

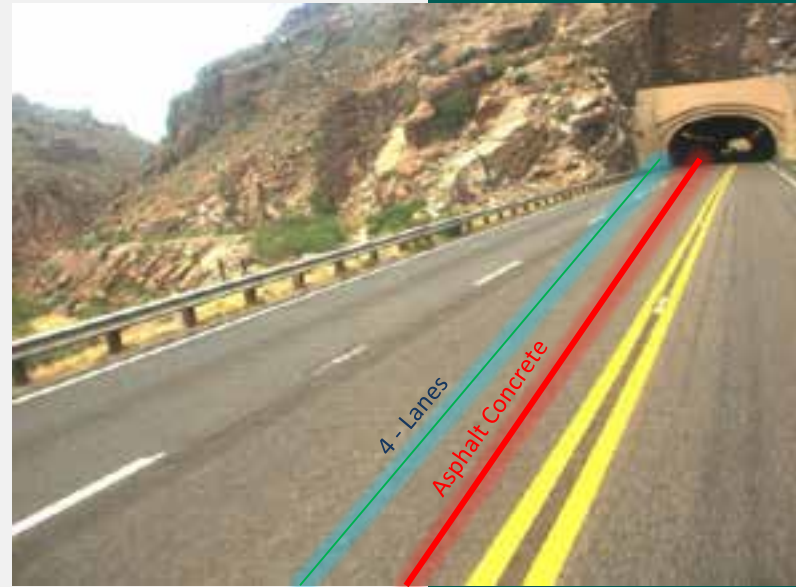
ADOT's Enterprise LRS

ESRI UC July 21st, 2015

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Overview

- q LRS Implementation
- q Product Enhancements
- q Best Practices
- q Roadway Characteristics Editor (RCE)
- q Future Endeavors

ADOT's Linear Referencing Systems

Legacy System

- q Multiple linear referencing methods
- q Route and Event editing within ArcMap
- q Robust geocoder/reverse geocoder
- q Tailored specifically for
Multimodal Planning Division
- q Used to maintain the LRS and submit HPMS
- q Required GIS/LRS knowledge
- q No Temporality

Current System - Roads and Highways

- q Measure based system
- q Route and event edits done separately
- q Custom geocoder/reverse geocoder
- q Tailored for all of ADOT
- q Used to maintain the LRS and working on
submitting HPMS
- q Requires GIS/LRS knowledge
- q Temporality

So Then Why Did ADOT Change its LRS?

New LRS - Business Advantages

- q Local agencies
 - q Local coordination
 - q Geocoding/editing in the RCE
 - q Start maintaining data spatially
 - q Easier to quality check data
 - q Take ownership of their data



Spatial

Tabular

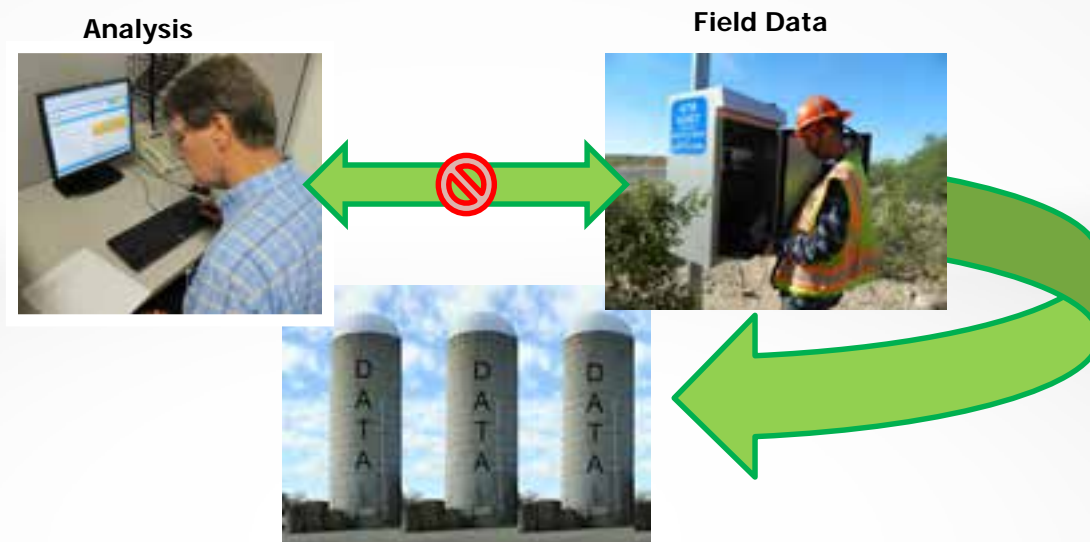
	A	B	C	D	E	F	G	H	I	J	K	L	M	N
	REC#	Program	Section	SeqNo	REC#	Seq	RI	IMP	CO	TRNG	LOCATION	LENG	District	
1	16891	HIGHWAYS	STATEWIDE	11714	223	1	8	2	VU	0	16TH STREET		Yuma	
2	15288	HIGHWAYS	STATEWIDE	15413	132	1	8	7	VU	H918201C	ARABY ROAD THREE CONSTRUCTION	0.02	Yuma	
3	12012	HIGHWAYS	STATEWIDE	20414	213	1	8	1	VU	H91261C	SOUTH FRONTAGE ROAD IMPROVEMENTS	2	Yuma	
4														
5	18421	HIGHWAYS	STATEWIDE	11214	118	1	8	12	VU	H91581C	FOOTHILLS BLVD-COME VALLEY	2.3	Yuma	
6	15581	HIGHWAYS	STATEWIDE	18315	118	1	8	21	LA	H908701C	OLD HIGHWAY 85 TO WELTON	8	Yuma	
7	15590	HIGHWAYS	STATEWIDE	22214	211	1	8	21	LA	0	OLD HIGHWAY 85 TO WELTON	8	Yuma	
8	12584	LRFCYCLE	RTP/P	46214	112	1	8	141	NA	H958701C	TREENWAY TO MARICOPA - PINAL COUNTY LINE	8.5	Yuma	
9	16894	HIGHWAYS	STATEWIDE	11214	123	1	8	163	PH	H927301C	SANTA ROSA WASH BR, STR 1182 E 1050		Tucson	
10	18485	HIGHWAYS	STATEWIDE	11803	118	1	8	170	PH	H917101C	SMAGG RD - JCT 110	0.33	Tucson	
11	15615	HIGHWAYS	STATEWIDE	50314	125	1	8	173	PH	H903101C	THORNTON ROAD TRIP, STR 1188	0.1	Tucson	



New LRS - Business Advantages

- q ADOT

- q Allow for data stewards to maintain their data spatially
- q Break down internal data silos
- q Same LRS for all of ADOT
- q Facilitate the possibility of bringing HPMS in house



Data Strong – Information Weak

LRS Implementation

- q Build vs Buy
- q Agile/Scrum Development Methodology
- q Over 200 user stories collected
- q Project Resulted - Mix of COTS and custom dev
- q Two phase project
 - q MPD LRS updates
 - q Data Warehouse updates

User Story ID 0036
Generated By Andy Creek
Feature ROI Editing
Story As an ROI Technician, I can create engineering stations in order to efficiently support extract information from engineering plans, so that I can correctly geocode the data from the plans to the LRS at the foot level.
Acceptance Criteria

1. Enter in engineering stations based off X,Y coordinates from the plan sheets.
2. When entered, need to follow standard engineering station nomenclature.
3. Entered into Engineering Station feature class.
4. Must be able to handle equation math so that stations can handle offsets from other stations.

