

MISSION ASSURANCE  
**MAD**  
DIVISION



*“Forewarned...Forearmed”*

Infrastructure Decision Support  
for Government and Industry



Naval Surface Warfare Center  
Dahlgren Division

**NSWCDD**

# Applying Interdependencies Using the 5 Ws

## *DoD Energy Issues: A Perspective*

*Regional Energy Critical Infrastructure Resiliency  
Conference*

*Pittsburgh, PA*

*October 29-31, 2007*



# Outline

- MAD Organization and Capabilities
- Why Energy Is Important to DoD?
- Power Vulnerabilities to the DoD Mission
- Alternative Fuel/Electricity Potentials
- Current Processes
- DoD Energy Strategy Issues
- Approach to Managing Risk
- Risk and Interdependencies (5 Ws)



# Our Work

- Make the Country's infrastructures more resilient to natural/terrorist threats & attacks
- DoD Support to Civil Authorities
- Enable quick mission recovery after an attack
- Support decision makers using solutions oriented analysis
- Representative customers
  - US Department of Defense
  - US Department of Homeland Security
  - US State Department
  - State Governments
  - US Secret Service
  - NASA





# MAD Evolution

Joint Program Office for Special Technology Countermeasures

**JPO-STC**

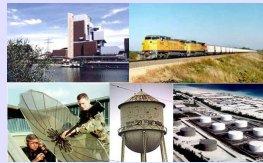


Established **Sept. 1988** by direction of USD(A), with Navy as Executive Agent

Special Technology Vulnerability Assessments of Blue Force Systems



Commercial Infrastructure Nodal Analysis



Defense Program Office for Mission Assurance

**DPO-MA**



Established **Oct. 2003** by direction of ASD(HD)

Mission Assurance-Focused Decision Support To Combatant Commanders



Commercial Infrastructure Nodal Analysis



Mission Assurance Division

**MAD**



Established **Sept. 2005** as ASD(HD) designated Center of Excellence

Critical infrastructure analysis for DoD, federal, state, and local agencies





# MAD Partnerships



NORTHCOM



Naval Surface Warfare Center/  
Mission Assurance Division



DTRA  
JSIVA/BSA



Navy  
NIVA



CIFA



JITF-CT



Raytheon

BAE SYSTEMS



National  
Geospatial  
Intelligence  
Agency



Surface Deployment &  
Distribution Command

ARINC

National  
Communications  
Systems



Booz | Allen | Hamilton





# Our People

- Business
- Engineering
  - Chemical
  - Civil
  - Communications
  - Computer
  - Electrical/Electronic
  - Industrial
  - Mechanical
  - Nuclear
  - Petroleum
  - Systems
- Finance
- Geography
- Humanities
- Information Technology
- Management
- Mathematics
- Military Technology
- Modeling & Simulation
- Operations Research
- Physical Sciences
- Project Management





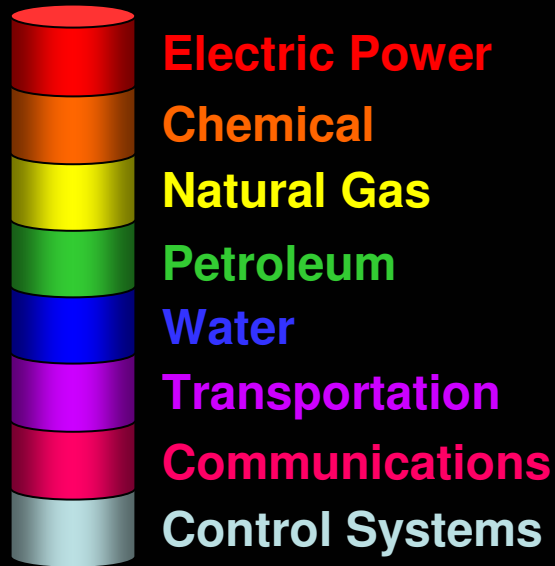
# Core Capabilities

- Mission Area Analysis support – *What am I required to do, and what do I do it with?*
- Conduct infrastructure characterization – *What infrastructure supports my requirements?*
- Commercial network mapping and analysis (e.g., EP, NG/POL, Trans, Water, Communications, Chemical, Mail) – *Connecting the dots, identifying the networks*
- Identification of intra/inter-dependencies – *How are they linked together...determining what's really critical to support our mission?*
- Assessments for verification/validation of data and identification of vulnerabilities
- Integration of results from disparate sources – *What's the overall picture...where's my greatest risk?*
- Provide analysis and products through Situational Awareness Technologies – *Information for the decision makers*
- Situational Awareness Technologies (SAT) development and implementation – *Developing tools to support the decision makers*

***Holistic Systems Engineering, Analysis, Integration,  
& Technology Development***



# Infrastructure Network Focus

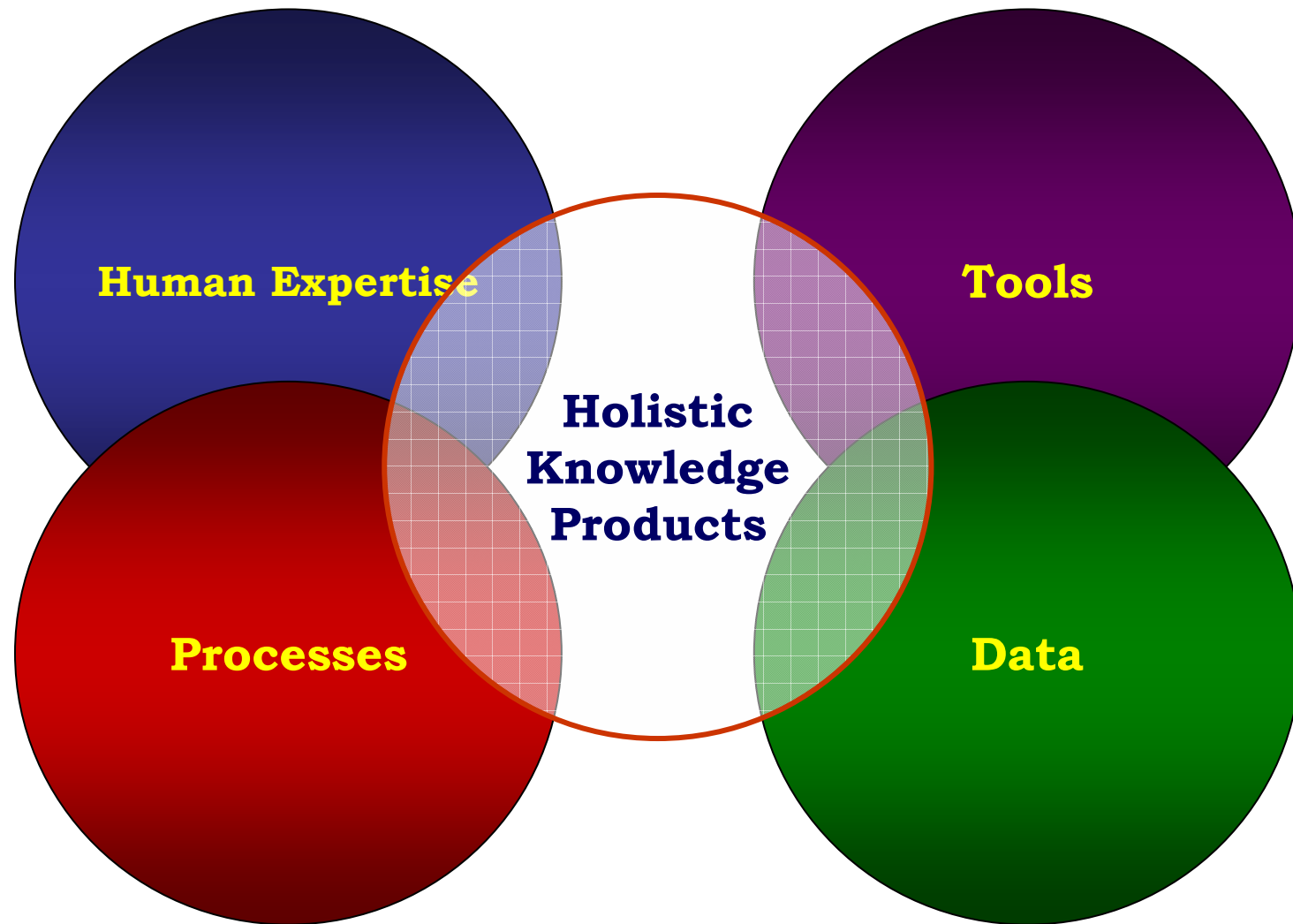


- Civilian and Military Impact
  - Commercial Infrastructures
    - 8 Major Areas
  - Defense Infrastructures
    - 10 DoD Sectors (including DIB)
  - Global Scope
  - Networked vs. Asset Approach
- Single Point of Failure Identification
  - Mission Linking & Impact Analysis
  - Infrastructure Network Analysis
  - Vulnerability Identification
  - Supply to End User Analysis
  - Nodal Analysis
  - Global Military Base Assessment
  - Government Facility Assessment
  - Industry Collaboration
  - DoD & Government Collaboration
  - DoD & National Exercise Support
  - Tool Development
  - Data Integration
  - Database Design & Development
  - Imagery Integration & Analysis
  - Predictive Analysis





# Capabilities Approach





# Product Examples

## Country Assessments

- Sensitive information (18)

## NSSEs

- Super Bowl XXXVIII
- G-8 Summit
- Daytona 500
- DNC – Boston
- RNC – NYC
- Presidential Debates
- Vice Presidential Debate
- Presidential Inauguration
- State of the Union Address

## Assessments

- Port of Morehead City
- Port of Long Beach
- Japan (multi sites)
- Korea (multi sites)
- Ramstein
- Camp Lejuene
- MCAS Yuma
- Navy Southeast Region
- Navy Southwest Region
- Port Elizabeth, NJ
- Port of Philadelphia
- NSA Norfolk
- Bangor IAP, ME

