An ArcGIS Server-based framework for oil and gas E&P decision support

Chad Cooper, Peter Smith, Malcolm Williamson, Jackson Cothren

Center for Advanced Spatial Technologies
University of Arkansas

IPAS: Infrastructure Placement Analysis System

- LINGO Low Impact Natural Gas and Oil
- DOE funded
  - NETL (National Energy Technology Laboratory)
- Integrates current technologies and practices to minimize adverse environmental impacts

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the Center for Advanced Spatial Technologies
CAST
Fayetteville
U of A
University of Arkansas

Argonne NATIONAL LABORATORY

NETL
NATIONAL ENERGY TECHNOLOGY LABORATORY

IPAS: Infrastructure Placement Analysis System

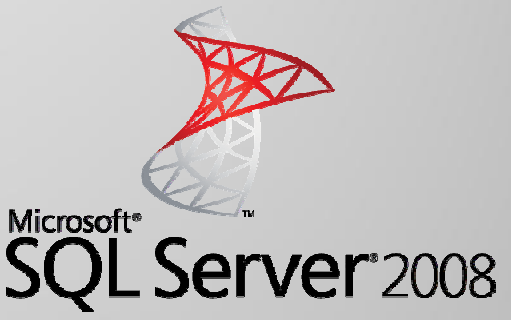
"Closed" web-based decision support system

- Drillers and regulators share:
  - Geographic view of proposed infrastructure
  - Environmental and sensitive area data
  - Models of potential impacts
  - Secure environment
- Increases communication efficiency
  - Speeds up permitting
- Increases transparency – regulators/producers

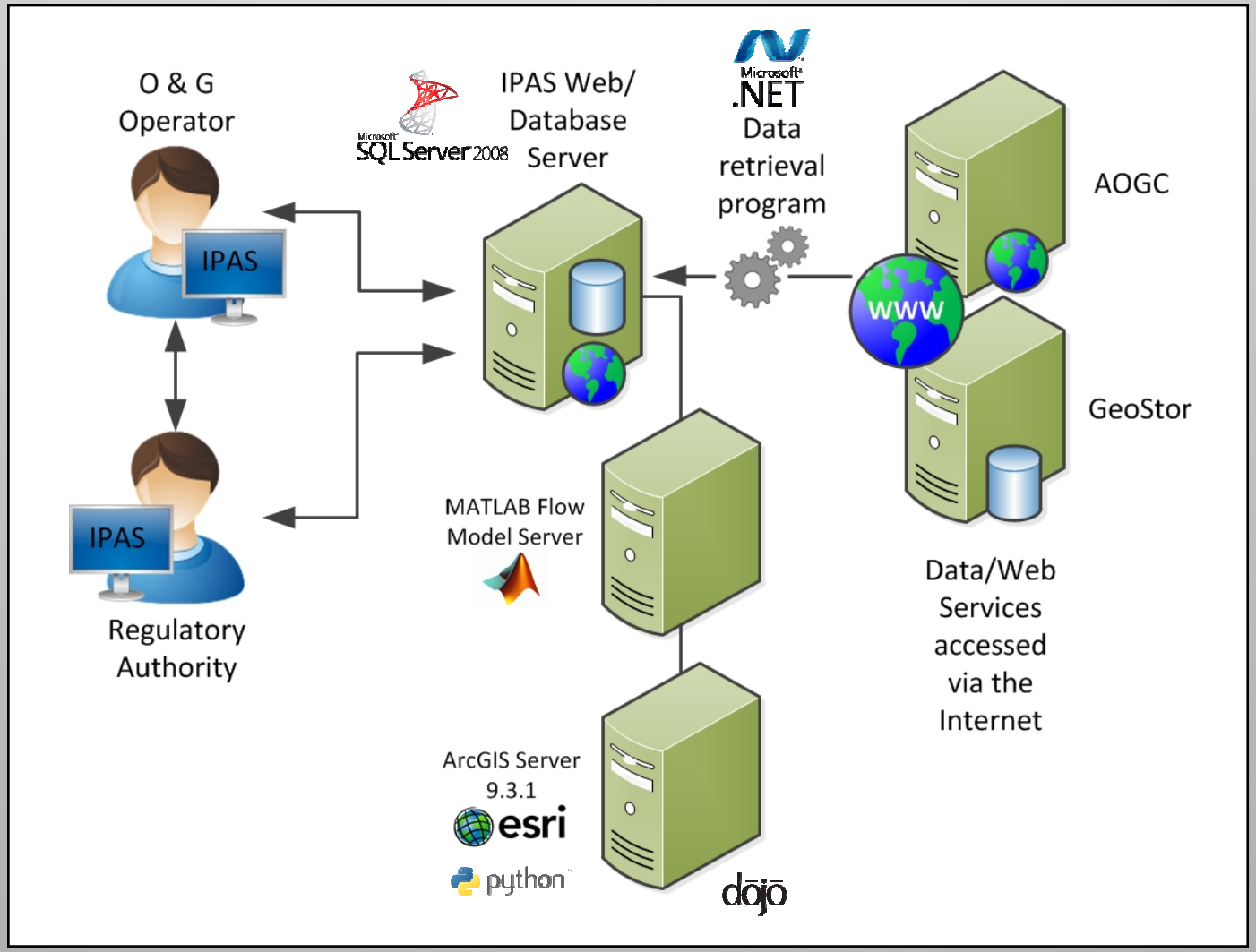
IPAS: Infrastructure Placement Analysis System

Architecture

- Ver. 1: 9.2 Web ADF
- Ver. 2: 9.3.1 ArcGIS Server
  - JavaScript API
    - Lots o' custom code
  - SQL Server 2008 Spatial
    - Spatial datatypes
  - Python – geoprocessing
  - Matlab – spill modeling
- Will be ported to AGS 10.x



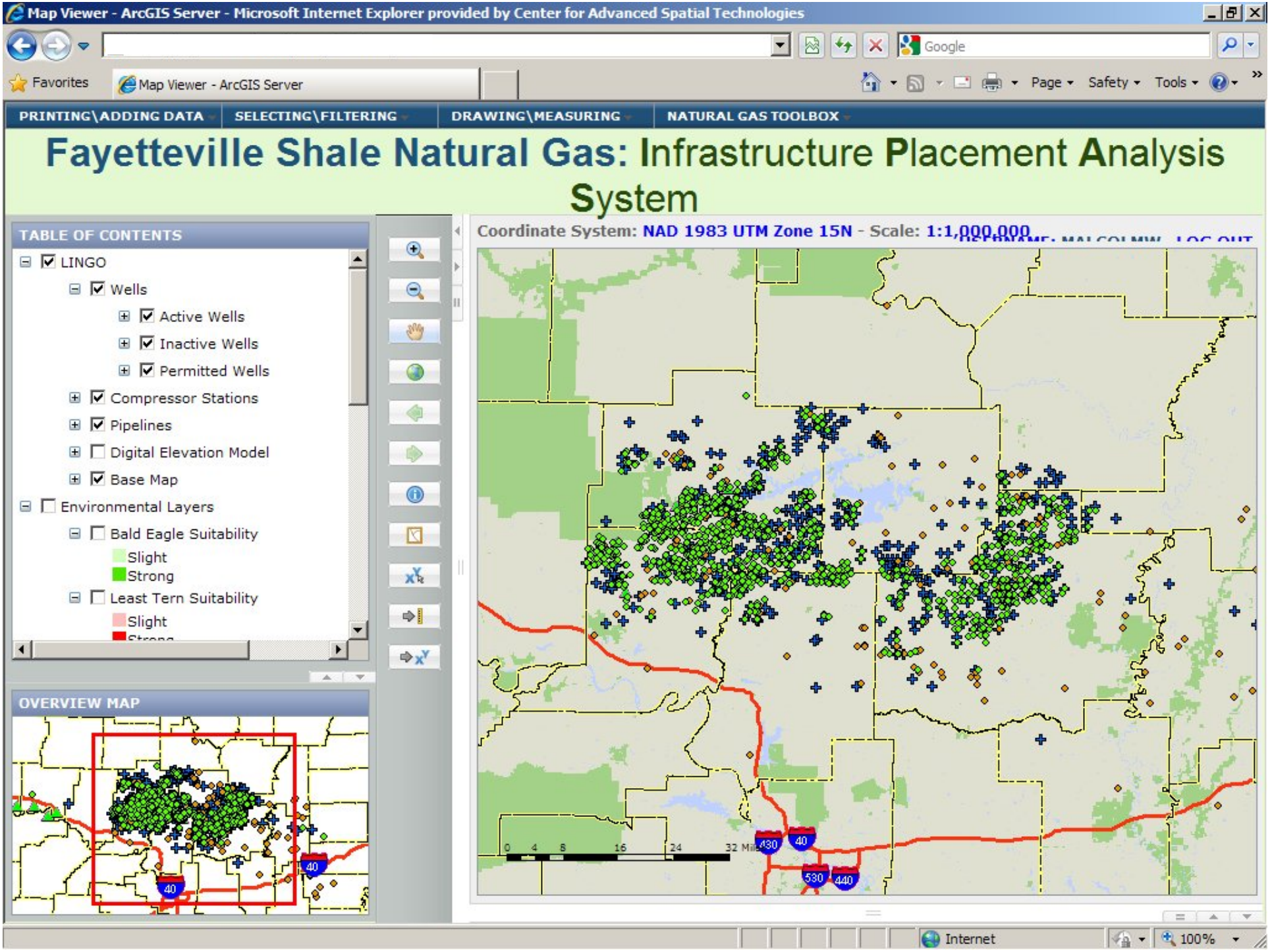
IPAS: Infrastructure Placement Analysis System