User Story ID 98
Generated By ADOT
Feature Intersection Library
Story As a GIS Technician I can check source data against a specified library (intersection table) to determine whether or not the selected field values match the values within the route field of the e library so that I can successfully geocode features.
Acceptance Criteria

Desktop Product Enhancement

- q Referents

- q To support data requests and HPMS

- q Maintain the human understood referents – Decision Makers

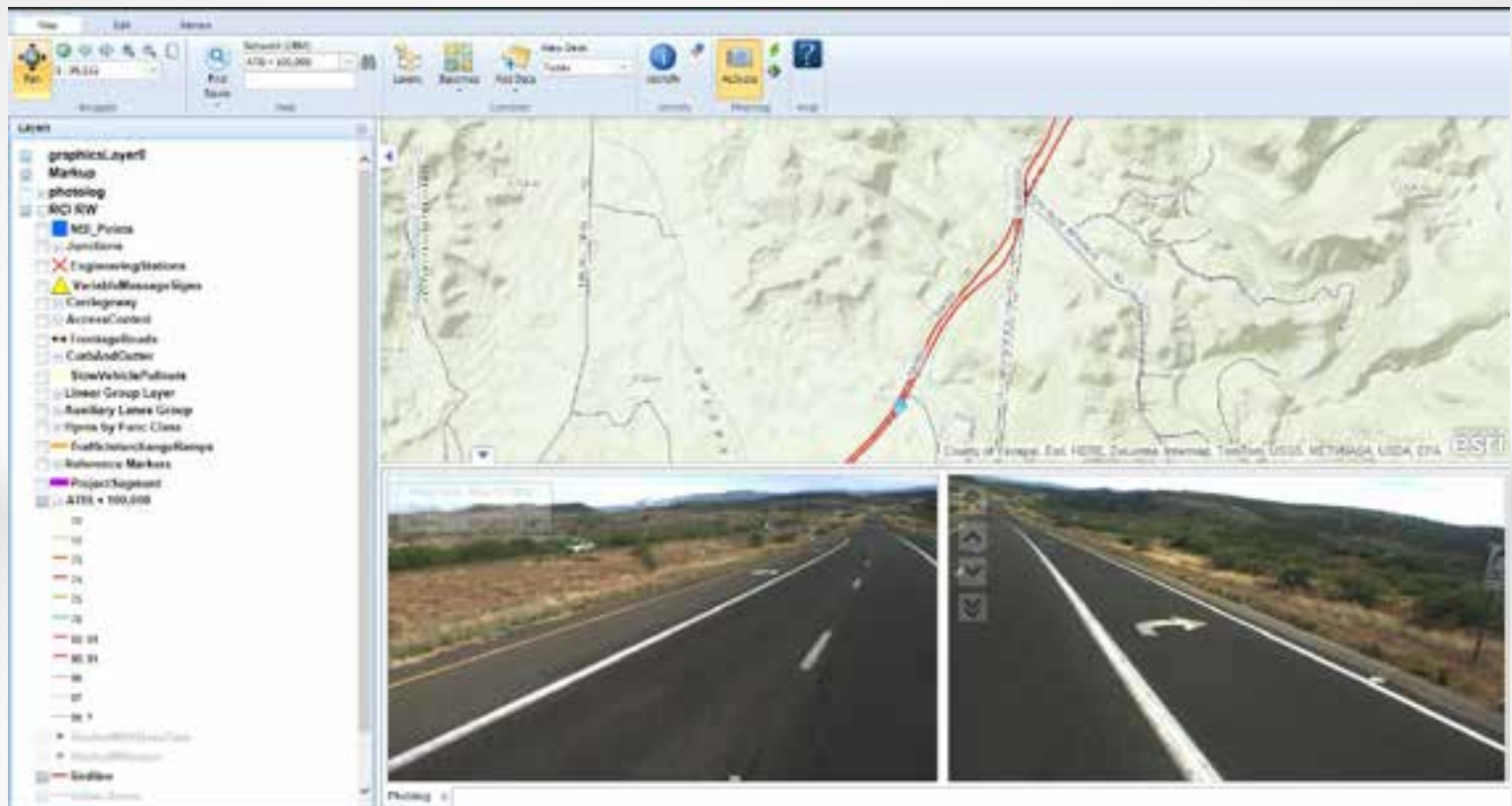
- q Measure is translated into a referent – not automated

Do you have a need for this?

RouteId *	FromMeasure	ToMeasure	NumberOfLanes	FromReferentLocation	FromReferentMethod	FromReferentOffset
5 089	58.075788	58.12526	4	{268E571C-0F84-4B68-BE1F-5AC130017576}	LRSI_RoutesWithRoutes	0
04 BCONTA ST	68.701762	68.182367	2	{3232762B-D486-4A8D-A786-5A4154C88091}	LRSI_RoutesWithRoutes	0
10 VALENCIA RD	10.660458	11.986747	4	{41676451-C60E-4BDC-A007-C1AD603DF60E}	LRSI_RoutesWithRoutes	-0.79924242
11 MAIN ST	31.061369	31.347351	2	{7BBF6A3D-8E95-4233-9B4F-2027171242AE}	LRSI_RoutesWithRoutes	0
11 MAIN ST	31.347351	31.563725	2	{51618488-E25E-4677-A5F3-8B26C4B100B1}	LRSI_RoutesWithRoutes	0
11 MAIN ST	31.563725	32.064705	2	{E2E1F447-A1FA-490D-9D16-1489321313E9}	LRSI_RoutesWithRoutes	0
11 MAIN ST	0.439083	1.200704	4	{35C67A4C-221B-483D-914A-6003035ADD11}	LRSI_RoutesWithRoutes	0
11 MAIN ST	68.497428	69.681385	2	{86746E72-80E1-4E74-8A14-A8E51C064093}	LRSI_RoutesWithRoutes	0
10 LA CHOLLA BLVD	16.537337	16.508837	2	{C15C078B-A577-420A-AP8A-C2686703457E}	LRSI_RoutesWithRoutes	0
10 LA CHOLLA BLVD	13.53559	14.537471	2	{5135A468-7171-480E-8C0B-6A030C07FE4A}	LRSI_RoutesWithRoutes	0
10 PANTANO RD	8.915543	9.414353	4	{4567789D-989C-4A03-8B0D-349218077B7A}	LRSI_RoutesWithRoutes	0
10 PANTANO RD	6.622629	7.627698	4	{A8CDA039-CA76-4906-9095-3891C8AB0063}	LRSI_RoutesWithRoutes	0
11 BATTAGLIA RD	12.061132	12.306993	2	{8C57A1C4-F5E3-486C-AC01-C16F3FD6C2A7}	LRSI_RoutesWithRoutes	0
11 BATTAGLIA RD	12.306993	13.037368	2	812689,641468	X/Y	0.24530999
01 SR-264 FRONTADE RD 0	0	0.05965	2	1506950,1713283	X/Y	0

