

## Overview

This technical document details implementation plan for data download and image and map services for LiDAR derivative datasets as outlined in the latest VT State LiDAR Plan. Part of the overall LiDAR data delivery strategy, these services will greatly improve access to robust resources for the business needs of a broad range of use cases. See **“Table 1: Primary Image and Web Map Services Overview”** below.

Vermont LiDAR data is broken into two general categories: 1) Currently available, none uniform “legacy” (Quality Level 3) data; and 2) Uniform higher accuracy Quality Level 2 (QL2) data. Legacy QL3 data was acquired between 2005 and 2012 at a variety of resolutions, range of deliverables and “hydro treatments”. Currently funded QL2 data covers approx. 48% of the state and will become available sequentially for each Area of Interest (AOI), i.e., Rutland/Grand Isle; “Eastern Vermont”; Windham County and Windsor County/CT River subbasin, respectively.

Initial services will be created using legacy data (see Table 4. Below), reprojected to the Vermont State Plane Coordinate System (VSPCS) as needed, while future service updates will include the more accurate and consistent QL2 data that will eventually cover the state.

## Background

Source legacy data will be used “as is” directly from the vendor supplied source data. Service implementation will be staggered with priority assigned to the DEM, Hillshade and Contour datasets, followed by the “bare earth” DEM “derivatives”, i.e., Aspect, DSM, Hillshade, nDSM, Slope rasters. Each theme will be imported into individual “mosaic datasets” by theme, year and resolution before being imported to a master “mosaic of mosaics” dataset (by theme) and published as ArcGIS Services + OGC WMS Services for public access.

In the beginning of the VT LiDAR Initiative (2011) a large effort was made to “normalize” the naming convention, directory structure, projection, derivative products and resolution. At that time, only the 2005 Essex County and the 2008 and 2010 Missisquoi data deliveries were available, all with different cell resolutions, origins, projections and naming convention. and no advance effort had been made to. In an attempt to ensure a continuous surface along the adjacent Missisquoi data boundaries the individual source LAS “point cloud” data from each delivery were joined to produce a continuous surface with a single resolution. While advantageous at the time it came at the expense of vendor applied “hydro-treatment” efforts on the “bare earth” DEMs.

With higher resolution QL2 data on the near horizon for over 50% of the state and consistent in every way, the legacy data will be used “as is” in its original cell resolution, with the value added “hydro treatments” and in the tiling scheme it was delivered in. The minor loss in consistency will be more than offset by gains in the quality of the bare earth “hydro treated” DEMs and subsequent derivatives.

Table 1: Primary Image and Web Map Services Overview	
Mosaic Dataset OR .mxd	Description
IMG_VCGI_LIDARDEM_SP_v1	All VT LiDAR DEMs rasters - State Plane
IMG_VCGI_LIDARDEM_WM_v1	All VT LiDAR DEMs rasters - Web Mercator
IMG_VCGI_LIDARDSM_SP_v1	All VT LiDAR DSMs rasters - State Plane
IMG_VCGI_LIDARHILLSHD_SP_v1	Color hillshade from LiDAR DEM data. VT State Plane Meters.
IMG_VCGI_LIDARHILLSHD_WM_v1	Color hillshade from LiDAR DEM data. Web Mercator.
MAP_VCGI_LIDARHILLSHDPLUS_SP_CACHE_v1.mxd	Color DEM hillshade & contours from LiDAR with hydro. VT State Plane Meters.
MAP_VCGI_LIDARHILLSHDPLUS_WM_CACHE_v1.MXD	Color DEM hillshade & contours from LiDAR with hydro. Web Mercator.
MAP_VCGI_LIDARCONTOURS_SP_CACHE_v1.MXD	Contours derived from LiDAR DEM. VT State Plane Meters.
MAP_VCGI_LIDARCONTOURS_WM_CACHE_v1.MXD	Contours derived from LiDAR DEM. Web Mercator.
IMG_VCGI_LIDARNDSM_SP_v1	All VT LiDAR nDSMs rasters - State Plane
IMG_VCGI_LIDARASPECT_SP_v1	All VT LiDAR aspect rasters - State Plane
<b>Priority items in orange</b>	<b>Secondary items in Green</b>

## Specifications for Legacy Data

Legacy data will be conflated to the following criteria as needed, while future QL2 data only requires application of the naming convention:

- VSPCS Coordinate System and Datum:** Vermont State Plane Meters, NAD 83, NAVD88 (National Spatial Reference System (NSRS) or most current). See “Alignment to a Common Origin” bullet below for related information.
- Vertical Units:** NAVD88 Meters *(Temp Note: MCB needs to re-verify this).*
- Cell Resolution:** As delivered by vendor.
- Tiling Scheme:** As delivered by vendor
- Naming Conventions:** The naming conventions of Vermont's Open GeoData Portal comply with guidelines defined in section **2.4.4 Data Layer Naming Convention** of the [“Enterprise VGIS System:](#)

[ArcSDE Configuration and Management Guidelines](#)” (version 5b)<sup>1</sup>. See the table below for examples of LiDAR derived dataset naming.

