3541367.235 | 51.470 | 51.490 |
| 12_NE_VVA-25 | 569840.832 | 3531834.798 | 40.314 | 40.310 |
| 12_NE_VVA-5 | 568159.988 | 3556911.948 | 66.925 | 66.980 |
| 12_SE_VVA-10 | 569709.265 | 3519702.609 | 43.680 | 43.690 |
| 12_SE_VVA-15 | 570944.994 | 3512739.827 | 53.916 | 53.940 |
| 12_SE_VVA-19 | 562785.918 | 3507512.218 | 22.332 | 22.420 |
| 12_SE_VVA-20 | 568010.634 | 3505823.189 | 30.881 | 30.940 |
| 12_SE_VVA-24 | 562461.032 | 3501500.943 | 22.361 | 22.400 |
| 12_SE_VVA-25 | 570707.525 | 3503911.849 | 51.077 | 51.240 |
| 12_SE_VVA-26 | 569267.001 | 3528270.095 | 44.597 | 44.630 |
| 12_SE_VVA-5 | 568134.948 | 3527710.125 | 38.093 | 38.190 |
| 13_NE_VVA-19 | 560812.419 | 3602607.464 | 26.770 | 26.760 |
| 13_NE_VVA-20 | 568266.885 | 3599489.792 | 54.833 | 54.840 |
| 13_NE_VVA-24 | 560162.987 | 3596148.680 | 39.747 | 39.680 |
| 13_NE_VVA-25 | 569709.830 | 3594516.912 | 37.223 | 37.210 |
| 13_SE_VVA-11 | 569028.999 | 3566100.517 | 59.442 | 59.470 |
| 13_SE_VVA-7 | 562766.072 | 3589206.783 | 42.001 | 41.980 |
| 13_SE_VVA-8 | 570224.972 | 3589957.674 | 42.459 | 42.430 |
| 13_SE_VVA-9 | 563635.703 | 3582999.455 | 62.569 | 62.600 |
| 15_SE_VVA-1 | 610994.626 | 3650329.725 | 29.670 | 29.690 |
| 15_SE_VVA-10 | 621239.997 | 3651676.266 | 50.121 | 50.150 |
| 15_SE_VVA-11 | 647232.631 | 3651126.382 | 31.480 | 31.550 |
| 15_SE_VVA-12 | 650902.570 | 3643469.477 | 33.137 | 33.230 |
| 15_SE_VVA-13 | 651502.352 | 3626290.735 | 25.940 | 25.840 |
| 15_SE_VVA-14 | 641295.690 | 3639755.718 | 30.869 | 30.920 |
| 15_SE_VVA-15 | 633219.270 | 3641587.226 | 28.531 | 28.640 |
| 15_SE_VVA-16 | 641181.527 | 3627422.014 | 28.379 | 28.300 |

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|---|---|---|---|---|
| 15_SE_VVA-17 | 634590.159 | 3634750.981 | 28.008 | 28.090 |
| 15_SE_VVA-18 | 625219.142 | 3637842.489 | 30.045 | 29.640 |
| 15_SE_VVA-19 | 625259.718 | 3631270.205 | 27.343 | 27.380 |
| 15_SE_VVA-2 | 620941.692 | 3649685.213 | 46.018 | 45.960 |
| 15_SE_VVA-20 | 613682.637 | 3625842.309 | 28.295 | 28.290 |
| 15_SE_VVA-21 | 620367.753 | 3638837.345 | 29.156 | 29.260 |
| 15_SE_VVA-22 | 628549.148 | 3626791.516 | 28.476 | 28.450 |
| 15_SE_VVA-23 | 632857.447 | 3639565.208 | 27.664 | 27.690 |
| 15_SE_VVA-3 | 617576.631 | 3644908.684 | 30.106 | 30.120 |
| 15_SE_VVA-4 | 612674.979 | 3631200.679 | 28.064 | 28.160 |
| 15_SE_VVA-5 | 622816.804 | 3641006.447 | 30.864 | 30.890 |
| 15_SE_VVA-6 | 639163.471 | 3650704.592 | 31.039 | 31.070 |
| 15_SE_VVA-7 | 637323.930 | 3644479.649 | 28.704 | 28.740 |
| 15_SE_VVA-8 | 627937.145 | 3649183.664 | 32.088 | 32.130 |
| 15_SE_VVA-9 | 625534.620 | 3651376.297 | 32.677 | 32.670 |
| 15_SW_VVA-1 | 571866.997 | 3650548.190 | 51.249 | 51.290 |
| 15_SW_VVA-10 | 607873.051 | 3645830.544 | 40.093 | 40.130 |
| 15_SW_VVA-11 | 605684.502 | 3637389.425 | 29.087 | 29.170 |
| 15_SW_VVA-12 | 607903.176 | 3635364.805 | 35.228 | 35.220 |
| 15_SW_VVA-13 | 594727.467 | 3632899.195 | 23.659 | 23.630 |
| 15_SW_VVA-14 | 588261.100 | 3636450.489 | 21.757 | 21.790 |
| 15_SW_VVA-15 | 574902.141 | 3634768.252 | 49.796 | 49.880 |
| 15_SW_VVA-16 | 577927.403 | 3625545.940 | 41.658 | 41.620 |
| 15_SW_VVA-17 | 607132.374 | 3629913.570 | 38.488 | 38.500 |
| 15_SW_VVA-18 | 576321.504 | 3628594.188 | 54.541 | 54.540 |
| 15_SW_VVA-19 | 592753.370 | 3625927.232 | 26.897 | 26.910 |
| 15_SW_VVA-2 | 592823.774 | 3651369.635 | 28.007 | 27.990 |
| 15_SW_VVA-20 | 590235.105 | 3628961.637 | 23.599 | 23.570 |
| 15_SW_VVA-21 | 592738.775 | 3644066.533 | 25.067 | 25.110 |
| 15_SW_VVA-22 | 603967.110 | 3624831.613 | 45.644 | 45.720 |
| 15_SW_VVA-3 | 603164.234 | 3646541.197 | 36.102 | 36.070 |
| 15_SW_VVA-4 | 606854.350 | 3651941.091 | 47.028 | 47.110 |
| 15_SW_VVA-5 | 596981.593 | 3647463.824 | 28.835 | 28.830 |
| 15_SW_VVA-6 | 575678.417 | 3640890.002 | 48.166 | 48.200 |
| 15_SW_VVA-7 | 571534.262 | 3645348.360 | 52.818 | 52.840 |
| 15_SW_VVA-8 | 577297.383 | 3644959.185 | 45.026 | 45.150 |
| 15_SW_VVA-9 | 596405.998 | 3640241.550 | 25.909 | 25.980 |
| 16_NE_VVA-1 | 614786.524 | 3622853.551 | 25.171 | 25.190 |
| 16_NE_VVA-10 | 621872.443 | 3612302.903 | 26.496 | 26.530 |
| 16_NE_VVA-11 | 627057.177 | 3611990.255 | 27.177 | 27.200 |
| 16_NE_VVA-12 | 623835.357 | 3614127.898 | 28.787 | 28.850 |
| 16_NE_VVA-13 | 633255.099 | 3612200.189 | 26.983 | 27.080 |
| 16_NE_VVA-14 | 641351.758 | 3614073.587 | 28.871 | 28.940 |
| 16_NE_VVA-15 | 646939.870 | 3610163.038 | 29.274 | 29.300 |