RCE Product Enhancement

q Photo Log Viewer – ADOT



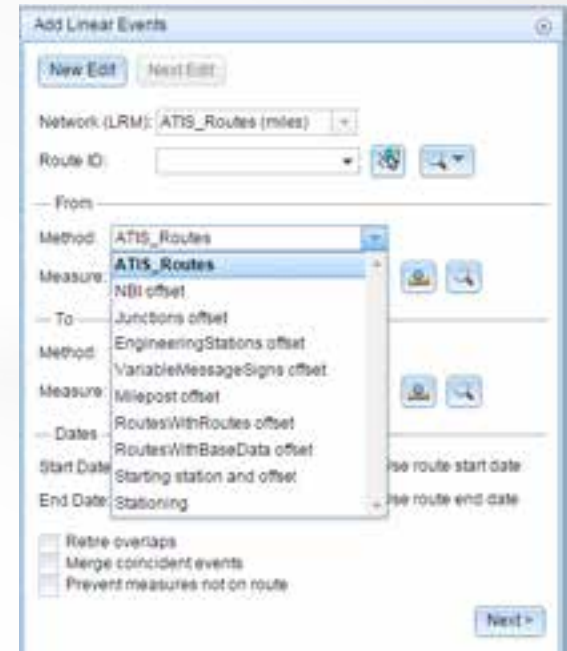
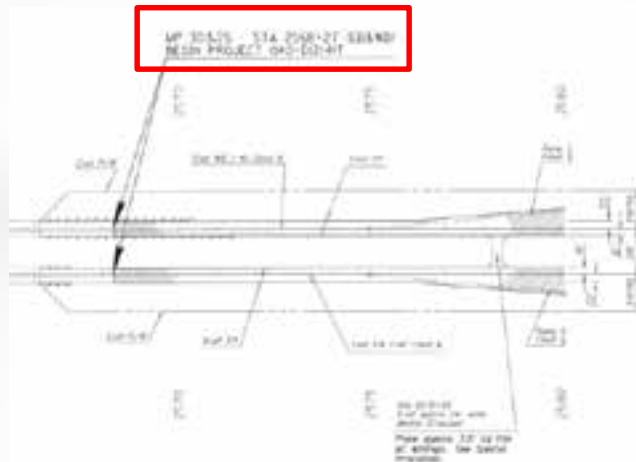
RCE Product Enhancement

- q Photo Log Viewer – ADOT
- q RCE Geocoder/Reverse Geocoder – ADOT
 - q Conflict resolver

The screenshot shows the 'Geocoding' software interface. It has a title bar 'Geocoding' and a subtitle 'Drag and drop CSV file on the map (HTML) or select the file on disk.' Below this is a 'Browse' button and a file input field. The 'Event Type' section has radio buttons for 'Point' and 'Line'. The 'Geocoding Method' section has radio buttons for 'Measure', 'Referent/Offset', and 'Geoid'. The 'Route Selection' section has a 'Route' dropdown menu. The 'From Location' section has dropdown menus for 'Crossing Feature Column', 'Crossing Cardinality Column', 'Crossing Type Column', 'Offset Column', and 'Units Column'. The 'To Location' section has dropdown menus for 'Crossing Feature Column', 'Crossing Cardinality Column', 'Crossing Type Column', 'Offset Column', and 'Units Column'. At the bottom is a 'Process File' button.The screenshot shows the 'Reverse Geocoding' software interface. It has a title bar 'Reverse Geocoding' and a subtitle 'Add a zipped shapefile to be reverse geocoded.' Below this is 'File Loaded: RestAreas.zip'. The 'Referent Type' dropdown is set to 'Milepost'. The 'Return All Referent Fields' dropdown is set to 'No'. The 'Force To Route Field' dropdown is set to 'Route'. The 'Candidate Routes' section has checkboxes for 'Interstates', 'US Highways', 'State Routes', 'Ramps', 'Frontage Roads', 'Business Routes', 'Turned Back Routes', 'Local Roads', and 'Other States Roads'. Each of the first three categories has sub-checkboxes for 'Cardinal' and 'Non-Cardinal'. At the bottom is a 'Reverse Geocode' button.

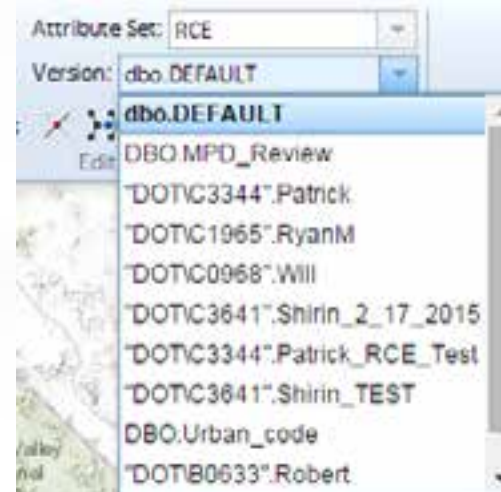
RCE Product Enhancement

- q Photo Log Viewer – ADOT
- q RCE Geocoder/Reverse Geocoder – ADOT
- q Custom Linear Referencing Methods – ADOT/ESRI
 - q Engineering Stations
 - q Routes with Routes



RCE Product Enhancement

- q Photo Log Viewer – ADOT
- q RCE Geocoder/Reverse Geocoder – ADOT
- q Custom Linear Referencing Methods – ADOT/ESRI
- q Versioning – ADOT



Best Practice - Desktop

q Event Behaviors

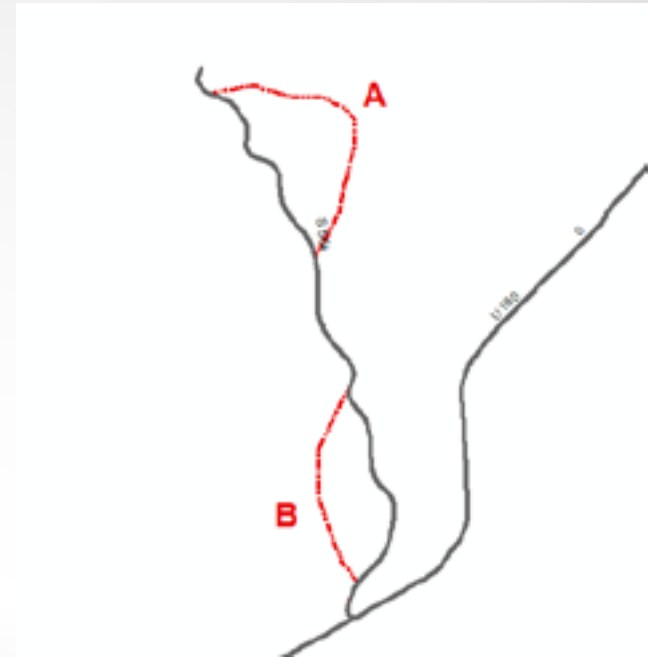
- q Understanding these behaviors is key to success
- q More complexity for the LRS editor
 - q Edits to the centerline affect the events
 - q Cartographic realignment – no temporality
 - q Lack of Snap behavior for RealignRoute



Temporality

q Temporality is Maintained using the FromDate

- Project A : OTT date is 1-11-2014
- Project B: OTT date is 1-12-2014



Table

ATIS_Routes

FromDate *	ToDate *	Route Date Last Build	Route Date C	Route Date O	RouteId *
7/11/2014	<Null>	11/8/2011 9:07:45 PM	<Null>	<Null>	S 564

Re-align according to Plan B

The image displays a software interface for route realignment, consisting of a dialog box and a map.

