



Advanced Data Visualization for Integrity Management



Pedro Carrizales and Colby Smith

- About NuStar
- Existing Challenges
- Alignment Sheet Implementation
- Automation Techniques

About NuStar



LEGEND

- Headquarters/International Office
- Nuclear Energy L.P. Refined Product Terminals
- Third Party Licensed Asphalt Terminal
- Nuclear Asphalt Terminal
- Crude Oil Storage Facilities
- Crude Oil Storage Tanks
- Asphalt Refinery
- Fuels Refinery
- Crude Terminal Ports
- Central West Crude Oil Pipeline System
- Central West Refined Products Pipeline System
- Single Line Refined Product Pipelines
- North Refined Products Pipeline System
- East Refined Products Pipeline System
- Atlantic Pipeline System

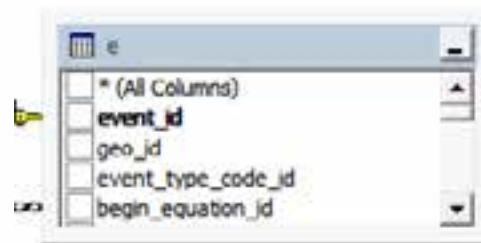
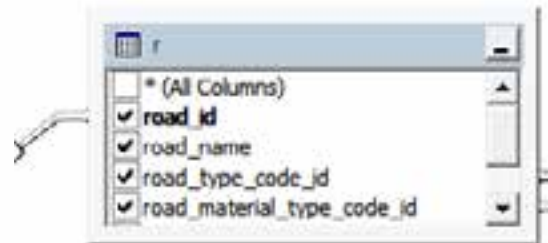
- Asset Stats:**
- Operations in the U.S., Canada, Mexico, the Netherlands, including St. Eustatius in the Caribbean, the United Kingdom and Turkey.
 - Own 89 terminal and storage facilities
 - Approximately 98 million barrels of storage capacity
 - 8,417 miles of crude oil and refined product pipelines
 - 2 asphalt refineries and a fuels refinery capable of processing 118,500 bpd of crude oil