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|---|---|---|---|---|
| 16_NE_VVA-16 | 613645.321 | 3603625.316 | 23.203 | 23.360 |
| 16_NE_VVA-17 | 620824.925 | 3604795.054 | 26.374 | 26.370 |
| 16_NE_VVA-18 | 631888.086 | 3605701.490 | 26.911 | 26.950 |
| 16_NE_VVA-19 | 641231.872 | 3602718.523 | 28.292 | 28.310 |
| 16_NE_VVA-2 | 622217.010 | 3618005.491 | 29.052 | 29.210 |
| 16_NE_VVA-20 | 646930.855 | 3606943.819 | 26.187 | 26.240 |
| 16_NE_VVA-21 | 612205.750 | 3597405.542 | 24.668 | 24.790 |
| 16_NE_VVA-22 | 619289.568 | 3598232.760 | 25.557 | 25.670 |
| 16_NE_VVA-23 | 629113.948 | 3594712.856 | 24.792 | 24.790 |
| 16_NE_VVA-24 | 636400.317 | 3600969.781 | 25.277 | 25.330 |
| 16_NE_VVA-25 | 647163.224 | 3597852.821 | 25.106 | 25.160 |
| 16_NE_VVA-26 | 647711.881 | 3605479.251 | 24.869 | 24.870 |
| 16_NE_VVA-3 | 630833.750 | 3623309.880 | 28.336 | 28.340 |
| 16_NE_VVA-4 | 631175.989 | 3616862.001 | 29.226 | 29.330 |
| 16_NE_VVA-5 | 638722.877 | 3622905.112 | 28.519 | 28.590 |
| 16_NE_VVA-6 | 627021.738 | 3619046.687 | 26.717 | 26.730 |
| 16_NE_VVA-7 | 641302.284 | 3616562.358 | 29.254 | 29.370 |
| 16_NE_VVA-8 | 646184.085 | 3620647.775 | 30.835 | 30.900 |
| 16_NE_VVA-9 | 640521.615 | 3619999.921 | 28.332 | 28.360 |
| 16_NW_VVA-1 | 574918.090 | 3622208.596 | 21.920 | 21.880 |
| 16_NW_VVA-10 | 608582.917 | 3617640.160 | 22.766 | 22.770 |
| 16_NW_VVA-11 | 571456.269 | 3607661.234 | 48.822 | 48.850 |
| 16_NW_VVA-12 | 580667.200 | 3610166.706 | 24.046 | 24.130 |
| 16_NW_VVA-13 | 592738.937 | 3606926.060 | 27.638 | 27.590 |
| 16_NW_VVA-14 | 599685.961 | 3609571.123 | 37.594 | 37.650 |
| 16_NW_VVA-15 | 609185.984 | 3610475.786 | 20.908 | 20.850 |
| 16_NW_VVA-16 | 573155.453 | 3602642.408 | 45.886 | 45.930 |
| 16_NW_VVA-17 | 583104.159 | 3603646.632 | 22.236 | 22.310 |
| 16_NW_VVA-18 | 591695.301 | 3602263.662 | 23.965 | 23.930 |
| 16_NW_VVA-19 | 597239.655 | 3601323.593 | 20.924 | 20.950 |
| 16_NW_VVA-2 | 582536.541 | 3620790.862 | 36.007 | 36.060 |
| 16_NW_VVA-20 | 608799.550 | 3602684.401 | 22.724 | 22.750 |
| 16_NW_VVA-21 | 572098.179 | 3594197.165 | 40.317 | 40.420 |
| 16_NW_VVA-22 | 583183.504 | 3594531.658 | 22.616 | 22.680 |
| 16_NW_VVA-23 | 591274.882 | 3596068.135 | 22.468 | 22.480 |
| 16_NW_VVA-24 | 600254.352 | 3594632.828 | 18.435 | 18.490 |
| 16_NW_VVA-25 | 609491.577 | 3597789.738 | 22.220 | 22.220 |
| 16_NW_VVA-3 | 593359.174 | 3619506.248 | 24.736 | 24.750 |
| 16_NW_VVA-4 | 601458.121 | 3622792.843 | 42.716 | 42.740 |
| 16_NW_VVA-5 | 606490.016 | 3619058.367 | 24.732 | 24.730 |
| 16_NW_VVA-6 | 573237.833 | 3616063.838 | 45.038 | 45.020 |
| 16_NW_VVA-7 | 581443.852 | 3614320.217 | 23.710 | 23.830 |
| 16_NW_VVA-8 | 593501.886 | 3613333.219 | 28.602 | 28.600 |
| 16_NW_VVA-9 | 599728.677 | 3614058.617 | 25.087 | 25.130 |

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| 16_SE_VVA-1 | 652517.608 | 3589644.645 | 22.218 | 22.300 |
| 16_SE_VVA-10 | 616106.057 | 3591903.066 | 24.243 | 24.470 |
| 16_SE_VVA-11 | 611900.894 | 3585746.576 | 21.521 | 21.590 |
| 16_SE_VVA-12 | 628110.779 | 3579891.967 | 24.835 | 25.060 |
| 16_SE_VVA-13 | 630984.242 | 3577862.134 | 25.859 | 25.890 |
| 16_SE_VVA-14 | 622657.552 | 3572587.494 | 23.080 | 23.090 |
| 16_SE_VVA-15 | 612989.188 | 3567617.400 | 17.926 | 18.150 |
| 16_SE_VVA-16 | 615045.506 | 3579336.471 | 22.815 | 22.820 |
| 16_SE_VVA-17 | 613858.837 | 3563280.447 | 21.337 | 21.540 |
| 16_SE_VVA-18 | 618939.456 | 3567288.018 | 22.458 | 22.440 |
| 16_SE_VVA-19 | 624410.902 | 3564667.614 | 24.169 | 24.350 |
| 16_SE_VVA-2 | 643591.266 | 3584123.419 | 24.001 | 24.060 |
| 16_SE_VVA-20 | 641297.142 | 3562370.150 | 20.049 | 20.080 |
| 16_SE_VVA-21 | 633889.367 | 3572710.093 | 27.314 | 27.240 |
| 16_SE_VVA-22 | 635376.178 | 3583841.415 | 26.167 | 26.120 |
| 16_SE_VVA-23 | 638361.382 | 3576439.468 | 27.496 | 27.620 |
| 16_SE_VVA-24 | 647578.103 | 3573121.939 | 22.832 | 22.870 |
| 16_SE_VVA-25 | 622721.737 | 3587758.885 | 24.141 | 24.160 |
| 16_SE_VVA-26 | 619349.770 | 3584624.304 | 24.097 | 24.140 |
| 16_SE_VVA-27 | 613912.822 | 3571653.880 | 21.503 | 21.690 |
| 16_SE_VVA-3 | 636341.819 | 3577239.511 | 27.055 | 27.230 |
| 16_SE_VVA-4 | 645244.244 | 3570905.208 | 21.482 | 21.480 |
| 16_SE_VVA-5 | 644360.310 | 3579158.170 | 22.788 | 22.880 |
| 16_SE_VVA-6 | 646993.448 | 3592402.070 | 25.121 | 25.090 |
| 16_SE_VVA-7 | 640136.040 | 3588801.581 | 28.807 | 28.840 |
| 16_SE_VVA-8 | 632912.828 | 3579807.144 | 24.974 | 25.050 |
| 16_SE_VVA-9 | 624171.209 | 3589465.833 | 23.884 | 24.150 |
| 16_SW_VVA-1 | 571872.178 | 3589721.313 | 27.245 | 27.260 |
| 16_SW_VVA-10 | 611281.741 | 3580527.152 | 22.199 | 22.390 |
| 16_SW_VVA-11 | 571299.007 | 3576235.876 | 62.903 | 63.020 |
| 16_SW_VVA-12 | 581928.841 | 3574883.417 | 21.209 | 21.330 |
| 16_SW_VVA-13 | 596344.290 | 3574450.085 | 20.855 | 21.200 |
| 16_SW_VVA-14 | 600455.630 | 3578692.837 | 20.736 | 20.810 |
| 16_SW_VVA-15 | 611263.453 | 3576527.996 | 20.865 | 20.950 |
| 16_SW_VVA-16 | 570779.380 | 3571055.858 | 34.861 | 34.920 |
| 16_SW_VVA-17 | 574819.059 | 3567596.947 | 55.807 | 55.800 |
| 16_SW_VVA-18 | 585112.452 | 3568304.799 | 19.515 | 19.640 |
| 16_SW_VVA-19 | 597565.316 | 3572203.496 | 20.815 | 20.830 |
| 16_SW_VVA-2 | 584319.491 | 3587242.453 | 21.647 | 21.690 |
| 16_SW_VVA-20 | 606646.153 | 3571706.508 | 18.935 | 18.970 |
| 16_SW_VVA-21 | 572065.319 | 3564191.988 | 62.883 | 62.930 |
| 16_SW_VVA-22 | 583616.789 | 3563013.094 | 21.793 | 21.980 |
| 16_SW_VVA-23 | 593310.059 | 3565393.332 | 19.500 | 19.650 |
| 16_SW_VVA-24 | 597217.778 | 3564235.211 | 19.464 | 19.520 |