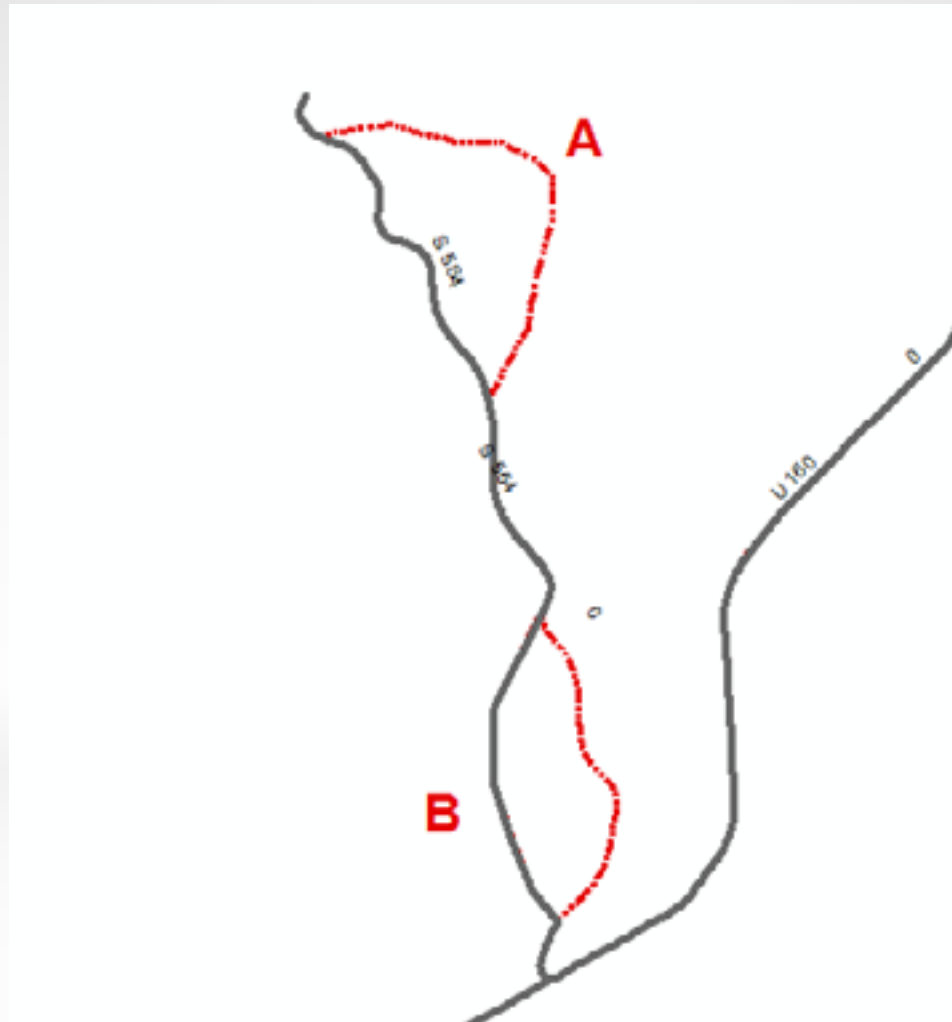
Realign Route Dialog Box:

- Source Route Parameters:**
 - Effective Date: 12/1/2014 12:00:00 AM
 - Route ID: 5 564
 - From Measure: 0.5745354 Miles
 - To Measure: 3.5945929 Miles
 - Recalibrate route downstream
- Split Measure Values:**
 - From Measure: 0.5745354 Miles
 - To Measure: 3.6902301 Miles
 - Do not apply event measure behaviors
- Buttons: OK, Cancel

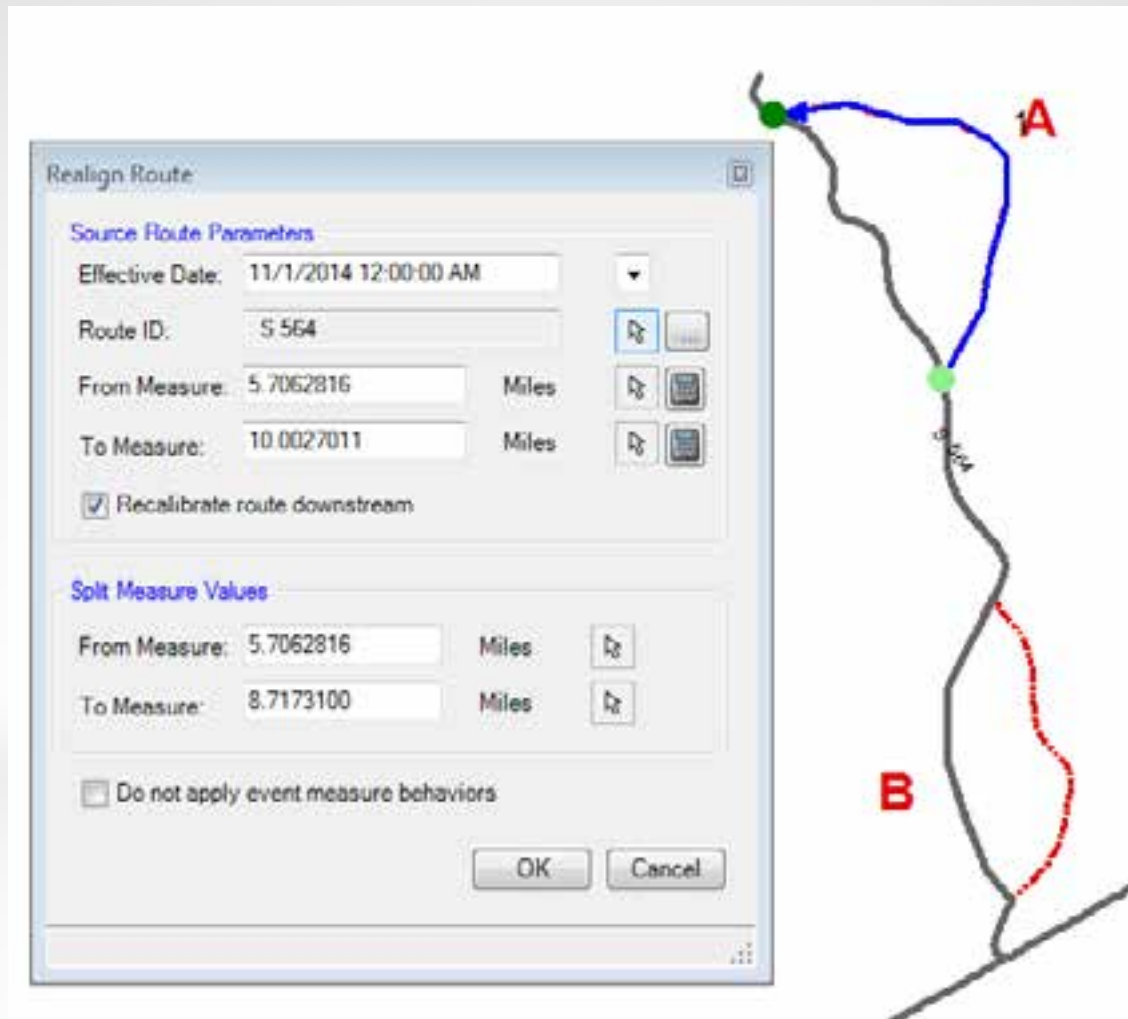
Map:

- A black line represents the original route.
- A red dotted line labeled 'A' shows a proposed new route segment.
- A blue line labeled 'B' shows a proposed new route segment that branches off from the original route.
- Green dots mark the start and end points of the new route segments.
- The number '1' is placed near the junction of the original route and the new route 'B'.