GIS History



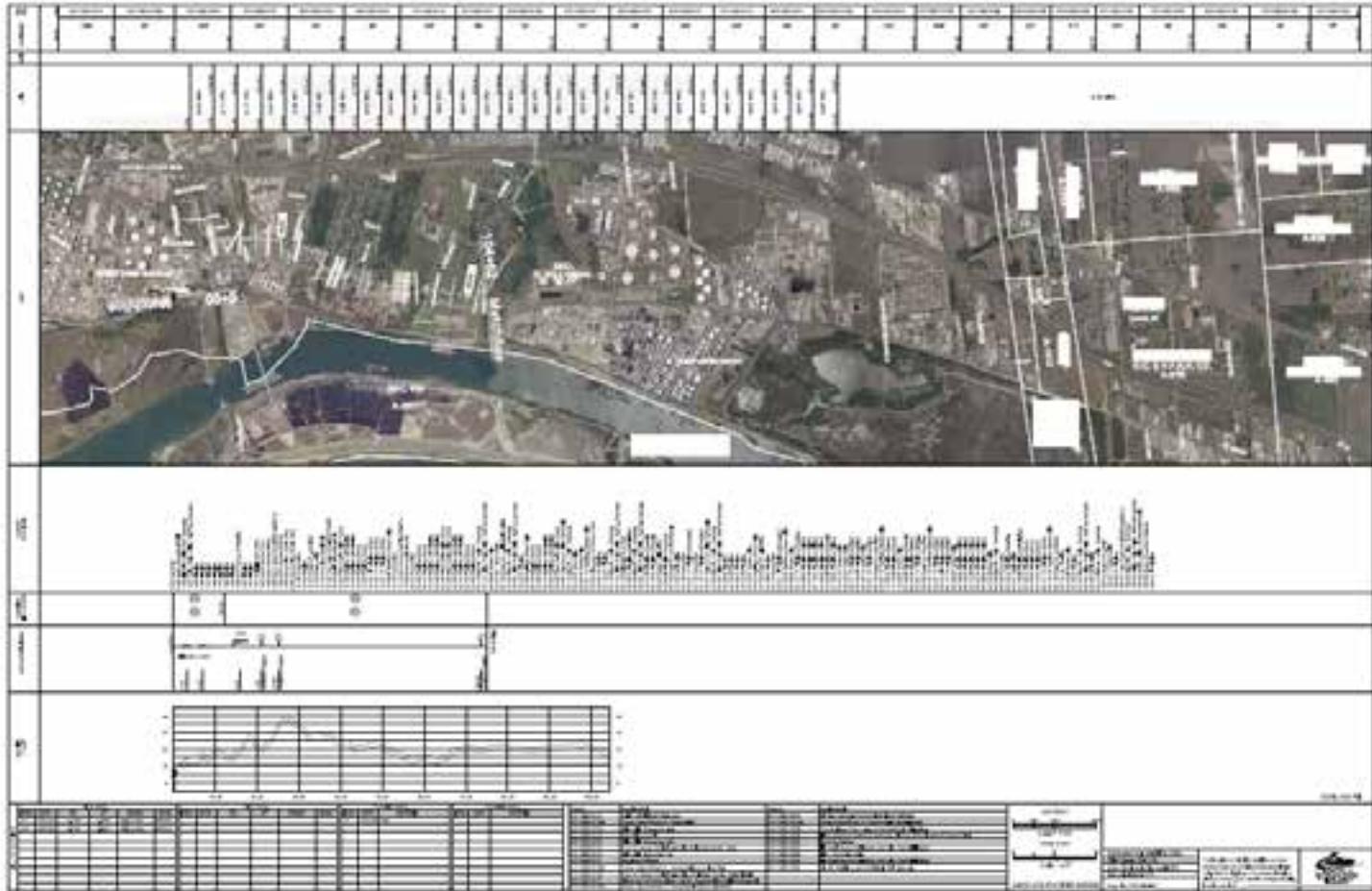
- Utilize PODS-like database model
 - Event based
 - Attribute tables



GIS History - Continued



- Engineering Alignment Sheets



New Regulations



- New regulations (verifiable, traceable, accurate)
- real-time data gathering
- Requires extensive systems / data integration – including ILLI, Corrosion, One-Call, etc..
- To facilitate reviews, IMP decided to create a Risk Alignment Sheet
 - Using the SheetCutter software, we can generate Risk alignment sheets in 20 minutes

Existing Challenges



- Chicken and egg problem between Sheets and Required Data
- Integration of External Charts
- Multiple organizations required for success

Chicken and the Egg

- Vast data requirements
 - As built
 - Operational
 - Assessment
 - Analysis
- Multiple options for storage
 - Part of the operational GIS
 - Part of a data warehouse
- Multiple options for display
 - Which way is most effective
 - Which type of band to use