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| 16_SW_VVA-25 | 611130.811 | 3563899.203 | 19.497 | 19.620 |
| 16_SW_VVA-3 | 594119.427 | 3591450.226 | 19.179 | 19.120 |
| 16_SW_VVA-4 | 601152.863 | 3587633.736 | 19.663 | 19.640 |
| 16_SW_VVA-5 | 610327.783 | 3587969.099 | 24.398 | 24.370 |
| 16_SW_VVA-6 | 574519.117 | 3580601.990 | 59.183 | 59.200 |
| 16_SW_VVA-7 | 583419.706 | 3582254.316 | 22.305 | 22.430 |
| 16_SW_VVA-8 | 594544.832 | 3585035.938 | 19.724 | 19.710 |
| 16_SW_VVA-9 | 600792.897 | 3583130.213 | 22.766 | 22.820 |
| 17_NE_VVA-1 | 614773.383 | 3558304.838 | 20.244 | 20.280 |
| 17_NE_VVA-10 | 649318.175 | 3552742.452 | 20.936 | 20.960 |
| 17_NE_VVA-11 | 613973.912 | 3547291.416 | 19.436 | 19.350 |
| 17_NE_VVA-12 | 621814.722 | 3544917.772 | 18.283 | 18.340 |
| 17_NE_VVA-13 | 627607.404 | 3548801.044 | 22.878 | 23.040 |
| 17_NE_VVA-14 | 638259.157 | 3543215.378 | 17.406 | 17.790 |
| 17_NE_VVA-15 | 649745.709 | 3547852.877 | 21.386 | 21.410 |
| 17_NE_VVA-16 | 617338.087 | 3540298.028 | 19.464 | 19.470 |
| 17_NE_VVA-17 | 622865.281 | 3539939.211 | 23.037 | 23.090 |
| 17_NE_VVA-18 | 633848.092 | 3537722.994 | 19.244 | 19.240 |
| 17_NE_VVA-19 | 641407.758 | 3542554.608 | 18.145 | 18.170 |
| 17_NE_VVA-2 | 625248.007 | 3558807.871 | 24.212 | 24.330 |
| 17_NE_VVA-20 | 652575.583 | 3540271.838 | 20.712 | 20.690 |
| 17_NE_VVA-21 | 614342.147 | 3533239.390 | 20.215 | 20.520 |
| 17_NE_VVA-22 | 622439.858 | 3533151.090 | 18.773 | 18.790 |
| 17_NE_VVA-23 | 627027.212 | 3535666.837 | 19.163 | 19.280 |
| 17_NE_VVA-24 | 639746.092 | 3533383.308 | 16.889 | 16.930 |
| 17_NE_VVA-25 | 650327.691 | 3535317.521 | 19.768 | 19.920 |
| 17_NE_VVA-3 | 634480.054 | 3560108.510 | 21.015 | 21.090 |
| 17_NE_VVA-4 | 644598.139 | 3561661.389 | 20.046 | 20.220 |
| 17_NE_VVA-5 | 651606.551 | 3555983.342 | 21.684 | 21.900 |
| 17_NE_VVA-6 | 617495.255 | 3553020.111 | 18.398 | 18.460 |
| 17_NE_VVA-7 | 622102.929 | 3554171.183 | 21.718 | 21.900 |
| 17_NE_VVA-8 | 630269.580 | 3549805.889 | 23.968 | 24.060 |
| 17_NE_VVA-9 | 639346.210 | 3551680.210 | 19.344 | 19.450 |
| 17_NW_VVA-1 | 574481.519 | 3560808.652 | 55.654 | 55.730 |
| 17_NW_VVA-10 | 593746.999 | 3546252.736 | 19.414 | 19.490 |
| 17_NW_VVA-11 | 605274.189 | 3548746.479 | 19.567 | 19.560 |
| 17_NW_VVA-12 | 606767.642 | 3540257.388 | 19.306 | 19.410 |
| 17_NW_VVA-13 | 610981.141 | 3534722.280 | 17.976 | 18.180 |
| 17_NW_VVA-15 | 591249.068 | 3543907.096 | 72.614 | 72.610 |
| 17_NW_VVA-16 | 597339.626 | 3539420.997 | 19.553 | 19.570 |
| 17_NW_VVA-17 | 590433.311 | 3531742.517 | 62.287 | 62.410 |
| 17_NW_VVA-18 | 584150.058 | 3540080.692 | 55.134 | 55.220 |
| 17_NW_VVA-19 | 580761.400 | 3530595.168 | 56.487 | 56.420 |
| 17_NW_VVA-2 | 579356.427 | 3556642.360 | 63.090 | 63.090 |

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| 17_NW_VVA-20 | 588395.592 | 3540265.669 | 54.860 | 54.940 |
| 17_NW_VVA-21 | 590691.822 | 3538138.395 | 63.575 | 63.670 |
| 17_NW_VVA-22 | 570985.631 | 3531251.281 | 39.950 | 40.040 |
| 17_NW_VVA-23 | 580410.233 | 3540644.235 | 53.781 | 53.810 |
| 17_NW_VVA-24 | 572360.183 | 3537717.038 | 28.954 | 29.040 |
| 17_NW_VVA-25 | 588925.906 | 3548958.531 | 18.823 | 18.840 |
| 17_NW_VVA-26 | 581181.117 | 3551472.323 | 64.624 | 64.680 |
| 17_NW_VVA-27 | 571688.387 | 3546480.179 | 49.483 | 49.520 |
| 17_NW_VVA-28 | 576752.932 | 3551682.477 | 51.143 | 51.190 |
| 17_NW_VVA-29 | 579062.505 | 3534543.209 | 62.532 | 62.550 |
| 17_NW_VVA-3 | 590441.362 | 3556993.543 | 17.817 | 18.080 |
| 17_NW_VVA-30 | 571216.794 | 3558270.795 | 41.496 | 41.490 |
| 17_NW_VVA-31 | 607535.434 | 3541917.157 | 19.149 | 19.210 |
| 17_NW_VVA-4 | 592408.084 | 3546937.716 | 19.520 | 19.630 |
| 17_NW_VVA-5 | 599739.435 | 3556408.922 | 18.942 | 19.110 |
| 17_NW_VVA-6 | 606904.013 | 3561753.441 | 18.124 | 18.170 |
| 17_NW_VVA-7 | 611777.487 | 3559706.110 | 20.976 | 21.150 |
| 17_NW_VVA-8 | 605433.499 | 3555618.197 | 16.325 | 16.360 |
| 17_NW_VVA-9 | 611612.236 | 3551644.269 | 19.787 | 19.880 |
| 17_SE_VVA-10 | 649555.148 | 3523990.410 | 19.679 | 19.690 |
| 17_SE_VVA-13 | 635913.749 | 3517914.876 | 18.228 | 18.260 |
| 17_SE_VVA-14 | 641932.318 | 3517983.641 | 18.254 | 18.260 |
| 17_SE_VVA-15 | 651892.250 | 3516549.114 | 17.760 | 17.770 |
| 17_SE_VVA-4 | 645650.459 | 3527765.935 | 19.266 | 19.370 |
| 17_SE_VVA-5 | 648721.277 | 3530095.756 | 19.204 | 19.220 |
| 17_SE_VVA-8 | 637983.033 | 3523661.575 | 19.808 | 19.800 |
| 17_SE_VVA-9 | 643823.706 | 3519512.877 | 17.831 | 17.880 |
| 17_SW_VVA-1 | 572881.577 | 3527403.588 | 33.464 | 33.450 |
| 17_SW_VVA-11 | 578157.199 | 3517553.970 | 55.234 | 55.140 |
| 17_SW_VVA-12 | 588461.840 | 3510486.504 | 70.255 | 70.380 |
| 17_SW_VVA-16 | 572293.450 | 3511050.503 | 48.722 | 48.720 |
| 17_SW_VVA-17 | 578151.431 | 3511270.515 | 53.919 | 53.900 |
| 17_SW_VVA-2 | 580280.985 | 3529595.208 | 42.215 | 42.190 |
| 17_SW_VVA-21 | 575178.206 | 3503184.512 | 54.281 | 54.370 |
| 17_SW_VVA-22 | 580963.602 | 3500367.058 | 61.045 | 61.010 |
| 17_SW_VVA-23 | 588650.124 | 3501040.356 | 65.118 | 65.120 |
| 17_SW_VVA-3 | 592924.736 | 3527609.425 | 79.275 | 79.280 |
| 17_SW_VVA-6 | 574421.585 | 3523988.293 | 44.648 | 44.620 |
| 17_SW_VVA-7 | 583841.763 | 3522099.911 | 62.678 | 62.720 |
| 17_SW_VVA-8 | 590487.398 | 3522432.343 | 68.754 | 68.800 |
| 18_NW_VVA-1 | 576588.141 | 3495173.670 | 57.377 | 57.310 |
| 18_NW_VVA-11 | 575590.104 | 3487999.365 | 35.515 | 35.510 |
| 18_NW_VVA-12 | 576323.703 | 3485105.703 | 23.739 | 23.940 |
| 18_NW_VVA-13 | 588132.291 | 3482778.674 | 14.407 | 14.520 |

