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Alaska Statewide Tile Index

for Lidar Projects

A Collaboration Between:

N|V|5 GEOSPATIAL

MAPAK
ALASKA GEOSPATIAL OFFICE

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Background

In 2022, the Alaska Geospatial Office (AGO) began contracting QL1 lidar on a regional and community scale, for areas across Alaska. Acknowledging similar efforts from other state, federal, and local stakeholders, the AGO identified potential benefits for prioritizing and coordinating specifications for such projects. Specifically, a unified statewide tile index, utilized by the greater stakeholder group, would allow separate organizations to independently contract remote sensing collections for their areas of interest, while ensuring that all efforts contribute to the long-term goal of completing statewide lidar for Alaska.

Together, the AGO and NV5 have created a tile index system for accommodating the collection, prioritization, and distribution of lidar data for Alaska. The requirements for this index are as follows:

- Complete, continuous coverage of Alaska;
- variable tile sizes;
- polygon coherence (tessellation) across entire system; and
- consistent area among all tiles.

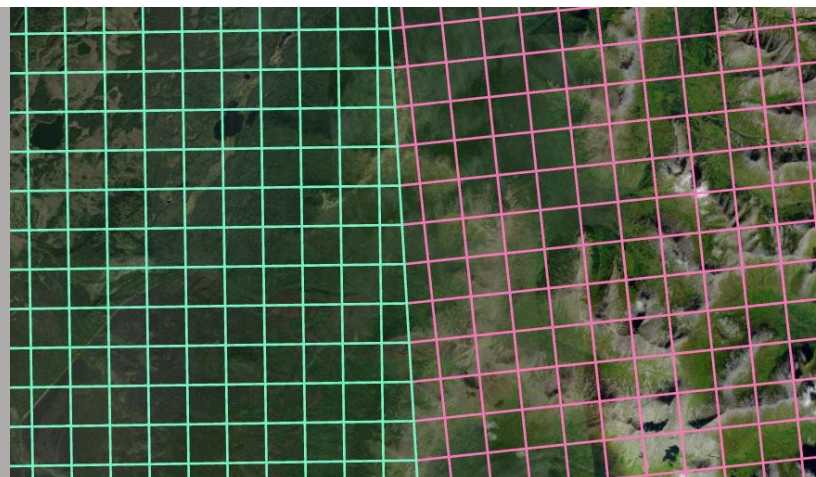
US National Grid

The US National Grid (USNG), adopted by the Federal Geographic Data Committee (FGDC) as a national standard, is a multi-purpose grid reference system optimized for local applications and is used across the contiguous United States (CONUS). The grid utilizes UTM projected coordinate systems to create local address networks on a regional basis. Any state may require one or more of these regions for full coverage, with eleven such regions required to completely cover Alaska.

The heterogeneity of projected coordinate systems used in the USNG does not allow for complete tile coherence across the state of Alaska. Rather, the margins between regions are comprised of angularly truncated tiles. If the USNG were implemented for the purpose of contracting contiguous remote sensing projects in Alaska, there would be inconsistency in contracted tile areas. Additionally, individual projects which span multiple USNG regions would be required to deliver data using multiple tile networks, which may present unnecessary confusion. For these reasons, **the use of the USNG for an Alaska-wide project scope is not recommended.**

This screenshot shows the boundary between USNG zones 5 and 6, just east of Anchorage, Alaska.

Imagery Credit: Maxar Products. Dynamic Mosaic © 2020 Maxar Technologies Inc., Alaska Geospatial Office, USGS



Statewide Tile Indices for Alaska

Two statewide tile grid indices have been created for Alaska. The Alaska Albers projected tile grid was selected to support **statewide** lidar acquisition planning, data delivery and cartographic needs. The Universal Transverse Mercator (UTM) projected grid was selected to support lidar data processing requirements and the delivery and use of lidar for smaller scale projects in Alaska.

Alaska Albers Projection

In keeping with the goals of statewide lidar mapping for Alaska, a projected coordinate system for an Alaska-specific tile system should adhere to the following criteria:

- Equal area projection;
- reduced distortion for Alaska; and
- interoperability with conventional GIS software.

An equal area projection is preferred due to the value of consistently sized tiles across the index. We believe this consistency will greatly simplify the project planning process for stakeholders. Another major consideration will be how well the shape of Alaska is preserved. Although distortion, in some form, is unavoidable with any projection, the standard parallels for the chosen projection should be optimally spaced across the extent of Alaska, to limit such effects as much as possible.

The projected coordinate system should be supported by most conventional GIS software (e.g., ArcGIS, QGIS, GDAL). For the reasons accounted for in this section, **we recommend NAD83 (2011) Alaska Albers, EPSG:6393 as the projected coordinate system to support statewide mapping needs.**

Alaska Albers is a commonly used system among Alaska geospatial professionals. This projection is used in cartographic materials, to track progress for statewide projects; and deliver metadata information to the public via the State Geoportal. The audience for these materials will appreciate a tile system that conforms to the geometry of Alaska's preferred projection.

These red lines show the standard parallels for the Alaska Albers projection. Placed at longitudes 55 and 65, they provide minimized distortion throughout the state.



NOTE: When the data is delivered in Alaska Albers projections, it is not sufficient to solely reproject the raster deliverables. The point cloud must be re-projected with all subsequent workflows to follow.

Universal Transverse Mercator

Universal Transverse Mercator (UTM) is the standard projection for lidar deliverables. This projection aligns with lidar processing workflows and supports user needs at smaller project scales. Alaska is split into 11 UTM zones (01, 02, 03, 04, 05, 06, 07, 08, 09, 59, 60). The provided tile grid schema is composed of these 11 zones with overlapping borders to better support the creation of seamless products and data delivery goals.

Statewide Tile Grids

Alaska Albers and UTM geodatabases should accompany this document. Each Index contains 750 and 1500-meter tile grids with associated *Tile_ID* which will be used in file naming conventions.