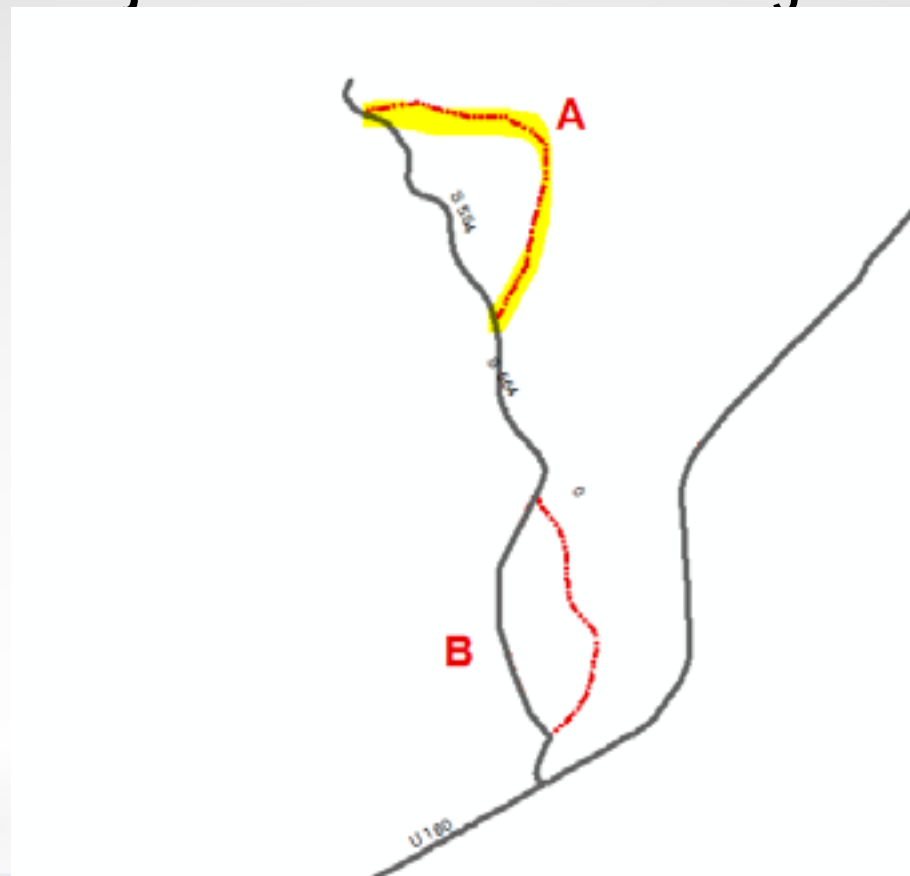
Plan B Realignment



Re-align according to Plan A



We can see new alignment for Project B but not for Project A .
 Project A is retired according to RH.



Table

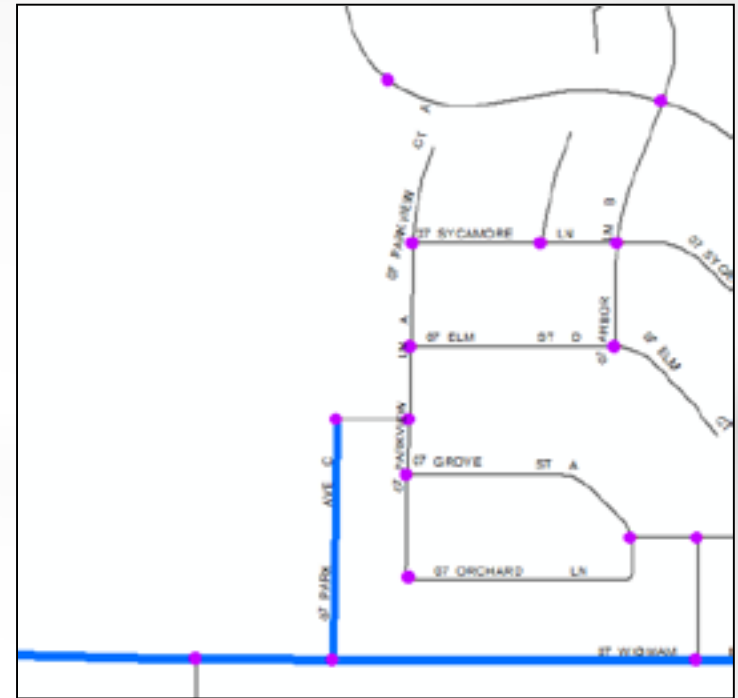
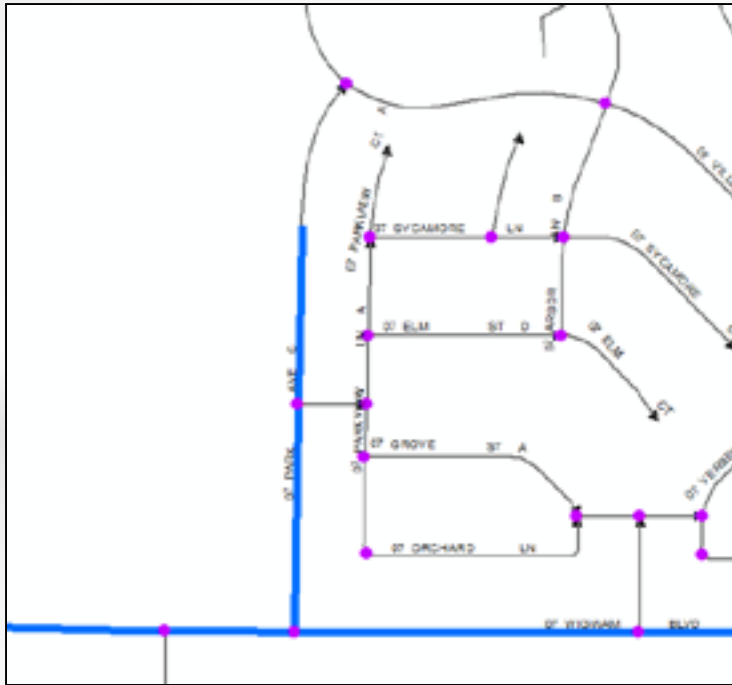


KTIS_Routes

FromDate *	ToDate *	Route Date Last Build	Route Date C	Route Date O	RouteId *	created_date	last_edited_user	last_edited_date
12/1/2014	<Null>	11/8/2011 9:07:45 PM	<Null>	<Null>	S 564	<Null>	C3641	7/1/2015 9:34:39 PM
11/1/2014	12/1/2014	11/8/2011 9:07:45 PM	<Null>	<Null>	S 564	7/1/2015 9:34:39 P	C3641	7/1/2015 9:38:07 PM
7/11/2014	11/1/2014	11/8/2011 9:07:45 PM	<Null>	<Null>	S 564	7/1/2015 9:38:07 P	C3641	7/1/2015 9:38:07 PM

Referent information in events

- Gain accurate referent information in RCE, lose them in desktop after editing routes



- Before

Table

FunctionalSystem

OBJECTID*	FromDate*	ToDa	EventID*	RouteID*	FromMeasure	ToMeasure	FunctionalSystem	FromReferencLocation	FromReferencOffset	ToReferencLocation	ToReferencOffset	
16206	3/23/2015 1:23:54 PM	ctab	(1829C28E-2488-41F1-8407-DE18CE1C365F)	07 PARK	AVE - C	0	0 233210	Major Collector	(A2F0C997-65F8-4698-8E15-8F988E458A02)	0	(001E464c-8FE3-43DA-80E1-32E470E75A3F)	-0.000363

- After

Table

FunctionalSystem

OBJECTID*	FromDate*	ToDa	EventID*	RouteID*	FromMeasure	ToMeasure	FunctionalSystem	FromReferencLocation	FromReferencOffset	ToReferencLocation	ToReferencOffset	
5628	9/25/2013	ctab	(1829C28E-2488-41F1-8407-DE18CE1C365F)	07 PARK	AVE - C	0	0 121940	Major Collector	(A2F0C997-65F8-4698-8E15-8F988E458A02)	0	ctab	ctab

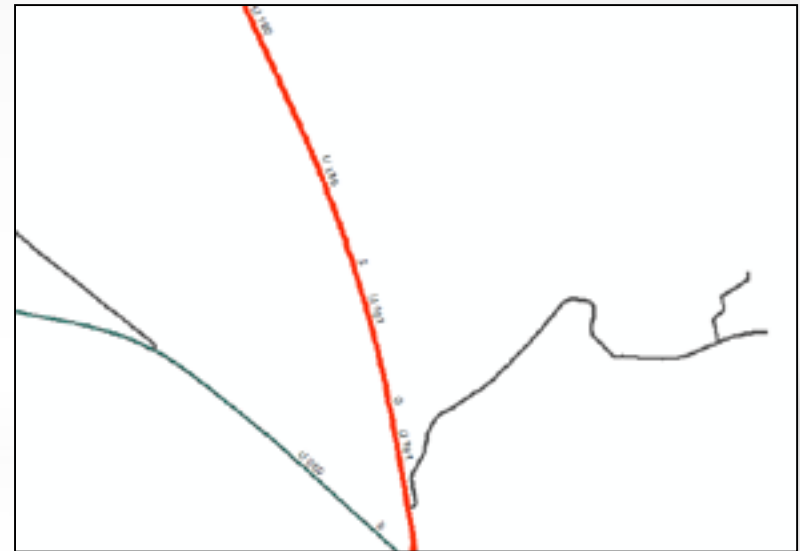
Highway Performance Monitoring System (HPMS)

