ERDC/CERL SR-02-12

Construction Engineering Research Laboratory

US Army Corps of Engineers®
Engineer Research and Development Center

Sustainable Installation Risk Assessment and Stationing Implications

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September 2002

Foreword

This study was conducted for Headquarters, U.S. Army Corps of Engineers (HQUSACE) under Project AT45 work unit "Energy Indices and Metrics". The technical monitors were Steven Love and Stephen Reynolds (CEMP-IP) of HQUSACE and William Goran, Director of Special Projects, Construction Engineering Research Laboratory (CERL).

The work was performed by the Energy Branch (CF-E) of the Facilities Division (CF), Construction Engineering Research Laboratory (CERL). The principal investigator was Brian M. Deal. Elisabeth Jenicek led the team that gathered the data, assisted by Heidi Howard, Tom Smith, William Brown, Adam Sagert, Mark Ginsberg, and Steven Sweeney. Thomas J. Hartranft is Chief, CF-E, and L. Michael Golish is Chief, CF. The associated Technical Director is Dr. Paul Howdyshell. Part of this work was done by Donald Fournier of the University of Illinois Building Research Council under contract DACA-88-99-D-0002. The technical editors were Linda L. Wheatley and William J. Wolfe, Information Technology Laboratory – Champaign. The Director of CERL is Dr. Alan Moore.

CERL is an element of the U.S. Army Engineer Research and Development Center (ERDC), U.S. Army Corps of Engineers. The Commander and Executive Director of ERDC is COL John Morris III, EN, and the Director of ERDC is Dr. James R. Houston.

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1 Introduction

Background

The U.S. Army is undergoing fundamental changes in capabilities to better support joint war fighting and operational objectives and to fulfill its obligations under the National Military Strategy (NMS). These changes in capabilities require stationing newly developed units and redefining the missions of existing ones. Army installations – where we house our soldiers and their families, project and sustain the force, train and develop leaders and soldiers, and acquire and maintain materiel to equip soldiers and organizations – are certainly part of the process. The unit and the installation must be a good "fit" for one another. Selecting the appropriate installation for stationing a unit is a complex decision and may carry unintended consequences. As the Army is transforming and modernizing to meet today's requirements, coincident transformations and changes have been occurring outside the gate. It is not a static world – societal changes, demographic shifts, and increasingly stringent environmental laws are affecting the Army's ability to effectively use its training lands and installations.

Historically, many Army installations have been isolated from development, thus creating protected havens for unique natural and cultural resources. In essence, Army land management practices and activities have served to protect and enhance the regional environment (Van Antwerp 2001). These isolated and remote Army installations originally had little residential or commercial development nearby, and the public had little awareness of training activities. Over the last several decades, however, the population and the amount of developed land around most U.S. cities, and consequently, military installations, have grown significantly. Meanwhile, the Army's ranges and training lands have remained undeveloped and insulated from the urbanization and sprawl development that has covered much of the landscape. Development led to habitat destruction leaving undeveloped ranges and training lands to become "islands of biodiversity." Their value as habitat and a natural resource base has steadily increased over time. Over time, population centers expanded to or near installation boundaries and residential development occurred in more remote areas and previously rural settings. Therefore, citizens became more aware of training and range activities. Economic expansion, some of it probably driven by the installation's economic impact in the local area, has resulted in new suburban communi-

ties developing near Army installations. The resulting effect is that Army installations are often now in the midst of large urbanized or urbanizing areas. Military training activities produce noise, dust, the expenditure of munitions, and ground activities that can be viewed as a nuisance and annoyance to those who now live nearby. Also, training activities may prevent access to land that is now the most pristine in the region.

The combination of new environmental laws and nearby urban development is creating significant pressures to alter land use practices on military installations. These pressures are termed "encroachment," which is a general descriptor for the many issues that limit the military use of land, air-, and sea-space (Angello 2001). The Department of Defense (DoD) Senior Readiness Oversight Council (SROC) has identified eight categories of encroachment. While there are other valid encroachment concerns, the issues most likely to negatively affect readiness and the ability to station forces in the immediate future are:

- Endangered Species and Critical Habitat
- Unexploded Ordnance and Munitions
- Frequency Encroachment
- Maritime Sustainability
- Airspace Restrictions
- Air Quality
- Airborne Noise
- Urban Growth.

Each encroachment issue becomes a stressor to installation sustainability and/or a threat to stationing. The Army's primary encroachment concerns are urban sprawl, threatened and endangered species (TES), and restrictions that affect use of munitions or other combat-related techniques such as obscurants. Army stationing may also be affected by restrictions due to air quality standards, erosion control requirements, water quality standards, and restrictions on wetland impacts. The Army has implemented programs to ensure compliance with environmental statutes and regulations and to address these issues. Most major training installations have ranges designed and constructed specifically to meet the requirements of the forces assigned to that installation. Compliance actions have led to training capability curtailments at some installations. Management of endangered species causes restrictions on timing and location of training events and large portions of some Army ranges are unavailable during all or portions of the year for training activities such as digging fighting positions, dismounted maneuvers, occupying positions for combat, combat service support functions, and use of camouflage. As the number of listed plants and animals

increases, the amount of land available for unmodified training activities may decrease further (Ellis 2001).

These restrictions reduce the Army's flexibility to use its present land, while the requirement for more maneuver space to exercise emerging weapons systems is growing. The Army is limited in its ability to acquire new land. New land acquisitions have been rare in recent decades, and those that have been proposed have been constrained by public, landowner, and stakeholder concerns. In addition, residential and commercial development on Army installation boundaries restricts land available for acquisition, causes competition for resources, and adds to the difficulty in sustaining undeveloped buffers around ranges and training areas.

The Army must now reconcile its training and stationing requirements while addressing multi-faceted encroachment issues and, at the same time, complying with environmental regulations and fulfilling its desire to act as good stewards of the natural resources. Installation sustainability and mission sustainment are complementary, where one relies on the other to make a complete whole. The development of a Sustainable Installation Risk Assessment (SIRA) methodology allows decisionmaking within a broader and more informed context. This is especially true when considering the changes required under Army transformation. The encroachment issue should be viewed as a threat to mission sustainability so that the opportunity for informed decisions is used to avoid or mitigate considerable problems in the future.

Objective

The objective of this study was to review the issue of installation sustainability in the context of defining risk and stressors that may complicate the stationing of forces under Army Transformation.

Approach

Stationing is a multi-faceted and complex issue requiring a careful and thoughtful approach that considers not only installation assets and resources, but that the installation and mission fit into the surrounding region. Important parameters to consider are how the region is developing and what resource requirements it has that may impact the installation's capability to sustain the current and proposed missions. The methodology and framework used are intended to

respond to the issue of stationing in an integrated manner as part of an overall installation sustainability concept.

The installations included in this analysis were selected in consultation with the Center for Army Analysis (CAA), HQUSACE, and staff at the Assistant Chief of Staff for Installations (ACSIM).

Mode of Technology Transfer

The information in this report is intended to be considered as one of many possible inputs into Army stationing decisions over the next few years. In addition, this information has relevance as "baseline" data for installation sustainability initiatives for any of the installations identified in this report.

Units of Weight and Measure

U.S. standard units of measure are used throughout this report. A table of conversion factors for Standard International (SI) units is provided below.

SI conversion factors		
1 in.	=	2.54 cm
1 ft	=	0.305 m
1 yd	=	0.9144 m
1 sq in.	=	6.452 cm^2
1 sq ft	=	0.093 m^2
1 sq yd	=	0.836 m^2
1 cu in.	=	16.39 cm^3
1 cu ft	=	0.028 m^3
1 cu yd	=	0.764 m^3
1 gal	=	3.78 L
1 lb	=	0.453 kg
1 kip	=	453 kg
1 psi	=	6.89 kPa
°F	=	(°C x 1.8) + 32

2 Sustainable Installation Risk Assessment

Stationing is a proactive process providing the opportunity to incorporate the broader perspective of installation sustainability and its implications for mission sustainment. SIRA is a process of characterizing installations based on a set of risks or stressors. The process uses uniform risk assessments with a broad set of indicators covering the range of issues that affect Army installations. The determined risk is used to express the relative ranking of installations based on single measures (or groups of measures) that define a stress. This standardized approach enables national-level data to be used to evaluate the regional aspects of the installation setting. This evaluation provides a heightened awareness of long-term issues that could threaten mission sustainment. This methodology was developed and will be presented in the forthcoming U.S. Army Engineer Research and Development Center/Construction Engineering Research Laboratory (ERDC/CERL) Technical Report "An Assessment of Encroachment Mitigation techniques for Army Lands" (Deal et al., draft 2002).

