

EPRI-GTC Transmission Line Siting Methodology

An Overview by Jesse Glasgow

Industry Need

**\$12 Billion Needed to Relieve
Immediate Congestion**

Utility Proposes 120-mile-long Transmission Line

**Study Says \$56 Billion Transmission
Line Investment Needed**

**U.S. Electricity Transmission System
Under Stress**

Public Perception



Scrutiny



Opponents Are Organized

cope - 8/24/2006 - Microsoft Internet Explorer

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Address <http://www.copeingeorgia.com>

C.O.P.E

Citizens Opposing Power Encroachment

Thursday, August 24, 2006

Search  PRINT



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Tuesday, June 13, 2006

At it Again

Power is coming into our neighborhoods once again. We need to get together and fight this thing. A meeting is scheduled in the month of October. Please click [here](#) for more information.

Please join us to fight against these unsightly lines that

Power is coming into our neighborhoods once again. We need to get together and fight this thing. A meeting is scheduled in



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...And Creative




...And Direct



Common Internal Challenges




What is the Methodology?

- Objective
 - Consistent
 - Standardized
 - Defensible
 - **Guideline**
- 

Has been used on:

- Over 70 transmission line projects
- A water transmission line
- Power generation plants
- Greenways

Unique Characteristics

- Standardizes alternative perspectives
 - Uses external stakeholder input on a programmatic basis
 - Uses computer algorithms to help identify alternative corridors
- 

Research & Development



Georgia**Transmission**

EPRI

ELECTRIC POWER
RESEARCH INSTITUTE

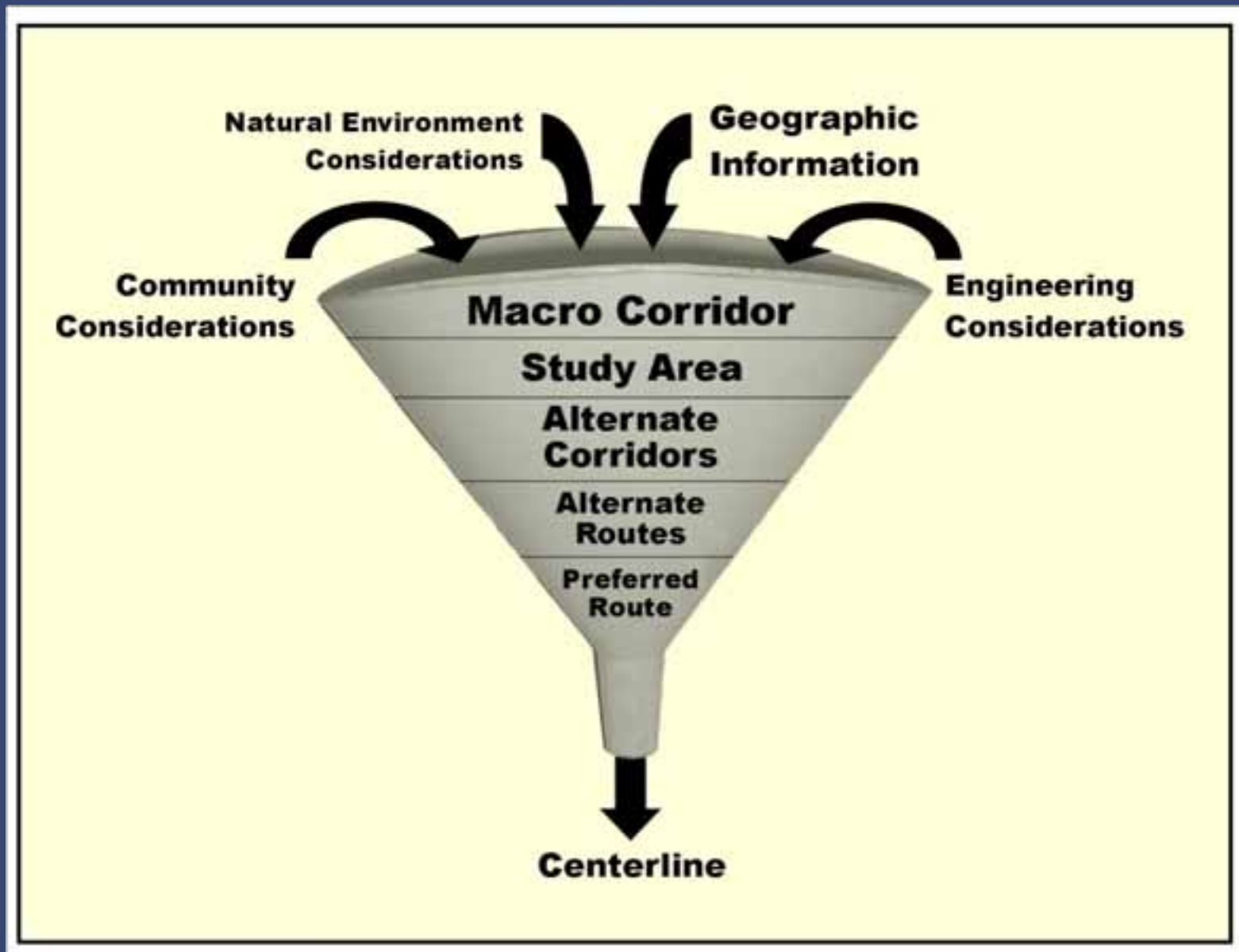


Photo Science

- 200 Employees: Photogrammetrists, Engineers, Surveyors, & Geographers
- Aerial Photography, Photogrammetry, LiDAR, Survey
- **Siting Analysis** and GIS Data Acquisition
- **Corridor Analyst** © Software Developer
- Viewshed Analysis and Photo Simulations
- GIS Implementation Services
- Full Service Geospatial Solutions



Corridor Analysis Funnel

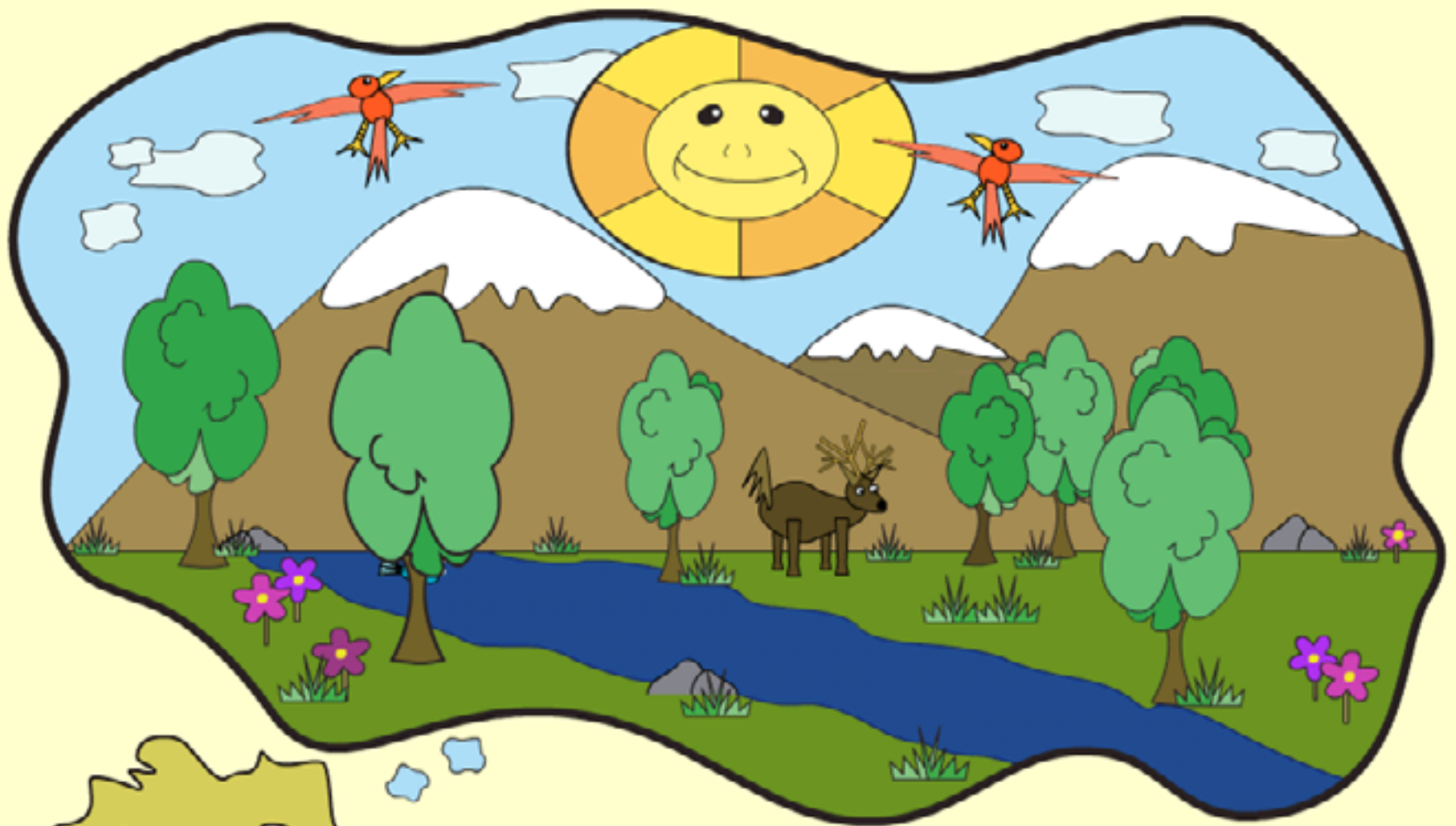


Infusing Stakeholder Input

- External Stakeholders
 - Governmental Interest
 - Environmental Interest
 - Community Interest
 - Cultural Resource Interest
- Internal Stakeholders
 - Engineers
 - Environmental Specialist
 - Land Acquisition Specialist



Natural Environment



Natural Perspective

- Sierra Club
- Dept. of Fish & Game
- Dept. of Natural Resources
- Conservation Division
- Water Division
- Local Environmental Groups
- Resources Council
- Nature Preserves Commission
- USFWS
- USACE
- USFS
- Nature Conservancy
- Utility Reps.