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| 18_NW_VVA-14 | 593980.422 | 3482180.479 | 16.173 | 16.270 |
| 18_NW_VVA-18 | 594014.335 | 3477922.948 | 15.658 | 15.730 |
| 18_NW_VVA-2 | 580767.660 | 3493022.698 | 29.886 | 29.880 |
| 18_NW_VVA-26 | 586863.052 | 3473783.182 | 13.869 | 13.920 |
| 18_NW_VVA-3 | 587304.928 | 3497579.879 | 28.492 | 28.650 |
| 18_NW_VVA-6 | 575133.541 | 3492104.997 | 56.975 | 56.990 |
| 18_NW_VVA-7 | 579093.804 | 3489319.960 | 53.782 | 53.820 |
| 27_NW_VVA-1 | 654995.850 | 3561721.033 | 21.284 | 21.360 |
| 27_NW_VVA-3 | 656811.246 | 3554759.421 | 17.462 | 17.510 |
| 27_NW_VVA-5 | 654308.491 | 3547975.672 | 20.092 | 20.250 |
| 27_NW_VVA-6 | 667748.580 | 3549915.428 | 21.449 | 21.800 |
| 27_NW_VVA-7 | 668252.005 | 3543409.857 | 22.302 | 22.290 |
| 27_NW_VVA-8 | 662934.231 | 3536761.973 | 21.858 | 21.950 |
| 27_NW_VVA-9 | 658377.340 | 3532963.721 | 19.510 | 19.710 |
| 27_SW_VVA-1 | 656406.296 | 3530259.327 | 20.729 | 21.040 |
| 27_SW_VVA-2 | 653792.869 | 3528920.186 | 19.876 | 20.050 |
| 27_SW_VVA-3 | 662757.683 | 3528694.833 | 18.945 | 19.110 |
| 27_SW_VVA-4 | 656011.806 | 3527279.727 | 19.200 | 19.340 |
| 27_SW_VVA-5 | 653809.983 | 3523647.691 | 19.699 | 19.640 |
| 28_NW_VVA-1 | 661721.886 | 3623073.777 | 26.939 | 26.940 |
| 28_NW_VVA-10 | 675028.638 | 3602122.852 | 26.890 | 26.890 |
| 28_NW_VVA-11 | 652694.154 | 3602682.900 | 26.031 | 26.060 |
| 28_NW_VVA-12 | 663019.281 | 3599246.584 | 24.596 | 24.780 |
| 28_NW_VVA-13 | 653676.766 | 3594682.369 | 23.699 | 23.800 |
| 28_NW_VVA-14 | 668738.390 | 3593975.060 | 24.340 | 24.500 |
| 28_NW_VVA-15 | 675518.554 | 3599246.383 | 28.537 | 28.500 |
| 28_NW_VVA-16 | 669986.529 | 3597481.620 | 25.276 | 25.470 |
| 28_NW_VVA-2 | 670017.822 | 3621350.012 | 28.790 | 28.770 |
| 28_NW_VVA-3 | 657434.348 | 3617265.506 | 27.289 | 27.340 |
| 28_NW_VVA-4 | 660897.572 | 3616886.354 | 25.003 | 25.060 |
| 28_NW_VVA-5 | 667492.502 | 3619336.345 | 27.281 | 27.310 |
| 28_NW_VVA-6 | 656394.570 | 3614161.735 | 26.658 | 26.710 |
| 28_NW_VVA-7 | 665591.797 | 3611221.696 | 26.229 | 26.550 |
| 28_NW_VVA-8 | 653132.369 | 3609320.500 | 26.551 | 26.540 |
| 28_NW_VVA-9 | 665713.078 | 3606508.393 | 26.188 | 26.270 |
| 28_SW_VVA-1 | 653322.325 | 3589431.686 | 24.621 | 24.620 |
| 28_SW_VVA-10 | 677653.525 | 3578757.800 | 24.494 | 24.540 |
| 28_SW_VVA-11 | 664194.643 | 3585508.123 | 21.983 | 21.980 |
| 28_SW_VVA-12 | 668577.955 | 3579640.970 | 22.556 | 22.720 |
| 28_SW_VVA-13 | 658145.586 | 3583992.151 | 23.011 | 23.110 |
| 28_SW_VVA-14 | 654444.643 | 3578311.309 | 22.210 | 22.420 |
| 28_SW_VVA-15 | 654892.716 | 3571067.842 | 22.191 | 22.260 |
| 28_SW_VVA-16 | 654880.523 | 3567423.156 | 22.065 | 22.210 |
| 28_SW_VVA-17 | 668459.589 | 3572237.262 | 23.691 | 23.730 |

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| 28_SW_VVA-18 | 676528.702 | 3566805.295 | 25.706 | 25.840 |
| 28_SW_VVA-19 | 666490.310 | 3564880.602 | 24.996 | 25.020 |
| 28_SW_VVA-2 | 661138.435 | 3591603.360 | 24.795 | 24.800 |
| 28_SW_VVA-20 | 680492.289 | 3575507.050 | 25.534 | 25.520 |
| 28_SW_VVA-21 | 670308.515 | 3583469.754 | 24.456 | 24.480 |
| 28_SW_VVA-22 | 672990.531 | 3578296.901 | 23.748 | 23.740 |
| 28_SW_VVA-23 | 671522.997 | 3573583.125 | 24.299 | 24.290 |
| 28_SW_VVA-3 | 673065.695 | 3591231.605 | 24.305 | 24.320 |
| 28_SW_VVA-4 | 678316.248 | 3588189.903 | 27.644 | 27.650 |
| 28_SW_VVA-5 | 679820.675 | 3586048.898 | 25.277 | 25.400 |
| 28_SW_VVA-6 | 688916.869 | 3579706.825 | 26.010 | 26.020 |
| 28_SW_VVA-7 | 683408.395 | 3575728.429 | 26.124 | 26.210 |
| 28_SW_VVA-8 | 692070.269 | 3576228.032 | 25.638 | 25.680 |
| 28_SW_VVA-9 | 683049.234 | 3572616.802 | 23.337 | 23.370 |
| 29_SW_VVA-1 | 655702.793 | 3647323.090 | 35.270 | 35.390 |
| 29_SW_VVA-10 | 670645.162 | 3628501.534 | 30.915 | 30.910 |
| 29_SW_VVA-11 | 653966.653 | 3640266.945 | 33.976 | 34.080 |
| 29_SW_VVA-2 | 667444.538 | 3647895.535 | 33.348 | 33.470 |
| 29_SW_VVA-3 | 665078.516 | 3640770.154 | 30.109 | 30.130 |
| 29_SW_VVA-4 | 678956.489 | 3644651.308 | 32.961 | 32.940 |
| 29_SW_VVA-5 | 660638.226 | 3636811.574 | 28.337 | 28.310 |
| 29_SW_VVA-6 | 653504.131 | 3633790.935 | 30.662 | 30.770 |
| 29_SW_VVA-7 | 668517.286 | 3634769.110 | 30.889 | 30.900 |
| 29_SW_VVA-8 | 654994.669 | 3625739.023 | 27.869 | 27.900 |
| 29_SW_VVA-9 | 660467.412 | 3625794.675 | 27.944 | 28.020 |

**Table 8- LA DOTD NE Lidar Project surveyed accuracy checkpoints**

There were nine checkpoints that were ecluded from vertical accuracy testing. Three because they fell outside the project boundary, four that had a vehicle or equipment parked over the point in the lidar, one that was flooded in the lidar, and one that was very dense vegetation in the lidar. Even with the removal of these nine points, there are enough total checkpoints and enough checkpoints per land cover category to satisfy project requirements. The image below shows a graphic of the checkpoints and those removed from testing (large green dots).

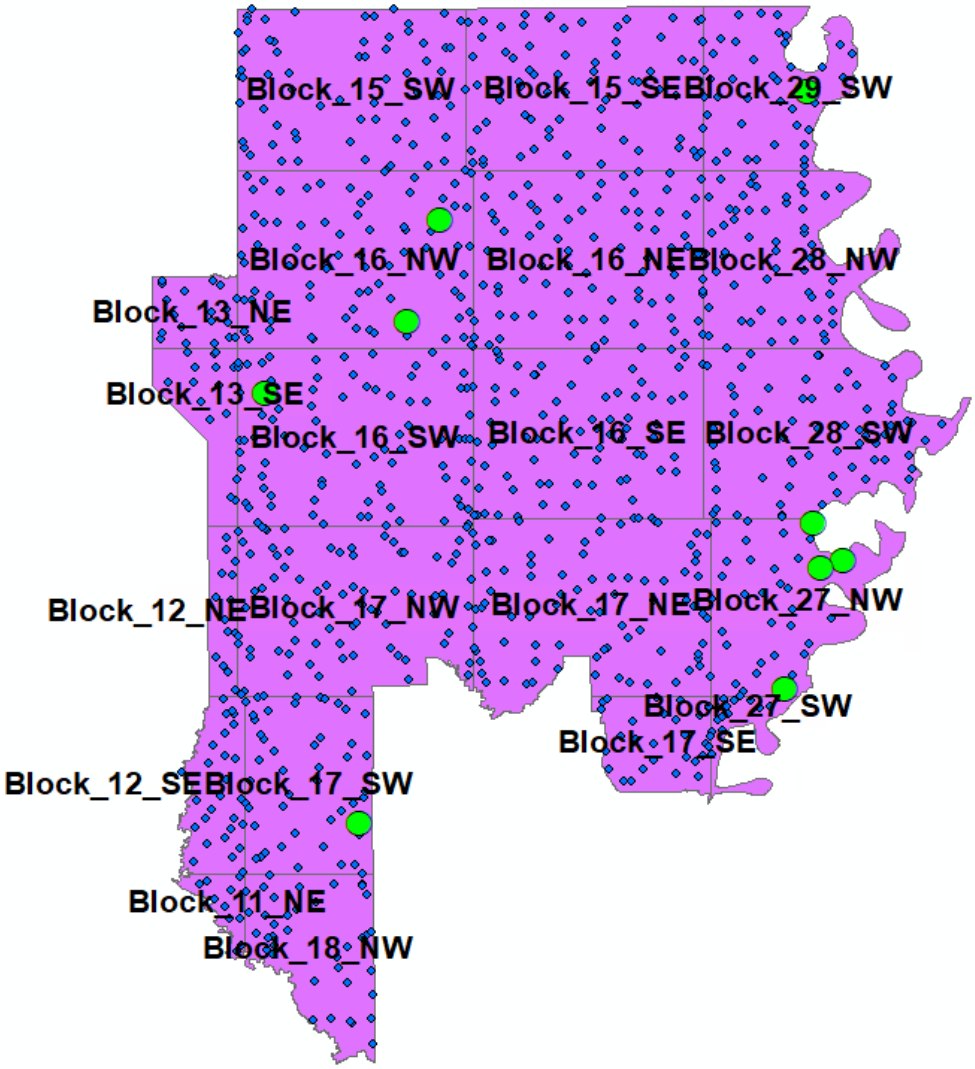


**Figure 15-Image of the project area showing checkpoints. Checkpoints in green identify the checkpoints excluded from testing**

