



# Solar Energy Development on DoD Installations in the Mojave & Colorado Deserts

**Bob Kwartin**

March 26, 2012



## Agenda

- Background and rationale for the study
- Study scope and key findings
- Techno-economic analysis process
- Conclusions, Recommendations and Implications

Report is available for download at:

<http://www.icfi.com/insights/reports/2012/full-report-solar-energy-development-on-department-of-defense-installations-mojave-colorado-deserts>



## Background and Rationale



## Congressional Language

- “Alternative Energy Study” - FY10 Conference Report 12/19/09
- Senate Appropriations Committee Report Language
  - “*Alternative Energy Study* —...a pilot study on the use of Department of Defense land for renewable energy production. The study to analyze the potential impacts of a program to develop large-scale renewable electricity generation projects shall be completed not later than one year after enactment of this act.”
- Seeking Balance
  - Desert Protection
  - Recreation
  - National Defense Missions
  - Alternative Energy



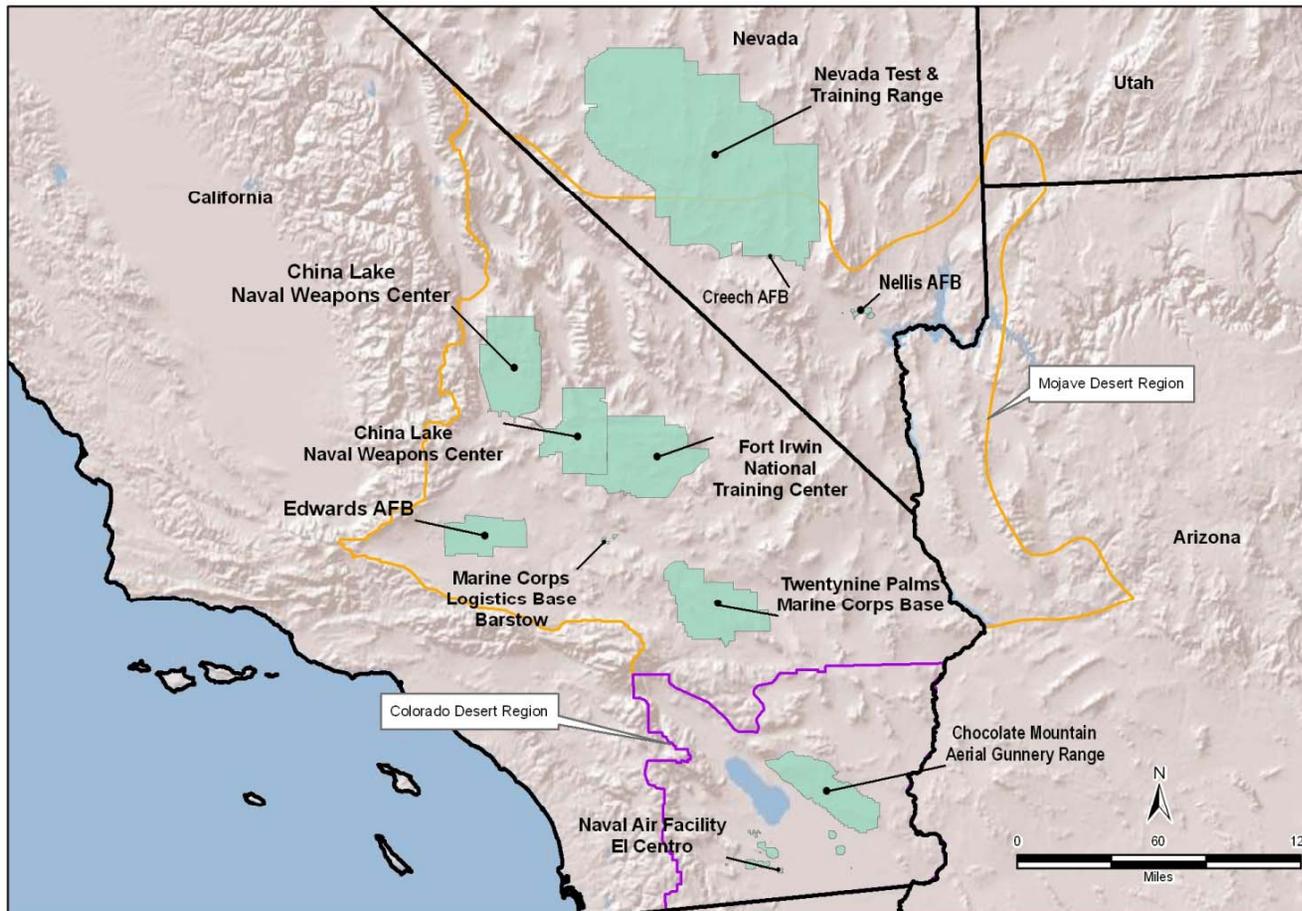
## Study Scope and Key Findings



## Study Charter

- Evaluate the technical and economic potential to site solar on 9 major DoD installations in the Mojave and Colorado Deserts of California and Nevada
- Evaluate the full range of solar technologies in all potential site types
  - Other RE technologies ruled out prior to study initiation
- Evaluate the policy and programmatic drivers and restrainers affecting solar development on DoD installations
- Assess whether/how solar can contribute to installation-level energy security
- Recommend policy and programmatic modifications to accelerate solar adoption
- Not in the charter:
  - Investment-grade project characterization
  - DoD Renewable Energy Plan

# Nine Installations in the Study



**Army:** 1  
Fort Irwin

**Navy:** 2  
NAWS China Lake  
NAF El Centro

**Air Force:** 3  
Edwards AFB  
Nellis AFB (including NTTR)  
Crech AFB

**Marine Corps:** 3  
MCAGCC Twentynine Palms  
MCLB Barstow  
Chocolate Mountain Aerial Gunnery Range

**Study restricted to land inside installation boundaries including Withdrawn Lands.**

Installations  
SERDP



**Approximately 6 million acres, roughly the area of Massachusetts.**



## Conducting the Study

- Study supervised by the Environmental Security Technology Certification Program (ESTCP) within the Office of the Secretary of Defense
- Research conducted by ICF's Renewable Energy, Environmental, Defense, Wholesale Power and Transmission practices
- Visited every major installation addressed by the study
- Hundreds of gigabytes of data collected
- Dozens of DoD staff were interviewed during the drafting process
  - Installations, regional commands, Services and OSD
- Documented and analyzed complex policy and programmatic drivers and restrainers
- 266 comments on the draft report from across DoD and other agencies
- Study period February – December 2011



## Key Findings

- Nevada installations entirely Category 4 (Unsuitable) beyond existing and planned projects
- 96% of the surface area of 7 major DoD installations in California cannot accommodate solar due to conflicts (mission, slope, biological & cultural resources) or poor economics
  - 25,000 acres suitable for solar (Category 1)
  - Another 100,000 acres “likely” or “questionably” suitable (Categories 2 and 3)
  - All the rest unsuitable (Category 4)
- Nevertheless, ~7000 MW<sub>AC</sub> of solar energy development is technically feasible and financially viable
  - 99.8% ground mount
  - 0.2% roof mount
  - Could generate 30x the electricity consumption of the 7 DoD installations
  - Roughly twice the amount of solar installed in the U.S. through late 2011
- Private developers can tap the solar potential with no capital investment requirement from DoD
- Federal Government could receive approximately \$100 million/year in rental payments and/or reduced cost power
- Technical, policy and programmatic barriers need to be overcome