IPAS: Infrastructure Placement Analysis System

Required datasets

- Wells (we harvest *some* well data)
- Sensitive areas/species
- Hydrography – NHD high-res preferably
- Soils – SSURGO (must be preprocessed)
- DEM
- Pipelines
- Typical cultural/base layers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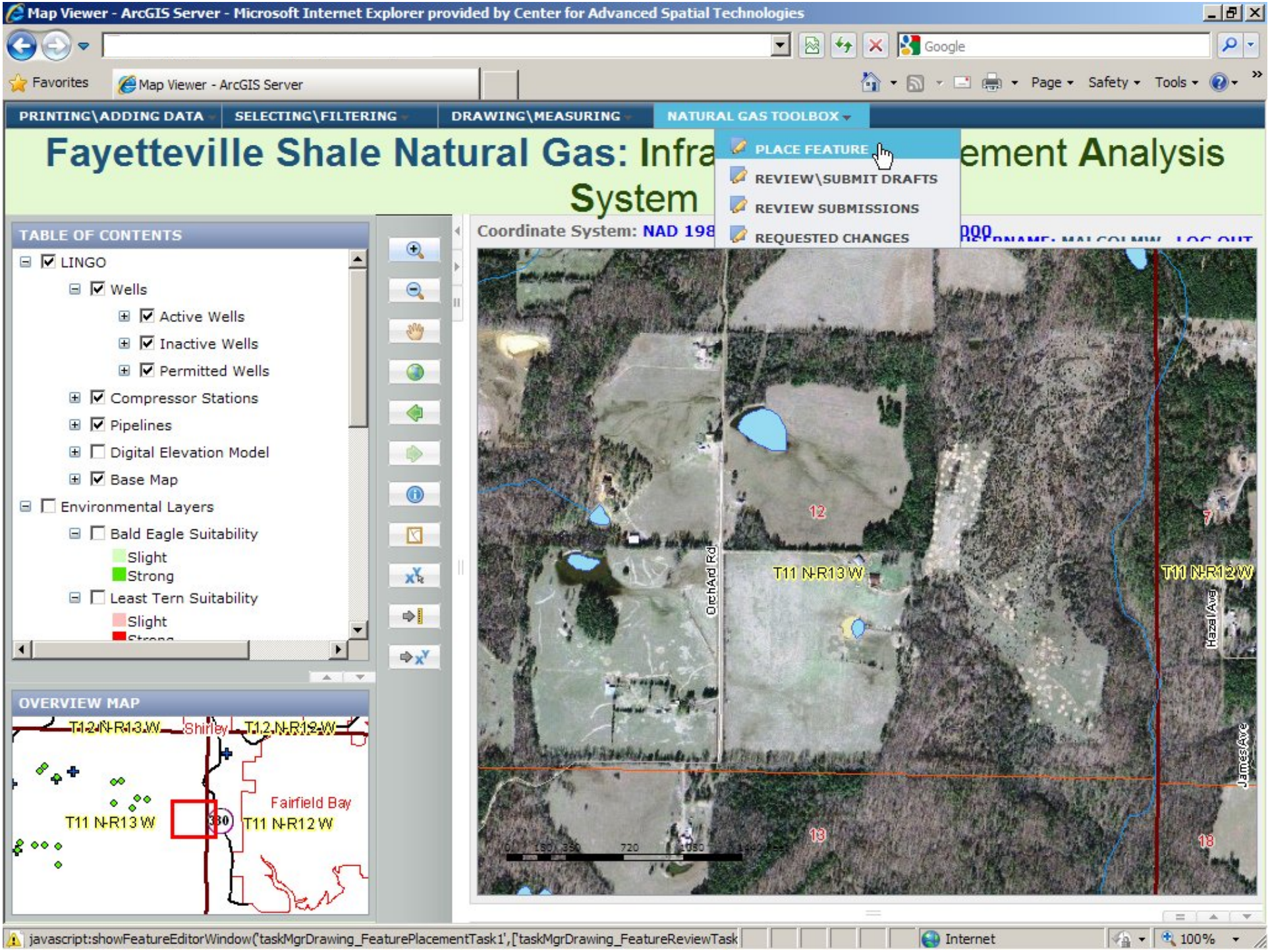
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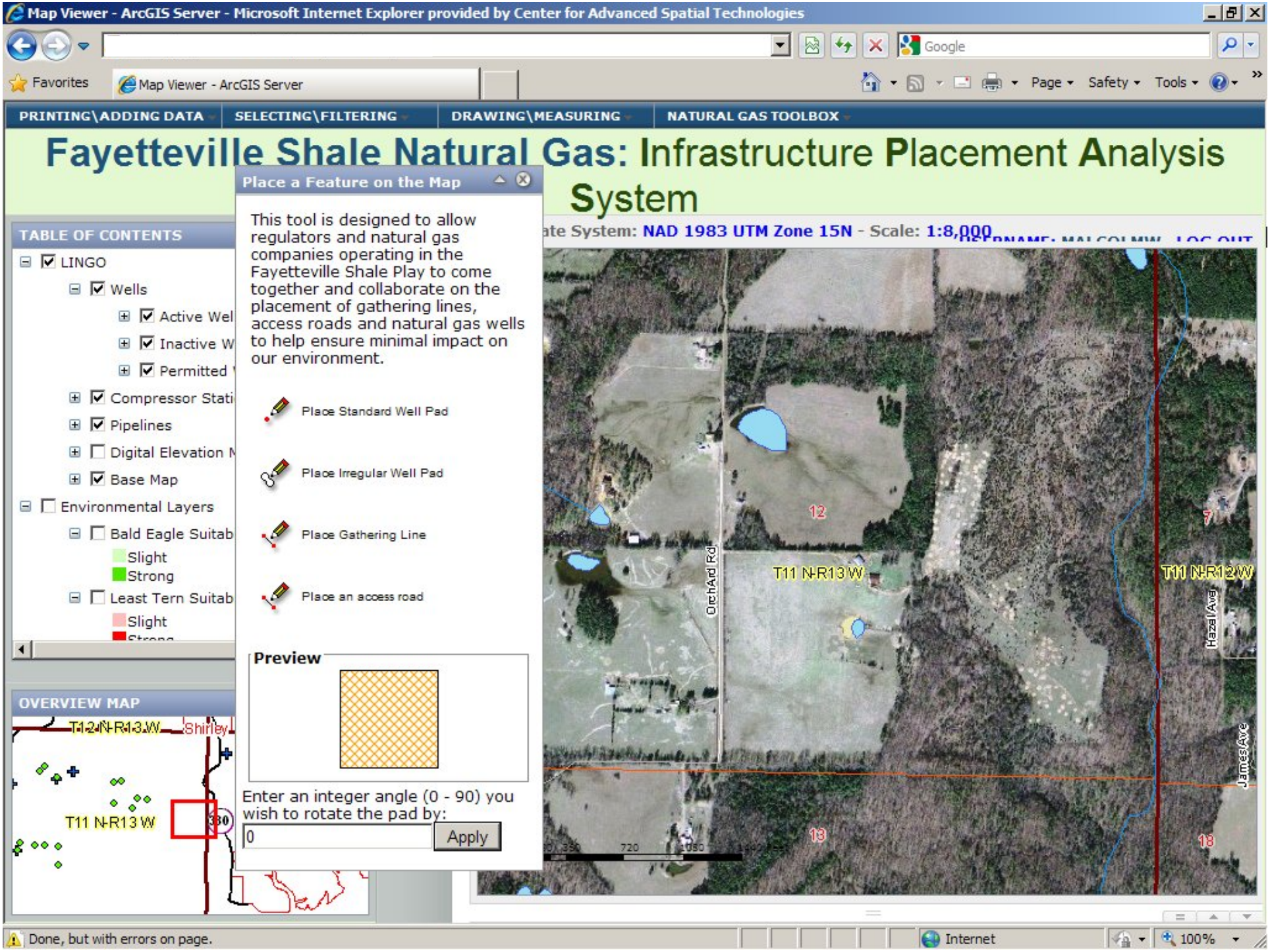
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This tool is designed to allow regulators and natural gas companies operating in the Fayetteville Shale Play to come together and collaborate on the placement of gathering lines, access roads and natural gas wells to help ensure minimal impact on our environment.
Place Standard Well Pad
Place Irregular Well Pad
Place Gathering Line
Place an access road
Preview
Enter an integer angle (0 - 90) you wish to rotate the pad by:
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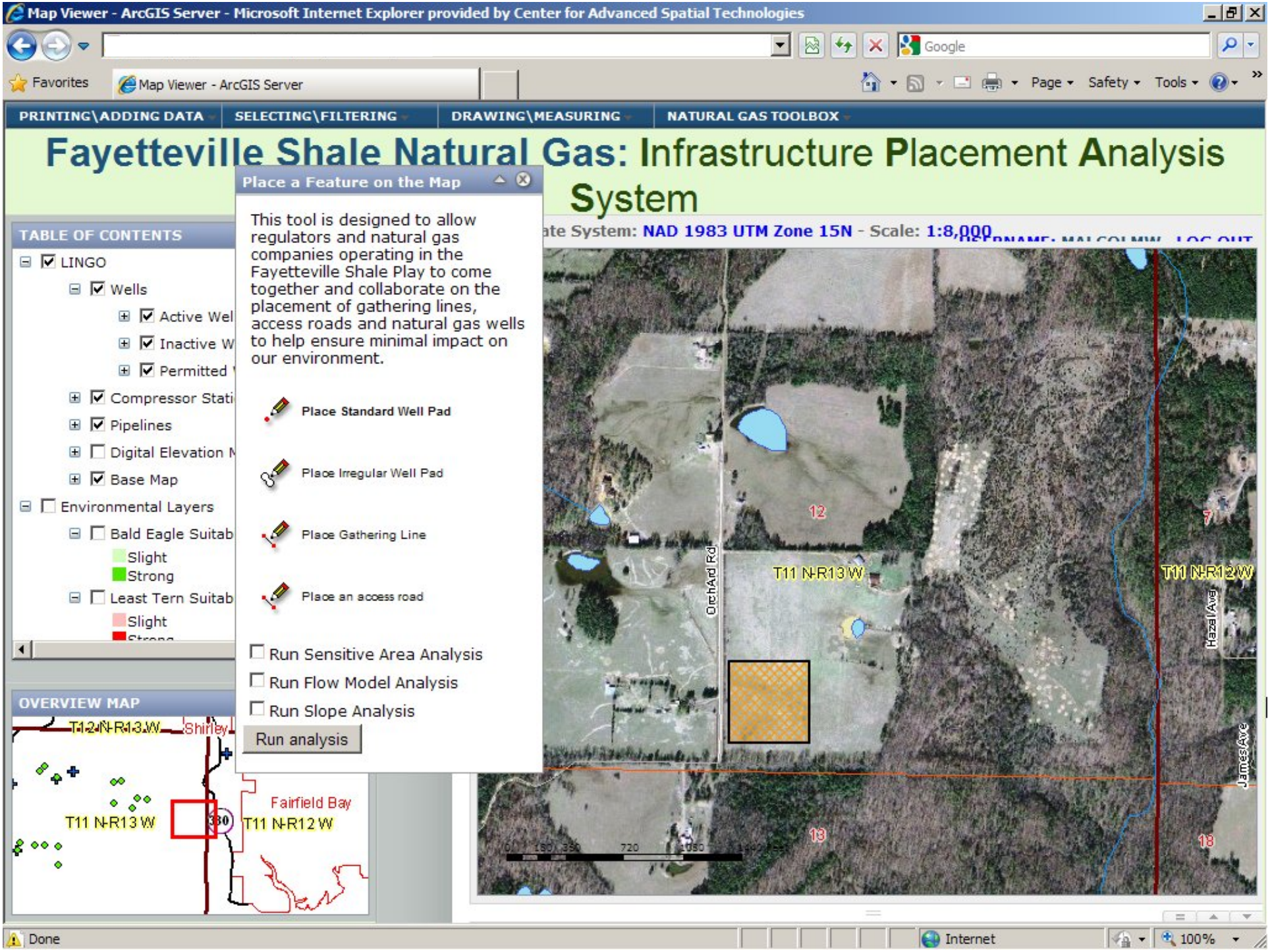
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Place an access road
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Run Flow Model Analysis
Run Slope Analysis
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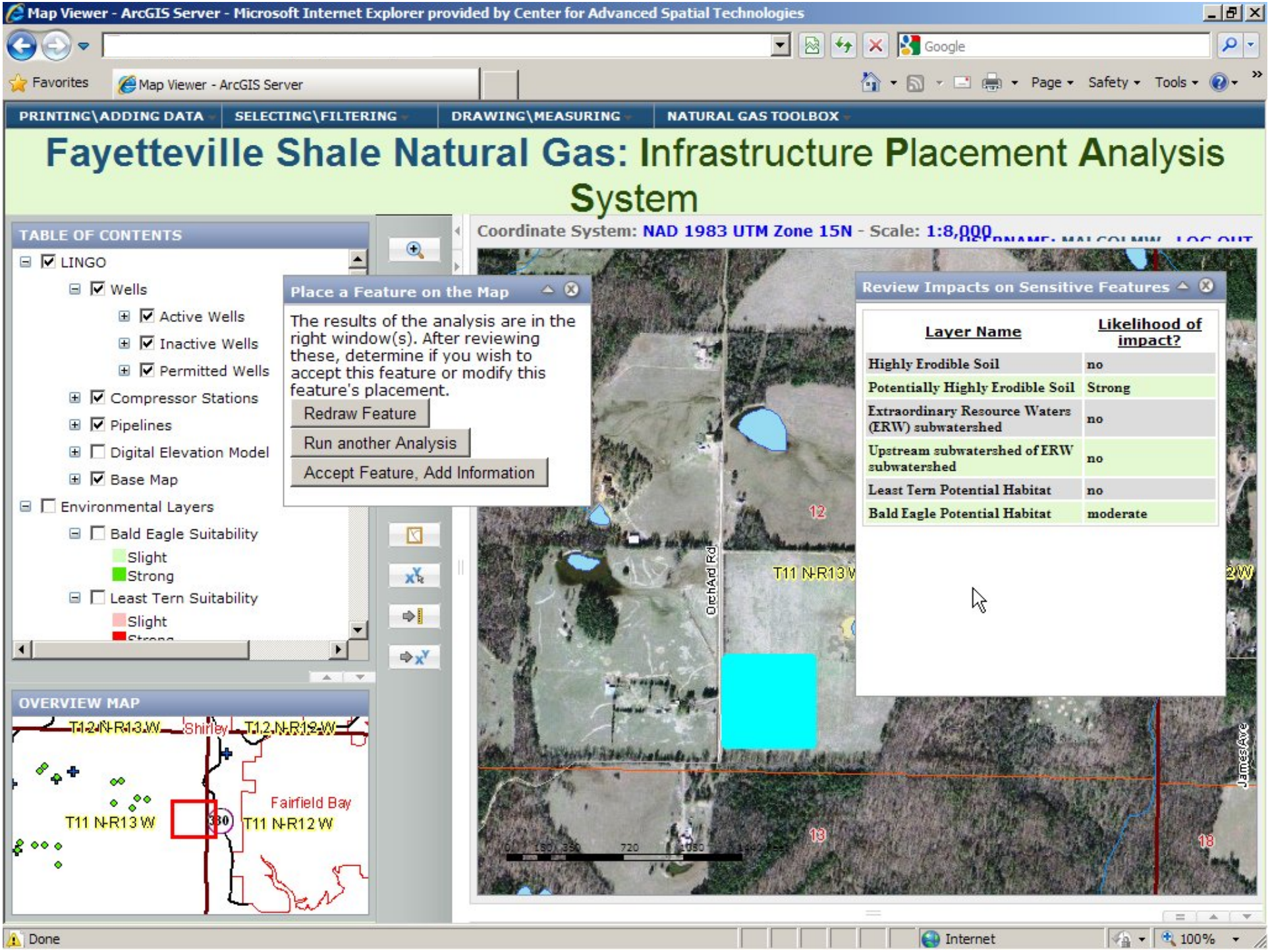
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The results of the analysis are in the right window(s). After reviewing these, determine if you wish to accept this feature or modify this feature's placement.
Redraw Feature
Run another Analysis
Accept Feature, Add Information
Review Impacts on Sensitive Features
Layer Name
Likelihood of impact?
Highly Erodible Soil
no
Potentially Highly Erodible Soil
Strong
Extraordinary Resource Waters (ERW) subwatershed
no
Upstream subwatershed of ERW subwatershed
no
Least Tern Potential Habitat
no
Bald Eagle Potential Habitat
moderate
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Done
Internet
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IPAS: Infrastructure Placement Analysis System

- Uncertainty
  - An attempt to deal with inaccuracies in spatial data
  - Used in sensitive area analyses and feature digitization
  - 90% confidence interval as defined by National Map Accuracy Standards
    - Created as inner and outer buffers

IPAS: Infrastructure Placement Analysis System

- Uncertainty
  - For maps on publication scales > 1:20,000, not more than 10% of the points shall be in error by more than 1/30 inch, measured on the publication scale; for maps on publication scales of <= 1:20,000, 1/50 inch
  - Soils: digitized at 24K → 40 foot inner and outer buffer
  - For digitized features, further zoomed out, greater the uncertainty

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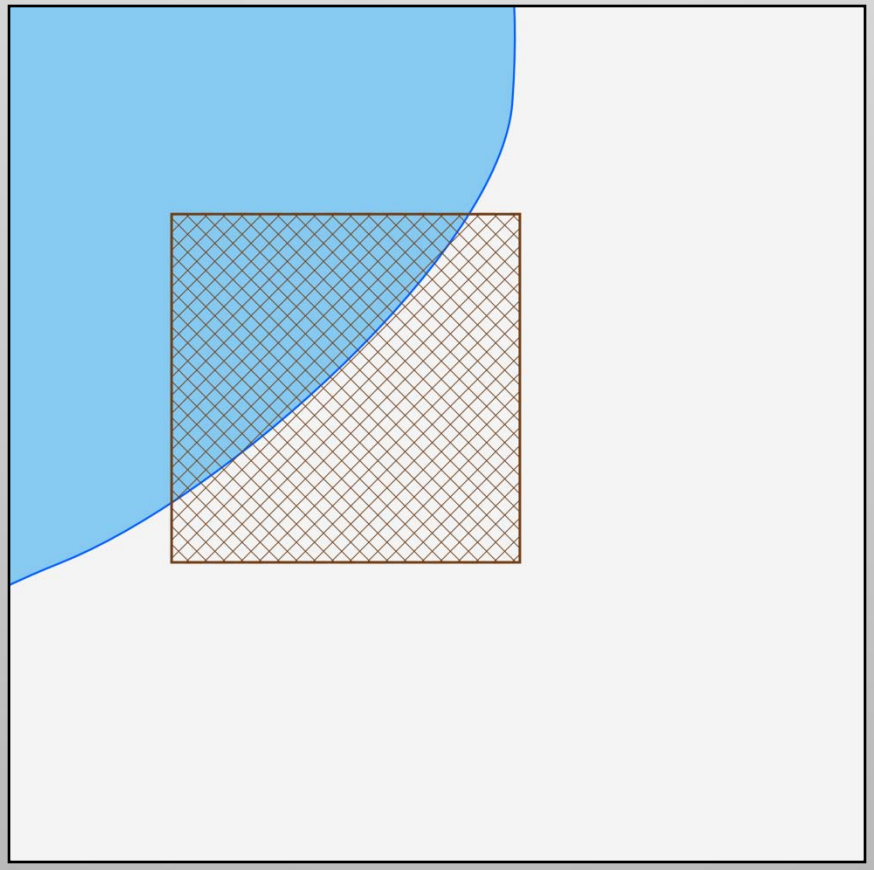

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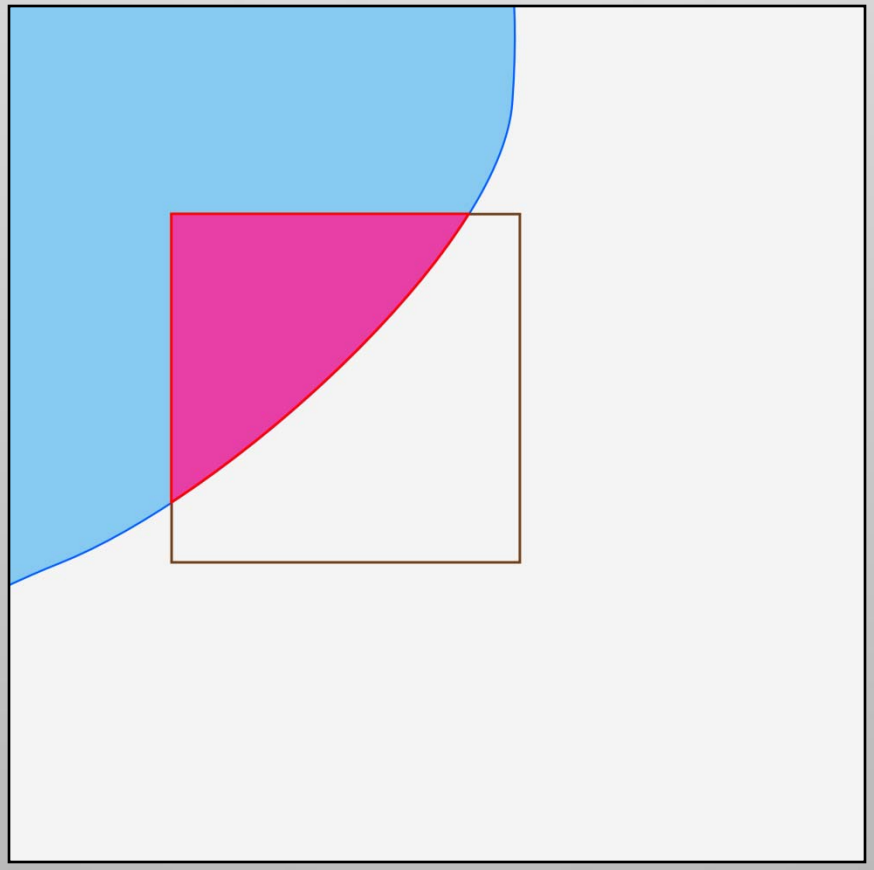

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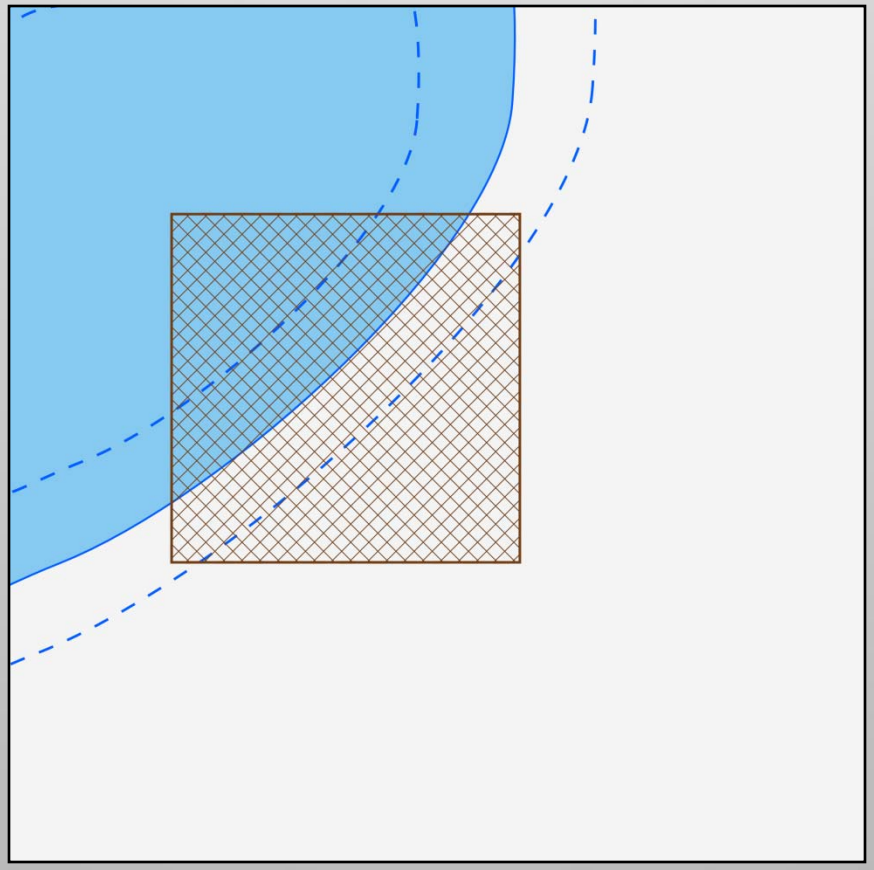