Alaska Albers Indices

Projection	Horizontal Datum	Description	Tile Size	File Format
Alaska Albers	NAD83 (2011) Meters	Full statewide tile index for Alaska.	1500-meter	ESRI File Geodatabase
Alaska Albers	NAD83 (2011) Meters	Full statewide tile index for Alaska.	750-meter	ESRI File Geodatabase

Alaska UTM Indices

Projection	Horizontal Datum	Description	Tile Size	File Format
UTM (1-9, 59 and 60)	NAD83 (2011) Meters	Full statewide tile index for Alaska.	1500-meter	ESRI File Geodatabase
UTM (1-9, 59 and 60)	NAD83 (2011) Meters	Full statewide tile index for Alaska.	750-meter	ESRI File Geodatabase

Tile Size and Naming

We have created a standard tile size of 1500 by 1500 meters with the capability of upscaling by a factor of 0.5 to reduce file size for denser data. The standard tile size was strategized to keep individual point cloud files (.las), of QL2 quality, to a manageable volume of <1 gigabyte. Sub gigabyte files allow for better download accessibility for Alaska stakeholders. A tile size of 750 by 750 meters would likewise be recommended for QL1 lidar, to account for an increase in point density.

Both the Alaska Albers and UTM tile grids are provided in two hierarchical size schemas with 750- and 1500-meter tiles. The selection of the tile size will be driven by data quality levels and associated file size delivery. Each tile has a *Tile_ID* attribute that will be used in the data delivery file naming conventions outlined below.

1500-meter Naming Convention

Each tile grid has a sequential naming convention starting in the southwest corner of the index, using a pair of four-digit codes to designate X and Y placement. For instance, in the Alaska Albers grid the furthest south and west tile will be named “0000_0000”. The adjacent tile east of “0000_0000” is “0001_0000”, while the adjacent tile north would be “0000_0001”. Each tile in the UTM grid schema includes a utmxx prefix (e.g., utm03_0000_0001.las).

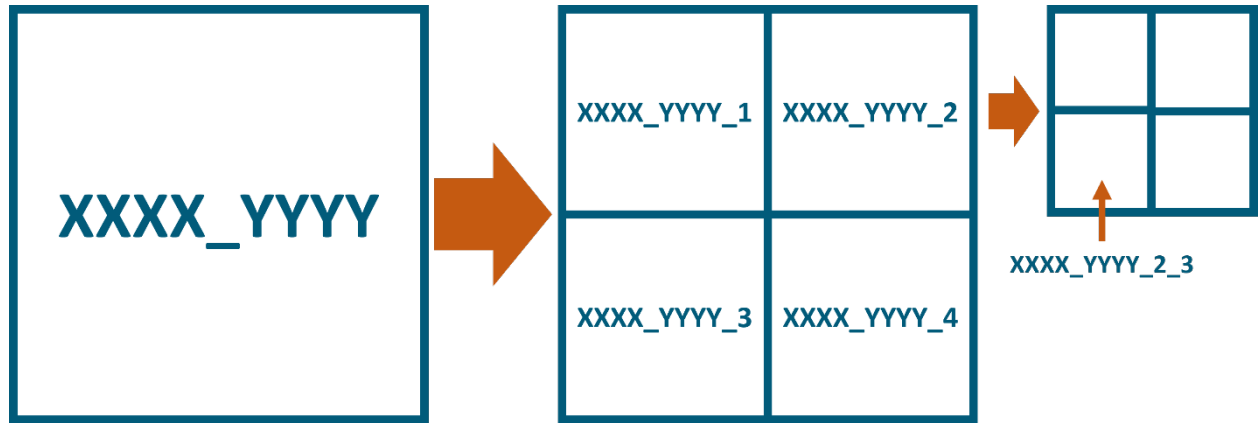


These tiles represent a project over Nulato, AK. Tiles are numbered sequentially west to east and south to north, using the convention “XXXX_YYYY”.

Image credit: ESRI, World Imagery Basemap

750-meter Naming Convention

The 750-meter tile index supports the subdivision of tiles into smaller quadrants to account for project needs, such as the data volume limitations per tile. To account for this in the naming convention, we’ve adopted the tried-and-true technique of quartering tiles and appending a number, one through four, at the end of the tile name. Both the Alaska Albers and UTM 750-meter *Tile_IDs* have adopted this naming convention.



File Name Suffix - YEAR

To differentiate between overlapping data from multiple time periods, the product “delivery year” should be appended as a suffix to the Alaska Albers or UTM 750 or 1500-meter tile names, using the yyyy format (e.g., utmxx_0000_0001_2023.las or 0000_0001_2_2024.las).

Contracting Considerations

Developing Areas of Interest

It is recommended that the Alaska Albers tile grid be used in the project development stages. And that Areas of Interest (AOI) are contracted to align along the borders with the 1500-meter tile grid. If a smaller tile size becomes more optimal for delivery, it is recommended the acquisition AOI align with the 750-meter tile grid along the borders.

Additionally, it is beneficial to contract a 100-meter buffer for the overall project area, to account for potential gaps between separately collected projects which are intended to cleanly abut one another.

Data Delivery Recommendations

UTM Deliverables

Product Type	File Type	Product Details
Points	LAS v.1.4 (*.las)	All Classified Returns in Orthometric heights
Points	LAS v.1.4 (.las)	All Classified Returns in Ellipsoidal heights
Rasters	0.5 meter GeoTIFFs (*.tif)	Hydroflattened Bare Earth Digital Elevation Model (DEM)

Rasters	1.0 meter GeoTIFFs (*.tif)	Swath Separation Rasters
Rasters	0.5 meter GeoTIFFs (*.tif)	Intensity Images
Rasters	1.0 meter GeoTIFFs (*.tif)	Maximum Surface Height Raster (MSHR)
Vectors	Shapefiles (*.shp)	Defined Project Area (DPA)
Vectors	Shapefiles (*.shp)	Master Tile Index (MTI)
Vectors	Shapefiles (*.shp)	Identifiable Snow Polygons/Areas of Low Confidence
Vectors	ESRI File Geodatabase (*.gdb)	Flightline Swaths
Vectors	ESRI File Geodatabase (*.gdb)	Breaklines
Vectors	Geopackage (*.gpkg)	Ground Survey Data
Metadata	Extensible Markup Language (*.xml)	Metadata

Alaska Albers Deliverables

We recommend all deliverables comply with U.S. Geological Survey Lidar Base Specifications and are delivered in accordance with the UTM grid and naming conventions outlined herein.