Integration of External Charts

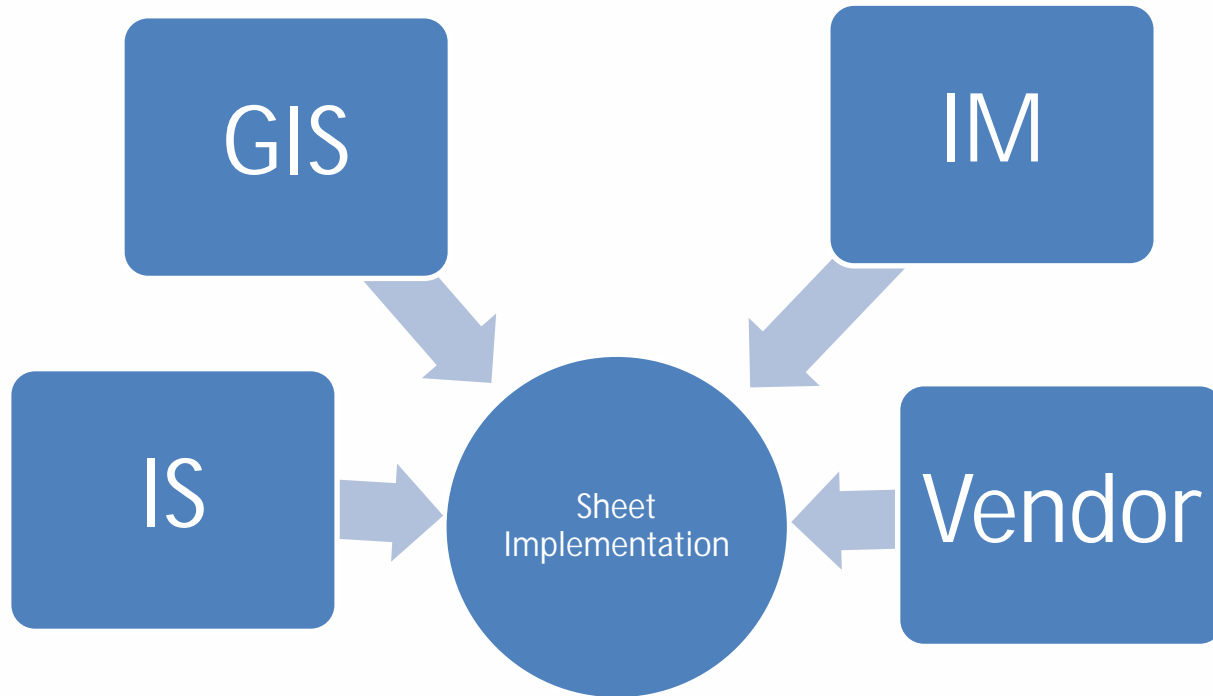
- Rectifier readings stored and charted in an external system
- Automated sheet creation
- Automated compatible data creation



Existing Challenges (cont.)