## State Reports

- Pennsylvania
- Virginia
- Maryland
- Alabama
- Alaska
- Florida
- Minnesota
- California
- Colorado
- New York
- West Virginia
- Washington
- South Carolina
- Georgia
- Texas
- Indiana
- Maine
- North Carolina
- Ohio

## Contingency/ Quick Turn Around

- Hurricane Impacts on FL (OASD)
- Top Four CIP States (OASD)
- Underwater Infrastructure Protection (OASD)
- Stolen Sensitive Information (NORTHCOM)
- Savannah, GA Assessment (NORTHCOM)
- Urban Area Security Initiative City List (DHS)
- Washington, DC Analysis (NORTHCOM)
- El Paso, TX, POE (NORTHCOM)
- Golden Gate Bridge Threat Analysis (NORTHCOM)
- Fairfield, Illinois GIG Assessment (DISA)
- Everglades Pipeline System Analysis (DHS)
- West Coast Cable (TRANSCOM)
- LNG in Trinidad & Tobago (SOUTHCOM)
- Global Energy Decisions Review (OASD)
- Hurricane Katrina Support (OASD, NC)
- Hurricane Rita Support (OASD, NC)
- Heartland Rivers Analysis (TRANSCOM)

## Contingency/ Quick Turn Around

- Reagan Funeral (NORTHCOM)
- Explosive Analysis of RR Bridges (NORTHCOM)
- Nellis/Indian Springs (DISA)
- California Wildfires (NORTHCOM)
- Ricin Incident (ASD(HD))
- European Rail (EUCOM)
- Lake Michigan (ASD(HD))
- NDW Waterways (ASD(HD))
- Haiti (x2) (SOUTHCOM)
- Telecoms Hotels (DISA)
- U.S. Army Critical Assets (ASD(HD))
- Financial Infrastructure Threat (ASD(HD))
- NCAA Final Four (NORTHCOM)
- Air Base Analysis (Nuclear Capable) (NORTHCOM)
- Pentagon Power Analysis (ASD(HD))
- Waco, Texas Energy (ASD(HD))
- Foreign Nuclear Power Plants (PACOM)
- Texas Critical Assets (ASD(HD))
- Other Classified Tasks
- Typhoon Man-Yi (PACOM)



# MAD's Experience

- The MAD has been engaged in Infrastructure/ Mission Assurance (IA) since 1994.
  - Predominately focused on CONUS infrastructures until 2002
- There are many vulnerabilities.
  - The nature of the CONUS electric power grid presents many targets for disruption
  - DoD installations often depend on a single substation, either inside or outside the fence
- The “low-hanging fruit” has been exhausted.
  - Most easy, low cost solutions have been applied
  - Most obvious vulnerabilities have been identified; e.g., the first point outside the fence
- “The List” is time- and scenario-dependent.
- Regardless of the ***threat***, vulnerabilities exist.



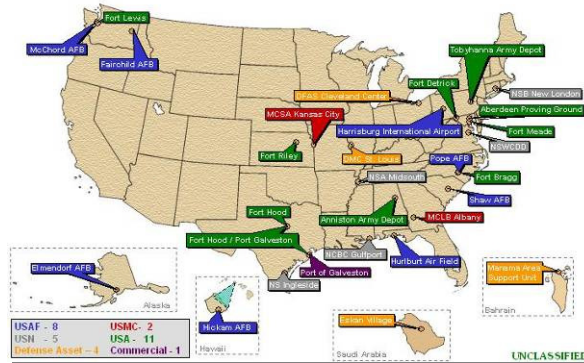
WHAT IT TAKES:

# Doing the "Homework"

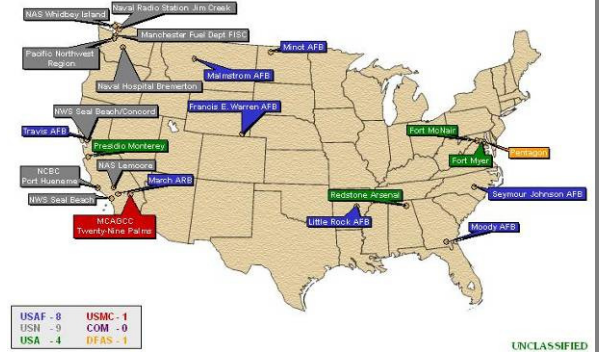
FY98 & prior



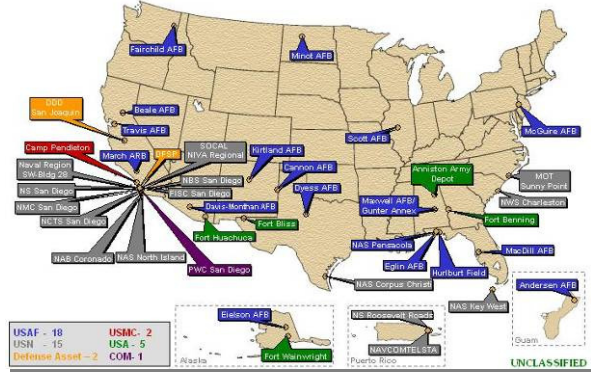
FY99



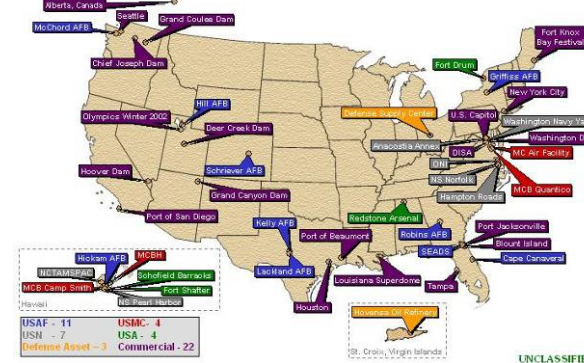
FY00



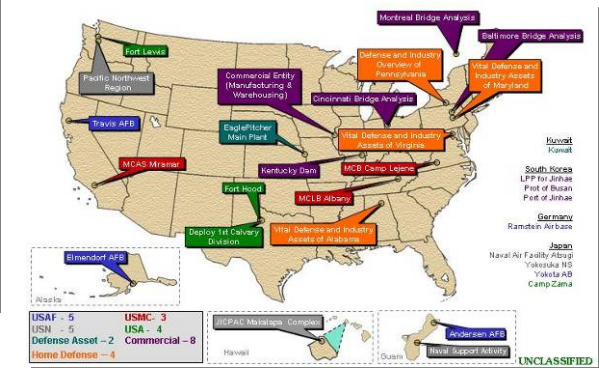
FY01



FY02



FY03



Over 400 Completed Assessments  
Inside and Outside the Fence



# Nature of CONUS Infrastructure

- Designed and Operated to Provide Value to Shareholders
- Complex Interdependencies
  - e.g., 2003 Northeast Blackout Impacts on Cleveland Water System
- Aging Transmission Systems Built for Peaceful Times and Slower Growth
- Stressed by Market Demands
- Reliability Standards Not Mandatory or Enforced
  - DoD Has Little Influence to Date
- Source and Transport Mechanisms Frequently Located in Remote, Vulnerable Locations

***No Experience With Long-term Outages (> 6 months)***



# Issues

- Electric Power – “The Grid”
  - Limited Resiliency in Electric Power Grid
  - Complex Interdependencies – Virtually Every Aspect of Society Depends on Electric Power
  - **All** DoD Missions/Activities Are Energy-dependent
  
- Electric Power Infrastructure Is Soft Target With Numerous Vulnerabilities
  - Physical Attacks (e.g., Transformer Destruction/Damage)
    - Minimal Input – a Bullet – Can Achieve Maximum Effect – Transformer Destruction
    - Insufficient Back-up Transformer Availability to Respond to Large-scale Attack
  - Electromagnetic Pulse (EMP)
  - Cyber Attacks
  
- Prevention Possible, but CHALLENGING
  - Short-, Medium-, and Long-term Mitigation Options Available
  - Continued Testing/Research Required to Fully Understand Risks/Vulnerabilities



# How Easily Is Electricity Disrupted?

Cause	Usual / Target	Impact	Risk / Duration
1 Tree branch	Line	Power loss, water system contamination	Regional blackout/3 days
Heat wave	Line, substation equipment	Power loss, premature aging of equipment	Rotating blackouts/2 hours
Hurricanes/ tornadoes	Line, substation, equipment, power plant	Power loss, water contamination, transportation	3 – 60 days (Katrina)
Market Manipulation	Unscheduled maintenance, re-routing	Price, rolling blackouts, demand management	Calif – 8 months
Deliberate Acts	Substation equipment, plants, gas pipelines, cyber, telecom, water	Energy loss, water contamination, economic, communications, social disruption	Loss of Energy/ 2+ years



# Why Should DoD Care?

- 85% of DoD-dependent Physical Infrastructure Is Commercially Owned
- 98% Dependent on Outside-of-the-fence Fuel and Electric Power
  - *Exceptions: China Lake*
  - *100% on Other Commercial Infrastructures (e.g., Equipment, Maintenance Personnel)*
- Commercial Infrastructures Are Soft Targets
- Easily Disrupted