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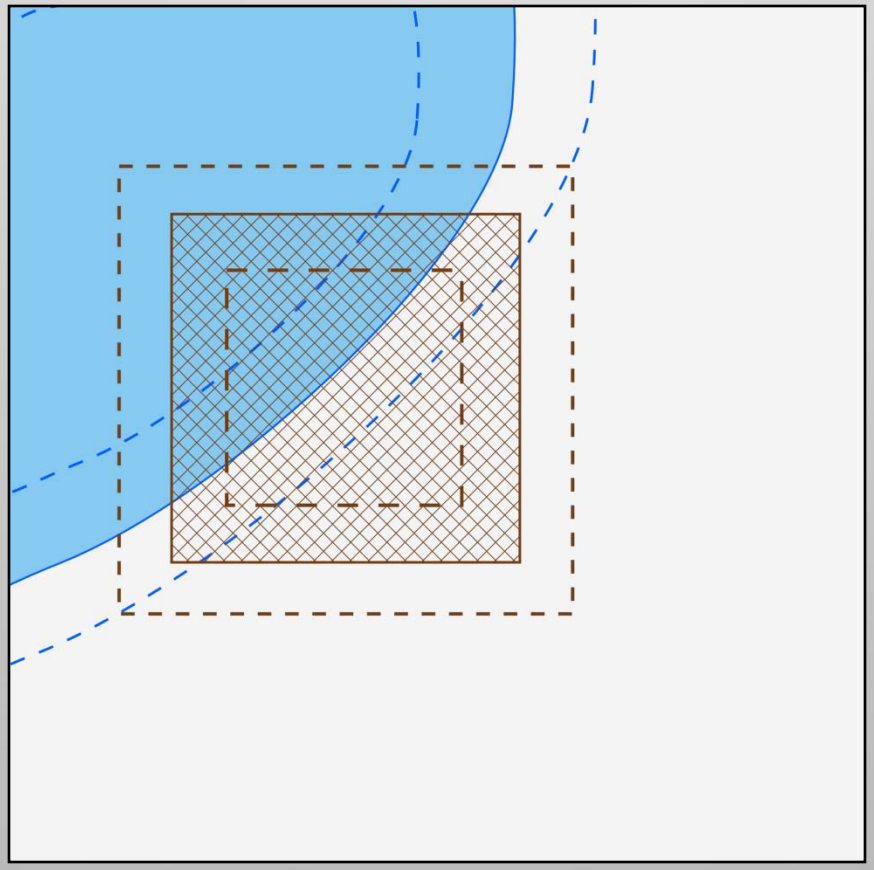

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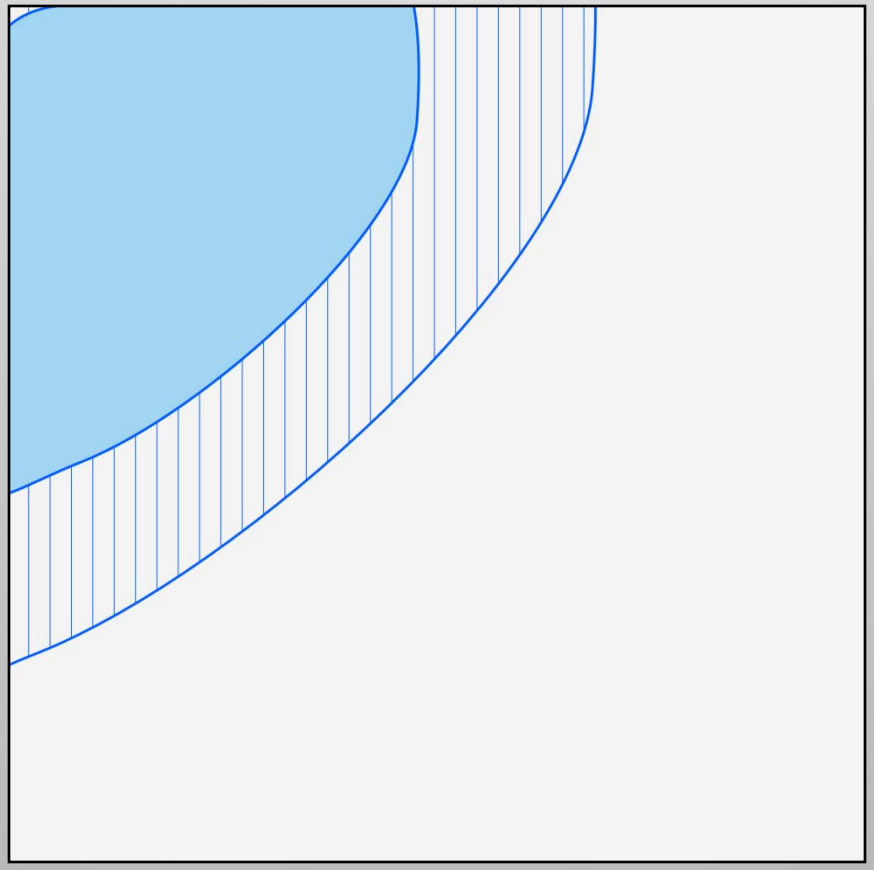

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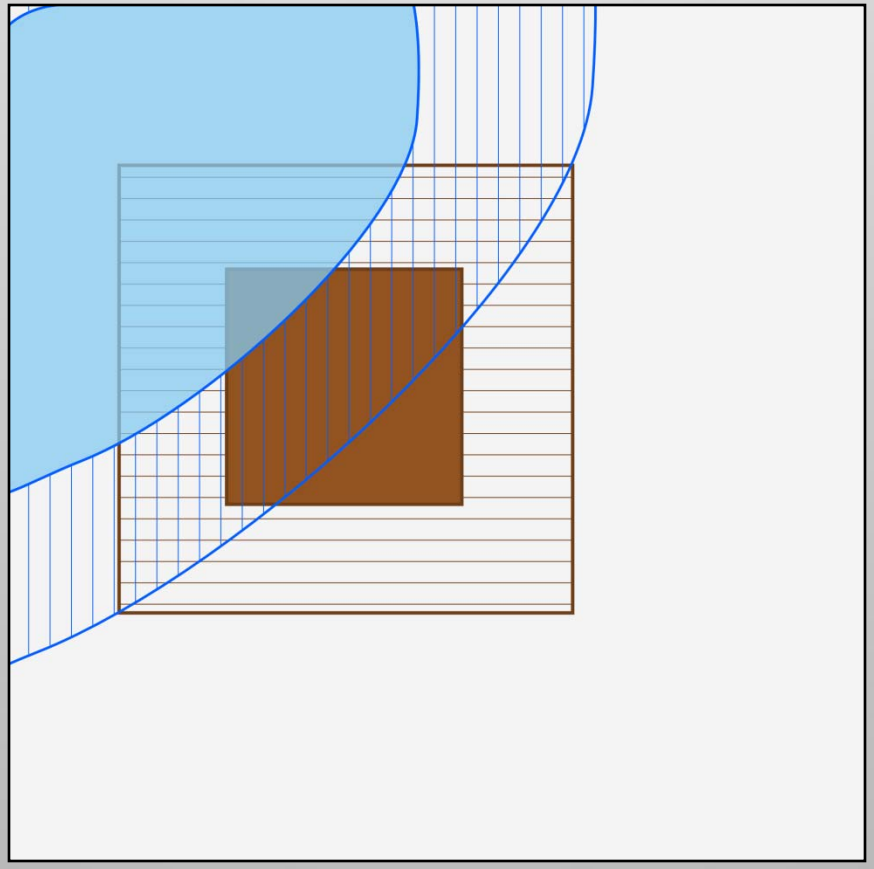

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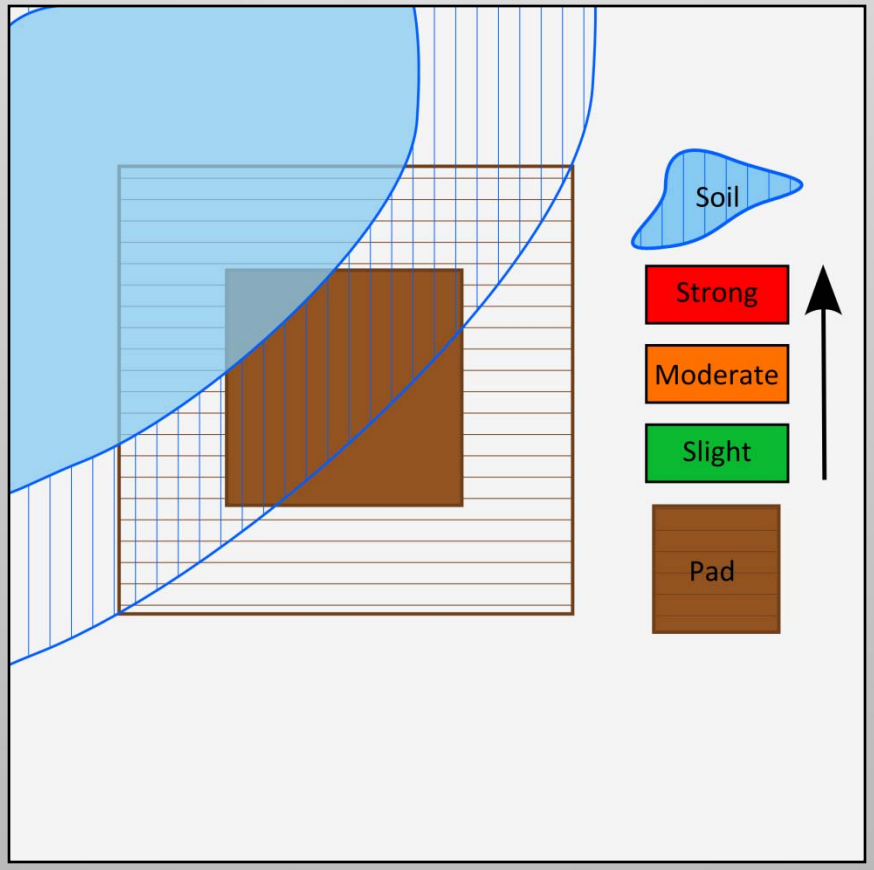

Likelihood of impact

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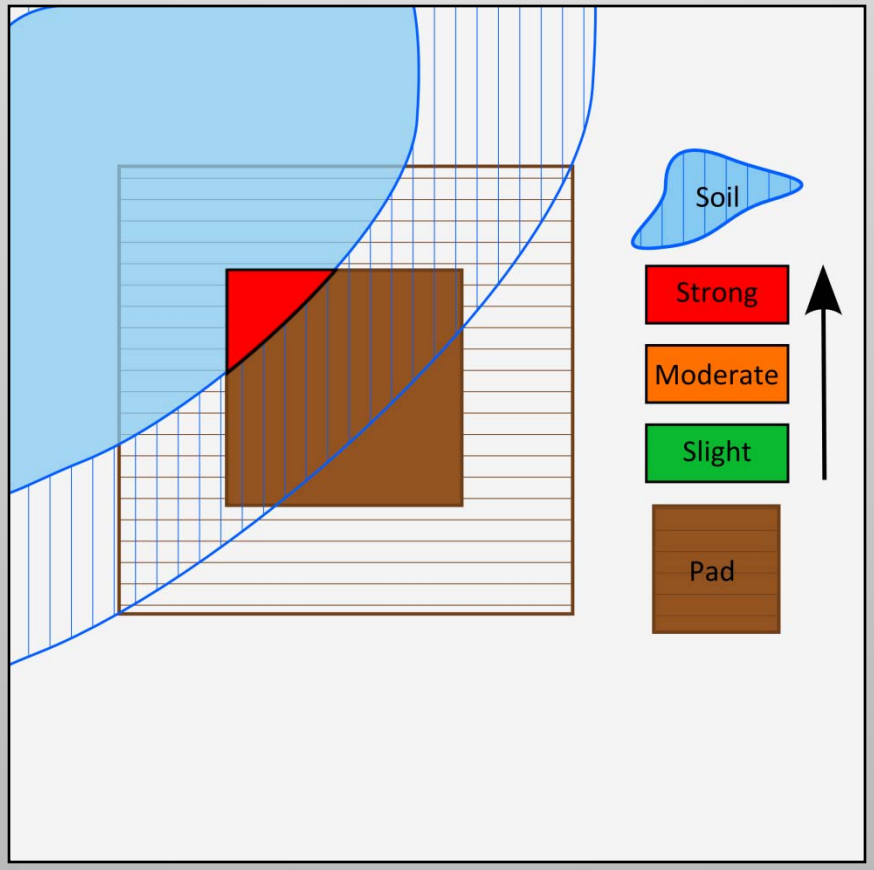

Likelihood of impact:

Strong – "certain" area of feature and "certain" sensitive area

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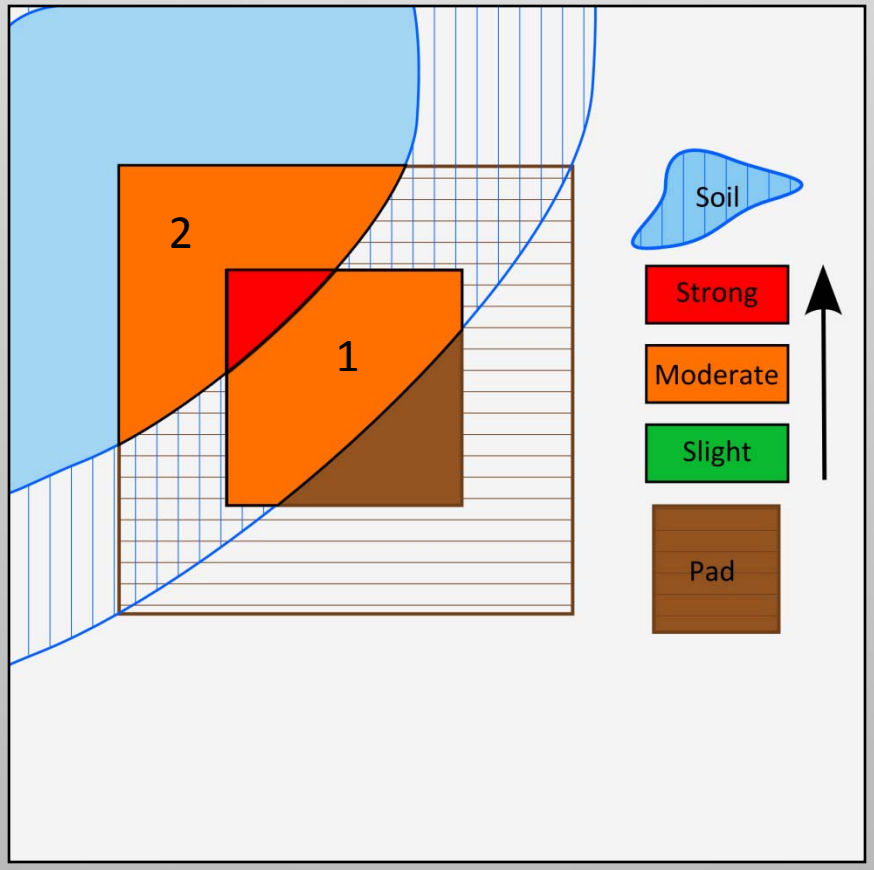

Likelihood of impact:
Moderate – "certain" area of feature and "uncertain" sensitive area (1), or "uncertain" area of feature and "certain" sensitive area (2)

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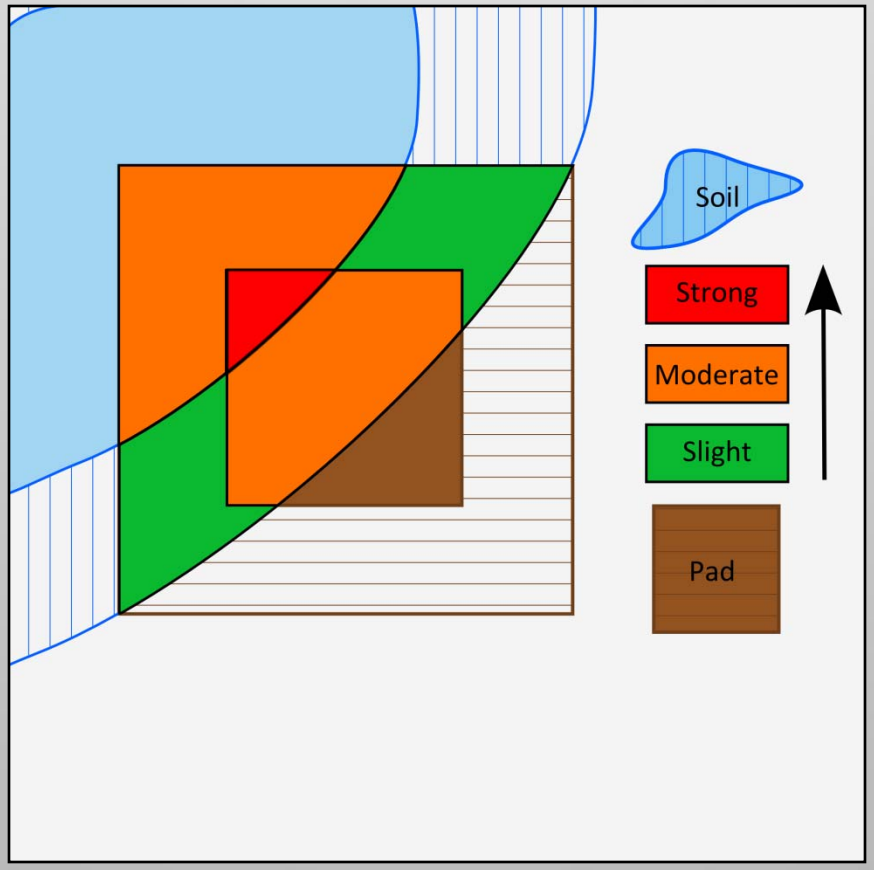