The coordinates of these nine excluded checkpoints are provided in the table below.

| Point ID | NAD83(2011) UTM 15 | | NAVD88 (Geoid 12B) | Lidar Z (m) | Delta Z | AbsDeltaZ | Comment |
|---|---|---|---|---|---|---|---|
| | Easting X (m) | Northing Y (m) | Survey Z (m) | | | | |
| 27_NW_NVA-8 | 677570.140 | 3555018.838 | 23.243 | Outside | -23.243 | 23.243 | Out |
| 17_SW_VVA- | 591775.969 | 3508356.596 | 68.240 | 67.810 | -0.430 | 0.430 | Truck |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 18 | | | | | | | |
| 27_NW_VVA-10 | 667043.907 | 3532228.088 | 22.045 | Outside | -22.045 | 22.045 | Out |
| 27_NW_VVA-2 | 672286.366 | 3561626.903 | 25.225 | Outside | -25.225 | 25.225 | Out |
| 27_NW_VVA-4 | 673392.818 | 3553568.298 | 23.341 | 24.630 | 1.289 | 1.289 | Submerged |
| 16_NW_NVA-13 | 606107.086 | 3615175.976 | 23.129 | 25.190 | 2.061 | 2.061 | Dense veg |
| 16_NW_NVA-34 | 600303.559 | 3597418.373 | 21.201 | 23.930 | 2.729 | 23.243 | Equipment |
| 16_SW_NVA-8 | 574984.947 | 3584652.590 | 36.707 | Slope | -36.707 | 0.430 | Car |
| 29_SW_NVA-13 | 671202.375 | 3638065.176 | 30.981 | Slope | -30.981 | 30.981 | Car |

**Table 9- Checkpoints excluded from vertical accuracy testing due to their location outside the project boundary or being obscured in the lidar.**

## VERTICAL ACCURACY TEST PROCEDURES

**NVA** (Non-vegetated Vertical Accuracy) is determined with check points located only in non-vegetated terrain, including open terrain (grass, dirt, sand, and/or rocks) and urban areas, where there is a very high probability that the lidar sensor will have detected the bare-earth ground surface and where random errors are expected to follow a normal error distribution. The NVA determines how well the calibrated lidar sensor performed. With a normal error distribution, the vertical accuracy at the 95% confidence level is computed as the vertical root mean square error ($RMSE_z$) of the checkpoints x 1.9600. For the LA_DOTD NE Lidar Project, vertical accuracy must be 19.6 cm or less based on an $RMSE_z$ of 10 cm x 1.9600.

**VVA** (Vegetated Vertical Accuracy) is determined with all checkpoints in vegetated land cover categories, including tall grass, weeds, crops, brush and low trees, and fully forested areas, where there is a possibility that the lidar sensor and post-processing may yield elevation errors that do not follow a normal error distribution. VVA at the 95% confidence level equals the 95$^{th}$ percentile error for all checkpoints in all vegetated land cover categories combined. The LA_DOTD NE Lidar Project VVA standard is 29.4 cm based on the 95$^{th}$ percentile. The VVA is accompanied by a listing of the 5% outliers that are larger than the 95$^{th}$ percentile used to compute the VVA; these are always the largest outliers that may depart from a normal error distribution. Here, $Accuracy_z$ differs from VVA because $Accuracy_z$ assumes elevation errors follow a normal error distribution where RMSE procedures are valid, whereas VVA assumes lidar errors may not follow a normal error distribution in vegetated categories, making the RMSE process invalid.

| Quantitative Criteria | Measure of Acceptability |
|---|---|
| Non-Vegetated Vertical Accuracy (NVA) in open terrain and urban land cover categories using $RMSE_z$ *1.9600 | 19.6 cm (based on $RMSE_z$ (10 cm) * 1.9600) |
| Vegetated Vertical Accuracy (VVA) in all vegetated land cover categories | 29.4 cm (based on combined 95$^{th}$ |

| | |
|---|---|
| combined at the 95% confidence level | percentile) |

Table 10 – Acceptance Criteria

The primary QA/QC vertical accuracy testing steps used by Dewberry are summarized as follows:

1. Dewberry's team surveyed QA/QC vertical checkpoints in accordance with the project's specifications.
2. Next, Dewberry and LA DOTD interpolated the bare-earth lidar DTM to provide the z-value for every checkpoint.
3. Dewberry then computed the associated z-value differences between the interpolated z-value from the lidar data and the ground truth survey checkpoints and computed NVA, VVA, and other statistics.
4. The data were analyzed by Dewberry to assess the accuracy of the data. The review process examined the various accuracy parameters as defined by the scope of work. The overall descriptive statistics of each dataset were computed to assess any trends or anomalies. This report provides tables, graphs and figures to summarize and illustrate data quality.

## VERTICAL ACCURACY RESULTS

The table below summarizes the tested vertical accuracy resulting from a comparison of the surveyed checkpoints to the elevation values present within the fully classified lidar LAS files.

| Land Cover Category | # of Points | NVA – Non-vegetated Vertical Accuracy ($RMSE_z$ x 1.9600) Spec=19.6 cm | VVA – Vegetated Vertical Accuracy (95th Percentile) Spec=29.4 cm |
|---|---|---|---|
| NVA | 483 | 8.7 | |
| VVA | 322 | | 20.1 |

Table 11 – Tested NVA and VVA

This lidar dataset was tested to meet ASPRS Positional Accuracy Standards for Digital Geospatial Data (2014) for a 10 cm RMSEz Vertical Accuracy Class. Actual NVA accuracy was found to be $RMSE_z$ =7 cm, equating to +/- 10 cm at 95% confidence level. Actual VVA accuracy was found to be +/- 11.6 cm at the 95th percentile.

Table 7 provides overall descriptive statistics.

| LiDAR Descriptive Statistics | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 100 % of Totals | # of Points | RMSEz (m) Spec=0.100 m NVA/ 0.180 m Submerged Topography | Mean (m) | Median (m) | Skew | Std Dev (m) | Kurtosis | Min (m) | Max (m) |
| NVA | 483 | 0.045 | 0.002 | 0.003 | -1.148 | 0.045 | 9.836 | -0.365 | 0.144 |
| VVA | 322 | N/A | 0.055 | 0.039 | 0.516 | 0.081 | 4.693 | -0.405 | 0.384 |

Table 12 – Overall Descriptive Statistics

**Based on the vertical accuracy testing conducted by Dewberry and LA DOTD, the lidar dataset for the LA DOTD Amite NE Lidar Project satisfies the project's pre-defined vertical accuracy criteria.**

### HORIZONTAL ACCURACY TEST PROCEDURES

Horizontal accuracy testing requires well-defined checkpoints that can be identified in the dataset. Elevation datasets, including lidar datasets, do not always contain well-defined checkpoints suitable for horizontal accuracy assessment. However, the ASPRS Positional Accuracy Standards for Digital Geospatial Data (2014) recommends at least half of the NVA vertical check points should be located at the ends of paint stripes or other point features visible on the lidar intensity image, allowing them to double as horizontal check points.

### HORIZONTAL ACCURACY RESULTS

No checkpoints were photo-identifiable in the intensity imagery; horizontal accuracy could not be tested on this dataset.

## Breakline Production & Qualitative Assessment Report

### BREAKLINE PRODUCTION METHODOLOGY

Dewberry and LA DOTD used GeoCue software to develop lidar stereo models of the project area so the lidar derived data could be viewed in 3-D stereo using SOCET GXP (Dewberry) or Cardinal Systems VR (LA DOTD) softcopy photogrammetric software. Using lidargrammetry procedures with lidar intensity imagery, analysts used the stereo models to stereo-compile the two types of hydrographic breaklines in accordance with the project's Data Dictionary.

All drainage breaklines are monotonically enforced to show downhill flow. Water bodies are at a constant elevation where the lowest elevation of the water body has been applied to the entire water body.

### BREAKLINE QUALITATIVE ASSESSMENT

Dewberry completed breakline qualitative assessments according to a defined workflow. The following workflow diagram represents the steps taken by Dewberry and LA DOTD to provide a thorough qualitative assessment of the breakline data.