Risk Assessment Framework and Metrics

Assessing installation sustainability is complex and requires the evaluation of a combination of risk factors, or stressors, that may not really lend themselves to prioritization. The effects of demographic change, community growth and sprawl, and regional economic vitality define levels of exogenous risk. Issues associated with installation mission, management, and cultural and natural histories define endogenous risk. The framework presented here is highly structured towards exogenous stressors that could be determined with data sets available nationwide. Another effort that looks more directly at endogenous risk is the Environmental Regulatory Climate Model (ERCM) developed by the U.S. Army Environmental Center (USAEC) and the Center for Army Analysis (CAA). Although there is some overlapping of indicators, these two efforts have been coordinated with one another, and the approaches are complementary. Determining the level of risk entails developing a set of indicators or indices that can provide reliable information about the level and type of a given risk exposure.

Overview of Indicator Development

An "indicator" is a piece of information that reflects what is happening in a larger system. It allows observers to see the big picture by looking at a smaller part of it. Indicators are often quantitative measures such as physical or economic data. For example, inflation and unemployment are traditional indicators used for making economic decisions. Indicators are widely used as a tool for monitoring progress and to simplify, quantify, and communicate complex issues. Multiple indicators are sometimes aggregated into an index, usually for comparison across locations or to indicate change over time. Indicators are often the feedback mechanism used to inform policy changes intended to improve the situation being measured.

Because the process of measuring focuses attention on the impact, it makes a great deal of difference what is measured and how it relates to what we wish to measure. Developing indicators is a six-step process (Maclaren 1996a):

- Define and conceptualize the goals for which indicators are needed.
- Identify the target audience, the associated purpose for which indicators will be used, and the relative number of indicators needed.
- Choose an appropriate indicator framework.
- Define indicator selection criteria.
- Identify a set of potential indicators and evaluate them against the selection criteria.
- Choose a final set of indicators and test their effectiveness.

A framework for developing a set of indicators is necessary for every indicator effort. Maclaren's recommended frameworks are goal-based, domain-based, issue-based, sectoral, and causal. They may also be a combination of two frameworks. A goal-based framework is predicated on the development of goals. Indicators are then created for each goal. A benefit of this framework is that there are fewer indicators. A weakness is that it does not capture linkages among the dimensions of the issue. A domain-based framework is based on the key dimensions of the issue like environment, economy, and society. Indicators are identified for each dimension. This framework is effective at ensuring that the key dimensions of the issue are covered. A weakness of this framework is that indicators are not linked to goals. An issue-based framework is based on definable issues such as sprawl, crime, industrial pollution, solid waste management, or encroachment. Sectoral-based indicators are defined by different sectors in the economy. Causal-based indicators are developed within a framework of conditions, stresses, and responses using composite indicators for each condition based on a set of stressors. Relief of the stresses points to the solution for the stress or risk.

The difficulty in selecting indicators is not a lack of measures but rather the overwhelming number of potentially useful indicators. The International Institute for Sustainable Development (IISD) selected the following criteria based on indicator literature and practical experience with performance measurement (IISD 2000):

- *Relevance* – Can the indicator be associated with one or several issues around which key policies are formulated? The indicator must be linked to critical decisions and policies.
- *Simplicity* – Can the information be presented in an easily understandable, appealing way to the target audience? Complex issues and calculations should yield clearly presentable and understandable information.
- *Validity* – Is the indicator a true reflection of the facts? Was the data collected using scientifically defensible measurement techniques? Is the indicator verifiable and reproducible? Methodological rigor is needed to make the data credible.
- *Temporality* – Is time-series data available, reflecting the trend of the indicator over time? Several data points are needed to visualize the direction the community or region may be going in the near future.
- *Measurability* – Is the data quantifiable – something that can be measured directly or can be counted? Data must be based on tangible information.
- *Availability and affordability of data* – Is good quality data available at a reasonable cost or is it feasible to initiate a monitoring process that will make it available in the future?
- *Expansiveness* – Is the indicator about a narrow or broad issue? Indicators that aggregate information on broader issues are preferred. For example, forest canopy temperature is a useful indicator of forest health and is preferable to measuring other indicators to come to the same conclusion.
- *Sensitivity* – Can the indicator detect a small change in the system? Determine whether small or large changes are relevant for monitoring.
- *Reliability* – Will you arrive at the same result if you make two or more measurements of the same indicator? Others should reach the same conclusions based on the indicator.

Sustainable Installation Risk Assessment Framework

The major SIRA issues are: Air Quality, Land Sustainability, Energy Resources, Water Resources, Social-Economic Impacts, and Infrastructure. Table 1 shows the risk assessment framework with stressors and indicators. Each indicator measures a different dimension of potential risk or stress.

Table 1. Risk assessment framework.

Issue 1			
	Stressor 1.1		
		Indicator	Data
		Indicator	Data
	Stressor 1.2		
		Indicator	Data
		Indicator	Data
Issue 2			
	Stressor 2.1		
		Indicator	Data
		Indicator	Data

Comparison across installations of values for an individual indicator can give a measure of relative stress along one dimension. Some stressors have only one indicator while others result from a combination of several indicators. The details for each indicator selected as germane to the stationing issue are given in Appendix A.

In addition to SIRA, the Environmental Regulatory Climate Model (ERCM) is underway by the U.S. Army Environmental Center and the Center for Army Analysis (USAEC 2001). ERCM is an indicator-based model used to assess demographic and environmental conditions in support of the Office of the Deputy Chief of Staff for Operations and Plans (DAMO-TR), Headquarters, Department of the Army, task of analyzing the relative training value of a variety of active component Army installations. The umbrella effort is the Installation Training Capacity (ITC) and is used to determine the relative capability of an installation to support live training by Active and Reserve Component units stationed at, or habitually training on, those installations, as well as live training requirements of Service Schools on those installations. ITC focuses on land, ranges, training facilities, and demographic/environmental factors affecting training. The study did not consider other installation capabilities such as cantonment area facilities, infrastructure, housing, etc. The ERCM is a process to identify and evaluate:

- Environmental regulatory issues
- Environmental issues that impact training
- Encroachment issues that impact training
- Impact of costs to maintain land for training
- Environmental ability of the land to support and sustain training
- Capability of the installation to expand or reconfigure to support training.

The ERCM Methodology is a coordinated effort by USAEC and the Major Army Commands and is continuing to be refined to ensure accuracy of information and pertinence of the criteria. ERCM is also being combined with CERL's exogenous risk indicator framework to develop a list of environmental factors to consider prior to restationing forces (Tomich 2002). ITC and SIRA complement one another and provide independent approaches to similar issues.

The research team has developed a set of risk indicators based on the process, framework, and criteria considerations described above. To help determine installation sustainability, our framework is a combination issue-based and causal-based. Using a combination framework has the advantage of being able to draw on the strength of the two frameworks while downplaying their weaknesses (Maclaren 1996b). This framework enables a relatively easy assessment of the risk or potential stress installations are experiencing. Risk analyses based solely on issues arising from stationing may use a subset of the risk factors. Stationing risk can be caused by factors originating both inside and outside the installation. For the purpose of explaining the data, risk factors can be evaluated in a framework based on installation specific risk issues with a causal-based stressor format. The issues are defined by a set of stressors and indicators that define the level of relative stress or potential problem areas. The indicators show where the risks lie and highlight potential long-term sustainability implications.

Installation Sustainability Stressors

The stressors selected for this analysis are based on community growth outside the installation boundaries. The indicators associated with such growth are determined using national data sources. Six main exogenous stressors are: air quality, energy resources, land use, water resources, socio-economic issues, and infrastructure. Air quality is assessed by the EPA on a regional basis. Regional air quality issues can limit the types of activities that may occur on a military installation. Water and energy resources are impacted by regional growth and related consumption and contamination. Regional types of energy use and their sources affect energy security, cost, and availability. Land use issues include the presence of pressures such as threatened and endangered species or a high level of seismic activities or natural disasters. Other land use threats relate to urban development in the surrounding community. Community size and economic strength indicate pressure for development of land to support residential, commercial, industrial, and support (schools, infrastructure, etc.) uses (Deal et al. 2000). DoD impacts are based on the economic contribution of the installation to the region. An installation that makes insignificant contributions to the region may be more readily regarded as a bad neighbor. Proximity stress results from community growth increasing the contiguity between outside development and

the installation. More and nearer neighbors increase the likelihood of incompatibility of land use and the conflicts that result. Given sufficient community size and proximity, the installation becomes an unintended growth limiter for the community. Socio-economic issues such as housing availability and healthcare cost can impact the quality of life available for military members and their families. Existing infrastructure may impact a regions' ability to support changes in military mission related to stationing decisions.