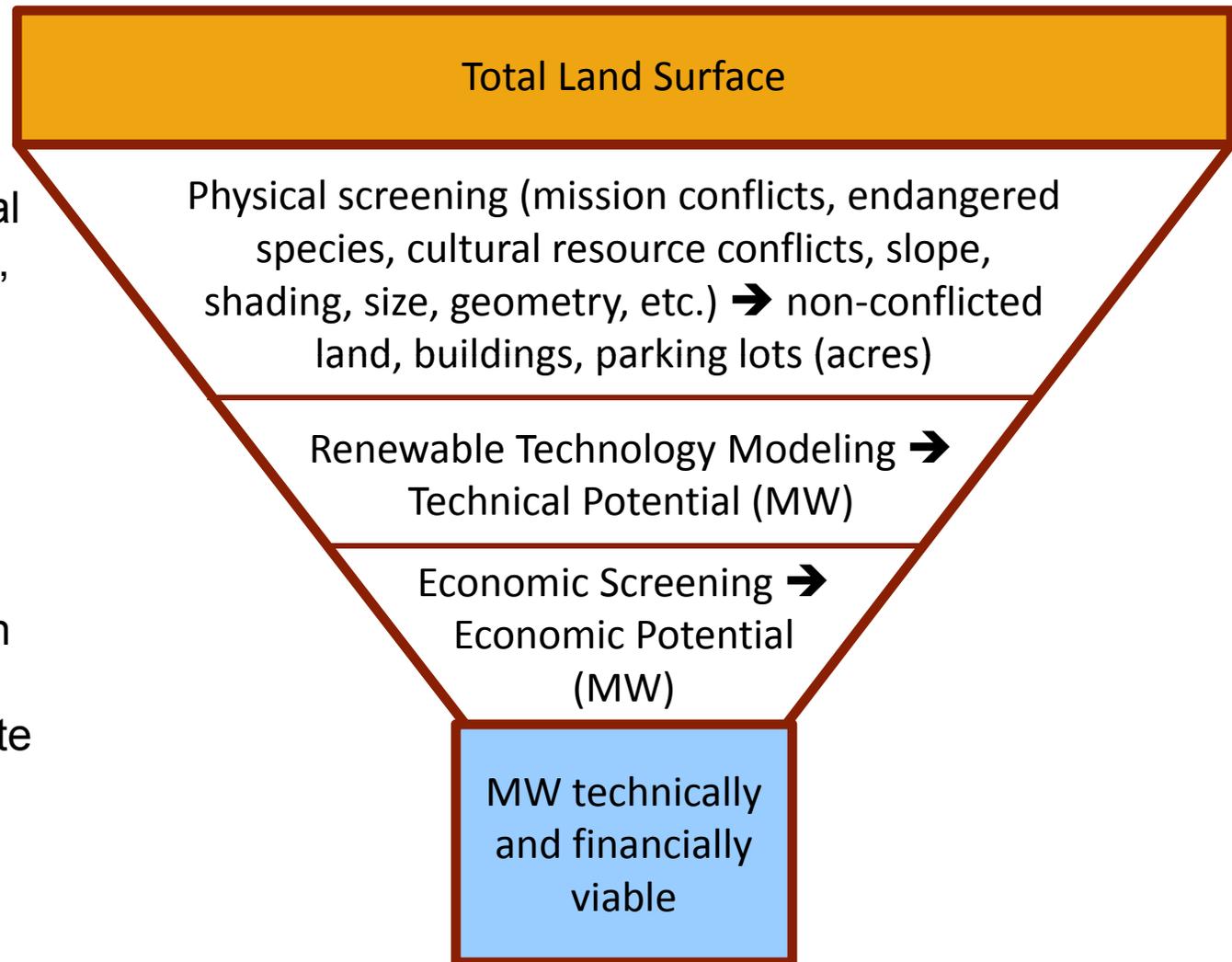


# The Techno-Economic Analysis

# Reduction Analysis



- Integrated physical resource screening, solar modeling and economic analysis.
- Rapid scenario modeling
- 4<sup>th</sup> implementation of the methodology for public and private clients





## Physical Screening: Rooftops and Parking Lot Shading Structures

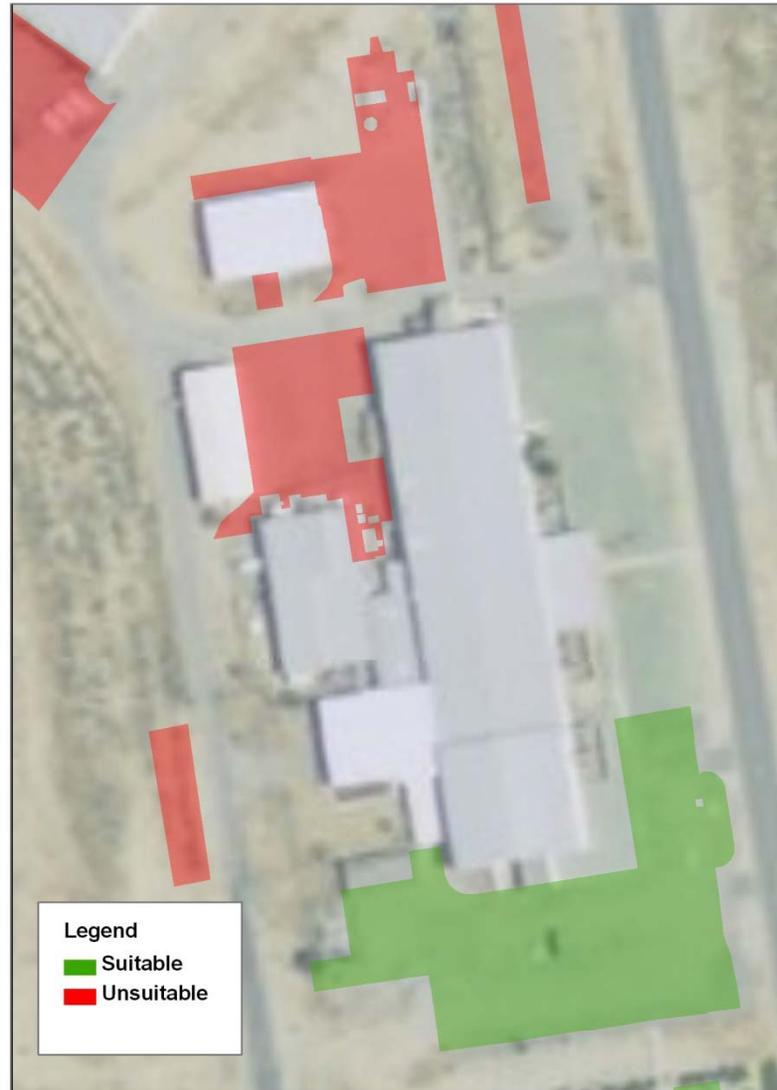
# Building Rooftop Analysis – Dimensional