Built Environment

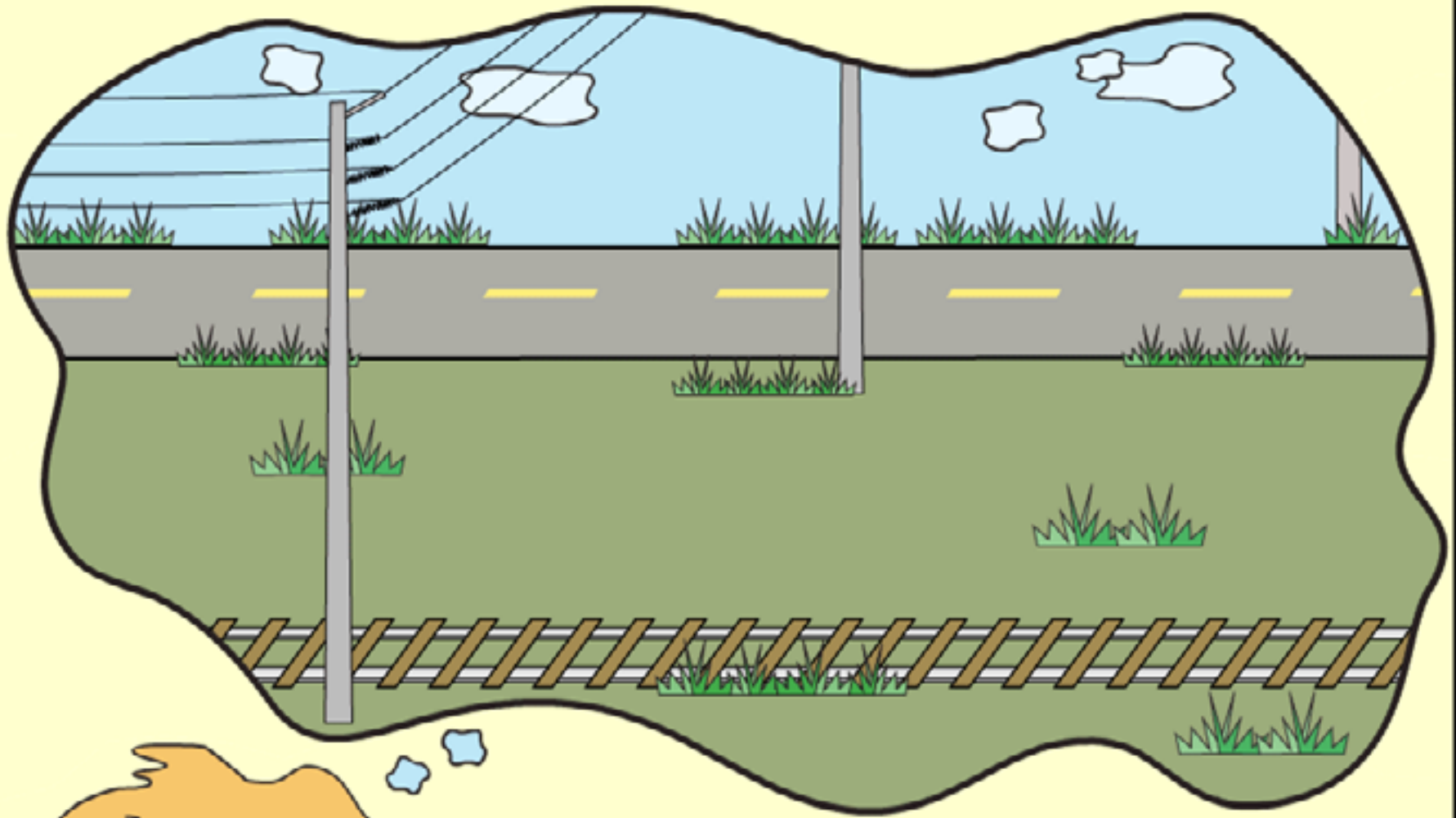


Built Perspective



- Economic Development
- Homeowners Associations
- Heritage Council
- Farm Bureau
- League of Cities
- Office of Archeology
- State Historic Preservation
- School Boards Association
- Utility Reps.

Engineering Environment

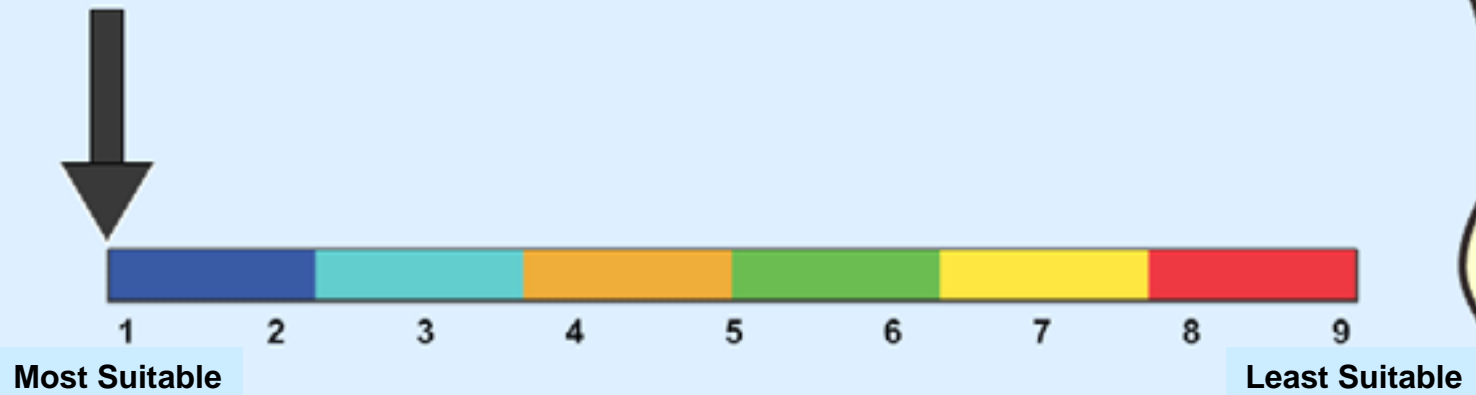


Engineering Perspective

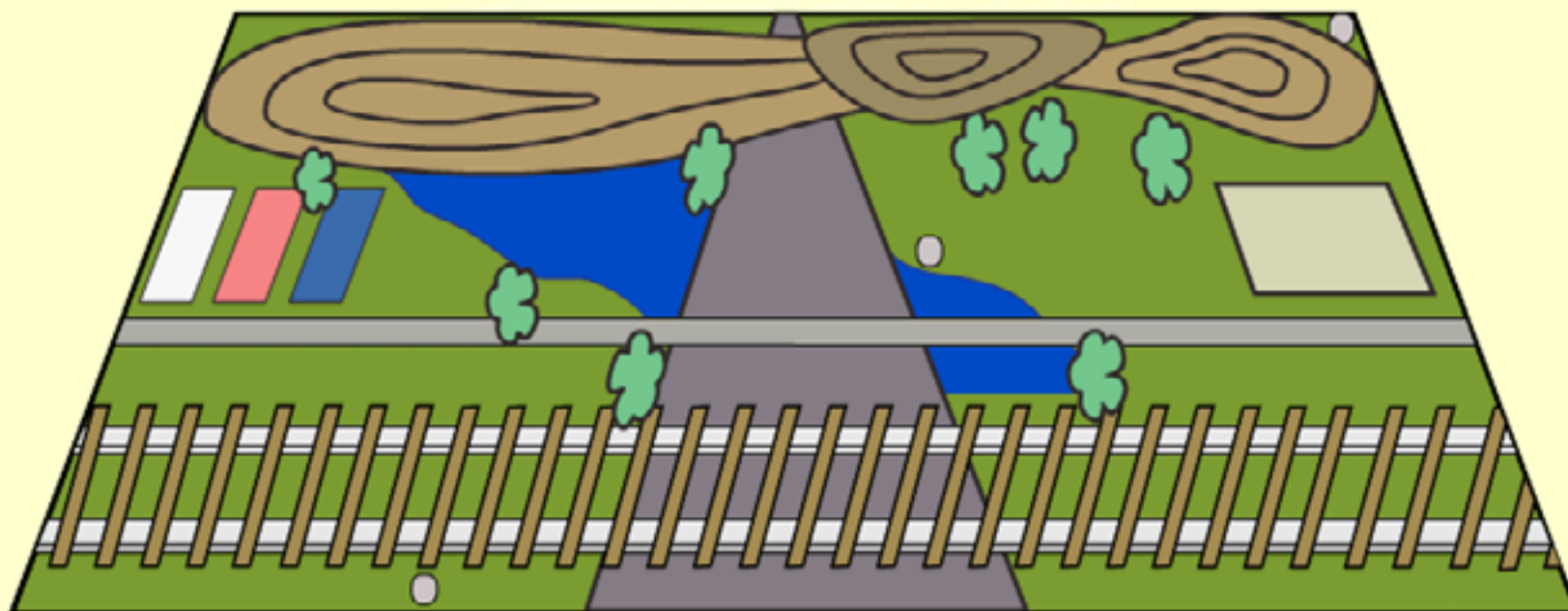
- DOT
- Railroad
- Pipeline
- Utility



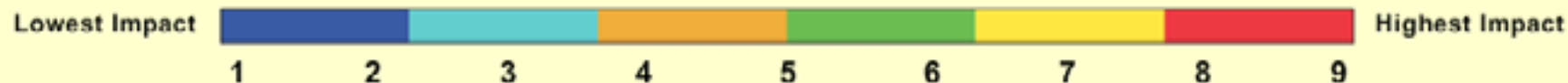
Suitability Values



Suitability Analysis



Suitability Values



Routing Across Preference Surface

- ➡ Built
- ➡ Natural
- ➡ Engineering
- ➡ Simple



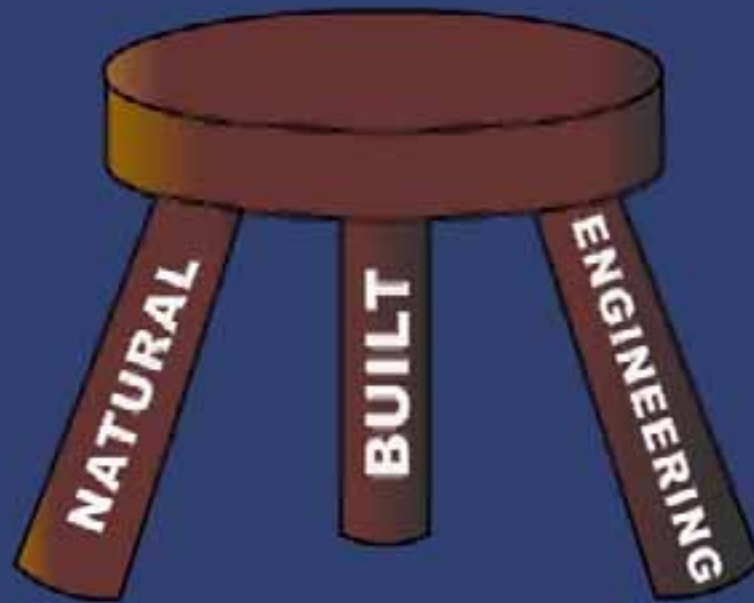
Alternative Corridors

- ➡ Built
- ➡ Natural
- ➡ Engineering
- ➡ Simple
- ➡ All



The Alternative Corridors are derived by considering the top 3% percent of the best routes within the project area.