In addition, and to support Alaska’s statewide mapping goals we recommend the following products are delivered in Alaska Albers, in addition to UTM:

Product Type	File Type	Product Details
Rasters	0.5 meter GeoTIFFs (*.tif)	Hydroflattened Bare Earth Digital Elevation Model (DEM)
Rasters	1.0 meter GeoTIFFs (*.tif)	Maximum Surface Height Raster (MSHR)
Vectors	Shapefiles (*.shp)	Defined Project Area (DPA)
Vectors	Shapefiles (*.shp)	Master Tile Index (MTI)

Vectors	ESRI File Geodatabase (*.gdb)	Breaklines
Metadata	Extensible Markup Language (*.xml)	Metadata

Folder Structure

To enable efficient integration of data, ingestion into the State Geoportal and faster delivery of resources to the public we recommend the following folder structure.

```
AKDNR_Example_Structure/
|-- bare_earth
| |-- be_rasters
| | |-- albers
| | |-- utm_zone_04
| | |-- utm_zone_05
| | |-- utm_zone_06
| | `-- utm_zone_07
| `-- breaklines
|   |-- albers
|   |-- utm_zone_04
|   |-- utm_zone_05
|   |-- utm_zone_06
|   `-- utm_zone_07
|-- metadata
| |-- reports
| | |-- vendor_provided_xml
| | | |-- albers
| | | |-- utm_zone_04
| | | |-- utm_zone_05
| | | |-- utm_zone_06
| | | `-- utm_zone_07
| | `-- vertical_accuracy
| |   |-- utm_zone_04
| |   | |-- check_point_photos
| |   | |-- check_points
| |   | `-- control_points
| |   |-- utm_zone_05
| |   | |-- check_point_photos
| |   | |-- check_points
| |   | `-- control_points
| |   |-- utm_zone_06
| |   | |-- check_point_photos
| |   | |-- check_points
```

```

| | | `-- control_points
| | | `-- utm_zone_07
| | | |-- check_point_photos
| | | |-- check_points
| | | `-- control_points
| |-- spatial_metadata
| | |-- acquisition_shapes
| | | |-- utm_zone_04
| | | |-- utm_zone_05
| | | |-- utm_zone_06
| | | `-- utm_zone_07
| | |-- contractor_provided
| | | |-- maximum_surface_height_raster
| | | | |-- albers
| | | | | |-- utm_zone_04
| | | | | |-- utm_zone_05
| | | | | |-- utm_zone_06
| | | | | `-- utm_zone_07
| | | `-- swath_separation_images
| | | | |-- utm_zone_04
| | | | |-- utm_zone_05
| | | | |-- utm_zone_06
| | | | `-- utm_zone_07
| |-- indices
| | |-- albers
| | | |-- DPA
| | | | `-- MTI
| | | |-- utm_zone_04
| | | | |-- DPA
| | | | | `-- MTI
| | | |-- utm_zone_05
| | | | |-- DPA
| | | | | `-- MTI
| | | |-- utm_zone_06
| | | | |-- DPA
| | | | | `-- MTI
| | | `-- utm_zone_07
| | | | |-- DPA
| | | | | `-- MTI
|-- other
| |-- intensity_images
| | |-- utm_zone_04
| | |-- utm_zone_05
| | |-- utm_zone_06

```

```

|   `-- utm_zone_07
|-- point_cloud
   |-- tilecls
      |-- ellipsoidal
         | |-- utm_zone_04
         | |-- utm_zone_05
         | |-- utm_zone_06
         | `-- utm_zone_07
      |-- orthometric
         |-- utm_zone_04
         |-- utm_zone_05
         |-- utm_zone_06
         `-- utm_zone_07

```

Metadata

It is recommended that all metadata provided to the Alaska Geospatial Office conform to the most recent template outlined by the USGS Lidar Base Specification, with one modification:

- For point cloud metadata, lidar accuracy statistics under `<lidar><ldraccur>` should be calculated by the vendor and provided accordingly.

See example USGS metadata xml for classified points below:

```

<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE metadata SYSTEM "http://thor-f5.er.usgs.gov/ngtoc/metadata/fgdc-std-001-1998.dtd">
<metadata>
  <idinfo>
    <!-- Identification Information - basic information about the data set.
Type: compound. -->
    <citation>
      <!-- Citation - information to be used to reference the data set. Type:
compound. -->
      <citeinfo>
        <!-- Citation Information - the recommended reference to be used for
the data set. -->
        <origin></origin>
        <!-- Originator - the name of an organization or individual that
developed the data set. Type: text. Domain: "Unknown" free text. -->
        <pubdate></pubdate>
        <!-- Publication Date - the date when the data set is published or
otherwise made available for release. Type: date. Domain: "Unknown"
"Unpublished material" free date-->
        <title></title>
        <!-- Title - the name by which the data set is known. Type: text.
Domain: free text. -->
        <geoform></geoform>
        <!-- Geospatial Data Presentation Form. Type: text. Domain: "Lidar
point cloud" free text. -->
      </citeinfo>

```

```

</citation>
<descript>
  <!-- Description - a characterization of the data set, including its
intended use and limitations. Type: compound. -->
  <abstract></abstract>
  <!-- Abstract - a brief narrative descriptive summary of the data set.
Type: text. Domain: free text. -->
  <purpose></purpose>
  <!-- Purpose - a summary of the intentions with which the data set was
developed. Type: text. Domain: free text. -->
  <supplinf>
    <!-- Supplemental Information - other descriptive information about
the data set. Type: text. Domain: free text. -->
  </supplinf>
  <lidar>
    <!-- For Classified Point Cloud and Swath metadata files -->
    <ldrinfo>
      <!-- Lidar Information - contains metadata about the sensor and
collection conditions. -->
      <ldrspec></ldrspec>
      <!-- Lidar Base Specification applicable to the point cloud. -->
      <ldrSENS></ldrSENS>
      <!-- Lidar Sensor make and model. -->
      <ldrmaxnr></ldrmaxnr>
      <!-- Lidar Maximum Number of Returns per pulse. -->
      <ldrnpS></ldrnpS>
      <!-- Lidar Nominal Pulse Spacing, in meters. -->
      <ldrdenS></ldrdenS>
      <!-- Lidar Nominal Pulse Density, in points per square meter. -->
      <ldrAnpS></ldrAnpS>
      <!-- Lidar Aggregate Nominal Pulse Spacing, in meters. -->
      <ldrAdenS></ldrAdenS>
      <!-- Lidar Aggregate Nominal Pulse Density, in points per square
meter. -->
      <ldrfltht></ldrfltht>
      <!-- Lidar Flight Height for the collection, in meters. -->
      <ldrfltsp></ldrfltsp>
      <!-- Lidar Nominal Flight Speed for the collection, in knots. -->
      <ldrscana></ldrscana>
      <!-- Lidar Sensor Scan Angle, total, in degrees. -->
      <ldrscanr></ldrscanr>
      <!-- Lidar Scan Frequency of the scanner, in hertz. -->
      <ldrpulsr></ldrpulsr>
      <!-- Lidar Pulse Rate of the scanner, in kilohertz. -->
      <ldrpulsd></ldrpulsd>
      <!-- Lidar Pulse Duration of the scanner, in nanoseconds. -->
      <ldrpulsw></ldrpulsw>
      <!-- Lidar Pulse Width of the scanner, in meters. -->
      <ldrwavel></ldrwavel>
      <!-- Lidar Central Wavelength of the sensor laser, in nanometers. -
->
      <ldrmpia></ldrmpia>
      <!-- Lidar Multiple Pulses In Air, 0 = No; 1 = Yes -->
      <ldrBmdiv></ldrBmdiv>
      <!-- Lidar Beam Divergence, in Milliradians. -->
      <ldrswatw></ldrswatw>
      <!-- Lidar Swath Width on the ground, in meters. -->