Completeness and horizontal placement is verified through visual reviews against lidar intensity imagery. Automated checks are applied on all breakline features to validate topology, including the 3D connectivity of features, enforced monotonicity on linear hydrographic breaklines, and flatness on water bodies.

The next step is to compare the elevation of the breakline vertices against the ground elevation extracted from the ESRI Terrain built from the lidar ground points, keeping in mind that a discrepancy is expected because of the hydro-enforcement applied to the breaklines and because of the interpolated imagery used to acquire the breaklines. A given tolerance is used to validate if the elevations differ too much from the lidar.

After all corrections and edits to the breakline features, the breaklines are imported into the final GDB and verified for correct formatting.

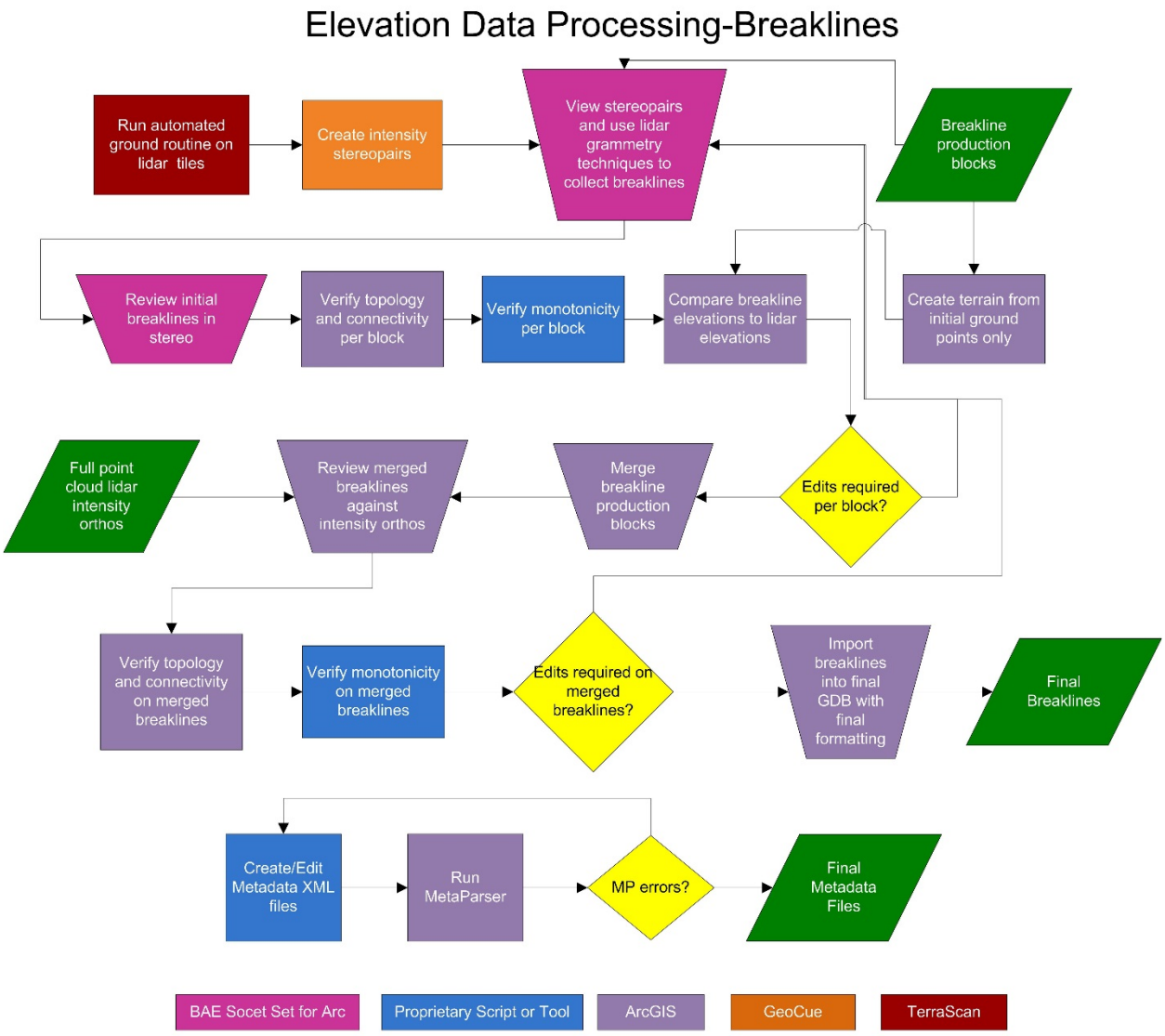


**Figure 16-Breakline QA/QC workflow**

## BREAKLINE CHECKLIST

The following table represents a portion of the high-level steps in production and QA/QC checklist that were performed for this project.

| Pass/Fail | Validation Step |
|---|---|
| Pass | Use lidar-derived data, which may include intensity imagery, stereo pairs, bare earth ground models, density models, slope models, and terrains, to collect breaklines according to project specifications. |

| | |
|---|---|
| Pass | In areas of heavy vegetation or where the exact shoreline is hard to delineate, it is better to err on placing the breakline *slightly* inside or seaward of the shoreline (breakline can be inside shoreline by 1x-2x NPS). |
| Pass | After each producer finishes breakline collection for a block, each producer must perform a completeness check, breakline variance check, and all automated checks on their block before calling that block complete and ready for the final merge and QC |
| Pass | After breaklines are completed for production blocks, all production blocks should be merged together and completeness and automated checks should be performed on the final, merged GDB. Ensure correct snapping-horizontal (x,y) and vertical (z)-between all production blocks. |
| Pass | Check entire dataset for missing features that were not captured, but should be to meet baseline specifications or for consistency. Features should be collected consistently across tile bounds. Check that the horizontal placement of breaklines is correct. Breaklines should be compared to full point cloud intensity imagery and terrains |
| Pass | Breaklines are correctly edge-matched to adjoining datasets in completion, coding, and horizontal placement. |
| Pass | Using a terrain created from lidar ground (all ground including 2, 8, and 10) and water points (class 9), compare breakline Z values to interpolated lidar elevations. |
| Pass | Perform all Topology and Data Integrity Checks |
| Pass | Perform hydro-flattening and hydro-enforcement checks including monotonicity and flatness from bank to bank on linear hydrographic features and flatness of water bodies. Tidal waters should preserve as much ground as possible and can include variations or be non-monotonic. |

**Table 13-A subset of the high-level steps from production and QA/QC checklist performed for this project.**

# DATA DICTIONARY

The following data dictionary was used for this project.

## Horizontal and Vertical Datum

The horizontal datum shall be North American Datum of 1983(2011), Units in Meters. The vertical datum shall be referenced to the North American Vertical Datum of 1988 (NAVD 88), Units in Meters. Geoid12B shall be used to convert ellipsoidal heights to orthometric heights.

## Coordinate System and Projection

All data shall be projected to UTM Zone 15, Horizontal Units in Meters and Vertical Units in Meters.

## Inland Streams and Rivers

**Feature Dataset:** BREAKLINES
**Feature Type:** Polygon
**Contains Z Values:** Yes
**XY Resolution:** Accept Default Setting
**XY Tolerance:** 0.003

**Feature Class:** STREAMS_AND_RIVERS
**Contains M Values:** No
**Annotation Subclass:** None
**Z Resolution:** Accept Default Setting
**Z Tolerance:** 0.001

### Description

This polygon feature class will depict linear hydrographic features with a width greater than 100 feet.

### Table Definition

| Field Name | Data Type | Allow Null Values | Default Value | Domain | Precision | Scale | Length | Responsibility |
|---|---|---|---|---|---|---|---|---|

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| OBJECTID | Object ID | | | | | | | Assigned by Software |
| SHAPE | Geometry | | | | | | | Assigned by Software |
| SHAPE_LENGTH | Double | Yes | | | 0 | 0 | | Calculated by Software |
| SHAPE_AREA | Double | Yes | | | 0 | 0 | | Calculated by Software |