Likelihood of impact:

Slight – "uncertainty zones" of both feature and sensitive area

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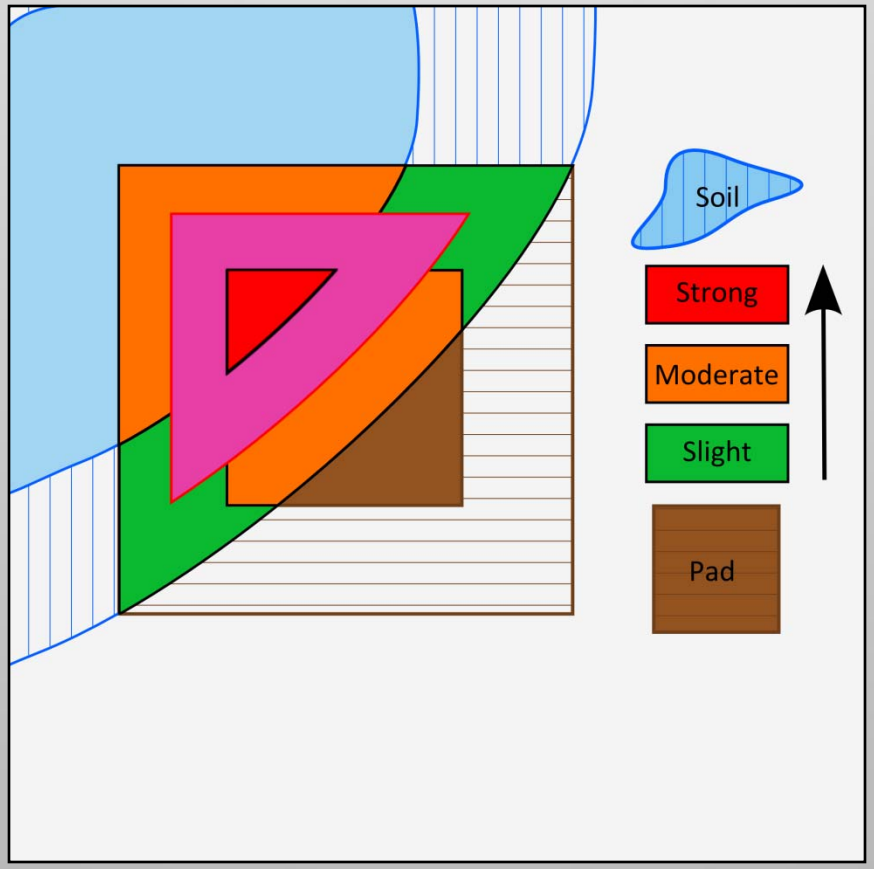