# Building Rooftop Analysis – Slope/Orientation



# Parking Lot Shading Structure Analysis

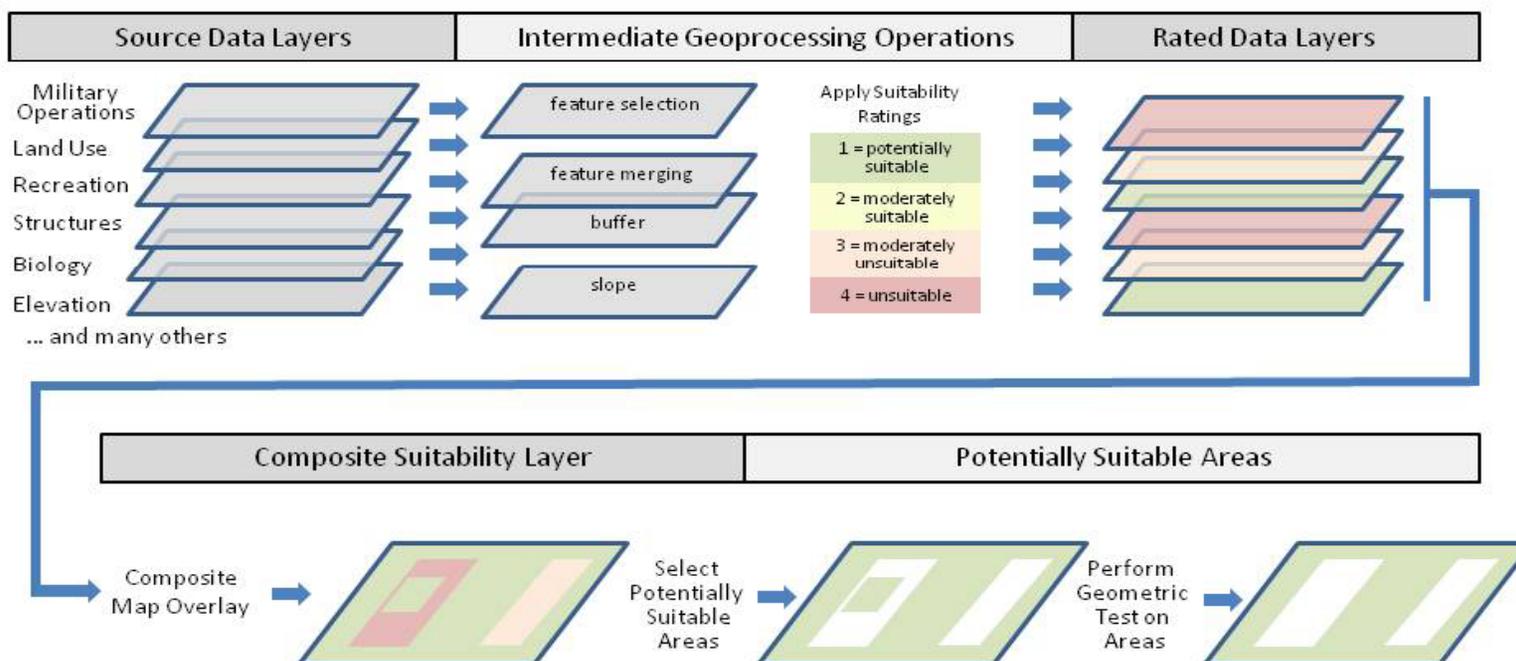




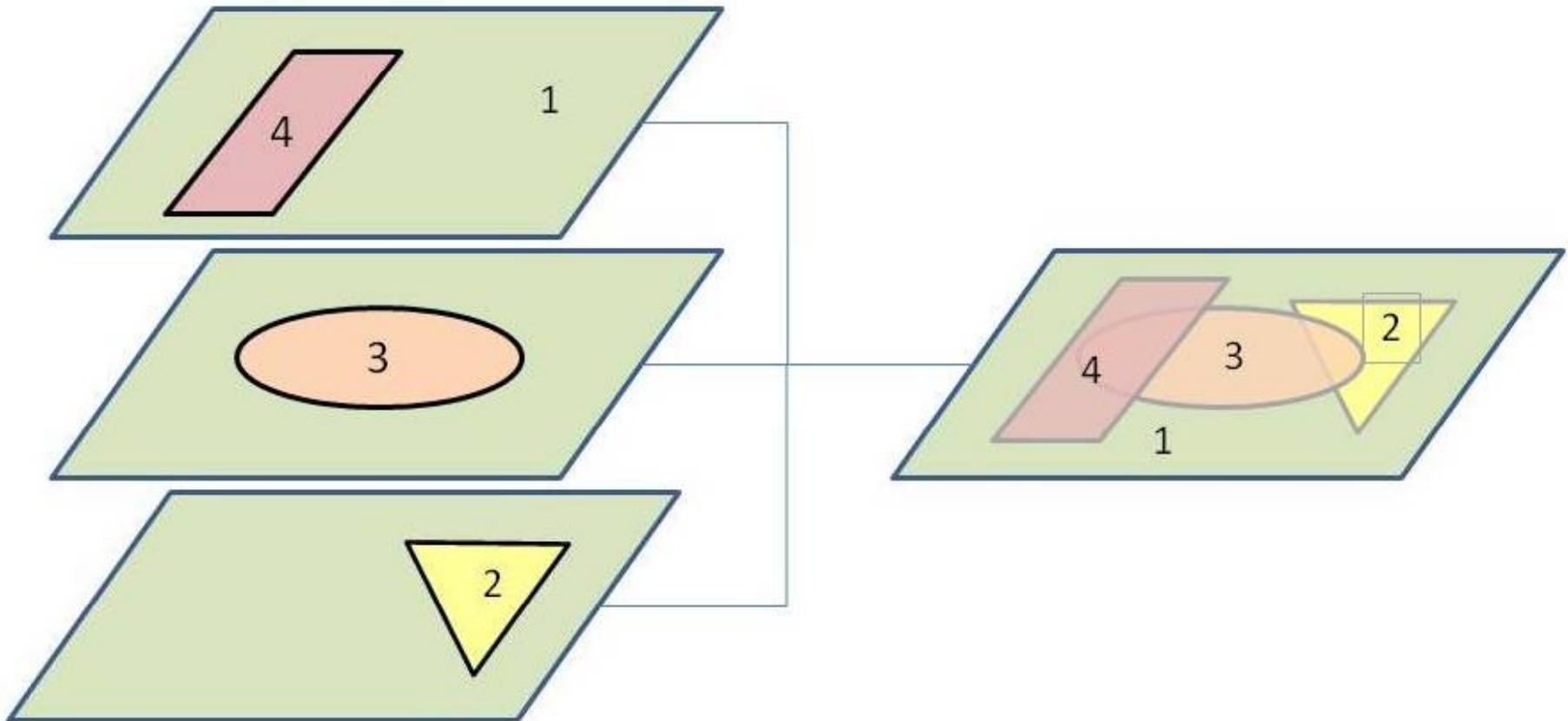
## Physical Screening: Ground Sites

# Screening Process

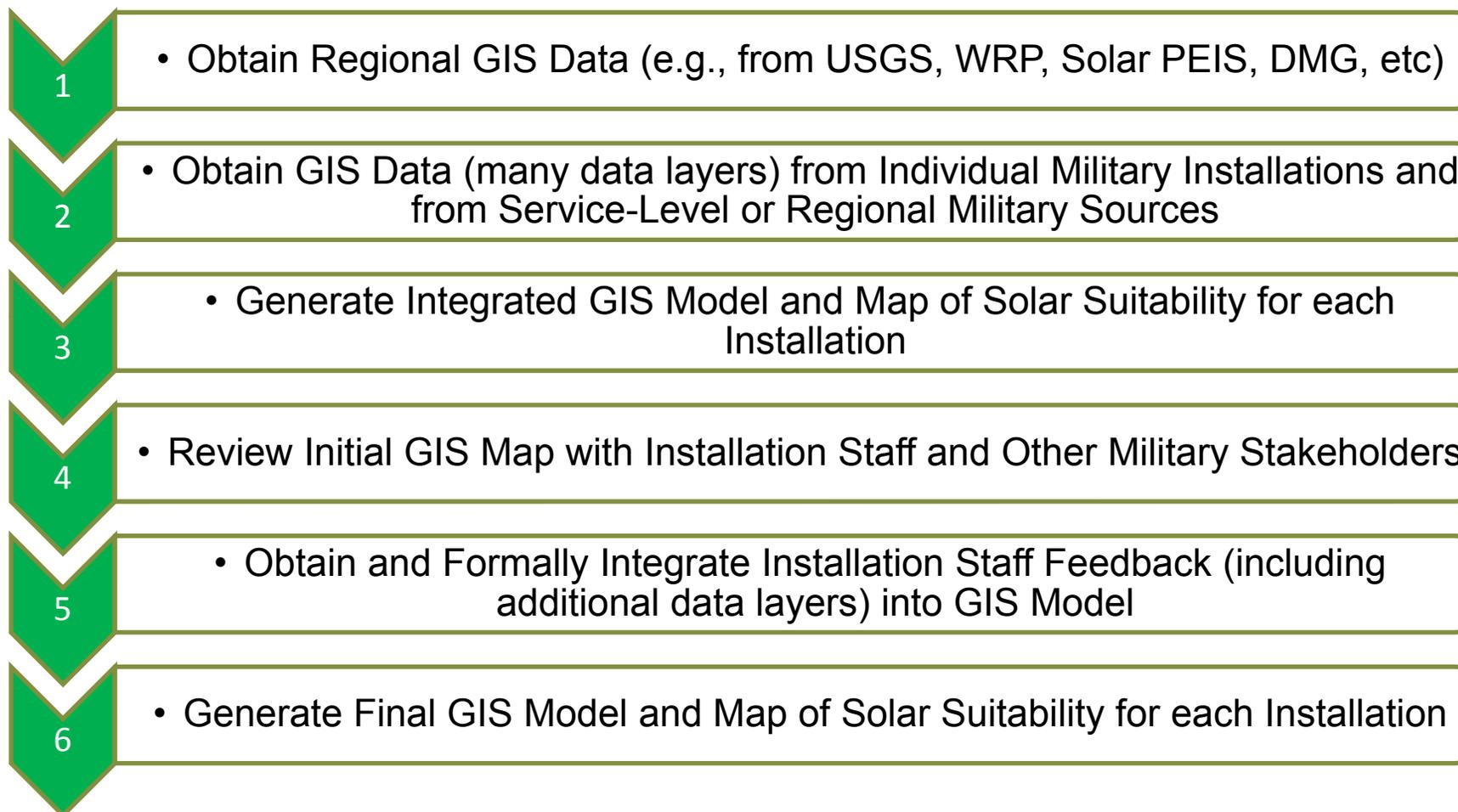
- Geographic Information System techniques used to overlay 20 to 40 independent variables per military installation
- Suitability rating established for each variable
- Most variables were “4”, i.e., elimination factors



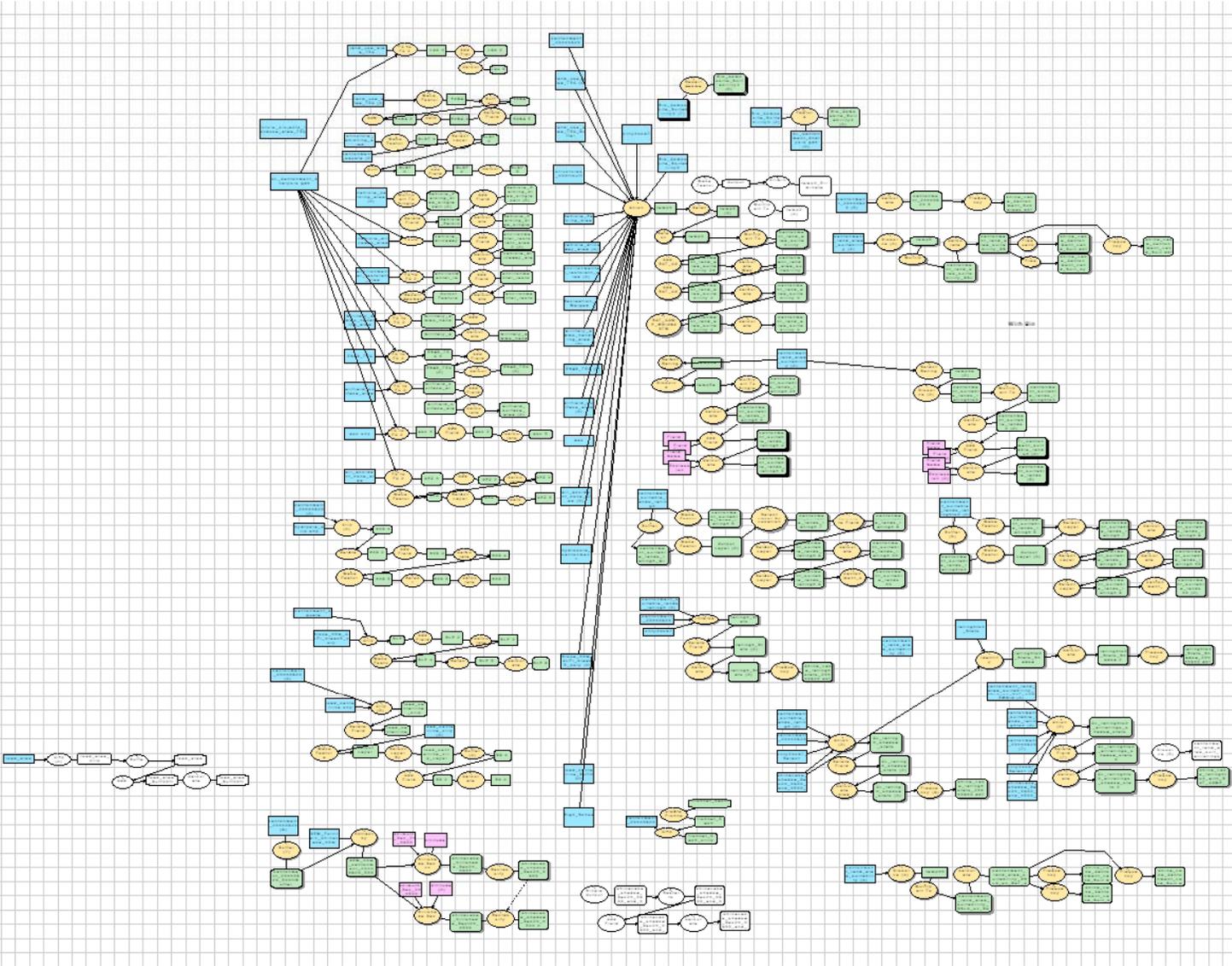
# Suitability Analysis – Worst Score is Final Score