Potential indicators for measuring these stressors were selected based on the following requirements:

- Available at a uniform scale for the entire study area to ensure consistency in comparisons.
- Recorded for multiple time periods to enable the evaluation of change.
- Prepared by a reputable source, such as a government agency or professional data vendor, and accompanied by metadata for quality assurance.
- Provided in a digital format to accelerate data gathering and preparation for analysis.

Indicators selected to represent the stressors were population, employment, developed land, land use classifications, watershed quality, and regional water demand.

The endogenous factors assumed to indicate risk are related to the type of mission on the installation, the size of its demands for natural resources, the natural history of the installation and its bioregional implications vis-à-vis habitat issues, and indications of effective management. Indicators come from a variety of sources such as the USGS for water resource information, the USEPA for air pollution data and water supply characterization, the U.S. Fish and Wildlife Service (USFWS) for endangered species data, and the U.S. Department of Energy (USDOE) for energy-related data. The installation itself is the source for much of the data as it relates to management programs and how the installation has historically approached the increasing requirements for natural and cultural resource management.

Stationing Risk Indicators

The SIRA framework provides for a multiplicity of views or aggregations of the data collected. Regional data sets can be parsed and aggregated into varying categorical constructs to provide a more coherent understanding of the risks to a specified set of policies or decisions. This enables a more focused view of the risks associated with specific objective questions. An example of this capability

can be seen in the following description of the SIRA data collected and aggregated to discern risks to Army stationing strategies.

A proposed SIRA categorization was developed by ACSIM to study potential regional environmental risks to stationing. Categories include: Strategic Response Capability, Supports Objective Force Training Requirements, and Facilities & Mission Support. SIRA stressor/indicator data sets were parsed into the proposed categories to improve categorical explanatory power. This listing is found at Table 2. A brief stressor level description follows for logical explanation of the data. Appendix A includes more detailed explanations for each indicator in the issue-based format, defining its calculation, value, definition, and purpose.

The SIRA format gathers indicators under several stressor categories, which places them in logical groupings. Energy is broken into three stressors: availability, security, and efficiency. The energy stressors are concerned with continuous energy supply in a secure and efficient manner. Installations need to address energy holistically, as the supply of petroleum and natural gas will come under considerable stress in the next 25 years (within the next decade for petroleum). The electric supply is also coming under stress as the uncertainties of deregulation and security play out. Water is also broken into three stressors: availability, quality, and security. Water may even be more important than energy and, in the next several decades, the U.S. water supply will be under increasing stress – population pressures, climate change, and surface and groundwater pollution issues all represent threats.

Other stressor groups are less complex, but just as important. Transportation is crucial to linking military installations with both the regions around them and the theatres of operation for force projection. Urban development and land use controls provide insight into issues of encroachment and regional demands for installation resources. Locational issues are those associated with natural disaster potential, such as droughts, floods and earthquakes. These may become more important as we learn more about climate change and its impact on local weather patterns. Environmental issues include air quality restrictions, stakeholder problems, and Threatened and Endangered Species (TES) habitat requirements. Air quality degradation due to off-installation emitters has the potential to re-strict activities on an installation. Stakeholders in the region can disrupt and make operations problematic by filing complaints and lawsuits. TES issues can lead to training and mission restrictions in order to comply with natural resource management requirements.

Table 2. Subset SIRA indicators for stationing decision support.

Strategic Response Capability		
	Stressor	***Indicator***
EA1	Energy Availability	Electrical Source
EA2	Energy Availability	Regionally Imported Natural Gas
EA3	Energy Availability	Regionally Imported Petroleum
EA4	Energy Availability	Electrical Price Structure
ES1	Energy Security	DG Regulations: Net Metering
WS1	Water Security	Sole-Source Aquifer
TA1	Transportation	Air Proximity
TA2	Transportation	Air Capacity
TRR1	Transportation	Rail Proximity
TRR2	Transportation	Rail Capacity
TR1	Transportation	Road Proximity
TR2	Transportation	Road Congestion
TR3	Transportation	Road Access
SP1	Infrastructure Security	Proximity to MSA
Supports Objective Force Training Requirements		
	Stressor	***Indicator***
N1	Noise	Complaints
N2	Noise	Joint Land Use Study
UD1	Urban Development	Regional Population Density
UD2	Urban Development	Increasing Regional Growth Rate
UD3	Urban Development	Regional Population Growth
UD4	Urban Development	Regional Land Urbanization
UD5	Urban Development	State Smart Growth Plans
Facilities and Mission Support		
	Stressor	***Indicator***
	Facilities	
EE1	Energy Efficiency	Progress Toward Goals
LI1	Locational Issues	Proximity to 100 Year Flood Plain
LI2	Locational Issues	Seismic Zones
LI3	Locational Issues	Natural Disasters
WV1	Water Availability	JAWRA
	Environmental Quality	
AQ1	Air Quality	Non-Attainment Status
AQ2	Air Quality	Air Quality Index
TE1	TES Restrictions	Species Listed
TE2	TES Restrictions	Critical Habitat
TE3	TES Restrictions	Species in State
WQ1	Water Quality	JAWRA
WS1	Water Security	Sole Source Aquifer
SH1	Stakeholders	# of Lawsuits
	Quality of Life	
DP1	DoD Economic Presence	Military Employment%
QL1	Quality of Life	Crime Rate
QL2	Quality of Life	Housing Availability
QL3	Quality of Life	Healthcare Costs
QL4	Quality of Life	Job Availability
QL5	Quality of Life	Educational Attainment
QL6	Quality of Life	Commute Times
QL7	Quality of Life	Cost of Living
QL8	Quality of Life	Community Economic Strength

The final stressor categories of quality of life and economic presence provide indicators of how the local economy is functioning and the potential economic opportunities for soldiers' spouses and family members. Problems in the local economy may spread to Army families that rely on that economy. Also, a low military presence in the community may result in the military installation not being valued by the greater community and even being seen as a nuisance. This can be a two-edged sword; a good local economy is good for families, but a local economy that is growing and robust may be an installation sustainability threat if the military economic contribution is diminishing and other users want to complete for the military assets.

SIRA Indicators Still Under Development

Several indicators were proposed for this effort, and their data availability and interpretation have been problematic. Work continues on these indicators in an effort to bring them into the decision process. Indicators still under consideration and development are those associated with frequency encroachment, flight restrictions, landfill availability, and proximity to floodplain.

The SIRA format has many indicators that have not been included in this effort. Those indicators are also under constant review to ascertain their applicability to the stationing risk assessment. As noted in the sections above, the development of indicators is challenging in that there are so many to choose from and only those that provide viable information can be used to inform decisions. Selection of indicators is somewhat subjective, so a thorough vetting of each one is required. Scaling and normalizing of the data also require judgment to ensure the indicators provide useful information. All Red or all Green indicators provide no differentiation for decisionmaking.

3 Sustainable Installation Risk Assessment for Selected Installations

The ERDC/CERL team developed the indicator data for 18 installations and subinstallations using the stationing risk subset of SIRA. The indices for each installation are broken down by category. The first category or group is Strategic Response Capability. These are indicators that provide information about region-wide resource and infrastructure issues that can indicate potential stresses when large demands are made upon these resources. Table 3 shows the indicators for this group and the results for the 18 installations. The second group of indicators provides information about the installations' ability to support Objective Force training requirements. These tend to be encroachment-related issues that could impact on the installations' ability to conduct training. Table 4 shows the indicators for this group and the results for the 18 installations. The third group of indicators provides information about facilities and mission support. This group has three subcategories: Facilities, Environmental, and Quality of Life. These indicators are more related to general sustainability issues and place the installations within the context of their local regions, highlighting stressors and risks that affect long-term mission sustainment. Indictors range from potential resource issues such as long-term water availability to issues that could indicate potential economic problems for soldiers and their families. These stressors are found in Table 5. Appendix B provides the actual data for each installation evaluated.

The results are not definitive and should be considered indicative of potential areas where problems could arise. The SIRA format is intended to provide information about potential areas of stress and inform policy decisions that relate to ameliorating that stress. Since all of the information for indicator calculations was derived from national data, many of the indicators are several years old. It takes time for these data sets to be assembled. In all cases, the most recent data available were used. In general, the types of data utilized do not change rapidly, and the trends indicated are valid.

Table 3. SIRA indicators for strategic response capability.