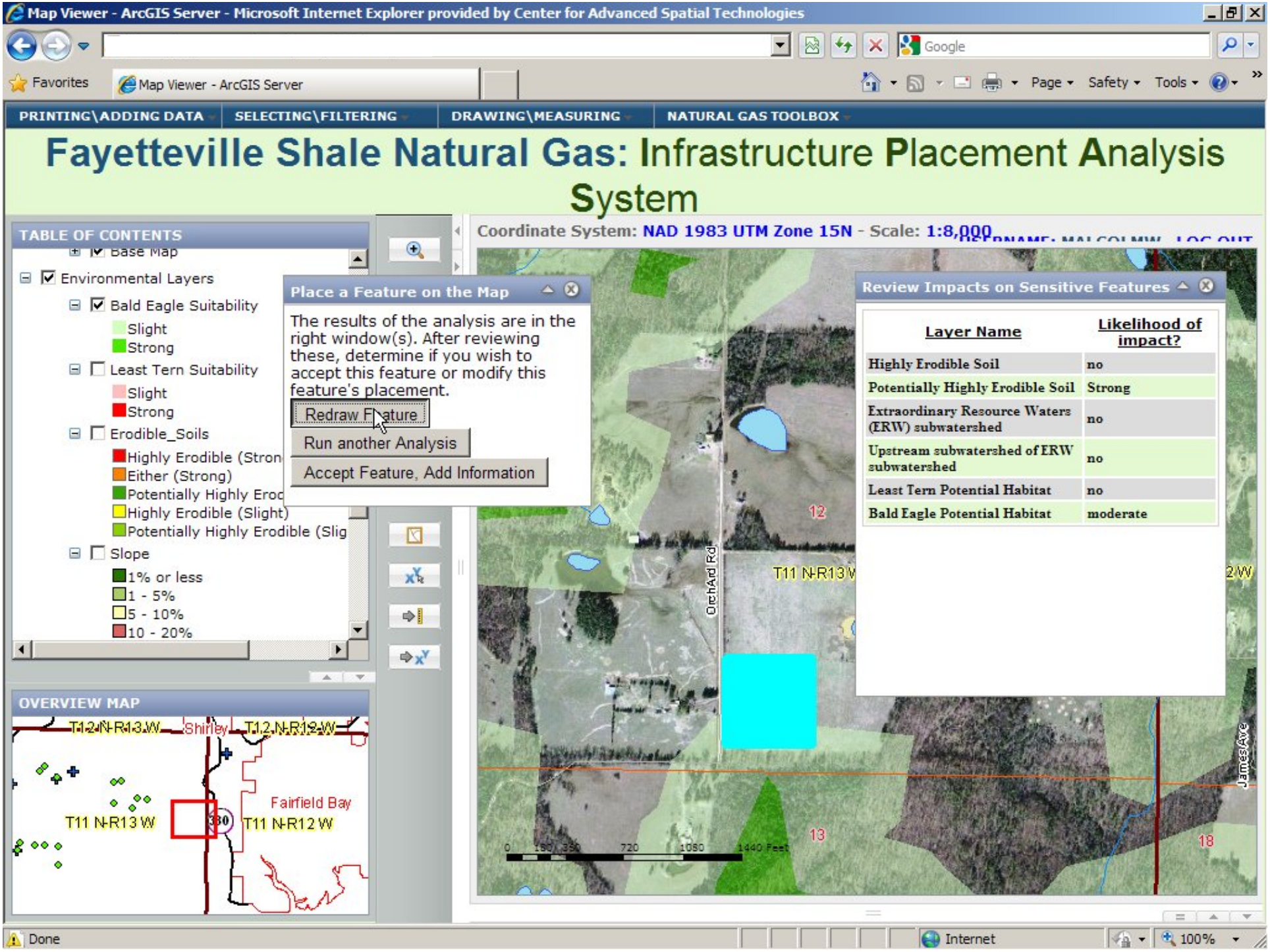
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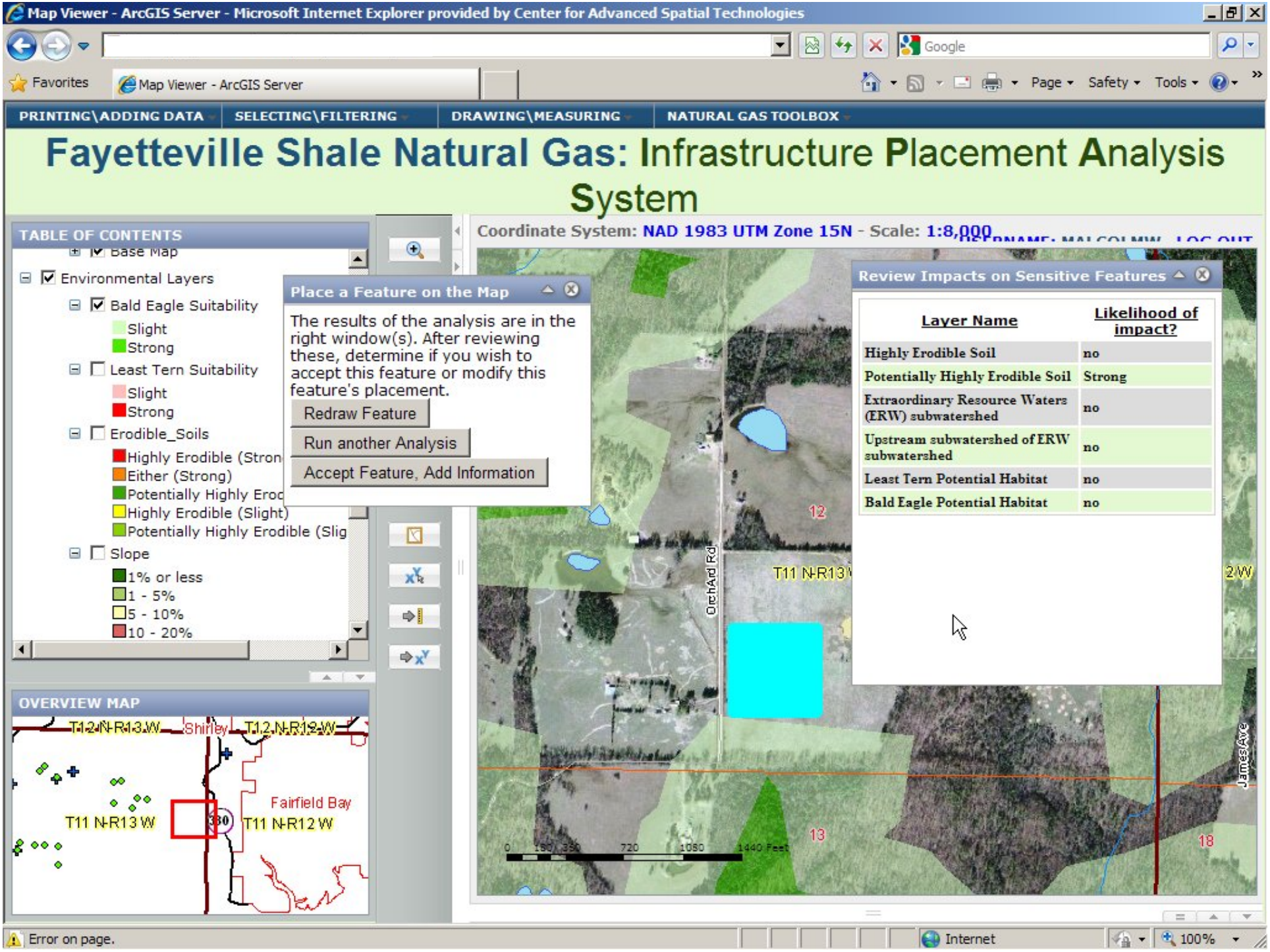
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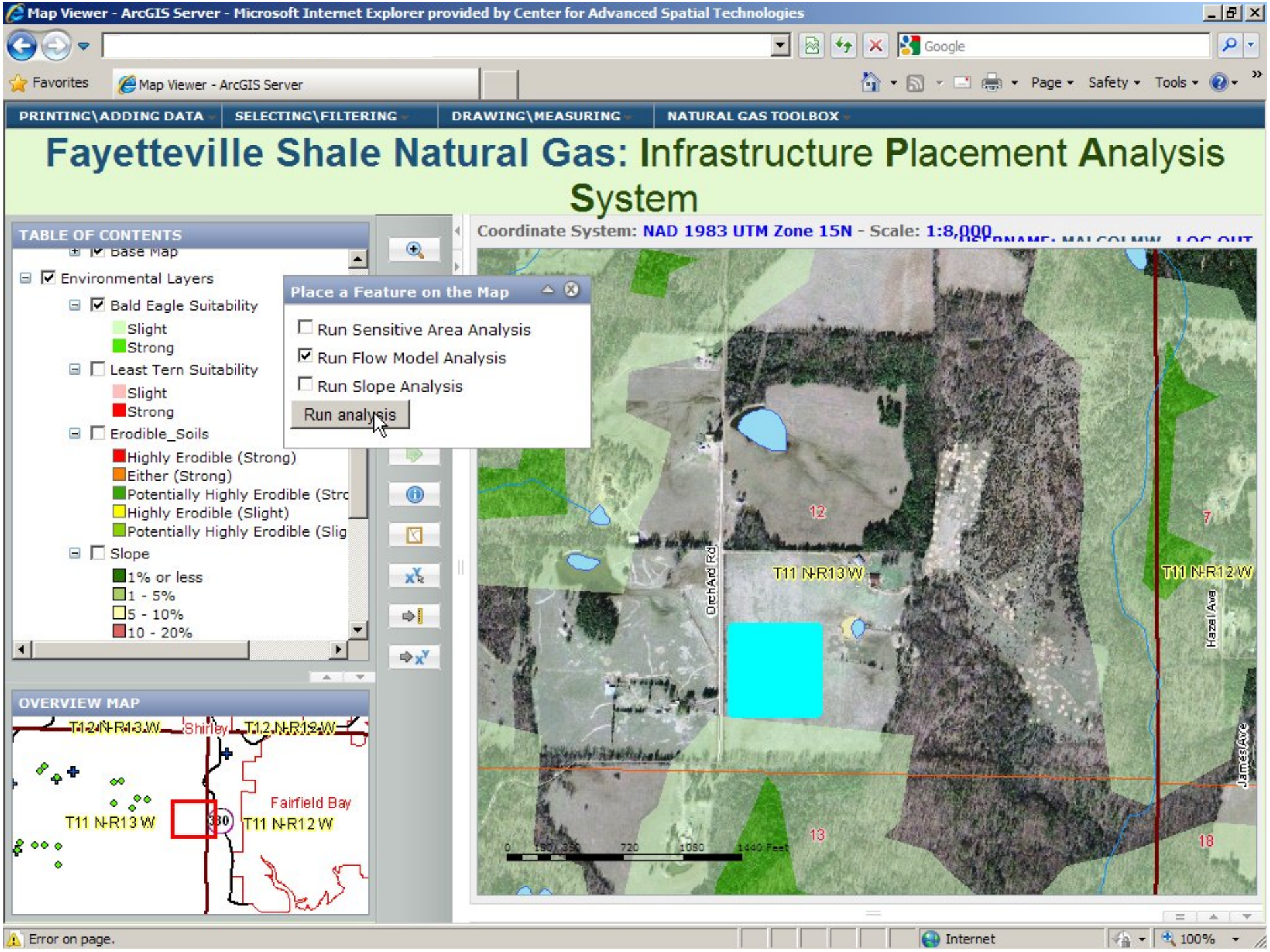
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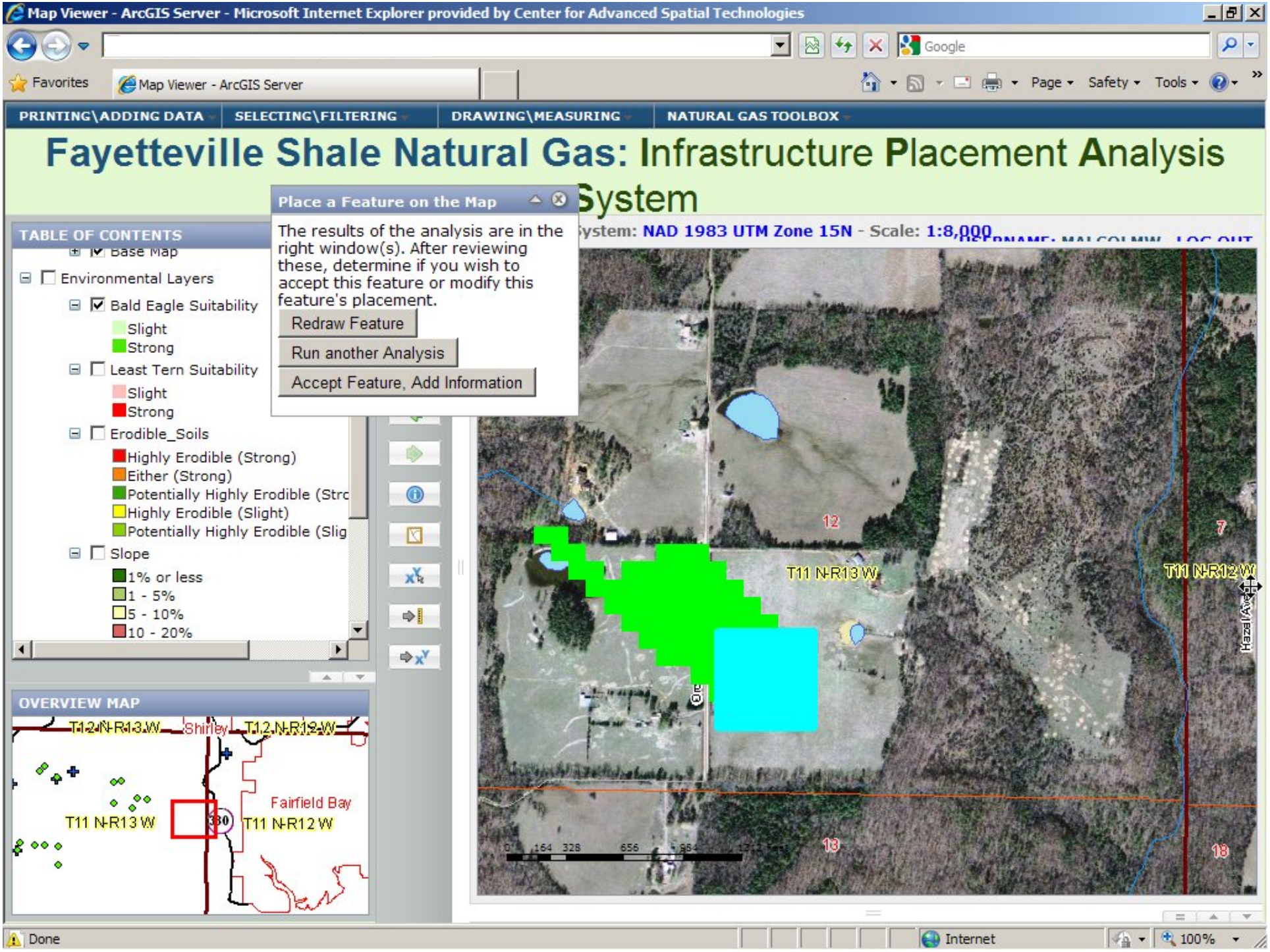
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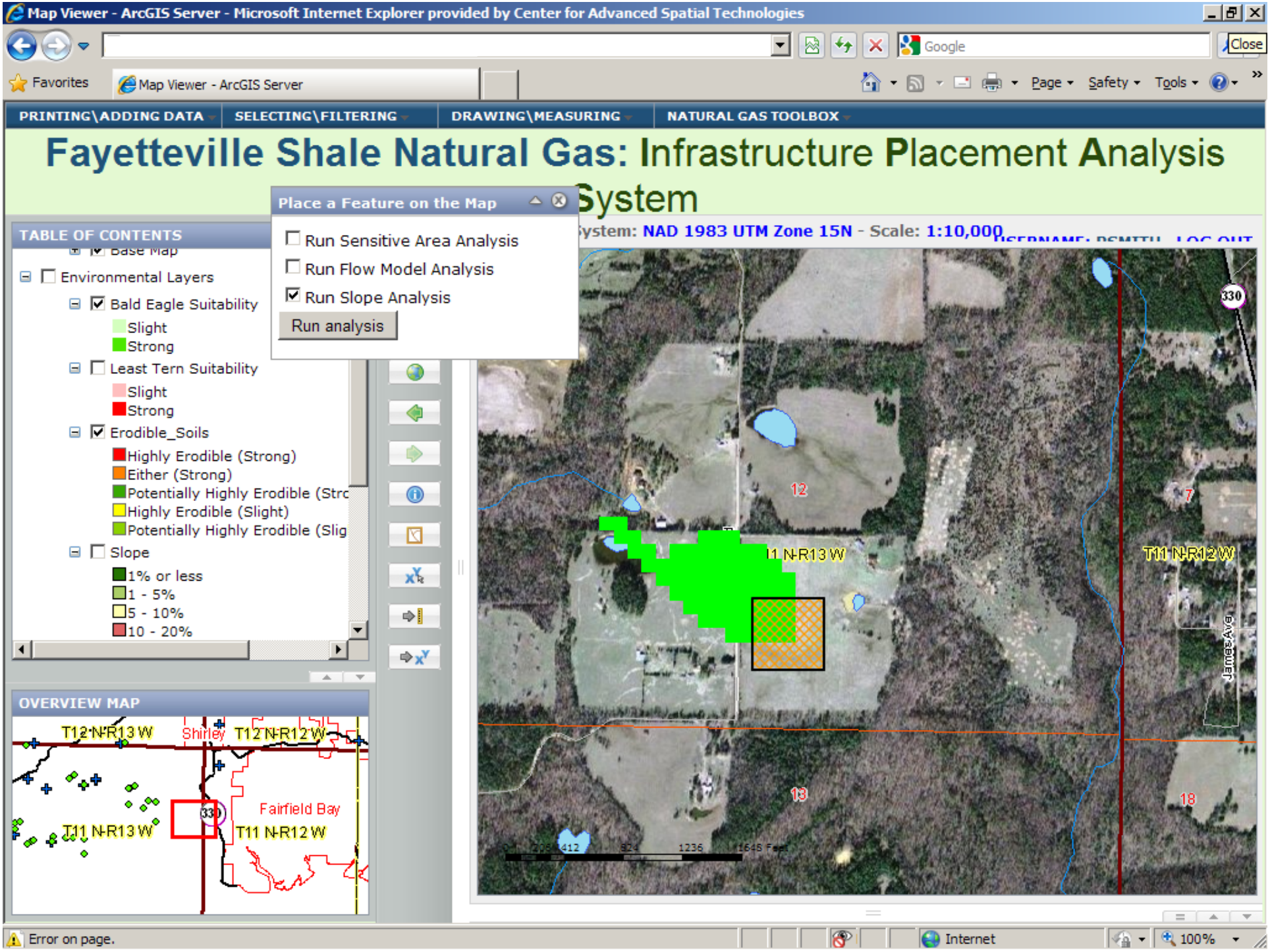
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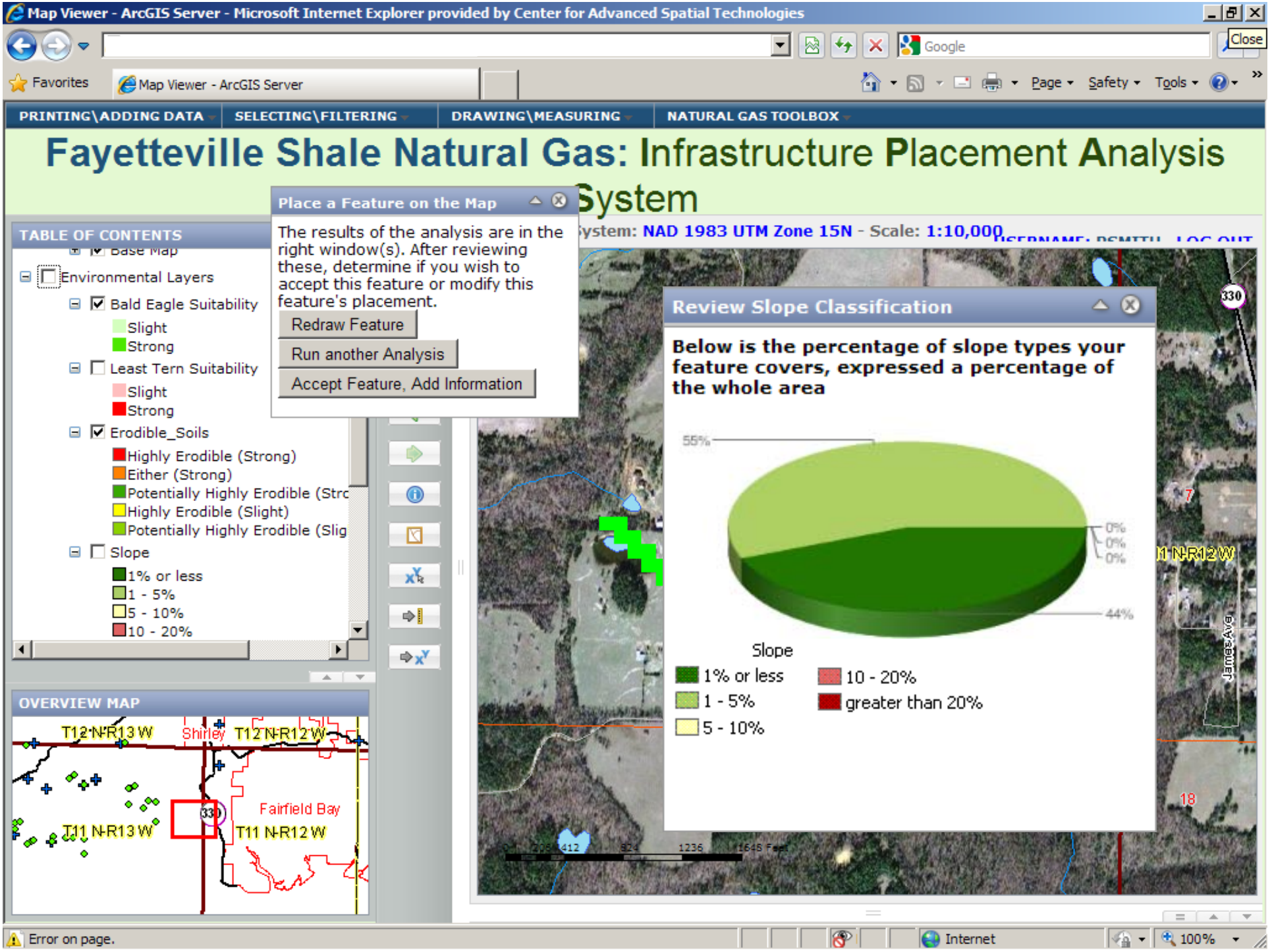
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Run another Analysis
Accept Feature, Add Information
ystem: NAD 1983 UTM Zone 15N - Scale: 1:10,000
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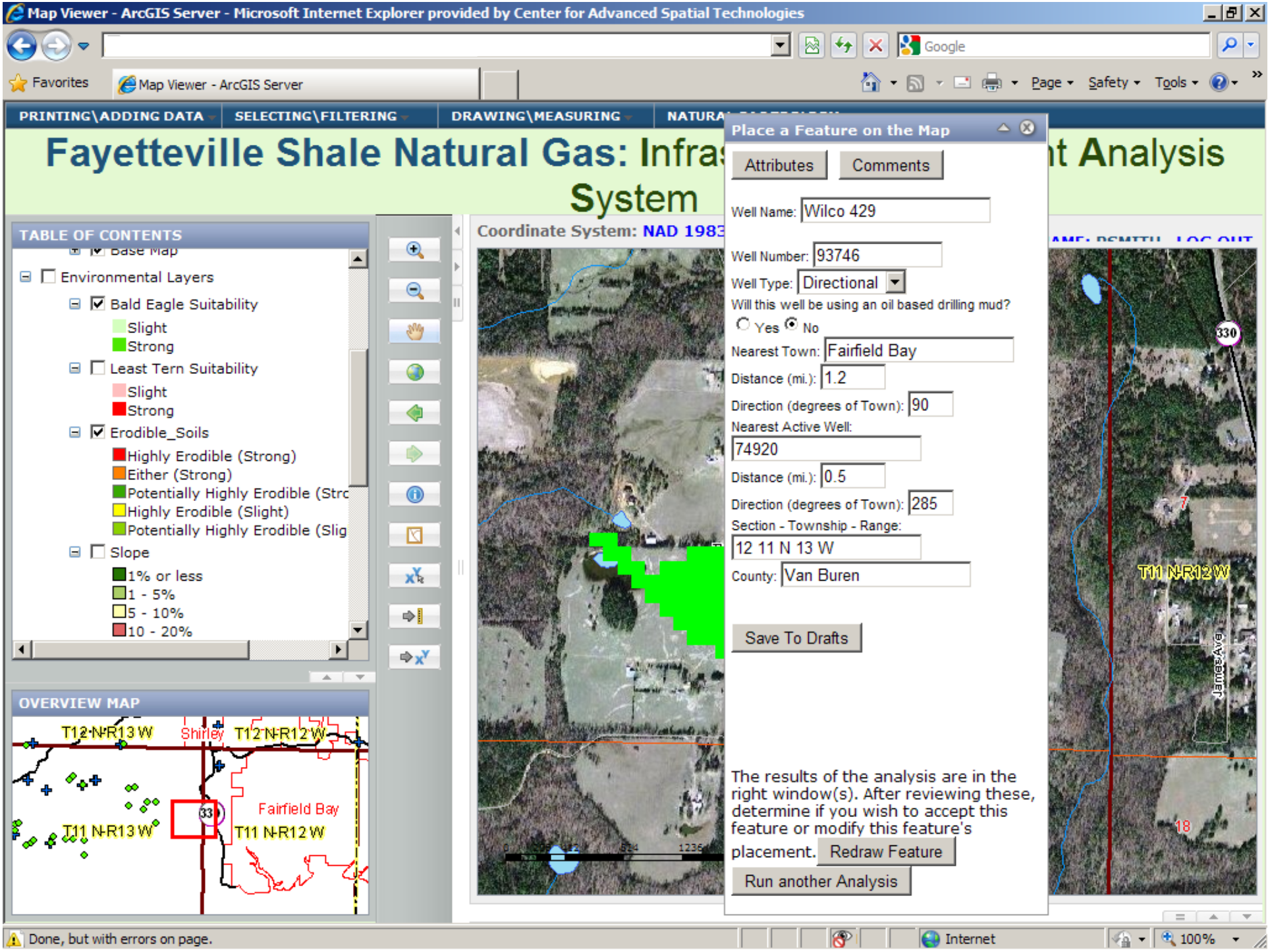
Either (Strong)
Potentially Highly Erodible (Strc
Highly Erodible (Slight)
Potentially Highly Erodible (Slig
Slope
1% or less
1 - 5%
5 - 10%
10 - 20%
OVERVIEW MAP
T12 N-R13 W
Shirley
T12 N-R12 W
Fairfield Bay
T11 N-R13 W
T11 N-R12 W
330
Review Slope Classification
Below is the percentage of slope types your feature covers, expressed a percentage of the whole area
55%
0%
0%
0%
44%
Slope
1% or less
1 - 5%
5 - 10%
10 - 20%
greater than 20%
330
7
T1 N-R12 W
Jamestown Ave
18
0 206 412 824 1236 1648 Feet
Error on page.
Internet
100%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Either (Strong)
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Potentially Highly Erodible (Slig
Slope
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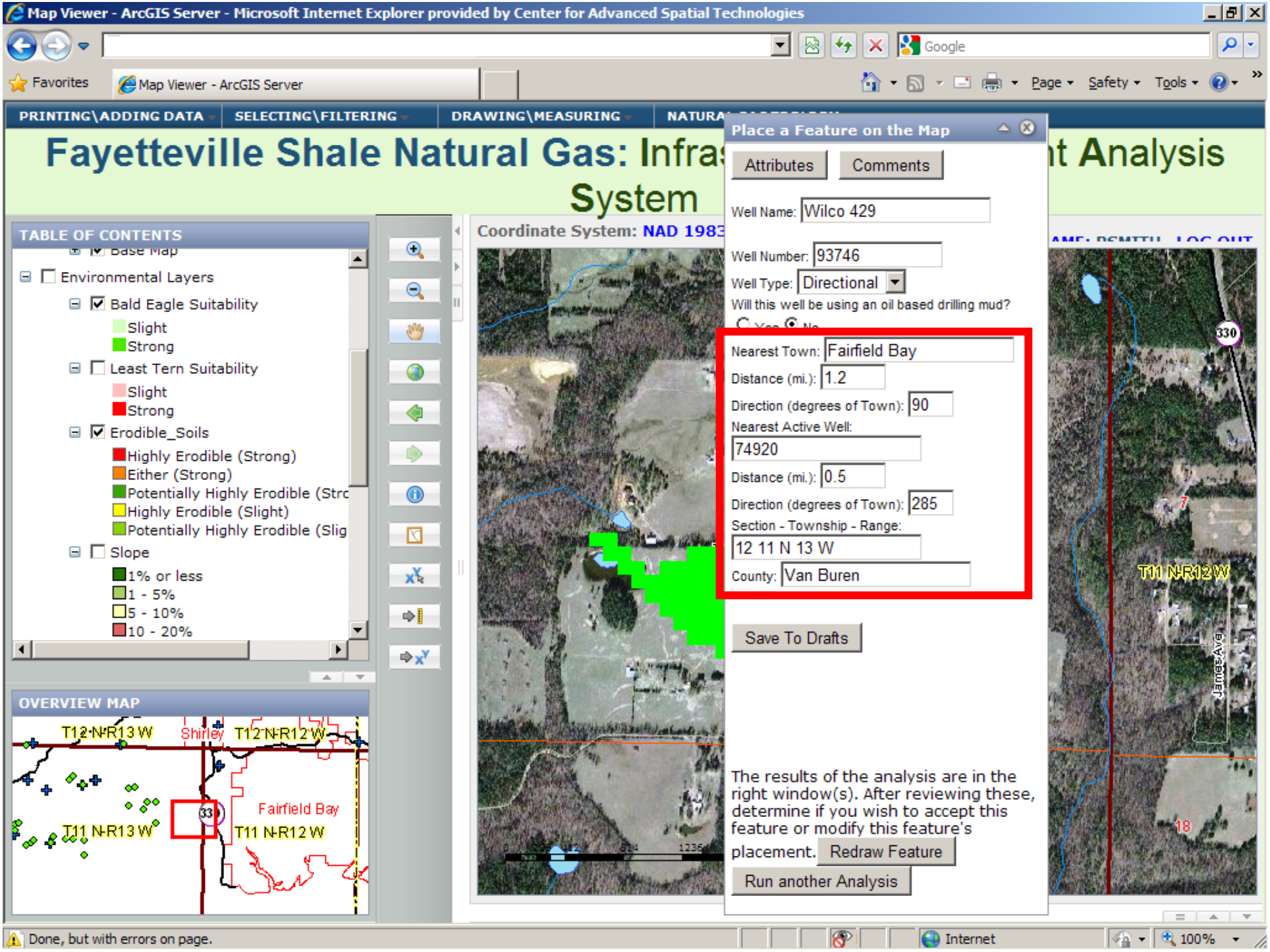
1 - 5%
5 - 10%
10 - 20%
OVERVIEW MAP
T12 N-R13 W
Shirley
T12 N-R12 W
Fairfield Bay
T11 N-R13 W
T11 N-R12 W
Coordinate System: NAD 1983
Place a Feature on the Map
Attributes
Comments
Well Name: Wilco 429
Well Number: 93746
Well Type: Directional
Will this well be using an oil based drilling mud?
Yes
No
Nearest Town: Fairfield Bay
Distance (mi.): 1.2
Direction (degrees of Town): 90
Nearest Active Well:
74920
Distance (mi.): 0.5
Direction (degrees of Town): 285
Section - Township - Range:
12 11 N 13 W
County: Van Buren
Save To Drafts
The results of the analysis are in the right window(s). After reviewing these, determine if you wish to accept this feature or modify this feature's placement.
Redraw Feature
Run another Analysis
330
T11 N-R12 W
Done, but with errors on page.
Internet
100%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T12 N-R13 W
Shirley
T12 N-R12 W
Fairfield Bay
T11 N-R13 W
T11 N-R12 W
Coordinate System: NAD 1983
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Comments
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Well Number: 93746
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Direction (degrees of Town): 90
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74920
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Direction (degrees of Town): 285
Section - Township - Range:
12 11 N 13 W
County: Van Buren
Save To Drafts
The results of the analysis are in the right window(s). After reviewing these, determine if you wish to accept this feature or modify this feature's placement.
Redraw Feature
Run another Analysis
330
T11 N-R12 W
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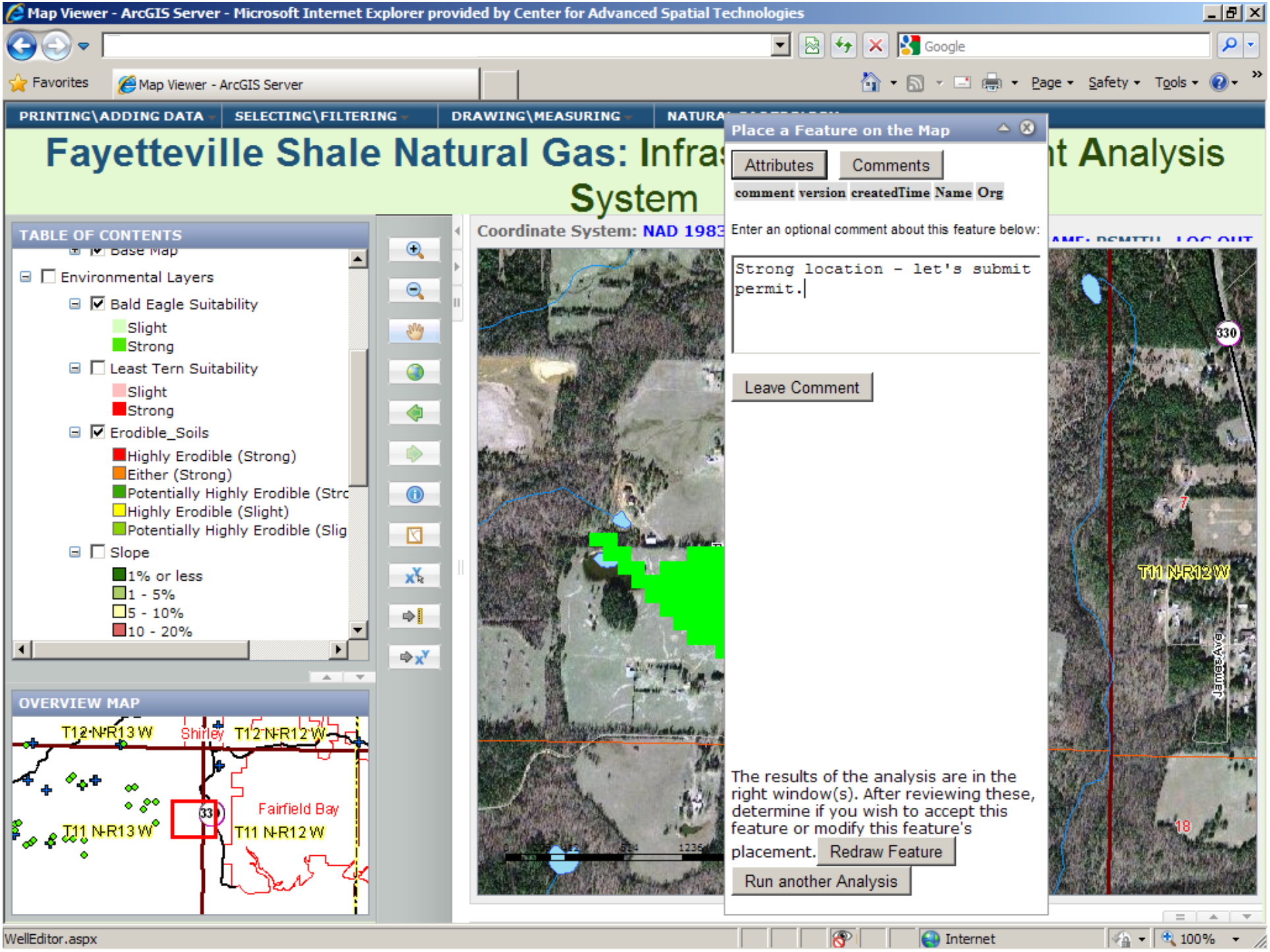
Internet
100%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Either (Strong)
Potentially Highly Erodible (Strc
Highly Erodible (Slight)
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1 - 5%