Dataset	Individual File Names	Description
ElevationOther_ASPECT1p6m	Elevation_ASPECT1p6m_2012_AVT_003.img	
ElevationOther_DEM1p6m	Elevation_DEM1p6m_2012_AVT_003.img	
ElevationOther_DEMHF1p6m	Elevation_DEMHF1p6m_2012_AVT_003.img	
ElevationOther_DEMHE1p6m	Elevation_DEMHE1p6m_2012_AVT_003.img	
ElevationOther_DSM1p6m	Elevation_DSM1p6m_2012_AVT_003.img	
ElevationOther_HILSHD1p6m	Elevation_HILSHD1p6m_2012_AVT_003.img	
ElevationOther_nDSM1p6m	Elevation_nDSM1p6m_2012_AVT_003.img	
ElevationSlope_SLOPE1p6m	Elevation_SLOPE1p6m_2012_AVT_003.img	

- Alignment to a Common Origin:**

While all QL2 data aligns with a common origin as processed by the vendor, i.e., VSCS (0, 0), “Legacy data” was not and those source data tiles will be reprojected to VSPC “as is” to avoid introducing horizontal shift errors, slivers and shifting data values from their original location.

**For any additional processing done to delivered QL2 data the following environmental variables will apply:**

- Output Extent:** The following coordinate control the processing extent (VTSPC NAD83 meters), expedites processing by limiting area considered and are common to all cell resolutions in the legacy data:

X_min	Y_min	X_max	Y_max
369,600	11,200	593,600	291,200

- Snap Raster:** Rasters for input to re-projection/resampling created based on the origin (0, 0) and varying by cell resolutions, ensure outputs from original vendor data adhere to the origin and share a common cell alignment, by resolution. Also insures no slivers in output data.

Name	Resolution
lidarsnap1p0m	1.0
lidarsnap1p4m	1.4
lidarsnap1p6m	1.6
Lidarsnap2p0m	2.0

<sup>1</sup> <https://outside.vermont.gov/sites/egcgeo/Documents/VGIS%20ArcSDE%20Config%20Guidelines.pdf>

Table 4: Legacy Data Characteristics						
ALL_LDRN	Src Res_m	Source Tiling m	Source Projection	DEM_HF	DEM_HE	Task/Issues
Essex County 2005	1	¼, ¼ quad	UTM 19 m; Zunits m	N	N	Tile #44071f6sec not available, not in delivery, not available from vendor... (Maidstone Lake USGS topo – SW corner)
Missisquoi Lower 2008	1.4	2000	VSPC m; Zunits m	Y	N	
Barre Montpelier 2009	1	Single image	WGS 84 UTM 18; Zunits m	N	N	Reproject original DEM. No DSM available - last return class not part of Scope.
Missisquoi Upper 2010	1.6	2000	VSPC m; Zunits m	Y	Y ?	
Addison County 2012	1.6	2000	UTM 18 m; Zunits m	Y	Y	
Bennington County 2012	2	1500	UTM 18 m; Zunits m	Y	N	Curent download is at 1.4m (point spacing supported it). Update will rely on source tiles with 2m resolution. Need to acquire data sliver on border w/NY & integrate.
DEM_HF: “Hydro-flattened” DEM DEM_FE: “Hydro-enforced” DEM; see USGS’s <a href="#">“Hydro Treatments of LiDAR Derived DEMs”</a> powerpoint for details						

Table 4: VCGI LiDAR Data Delivery Services						
Access Options	Datasets*					
	DEM	DSM	Hillshade	Contours	Source LAS files	Other Derivatives **
External Drive Product	✓	✓*	✓	✓	✓	✓
Direct Download	✓	✓	✓	✓		✓
Map Services			✓***	✓		
Image Services	✓	✓	✓			✓
VT Interactive Map Viewer	✓	✓	✓	✓		✓
	* Where available; coverage is not currently statewide					
	** Derivatives: Aspect, Normalized DSM (nDSM) and Slope rasters					
	***Hillshade combined with contours as map service					
	<b>Note:</b> Map and Image Services detailed in <a href="#">“Proposed Suite of LiDAR-based Web Services Created and Hosted by VCGI”</a> .					

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