Strategic Response Capability																							
Indicator Number	**Issue**	**Stressor**	**Indicator**	White Sands Missile Range	Yuma Proving Grouns	Rock Island Arsenal	Redstone Arsenal	Fort Drum	Fort Carson	Pinyon Canyon Maneuver Site	Fort Lewis/Yakima	Fort Richardson	Fort Stewart/Hunter AAF	Fort Polk	Fort Benning	Fort Bliss	Fort Riley	Fort Knox	Fort Campbell	Fort Bragg	Fort Hood
EA1	Energy	Energy Availabity	Electrical Source																		
EA2	Energy	Energy Availabity	Natural Gas Price Variability																		
EA3	Energy	Energy Availabity	Petroleum Price Variability																		
EA4	Energy	Energy Availabity	Electrical Price Structure																		
ES1	Energy	Energy Security	DG Regulations: Net Metering																		
WS1	Water	Water Security	Sole-Source Aquifer																		
TA1	Infrastructure	Transportation	Commercial Airport Proximity																		
TA2	Infrastructure	Transportation	Air Capacity																		
TA3	Infrastructure	Transportation	Military Airfield Proximity																		
TRR1	Infrastructure	Transportation	Rail Proximity																		
TRR2	Infrastructure	Transportation	Rail Capacity																		
TR1	Infrastructure	Transportation	Road Proximity																		
TR2	Infrastructure	Transportation	Road Congestion																		
TR3	Infrastructure	Transportation	Road Access																		
SP1	Infrastructure	Infrastructure Security	Proximity to MSA																		

Risk Legend	
	Low
	Medium
	High

Table 4. SIRA indicators for supporting objective force training requirements.

Supports Objective Force Training Requirements																						
Indicator Number	**Issue**	**Stressor**	**Indicator**	White Sands Missile Range	Yuma Proving Grouns	Rock Island Arsenal	Redstone Arsenal	Fort Drum	Fort Carson	Pinyon Canyon Maneuwer Site	Fort Lewis/Yakima	Fort Richardson	Fort Stewart/Hunter AAF	Fort Polk	Fort Benning	Fort Bliss	Fort Riley	Fort Knox	Fort Campbell	Fort Bragg	Fort Hood
N1	Air	Noise	Complaints																		
N2	Air	Noise	Joint Land Use Study																		
UD1	Land Use	Urban Development	Regional Population Density																		
UD2	Land Use	Urban Development	Increasing Regional Growth Rate																		
UD3	Land Use	Urban Development	Regional Population Growth																		
UD4	Land Use	Urban Development	Regional Land Urbanization																		
UD5	Land Use	Urban Development	State Smart Growth Plans																		
		Risk Legend																			
			Low																		
			Medium																		
			High																		

Table 5. SIRA indicators for facilities and mission support.

Facilities and Mission Support																										
Indicator Number	**Group**	**Stressor**	**Indicator**	White Sands Missile Ran	Yuma Proving Grouns	Rock Island Arsenal	Redstone Arsenal	Fort Drum	Fort Carson	Pinyon Canyon Maneuve	Fort Lewis/Yakima	Fort Richardson	Fort Stewart/Hunter AAF	Fort Polk	Fort Benning	Fort Bliss	Fort Riley	Fort Knox	Fort Campbell	Fort Bragg	Fort Hood
EE1	Facilities	Energy Efficiency	Progress Toward Goals																		
LI2	Facilities	Locational Issues	Seismic Zones																		
LI3	Facilities	Locational Issues	Natural Disasters																		
AQ1	Env Quality	Air Quality	Non-Attainment Status																		
AQ2	Env Quality	Air Quality	Air Quality Index																		
TE1	Env Quality	TES Restrictions	TES Species																		
TE2	Env Quality	TES Restrictions	TES Impacts																		
TE3	Env Quality	TES Restrictions	Critical Habitat																		
TE4	Env Quality	TES Restrictions	Species of Concern																		
WQ1	Env Quality	Water Quality	Water Quality Index																		
WV1	Env Quality	Water Vulnerability	Water Vulnerability Index																		
SH1	Env Quality	Stakeholders	# of Lawsuits																		
SH2	Env Quality	Stakeholders	Biological Opinions																		
DP1	Quality of Life	DoD Economic Presenc	Military Employment%																		
QL1	Quality of Life	Quality of Life	Crime Rate																		
QL2	Quality of Life	Quality of Life	Housing Availabilty																		
QL3	Quality of Life	Quality of Life	Healthcare Costs																		
QL4	Quality of Life	Quality of Life	Job Availability																		
QL5	Quality of Life	Quality of Life	Educational Attainment																		
QL6	Quality of Life	Quality of Life	Commute Times																		
QL7	Quality of Life	Quality of Life	Cost of Living																		
QL8	Quality of Life	Quality of Life	Community Economic Strength																		

Risk Legend	
	Low
	Medium
	High

4 Conclusions and Recommendations

Conclusions

Collectively, indicators can aid in identifying potential issues that should be considered when stationing decisions are made. Some limitations of this study do necessitate caution in the use and application of the results. The set of indicators is based on the expert judgments and consensus of those who participated in the project team and were somewhat restricted by the available data. We required that data be readily accessible and available nationwide. The identification of specific risk thresholds and classifications is subjective in some cases, and alternative classifications are possible. No attempt has been made to either weight the indicators or rank the relative importance of individual indicators. The team's goal has been to provide useful insight into identifying relative risks across installations, and these results should not be interpreted as absolute. Different installations have different risks and differing missions, so the data should be applied with this in mind.

Recommendations

The tremendous amount of growth and urbanization that has occurred since World War II has changed the landscape of the nation. Military installations can no longer be considered isolated and self-sufficient entities with no responsibilities to the region in which they reside. Virtually every military installation is at risk for some type of stationing issue. Some are certainly at greater risk than others, but the increasingly demanding regulatory climate and urbanization patterns indicate a continued and growing pressure on installations.

Stationing is a subset of the sustainability issue. Military installations will be required to address this larger issue of sustainability in the not too distant future. An installation that focuses solely on its military mission and ignores the sociopolitical and environmental issues in the region does so at its own peril. A proactive stance where the installation increases its public involvement in the region through educational activities, partnerships, regional planning, and ecoregional problem solving will greatly enhance the installation's long term viability and ease stationing decisions. Therefore, these issues must be considered when stationing decisions are made. Here, as elsewhere, an ounce of prevention is certainly worth a pound of cure.

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Appendix A: Selected Risk Indicators for Stationing Risk Assessment

Strategic Response Capability

Stressor: Energy Availability

EA1. Indicator: Electrical Source ($NCFF_E/T_E$)

The Electrical Source indicator shows the amount of non-coal fossil fuel used in the production of electricity on the grid that services the military installation. The indicator (in percent) is the amount of non-coal fossil-fuel-derived electricity ($NCFF_E$) divided by the total electricity (T_E), in MWh, produced in the region of the military installation.

Risk Class: Low (<10%), Medium (10 - 40%), and High (>40%).

This indicator is important because the use of renewables, coal, and nuclear energy indicate a high degree of availability in fuel source. The use of coal does indicate a potential environmental problem for the utilities, but the resource is in great supply and domestically produced. Oil and natural gas on the other hand have looming resource availability problems. Fuel source data are available from the U.S. Environmental Protection Agency (USEPA) Office of Atmospheric Programs, Emissions & Generation Resource Integrated Database (E-GRID) 2000, Version 2.0, Data Years 1996-1998, September 2001.

EA2. Indicator: Natural Gas Price Variability ($\$G_N - \$G_S)/\$G_N$

Natural Gas Price Variability indicates the relationship between the state price to the national average.

Risk Class: Low (=>10% below US avg), Medium (0 to 10% below US avg),

High (=>US avg)

This indicator is important because price variability is related to demand in the region which affects availability to the military installation. The natural gas grid is highly vulnerable to disruption through terrorist acts and natural gas is an increasingly imported commodity. These data are available from the Energy Information Administration at the U.S. Department of Energy (DOE).

EA3. Indicator: Petroleum Price Variability ($\$P_N$ - $\$P_S$)/$\$P_N$

Petroleum Price Variability indicates the relationship between the state price to the national average. indicates the amount of oil consumed locally near the installation that is produced elsewhere.

Risk Class: Low (=>10% below US avg), Medium (0 to 10% below US avg),

High (=>US avg)

This indicator is important because price variability is related to demand in the region which affects availability to the military installation. Petroleum continues to be an increasingly imported commodity and the infrastructure is susceptible to interruptions. These data are available from the Energy Information Administration at the DOE.