5 - 10%
10 - 20%
OVERVIEW MAP
T12 N-R13 W
Shirley
T12 N-R12 W
Fairfield Bay
T11 N-R13 W
T11 N-R12 W
Coordinate System: NAD 1983
Place a Feature on the Map
Attributes
Comments
comment version createdTime Name Org
Enter an optional comment about this feature below:
Strong location - let's submit permit.
Leave Comment
The results of the analysis are in the right window(s). After reviewing these, determine if you wish to accept this feature or modify this feature's placement.
Redraw Feature
Run another Analysis
330
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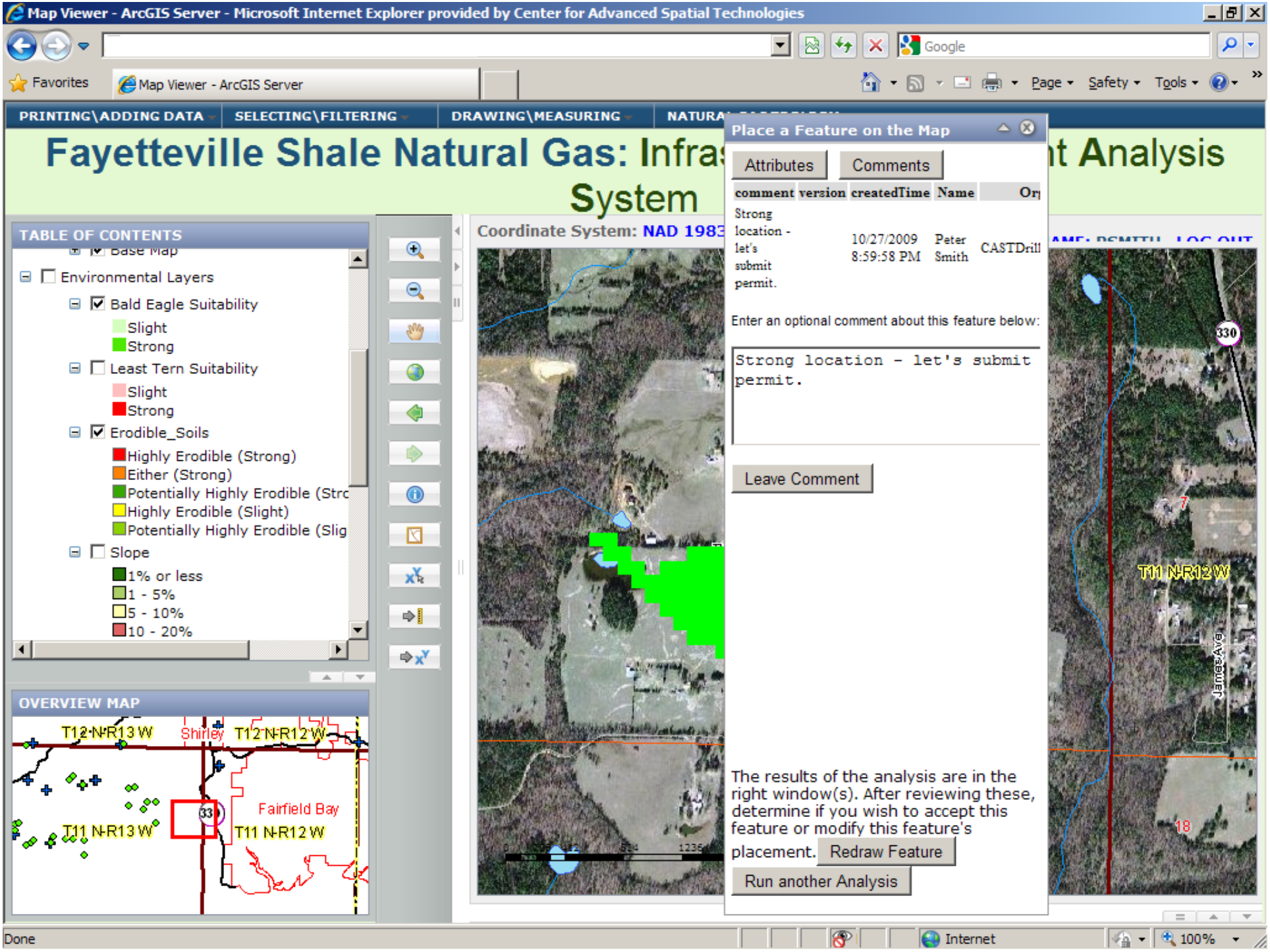
Temple Ave
WellEditor.aspx
Internet
100%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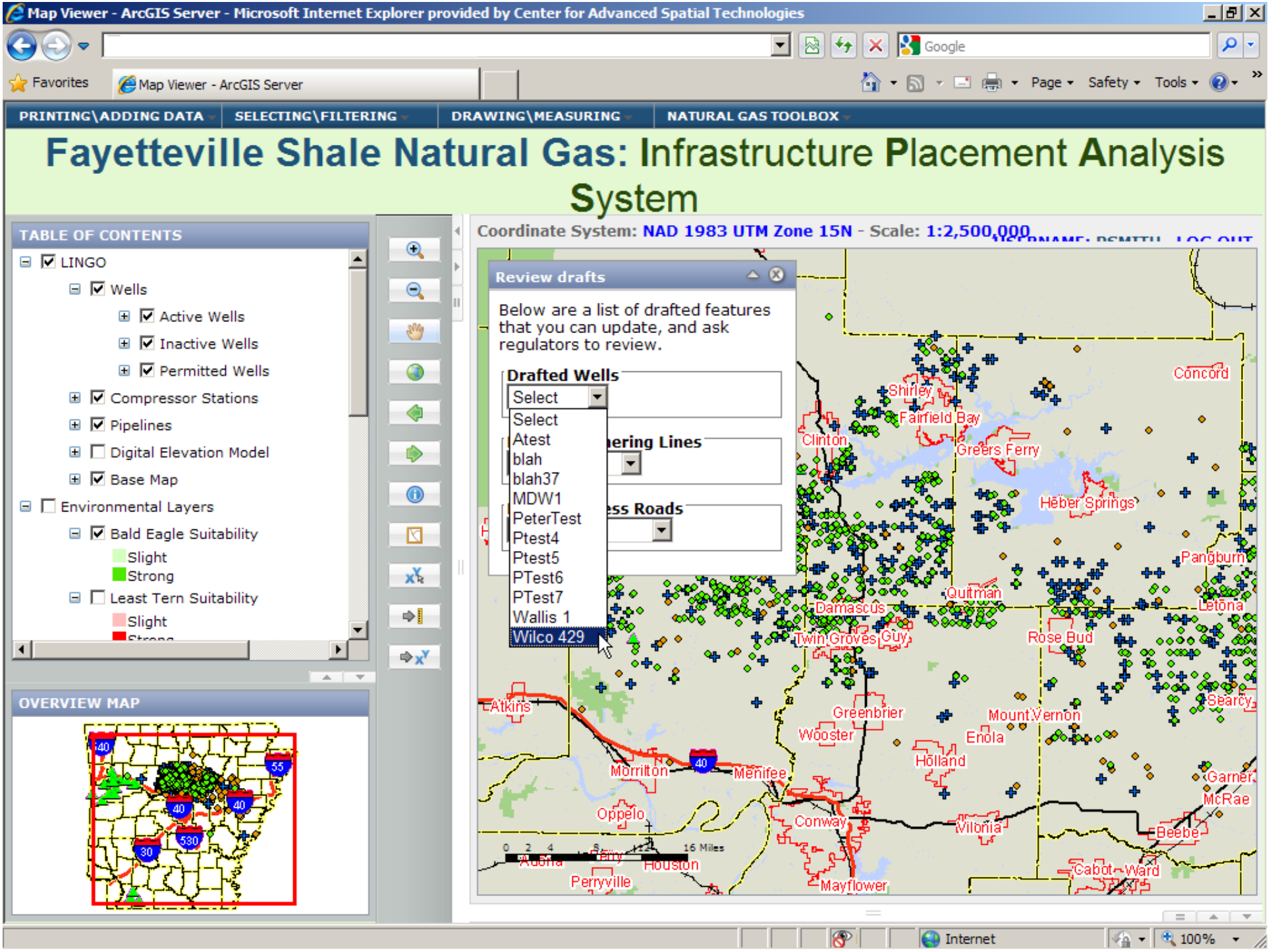
Either (Strong)
Potentially Highly Erodible (Strc
Highly Erodible (Slight)
Potentially Highly Erodible (Slig
Slope
1% or less
1 - 5%
5 - 10%
10 - 20%
OVERVIEW MAP
T12 N-R13 W
Shirley
T12 N-R12 W
Fairfield Bay
T11 N-R13 W
T11 N-R12 W
Coordinate System: NAD 1983
Place a Feature on the Map
Attributes
Comments
comment
version
createdTime
Name
Strong location - let's submit permit.
10/27/2009 8:59:58 PM
Peter Smith
CASTDrill
Enter an optional comment about this feature below:
Strong location - let's submit permit.
Leave Comment
The results of the analysis are in the right window(s). After reviewing these, determine if you wish to accept this feature or modify this feature's placement.
Redraw Feature
Run another Analysis
330
T11 N-R12 W
Done
Internet
100%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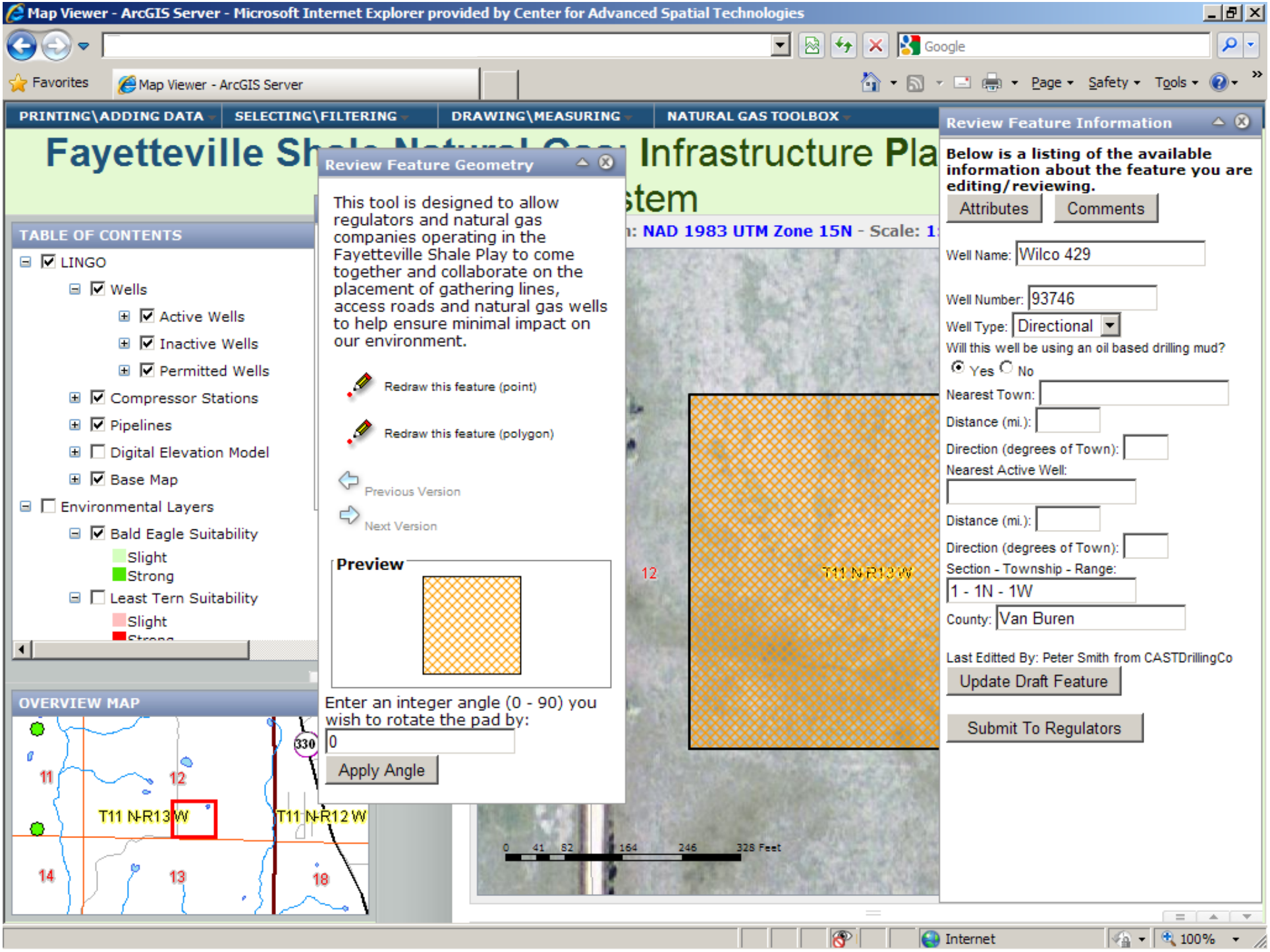
Least Tern Suitability
Slight
OVERVIEW MAP
Coordinate System: NAD 1983 UTM Zone 15N - Scale: 1:2,500,000
Review drafts
Below are a list of drafted features that you can update, and ask regulators to review.
Drafted Wells
Select
Select
Atest
blah
blah37
MDW1
PeterTest
Ptest4
Ptest5
PTest6
PTest7
Wallis 1
Wilco 429
Concord
Shirley
Fairfield Bay
Clinton
Greers Ferry
Heber Springs
Pangburn
Quitman
Damascus
Letona
Twin Groves
Guy
Rose Bud
Atkins
Searcy
Greenbrier
Mount Vernon
Wooster
Enola
Holland
Morrilton
Menifee
Garner
McRae
Oppelo
Conway
Vilonia
Beebe
Houston
Perryville
Mayflower
Cabot
Ward
16 Miles
Internet
100%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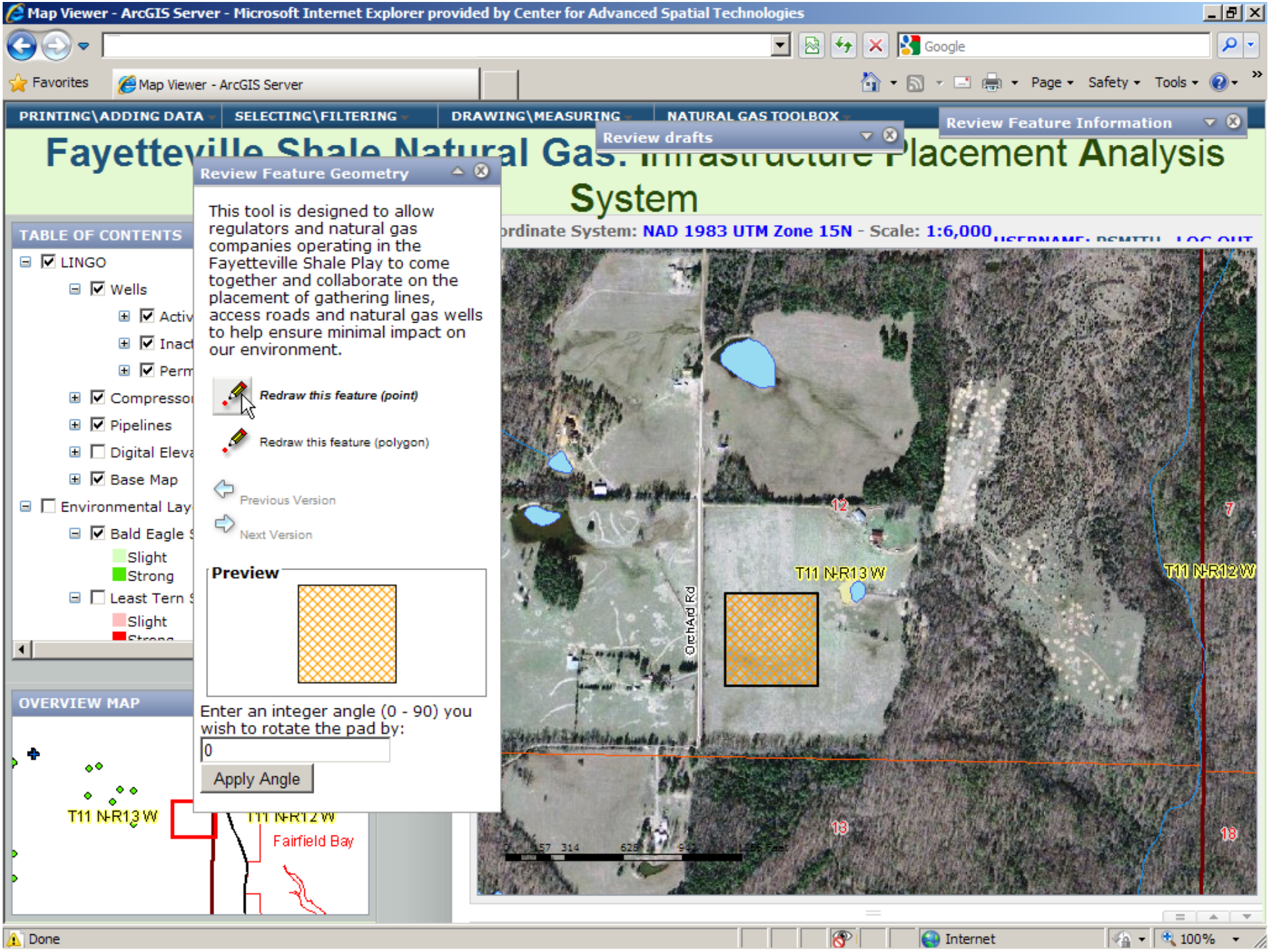
Slight
OVERVIEW MAP
T11 N-R13 W
T11 N-R12 W
Review Feature Geometry
This tool is designed to allow regulators and natural gas companies operating in the Fayetteville Shale Play to come together and collaborate on the placement of gathering lines, access roads and natural gas wells to help ensure minimal impact on our environment.
Redraw this feature (point)
Redraw this feature (polygon)
Previous Version
Next Version
Preview
Enter an integer angle (0 - 90) you wish to rotate the pad by:
0
Apply Angle
NAD 1983 UTM Zone 15N - Scale: 1
T11 N-R12 W
0 41 82 164 246 328 Feet
Review Feature Information
Below is a listing of the available information about the feature you are editing/reviewing.
Attributes
Comments
Well Name: Wilco 429
Well Number: 93746
Well Type: Directional
Will this well be using an oil based drilling mud?
Yes
No
Nearest Town:
Distance (mi.):
Direction (degrees of Town):
Nearest Active Well:
Distance (mi.):
Direction (degrees of Town):
Section - Township - Range:
1 - 1N - 1W
County: Van Buren
Last Editted By: Peter Smith from CASTDrillingCo
Update Draft Feature
Submit To Regulators
Internet
100%