Alternative Perspectives



Natural Perspective

<i>Natural Environment</i>			
Floodplain	6.2%	Protected Lands	16.0%
Background	1	Background	1
100 Year Floodplain	9	Maryland Green Infrastructure	2
Streams/Wetlands	20.9%	Land Zoned Conservation	3
Background	1	Other Conservation Land	8.3
Streams < 5cfs+ Regulatory Buffer	5.1	Chesapeake Bay Critical Area	8.3
Tidal Stream <5cfs+ Regulatory Buffer	5.1	WMA	9
Non-forested Non-Tidal Wetlands a+ 30'	6.1	Land Cover	20.9%
Rivers/Streams > 5cfs+ Regulatory Buffer	7.4	Open Land	1
Tidal Stream >5cfs+ Regulatory Buffer	7.4	Row Crops and Horticulture	2.2
Non-forested Tidal Wetlands a+ 30'	8.4	Developed Land	6.5
Forested Wetlands + 30' Buffer	9	Natural Forests	9
		Species of Concern Habitat	36.0%
		Background	1
		Potential Habitat	3
		Occupied Habitat	9

Built Perspective

Built Environment			
Proximity to Buildings	11.5%	Proposed Development	6.3%
Background	1	Background	1
900-1200	1.8	Proposed Development	9
600-900	2.6	Other Waterbodies	3.8%
300-600	4.2	Background	1
0-300	9	Spannable Waterbodies	9
Proximity to Cultural Resources	13.9%	Major Property Lines	8.0%
Background	1	Edge of field	1
0 - 1500	9	Landlots	7.9
Building Density	37.4%	Background	9
0 - 0.05 Buildings/Acre	1	Land Use	19.1%
0.05 - 0.2 Buildings/Acre	3	Undeveloped	1
0.2 - 1 Buildings/Acre	5	Non-Residential	3
1 - 4 Buildings/Acre	7	Residential	9
4 - 25 Buildings/Acre	9		

Engineering Perspective

<i>Engineering</i>	
Linear Infrastructure	53.1%
Parallel Existing Transmission Lines	1
Parallel Gas Pipelines	4.3
Parallel Railway ROW	4.8
Background	5.3
Future MDOT Plans	7.4
Road ROW	8.4
Scenic Highways ROW	9
Intensive Agriculture	46.9%
Background	1
Fruit Orchards	5
Center Pivot Agriculture	9

Avoidances

AVOIDANCE AREAS

Airports

EPA Superfund Sites

Non Span-able Waterbodies

State and National Parks

Military Facilities

City and County Parks

Mines and Quarries

Day Care Parcels

Cemetery Parcels

School Parcels (K-12)

Church Parcels

Wild/Scenic Rivers

Areas of Ritual Importance

Federal Wildlife Refuge

Buildings + Buffer

Alternative Corridor Model

Alternative Corridor Model (Draft 06/20/2008)

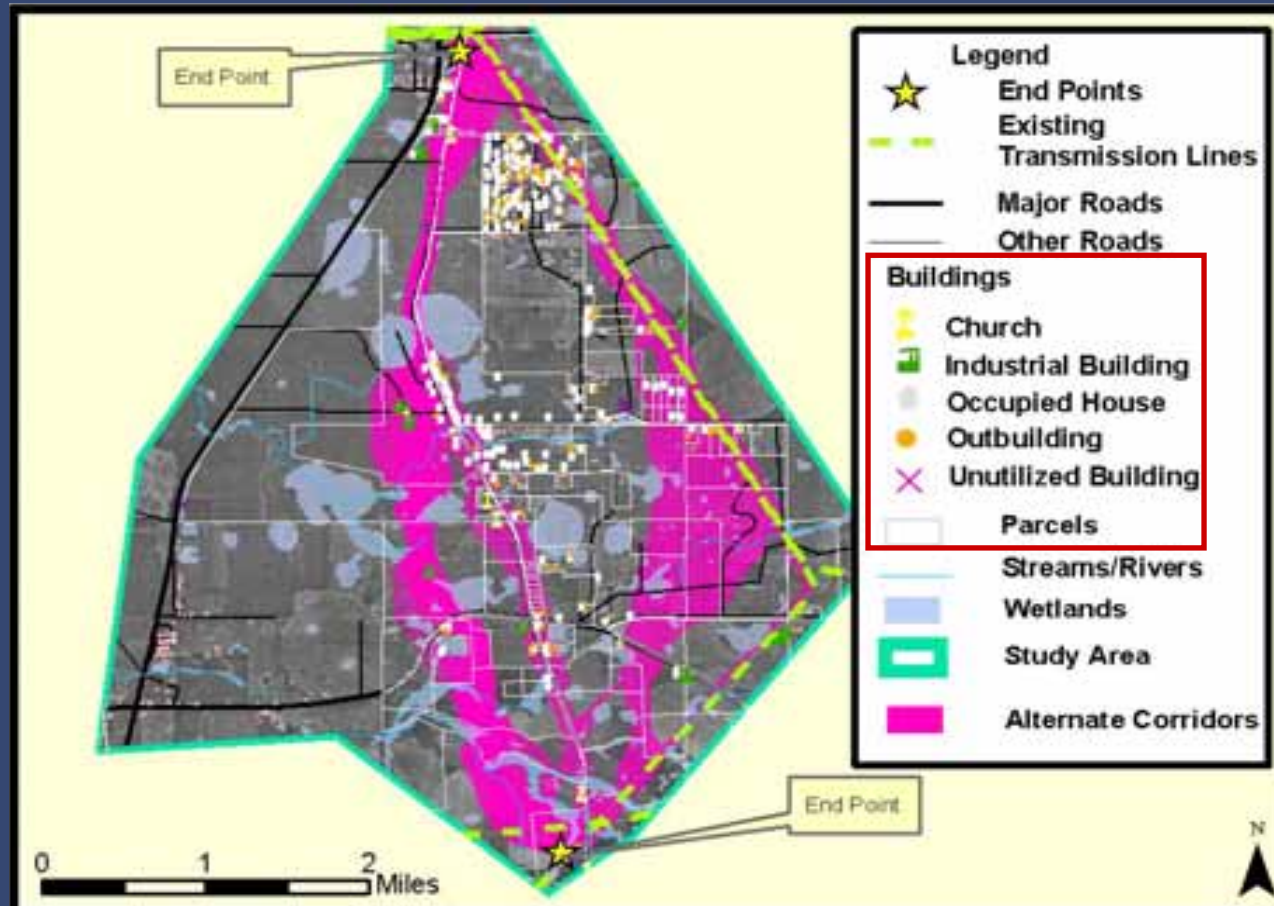
Engineering		Natural Environment		Built Environment		AVOIDANCE AREAS
Linear Infrastructure	53.1%	Floodplain	6.2%	Proximity to Buildings	11.5%	Airports
Parallel Existing Transmission Lines	1	Background	1	Background	1	EPA Superfund Sites
Parallel Gas Pipelines	4.3	100 Year Floodplain	9	900-1200	1.8	Non-spannable waterbodies
Parallel Railway ROW	4.8	Streams/Wetlands	20.9%	600-900	2.6	State and National Parks
Background	5.3	Background	1	300-600	4.2	Military Facilities
Future MDOT Plans	7.4	Streams < 5cfs+ Regulatory Buffer	5.1	0-300	9	City and County Parks
Road ROW	8.4	Tidal Stream <5cfs+ Regulatory Buffer	5.1	Proximity to Cultural Resources	13.9%	Mines and Quarries
Scenic Highways ROW	9	Non-forested Non-Tidal Wetlands a+ 30'	6.1	Background	1	Day Care Parcels
Intensive Agriculture	46.9%	Rivers/Streams > 5cfs+ Regulatory Buffer	7.4	0 - 1500	9	Cemetery Parcels
Background	1	Tidal Stream >5cfs+ Regulatory Buffer	7.4	Building Density	37.4%	School Parcels (K-12)
Fruit Orchards	5	Non-forested Tidal Wetlands a+ 30'	8.4	0 - 0.05 Buildings/Acre	1	Church Parcels
Center Pivot Agriculture	9	Forested Wetlands + 30' Buffer	9	0.05 - 0.2 Buildings/Acre	3	Wild/Scenic Rivers
		Protected Lands	16.0%	0.2 - 1 Buildings/Acre	5	Areas of Ritual Importance
		Background	1	1 - 4 Buildings/Acre	7	Federal Wildlife Refuge
		Maryland Green Infrastructure	2	4 - 25 Buildings/Acre	9	Buildings + Buffer
		Land Zoned Conservation	3	Proposed Development	6.3%	
		Other Conservation Land	8.3	Background	1	
		Chesapeake Bay Critical Area	8.3	Proposed Development	9	
		WMA	9	Other Waterbodies	3.8%	
		Land Cover	20.9%	Background	1	
		Open Land	1	Waterbodies	9	
		Row Crops and Horticulture	2.2	Major Property Lines	8.0%	
		Developed Land	6.5	Edge of field	1	
		Natural Forests	9	Background	9	
		Species of Concern Habitat	36.0%	Land Use	19.1%	
		Background	1	Undeveloped	1	
		Potential Habitat	3	Non-Residential	3	
		Occupied Habitat	9	Residential	9	

Alternative Corridor Model

Alternative Corridor Model (Draft 06/20/2008)

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Linear Infrastructure	53.1%	Floodplain	6.2%	Proximity to Buildings	11.5%	Airports
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		Occupied Habitat	9	Residential	9	