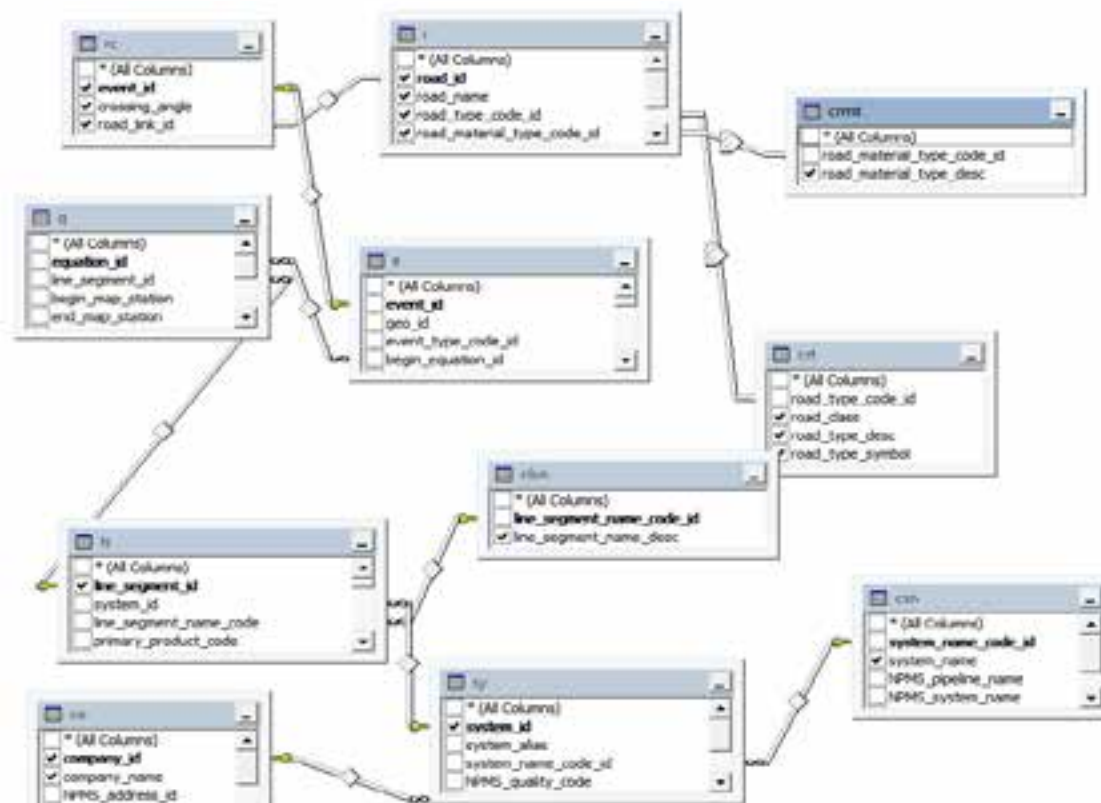
Multiple groups required for success



Risk Sheet Set-Up



- Installed the software on top of ArcEditor
- Created a template file that points to the source data
 - Database views
 - Static tables that are refreshed



Risk Sheet Set-Up Continued



SQLQuery2.sql - ...OM1\00147 (98) SQLQuery1.sql - ...OM1\00147 (191) Object Explorer Details

```
SELECT TOP 1000 [event_id]
, [geo_id]
, [company_id]
, [company_name]
, [system_id]
, [system_name]
, [line_id]
, [line_segment_name_desc]
, [absolute_station]
, [end_absolute_station]
, [crossing_angle]
, [road_link_id]
, [road_id]
, [road_name]
, [road_type_code_id]
, [road_material_type_code_id]
, [shape_id]
, [c_and_c_import_id]
, [road_class]
, [road_type_desc]
, [road_type_symbol]
, [road_material_type_desc]
, [absolute_station_desc]
```

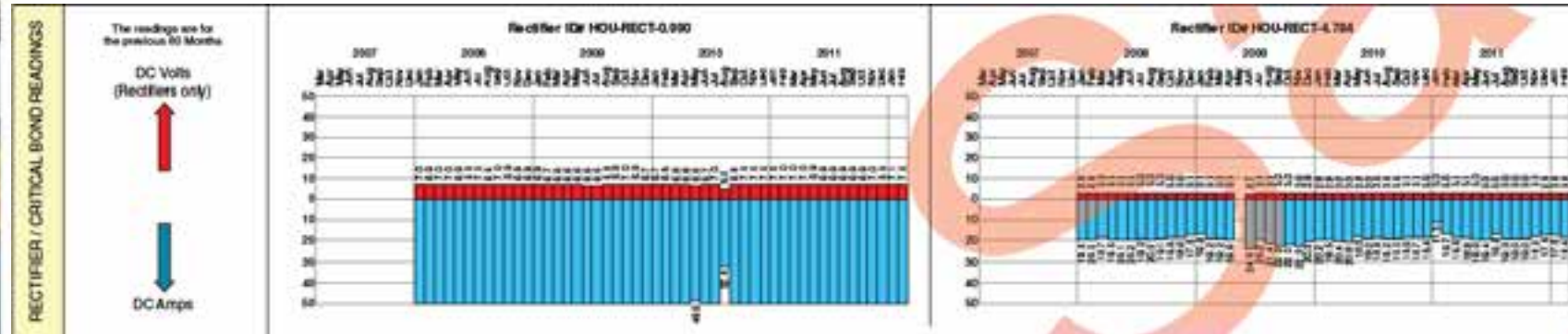
Results Messages

	event_id	geo_id	company_id	company_name	system_id	system_name	line_id	line_segment_name_desc	absolute_station	end_absolute_station
1	2385	3657	2		2		2		121545.0	121545.0
2	2391	3675	2		2		2		122554.2	122554.2
3	2398	3685	2		2		2		122109.8	122109.8
4	2399	3686	2		2		2		124808.8	124808.8
5	2404	3697	2		2		2		125659.8	125659.8
6	2405	3701	2		2		2		124587.0	124587.0
7	2410	3709	2		2		2		128567.0	128567.0
8	2417	3716	2		2		2		135985.8	135985.8
9	2421	3720	2		2		2		139634.8	139634.8
10	2427	3735	2		2		2		142184.8	142184.8
11	2428	3739	2		2		2		141097.3	141097.3
12	2433	3753	2		2		2		141242.8	141242.8
13	2434	3754	2		2		2		142372.8	142372.8
14	2436	3759	2		2		2		143747.8	143747.8
15	2558	3895	2		2		3		149841.5	149841.5

