Linear Reference System and Linear Reference Methods

ARNOLD – All Roads Network of Linear-referenced Data
Trans_LRS_Route_twn – Town-Based Measures
Trans_LRS_Route_ete – End-to-End Measures

   VTrans maintains a linear reference system (LRS) of publicly traveled highways that are functionally classed as local roads and above, with the All Roads Network Of Linear-referenced Data (ARNOLD). In 2012, the Federal Highway Administration (FHWA) announced the requirement for State Departments of Transportation to submit a Linear Reference System (LRS) that included all public roads as part of their Highway Performance Monitoring System (HPMS) submittal. Prior to this, the requirement for an LRS applied only to highways that were functionally classed as minor collectors (FC 6) and above.

https://www.fhwa.dot.gov/policyinformation/hpms/documents/arnold_reference_manual_2014.pdf

VTrans also maintains two linear reference methods (LRM) based on two methods of route measures, with these being a town-based (TWN) LRM that has measures that are unique to a town and a route re-zeros at town boundaries and the end-to-end (ETE) LRM that has cumulative mileage for an entire route, from original to terminus. The TWN and ETE LRMs are based on all highways that are functionally classed as minor collector (FC 6) and above and do not include any local roads. The ARNOLD data layer pulls together the ETE LRM and the local road LRM into a single all roads network of linear referenced data.

The ARNOLD, Trans_LRS_Route_ete, and Trans_LRS_Route_twn have the same data schema and are generated from geometry of the master road centerline data layer.   The ETE and TWN LRMs are calibrated using a series points within the route log point (RTLOGPTS) data layer that includes route codes and measures. ARNOLD is a dataset that is created from the ETE LRM fused with the local road linear referenced data that is generated through an automated process annually.

Data Field Descriptions

1. **OBJECTID** (OID, 4)

   GIS software generated unique object identifier.

2. **BeginDate** (Date)

   The begin date of the highway segment is being reported.   The intent is to have this value reflect the date that a highway segment was opened and was added to the network but has yet to be populated to this extent.

3. **StateID**, (SmallInteger, 2)

The State Federal Information Processing Standard (FIPS) code used to identify the state for the HPMS. Vermont is coded as "50".

More State Codes can be found at FHWA at the following links:

https://www.fhwa.dot.gov/policyinformation/hpms/fieldmanual/page12.cfm

4. **RouteID** (String, 60)

The unique identifier for a given roadway (i.e., route) and based on a route identifier defined by the States. In the case of Vermont and the TWN linear reference method, the RouteID is coded to match the TWN_LR route identifier. For the ARNOLD data, the RouteID conforms to HPMS requirements and is based on the ETE_LR and local road linear reference codes.

5. **Comments** (String, 50)

Field for use to add any comments regarding the LRS segment and if there are any issues or anomalies regarding mileage, configuration or status.

6. **TWN_LR**(String, 15)

Town-based (TWN) linear reference code used to generate the town-based LRM data layer. The TWN measures reset at each town boundary for a route and represent the measures solely within an individual municipality, whereas the End-to-End (ETE) linear reference method is cumulative mileage for an entire route. The TWN_LR is related to the ETE_LR field but also includes the CTCODE. For example, the TWN_LR value for VT Route 12 in Montpelier is V012-1211 (ETE_LR = V012, CTCODE = 1211). The TWN measures have a relationship to the green placard reference markers on the highway network that include the a 4 digit route code, the 4 digit CTCODE and a 4 digit measurement with an implied decimal after the second digit.

7. **ETE_LR** (String, 15)

End-to-End linear reference code used to generate the end-to-end LRM data layer . It is used to identify "routed" highways and is assigned by VTrans. The ETE_LR can be broken down into the following components (or redefined items):

   - Route Type
      Field values:

A = Alternate Route
B = Business Route
I = Interstate
N = Named State Highway
S = Special Route: a town highway that is a major or minor collector, or is an urban route
U = US Route
V = VT Signed Route

- <u>Route Number</u>
    The numeric portion of the highway number (three digits), right-justified in characters 2-4. For Named State Highways, Major Collectors, and Urban Collectors, four-digit codes are used (in characters 2 -5).

- <u>Route # Modifier</u>
    Used for a letter or special modifier, if needed. Named State Highways, Major Collectors, and Urban Collectors retain their full four-digit codes in common usage. For these, the Highway Number and Modifier are combined to form a four-digit highway number. For the three separate sections of Alternate US 5, the modifiers (1 to 3) are:
        A0051 = Alternate US 5, St. Johnsbury
        A0052 = Alternate US 5, Newport
        A0053 = Alternate US 5, Derby
    Valid Highway # Modifier characters include:
        [letter] = highway letter (e.g., the 'A' in Highway 2A)
        [digit] = special cases (e.g., Alternate US 5); digit for a Named State Highway, Major, or Urban Collector
        [blank] = cases where no modifier is needed and no subsequent components are needed for the ETE_LR
        [dash] = cases where no modifier is needed but other ETE_LR components follow