- Converting spatial data to tabular
 - There is not an easy way to reassign events on overlapping routes

ATIS_Routes	
	Routelid *
<input type="checkbox"/>	U 180
<input type="checkbox"/>	U 191

FunctionalClass	
	Routelid *
<input type="checkbox"/>	U 180

AADT	
	Routelid *
<input checked="" type="checkbox"/>	U 191



Best Practice - Data Conversion

- q New Data Structure
- q Broke out events (i.e. Auxiliary Lanes)
- q Quality control for overlaps/duplicates
- q Organized domains per HPMS requirements
- q To support straight line diagramming

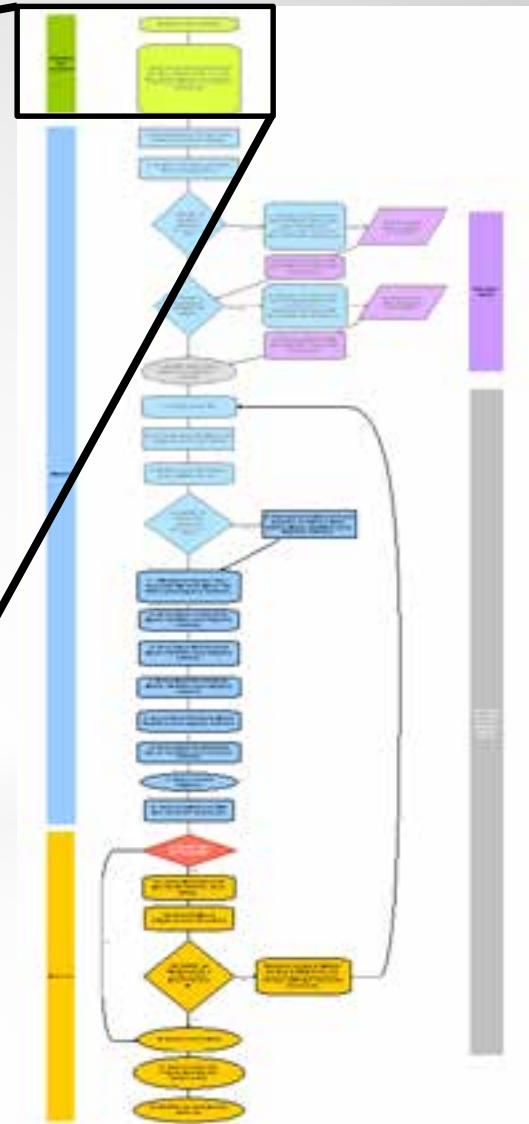
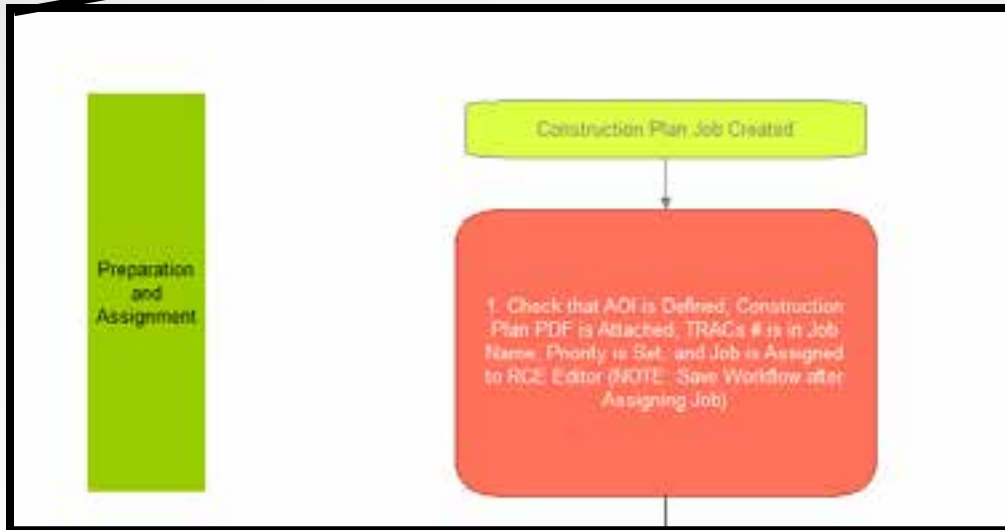
ADOT Roads & Highways RCI Data Model (v 7.0)

Overview Event Classes Domains

Field name	Data type	Allow Nulls	Default value	Domain	Free-Item Scale Length
OBJECTID	Object ID				
RunDate	Date	Yes			0 0 4
TotDate	Date	Yes			0 0 4
Event	Char	Yes			0 0 34
Route	String	Yes			32
FromFeature	Double	Yes			0 0
ToFeature	Double	Yes			0 0
NumberOfLanes	Short Integer	Yes			0 0
AngleNorthPI	Double	Yes			0 0
LaneComment	String	Yes			100
FromFeatureLocation	String	Yes			32
FromFeatureMethod	Short Integer	Yes			0
FromFeatureOffset	String	Yes			32
ToFeatureLocation	String	Yes			32
ToFeatureMethod	Short Integer	Yes			0
ToFeatureOffset	String	Yes			32
SourceClass	String	Yes			256
DefaultDir	String	Yes			40