EA4. Indicator: Electrical Price Structure (PS)

The price structure for electricity demand and delivery indicates whether the commodity has been deregulated and is thus more susceptible to market distortion such as price instability and availability fluctuations. A standard pricing structure (SPS) indicates stable pricing, a time of day (TOD)-sensitive rate structure indicates some variability in costs, and a deregulated time of day (DTD)-sensitive market indicates potential market volatility.

Risk Class: Low (SPS), Medium (TOD), High (DTD)

This indicator is important because installations that pay TOD-sensitive energy rates may have to adjust the time that energy intensive activities take place in order to avoid excessive costs. Deregulation of electrical markets in the United States is still very much a "work in progress," and the market has not normalized. These data are available on an installation-by-installation basis.

Stressor: Energy Security

ES1. Indicator: Net Metering (NM)

The availability of net metering indicates whether a state allows non-energy producers, such as consumers, to sell excess electrical energy produced onsite back to the grid at the local rate. If net metering is allowed in the installation's state then NM equals yes. If the state legislation is in the process of allowing net metering, NM equals IP. No state action made towards net metering indicates a no.

Risk Class: Low (Yes), Medium (IP), High (No)

The implications of this indicator are whether or not the State is progressive in its approach to integrated resource planning and management. A progressive approach ensures electricity availability and security in the future, while other approaches may not. The use of distributed generation adds to the robustness of the grid and its overall reliability.

Stressor: Water Security

WS1. Indicator: Sole-Source Aquifer (A_S)

This indicator measures to what degree the installation "lies" on a sole source/ primary aquifer that supplies water for the public.

Risk Class: Low (not a primary aquifer location), Medium (partial aquifer), High (primary aquifer)

The degree to which an installation is located over a primary aquifer is a strong indicator of the risk the Army runs of polluting waters intended for public use, and vice versa. This indicator calculation was found at the U.S. Army Environmental Center (AEC).

Stressor: Transportation

TA1. Indicator: Proximity to Commercial Airport (P_{AP})

This indicator provides a measurement of the proximity of the nearest commercial airport.

Risk Class: Low (<5 miles), Medium (5 to 25 miles), High (>25 miles)

The proximity of an airport to an installation is an indicator of the ability to strategically mobilize the force. This information was from the Terminal Area Forecast (TAF) System.

TA2. Indicator: Airport Capacity (A_C)

This indicator provides a measurement of the number of operations performed at the airport nearest an installation.

Risk Class: Low (<500 operations daily), Medium (500 to 1000 operations daily), High (>1000 operations daily)

The number of operations performed per day is an indicator of the number of potential airborne threats near an installation. This information was from the Federal Aviation Administration (FAA).

TA3. Indicator: Proximity to Military Airfield (P_{AF})

This indicator provides a measurement of the proximity of the nearest military airfield.

Risk Class: Low (<5 miles), Medium (5 to 25 miles), High (>25 miles)

The proximity of an airfield to an installation is an indicator of the ability to strategically mobilize the force. This information was from the Terminal Area Forecast (TAF) System and installation proximity to Air Force bases.

TRR1. Indicator: Proximity to Rail (P_R)

This indicator provides a measurement of the proximity of the nearest rail terminal to an installation.

Risk Class: Low (<5 miles), Medium (5 to 10 miles), High (>10 miles)

The proximity of a rail terminal to an installation is a strong indicator of force projection capabilities. This information was from the TAF System.

TRR2. Indicator: Capacity (trains/crossing/day)

This indicator provides a measurement of the number of trains passing through the terminal nearest to the installation per day.

Risk Class: Low (<5 trains a day), Medium (5 to 10 trains a day), High (>10 trains a day).

The number of daily trains crossing the terminal nearest an installation is an indicator of potential availability problems and congestion on the rail system. This information was from the Federal Railroad Administration.

TR1. Indicator: Proximity to Interstate (P_I)

This indicator provides a measurement of the distance from the nearest interstate highway to the installation.

Risk Class: Low (<25 miles), Medium (25 to 50 miles), High (>50 miles).

The proximity of an interstate to an installation is a indicator of availability of full transportation access. This information was from the Intelligent Road/Rail Information System (IRRIS).

TR2. Indicator: Congestion (RCI)

This indicator provides a measurement of the congestion of the local road network surrounding an installation.

Risk Class: Low (RCI<.74), Medium (.74 to 1), High (>1).

Road congestion is an indicator of potential problems using the highways near the installation. Road congestion is defined by the Roadway Congestion Index (RCI), which is defined as the ratio of traffic volume to road capacity, based on the *2002 Urban Mobility Study* published by the Texas Transportation Institute.

TR3. Indicator: Access (bridging/traffic volume)

This indicator provides a measurement of the congestion of the local road network surrounding an installation.

Risk Class: Low (<50,000 vehicles per day), Medium (50,000 to 100,000), High (>100,000).

Road access is defined by annual average daily traffic (AADT), which is a traffic count of the number of vehicles passing through a particular road segment. The majority of state Department of Transportation agencies provide annual traffic reports containing data on AADT, along with road segments and road structures.

Stressor: Security

SP1. Indicator: Proximity to MSA (MSA)

This indicator provides a measurement of the size of the nearby metropolitan statistical area.

Risk Class: Low (<100,000), Medium (100,000 to 300,000), High (>300,000).

Proximity to a large metro area is indicative of many stressors that impact the installation. Salient of these is the security risk associated with a nearby large population. The large population brings congestion, demand for resources, pressures of encroachment, and anonymity with coincident opportunity for domestic and foreign-based terrorism.

Support of Objective Force Training Requirements

Stressor: Noise

N1. Indicator: Noise Complaints (C_N)

The number of complaints (C_N) indicates the number of noise complaints registered at each military installation that result in a training adjustment.

Risk Class: Low (little or no restrictions), Medium (some restrictions), and High (severe restrictions). NA indicates insufficient data.

This indicator is important because noise management issues restrict training, cause installations to limit range fire during certain hours, or cause the installation to abandon certain areas previously used for training. Knowing the current levels of noise complaints for each installation will allow the Army to proactively address this issue. These data are from the AEC Environmental Regulatory Climate Model (ERCM).

N2. Indicator: Joint Land Use Study (JLUS)

JLUS indicates whether or not the military installation has a Joint Land Use Study in effect at the installation.

Risk Class: Low (Yes), Medium (No). NA indicates insufficient data.

This indicator is important because noise management issues that restrict training can be mitigated through a JLUS. These data are from the AEC ERCM.

Stressor: Urban Development

UD1. Indicator: Regional Population Density (P_T/L_T)

This indicator provides a measure of the population density of all counties adjacent to the installation. The indicator is found by dividing the total regional population (P_T) by the total regional land area (L_T) of all adjacent counties in square miles.

Risk Class: Low (<100 pp/sq mi), Medium (100-250 pp/sq mi), High (>250 pp/sq mi)

A high population density surrounding a military installation is a strong indicator of potential encroachment issues. This can affect the type and intensity of training that can take place on the installation. This indicator calculation was based on data (both county populations and square mileages) accessible through the U.S. Census Bureau.

UD2. Indicator: Increasing Regional Growth Rate ($P_{90\text{-}00}/P_{80\text{-}90}$)

This indicator provides a measure of the rate of change of population growth of all counties adjacent to the installation from the decade of the 1980s to that of the 1990s. The indicator value is found by dividing the regional population growth rate from 1990- 2000 ($P_{90\text{-}00}$) by the regional population growth rate from 1990 to 2000 ($P_{80\text{-}90}$).

Risk Class: Low (<1), Medium (>1), High (NA).

An increasing rate of regional population growth is a strong indicator of increased population pressure in the future leading to greater demands for services, access, resources, and land in competition with the military installation. This can affect the type and intensity of training that can take place on the installation. This indicator was calculated based on information from the U.S. Census Bureau.

UD3. Regional Population Growth (P_{2000}/P_{1990})

This indicator provides a measure (in percent) of the population growth of all counties adjacent to the installation from 1990 to 2000. The indicator value is found by dividing the regional population in 2000 (P_{2000}) by the regional population in 1990 (P_{1990}).

Risk Class: Low (<2%), Medium (2 to 7%), High (>7%).

The degree of regional population growth is a strong indicator of demand for services, access, resources, and land in competition with the military installation. This can affect the type and intensity of training that can take place on the installation. This indicator was calculated based on information from the U.S. Census Bureau.

UD4. Regional Land Urbanization (L_U/L_T)

This indicator provides a measure (in percent) of land urbanization within a 20-mile boundary surrounding the installation. The indicator value is found by dividing the amount of urbanized land (L_U) by the total land area (L_T).

Risk Class: Low (< 29%), Medium (29-35%), High (>35%).