- <u>Direction</u>
    The direction character is included only if the highway is divided. However, it is NOT used for northbound or eastbound mainline routes. The direction character is used only with northbound or eastbound approaches, connectors, jughandles, ramps, and spurs.
        Field values:
            ' ' = [blank] = undivided route with no subsequent ETE_LR components
            E = eastbound (for divided routes)
            N = northbound (for divided routes)
            S = southbound (for divided routes)
            W = westbound (for divided routes)
        Examples:
            I089 = I-89, northbound lane
            I089-S = I-89, southbound lane
            U002 = US-2, undivided portions
            U002-W = US-2, westbound portions (where divided)

V003-NA020 = VT 3, approach 20 (approaches generally use the same direction as the parent road)

- Subtype
  This field describes sections of road that are not on the main line, yet have defined lengths recognized by the Agency.
  Field values:
  ' ' = [blank] = no subtype
  A = approach
  C = connector
  F = facilities/rest areas, turnouts, access roads
  J = jughandle
  R = ramp
  S = spur

- Numeric ID
  The ID number represents different things according to the subtype. Approaches and jughandles are numbered (initially) in ascending order from the start of the parent route in the primary direction. Numbers will increment by multiples of ten (ex: 10, 20, 30, 40, etc.). Gaps are left between numbers for future construction. For ramps and spurs, the number refers to the exit number for the parent route. A few ramps exit at locations that have no exit number; these have zeros in this field. Where no ID is required in this field, blanks are used.

- Alpha ID
  This letter identifies ramps and spurs, as taken from the route logs (except for two ramps at I-91's Exit 2, which were named A/B and C/D on the route logs. These have been renamed 'E' and 'F', respectively.) Where no ID is required in this field, a blank space is used.
  Examples:
  U004 = US-4 eastbound, divided highway
  U004-W = US-4 westbound, divided highway
  V100-NA002 = VT-100, Approach #2
  B004-WJ001 = Business Route US-4 westbound, Jughandle #1
  I089-SR009A = I-89 southbound, Exit 9 ramp

8. **STARTMEASURE**, (Double, 8)

Start measure for the segment in miles. Typically rounded to the nearest 1/1000th of a mile. Measures are based on official mileage and are typically 3D measures from on the ground measurements with a distance measuring instrument (DMI) or other sources and are based on measures that Mapping Section has on record.

9. **ENDMEASURE**, (Double, 8)

End measure for the segment in miles. Typically rounded to the nearest 1/1000th of a mile. Measures are based on official mileage and are typically 3D measures from on the ground measurements with a distance measuring instrument (DMI) or other sources and are based on measures that Mapping Section has on record.

10. **LENGTH**, (Double, 8)

Length of the segment in miles, calculated as the difference between the end measure and begin measure.

11. **SHAPE_MILES**, (Double, 8)

Length in miles of the segment calculated from the system generated length field - Shape.STLength(), through a meter to mile calculation.   As of October 2020, this mileage is a planimetric measurement and does not reflect a driven 3D measurement, but it is the intent to include z-values in the road centerline data that will allow more accurate 3D measures to be generated.

12. **CTCODE**, (String, 4)

County-Town Code - defined by the Vermont Agency of Transportation(VTrans). The CTCODE is comprised of the first two digits representing the County and the last two digits representing the Town in alphabetical order within the County. The counties are numbered sequentially starting with Addison County (01) and ending with Windsor County (14). Each town is then numbered sequentially within each county, producing a unique CTCODE. The county-town code identifies the municipality in which each road falls. The CTCODE is evident on reference markers in the field, which include the CTCODE, route identifier and mile marker.

NOTE: The order of towns like Saint Albans (aka St. Albans) and Saint Johnsbury (aka St. Johnsbury) is based on the unabbreviated names - for example, in Caledonia County the CTCODE order for Saint Johnsbury places it between Ryegate and Sheffield (0310 Ryegate, 0311 Saint Johnsbury, 0312 Sheffield).

NOTE: The CTCODE system was implemented before the Town of Sherburne changed its name to Killington - the name was changed, but the CTCODE was not (its CTCODE remained 1121, between 1120 Rutland Town and 1122 Shrewsbury).

http://vtransmaps.vermont.gov/Maps/Publications/CTCODE_listing.pdf

13. **AOTMILES_SUM**, (Double, 8)

   Sum of the AOTMILES filed in the master road centerline data layer, providing the official mileage for the segments that are combined to create the route. Due to some hand updates that occur in the final production of the TWN and ETE LRMs, there may be some AOTMILES_SUM values that don't reflect the true official mileage. All segments of highway that are non-primary direction and the AOTMILES in the road centerline data layer have and AOTMILES_SUM that will not reflect the traveled mileage.

14. **VersionDate**, (Date, 8)

   Date the linear reference method was generated. The TWN and ETE LRMs are generated twice a year in December and May, and ARNOLD is generated once a year in May. The VersionDate records the actual date the LRS was generated.

15. **Shape**, (Geometry, 8)

   Binary geometry object stored by the GIS software.

16. **Shape.STLength()**, (Double, 0)

   Length of the arc generated by the GIS software and based on the data layer units. In the case of the ARNOLD, TWN and ETE LRMs, the native data is stored in Vermont State Plane Meters - NAD83, so this length is represented in meters.