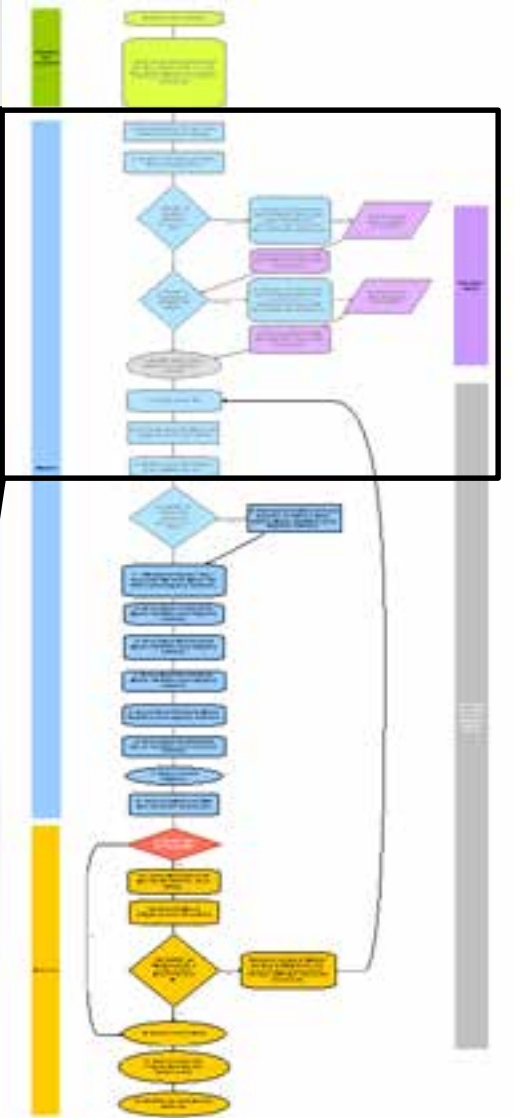
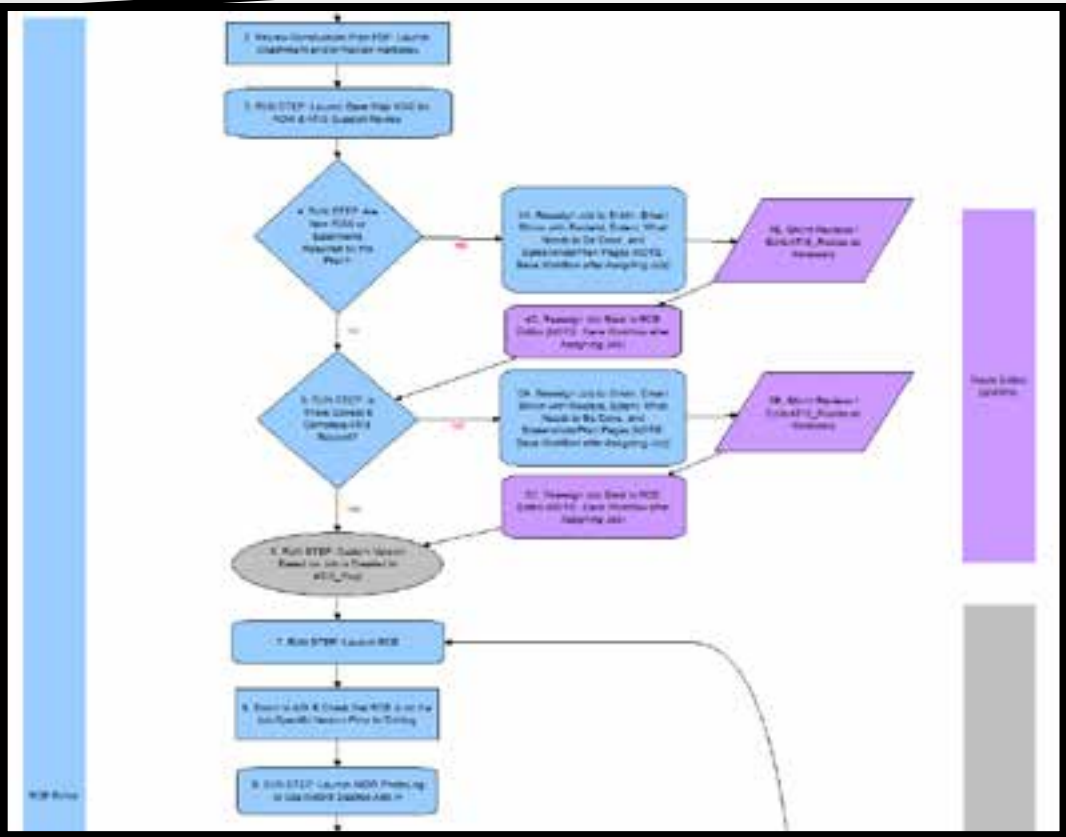
Best Practice – Workflows

q Workflow Manager



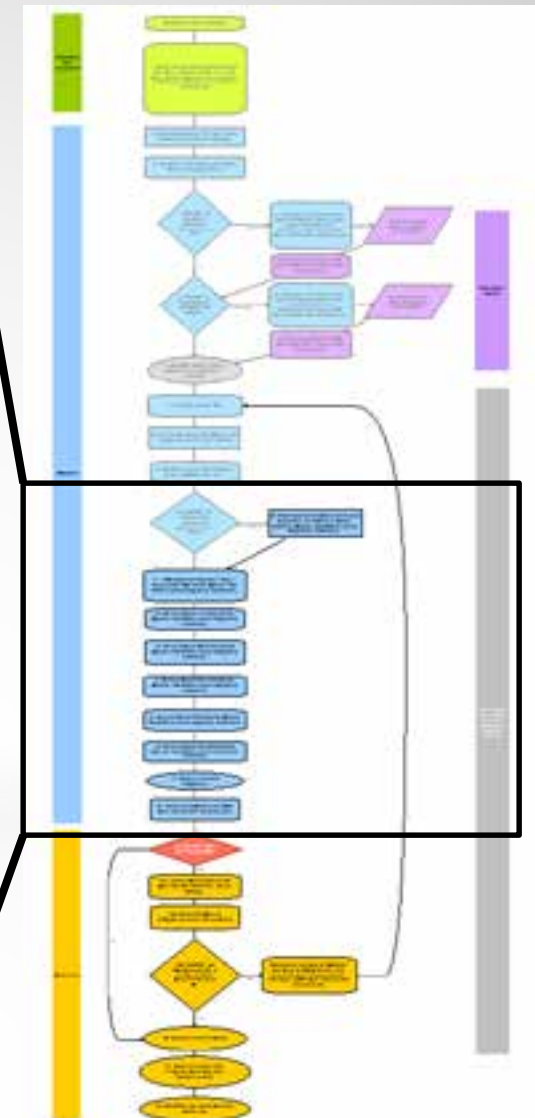
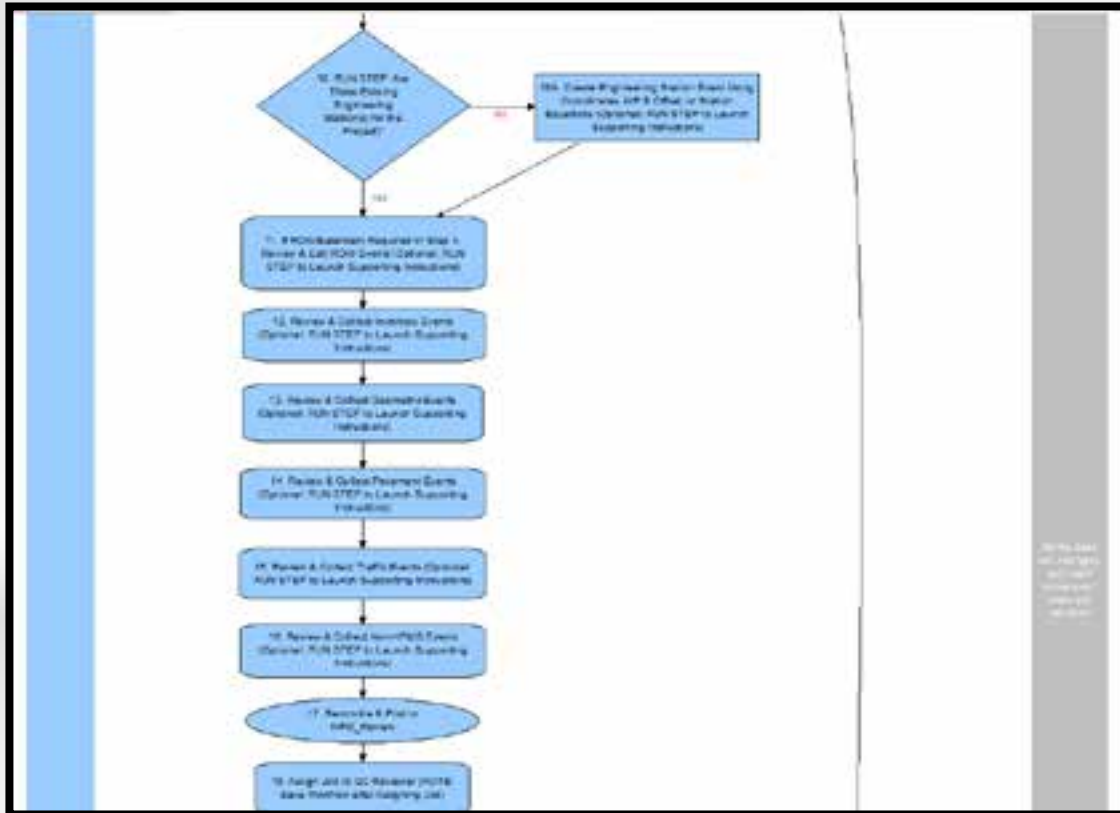
Best Practice – Workflows