## Geographic Analysis Steps



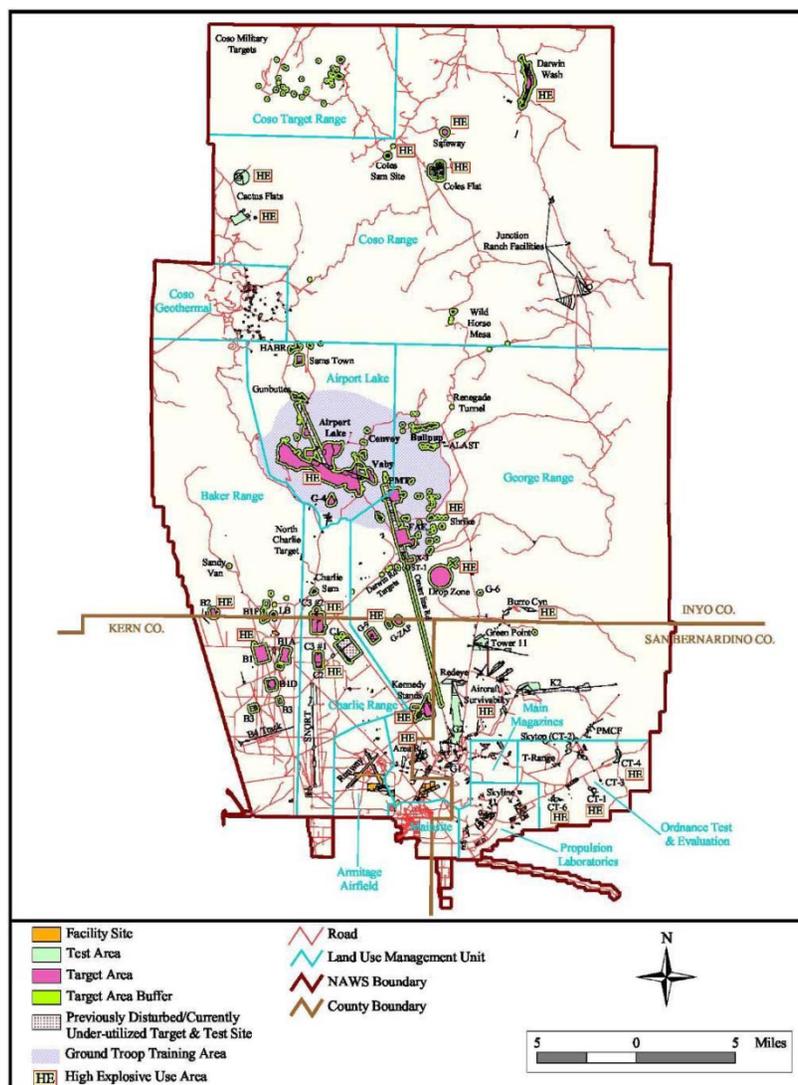
# GIS models developed to implement decision rules



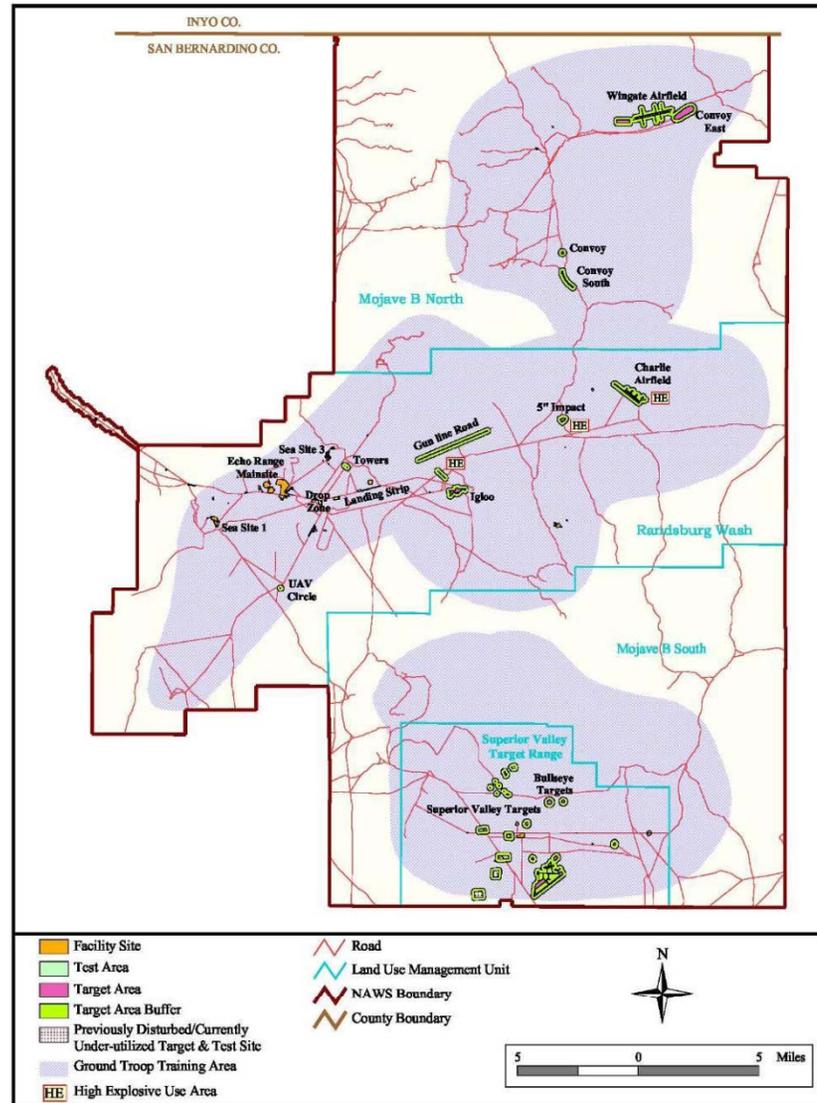
## Mission Compatibility

- The single most important consideration
- Military ranges rated Category 4 (Unsuitable) due to mission conflicts – accounted for the large majority of Category 4 acreage
- 3 kinds of mission compatibility issues
  - Security (site sensitivity, access, monitoring)
  - Physical interaction (live-fire training, maneuver areas, etc.)
  - Spectrum interaction (weapons, communications, sensors – training and RDT&E): need for a pristine test environment
- Security and physical interactions well-understood; spectrum issues need further research
- Study offers a comprehensive review of mission activities and the solar compatibility research conducted to date, but results are “non-reproducible”
- Technical potential primarily in and adjacent to cantonment areas at each installation – avoids mission conflicts

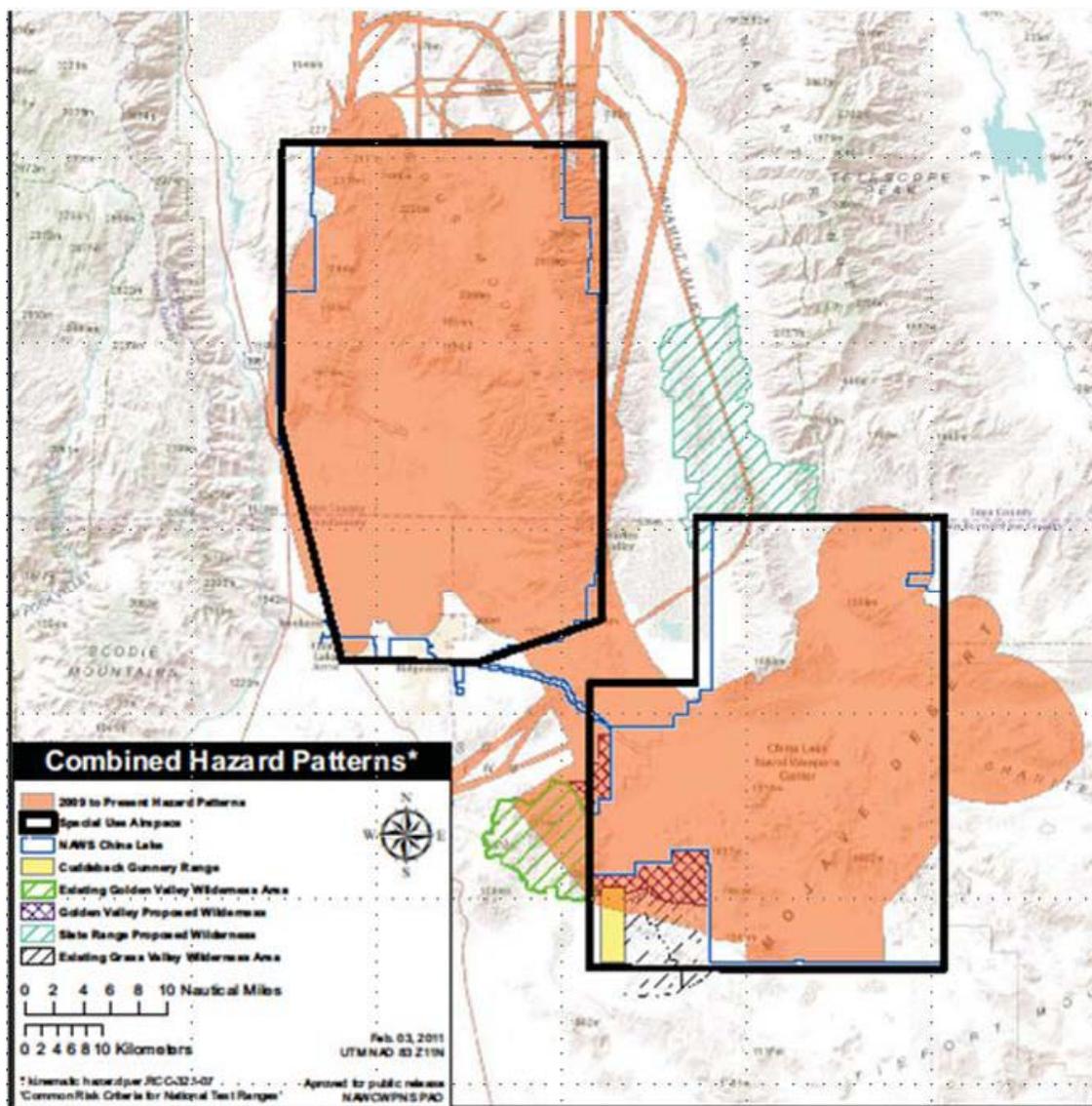
# Example: NAWS China Lake – North Range