The degree of regional development is a strong indicator of potential encroachment problems that can affect the type and intensity of training that can take place on the installation. This indicator calculation was performed with Geographical Information Systems (GIS) using the National Land Cover Data available at the U.S. Geological Survey (USGS).

UD5. Indicator: State Smart Growth Plans

This indicator provides a measure of the presence of smart growth legislation in states in which an installation is located.

Risk Class: Low (state has instituted smart growth),
Medium (legislation is pending), High (no legislation)

The presence of a state smart growth plan is important because smart growth legislation can decrease the growth of urbanized land surrounding a military installation. This information is available from the American Planning Association.

Facilities and Mission Support – Facilities

Stressor: Energy Efficiency

EE1. Indicator: Progress Toward Goals ($1-EI_I/EI_B$)

Energy intensity glide path is a measure of facility energy consumption over time and how the installation is progressing towards goals. Facilities energy

consumption is averaged over all non-family housing facilities on an installation and compared to the FY85 baseline. Energy intensity for the installation (EI_I) is divided by the installation baseline (EI_B) and calculated as a percent.

Risk Class: Low (>=25%), Medium (>0 and <25%), High (<0).

This indicator is important because Executive Order 13123 sets a goal for standard buildings/facilities to achieve 30% reduction in energy consumption per gross square foot by the year 2005 (a 1.5% reduction each year) and 35% reduction by the year 2010 relative to 1985 levels. Intensity is calculated by dividing the annual building energy consumption by the annual building square footage. These goals are going to be raised over time. Data on annual building energy consumption and square footages are available from the Headquarters, Redesigned Army Defense Utility Energy Reporting System (DUERS) Data System (HQRADDS) database.

Stressor: Locational Issues

LI1. Indicator: Proximity to 100-Year Flood Plain

This indicator is currently in limbo because of difficulty in measurement. Examination of Federal Emergency Management Agency (FEMA) flood documents have shown that the Army buildings are not located within the 100-Year floodplain, although other installation property is. Whether this is important cannot be determined due to a current lack of information.

LI2. Indicator: Seismic Zones (SZ)

Seismic Zones indicates the intensity of an earthquake threat to an installation. Seismic risk is on a scale from 0 to 32.

Risk Class: Low (<8), Moderate (8-16), High (>16).

This indicator is important because the Army must be sensitive to potential threats from the natural environment. This information is available from the USGS.

LI3. Indicator: Natural Disasters (ND)

This indicator provides a measurement of the cost of the loss of crops and damage due to natural disasters.

Risk Class: Low (<$1,184M), Medium (>=1,184 and <=$3,003M)

High (>$3,003M)

The historical damage and losses due to natural disasters is a good indicator of future losses. This information is available from the National Weather Service at www.nws.noaa.gov/om/hazstats.shtml.

Facilities and Mission Support – Environmental Quality

Stressor: Air Quality

AQ1. Indicator: Non-Attainment Status (Non-Att)

Emission status indicates whether or not a US County is in attainment of USEPA air quality emission standards for the six criteria pollutants. The six pollutants are CO (Carbon Monoxide), PM (particulate matter), SO_2 (Sulfur Dioxide), NO_2 (Nitrogen Dioxide), O (Ozone), and Pb (Lead). If any county adjacent to an installation is not in attainment, then a high risk is assigned to that installation.

Risk Class: Low (No), High (Yes)

Being in a non-attainment zone is a strong indicator that the military may face restrictions on the amounts of certain emissions they can release (including mobility emissions). This information is available from the U.S. Environmental Protection Agency.

AQ2. Indicator: Air Quality Index (AQI)

The aggregated air quality index indicates the maximum level (ppm) of the six criteria pollutants present in counties adjacent to Army installations. The levels of each of these pollutants (AQI) are measured as good, moderate, unhealthy, very unhealthy, and hazardous. The six individual pollutants are then aggregated into a risk class for each installation based on a statistical calculation.

Risk Class: Low (0-50), Medium (51-150), High (>150)

This indicator is important because these six pollutants have been cited as hazardous by the USEPA, and are all subject to current regulations. They may face stronger regulation in the near future. Knowing the current levels of these pollutants in installation areas will allow the Army to be proactive in addressing

the issue of air pollution. The basic data for this index are available from the USEPA.

Stressor: Threatened and Endangered Species (TES) Restrictions

TE1. Indicator: TES Species Listed (SL)

Species Listed indicates the number of threatened and endangered species (TES) listed as present on an Army installation.

Risk Class: Low (none present), Medium (TES presence;1-4 species), High (high TES presence; >4)

This indicator is important because the presence of endangered species and their accommodation can severely impact the mission on an installation. This information is available from the U.S Army Environmental Center (USAEC).

TE2. Indicator: TES Species Impacts (SI)

TES Species Impacts indicates the relative impacts that TES are having on an installation.

Risk Class: Low (none present), Medium (TES present, no impact), High (TES present and mission impacted).

The Army must be sensitive to activities that disturb these species on installation property, and many installations are required to take positive action to encourage the survival of these species.

TE3. Indicator: Critical Habitat (CH)

Critical Habitat indicates whether or not a critical habitat has been designated on an installation for a threatened or endangered species.

Risk Class: Low (No), Medium (Yes).

This indicator is important because the Army must be sensitive to activities that disturb these species on installation property, and many installations are required to take positive action to encourage the survival of these species. This information is available from the US AEC.

TE4. Indicator: Species of Concern (SC)

Species of Concern indicates the potential impact of species located on an installation that are candidates to become threatened and endangered. It includes: proposed, candidate, and state-listed species.

Risk Class: Low (none), Medium (1-30) and High (30 or more).

This indicator provides insight into possible future TES issues. It can indicate the existence of significant and potentially significant habitat on the installation. Installations are generally required to take positive action to encourage the survival of these species. This information is available from the U.S. Fish and Wildlife Service (USFWS), State Natural Resource agencies, and the installations contacted.

Stressor: Water Resource Quality

WQ1. Indicator: Water Quality Index (WQ)

The WQ score is a composite index and provides a measure of overall watershed health in terms of flood risk, navigation, ecosystem thermal sensitivity, dissolved oxygen, low flow sensitivity, species at risk and population. The indicator value is found by indexing several national watershed characterization indicators into a composite rating for each watershed.

Risk Class: Low (better water quality), Medium (less serious water quality problems), High (more serious water quality problems)

The degree of watershed health is a strong indicator of local water quality. This indicator is taken from a study done by B. Hurd et al. (1999).

Stressor: Water Resource Vulnerability

WV1. Indicator: Water Vulnerability Index (WV)

This index of water vulnerability is a composite index that measures the overall health of the local water supply in terms of development, natural variability, dryness ratio, groundwater depletion, industrial water use flexibility, institutional flexibility, and population.

Risk Class: Low (low vulnerability), Medium (moderate vulnerability), High (high vulnerability)

The vulnerability of the water supply is a strong indicator of the ability to sustain current water consumption levels and sensitivity to climate change. This indicator is taken from a study done by B. Hurd et al. (1999).

Stressor: Stakeholders

SH1. Indicator: Lawsuits (L_M)

This indicator provides a measurement of the amount in dollars that an installation has paid out in environmental settlements and fines.

Risk Class: Low (<=$82,000), Medium (>$82,000 and <$370,690),

High (>=$370,690).

The amount paid in fines and settlements is a strong indicator of stakeholder dissatisfaction outside of the fence line. This information was received from Maj. Gregory A. Marchand, Headquarters, U.S. Army Corps of Engineers (USACE).

SH2. Indicator: Biological Opinions (Bo)

This indicator provides an indirect representation of regional stakeholder involvement. A biological opinion is requested when sufficient concern about TES issues necessitates formal opinion.

Risk Class: Low (no bio-opinions requested), Medium (one bio-opinion requested)
High (more than one bio-opinion requested).

This information was obtained from the participating installations. Data only for the last 5 years was considered.

Facilities and Mission Support – Quality of Life

Stressor: DoD Economic Presence

EP1. Indicator: DoD Local Employment (E_D/E_T)

This indicator provides a measure of the percentage of local employment provided by the DoD in all counties adjacent to the installation. The indicator value

is found by dividing total local DoD employment (E_D) by the total local employment (E_T).

Risk Class: Low(0 to 4%), Medium (>4 and <18%), High (>18%)

The percentage of local employment provided by DoD is a strong indicator of local economic dependence on military employment. This indicator calculation was performed using information from the U.S. Census Bureau.

Stressor: Locality Quality of Life

QL1. Indicator: Crime Rate (TC/TP*1000)

This indicator provides a measure of the local crime rate for all counties adjacent to the installation. The indicator value is found by dividing total local crime (TC) by the total local population (TP) and multiplying by 1000 (Crimes per 1000 people).