Map Viewer - ArcGIS Server - Microsoft Internet Explorer provided by Center for Advanced Spatial Technologies
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NATURAL GAS TOOLBOX
Review drafts
Review Feature Information
Fayetteville Shale Natural Gas Infrastructure Placement Analysis System
Review Feature Geometry
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Redraw this feature (point)
Redraw this feature (polygon)
Previous Version
Next Version
Preview
Enter an integer angle (0 - 90) you wish to rotate the pad by:
0
Apply Angle
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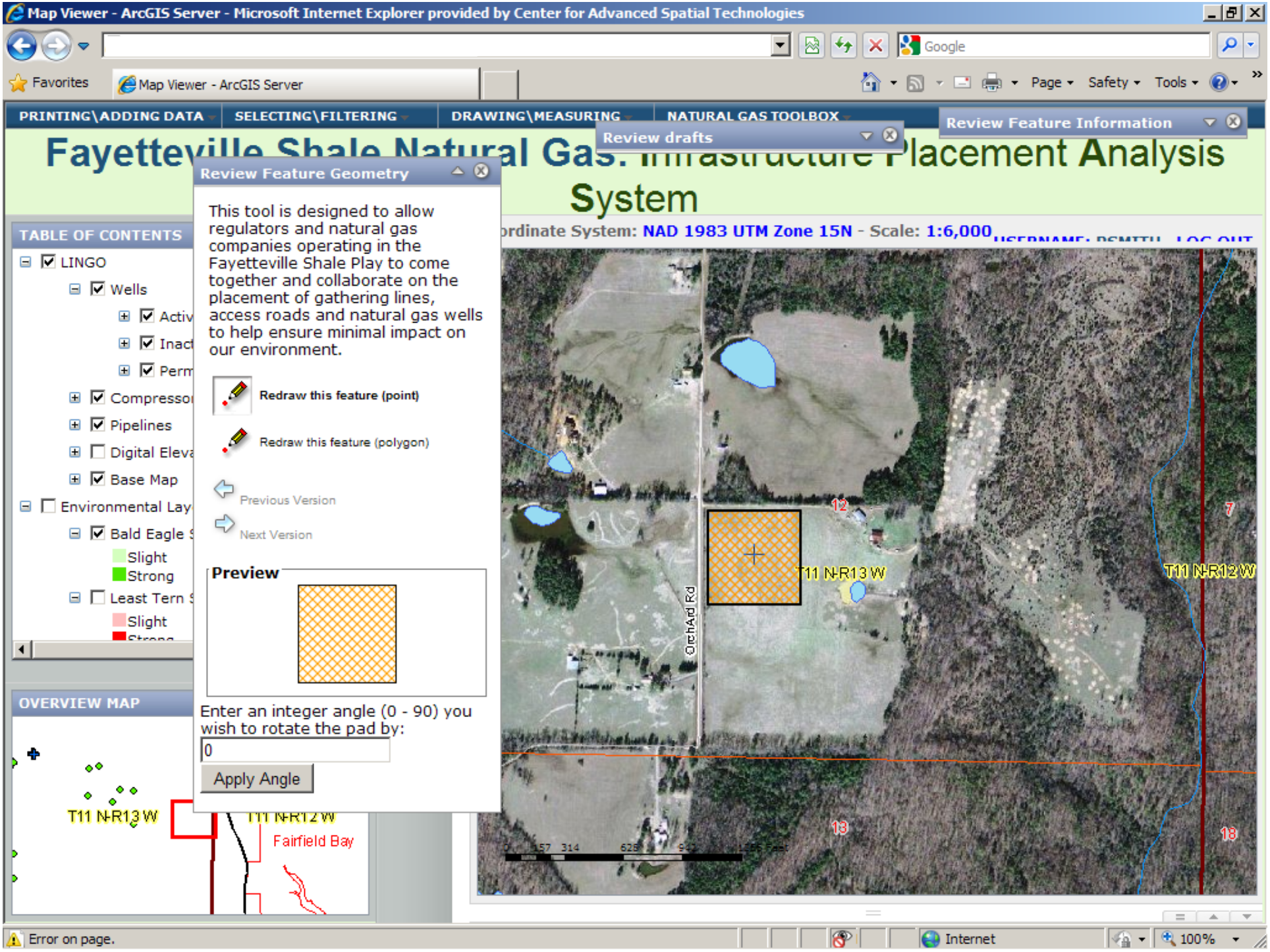
Slight
OVERVIEW MAP
T11 N-R13 W
T11 N-R12 W
Fairfield Bay
ordinate System: NAD 1983 UTM Zone 15N - Scale: 1:6,000
T11 N-R13 W
T11 N-R12 W
Orchard Rd
12
7
13
18
Done
Internet
100%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Redraw this feature (polygon)
Previous Version
Next Version
Preview
Enter an integer angle (0 - 90) you wish to rotate the pad by:
0
Apply Angle
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OVERVIEW MAP
T11 N-R13 W
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ordinate System: NAD 1983 UTM Zone 15N - Scale: 1:6,000
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T11 N-R12 W
Orchard Rd
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Error on page.
Internet
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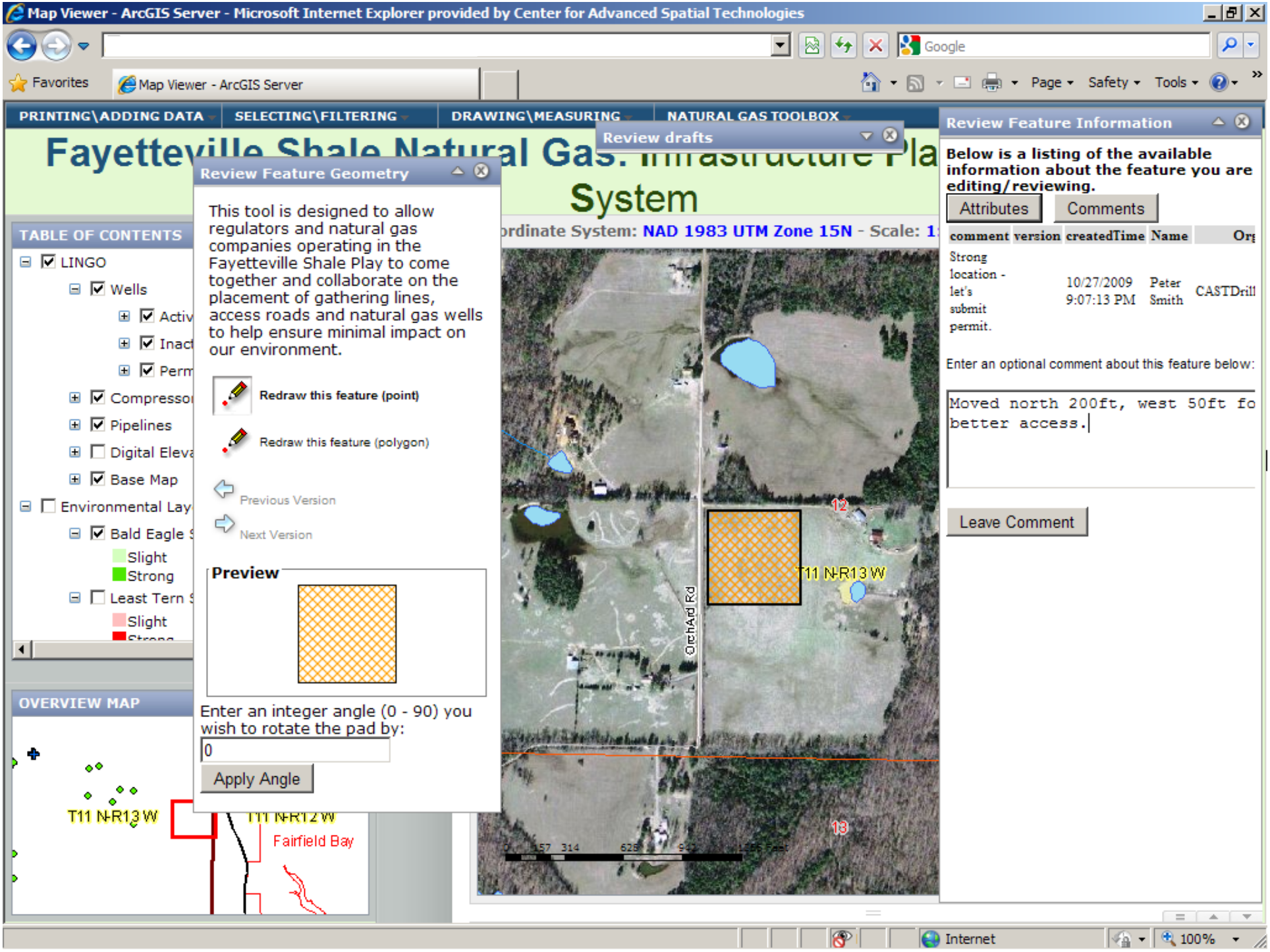
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Review drafts
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This tool is designed to allow regulators and natural gas companies operating in the Fayetteville Shale Play to come together and collaborate on the placement of gathering lines, access roads and natural gas wells to help ensure minimal impact on our environment.
Redraw this feature (point)
Redraw this feature (polygon)
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Apply Angle
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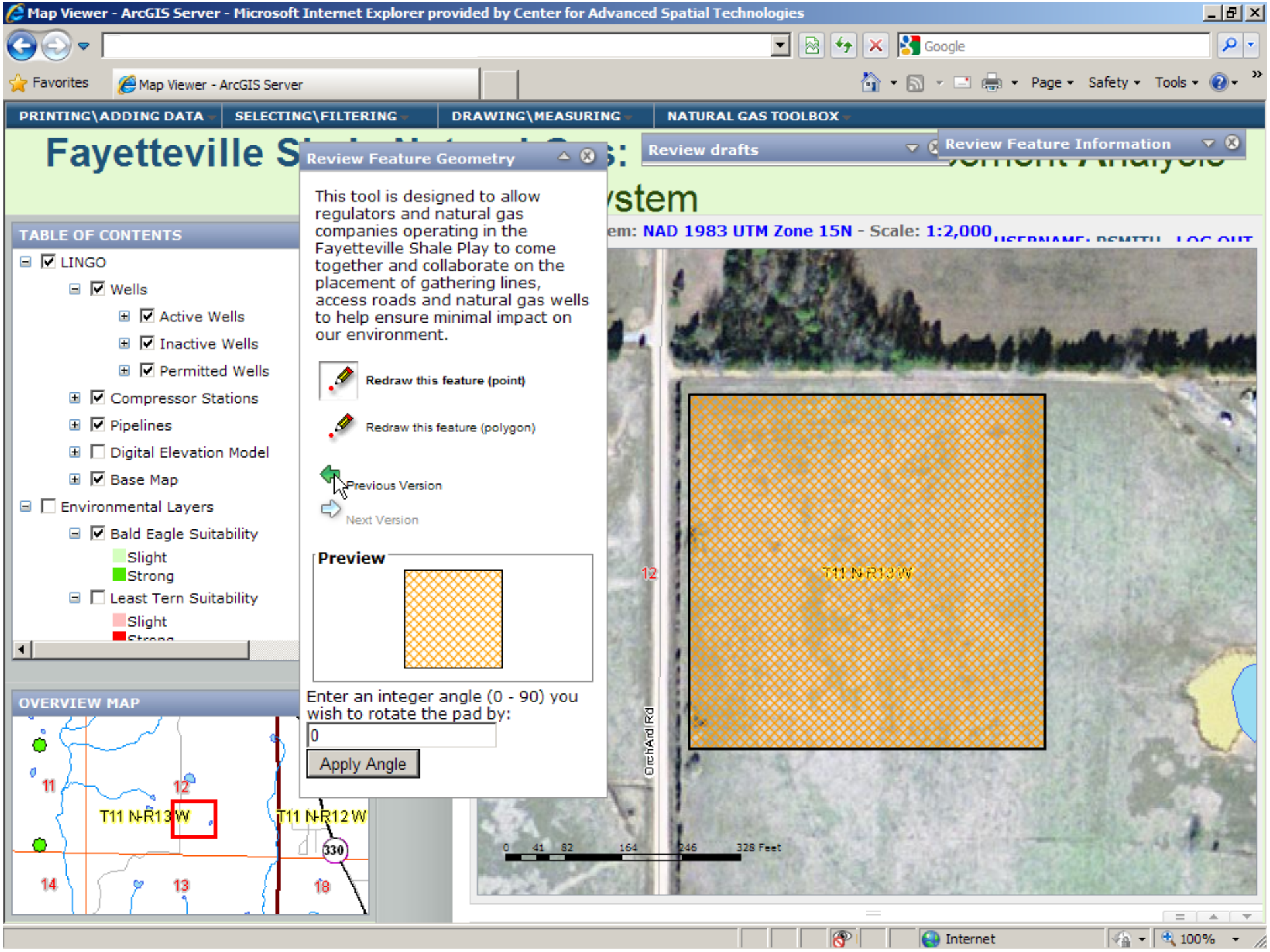
OVERVIEW MAP
T11 N-R13 W
T11 N-R12 W
Fairfield Bay
Coordinate System: NAD 1983 UTM Zone 15N - Scale:
T11 N-R13 W
Orchard Rd
12
13
Review Feature Information
Below is a listing of the available information about the feature you are editing/reviewing.
Attributes
Comments
comment
version
createdTime
Name
Org
Strong location - let's submit permit.
10/27/2009 9:07:13 PM
Peter Smith
CASTDrill
Enter an optional comment about this feature below:
Moved north 200ft, west 50ft fo better access.
Leave Comment
Internet
100%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Redraw this feature (polygon)
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Next Version
Preview
Enter an integer angle (0 - 90) you wish to rotate the pad by:
0
Apply Angle
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Strong
Least Tern Suitability
Slight
em: NAD 1983 UTM Zone 15N - Scale: 1:2,000
T11 N-R13 W
12
Orchard Rd
0 41 82 164 246 328 Feet
OVERVIEW MAP
11
12
T11 N-R13 W
T11 N-R12 W
330
14
13
18
Internet
100%