## Feature Definition

| Description | Definition | Capture Rules |
|---|---|---|
| Streams and Rivers | Linear hydrographic features such as streams, rivers, canals, etc. with an average width greater than 100 feet. In the case of embankments, if the feature forms a natural dual line channel, then capture it consistent with the capture rules. Other natural or manmade embankments will not qualify for this project. | Capture features showing dual line (one on each side of the feature). Average width shall be greater than 100 feet to show as a double line. Each vertex placed should maintain vertical integrity. Generally both banks shall be collected to show consistent downhill flow. There are exceptions to this rule where a small branch or offshoot of the stream or river is present.<br><br>The banks of the stream must be captured at the same elevation to ensure flatness of the water feature. If the elevation of the banks appears to be different see the task manager or PM for further guidance.<br><br>Breaklines must be captured at or just below the elevations of the immediately surrounding terrain. Under no circumstances should a feature be elevated above the surrounding lidar points. Acceptable variance in the negative direction will be defined for each project individually.<br><br>These instructions are only for docks or piers that follow the coastline or water's edge, not for docks or piers that extend perpendicular from the land into the water. If it can be reasonably determined where the edge of water most probably falls, beneath the dock or pier, then the edge of water will be collected at the elevation of the water where it can be directly measured. If there is a clearly-indicated headwall or bulkhead adjacent to the dock or pier and it is evident that the waterline is most probably adjacent to the headwall or bulkhead, then the water line will follow the headwall or bulkhead at the elevation of the water where it can be directly measured. If there is no clear indication of the location of the water's edge beneath the dock or pier, then the edge of water will follow the outer edge of the dock or pier as it is adjacent to the water, at the measured elevation of the water.<br><br>Every effort should be made to avoid breaking a stream or river into segments.<br><br>Dual line features shall break at road crossings (culverts). In areas where a bridge is present the dual line feature shall continue through the bridge.<br><br>Islands: The double line stream shall be captured around an island if the island is greater than 1 acre. In this case a segmented polygon shall be used around the island in order to allow for the island feature to remain as a "hole" in the feature. |

## Inland Ponds and Lakes

**Feature Dataset:** BREAKLINES
**Feature Type:** Polygon
**Contains Z Values:** Yes
**XY Resolution:** Accept Default Setting
**XY Tolerance:** 0.003

**Feature Class:** PONDS_AND_LAKES
**Contains M Values:** No
**Annotation Subclass:** None
**Z Resolution:** Accept Default Setting
**Z Tolerance:** 0.001

### Description

This polygon feature class will depict closed water body features that are at a constant elevation.

### Table Definition

| Field Name | Data Type | Allow Null Values | Default Value | Domain | Precision | Scale | Length | Responsibility |
|---|---|---|---|---|---|---|---|---|
| OBJECTID | Object ID | | | | | | | Assigned by Software |
| SHAPE | Geometry | | | | | | | Assigned by Software |
| SHAPE_LENGTH | Double | Yes | | | 0 | 0 | | Calculated by Software |
| SHAPE_AREA | Double | Yes | | | 0 | 0 | | Calculated by Software |

### Feature Definition

| Description | Definition | Capture Rules |
|---|---|---|
| Ponds and Lakes | Land/Water boundaries of constant elevation water bodies such as lakes, reservoirs, ponds, etc. Features shall be defined as closed polygons and contain an elevation value that reflects the best estimate of the water elevation at the time of data capture. Water body features will be captured for features 2 acres in size or greater.<br><br>"Donuts" will exist where there are islands within a closed water body feature. | Water bodies shall be captured as closed polygons with the water feature to the right. The compiler shall take care to ensure that the z-value remains consistent for all vertices placed on the water body.<br><br>Breaklines must be captured at or just below the elevations of the immediately surrounding terrain. Under no circumstances should a feature be elevated above the surrounding lidar points. Acceptable variance in the negative direction will be defined for each project individually.<br><br>An Island within a Closed Water Body Feature that is 1 acre in size or greater will also have a "donut polygon" compiled.<br><br>These instructions are only for docks or piers that follow the coastline or water's edge, not for docks or piers that extend perpendicular from the land into the water. If it can be reasonably determined where the edge of water most probably falls, beneath the dock or pier, then the edge of water will be collected at the elevation of the water where it can be directly measured. If there is a clearly-indicated headwall or bulkhead adjacent to the dock or pier and it is evident that the waterline is most probably adjacent to the headwall or bulkhead, then the water line will follow the headwall or bulkhead at the elevation of the water where it can be directly measured. |

| | | |
|---|---|---|
| | | If there is no clear indication of the location of the water's edge beneath the dock or pier, then the edge of water will follow the outer edge of the dock or pier as it is adjacent to the water, at the measured elevation of the water. |

## Bridge Saddle Breaklines

**Feature Dataset:** BREAKLINES
**Feature Type:** Polyline
**Contains Z Values:** Yes
**XY Resolution:** Accept Default Setting
**XY Tolerance:** 0.003

**Feature Class:** Bridge_Breaklines
**Contains M Values:** No
**Annotation Subclass:** None
**Z Resolution:** Accept Default Setting
**Z Tolerance:** 0.001

### Description

This polyline feature class is used to enforce terrain beneath bridge decks where ground data may not have been acquired. Enforcing the terrain beneath bridge decks prevents bridge saddles.

### Table Definition

| Field Name | Data Type | Allow Null Values | Default Value | Domain | Precision | Scale | Length | Responsibility |
|---|---|---|---|---|---|---|---|---|
| OBJECTID | Object ID | | | | | | | Assigned by Software |
| SHAPE | Geometry | | | | | | | Assigned by Software |
| SHAPE_LENGTH | Double | Yes | | | 0 | 0 | | Calculated by Software |

### Feature Definition

| Description | Definition | Capture Rules |
|---|---|---|
| Bridge Saddle Breaklines | Bridge saddle Breaklines should be used where necessary to enforce terrain beneath bridge decks and to prevent bridge saddles in the bare earth DEMs. | Bridge saddle breaklines should be collected beneath bridges where bridge saddles exist or are likely to exist in the bare earth DEMs.<br><br>Bridge saddle breaklines should be collected perpendicular to the bridge deck so that the endpoints are on either side of the bridge deck. Typically two bridge breaklines are collected per bridge deck, one at either end of the bridge deck to enforce the terrain under the full bridge deck.<br><br>The endpoints of the bridge breaklines will match the elevation of the ground at their xy position to enforce the ground/bare earth elevations beneath the bridge deck and prevent bridge saddles from forming. |

# DEM Production & Qualitative Assessment

## DEM PRODUCTION METHODOLOGY

Dewberry and LA DOTD utilized ESRI software and Global Mapper for the DEM production and QC process. ArcGIS software is used to generate the products and the QC is performed in both ArcGIS and Global Mapper. The figure below shows the entire process necessary for bare earth DEM production, starting from the lidar swath processing.

The final bare-earth lidar points are used to create a terrain. The final 3D breaklines collected for the project are also enforced in the terrain. The terrain is then converted to raster format using linear interpolation. For most projects, a single terrain/DEM can be created for the whole project. For very large projects, multiple terrains/DEMs may be created. The DEM(s) is reviewed for any issues requiring corrections, including remaining lidar mis-classifications, erroneous breakline elevations, poor hydro-flattening or hydro-enforcement, and processing artifacts. After corrections are applied, the DEM(s) is then split into individual tiles following the project tiling scheme. The tiles are verified for final formatting and then loaded into Global Mapper to ensure no missing or corrupt tiles and to ensure seamlessness across tile boundaries.


**Figure 17-DEM Production Workflow**

## DEM QUALITATIVE ASSESSMENT

Dewberry performed a comprehensive qualitative assessment of the bare earth DEM deliverables to ensure that all tiled DEM products were delivered with the proper extents, were free of processing artifacts, and contained the proper referencing information. This process was performed in ArcGIS software with the use of a tool set Dewberry has developed to verify that the raster extents match those of the tile grid and contain the correct projection information. The DEM data was reviewed at a scale of 1:5000 to review for artifacts caused by the DEM generation process and to review the hydro-flattened features. To perform this review Dewberry creates HillShade models and overlays a partially transparent colorized elevation model to review for these issues. All corrections are completed using Dewberry's proprietary correction workflow. Upon completion of the corrections, the DEM data is loaded into Global Mapper for its second review and to verify corrections. Once the DEMs are tiled out, the final tiles are again loaded into Global Mapper to ensure coverage, extents, and that the final tiles are seamless.

The images below show an example of a bare earth DEM.