```

```

</ldrswato></ldrswato>
<!-- Lidar Nominal Swath Overlap, as a percentage. -->
</ldrgeoid></ldrgeoid>
<!-- geoid used for vertical reference. -->
</ldrininfo>
<ldrininfo>
  <!-- Lidar Information - contains metadata about the sensor and
collection conditions. When multiple instruments are used (e.g. two different
instruments in a single plane), please use multiple <ldrininfo> tags to
describe each individual instrument. -->
  <ldrspec></ldrspec>
  <!-- Lidar Base Specification applicable to the point cloud. -->
  <ldrsens></ldrsens>
  <!-- Lidar Sensor make and model. -->
  <ldrmaxnr></ldrmaxnr>
  <!-- Lidar Maximum Number of Returns per pulse. -->
  <ldrnps></ldrnps>
  <!-- Lidar Nominal Pulse Spacing, in meters. -->
  <ldrdens></ldrdens>
  <!-- Lidar Nominal Pulse Density, in points per square meter. -->
  <ldranps></ldranps>
  <!-- Lidar Aggregate Nominal Pulse Spacing, in meters. -->
  <ldradens></ldradens>
  <!-- Lidar Aggregate Nominal Pulse Density, in points per square
meter. -->
  <ldrfltht></ldrfltht>
  <!-- Lidar Flight Height for the collection, in meters. -->
  <ldrfltsp></ldrfltsp>
  <!-- Lidar Nominal Flight Speed for the collection, in knots. -->
  <ldrscana></ldrscana>
  <!-- Lidar Sensor Scan Angle, total, in degrees. -->
  <ldrscanr></ldrscanr>
  <!-- Lidar Scan Frequency of the scanner, in hertz. -->
  <ldrpulsr></ldrpulsr>
  <!-- Lidar Pulse Rate of the scanner, in kilohertz. -->
  <ldrpulsd></ldrpulsd>
  <!-- Lidar Pulse Duration of the scanner, in nanoseconds. -->
  <ldrpulsw></ldrpulsw>
  <!-- Lidar Pulse Width of the scanner, in meters. -->
  <ldrwavel></ldrwavel>
  <!-- Lidar Central Wavelength of the sensor laser, in nanometers. -
->
  <ldrmpia></ldrmpia>
  <!-- Lidar Multiple Pulses In Air, 0 = No; 1 = Yes -->
  <ldrbmdiv></ldrbmdiv>
  <!-- Lidar Beam Divergence, in Milliradians. -->
  <ldrswatw></ldrswatw>
  <!-- Lidar Swath Width on the ground, in meters. -->
  <ldrswato></ldrswato>
  <!-- Lidar Nominal Swath Overlap, as a percentage. -->
  </ldrgeoid></ldrgeoid>
  <!-- geoid used for vertical reference. -->
</ldrininfo>
  <ldraccur><!-- Lidar Accuracy. Non-vegetated vertical accuracy values
for the swath. ALL VALUES ARE REPORTED IN METERS.
  <ldrchacc></ldrchacc>

```

```

-->      <!-- Lidar Calculated Horizontal Accuracy of the point cloud data.
-->      <rawnva></rawnva>
data.-->      <!-- Raw Nonvegetated Vertical Accuracy of the raw point cloud
-->      <rawnvan></rawnvan>
-->      <!-- Raw Nonvegetated Vertical Accuracy Number of checkpoints used
to calculate the reported nonvegetated vertical accuracy of the raw point
cloud data.-->
-->      </ldraccur>
-->      <lasinfo>
-->      <!-- LAS Information. Type: compound. -->
-->      <lasver></lasver>
-->      <!-- LAS Version -->
-->      <lasprf></lasprf>
-->      <!-- LAS Point Record Format. -->
-->      <laswheld></laswheld>
-->      <!-- Describe how withheld points are identified. -->
-->      <lasolap></lasolap>
-->      <!-- Describe how overage points are identified. -->
-->      <lasintr></lasintr>
-->      <!-- Specify the native radiometric resolution of intensity values,
in Bits. -->
-->      <lasclass>
-->      <!-- LAS Classification. Type: compound. -->
-->      <clascode></clascode>
-->      <!-- Classification Code -->
-->      <clasitem></clasitem>
-->      <!-- Classification Item -->
-->      </lasclass>
-->      <lasclass>
-->      <!-- LAS Classification. Type: compound. -->
-->      <clascode></clascode>
-->      <!-- Classification Code -->
-->      <clasitem></clasitem>
-->      <!-- Classification Item -->
-->      </lasclass>
-->      <lasclass>
-->      <!-- LAS Classification. Type: compound. -->
-->      <clascode></clascode>
-->      <!-- Classification Code -->
-->      <clasitem></clasitem>
-->      <!-- Classification Item -->
-->      </lasclass>
-->      <lasclass>
-->      <!-- LAS Classification. Type: compound. -->
-->      <clascode></clascode>
-->      <!-- Classification Code -->
-->      <clasitem></clasitem>
-->      <!-- Classification Item -->
-->      </lasclass>
-->      <lasclass>
-->      <!-- LAS Classification. Type: compound. -->
-->      <clascode></clascode>
-->      <!-- Classification Code -->
-->      <clasitem></clasitem>
-->      <!-- Classification Item -->
-->      </lasclass>