# Hurricane Katrina

## DoD Mission Issues



30 August 2005

**DoD** – Facilities

11 DoD facilities evacuated  
aircraft

**DIB** – Raytheon Forest,  
MS

Shut-down due to power  
outage - no immediate DoD  
impact

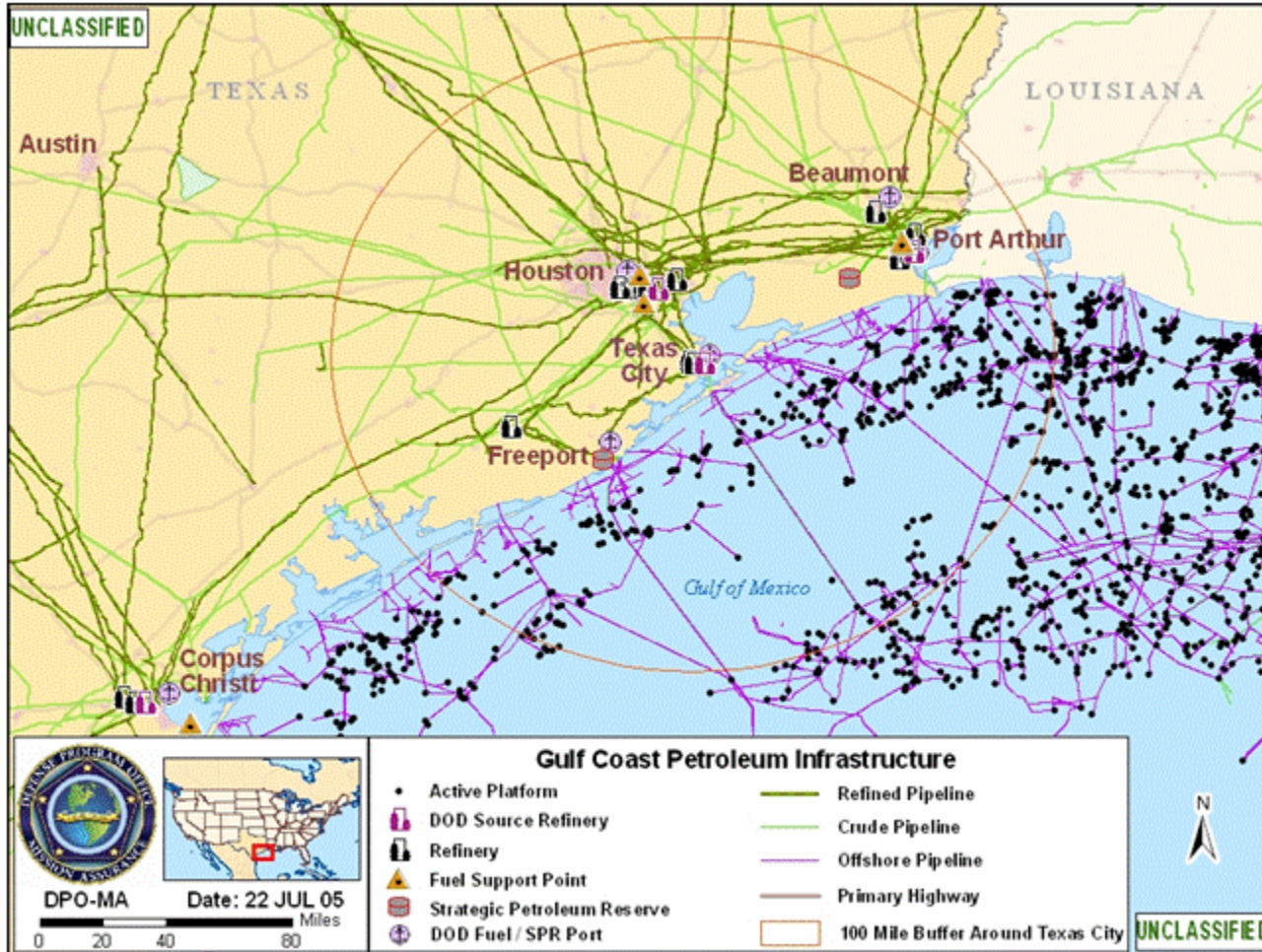
**DFSP** – 20 Defense Fuel  
Support Points supplying  
1 million gallons/year of  
JP-5 & JP-8

DoD Impact

No major mission impact



# Hurricane Katrina Impact Petroleum Infrastructure



29 August 2005

90% shutdown of oil & gas production in Gulf of Mexico

Colonial, Plantation, & Capline pipeline systems shut down due to loss of electric power

1 September 2005

Colonial 40% capacity

Plantation 25% capacity

13 September 2005

900,000 b/d refinery capacity remains idle (Chevron, ConocoPhillips, ExxonMobil, & Murphy)

Impact

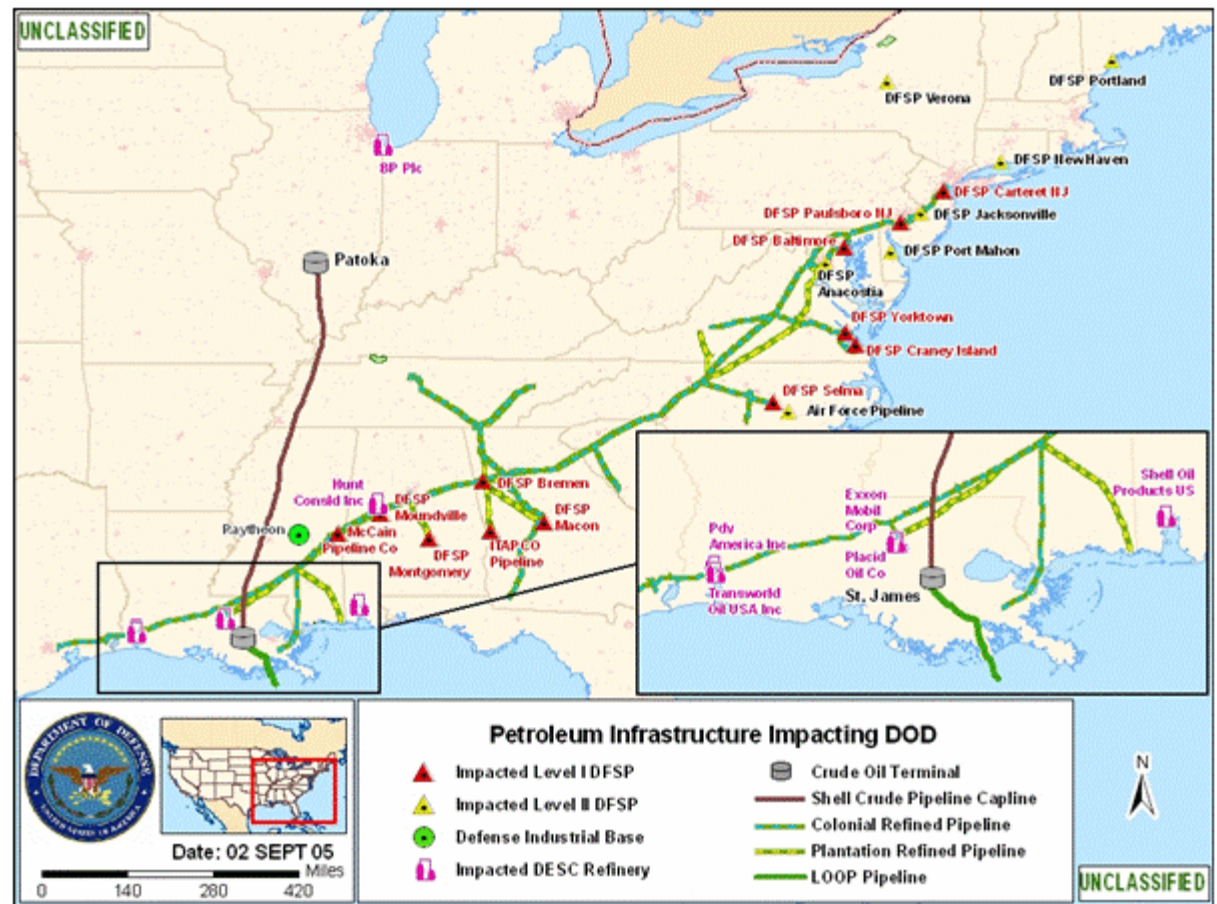
Price spike



# DoD Dependency – U.S. Pipelines

## Colonial & Plantation Systems

- ~135 Defense Fuel Support Points
- Primary Transportation Route for JP-5, JP-8, & F-76
- Systems shut down or operated at reduced rate during Hurricane Katrina & Rita in '05