Data Band Examples



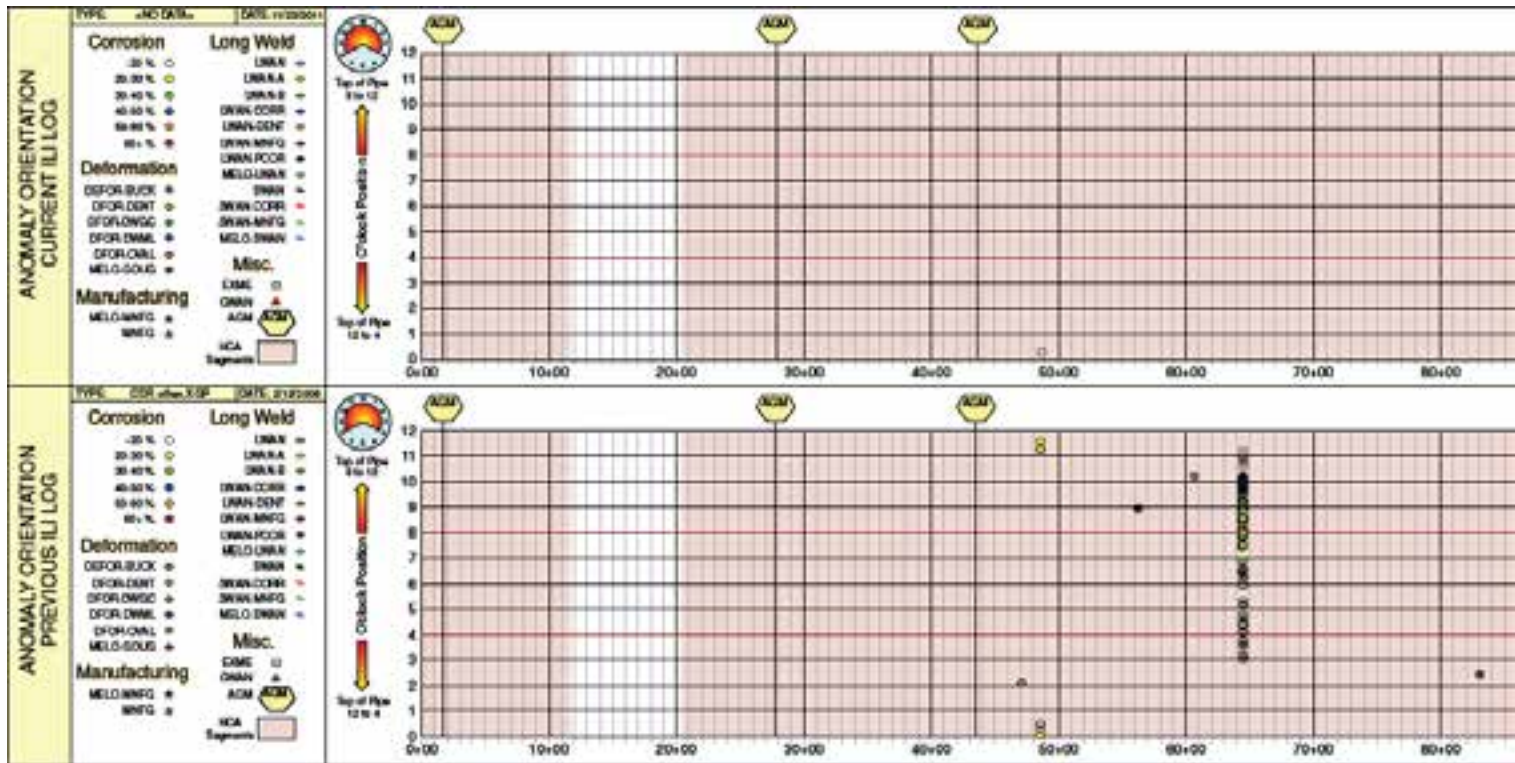
- Attachment Band



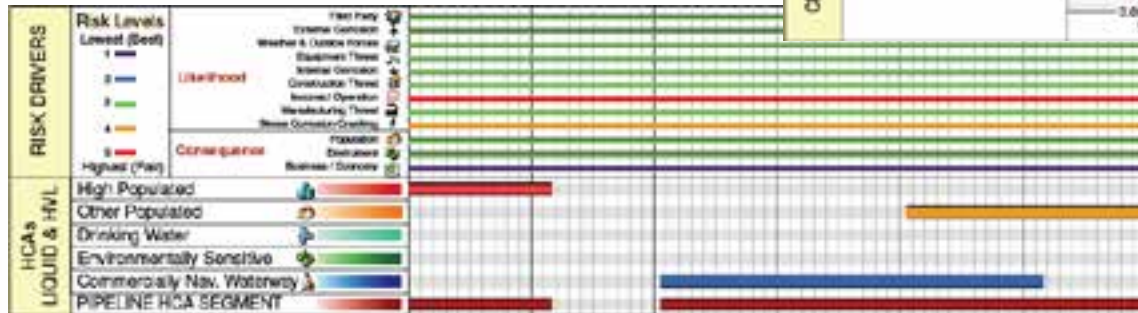