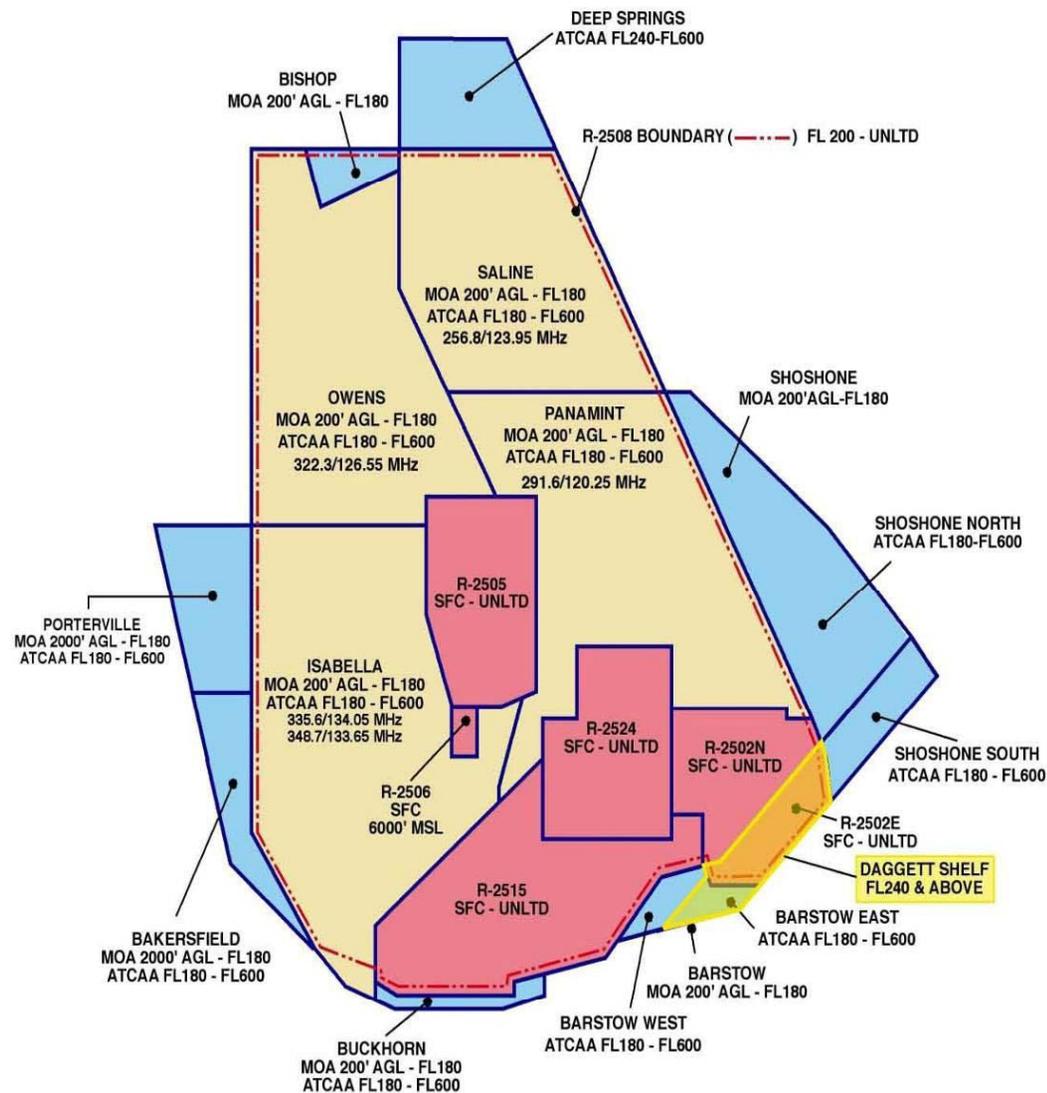
# China Lake South Range



# Combined Hazard Pattern



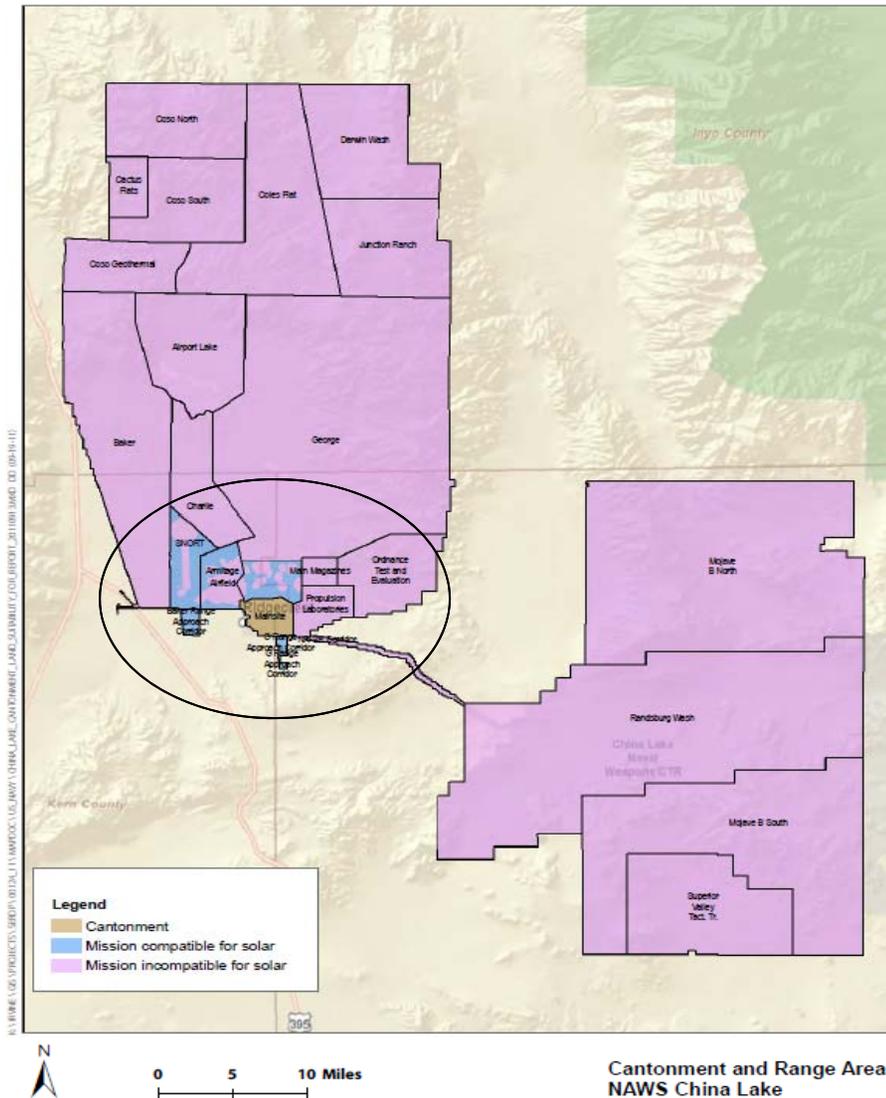
# R-2508 Overlay

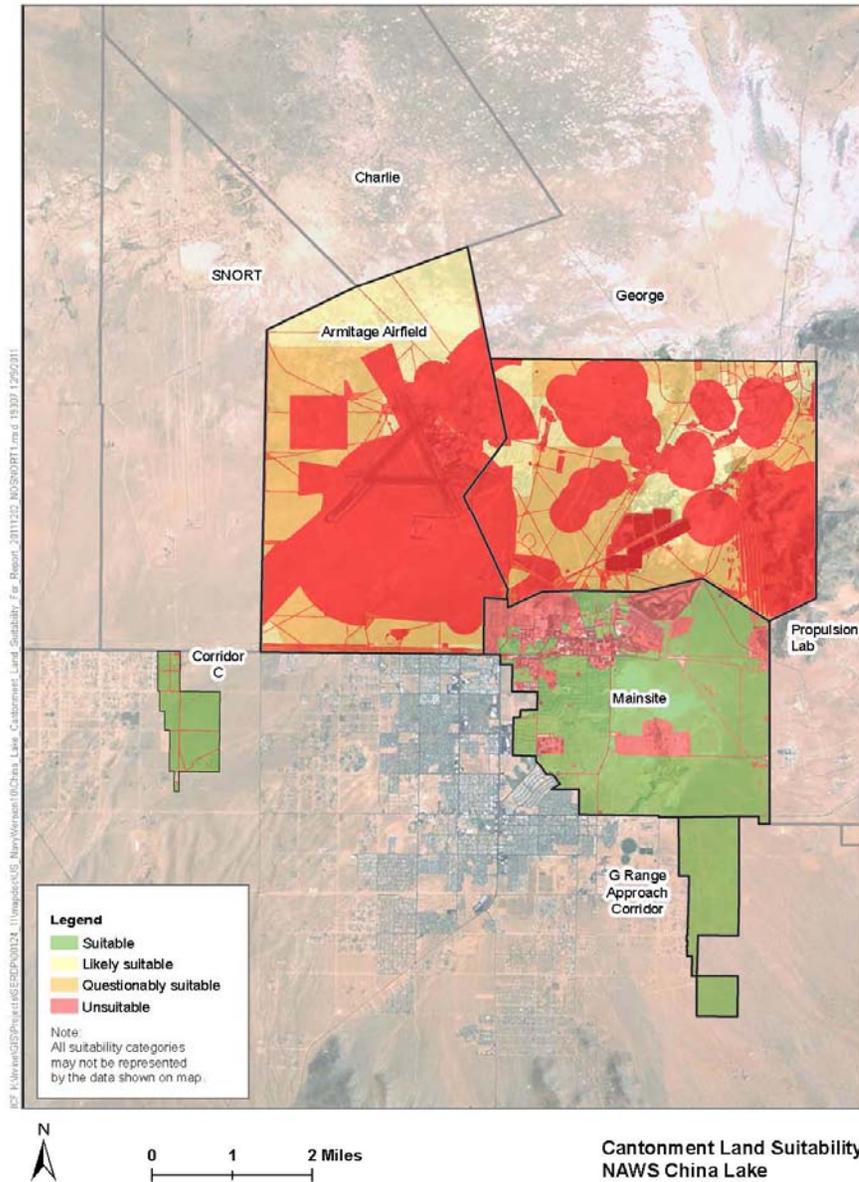


# NAWS China Lake Results



- Cantonment and close-in range
- 20 data layers including
  - Mission compatibility
  - Protected species
- Review of initial map by 9 staff
  - Base, NAVAIR, NAVFAC SW
  - Considerable feedback; integrated into current map
- 5,000 Category 1 acres
- 6,000 Category 2 & 3 acres