IPAS: Infrastructure Placement Analysis System

- Other features
  - Collaboration system
    - Operator to regulator
    - Emailing
    - Could be for internal use only as well
  - Audit tracking
  - Public informational sites

Fayetteville Shale Natural Gas: Reducing Environmental Impacts

UNIVERSITY of ARKANSAS 1871

Argonne NATIONAL LABORATORY

About the Fayetteville Shale

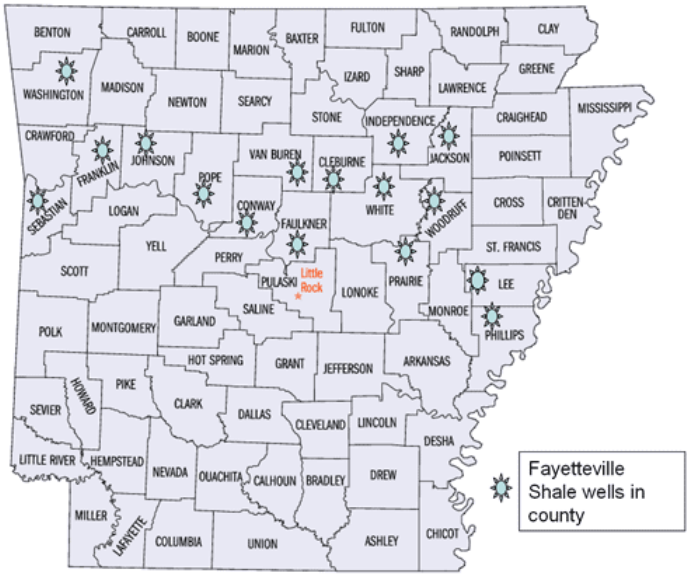
An introduction to the Fayetteville Shale including its location and geographic extent, economic importance, and physical characteristics.

The Fayetteville Shale is an unconventional natural gas reservoir located on the Arkansas side of the Arkoma Basin, ranging in thickness from 50 to 550 feet and ranging in depth from 1,500 to 6,500 feet. The shale is a Mississippian-age shale that is the geologic equivalent of the Caney Shale found on the Oklahoma side of the Arkoma Basin and the Barnett Shale found in north Texas.

Location

The Fayetteville Shale play stretches across Arkansas from approximately Fort Smith east to beyond Little Rock, Arkansas. It is approximately 50 miles wide from north to south. The figure shows those counties that have some wells drilled to the Fayetteville Shale formation.

The most active area of natural gas development is from western Conway County through eastern White County. Development further to the east is anticipated to proceed very slowly because the shale is considerably deeper, making gas extraction less economical.



Economic Importance

The Fayetteville Shale is important to Arkansas because it holds large quantities of natural gas. Unlike more traditional oil and gas fields that contain hydrocarbons in porous rock formations, shale holds natural gas in a fine-grained rock matrix. Until recent years, most shale formations were not considered profitable areas for gas production. With new technology and elevated natural gas prices, companies have made the Barnett Shale play in north Texas one of the hottest production fields in the country. Encouraged by the success in the Barnett Shale formation, operators looked at other large shale formations, including the Fayetteville Shale.

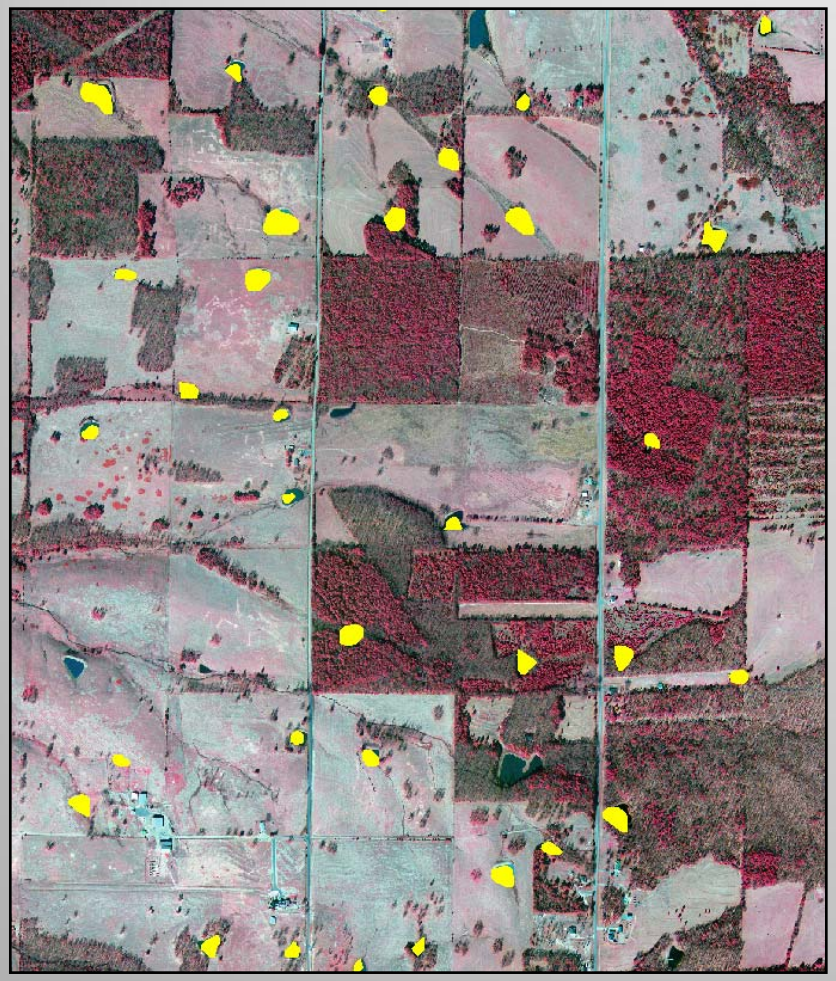
IPAS: New Directions

- Haynesville Shale play
  - Funded through Houston Advanced Research Center/Environmentally Friendly Drilling program
  - Port the app across plays
  - Challenges of multi-state regulations *and* data

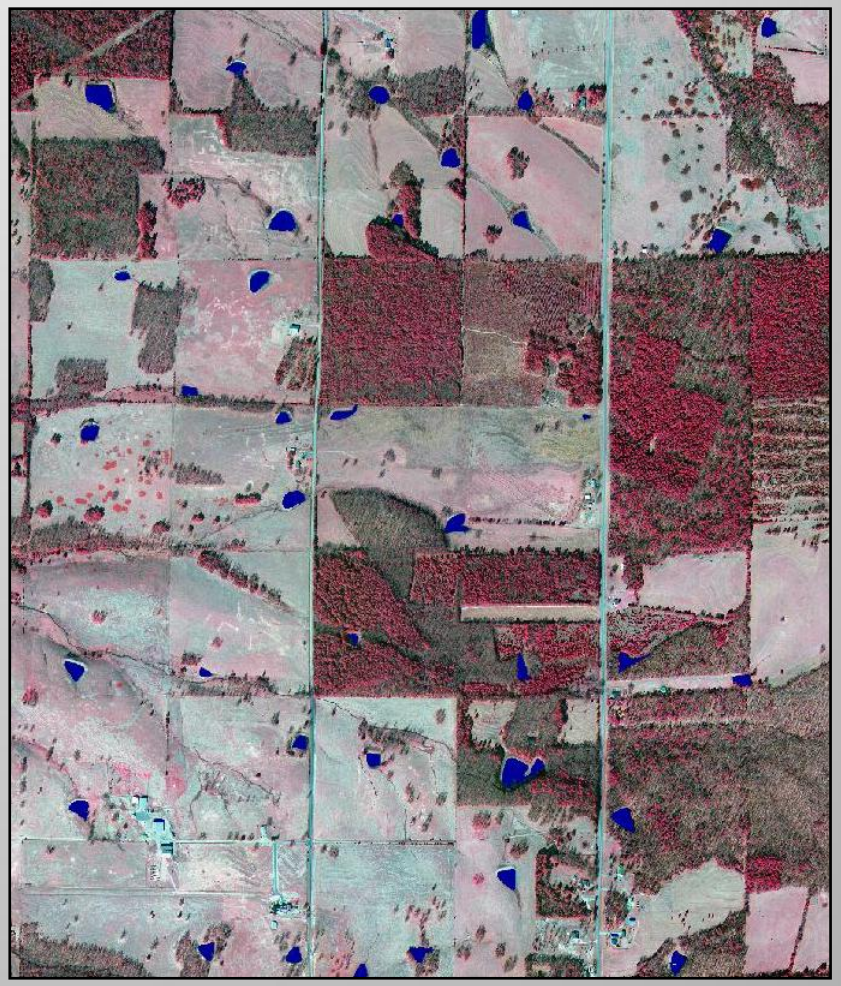
IPAS: New Directions

- Water modeling in the Fayetteville play
  - Blacklands Research & Extension Center, Texas A&M – (modified) SWAT model
  - DOE funding through NETL
  - Focus on surface water
    - AR Natural Resources Commission
  - Improved understanding of available water
    - Faster permitting with peace of mind

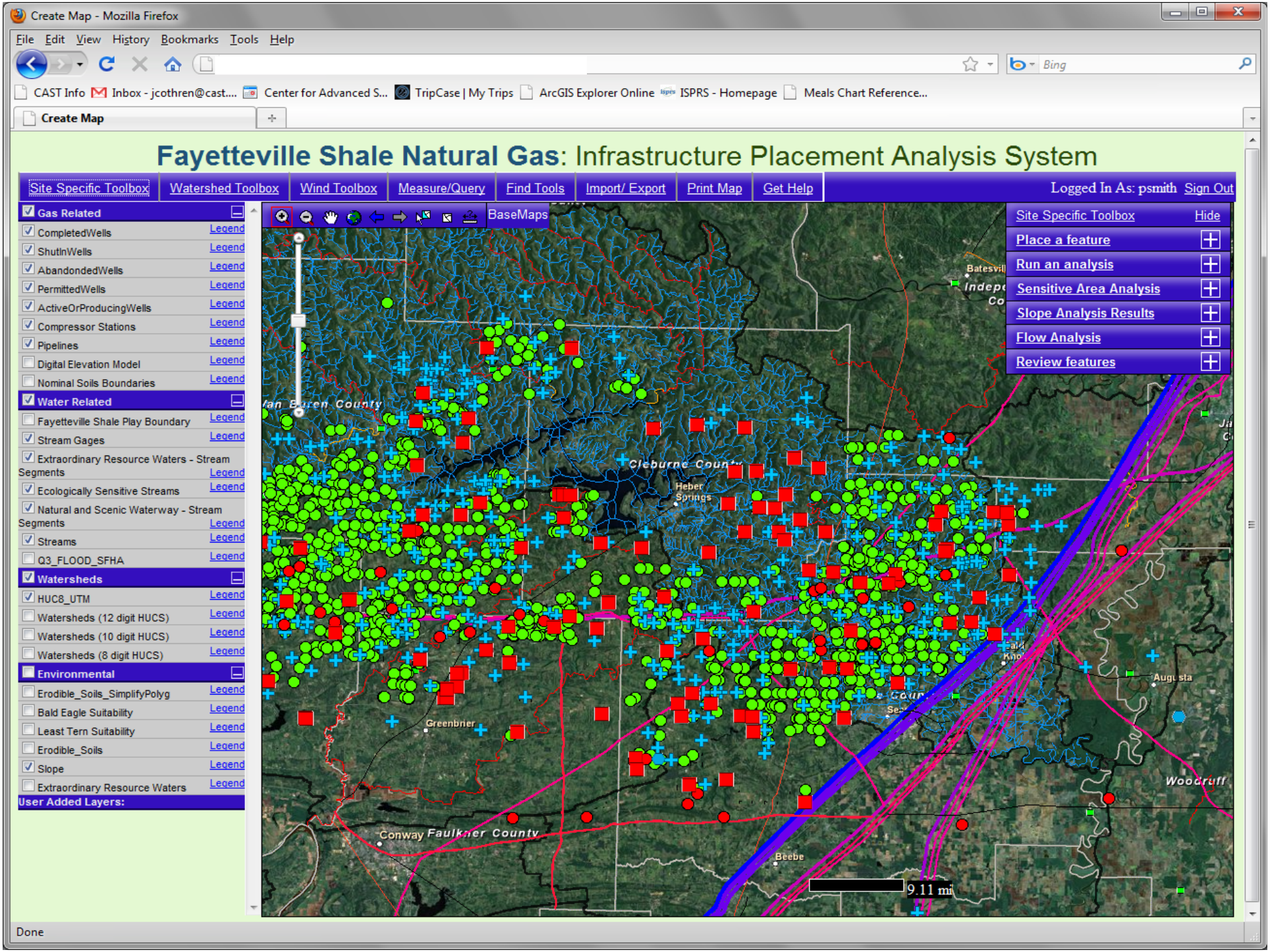
IPAS: New Directions



NHD high-resolution water layer (yellow).



Water (blue) extracted from the color-infrared imagery. Object-based classification using Trimble eCognition.


Create Map - Mozilla Firefox
File Edit View History Bookmarks Tools Help
Bing
CAST Info
Inbox - jcothren@cast....
Center for Advanced S...
TripCase | My Trips
ArcGIS Explorer Online
ISPRS - Homepage
Meals Chart Reference...
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Watershed Toolbox
Wind Toolbox
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Find Tools
Import/ Export
Print Map
Get Help
Logged In As: psmith
Sign Out
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ShutInWells
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Digital Elevation Model
Nominal Soils Boundaries
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Extraordinary Resource Waters - Stream Segments
Ecologically Sensitive Streams
Natural and Scenic Waterway - Stream Segments
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Watersheds
HUC8_UTM
Watersheds (12 digit HUCS)
Watersheds (10 digit HUCS)
Watersheds (8 digit HUCS)
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Erodible_Soils_SimplifyPolyg
Bald Eagle Suitability
Least Tern Suitability
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Place a feature
Run an analysis
Sensitive Area Analysis
Slope Analysis Results
Flow Analysis
Review features
Van Buren County
Cleburne County
Heber Springs
Greenbrier
Conway
Faulkner County
Beebe
Augusta
Woodruff
9.11 mi
Done

www.cast.uark.edu