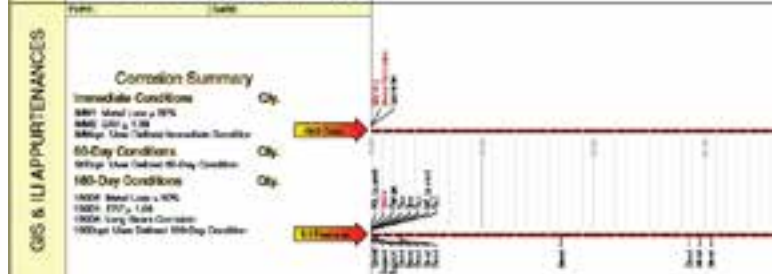
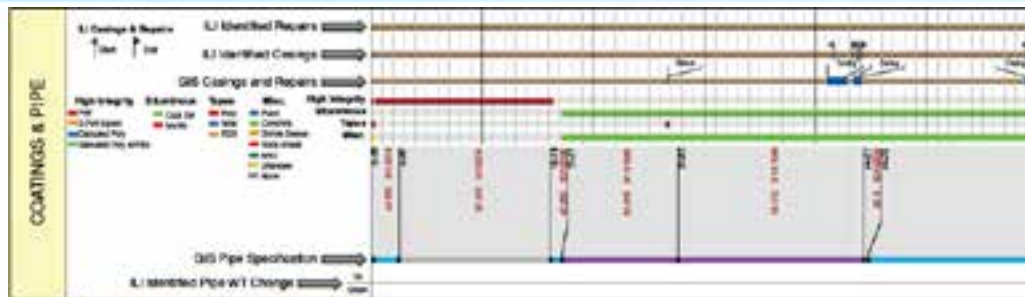
Data Band Examples Continued