Risk Class: Low (0 to 39), Medium (40 to 57), High (>57)

The local crime rate is a strong indicator of local quality of life. This indicator calculation was performed using information from the USA Counties 1998 data set.

QL2. Indicator: Housing Availability (VR-SV)

This indicator provides a measure of the local housing vacancy rate for all counties adjacent to the installation. The indicator value is found by subtracting the local seasonal vacancy rate (SV) from the total local vacancy rate (VR) to get the true vacancy rate.

Risk Class: Low (0 to 5.5%), Medium (5.6 to 9.5%), High (>9.5%)

The local housing vacancy rate is a strong indicator of local quality of life. This indicator calculation was performed using information from the U.S. Census Bureau.

QL3. Indicator: Healthcare Costs

This indicator provides a measure of the average local healthcare cost per person per year.

Risk Class: Low (<=$3,100), Medium ($3,101 to $3,700), High (>$3,700)

The local average healthcare cost is a strong indicator of local quality of life. This indicator value was found in the article "Healthcare Spending During 1991-1998: A Fifty State Review," by Anne Martin et al. The Project Hope Foundation, 2002.

QL4. Indicator: Job Availability (JA)

This indicator provides a measure of the availability of local jobs. The average local unemployment for all counties adjacent to the installation is used as a proxy for this indicator.

Risk Class: Low (<=5.7%), Medium (5.8 to 8.3%), High (>8.3%)

The availability of employment is a strong indicator of local quality of life. This indicator calculation was performed using information from the U.S. Census Bureau.

QL5. Indicator: Educational Attainment (HG)

This indicator provides a measure of the education level of the local community surrounding and including the installation. The indicator value is found by adding the percentage of persons 25 and older who have completed high school (HG) for all counties adjacent to the installation.

Risk Class: Low (<=73.28%), Medium (>73.28 and <80.44%), High (>80.44%)

The local education level is a strong indicator of local quality of life. This indicator calculation was performed using information from the U.S. Census Bureau.

QL6. Indicator: Commute Times (CT)

This indicator provides a measure of the average commute to work times for the local community surrounding and including the installation. The average commute time for each installation was found by averaging the commute times for all counties adjacent to the installation.

Risk Class: Low (<=19.5), Medium (19.6 to 23.5), High (>23.5)

Commute times are a strong indicator of local quality of life. This indicator was found in a Census report at URL:

http://www.transact.org/Reports/Census2000/census2000.htm.

QL7. Indicator: Cost of Living (HC/MI)

This indicator provides a measure of the cost of living for the local community surrounding and including the installation. The indicator value is found by dividing the average yearly housing cost (HC) by the mean family income (MI) for all counties adjacent to the installation.

Risk Class: Low (<=18.8%), Medium (18.9 to 27.5%), High (>27.5%)

The local cost of living is a strong indicator of local quality of life. This indicator calculation was performed using information from the Census at census.gov to determine the mean family income and from the army's Per Diem Committee to determine average housing rates (http://www.dtic.mil/perdiem/bahform.html).

QL8. Indicator: Community Economic Strength (CES)

This indicator provides a measure of the economic strength for the local community surrounding the installation.

Risk Class: Low (A+ to B+), Medium (B to C), High C- to D-)

A community's economic strength is a strong indicator of local quality of life. This indicator was found in a Community Economic Strength study published by the Policom organization at http://www.policom.com/area.htm.

Stressor: Security

SP1. Indicator: Proximity to MSA (MSA)

This indicator provides a measurement of the size of the nearby metropolitan statistical area.

Risk Class: Low (<100,000), Medium (100,000 to 300,000), High (>300,000).

Proximity to a large metro area is indicative of many stressors that impact the installation. Salient of these is the security risk associated with a nearby large population. The large population brings congestion, demand for resources, pressures of encroachment, and anonymity with coincident opportunity for domestic and foreign-based terrorism.

Appendix B: Stationing Risk Indicators and Data for Selected Installations

Stressor	Indicator Number	Indicator	Measure	White Sands Missile Range		Yuma Proving Grouns		Rock Island Arsenal		Redstone Arsenal		Fort Drum		Fort Carson		Pinyon Canyon Maneuver Site		Fort Lewis/Yakima		Fort Richardson	
				Indicator	Risk	Indicator	Risk	Indicator	Risk	Indicator	Risk	Indicator	Risk	Indicator	Risk	Indicator	Risk	Indicator	Risk	Indicator	Risk
Issue: Air																					
Quality	AQ1	Non-Attainment	Attainment: Y/N	Yes	0	No	4	No	4	No	4	Yes	0	No	4	No	4	Yes	0	Yes	0
	AQ2	Air Quality Index	Maximum ppm	100	2	77	2	75	2	112	2	85	2	87	2			122	2	72	2
Noise	N1	Complaints	level of restrictions	little	0	little	0					some	2	some	2			some	2	little	0
	N2	Joint Land Use Study	Study: Y/N	No	4	No	4					Yes	0	Yes	0			Yes	0	No	4
Airspace Security	F1	Flight Restrictions	NA																		
Frequency	F2	Frequency Restrictions	NA																		
Issue: Energy																					
Availability	EA1	Electrical Source	% Non-Coal Fossil Fuels	13.84	2	4.86	0	4.78	0	3.98	0	40.48	4	10.22	2	10.22	2	4.43	0	71.24	4
	EA2	Natural Gas Price Variability	% below Us avg	39.56	0	-3.36	2	19.12	0	-16.02	4	-2.84	4	18.6	0	18.6	0	21.71	0	37.33	0
	EA3	Petroleum Price Variability	% below Us avg	-7.41	4	-7.3	4	-11.87	4	-4.04	4	-2.87	4	-9.87	4	-9.87	4	-12.2	4	-25.88	4
	EA4	Electrical Price Structure	Standard/time of day	standard	0	standard	0	standard	0	standard	0	time of day	2	time of day	2	standard	0	standard	0	standard	0
Efficiency	EE1	Progress Toward Goals	% over glidepath	-8.7	0			-10.5	0	30.5	4	28.2	4	16	4			31.1	4	18.3	0
Security	ES1	DG Regulations: Net Metering	yes/progess/no	yes	0	yes	0	no	4	No	4	no	4	no	4	no	4	yes	0	no	4
Issue: Land Use																					
Urban Development	UD1	Regional Population Density	density	10.99	0	17.78	0	349.8	4	343.7	4	47.46	0	115.54	2	5.9	0	386.55	4	146.42	2
	UD2	Increasing Regional Growth Rate	% growth 90s/80s	1	2	3.1	2	-0.3	0	0.7	0	0	0	1.5	2	-0.5	0	1	2	0.5	0
	UD3	Regional Population Growth	pop 2000/1990	28.91	4	15.62	4	-14.58	0	23.19		9.86	0	18.31	4	-9.38	0	21.72	4	28.74	4
	UD4	Regional Development	LU/LT	1.2	2	0.7	0	9.1	4	8.8	4	1.1	2	5.6	4	0.1	0	9.7	4	1.7	2
	UD5	State Smart Growth Plans	yes/progess/no	progress	2	progress	2	progress	2	no	4	progress	2	progress	2	progress	2	yes	0	no	4
TES Restrictions	TE1	Species Listed	presence of TES	1	2	0	0	1	2	4	2	0	0	3	2	3	2	2	2	0	0
	TE2	Species Impacts	TES impacts to Installations		4		0		0		0		0		0		0		4		0
	TE3	Critical Habitat	yes/no	no	0	no	0	no	0	no	0	no	0	no	0	no	0	no	2	no	
	TE4	Species of Concern	potential TES	2	2	8	2	0	0	7	2	20	2	52	4		4	4	2	0	0
Locational Issues	LI1	Seismic Zones	highest seismic risk	8	0	16	2	4	0	8	0	16	2	4	0	4	0	32	4	32	4
	LI2	Natural Disasters	costs(thousands)	$1,585.3	2	$412.4	2	$395.7	2	$1,254.9	2	$1,122.3	2	$831.5	2	$831.5	2	$266.7	0	$48.3	0
	LI3	Floodplain	NA																		