```

```

    </lasclass>
  <lasclass>
    <!-- LAS Classification. Type: compound. -->
    <clascode></clascode>
    <!-- Classification Code -->
    <clasitem></clasitem>
    <!-- Classification Item -->
  </lasclass>
</lasinfo>
</lidar>
</descript>
<timeperd>
  <!-- Time Period of Content. Type: compound. -->
  <timeinfo>
    <!-- Time Period Information - information about the date and time of
an event. May be a single date (sngdate), multiple dates (multiples of
[sngdate]), or a range of dates (rngdates). Type: compound. -->
    <sngdate>
      <!-- Single Date/Time - This date is the date of the lidar
collection, if the collection was completed in one day. -->
      <caldate></caldate> <!-- Calendar date for a single date. The
field MUST be formatted YYYYMMDD.-->
    </sngdate>
    <mdattim>
      <!-- Mutliple Dates/Times - Dates of lidar collection for a
collection completed in multiple days. -->
      <sngdate>
        <caldate></caldate> <!-- Calendar date for a single date. The
field MUST be formatted YYYYMMDD.-->
      </sngdate>
      <sngdate>
        <caldate></caldate> <!-- Calendar date for a single date. The
field MUST be formatted YYYYMMDD.-->
      </sngdate>
      <sngdate>
        <caldate></caldate> <!-- Calendar date for a single date. The
field MUST be formatted YYYYMMDD.-->
      </sngdate>
      <sngdate>
        <caldate></caldate> <!-- Calendar date for a single date. The
field MUST be formatted YYYYMMDD.-->
      </sngdate>
    </mdattim>
    <rngdates>
      <!-- Range of Dates/Times. Type: compound. -->
      <begdate></begdate>
      <!-- Beginning Date - the first year, month, and day of the
collection. The field MUST be formatted YYYYMMDD. Domain: "Unknown" free
date. -->
      <enddate></enddate>
      <!-- Ending Date - the last year, month, and day for the
collection. The field MUST be formatted YYYYMMDD. Type: date. Domain:
"Unknown" free date. -->
    </rngdates>
  </timeinfo>
</current></current>

```

```

        <!-- Currentness Reference. Type: text. Domain: "ground condition" free
text. -->
    </timeperd>
    <status>
        <!-- Status - the state of the maintenance information for the data
set. Type: compound. -->
        <progress></progress>
        <!-- Progress - the state of the data set. Type: text. Domain:
"Complete" "In Work" "Planned" free text. -->
        <update></update>
        <!-- Maintenance and Update Frequency - the frequency with which
changes and additions are made to the data set after the initial data set is
completed. Type: text. Domain: "Unknown" "As needed" "None planned" free
text-->
    </status>
    <spdom>
        <!-- Spatial Domain - the geographic areal domain of the data set.
Type: compound. -->
        <bounding>
            <!-- Bounding Coordinates - the limits of coverage of a data set
expressed by latitude and longitude values in the order western-most,
eastern-most, northern-most, and southern-most. Type: compound. -->
            <westbc></westbc>
            <!-- West Bounding Coordinate - western-most coordinate of the limit
of coverage expressed in longitude. Type: real. Domain: -180.0 <= West
Bounding Coordinate < 180.0 -->
            <eastbc></eastbc>
            <!-- East Bounding Coordinate - eastern-most coordinate of the limit
of coverage expressed in longitude. Type: real. Domain: -180.0 <= East
Bounding Coordinate <= 180.0 -->
            <northbc></northbc>
            <!-- North Bounding Coordinate - northern-most coordinate of the
limit of coverage expressed in latitude. Type: real. Domain: -90.0 <= North
Bounding Coordinate <= 90.0 -->
            <southbc></southbc>
            <!-- South Bounding Coordinate - southern-most coordinate of the
limit of coverage expressed in latitude. Type: real. Domain: -90.0 <= South
Bounding Coordinate <= 90.0-->
        </bounding>
        <lboundng>
            <leftbc></leftbc>
            <!-- Left (western-most) Bounding Coordinate for coverage of the
dataset expressed in the Coordinate Reference System in which the data are
delivered. -->
            <rightbc></rightbc>
            <!-- Right (eastern-most) Bounding Coordinate for coverage of the
dataset expressed in the Coordinate Reference System in which the data are
delivered. -->
            <topbc></topbc>
            <!-- Top (northern-most) Bounding Coordinate for coverage of the
dataset expressed in the Coordinate Reference System in which the data are
delivered. -->
            <bottombc></bottombc>
            <!-- Bottom (southern-most) Bounding Coordinate for coverage of the
dataset expressed in the Coordinate Reference System in which the data are
delivered. -->
        </lboundng>

```



```

    </spdom>
    <keywords>
      <!-- Keywords - words or phrases summarizing an aspect of the data set.
Type: compound. -->
      <theme>
        <!-- Theme - subjects covered by the data set. Type: compound. -->
        <themekt></themekt>
        <!-- Theme Keyword Thesaurus. Type: text. Domain: "None" free text. -
->
        <themekey></themekey>
        <themekey></themekey>
        <themekey></themekey>
        <themekey></themekey>
        <themekey></themekey>
        <themekey></themekey>
        <!-- Theme Keyword - common-use word or phrase used to describe the
subject of the data set. Type: text. Domain: free text. -->
        </theme>
        <place>
          <!-- Place - geographic locations characterized by the data set.
Type: compound. -->
          <placekt></placekt>
          <!-- Place Keyword Thesaurus. Type: text. Domain: "None" free text. -
->
          <placekey></placekey>
          <placekey></placekey>
          <placekey></placekey>
          <!-- Place Keyword - the geographic name of a location(s) covered by
a data set. Type: text Domain: free text. -->
          </place>
        </keywords>
        <accconst></accconst>
        <!-- Access Constraints - restrictions and legal prerequisites for
accessing the data set. Type: text. Domain: "None" free text. -->
        <useconst></useconst>
        <!-- Use Constraints - restrictions and legal prerequisites for using the
data set after access is granted. Type: text. Domain: "None" free text. -->
        <native></native>
        <!-- Native Data Set Environment - a description of the data set in the
producer's processing environment, including items such as the name of the
software (including version), the computer operating system, file name
(including host-, path-, and filenames), and the data set size. Domain: free
text -->
        </idinfo>
        <dataqual>
          <!-- Data Quality Information. Type: compound. -->
          <logic></logic>
          <!-- Logical Consistency Report - an explanation of the fidelity of
relationships in the data set and tests used. Type: text. Domain: free text.
-->
          <complete></complete>
          <!-- Completeness Report - information about omissions, selection
criteria, generalization, definitions used, and other rules used to derive
the data set. Type: text. Domain: free text-->
          <posacc>