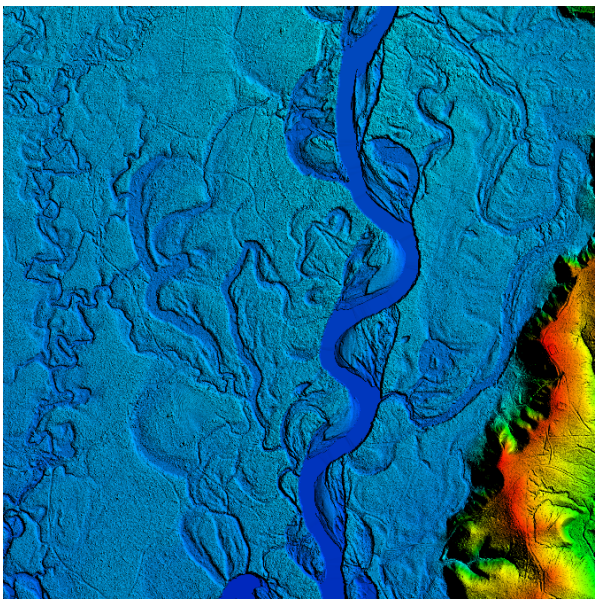

**Figure 18- Bare earth DEM.**

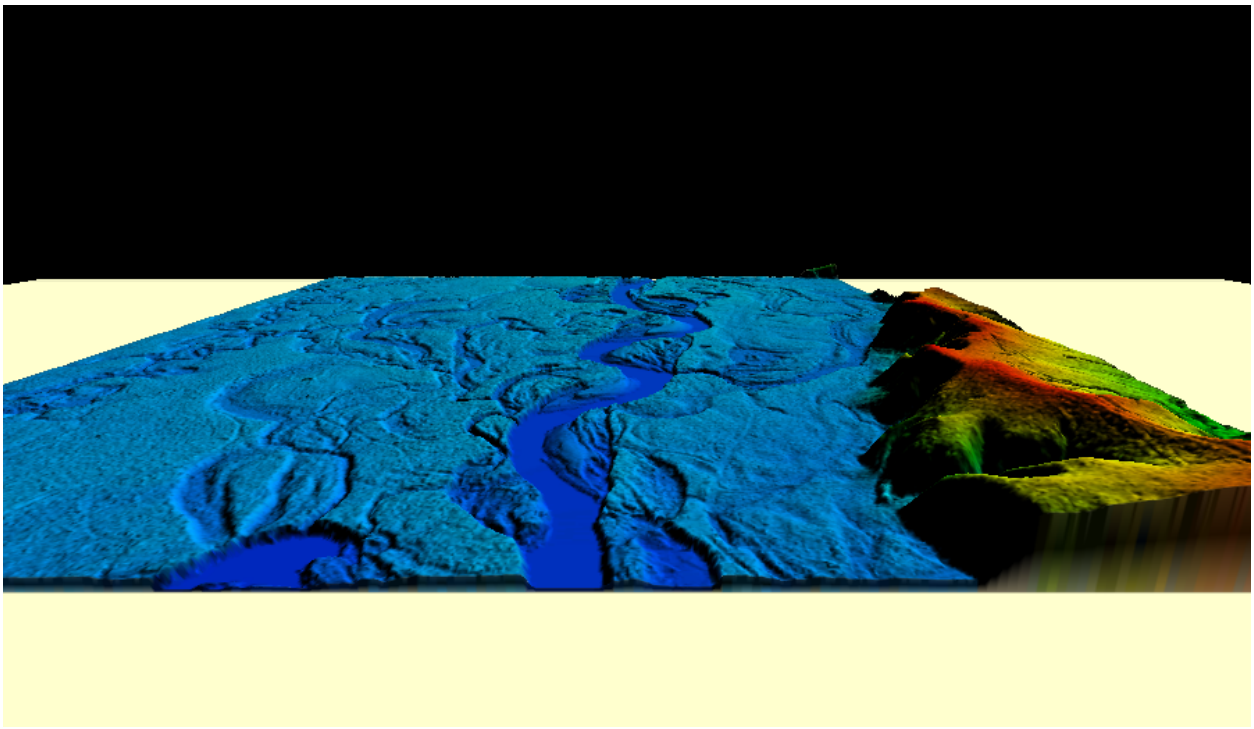

Figure 19- 3D Profile view of the bare earth DEM

When some bridges are removed from the ground surface, the distance from bridge abutment to bridge abutment is small enough that the DEM interpolates across the entire bridge opening, forming 'bridge saddles.' Dewberry collected 3D bridge saddle breaklines in locations where bridge saddles were present and enforced these breaklines in the final DEM creation to help mitigate the bridge saddle artifacts. The image below on the left shows a bridge saddle while the image below on the right shows the same bridge after bridge breaklines have been enforced.

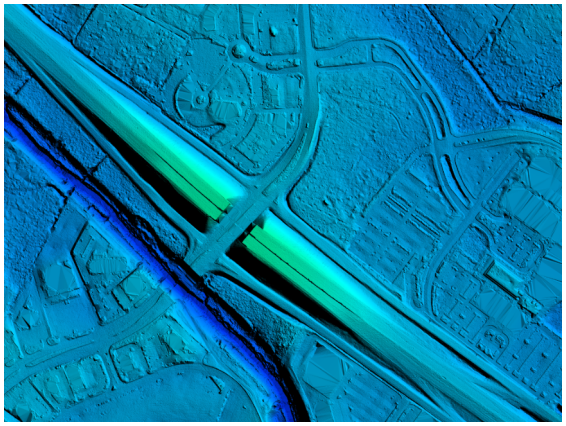

Figure 20- The DEM shows the bridge after breaklines have been enforced.

## DEM VERTICAL ACCURACY RESULTS

The same 805 checkpoints that were used to test the vertical accuracy of the lidar were used to validate the vertical accuracy of the final DEM products as well. Accuracy results may vary between the source lidar and final DEM deliverable. DEMs are created by averaging several

lidar points within each pixel which may result in slightly different elevation values at each survey checkpoint when compared to the source LAS, which does not average several lidar points together but may interpolate (linearly) between two or three points to derive an elevation value. The vertical accuracy of the DEM is tested by extracting the elevation of the pixel that contains the x/y coordinates of the checkpoint and comparing these DEM elevations to the surveyed elevations. Dewberry typically uses LP360 software to test the swath lidar vertical accuracy, Terrascan software to test the classified lidar vertical accuracy, and Esri ArcMap to test the DEM vertical accuracy so that three different software programs are used to validate the vertical accuracy for each project.

Table 9 summarizes the tested vertical accuracy results from a comparison of the surveyed checkpoints to the elevation values present within the final DEM dataset.

| Land Cover Category | # of Points | NVA – Non-vegetated Vertical Accuracy ($RMSE_z$ x 1.9600) Spec=19.6 cm | VVA – Vegetated Vertical Accuracy (95th Percentile) Spec=29.4 cm |
|---|---|---|---|
| NVA | 483 | 8.7 | |
| VVA | 322 | | 19.6 |

Table 14 – DEM tested NVA and VVA

This DEM dataset was tested to meet ASPRS Positional Accuracy Standards for Digital Geospatial Data (2014) for a 10 cm RMSEz Vertical Accuracy Class. Actual NVA accuracy was found to be $RMSE_z$ =6.8 cm, equating to +/- 10 cm at 95% confidence level. Actual VVA accuracy was found to be +/- 10.8 cm at the 95th percentile.

Table 11 provides overall descriptive statistics.

| 100 % of Totals | # of Points | RMSEz (m) Spec=0.100 m NVA/ 0.180 m Submerged Topography | Mean (m) | Median (m) | Skew | Std Dev (m) | Kurtosis | Min (m) | Max (m) |
|---|---|---|---|---|---|---|---|---|---|
| NVA | 483 | 0.044 | 0.002 | 0.003 | -1.220 | 0.044 | 10.618 | -0.371 | 0.141 |
| VVA | 322 | N/A | 0.056 | 0.042 | 0.481 | 0.081 | 5.138 | -0.413 | 0.408 |

Table 15 – Overall Descriptive Statistics

**Based on the vertical accuracy testing conducted by Dewberry and LA DOTD, the DEM dataset for the LA DOTD NE Lidar Project satisfies the project's pre-defined vertical accuracy criteria.**

## DEM CHECKLIST

The following table represents a portion of the high-level steps in Dewberry's bare earth DEM Production and QA/QC checklist that were performed for this project.

| Pass/Fail | Validation Step |
|---|---|
| Pass | Masspoints (LAS to multipoint) are created from ground points only (class 2 and class 8 if model key points created, but no class 10 ignored ground points or class 9 water points |
| Pass | Create a terrain for each production block using the final bare earth lidar points and final breaklines. |

| | |
|---|---|
| Pass | Convert terrains to rasters using project specifications for grid type, formatting, and cell size |
| Pass | Create hillshades for all DEMs |
| Pass | Manually review bare-earth DEMs in ArcMap with hillshades to check for issues |
| Pass | DEMs should be hydro-flattened or hydro-enforced as required by project specifications |
| Pass | DEMs should be seamless across tile boundaries |
| Pass | Water should be flowing downhill without excessive water artifacts present |
| Pass | Water features should NOT be floating above surrounding |
| Pass | Bridges should NOT be present in bare-earth DEMs. |
| Pass | Any remaining bridge saddles where below bridge breaklines were not used need to be fixed by adding below bridge breaklines and re-processing. |
| Pass | All qualitative issues present in the DEMs as a result of lidar processing and editing issues must be marked for corrections in the lidar These DEMs will need to be recreated after the lidar has been corrected. |
| Pass | Calculate DEM Vertical Accuracy including NVA, VVA, and other statistics |
| Pass | Split the DEMs into tiles according to the project tiling scheme |
| Pass | Verify all properties of the tiled DEMs, including coordinate reference system information, cell size, cell extents, and that compression has not been applied to the tiled DEMs |
| Pass | Load all tiled DEMs into Global Mapper to verify complete coverage to the (buffered) project boundary and that no tiles are corrupt. |

**Table 16-A subset of the high-level steps from Dewberry's bare earth DEM Production and QA/QC checklist performed for this project.**

## Appendix A: Checkpoint Survey Report

## Appendix B: Ground Control Survey Report

## Appendix C: Complete List of Delivered Tiles