Additional Data for Alternative Route Delineation

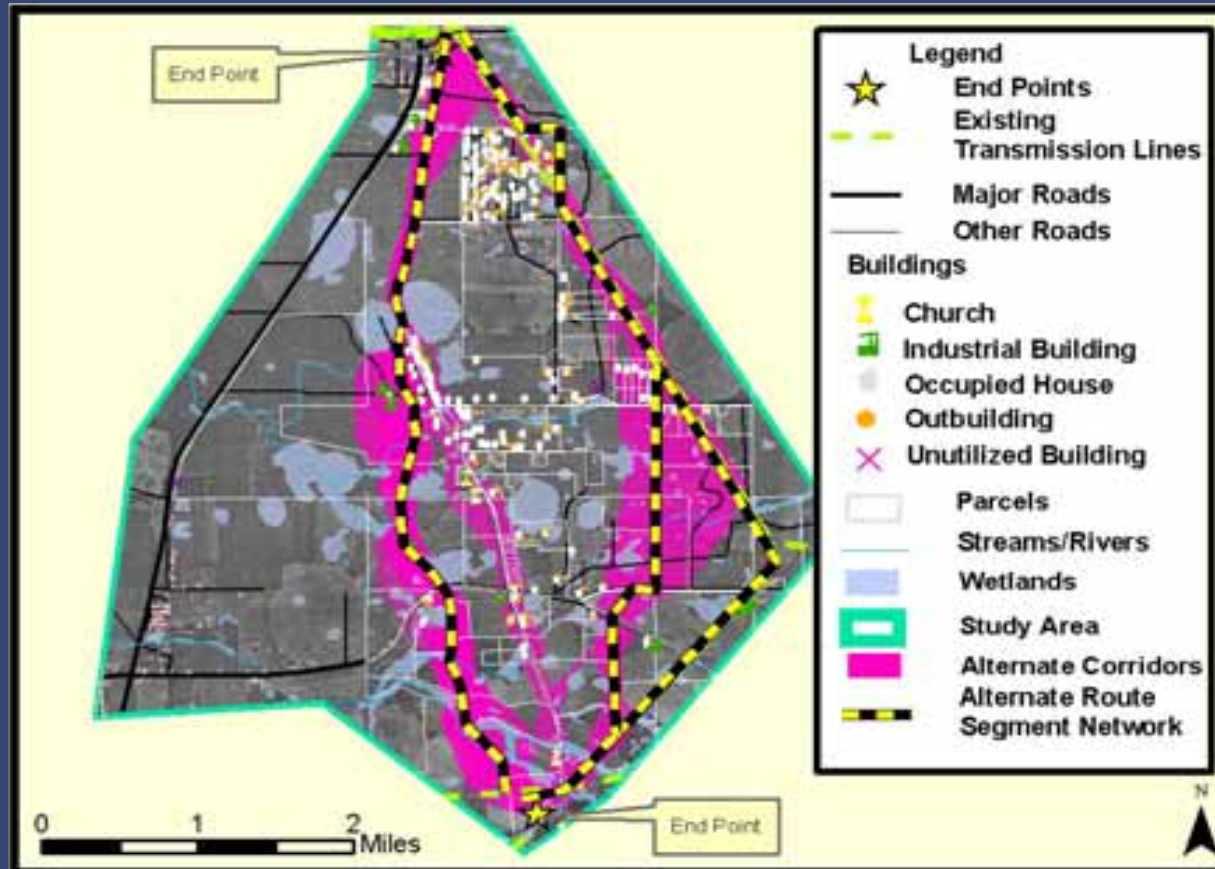


Data collection is focused within the Alternate corridors.

Windshield Surveys and Site Visits

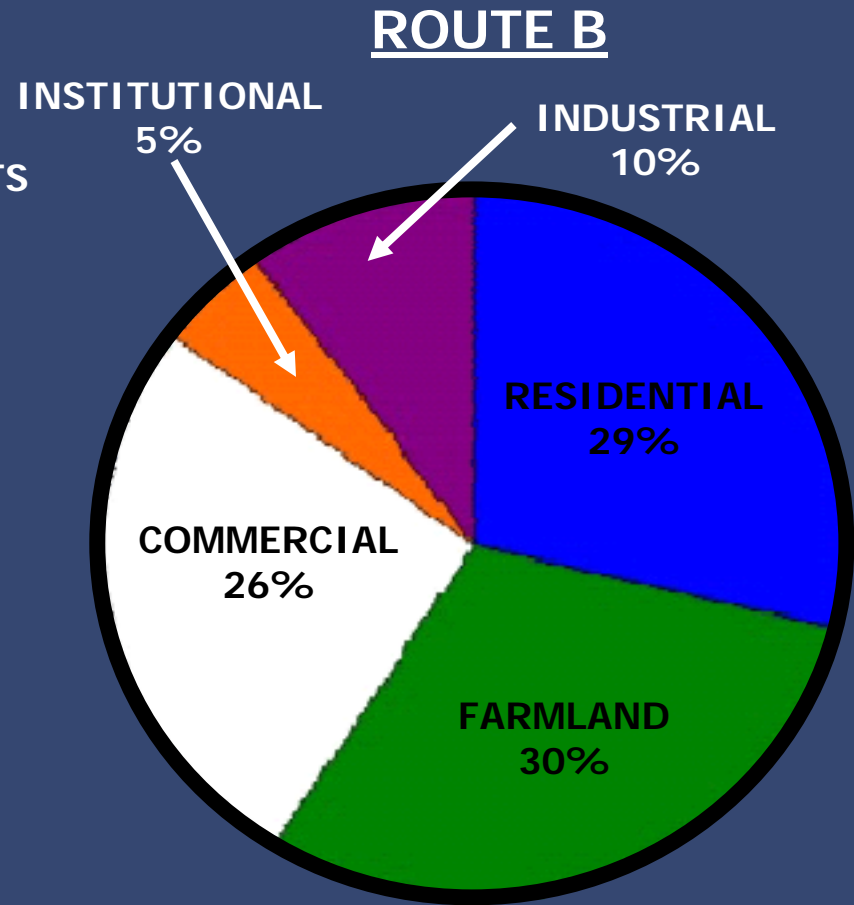
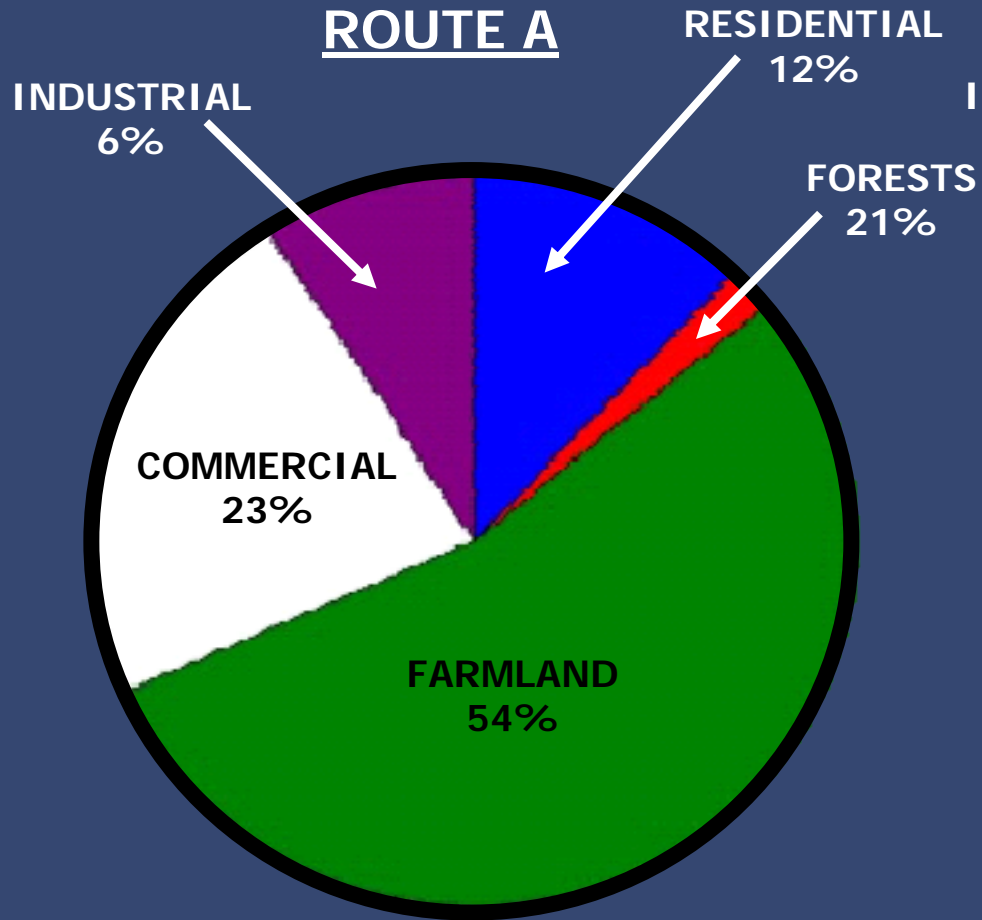


Alternative Route Network



A Route Network is based on segments derived from the optimal routes within each of the Alternative Corridors and routes drawn in manually by the project team.

Alternative Route Analysis



Alternative Route Evaluation Model

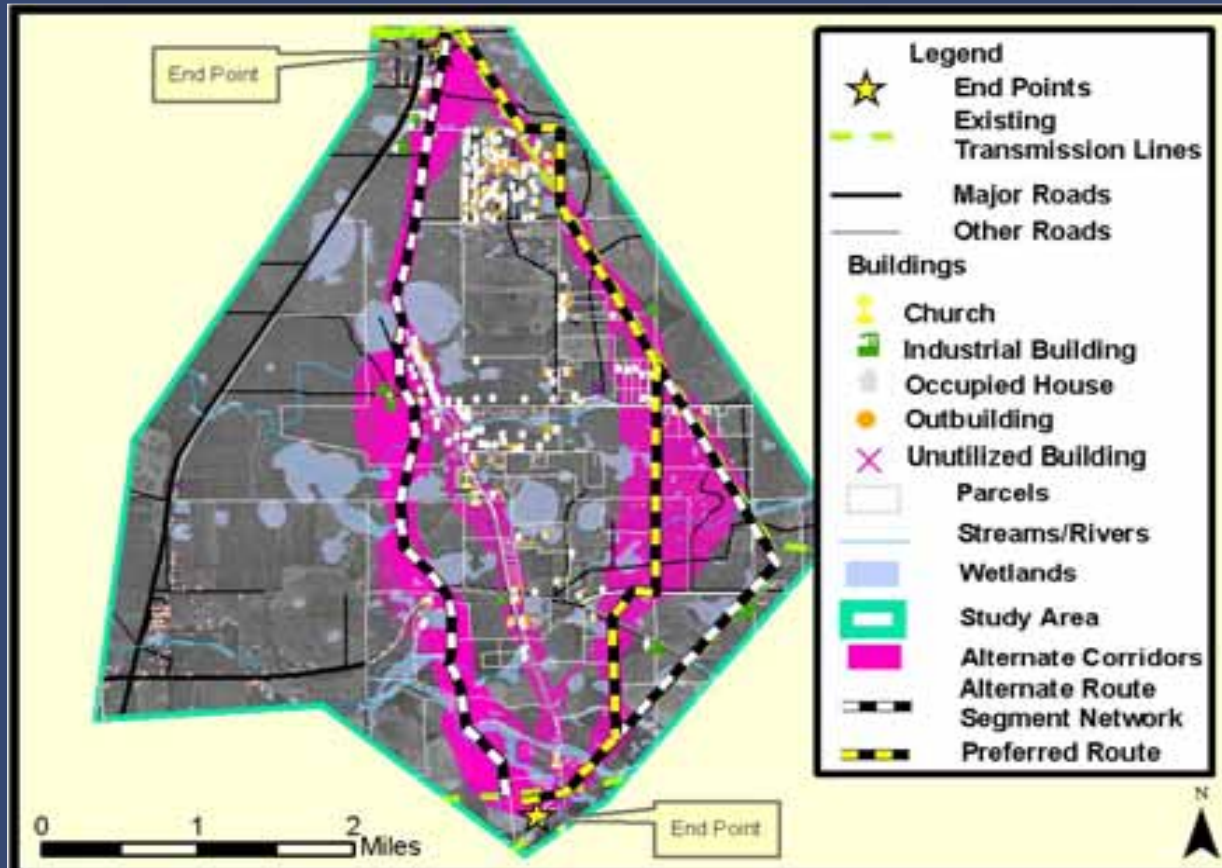
FOR ALL ROUTES	Sample Weights						
Built	33%	Route A	Route B	Route C	Route D	Route E	Route F
Feature		Unit	Unit	Unit	Unit	Unit	Unit
Relocated Residences (within 75' Corridor)	44.3%	0.00	0.00	1.00	0.00	1.00	0.00
<i>Weighted</i>		0.00	0.00	0.44	0.00	0.44	0.00
Proximity to Residences (300')	13.1%	0.00	1.00	0.25	0.13	0.28	0.16
<i>Weighted</i>		0.00	0.13	0.03	0.02	0.04	0.02