```

```

    <!-- Positional Accuracy - an assessment of the accuracy of the
positions of spatial objects. Type: compound. -->
    <horizpa>
        <!-- Horizontal Positional Accuracy - an estimate of accuracy of the
horizontal positions in the data set. This set of tags is suggested for
projects that include both classified and unclassified las files and required
for projects that only include classified las files. Type: compound. -->
        <horizpar></horizpar>
        <!-- Horizontal Positional Accuracy Report - an explanation of the
accuracy of the horizontal coordinate measurements and a description of the
tests used. Use statement, "This data set was produced to meet ASPRS
Positional Accuracy Standards for Digital Geospatial Data (2014) for a ____
(cm) RMSEx / RMSEy Horizontal Accuracy Class which equates to Positional
Horizontal Accuracy = +/- ____ cm at a 95% confidence level." Type: text.
Domain: free text. -->
        </horizpa>
        <vertacc>
            <!-- Vertical Positional Accuracy - an estimate of accuracy of the
vertical positions in the data set. This set of tags is suggested for
projects that include both classified and unclassified las files and required
for projects that only include classified las files. Type: compound. -->
            <vertaccr></vertaccr>
            <!-- Vertical Positional Accuracy Report -an explanation of the
accuracy of the vertical coordinate measurements and a description of the
tests used. Use statement, "This data set was produced to meet ASPRS
Positional Accuracy Standard for Digital Geospatial Data (2014) for a 10-cm
RMSEz Vertical Accuracy Class." Type: text. Domain: free text. -->
            </vertacc>
        </posacc>
        <lineage>
            <!-- Lineage - information about the events, parameters, and source
data which constructed the data set, and information about the responsible
parties. Type: compound. -->
            <procstep>
                <!-- Process Step - information about a single processing step.
Please provide information for each step of the data acquisition,
calibration, processing, and analysis. Type: compound. -->
                <procdesc></procdesc>
                <!-- Process Description - an explanation of the the processing step
and parameters used. Include Flight, Imagery development, Analysis. Type:
text. Domain: free text-->
                </procstep>
            </procstep>
            <!-- Process Step - information about a single processing step. Type:
compound. -->
            <procdesc></procdesc>
            <!-- Process Description - an explanation of the the processing step
and parameters used. Include Flight, Imagery development, Analysis. Type:
text. Domain: free text-->
            <procdesc></procdesc>
            <!-- Process Date - the date when the processing step was completed.
The field MUST be formatted YYYYMMDD Type: text. Domain: "Unknown" "Not
complete" free date. -->
            </procstep>
            <procstep>
                <!-- Process Step - information about a single processing step. Type:
compound. -->

```

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        <procdesc></procdesc>
        <!-- Process Description - description of the TESTED values of
NPS/ANPS and NPD/ANPD (in meters). Description of the method used by the
contractor to test pulse spacing and pulse density. Type: text. Domain: free
text-->
        <!-- Until there is an ASPRS defined method for testing ANPS/ANPD,
please provide the contractor's method for testing. -->
        <procdesc></procdesc>
        <!-- Process Date - the date when the processing step was completed.
The field MUST be formatted YYYYMMDD Type: text. Domain: "Unknown" "Not
complete" free date. -->
        </procstep>
        <procstep>
        <!-- Process Step - information about a single processing step. Type:
compound. -->
        <procdesc></procdesc>
        <!-- Process Description - description of the method and parameters
used to generate maximum surface height rasters from the classified point
cloud. Type: text. Domain: free text-->
        <procdesc></procdesc>
        <!-- Process Date - the date when the processing step was completed.
The field MUST be formatted YYYYMMDD Type: text. Domain: "Unknown" "Not
complete" free date. -->
        </procstep>
        <procstep>
        <!-- Process Step - information about a single processing step. Type:
compound. -->
        <procdesc></procdesc>
        <!-- Process Description - description of the method and parameters
used to generate swath separation imagery from the classified point cloud.
Type: text. Domain: free text-->
        <procdesc></procdesc>
        <!-- Process Date - the date when the processing step was completed.
The field MUST be formatted YYYYMMDD Type: text. Domain: "Unknown" "Not
complete" free date. -->
        </procstep>
        <procstep>
        <!-- Process Step - information about a single processing step. Type:
compound. -->
        <procdesc></procdesc>
        <!-- Process Description - an explanation of the the processing step
and parameters used. Include Flight, Imagery development, Analysis. Type:
text. Domain: free text-->
        <srcused></srcused>
        <!-- Source Used Citation Abbreviation - the Source Citation
Abbreviation of a data set used in the processing step. Domain: Source
Citation Abbreviations from the Source Information entries for the data set.
-->
        <procdesc></procdesc>
        <!-- Process Date - the date when the processing step was completed.
The field MUST be formatted YYYYMMDD. Type: text. Domain: "Unknown" "Not
complete" free date. -->
        </procstep>
    </lineage>
</dataqual>
<spdoinfo>
    <!-- Spatial Data Organization Information. Type: compound. -->

```