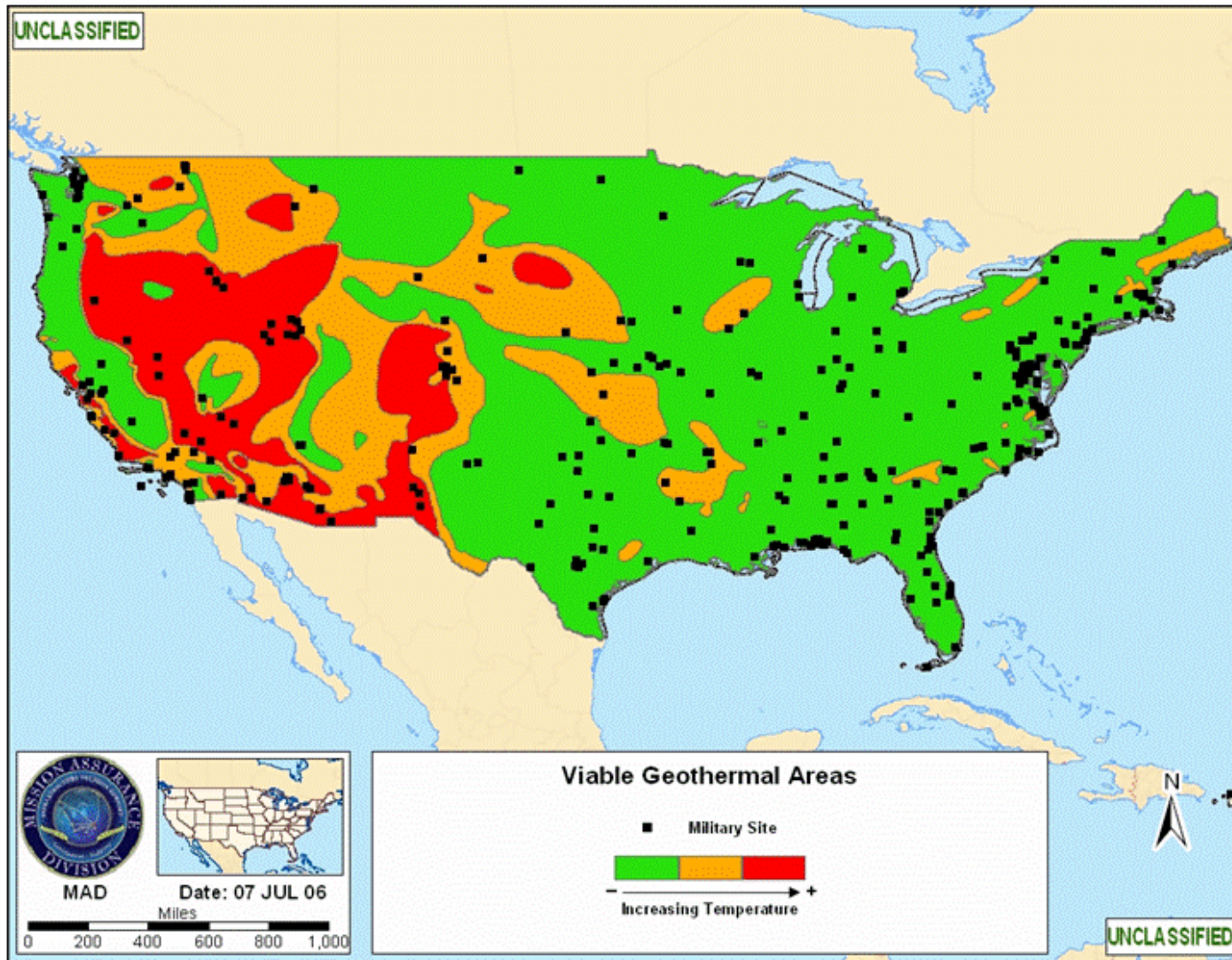


# Electric Power Story

- Transmission Congestion Primarily Caused by Power Trading Market
- Substations Are Key Assets That Cause the Largest Outage Footprint on the Grid
- Military Mission Vulnerabilities
  - Single Point of Failure Feeding Installations
  - Elimination of Substation Put Installations Into Outage Footprint
  - High Reliance on Diesel for Backup Generation
- DoD Energy Requirements – Especially in CONUS – Have Much Potential to Be Supported/Augmented by “Alternate” Energy Sources or Generation Technologies