FOR ALL ROUTES	Sample Weights					
Built	33%	Route A	Route B	Route C	Route D	R
Feature		Unit	Unit	Unit	Unit	
Relocated Residences (within 75' Corridor)	44.3%	0.00	0.00	1.00	0.00	
<i>Weighted</i>		0.00	0.00	0.44	0.00	
Proximity to Residences (300')	13.1%	0.00	1.00	0.25	0.13	
<i>Weighted</i>		0.00	0.13	0.03	0.02	
Proposed Residential Developments	5.4%	0.00	0.00	0.00	0.00	
<i>Weighted</i>		0.00	0.00	0.00	0.00	
Proximity to Commercial Buildings (300')	3.6%	1.00	1.00	1.00	1.00	
<i>Weighted</i>		0.04	0.04	0.04	0.04	
Proximity to Industrial Buildings (300')	1.8%	0.33	0.00	0.00	0.00	
<i>Weighted</i>		0.01	0.00	0.00	0.00	
School, DayCare, Church, Cemetery, Park	16.3%	1.00	1.00	1.00	1.00	
<i>Weighted</i>		0.16	0.16	0.16	0.16	
NRHP Listed/Eligible Strucs./Districts (1500' from edge of R/W)	15.5%	1.00	0.50	0.00	0.00	
		0.16	0.08	0.00	0.00	
TOTAL	100.0%	0.36	0.41	0.67	0.22	

Expert Judgment Route Selection Model

FOR TOP 3-5 ROUTES (INTERNAL) EXPERT JUDGEMENT					
		Sample Weights			
	Per Project	Route A	Route B	Route D	
Visual Issues	10%	1	3	1	
Weighted		0.1	0.3	0.1	
Community Issues	20%	1	3	2	
Weighted		0.2	0.6	0.4	
Schedule Delay Risk	0%	0	0	0	
Weighted		0	0	0	
Special Permit Issues	40%	1	3	1	
Weighted		0.4	1.2	0.4	
Construction/ Maintenance Accessibility	30%	3	1	2	
Weighted		0.9	0.3	0.6	
Environmental Justice	0%	0	0	0	
Weighted		0	0	0	
TOTAL					
	100%	1.6	2.4	1.5	

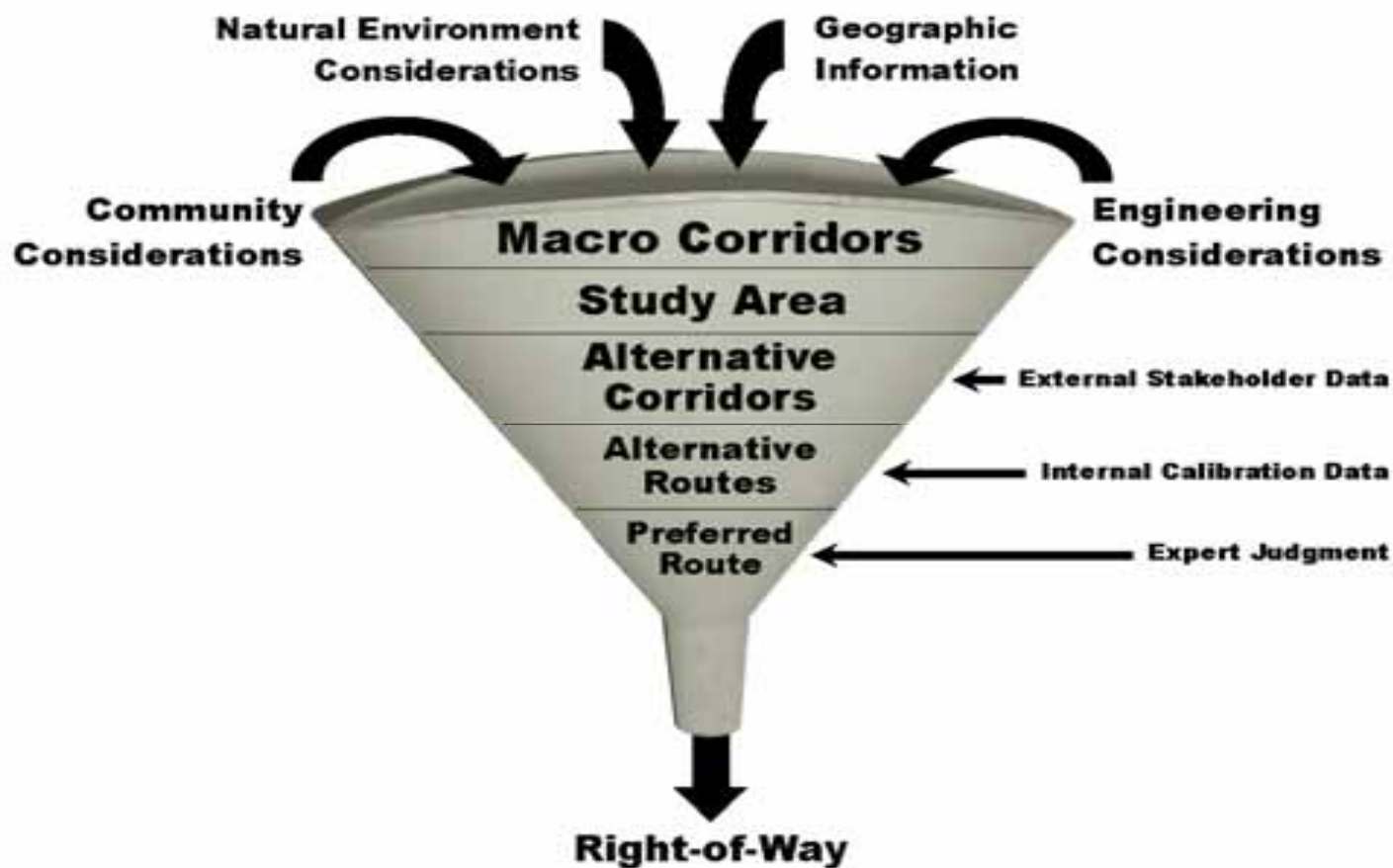
Preferred Route Selection



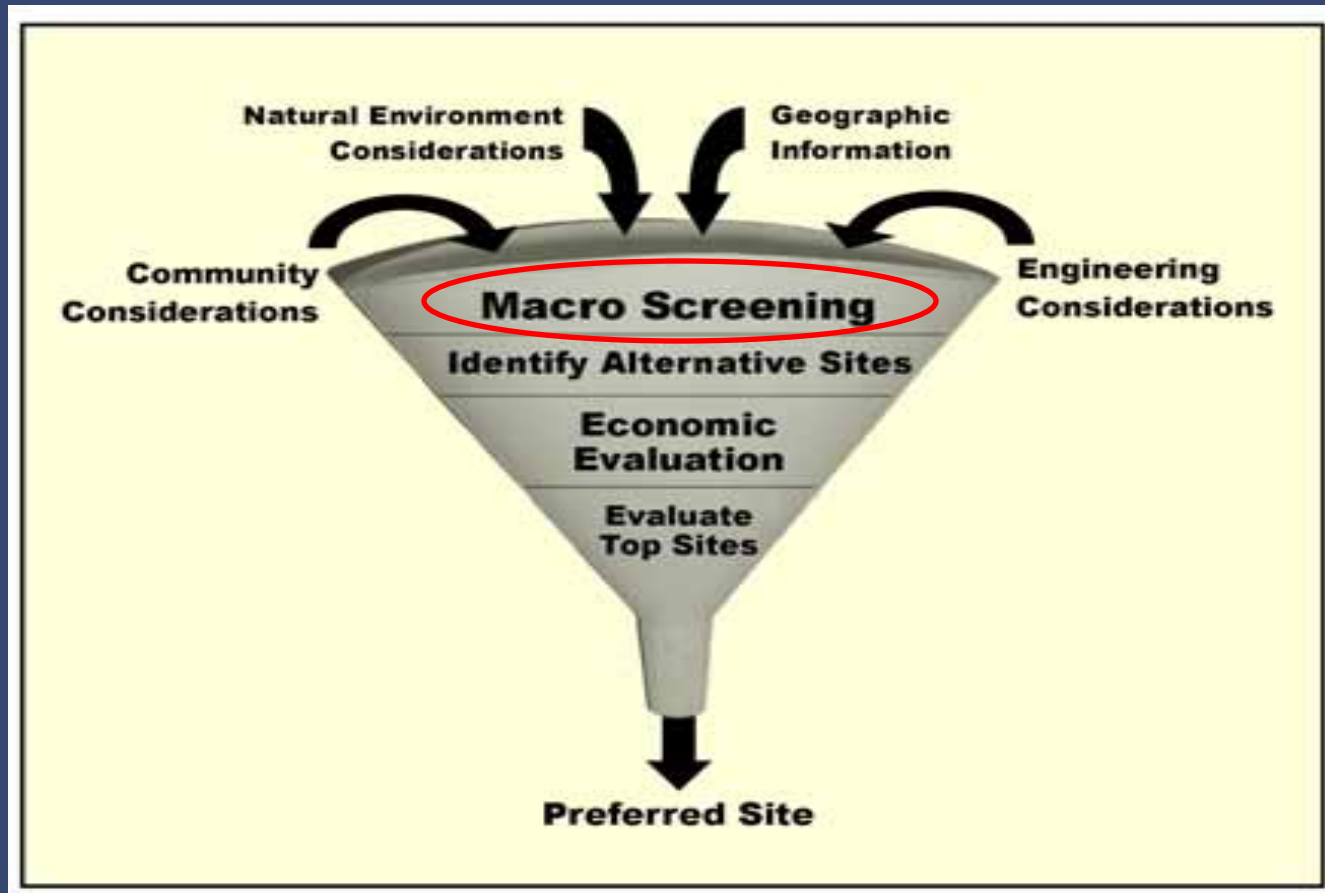
Preferred Route is a product of the siting methodology—

The best set of potential route segments considering Built, Engineering and Natural factors.