```

<direct>Point</direct>
  <!-- Direct Spatial Reference Method - the system of objects used to
represent space in the data set. Type: text. Domain: "Point" -->
  <ptvctinf>
    <!-- Point and Vector Object Information - the types and numbers of
vector or nongridded point spatial objects in the data set. Type: Compound. -
->
    <sdtsterm>
      <!-- SDTS Terms Description - point and vector object information
using the terminology and concepts from "Spatial Data Concepts," which is
Chapter 2 of Part 1 in Department of Commerce, 1992, Spatial Data Transfer
Standard (SDTS) (Federal Information Processing Standard 173): Washington,
Department of Commerce, National Institute of Standards and Technology. (Note
that this reference to the SDTS is used ONLY to provide a set of terminology
for the point and vector objects.). Type: Compound. -->
      <sdtstype>Point</sdtstype>
      <!-- SDTS Point and Vector Object Type - name of point and vector
spatial objects used to locate zero-, one-, and two-dimensional spatial
locations in the data set. Domain: (The domain is from "Spatial Data
Concepts," which is Chapter 2 of Part 1 in Department of Commerce, 1992,
Spatial Data Transfer Standard (SDTS) (Federal Information Processing
Standard 173): Washington, Department of Commerce, National Institute of
Standards and Technology): "Point" "Entity point" "Label point" "Area point"
"Node, planar graph" "Node, network" "String" "Link" "Complete chain" "Area
chain" "Network chain, planar graph" "Network chain, nonplanar graph"
"Circular arc, three point center" "Elliptical arc" "Uniform B-spline"
"Piecewise Bezier" "Ring with mixed composition" "Ring composed of strings"
"Ring composed of chains" "Ring composed of arcs" "G-polygon" "GT-polygon
composed of rings" "GT-polygon composed of chains" "Universe polygon composed
of rings" "Universe polygon composed of chains" "Void polygon composed of
rings" "Void polygon composed of chains"-->
      <ptvctcnt></ptvctcnt>
      <!-- Point and Vector Object Count - the total number of the point or
vector object type occurring in the data set. Type: integer. Domain: Point
and Vector Object Count > 0 -->
      </sdtsterm>
    </ptvctinf>
  </spdoinfo>
<spref>
  <!-- Spatial Reference Information. Type: compound. -->
  <horizsys>
    <!-- Horizontal Coordinate System Definition. Type: compound. -->
    <planar>
      <!-- Planar. Type: compound -->
      <gridsys>
        <!-- Grid Coordinate System - this section should be filled out
with the relevant parameters for the coordinate reference system for the
data. Typically it is UTM or State Plane Zone. -->
        <gridsysn></gridsysn>
        <!-- Grid Coordinate System Name - name of the grid coordinate
system. Type: text. Domain: "Universal Transverse Mercator" "Universal Polar
Stereographic" "State Plane Coordinate System 1927" "State Plane Coordinate
System 1983" "ARC Coordinate System" "other grid system" -->
        <utm>
          <!-- Universal Transverse Mercator (UTM) - a grid system based on
the transverse mercator projection, applied between latitudes 84 degrees
north and 80 degrees south on the Earth's surface. Type: compound. -->

```

```

    <utmzone></utmzone>
    <!-- UTM Zone Number - identifier for the UTM zone. Type:
integer. Domain: 1 <= UTM Zone <= 60 for the northern hemisphere; -60 <= UTM
Zone Number <= -1 for the southern hemisphere -->
    <transmer>
    <!-- Transverse Mercator - contains parameters for the
Transverse Mercator projection. Type: compound. -->
    <sfctrmer></sfctrmer>
    <!-- Scale Factor at Central Meridian - a multiplier for
reducing a distance obtained from a map by computation or scaling to the
actual distance along the central meridian. Type: real. Domain: Scale Factor
at Central Meridian > 0.0 -->
    <longcm></longcm>
    <!-- Longitude of Central Meridian - the line of longitude at
the center of a map projection generally used as the basis for constructing
the projection. Type: real. Domain: -180.0 <= Longitude of Central Meridian <
180.0 -->
    <latprjo></latprjo>
    <!-- Latitude of Projection Origin - latitude chosen as the
origin of rectangular coordinates for a map projection. Type: real. Domain: -
90.0 <= Latitude of Projection Origin <= 90.0 -->
    <feast></feast>
    <!-- False Easting - the value added to all "x" values in the
rectangular coordinates for a map projection. This value frequently is
assigned to eliminate negative numbers. Expressed in the unit of measure
identified in Planar Coordinate Units. Type: real. Domain: free real -->
    <fnorth></fnorth>
    <!-- False Northing - the value added to all "y" values in the
rectangular coordinates for a map projection. This value frequently is
assigned to eliminate negative numbers. Expressed in the unit of measure
identified in Planar Coordinate Units. Type: real. Domain: free real -->
    </transmer>
  </utm>
</gridsys>
<planci>
  <!-- Planar Coordinate Information. Type: compound. -->
  <plance></plance>
  <!-- Planar Coordinate Encoding Method - the means used to
represent horizontal positions. Type: text. Domain: "coordinate pair" -->
  <coordrep>
  <!-- Coordinate Representation - the method of encoding the
position of a point by measuring its distance from perpendicular reference
axes (the "coordinate pair" method). Type: compound. -->
  <absres></absres>
  <!-- Abscissa Resolution - the (nominal) minimum distance between
the "x" or column values of two adjacent points, expressed in Planar Distance
Units of measure. Type: real. Domain: Abscissa Resolution > 0.0 -->
  <ordres></ordres>
  <!-- Ordinate Resolution - the (nominal) minimum distance between
the "y" or row values of two adjacent points, expressed in Planar Distance
Units of measure. Type: real. Domain: Ordinate Resolution > 0.0 -->
  </coordrep>
  <plandu></plandu>
  <!-- Planar Distance Units - units of measure used for distances.
Type: text. Domain: "meters" "international feet" "US survey feet" free text
-->
</planci>

```