- ILI Data



Data Band Examples Continued



Data Band Inventory



Integrity Profile Sheet Data Bands - Production IMP Template 01-27-11								
Integrity Band	Band Name (NC)	Name	Type	Connection	Table	Data Column	Data Source	Responsibility
Pipeline Profile and Potential Release Volume	Profile	Profile	Linear Reference Data source		dbo.V_NC_Matural_Ground_Elevation	elevation		GIS Department
	Profile Valves	Valves	Linear Reference Data source		dbo.V_NC_Valves	<None>		GIS Department
	Drain Volumes	Initial Volume	Linear Reference Data source		dbo.V_NC_Maximum_Draindown_Volume	vol_initial rupture	LVR used for current HCA analysis	IMP
		Total Volume	Linear Reference Data source		dbo.V_NC_Maximum_Draindown_Volume	vol_total rupture	LVR used for current HCA analysis	IMP
Map	Map frame	1000 Foot	Reference Foot Data source		<None>	1000		n/a
	Map AGMs	Map AGMs	Linear Reference Data source		dbo.V_NC_ILFeatures	<None>	Most current IL log	IMP
	Map Foreign Line Crossings	Map Foreign Line Crossings	Linear Reference Data source		dbo.V_NC_ForeignLineCrossings	<None>		GIS Department
		Map Foreign Line Crossings	Linear Reference Data source		dbo.V_NC_ForeignLineCrossings	<None>		GIS Department
	MAP Valves	MAP Valves	Linear Reference Data source		dbo.V_NC_Valves	<None>		GIS Department
	Mile Marker	Mile Marker	Linear Reference Data source		dbo.V_NC_Mile_Markers	<None>		GIS Department
	Matchlines							n/a
Soils	Soils	Soils-Texture	Linear Reference Data source		dbo.V_NC_Soils	<None>		GIS Department
	Corrosivity	Corrosivity	Linear Reference Data source		dbo.V_NC_Soils	<None>		GIS Department
	Soil Stress	Soil Stress	Linear Reference Data source		dbo.V_NC_Soils	<None>		GIS Department
	Drainage	Drainage	Linear Reference Data source		dbo.V_NC_Soils	<None>		GIS Department
	Permeability	Permeability Stages	Linear Reference Data source		dbo.V_NC_Soils	<None>		GIS Department
Third Party Activity	One Call Activity 2008	OneCall2008	Linear Reference Data source		dbo.V_NC_ThirdPartyActivity2007	<None>		GIS Department
	One Call Activity 2009	OneCall2009	Linear Reference Data source		dbo.V_NC_ThirdPartyActivity2007	<None>		GIS Department
	One Call Activity 2010	OneCall2010	Linear Reference Data source		dbo.V_NC_ThirdPartyActivity2007	<None>		GIS Department
Pipe Deformation and Foreign Line Crossings	Above Ground Crossings 2	Road Crossing	Linear Reference Data source		dbo.V_NC_RoadCrossings	<None>		GIS Department
		Water	Linear Reference Data source		dbo.V_NC_WaterPointEvents	<None>		GIS Department
	Above Ground Crossings	Road Crossing	Linear Reference Data source		dbo.V_NC_ForeignLineCrossings	<None>		GIS Department
		Water	Linear Reference Data source		dbo.V_NC_WaterPointEvents	<None>		GIS Department
	Water Crossing	Water Crossings	Linear Reference Data source		dbo.V_NC_WaterRangedEvents	<None>		GIS Department
		ILI DFOR DVAL	Linear Reference Data source		dbo.V_NC_ILAnomalies	ID_Prediction_Mod		IMP
		ILI DFOR DENT	Linear Reference Data source		dbo.V_NC_ILAnomalies	ID_Prediction_Mod		IMP
		ILI DFOR DVGIC	Linear Reference Data source		dbo.V_NC_ILAnomalies	ID_Prediction_Mod		IMP
		ILI DFOR DUCK	Linear Reference Data source		dbo.V_NC_ILAnomalies	ID_Prediction_Mod		IMP
		ILI DFOR DVMI	Linear Reference Data source		dbo.V_NC_ILAnomalies	ID_Prediction_Mod		IMP
	ILI MELO GUNG	Linear Reference Data source		dbo.V_NC_ILAnomalies	ID_Prediction_Mod		IMP	
	ILI Deel Grid	Profile	Linear Reference Data source		dbo.V_NC_Centerlines_M_Avare	ELEVATION		n/a
	Foreign line grid 2	Profile	Linear Reference Data source		dbo.V_NC_Centerlines_M_Avare	ELEVATION		n/a
	Foreign line grid 1	Profile	Linear Reference Data source		dbo.V_NC_Centerlines_M_Avare	ELEVATION		n/a
	Water Crossing 3	Water Crossings	Linear Reference Data source		dbo.V_NC_WaterRangedEvents	<None>		GIS Department
	Below Ground Crossings 2	Foreign Line Crossings	Linear Reference Data source		dbo.V_NC_ForeignLineCrossings	<None>		GIS Department
		Foreign Line Crossings	Linear Reference Data source		dbo.V_NC_ForeignLineCrossings	<None>		GIS Department
	Below Ground Crossings 1	Foreign Line Crossings	Linear Reference Data source		dbo.V_NC_ForeignLineCrossings	<None>		GIS Department
		Foreign Line Crossings	Linear Reference Data source		dbo.V_NC_ForeignLineCrossings	<None>		GIS Department
	Casings	Casings	Linear Reference Data source		dbo.V_NC_Casings	<None>		GIS Department
Water Crossing 1	Water Crossings	Linear Reference Data source		dbo.V_NC_WaterRangedEvents	<None>		GIS Department	
Water Crossing 2	Water Crossings	Linear Reference Data source		dbo.V_NC_WaterRangedEvents	<None>		GIS Department	
Test Leads	Test Leads	Linear Reference Data source		dbo.V_NC_TestLeads	<None>		GIS Department	
	Pipe to Soil	Linear Reference Data source		dbo.V_NC_AnnualPipeToSoil_StructurePS	<None>		GIS Department	
Annual Pipe to Soil Potentials	Pipe Potential Summary	Pipe Potentials	Tabular Summary					IS&GS Department
	Test Leads Rectifiers	Test Leads	Linear Reference Data source		dbo.V_NC_TestLeads	<None>		IS&GS Department
Close Interval Survey	GIS	Rectifiers	Linear Reference Data source		dbo.V_NC_RectifierLocations	<None>		IS&GS Department
		VIR CTS ON	Linear Reference Data source		<None>	P_S_ON_V		GIS Department
Rectifier / Critical Band Readings	GIS	VIR CTS OFF	Linear Reference Data source		<None>	P_S_OFF_V		GIS Department
		Point Chart Band						IS&GS Department