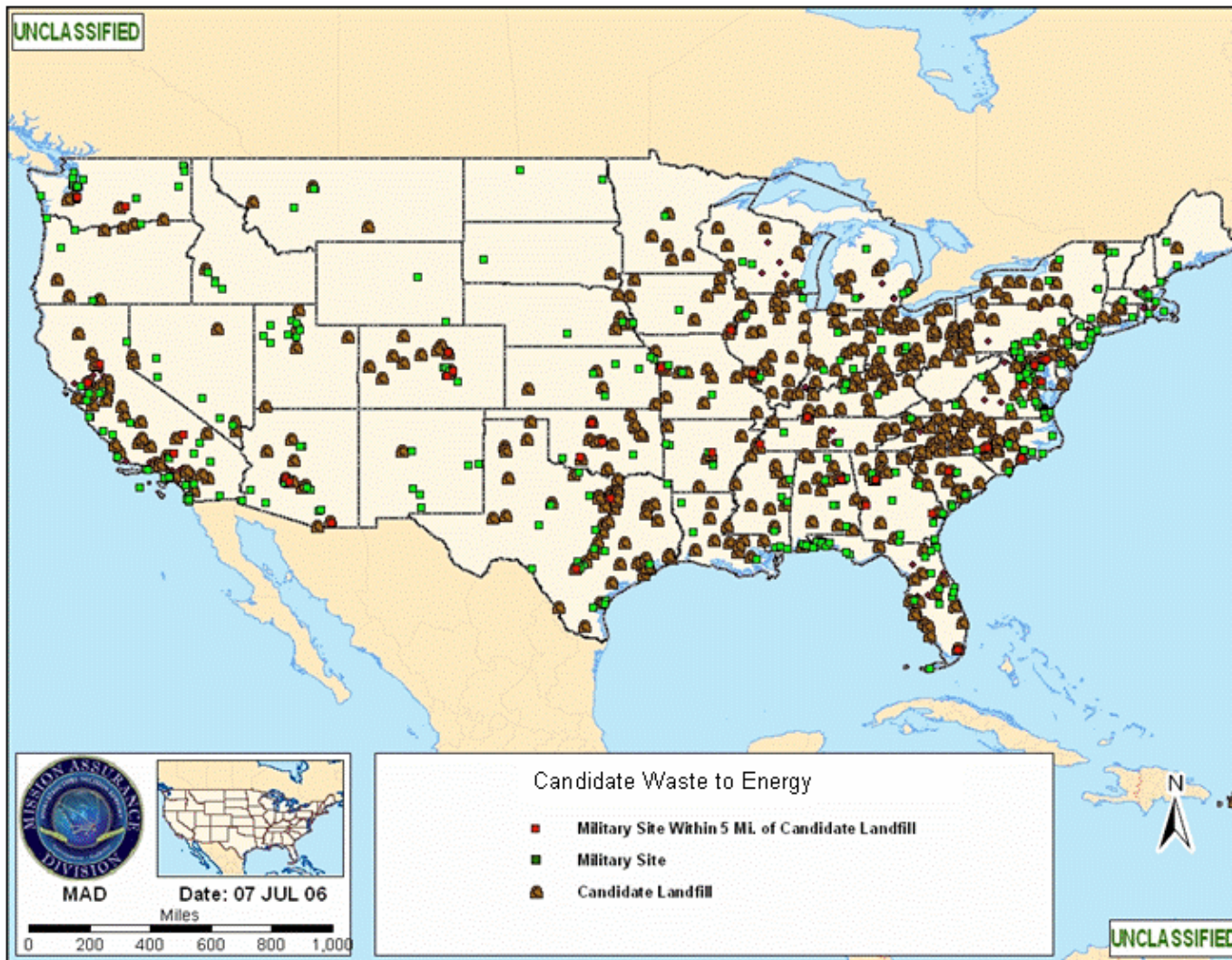


# Geothermal – Optimal Locations



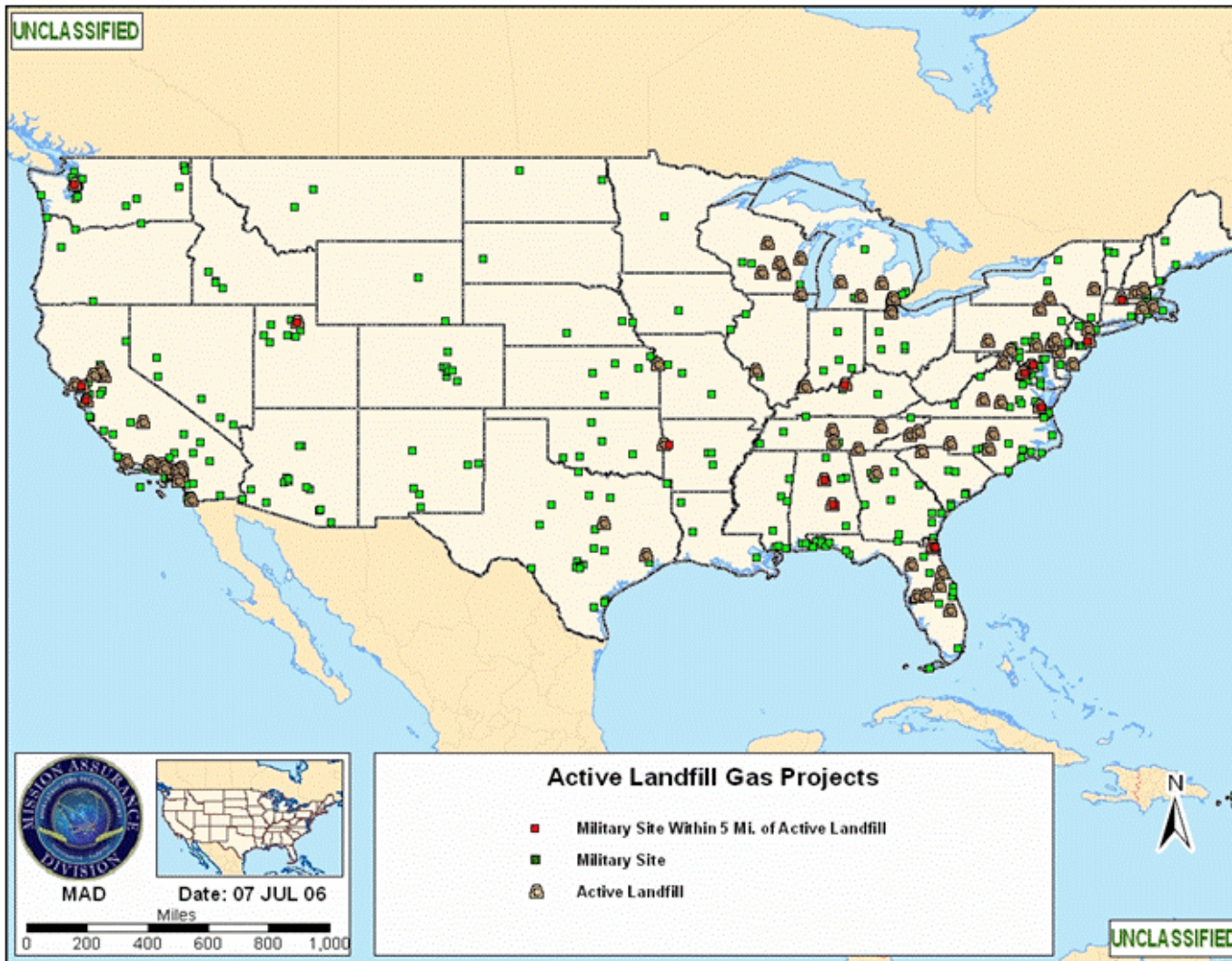


# Municipal Waste – Optimal Locations



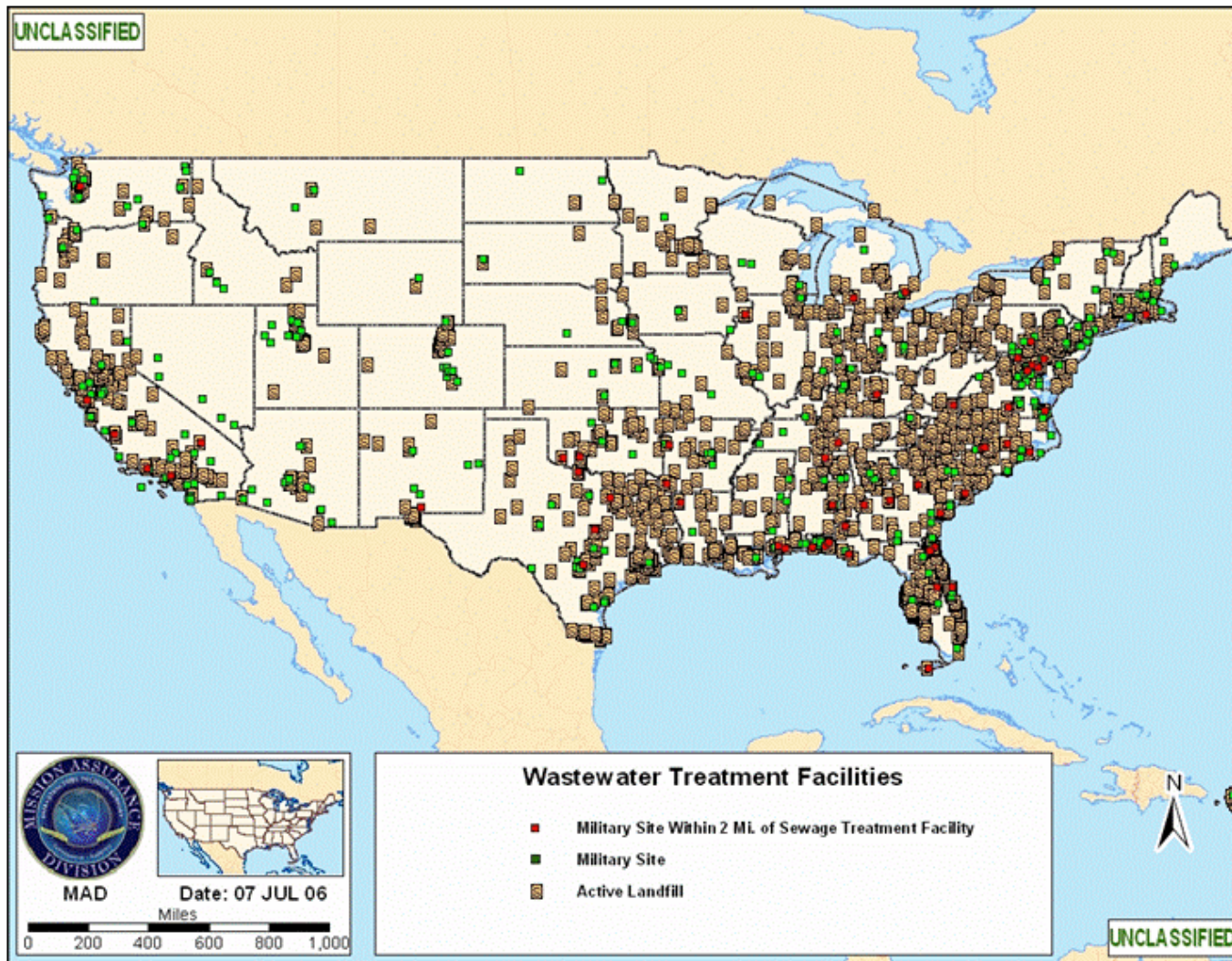


# Landfill Gas – Excess Gas Projects





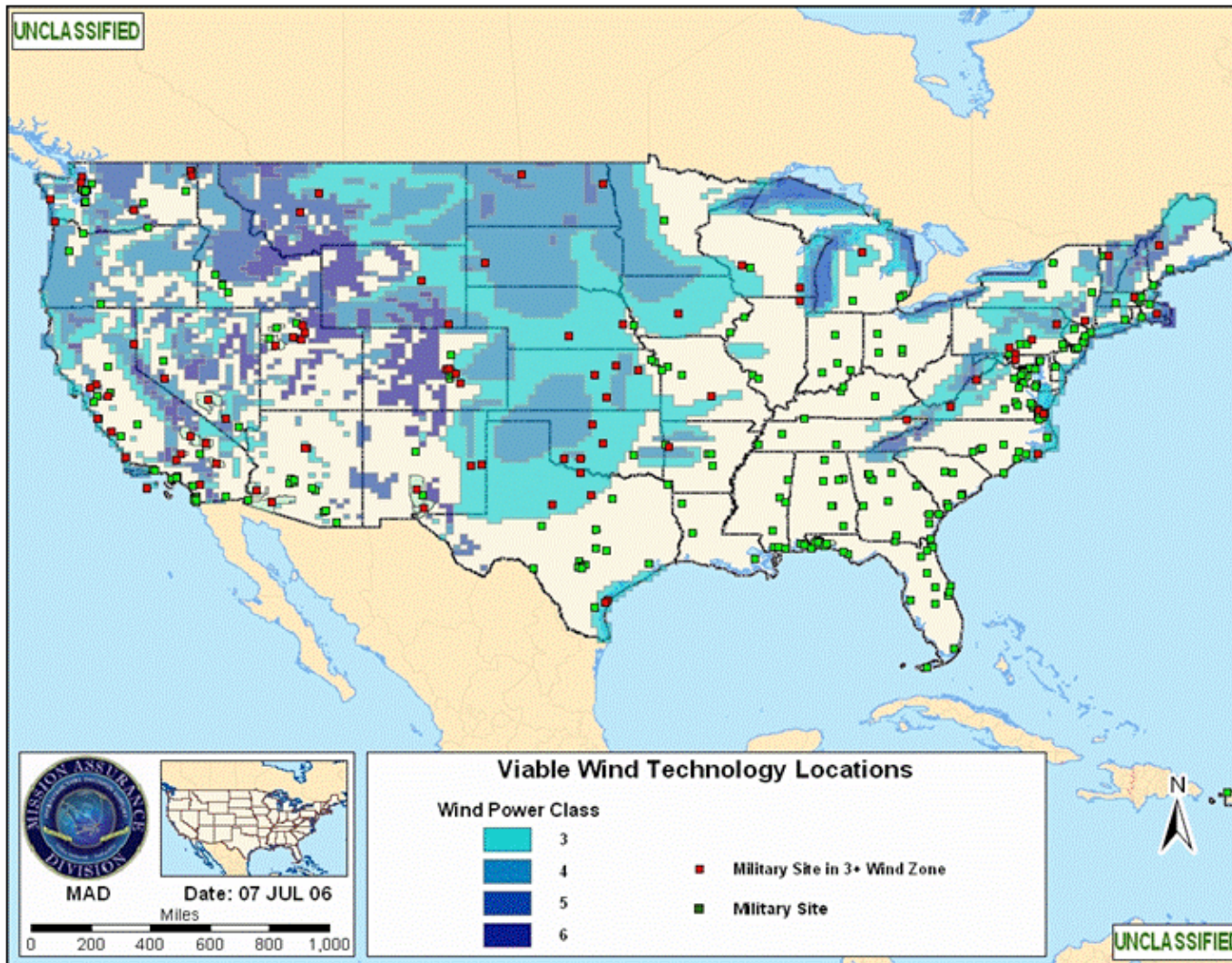
# Wastewater Gas – Optimal Locations





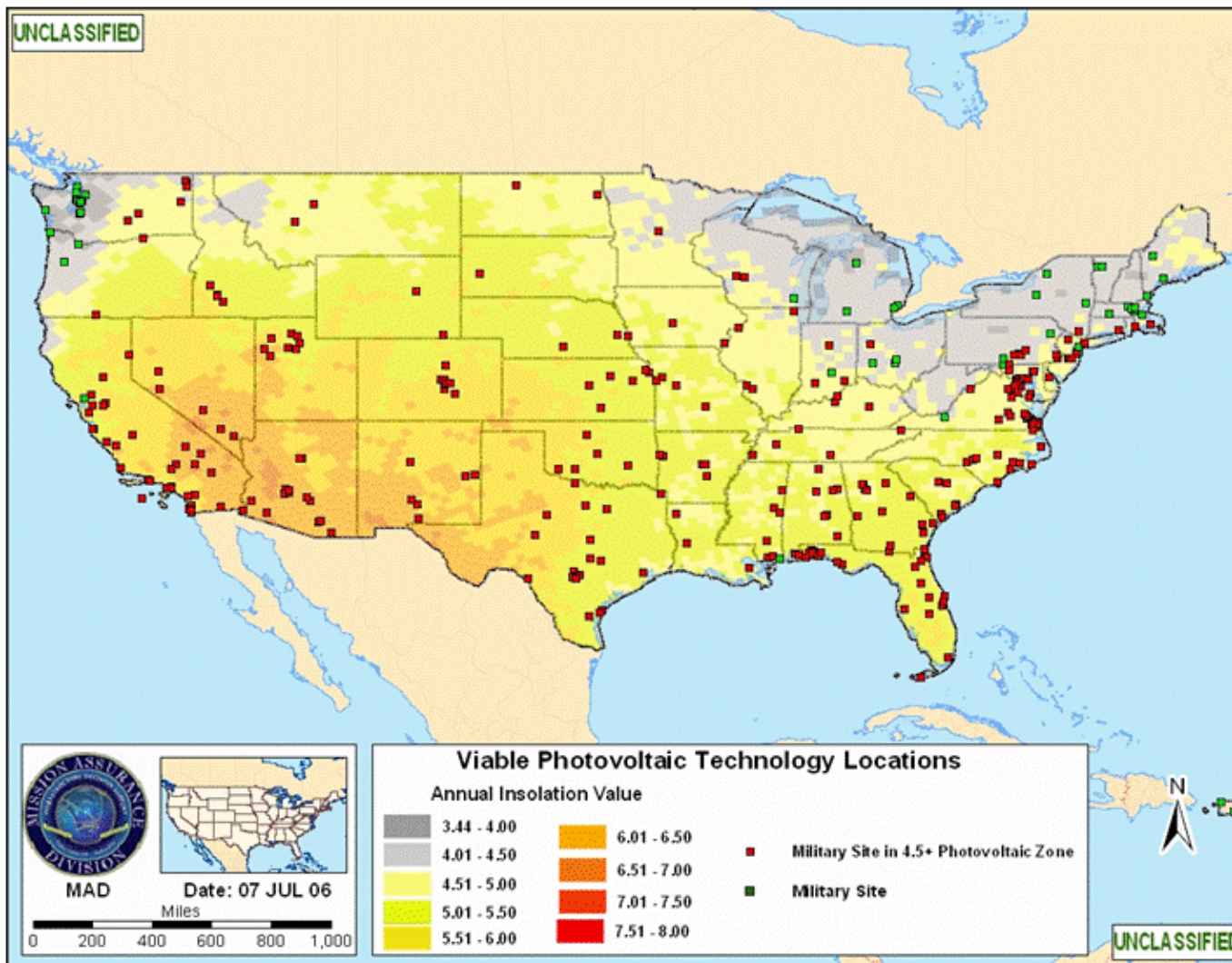


# Wind – Optimal Locations



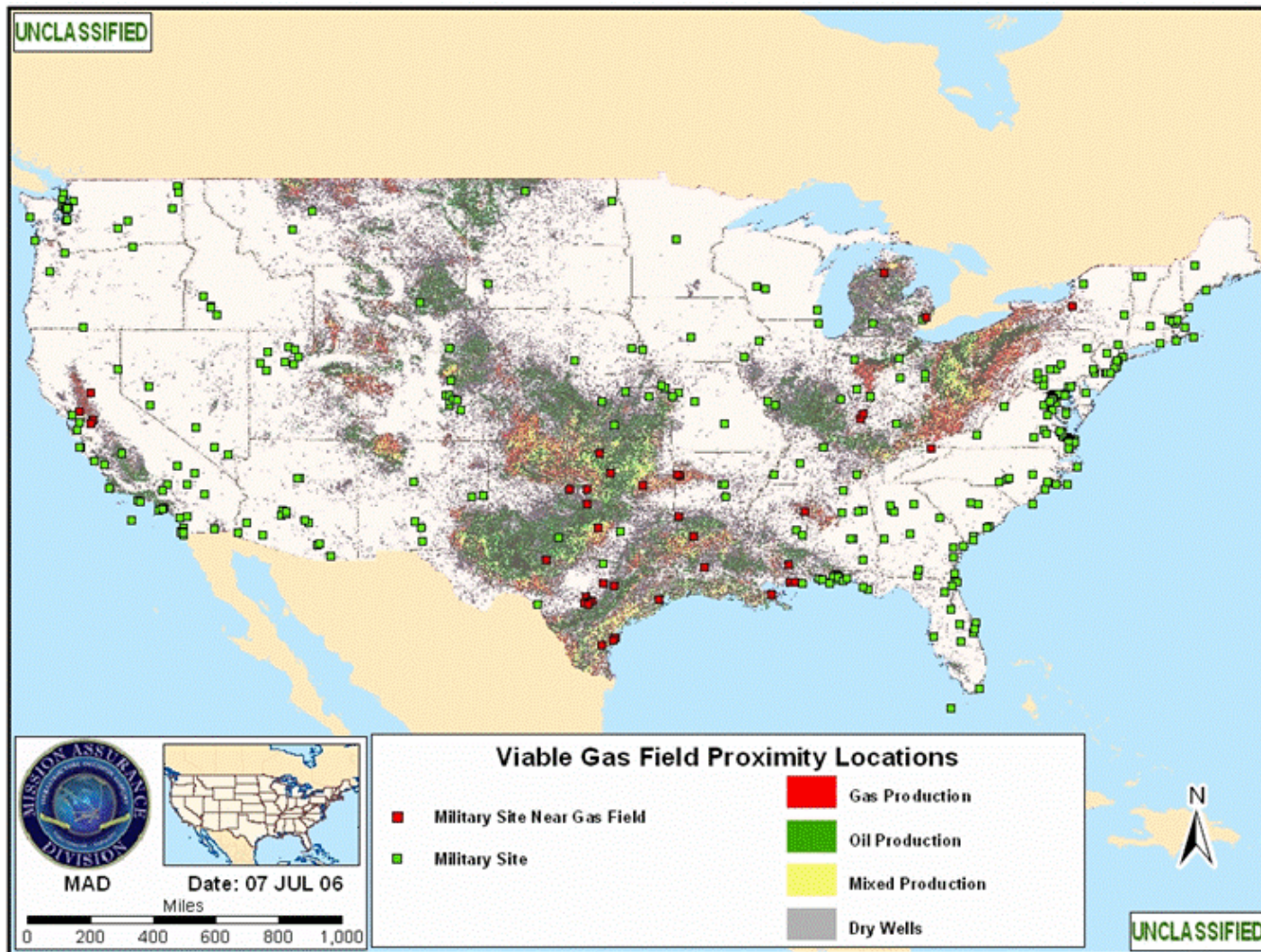


# Photovoltaic – Optimal Locations



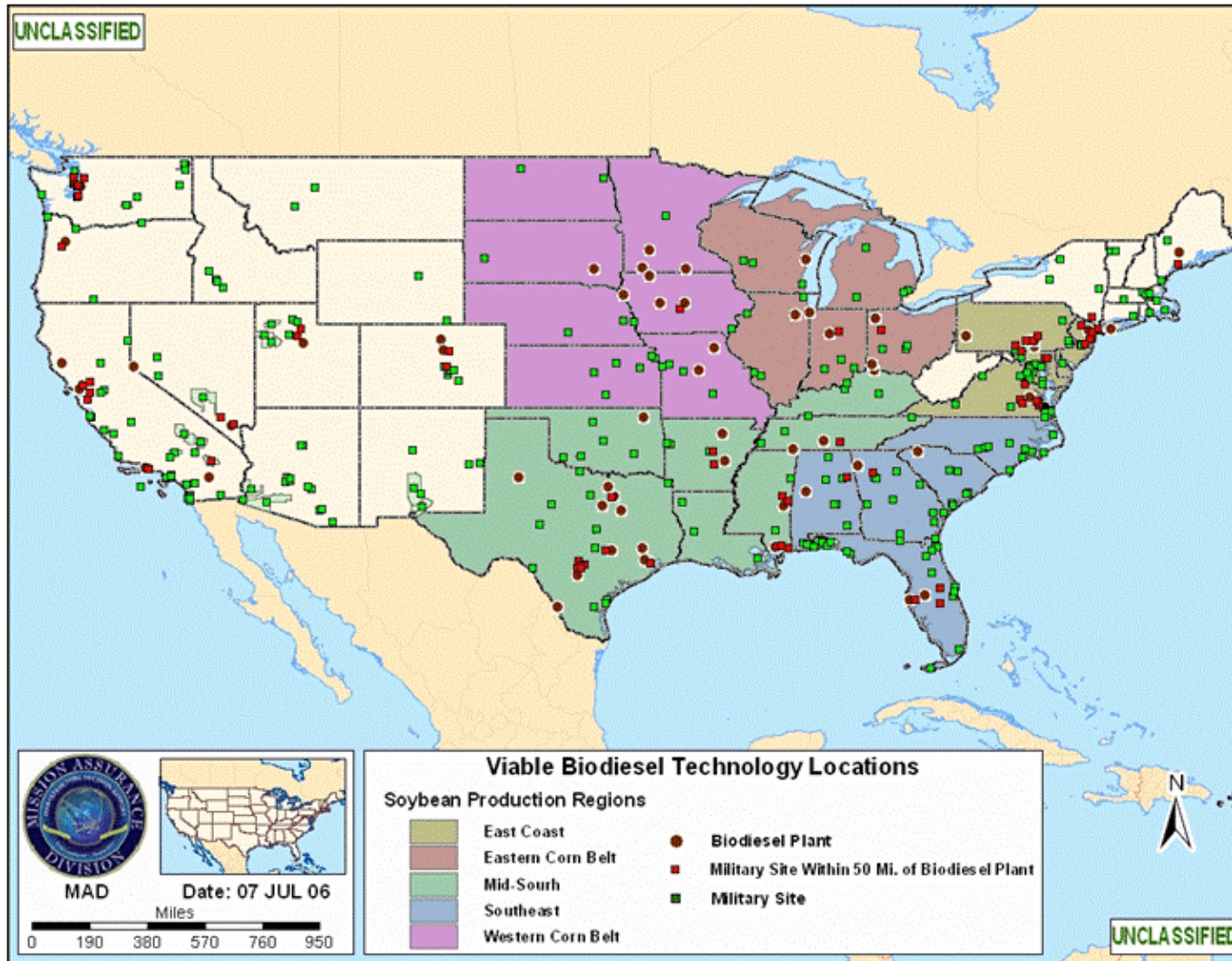


# Natural Gas – Optimal Locations



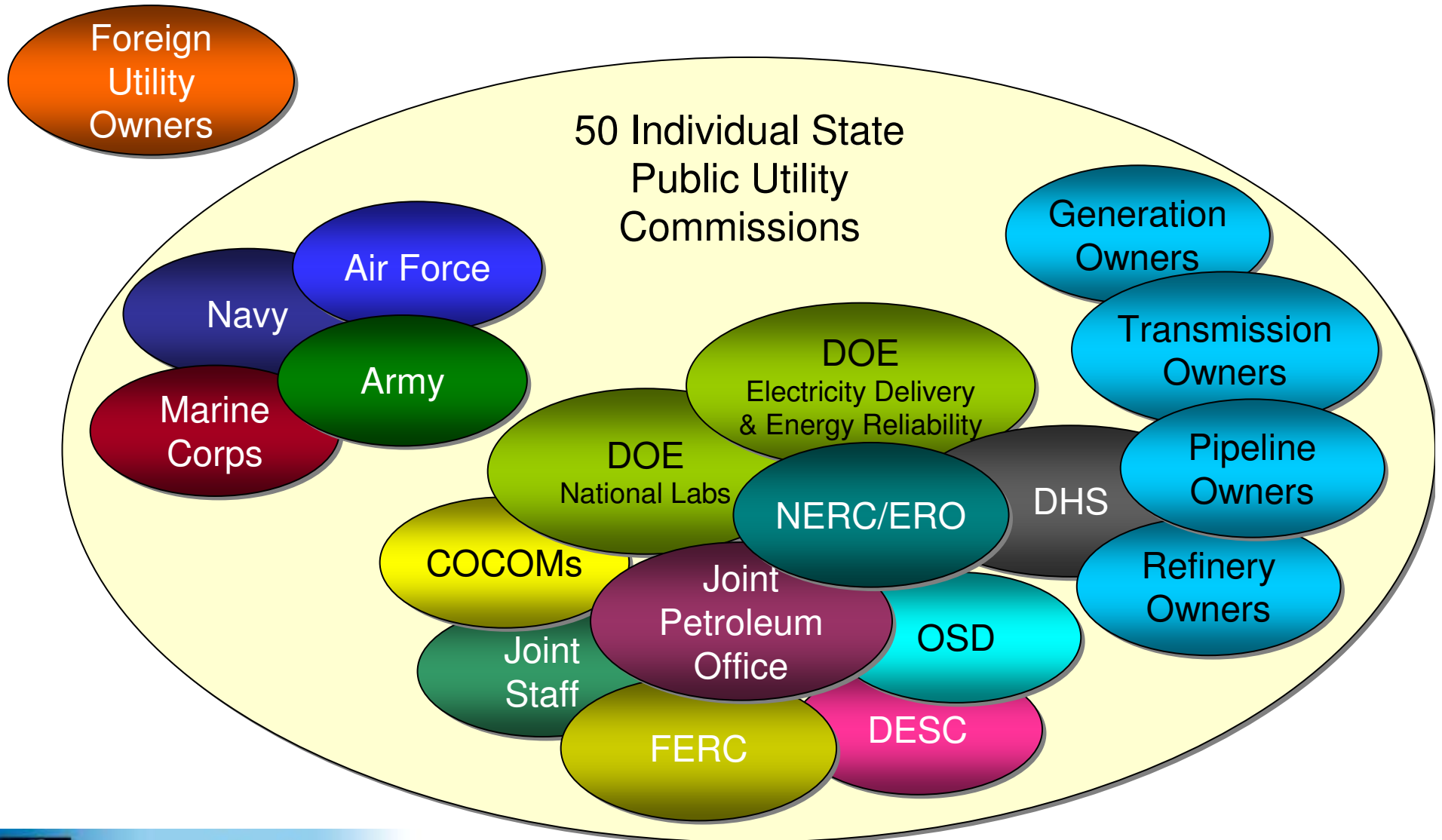


# Biodiesel - Optimal Locations





# Energy Stakeholders





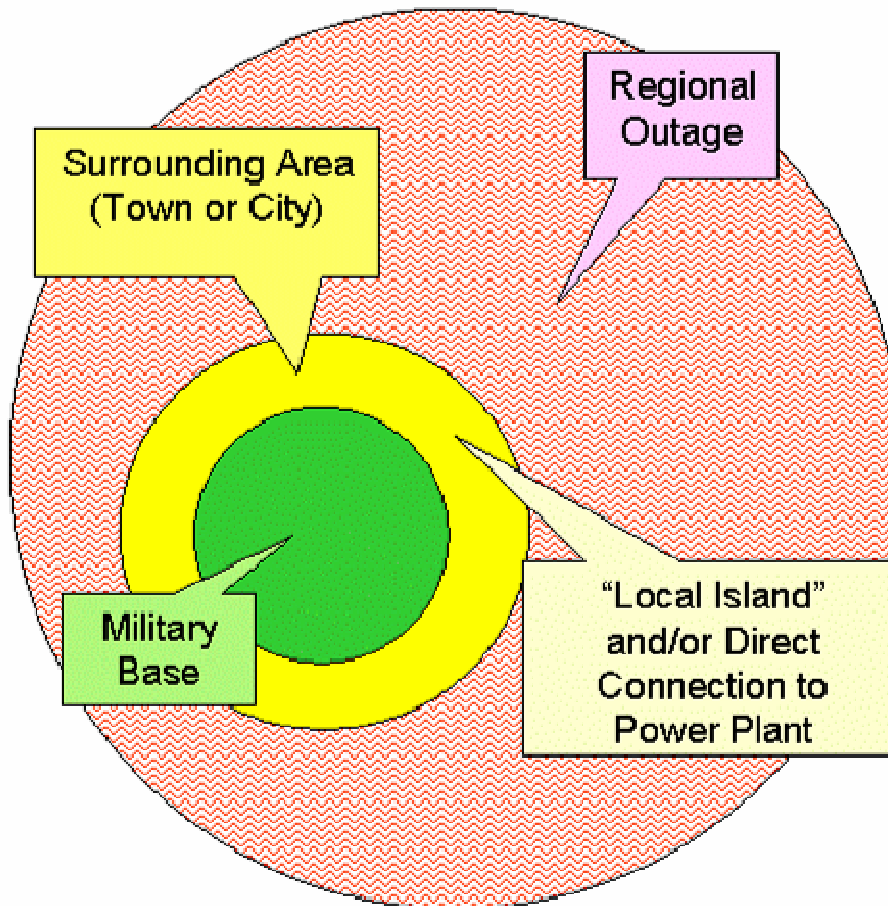
# Preventing Long-term Outages

## Industry Planning Criteria

- Expand Number of Simultaneous Contingencies