Workflow Manager



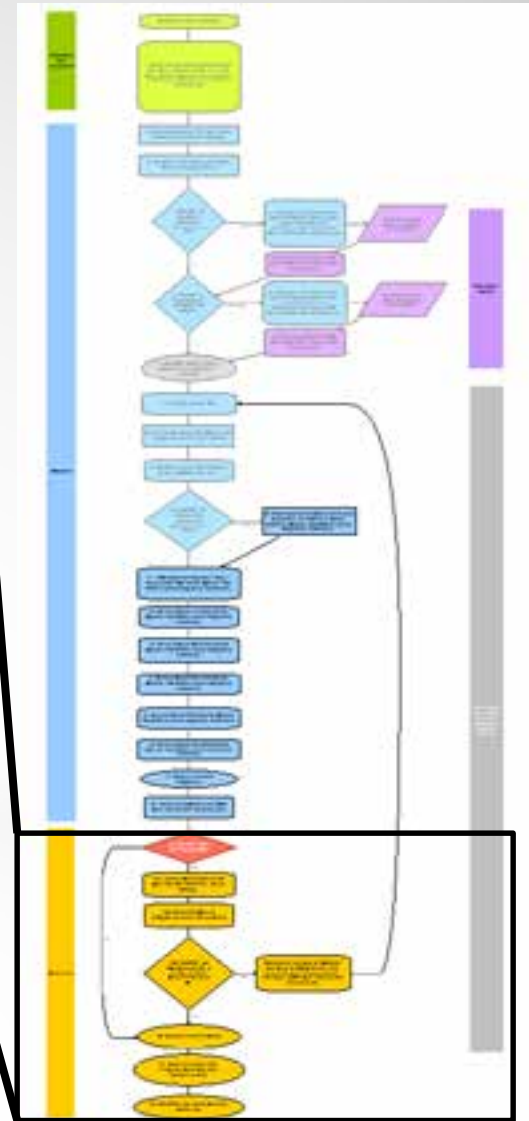
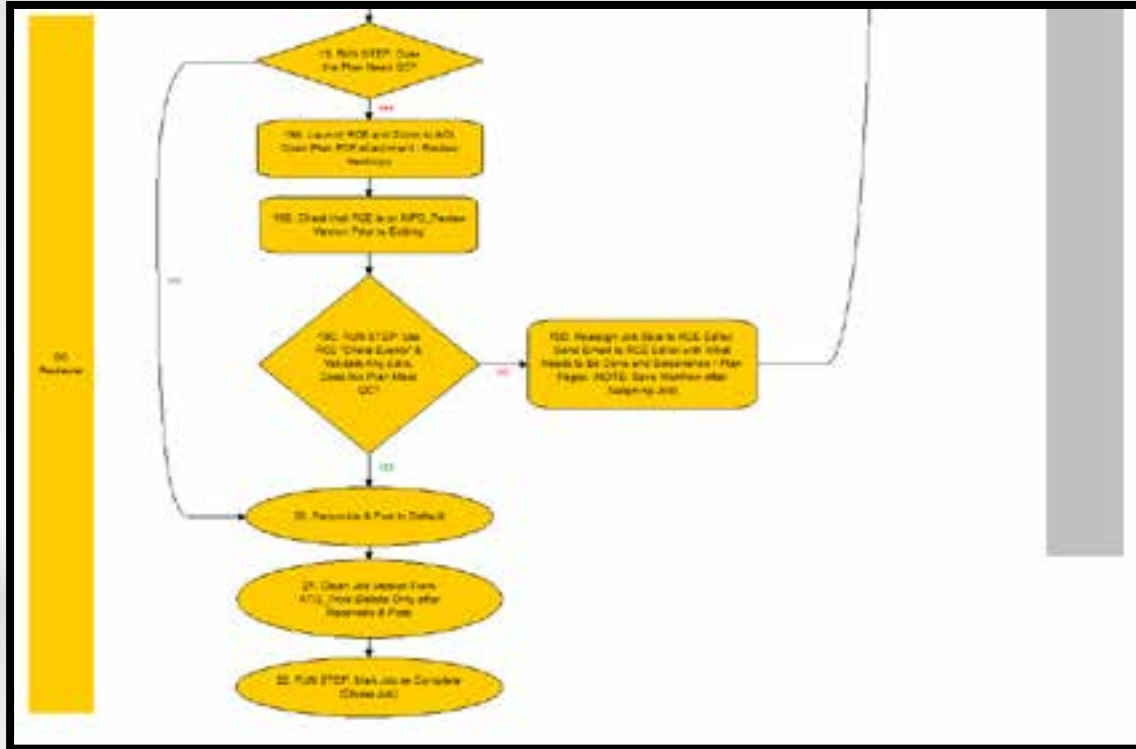
Best Practice – Workflows

Workflow Manager



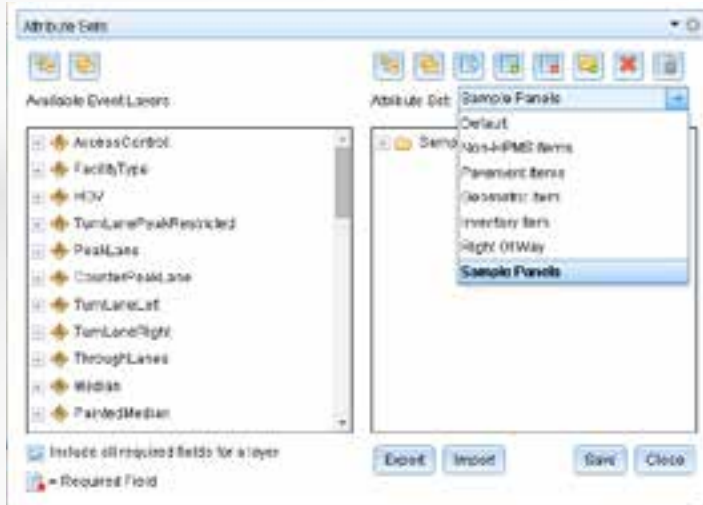
Best Practice – Workflows

Workflow Manager



Best Practice – Roadway Characteristics Editor

- q Browser Specific
- q No Undo Button
- q Limited capabilities for GIS staff
 - q May require customization
- q Useful for non-GIS staff (local agencies)



Future Plans

- q Continue to refine process
- q Clean up data
 - q Measure issues
 - q Overlapping event records
- q Submitting HPMS
 - q Plan Extraction
 - q Sample Panels
 - q Geoprocessing Models
- q Working with local agencies (Cities, Counties, COGs/MPOs)
- q Support FHWA Requirement – ARNOLD, FMIS, NBI, MIRE



Phase II - Data Warehouse

- q Duplication of legacy QA/QC processes
 - q QA/QC done via SQL database views
 - q Evaluate data errors - Assign Ownership
- q Determine DW ability to detect changes
 - q Web Services
 - q Use of Delta tables
- q Creation of LRS/GIS functionality in DW
 - q Data lookups for Applications
 - q Replacement of GIS DataMarts in applications
 - q All functions must be "batch mode" compatible

Final Thoughts

- q Linear Referencing is a complex topic
- q Roads & Highways is on the way to becoming an industry standard tool
- q New LRS will support all of ADOT
- q New LRS will become more robust with time
- q ADOT is still discovering new methods to improve the system



Questions?

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