Corridor Analysis Funnel



Generation Siting Process Funnel




Generation Resources

- Simple Cycle
 - 600 MW
 - 900 MW
- Combined Cycle
 - 550 MW
 - 1100 MW
- Coal
 - 900 MW
 - 1800 MW

Study Inputs

- **Environmental**
 - Proximity to Ozone Non-Attainment Areas
 - Proximity to Class 1 Areas
 - Proximity to Existing Plants
 - Population Density
 - Land Use
 - Proximity to Sequestration

Study Inputs (Cont'd)

- **Water**
 - Surface
 - Grey Water
 - Groundwater
 - **Fuel Supply**
 - Rail or Gas Pipeline
 - **Transmission**
 - 500 and 230 KV Lines
- 

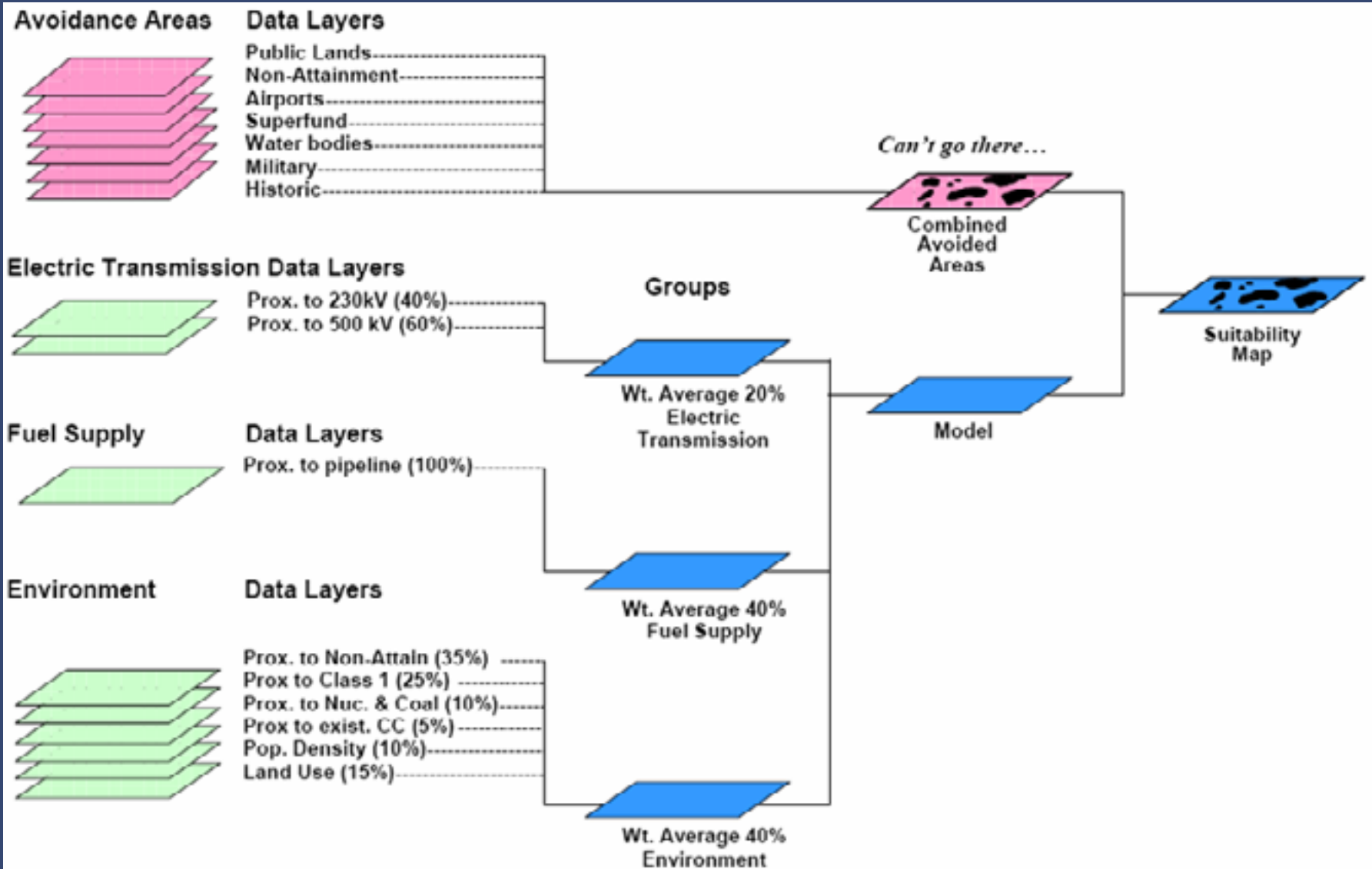
Study Inputs (Cont'd)

- **Avoidance Areas**
 - Public Lands (State/Federally Owned)
 - Ozone Non-Attainment Areas
 - Particulate Non-Attainment Areas
 - Airports
 - EPA Superfund Sites
 - Water bodies
 - Military Facilities
 - Listed NRHP Districts and Buildings

Sample Generation Model (1800 MW Coal)

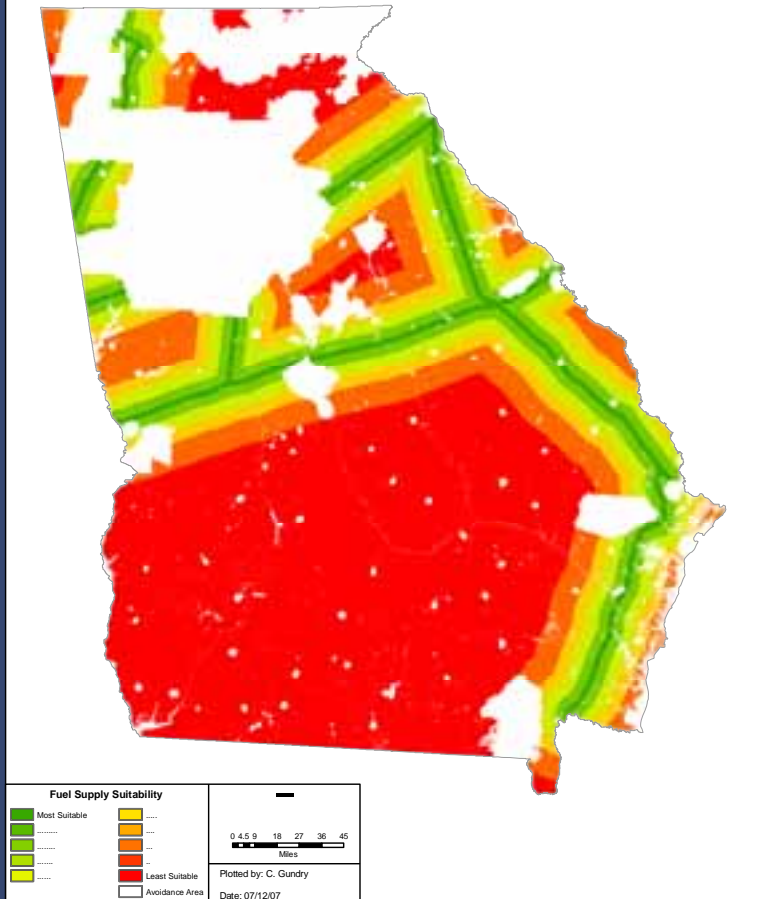
Electric Transmission		Water Supply		Fuel Supply		Environment	
	10%		35%		20%		35%
Proximity to 230 kV T/Ls	5.0%	Prox. - Viable Surface Water	70%	Proximity to Rail	100.0%	Areas of Ozone Restrictions	30.0%
0 - 1 miles	1	Proximity to High Suitability	70.0%	0 - 1 miles	1	No ozone restrictions	1
1 - 5 miles	3	0 - 1 miles	1	1 - 5 miles	3	Macon Maintenance Area	9
5 - 10 miles	5	1 - 5 miles	3	5 - 10 miles	5	Area of influence	9
10 - 15 miles	7	5 - 10 miles	5	10 - 15 miles	7	Catoosa County Early Action Comp	9
15 - 25 miles	8	10 - 15 miles	7	15 - 25 miles	8	Proximity to Class 1 Areas	30.0%
> 25 miles	9	15 - 25 miles	8	> 25 miles	9	> 200 km	1
Proximity to 500 kV Trans Lines	95.0%						
0 - 1 miles	1	> 25 miles	9			100 - 200 km	5
1 - 5 miles	3	Proximity to Med Suitability	20.0%			10 - 100 km	8
		0 - 1miles	1			0 - 10 km	9
5 - 10 miles	5	1 - 5 miles	3			Proximity to Existing Coal and Nuclear Plants	10.0%
10 - 15 miles	7	(Data removed for space)				> 30 miles	1
15 - 25 miles	8	> 25 miles	9			10 - 30 miles	5
> 25 miles	9	Proximity to Low Suitability	10.0%			0 - 10 miles	9
		0 - 1miles	1			Proximity to Existing CC Plants	5.0%
		1 - 5 miles	3			> 30 miles	1
		(Data removed for space)				10 - 30 miles	5
		> 25 miles	9			0 - 10 miles	9
		Proximity to Gray Water	20.0%			Population Density	5.0%
		Small (0 - 5 MGD)	2.0%			< 0.3 people per acre	1
		0 - 1miles	1			(Data removed for space)	
		1 - 5 miles	3			> 2.5 people per acre	9
		(Data removed for space)				Land Use	10.0%
		> 25 miles	9			Open Land	1
		Medium (5.1 - 10 MGD)	8.0%			Agriculture	3
		0 - 1miles	1			Surface Mining	5
		1 - 5 miles	3			Wetlands	9
		(Data removed for space)				Urban	9
		> 25 miles	9			Proximity to carbon sequestration areas	10.0%
		Large (> 10.1 MGD)	90.0%			< 1 miles	1
		0 - 1miles	1			1 - 10 miles	3
		1 - 5 miles	3			(Data removed for space)	
		(Data removed for space)				> 200 miles	9
		> 25 miles	9				
		Proximity to Groundwater	10.0%				
		Groundwater Area	1				
		No Groundwater Area	9				
AVOIDANCE AREAS							
Public Lands (State / Federally Owned)		0 - 1miles	1				
Ozone Non - Attainment Areas		1 - 5 miles	3				
Particulate Non-Attain. Areas		(Data removed for space)					
Airports-with buffer		> 25 miles	9				
EPA Superfund Sites		Medium (5.1 - 10 MGD)	8.0%				
Waterbodies		0 - 1miles	1				
Military Facilities		1 - 5 miles	3				
Listed NRHP Districts & Bldgs		(Data removed for space)					
		> 25 miles	9				
		Large (> 10.1 MGD)	90.0%				
		0 - 1miles	1				
		1 - 5 miles	3				
		(Data removed for space)					
		> 25 miles	9				
		Proximity to Groundwater	10.0%				
		Groundwater Area	1				
		No Groundwater Area	9				

Sample Suitability Analysis Layers (600 MW CT)