  - Traditional N-1
    - Unexpected Loss of One Bulk Electric System Facility (Line, Generator, Transformer, etc.) Caused by a Single Initiating Failure or Outage
  - Expanded N-(2, 3, etc.)
    - Substations Have Multiple Bulk Electric System Facilities
    - Elimination of Substation(s) Around a Military Base Can Cause Prolonged Outage (Months)
    - Identify Multiple Contingency Scenarios and Share With Local Utility for Resolution
- Special Protection System (Remedial Action Scheme)
  - Automatically Takes Corrective Actions After Contingency
    - Changes Demand
    - Changes Generation
    - Changes System Configuration
    - Does Not Include Underfrequency or Undervoltage Load Shedding Fault Conditions That Must Be Isolated and Out-of-step Relaying (Detects Loss of Synchronism Caused by Unstable Power Swings)



# Managing Long-term Outages A Different Paradigm



## Micro-Grid

- Extended regional outages (months)
- “Strategic Islanding” or maintaining a micro-grid using fuel and generation diversity
- Electric power energy security through military/utility collaboration
- DoD energy savings through military/utility collaboration



# DoD Energy Vulnerability Issues

- Are DoD vulnerabilities known for mission assurance?
- What is the DoD operational standard and who sets that?
- Who has responsibility to resolve?
- Are the priority problems being fixed?
- Are the current work arounds sufficient?
- Can all the priority vulnerabilities be resolved under the current systems?
- Who has management / oversight responsibility?