ESRI Integration



Point Chart Band - ILI

General | Data Display | X Axis | Y Axis | Fixed Values

General

Band Name: ILI

Bottom: 12.26 Height: 2

Left: 3.75 Width: 31

Hide frame during generation Static horizontal

Grid Band:

Slot: 1

Grid height (in): 2.40

Data Sources:

- ILI MELO-CORR L20
- ILI MELO-CORR 2030
- ILI MELO-CORR 3040
- ILI MELO-CORR 4050
- ILI MELO-CORR 5060
- ILI MELO-CORR GEG0
- DFOR-BUCK

OK

Edit Data Source

Data Source

Name: ILI MELO-CORR L20

Connection: Valgis

Table: V_NC_ILIAnomalies

Linear Reference

Route ID: line_id

Begin Measure: absolute_station

End Measure: absolute_station

Additional Filtering

Select Field: <None>

Metal_Loss_Buckets = 'L20' AND ILI_DC_BandPriority=1

Validate

Clear

Linear Display

Begin Series: <None>

End Series: <None>

Begin Station: absolute_station

End Station: absolute_station

Data Field

Select Data Field: Oclock_decimal_hour

OK Cancel

ESRI Integration



Linear Band - Soils

General Data Display Schematic Line Summary

Show schematic line symbol(s)

Use the Focus Line Symbol for this slot

Use Line Sub Classes to symbolize by type

Line Sub Classes

Soils-Texture - Caliche	Soils-Texture - Cemented
Soils-Texture - Clay	Soils-Texture - Cobbles
Soils-Texture - Gravel	Soils-Texture - Loam

OK

Tabular Attachment DataSource - Rectifier Readings

Data Source

Name: Rectifier Readings

Connection: Valgis

Table: V_NC_RectifierLocations

Linear Reference:

Route ID: line_id

Begin Measure: absolute_station

End Measure: absolute_station

Additional Filtering

Select Field: <None>

Validate

Clear

Attachments

File Field: UriPath

Caption Field: <None> (Optional)

OK Cancel

Summary



- Risk / Integrity Alignment Sheet
 - Multiple data sources
 - Multiple organizations
 - Team Effort
- IS / IT Automation
 - Simplify consumption of data for Integrity
 - Improve performance

Thank you



Pedro Carrizales
I/S Project Manager
NuStar Energy
Pedro.Carrizales@nustarenergy.com

Colby Smith
Director, Technical Sales and Marketing
New Century Software
Colby.Smith@newcenturysoftware.com