- Almost 1,000 MW<sub>AC</sub> ground solar potential
- **Much of range (> 1 M acres) off-limits but still huge potential**

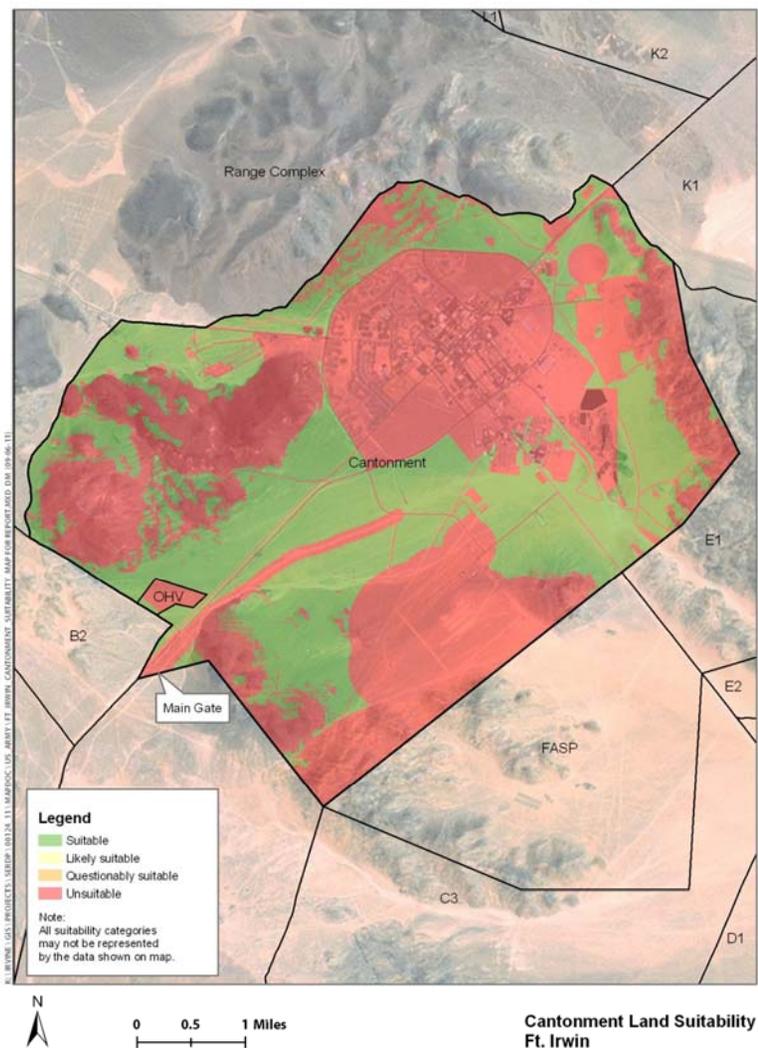




## NAWS China Lake - Cantonment and Adjacent Ranges

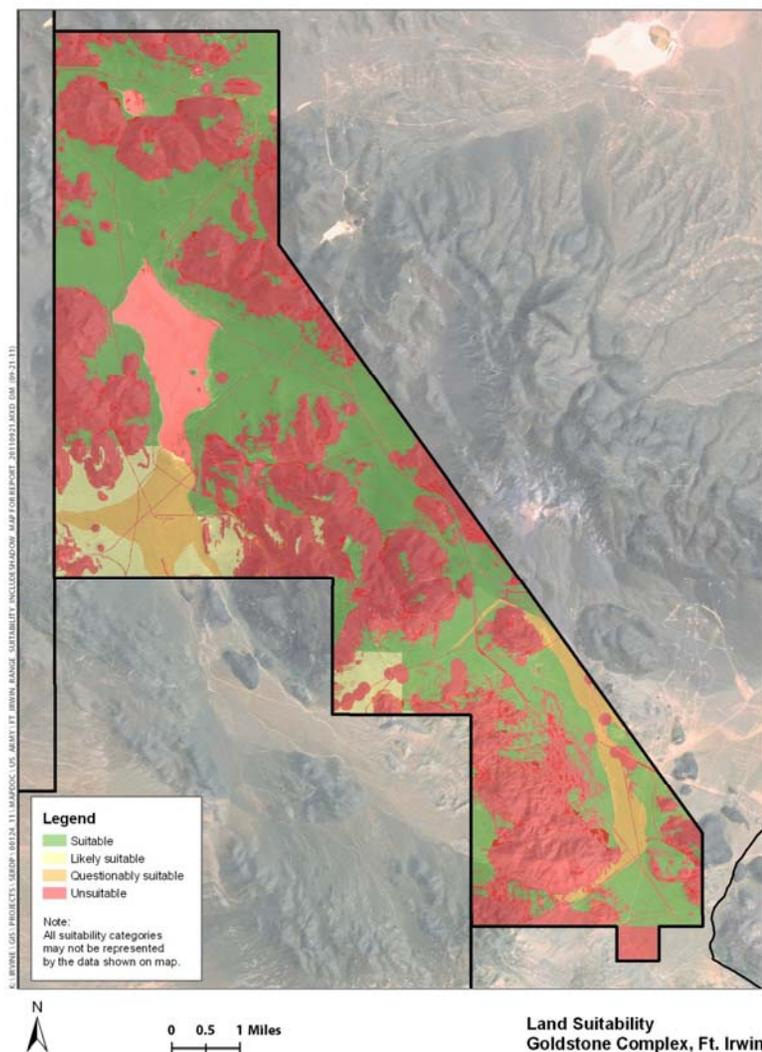
## Ft. Irwin/NTC – Near Cantonment Ranges

Unsuitable areas include ammunition storage, slopes >5%, restricted areas, future build-out areas, environmental cleanup areas, service roads, etc. Much of the additional exclusion area defined through conversations with Base DPW and Master Planning.