# Mitigating DoD Energy Vulnerabilities

- GWOT Requires an Imaginative Approach for DoD Energy Security to Defeat the Enemy
  - Sufficient Local Generation and Pre-scripted Schemes for Islanding Mission-critical Functions and Installations
  - Reduce Single-line Connections to the Electric Power Grid – Maximize Redundancy
  - Maximum Protection From Control/Protective System Vulnerabilities
  - Minimize Use of Shore Power by Naval Vessels in Foreign Ports
  - Identify Viable Energy Independent Installations – Tapping Renewable and Alternate Energy Sources
  - Consider Relocating Mission-critical Operations to Bases Capable of Islanding Power and Fuel
  - Use DoD Renewable Energy Assessment Final Report (14 March 2005) and Apply, Where Practicable



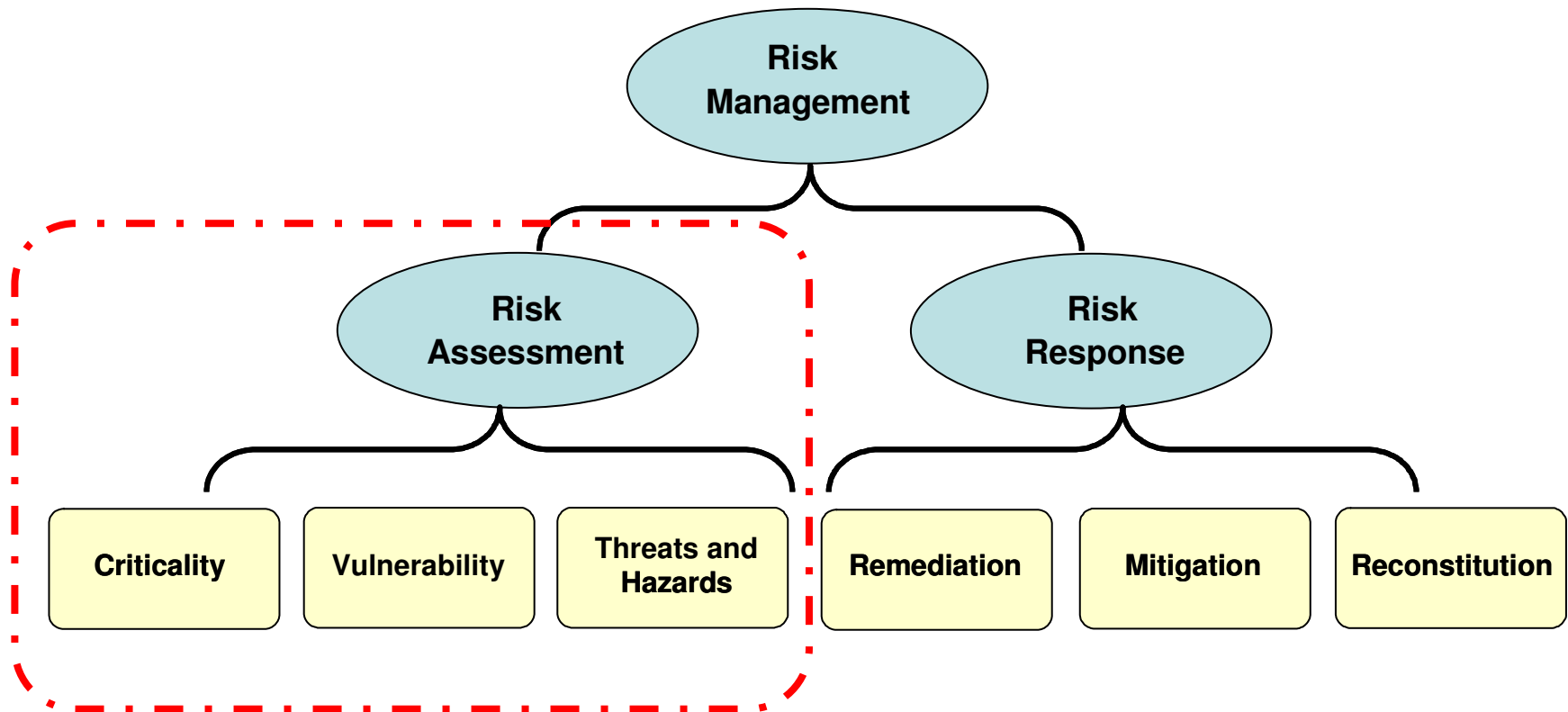
# Risk Management Process

- **Risk Management Program examined in two parts**
  - Risk Assessment – what critical operations are at risk
  - Risk Response – what can be done to reduce risk
- **Risk Management Program highlights**
  - Top-down approach based on operations deemed critical by an organization (company, agency, department, government, etc.)
  - Focused on assuring accomplishment of those critical operations and the assets they are dependent upon
  - Assets can be people, property, equipment, activities, and operations, information, facilities, and materials to include supporting private/public infrastructure
  - Examines vulnerabilities and risk from all threats/hazards
  - Prioritizes critical assets to support resource allocation and remediation decisions

**An Ounce of Prevention!**

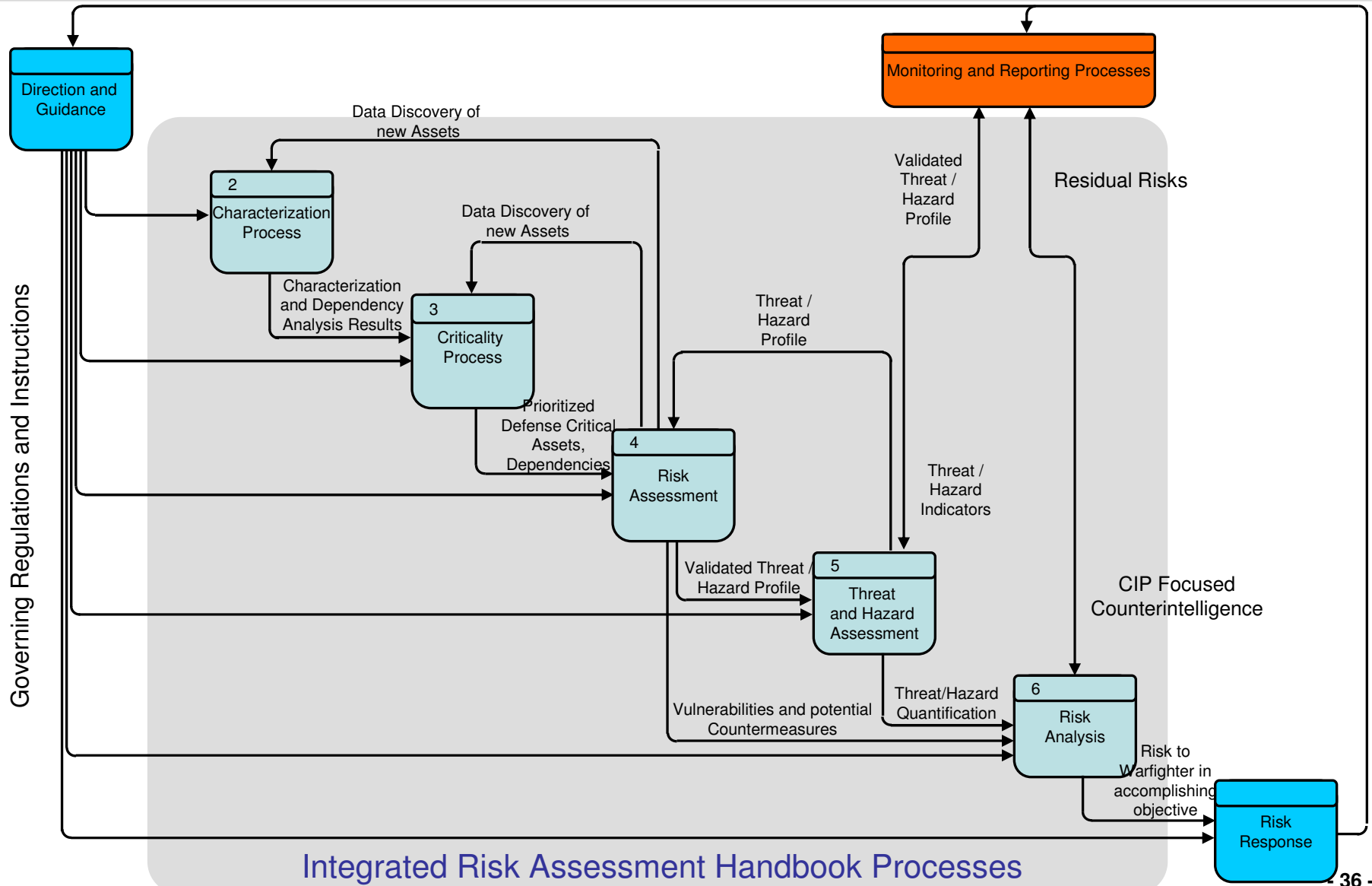


# Risk Assessments





# Integrated Risk Assessment Process





# Risk and Interdependencies

**Most (if not all) networks rely on other networks to perform their functions.**

**To understand the risk (including extent) of a network disruption, understanding the risk of the supporting networks is crucial.**

## **Incorporating Interdependencies into Risk Assessments:**

- Mission Focus (tendency is to want to boil the ocean)
- Characterize THE network
- Characterize the supporting networks
- Develop generic network linking rules based on the 5Ws
- Use Who, What, Why, Where, When for linking of networks
- Use all hazards approach
- Identify criticality (answers the “so what?”)
- Use datasets that can be queried (e.g. relational, historical, GIS visualization)



# The Five Ws

**Interdependencies** - Commodities produced by other networks that makes **THE** network function.

1. **Who** is supplying the commodity, name and phone number
2. **What** is the commodity, the quantity needed
3. **Why** is there a need for the commodity, the function the commodity performs for **THE** network
4. **Where** is the commodity needed, the asset or touch point that links the commodity flow to **THE** network, physical location
5. **When** is the commodity needed, for how long is it needed



# Example of Applying the 5 Ws



## Electric Power Dependence on Water

*Who:* Municipal Water Company, Bill Waters, 866-222-9222

*What:* Water, 2 gal/min

*Why:* Maintain 1000 amp transformer output to meet demand

*Where:* Transformer (Latitude: 47.15 Longitude: -122.52)

*When:* Between 4-6 pm June, July & Aug



# Interdependency Recommendations

- Use a phased approach to limit initial complexity  
*(Manual, automation to support analysts, modeling, simulation)*
- Build out interdependency rules for use by analysts  
*(Logical, Geo, Legal, Capacity, Reconstitution, etc.)*
- Develop tools to support the analysts vs. tools that require analytical support
- Consider network operator intervention when modeling impacts
- Standardize data format and define essential data elements
- Ensure data quality through a scoring process
- Always consider the “so what?”
- Focus on ‘your’ mission



# MISSION ASSURANCE DIVISION CONTACT INFORMATION



*“Forewarned...Forearmed”*

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for Government and Industry

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HOMELAND AND FORCE PROTECTION