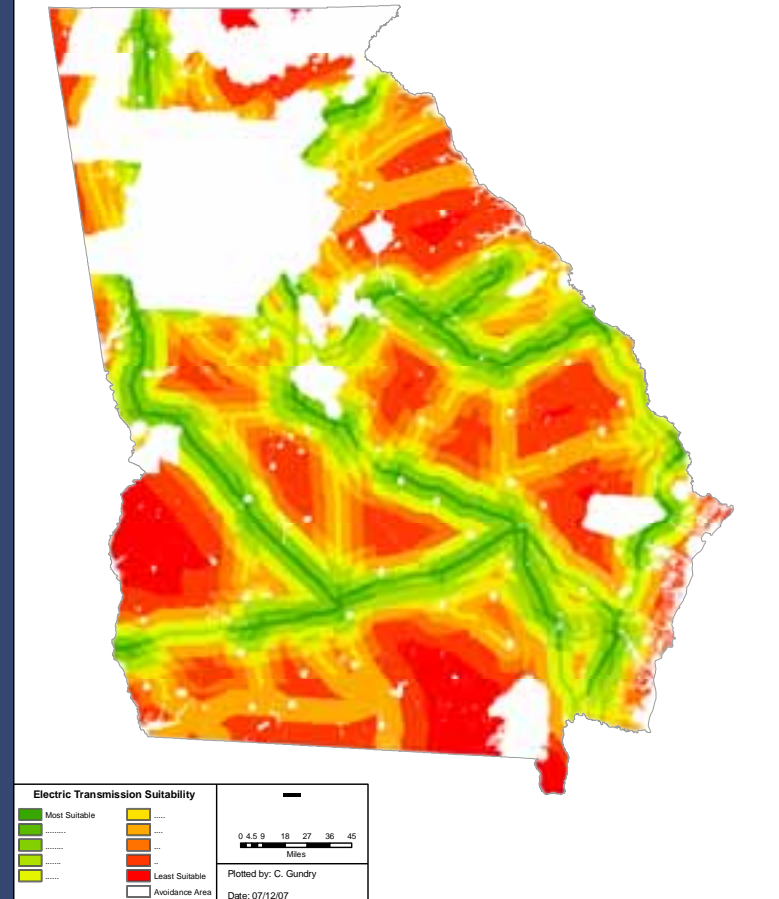


Example 550 MW Combined Cycle Plant

550 MW Combined Cycle - Fuel Supply Suitability -

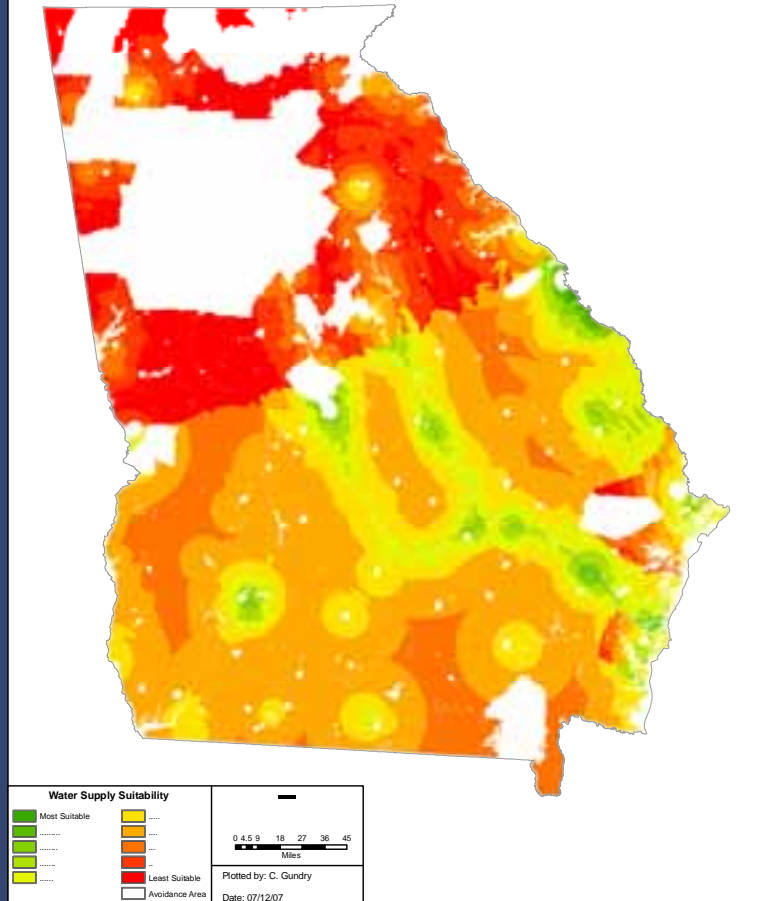


**550 MW Combined Cycle
- Electric Transmission Suitability -**

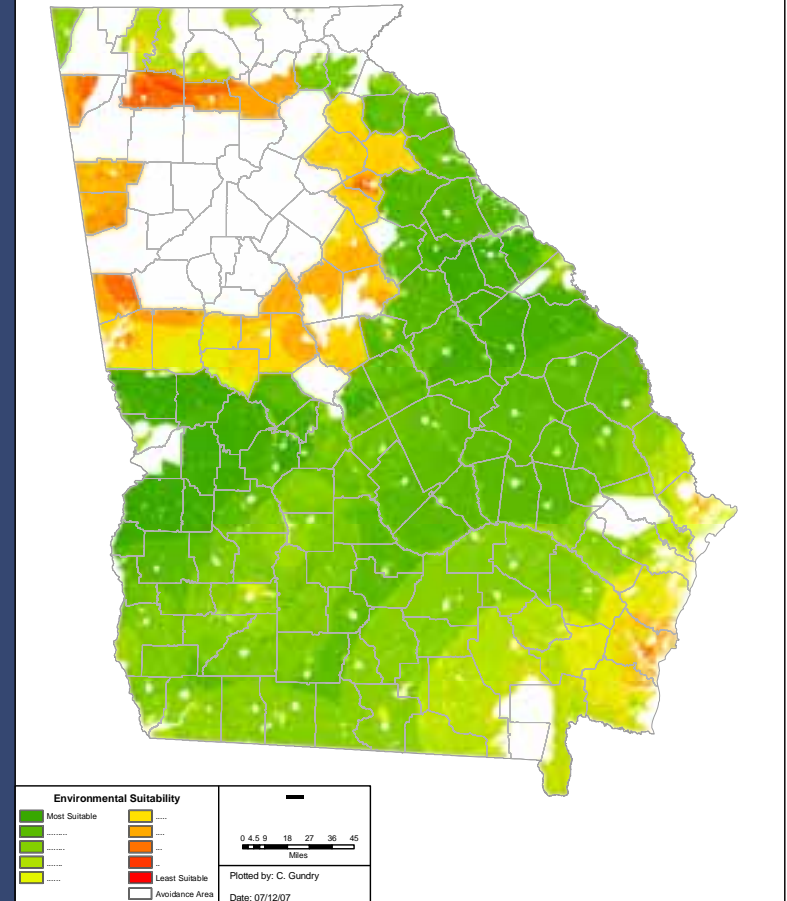


Example 550 MW Combined Cycle Plant (Cont'd)

**550 MW Combined Cycle
- Water Supply Suitability -**

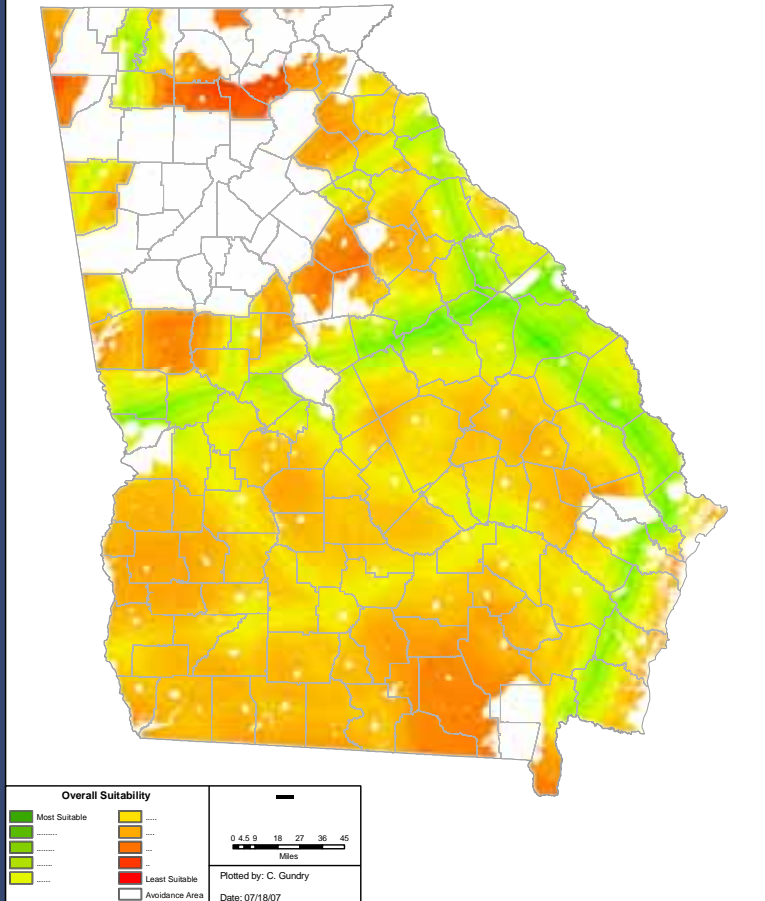


**550 MW Combined Cycle
- Environmental Suitability -**

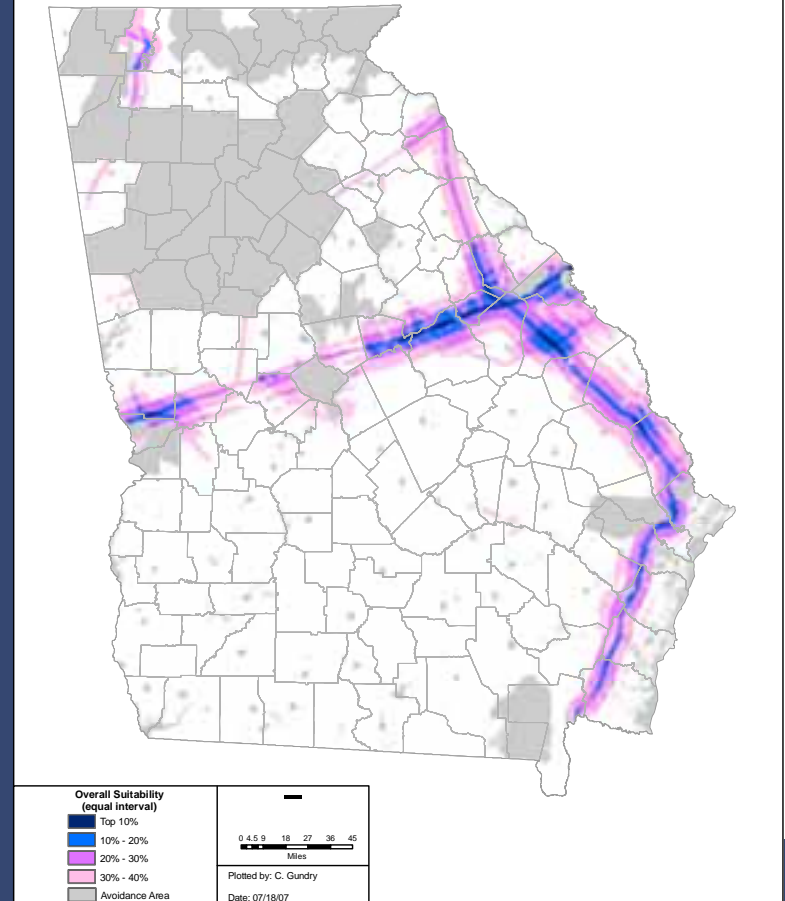


Example 550 MW Combined Cycle Plant (Cont'd)