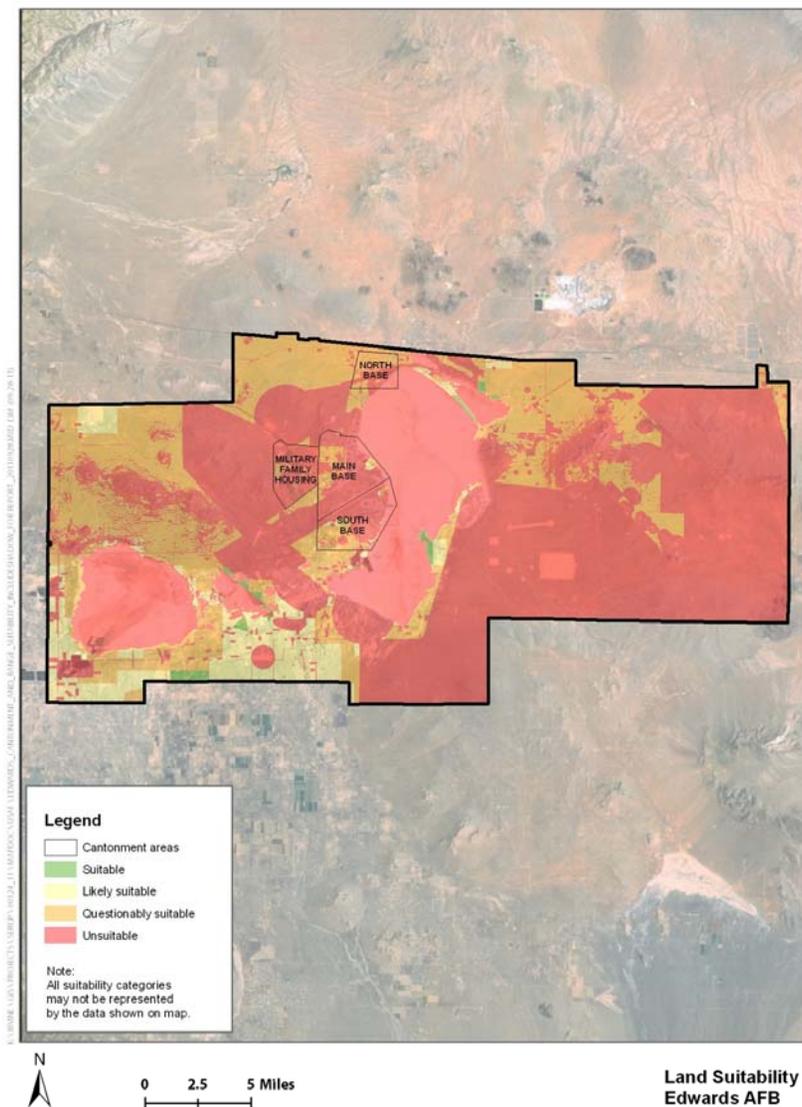
# Ft. Irwin/NTC - Goldstone Complex

Main exclusion factors included slope, shading, flood zones and playas, buffers around antennas, flora and fauna management areas and cultural resource buffers. MGS density graded 1-4.



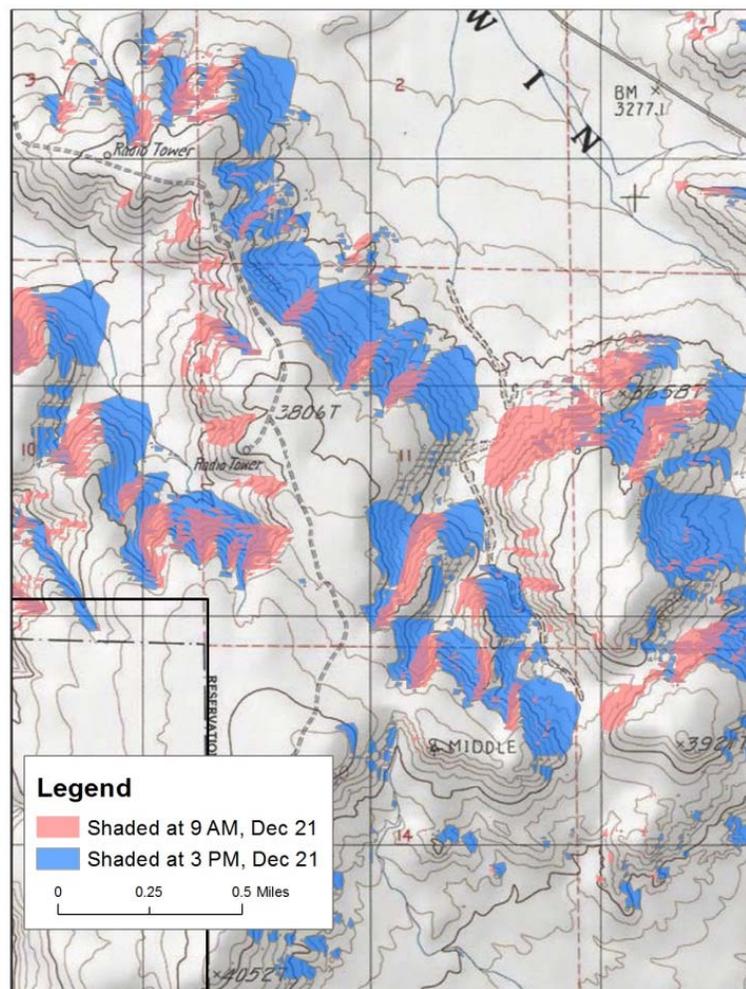
## Edwards AFB

- Security-sensitive test areas
- Desert tortoise and MGS habitat avoided
- More “edges and corners” than other installations
- No ground maneuver
- Limited live bomb drop
- ~350 MW project proposed for NW corner



## Hillside Shading Analysis

- Not a lot of trees in this part of the world
- Ground-mount sites in the cantonments were required to be >100 ft from any building (mostly low-rise)
- Ground-mount sites were required to be shade-free from 9 am to 3 pm on December 21, 2015



# Geometric criteria: minimum size



All suitable areas (Rating 1)



Passed geometry test (Rating 1)





# Technology and Economic Analysis



## Technology Analysis

- Take 100% of Category 1 area and 25% of Category 2 and 3 area
  - Eliminate most Category 2 and 3 because of the likelihood of finding real issues when walking the ground
- Build six different solar packages on every acre
  - Thin-film and crystalline PV x fixed and single-axis tracking
  - Trough
  - Dish/Stirling engine
- Technical Potential
  - Equipment specifications (MW of each technology, defines cost)
  - Hourly electricity generation (drives revenue)
  - Water consumption

## Economic Analysis - Framework

- 20-year discounted cash flow model
- 2015 project date
- Applied at the military installation level (expense and revenue drivers vary across installations) from the project's perspective
- 5 site types
- 6 solar technologies
- 2 ownership structures (MILCON and 3<sup>rd</sup> party)
- Outputs: net present value (NPV) and internal rate of return (IRR)

## Economic Analysis – Cost Elements

- Capital (e.g., panels, racking, trackers, BOS, installation labor). Assume 20% cost reduction for panels in 2015 vs. early 2011
- Running costs (e.g., O&M labor, insurance, inverter replacement accrual, decommissioning accrual)
- Water cost (CSP)
- Land lease rates for 3<sup>rd</sup> party owned – 2 models
  - BLM solar lease rates (differentiated by County and technology)
  - “Gain sharing” lease rate – cap developer’s IRR at 16% and evaluate potential for additional rent
- Transmission extension costs
  - Ignored the very real transmission constraints
  - Priced in costs to reach nearest major point of interconnection
  - Did not model network impact costs



## Economic Analysis - Revenue Elements

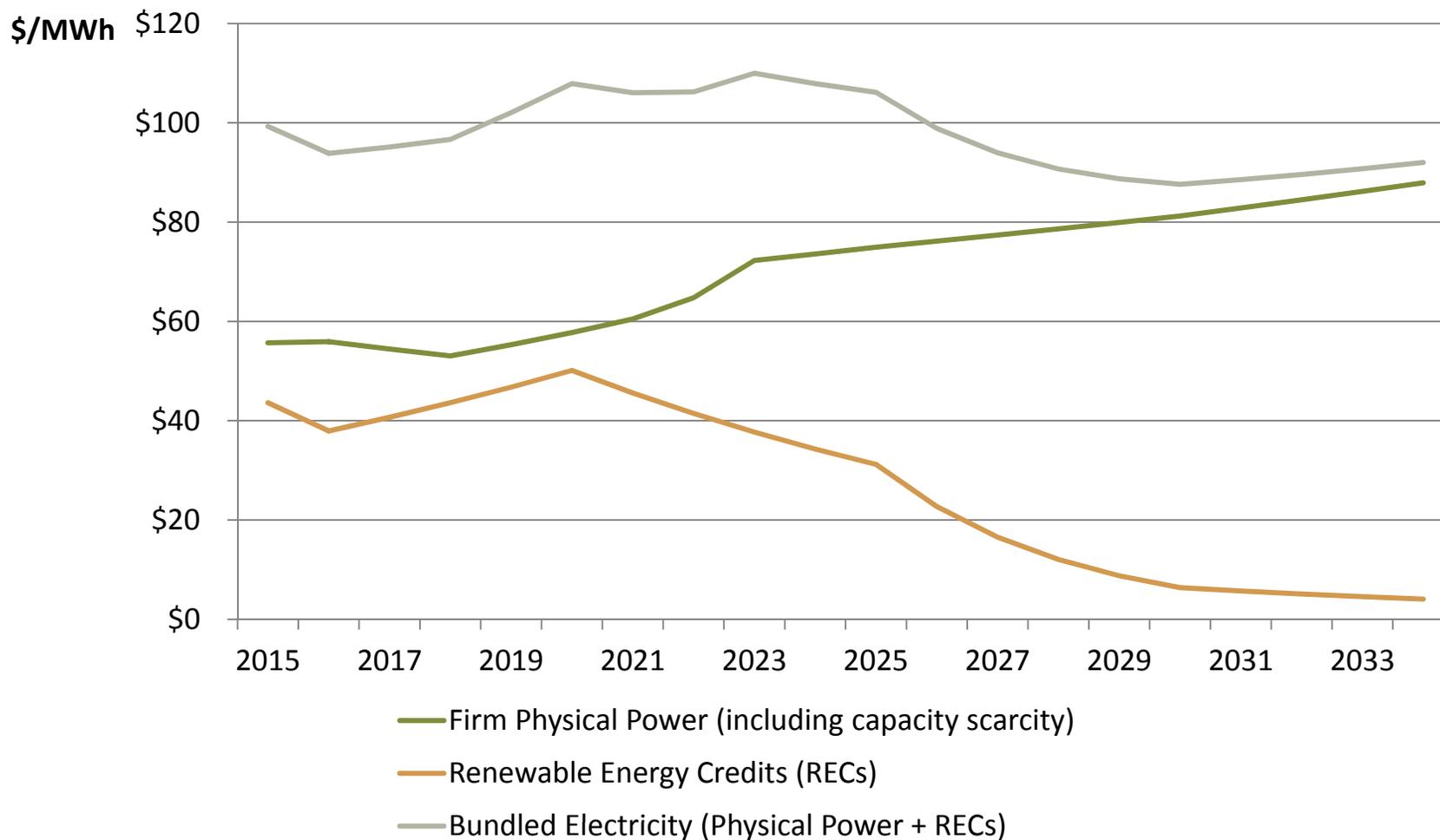
- Electricity prices (20-year wholesale and self-generation projection) developed using ICF's IPM model
- REC prices (20-year projection) developed using IPM
- Assume all RECs sold to realize ~25% of project revenue.  
Cheap replacement RECs available
- Solar incentives taken by private developers (not if MILCON)
  - Business Investment Tax Credit (30% of capital cost)
  - Modified Accelerated Cost Recovery System (MACRS) – 6 year depreciation schedule
  - Other California and Nevada state incentives not expected to be material