```

</planar>
<geodetic>
  <!-- Geodetic Model - parameters for the shape of the earth. Type:
compound. -->
  <horizdn></horizdn>
  <!-- Horizontal Datum Name - the identification given to the
reference system used for defining the coordinates of points. Type: text.
Domain: "North American Datum of 1927" "North American Datum of 1983" free
text -->
  <ellips></ellips>
  <!-- Ellipsoid Name - identification given to established
representations of the Earth's shape. Type: text. Domain: "Clarke 1866"
"Geodetic Reference System 80" free text. -->
  <semiaxis></semiaxis>
  <!-- Semi-major Axis - radius of the equatorial axis of the
ellipsoid. Type: real. Domain: Semi-major Axis > 0.0 -->
  <denflat></denflat>
  <!-- Denominator of Flattening Ratio - the denominator of the ratio
of the difference between the equatorial and polar radii of the ellipsoid
when the numerator is set to 1. Type: real. Domain: Denominator of Flattening
> 0.0 -->
</geodetic>
</horizsys>
<vertdef>
  <!-- Vertical Coordinate System Definition - the reference frame or
system from which vertical distances (altitudes or depths) are measured.
Type: compound. -->
  <altsys>
    <!-- Altitude System Definition - the reference frame or system from
which altitudes (elevations) are measured. Type: compound. -->
    <altdatum></altdatum>
    <!-- Altitude Datum Name. Type: text. Domain: "National Geodetic
Vertical Datum of 1929" "North American Vertical Datum of 1988" free text-->
    <altres></altres>
    <!-- Altitude Resolution - the minimum distance possible between two
adjacent altitude values, expressed in Altitude Distance Units of measure.
Type: real. Domain: Altitude Resolution > 0.0 -->
    <altunits></altunits>
    <!-- Altitude Distance Units - units in which altitudes (elevations)
are recorded. Type: text. Domain: "meters" "international feet" "US survey
feet" free text-->
    <altenc></altenc>
    <!-- Altitude Encoding Method - the means used to encode the
altitudes. Type: text. Domain: "Explicit elevation coordinate included with
horizontal coordinates" -->
  </altsys>
</vertdef>
</spref>
<metainfo>
  <!-- Metadata Reference Information - information on the currentness of
the metadata information, and the responsible party. Type: compound. -->
  <metd></metd>
  <!-- Metadata Date - the date that the metadata were created or last
updated. Type: date. Domain: free date. -->
  <metrd></metrd>

```

```

    <!-- Metadata Review Date - if applicable, the date of the latest review
of the metadata entry. Domain: free data; Metadata Review Date should be
later than Metadata Date -->
    <metc>
        <!-- Metadata Contact - the party responsible for the metadata
information. Type: compound. -->
        <cntinfo>
            <!-- Contact Information - Identity of, and means to communicate
with, person(s) and organization(s) associated with the data set.Type:
compound. -->
            <cntorgp>
                <!-- The organization, and the member of the organization if
desired, associated with the data set. THIS POINT OF CONTACT SHALL BE CONTACT
INFORMATION FOR THE PRIMARY CONTRACTOR. Please DO NOT include contact
information for the USGS. If desired, the primary contractor may add contact
information to data sections where the data was obtained by a sub-contractor,
however this is not required. More details can be found in the USGS LBS 1.3
under Appendix 4. Type: compound. -->
                <cntorg></cntorg>
                <!-- Contact Organization - the name of the organization. Type:
text. Domain: free text. -->
                </cntorgp>
                <cntaddr>
                    <!-- Contact Address - the address for the organization or
individual. Type: compound. -->
                    <addrtype></addrtype>
                    <!-- Address Type. Type: text. Domain: "mailing" "physical"
"mailing and physical", free text. -->
                    <address></address>
                    <!-- Address - an address line for the address. Type: text. Domain:
free text. -->
                    <city></city>
                    <!-- City - the city of the address. Type: text. Domain: free text.
-->
                    <state></state>
                    <!-- State or Province - the state or province of the address.
Type: text. Domain: free text. -->
                    <postal></postal>
                    <!-- Postal Code - the ZIP or other postal code of the address.
Type: text. Domain: free text. -->
                    <country></country>
                    <!-- Country - the country of the address. Type: text. Domain: free
text. -->
                    </cntaddr>
                    <cntvoice></cntvoice>
                    <!-- Contact Voice Telephone - the telephone number by which
individuals can speak to the organization or individual. Type: text. Domain:
free text. -->
                    </cntinfo>
                </metc>
                <metstdn></metstdn>
                <!-- Metadata Standard Name - the name of the metadata standard used to
document the data set. Type: text. Domain: "FGDC Content Standard for Digital
Geospatial Metadata" free text -->
                <metstdv></metstdv>

```

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    <!-- Metadata Standard Version - identification of the version of the
metadata standard used to document the data set. Type: text. Domain: free
text. -->
    <metac></metac>
    <!-- Metadata Access Constraints - restrictions and legal prerequisites
for accessing the metadata. These include any access constraints applied to
assure the protection of privacy or intellectual property, and any special
restrictions or limitations on obtaining the metadata. Domain: free text -->
    <metuc></metuc>
    <!-- Metadata Use Constraints - restrictions and legal prerequisites for
using the metadata after access is granted. These include any metadata use
constraints applied to assure the protection of privacy or intellectual
property, and any special restrictions or limitations on using the metadata.
Domain: free text. -->
    <metysi>
    <!-- Metadata Security Information - handling restrictions imposed on the
metadata because of national security, privacy, or other concerns. Type:
compound. -->
    <metscs></metscs>
    <!-- Metadata Security Classification System - name of the classification
system for the metadata. Domain: free text -->
    <metsc></metsc>
    <!-- Metadata Security Classification - name of the handling restrictions
on the metadata. Domain: "Top secret" "Secret" "Confidential" "Restricted"
"Unclassified" "Sensitive" free text -->
    <metshd></metshd>
    <!-- Metadata Security Handling Description - additional information
about the restrictions on handling the metadata. Domain: free text. -->
</metysi>
<metextns>
    <!-- Metadata Extensions - a reference to extended elements to the
standard which may be defined by a metadata producer or a user community.
Extended elements are elements outside the Standard, but needed by the
metadata producer. If extended elements are created, they must follow the
guidelines in Appendix D, Guidelines for Creating Extended Elements to the
Content Standard for Digital Geospatial Metadata. Type: Compound -->
    <onlink></onlink>
    <!-- Online Linkage - the name of an online computer resource that
contains the metadata extension information for the data set. Entries should
follow the Uniform Resource Locator convention of the Internet. Domain: free
text. -->
    <metprof></metprof>
    <!-- Profile Name - the name given to a document that describes the
application of the Standard to a specific user community. Domain: free text.
-->
</metextns>
</metainfo>
</metadata>

```

Appendices

Appendix 1. Alaska Albers Statewide Tile Index geodatabase

Appendix 2. Alaska UTM Statewide Tile Index geodatabase

Appendix 3. Example Folder Structure for data delivery

Appendix 4. USGS Classified Point Cloud xml template

Appendix 5. NV5 Classified Point Cloud xml example