**550 MW Combined Cycle
- Overall Suitability -**

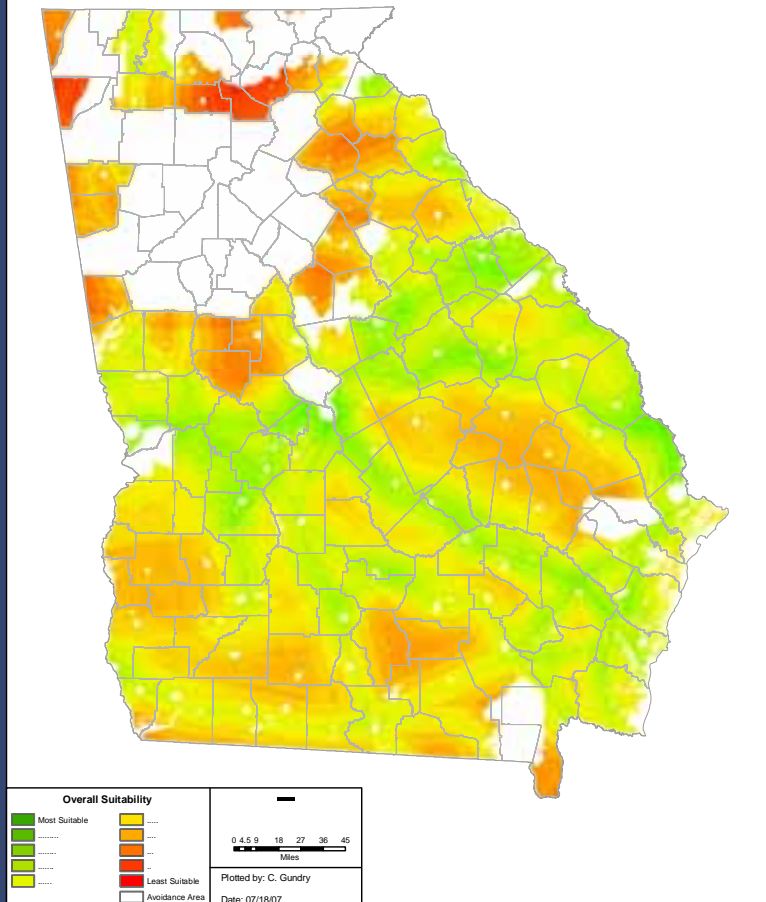


**550 MW Combined Cycle
- Top 40% of Suitability Values -**

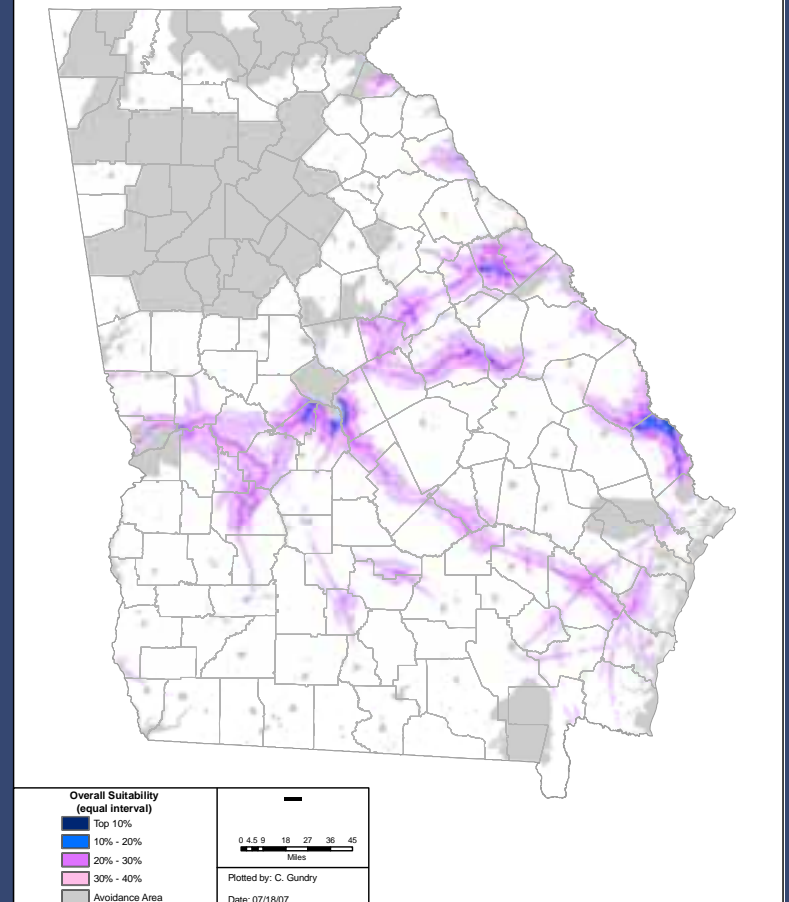


1800 MW Coal

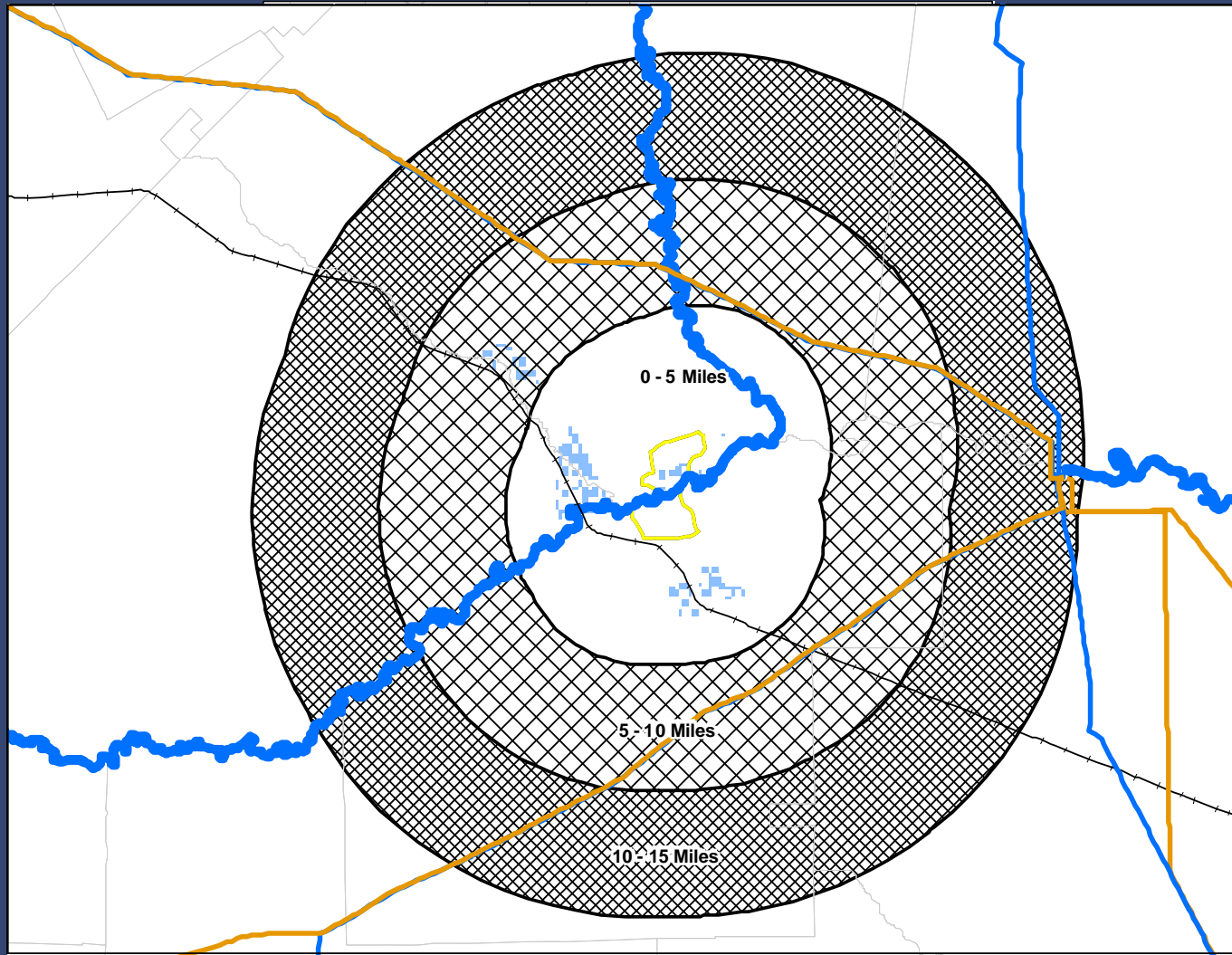
**1800 MW Coal
- Overall Suitability -**



**1800 MW Coal
- Top 40% of Suitability Values -**



Focus Area Demonstration



MillionMile Greenway™


Conserve, Connect...One Mile at a Time




Methodology Used By:

- **Big Rivers Electric** (Kentucky)
- **Dominion** Virginia Power
- **East Kentucky** Power
- **E.ON-U.S** (Kentucky)
- **Exelon** (Texas)
- **Georgia Power** Company
- **Georgia Transmission** Corporation
- **Bluegrass Water Supply** Consortium (Kentucky)
- **MillionMile Greenway**
- **Oglethorpe Power** Corporation (Georgia)
- **Pepco Holdings, Inc.** (Maryland)
- **Vectren** (Indiana)
- **SWCA** Environmental Consultants (Oregon)
- **Korean Power** Engineering Company
- Others...

The EPRI -GTC Siting Methodology:

- Produces Routing Decisions that are Quantifiable, Consistent, and Defensible.
 - Improves productivity and analytical capabilities.
 - Reduces Risks by public, political, regulatory and legal scrutiny.
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Conclusion

- There is a need for an **objective, transparent, inclusive, and consistent** methodology.
 - Photo Science, Georgia Transmission, and EPRI have developed a **defendable** methodology to meet this need.
 - Methodology earned GTC the CRN Innovators Award in 2006
 - Suitability modeling is used for linear and non-linear facilities
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Questions?

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