# Southern California Wholesale Power Price Projections: Background



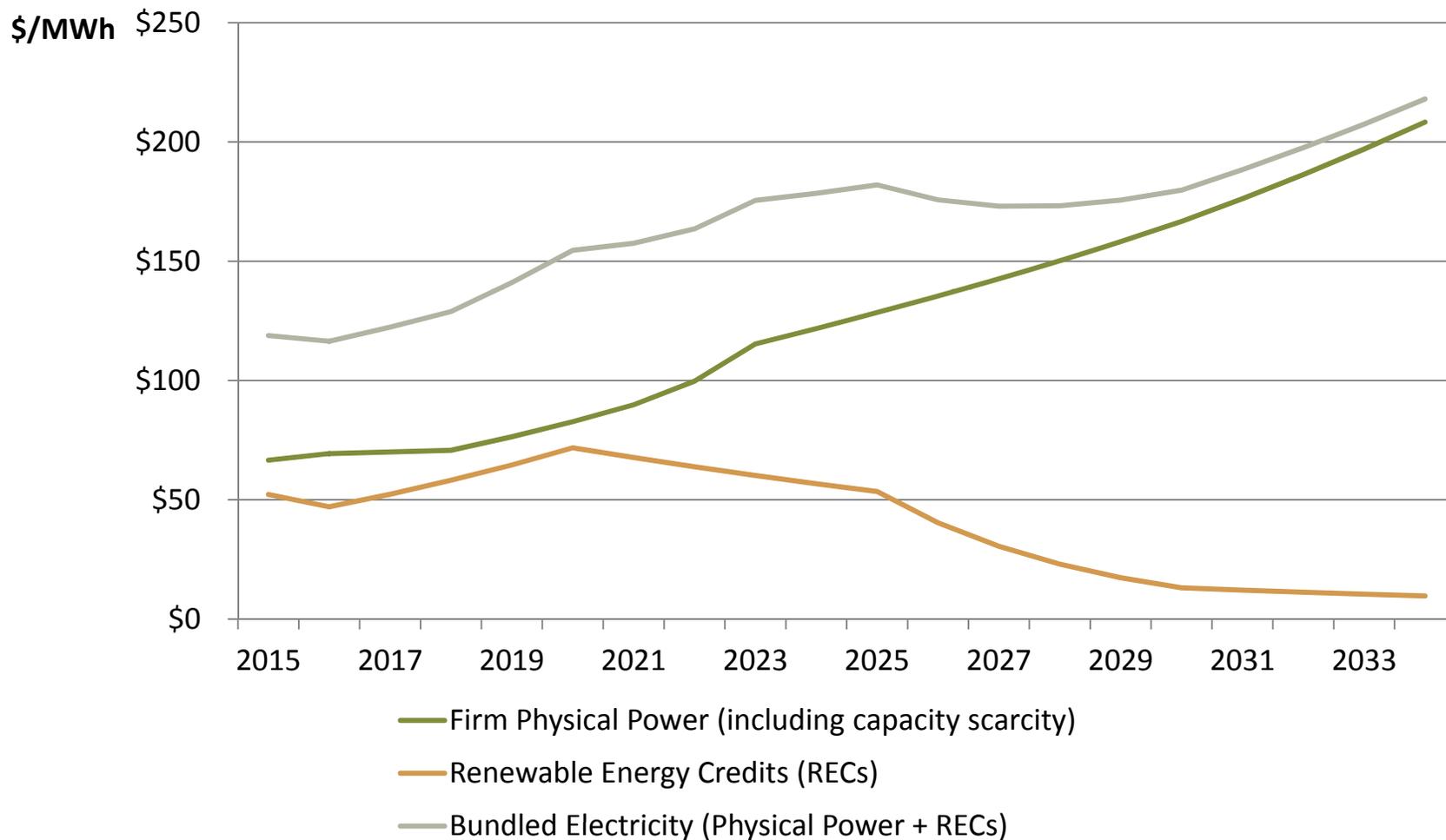
- ICF's proprietary economic modeling software, Integrated Planning Model (IPM®) was utilized
  - Software is used by EPA, utilities, generators, and others to understand short-term and long-term U.S. electricity market dynamics
- Input and other assumptions from EPA's latest Base Case 4.10
- Though physical power and RECs are bundled in CA, they are broken out in the study for analytic clarity
- On-peak and off-peak prices were modeled and utilized in the study; their weighted-average is displayed in graphs here
- Projections in real 2010 dollars were converted to nominal dollars using 3.66% annual inflation rate

# Modeled Southern California Wholesale Power Prices for 2015-2034: Real 2010 Dollars



From EPA's Base Case 4.10 assumptions

# Modeled Southern California Wholesale Power Prices for 2015-2034: Nominal Dollars



From EPA's Base Case 4.10 assumptions



## Economic Results

- Only third-party financing works. MILCON fails comprehensively
- All parking lot shading structures failed the economic test due to cost of building the shade canopy
- All technically-eligible rooftop potential was economically viable
- Almost all technically-eligible ground sites were economically viable for at least one solar technology
- BLM ground rental rates could increase and still give developer 16% IRR
  - BLM's methodology has important differences from ICF's
  - ANPRM for competitive leasing published December 29



## Conclusions and Recommendations



## Analytical Conclusions

- Substantial solar potential available after accounting for mission compatibility, environmental and cultural resource conflicts, etc.
- DoD needs to work with private-sector developers to ensure financial viability
- Potential for significant new value to be earned
- Development should be accelerated to maintain access to current Federal tax credits
- Programmatic scale-up necessary and desirable



## Analytical Cautions

- The analysis is only as good as the data, which were often incomplete, coarse-scale, old, or poorly documented.
- Technical and economic potential numbers were based on GIS and economic analysis. Reality will inevitably be more complex and the results smaller.
- Within an unclassified study, there were some issues (e.g., mission compatibility) that could not be as thoroughly explored as we would have liked.
- As with any forecast/projection, the results are subject to the evolution of technology, policy and markets.
- The potential numbers are an upper limit to show what is possible, however it is extraordinarily unlikely that DoD would need or want to build out the full potential



## Policy Recommendations

- Clarify withdrawn lands policy and land rental formula with the Department of the Interior
- Work with stakeholders to accelerate transmission development
- Clarify DoD policy on REC ownership and accounting
- Clarify and develop programs to achieve energy security goals
- Increase coordination and integration of renewable energy projects and initiatives among military installations and Services
- Develop a consistent and incentive-focused formula to allocate project benefits and costs between the host installation and parent organizations
- Develop methodology for solar mission compatibility analysis, especially for spectrum interactions



## California Government Considerations

- Development on DoD-controlled lands is different from development on BLM-managed or privately-owned lands
  - Military mission performance cannot be jeopardized
- Within DoD, each service and installation is different
- Solar can work on DoD installations, but there needs to be a good reason for DoD and the developer to proceed
  - Large-scale projects constrained by transmission availability
  - “Behind-the-meter” projects may be more attractive to DoD and developers in the short term and possibly the long term
- Does State want to encourage preferential location of solar on DoD installations? If so, what will the State do to encourage it?



## Developer Considerations

- Need to consider the relative attractiveness of developing on DoD-controlled land vs. BLM-managed and private land
  - Explicit or implicit land rental costs
  - Infrastructure availability
  - Effective, motivated counterparties with fast, smooth, predictable process
- Can a wholesale-competitive project be sited on DoD installations?
- Potential to serve significant (tens of MW) onsite load with higher payments than wholesale market participation
- Opportunity to combine with microgrids, storage, other technologies



## DoD Considerations

- Protection (and if possible, enhancement) of mission performance
  - Installation energy independence and security (but requires more than just solar)
- Revenue or in-kind consideration, preferably with some remaining at the installation
- Mandate compliance is in third place



## Thanks

Bob Kwartin  
Vice President  
ICF International  
9300 Lee Highway  
Fairfax, VA 22031  
[rkwartin@icfi.com](mailto:rkwartin@icfi.com)

703-934-3586  
703-934-3530 fax

[www.icfi.com](http://www.icfi.com)