Risk Legend	
	Low
	Medium
	High

Stressor	Indicator Number	Indicator	Measure	Fort Stewart/Hunter AAF		Fort Polk		Fort Benning		Fort Bliss		Fort Riley		Fort Knox		Fort Campbell		Fort Bragg		Fort Hood	
				Indicator	Risk	Indicator	Risk	Indicator	Risk	Indicator	Risk	Indicator	Risk	Indicator	Risk	Indicator	Risk	Indicator	Risk	Indicator	Risk
Issue: Air																					
Quality	AQ1	Non-Attainment	Attainment: Y/N	No	4	Yes	0	No	4	No	4	Yes	0	Yes	0	No	4	Yes	0	No	4
	AQ2	Air Quality Index	Maximum ppm	100	2			177	4	100	2			100	2	100	2	167	4		4
Noise	N1	Complaints	level of restrictions	some	2	some	2	little	0	little	0	some	2	little	0	some	2	some	2	some	2
	N2	Joint Land Use Study	Study: Y/N	No	4	Yes	0	No	4	Yes	0	Yes	0	Yes	0	Yes	0	Yes	0	Yes	0
Airspace Security	F1	Flight Restrictions	NA																		
Frequency	F2	Frequency Restrictions	NA																		
Issue: Energy																					
Availability	EA1	Electrical Source	% Non-Coal Fossil Fuels	4.04	0	54.1	4	4.04	0	50.22	4	7.55	0	1.39	0	1.39	0	1.99	0	50.22	4
	EA2	Natural Gas Price Variability	% below Us avg	17.83	0	-1.03	4	17.83	0	14.99	0	-2.84	4	-4.91	4	-4.91	4	1.55	2	14.99	0
	EA3	Petroleum Price Variability	% below Us avg	-2.56	4	5.49	2	-2.56	4	6.5	2	8.21	2	-5.14	4	-5.14	4	5.5	2	6.5	2
	EA4	Electrical Price Structure	Standard/time of day	time of day	2	standard	0	time of day	2	standard	0	deregulated	4	time of day	2	standard	0	time of day	2	standard	0
Efficiency	EE1	Progress Toward Goals	% over glidepath	46.4	4	31.6	4	-19.8	0	2.69	2	7.4	4	3.9	2	-30	0	-8.91	0	6.79	2
Security	ES1	DG Regulations: Net Metering	yes/progess/no	progress	2	no	4	progress	2	No	4	no	4	Yes	0	No	4	no	4	No	4
Issue: Land Use																					
Urban Development	UD1	Regional Population Density	density	146.78	2	31.35	0	170.62	2	80.39	0	58.62	0	145.49	2	103.33	2	185.88	2	146.8	2
	UD2	Increasing Regional Growth Rate	% growth 90s/80s	1.1	2	-3.3	0	2	2	0.7	0	-2.2	0	3.3	2	1.8	2	1.6	2	1.2	2
	UD3	Regional Population Growth	pop 2000/1990	12.7	4	1.55	0	1.54	0	24.56	4	2.98	0	3.97	4	12.22	4	10.12	4	18.93	4
	UD4	Regional Development	LU/LT	1.9	2	0.4	0	2.1	2	1.7	2	1.1	0	1.9	2	1.3	0	2.2	2	1.8	2
	UD5	State Smart Growth Plans	yes/progess/no	progress	2	no	4	progress	2	progress	2	no	4	progress	2	Yes	0	progress	2	progress	2
TES Restrictions	TE1	Species Listed	presence of TES	6	4	1	2	5	4	3	2	4	2	2	2	2	2	5	4	2	2
	TE2	Species Impacts	TES impacts to Installations		4		0		2		0		0		0		0		4		4
	TE3	Critical Habitat	yes/no	no	0	no	0	no	0	no	0	no	0	no	0	no	0	no	0	no	0
	TE4	Species of Concern	potential TES	40	4	11	2	40	4	11	2	10	2	3	2	5	2	51	4	1	2
Locational Issues	LI1	Seismic Zones	highest seismic risk	4	0	4	0	4	0	4	0	8	0	8	0	16	2	4	0	4	0
	LI2	Natural Disasters	costs(thousands)	$919.2	2	$1,110.2	2	$919.2	2	$7,906.7	4	$756.7	2	$1,563.3	2	$1,563.3	2	$7,145.4	4	$7,906.7	4
	LI3	Floodplain	NA																		

Risk Legend	
	Low
	Medium
	High

Stressor	Indicator Number	Indicator	Measure	White Sands Missile Range		Yuma Proving Grouns		Rock Island Arsenal		Redstone Arsenal		Fort Drum		Fort Carson		Pinyon Canyon Maneuver Site		Fort Lewis/Yakima		Fort Richardson	
				Indicator	Risk	Indicator	Risk	Indicator	Risk	Indicator	Risk	Indicator	Risk	Indicator	Risk	Indicator	Risk	Indicator	Risk	Indicator	Risk
Issue: Water																					
Quality	WQ1	Water Quality	Index		2		0		2		2		0		2		2		0		
Security	WS1	Sole-Source Aquifer	Yes/Partial/No		0		0						0		0		0		4		0
Availability	WV1	Water Vulnerability	Index		4		4		2		2		0		4		4		0		
Issue: Socio-Economic																					
DoD Econ Presence	EP1	Military Employment%	mil emp/total emp	3.69%	0	6.43%	2	0.09%	0	0.86%	0	10.16%	2	7.46%	2	0.02%	0	4.54%	2	6.76%	2
Quality of Life	QL1	Crime Rate	crimes per 100,000 people	4,483	2	3,617	0	4,911	2	6,026	4	2,349	0	5,679	2	3,481	0	6,614	4	7,269	4
	QL2	Housing Availabilty	vacancy rate	9.40%	2	11.50%	0	5.50%	4	8%	2	7.10%	2	4.80%	4	10.30%	0	4.90%	4	4.40%	4
	QL3	Healthcare Costs	healthcare cost/person	$3,100	0	$3,339	2	$3,733	4	$3,686	2	$3,288	2	$3,331	2	$3,331	2	$3,382	2	$3,414	2
	QL4	Job Availability	unemployment rate	8.50%	4	11.%7	4	8.30%	4	5.70%	0	8.70%	4	5%	0	7%	2	6.40%	2	6.80%	2
	QL5	Educational Attainment	high school + college grad %	73.72%	2	66.19%	4	82.60%	2	85.40%	0	81.06%	2	88.65%	0	76.22%	4	89.04%	0	90.30%	0
	QL6	Commute Times	avg commute time in minutes	21.1	2	18.5	0	19.5	0	20.9	2	19.5	0	22.10	2	19.1	0	27.5	4	19.5	0
	QL7	Cost of Living	Avg Hsg Cost/Median Fam Inc	28%	4	29.70%	4	18.70%	0	15.60%	0	20.20%	2	23.30%	2	37.30%	4	22.70%	2	21.70%	2
	QL8	Community Economic Strength	Grade	D	4	D-	4	C-	4	B-	2	D+	4	B-	2	C-	4	A-	0	D-	4
Stakeholders	SH1	Lawsuits	$ in fines/settlements	0	0	0	0	0	0	0	0	$135,000	2	$57,000	2	0	2	$260,000	2	0	0
	SH2	Biological Opinions	no. of bio-opinions requested	0	0	0	0	0	0	0	0	0	0	2	4	2	4	0	0	0	0
Issue: Infrastructure																					
Transportation	TA1	Proximity to commercial airport	Miles		4		2		2		2		4		4		4		4		4
	TA2	Capacity	Aircraft Operations/day	388	0	473	0	180	0	256	0	390	0	596	2	596	2	1,168.00	4	897	2
	TA3	Proximity to military airfield	Miles		0		4		4		2		0		0		0		0		0
	TRR1	Proximity	Miles	66.3	4	5	2	6.2	2	8	2	11.8	4	36.8	4			14.6	4	10.4	4
	TRR2	Capacity	Trains/crossing/day	8	2	14	4	3	0	3	0	5	2	13	4	11	4	15	0	8	2
	TR1	Proximity to interstate	Miles	50	2	35	2	4	0	9	0	13	0	5	0			21	0	4	0
	TR2	Congestion	Road Congestion Index	0.71	0	0.15	0	0.21	0	1.01	4	0.27	0	0.62	0	0.13	0	1.81	4	0.95	2
	TR3	Access	Bridging/traffic Volume	40,000	0	4,308	0	12,000	0	11,110	0	7,621	0	17,339	0			176,781	4	53,200	2
Security	SP1	Proximity to MSA	MSA Size	287,739	2	179,741	2	149,341	2	276,700	2	250,613	2	704,546	4	35,518	0	908,175	4	260,238	2

Risk Legend	
	Low
	Medium
	High

Stressor	Indicator Number	Indicator	Measure	Fort Stewart/Hunter AAF		Fort Polk		Fort Benning		Fort Bliss		Fort Riley		Fort Knox		Fort Campbell		Fort Bragg		Fort Hood	
				Indicator	Risk	Indicator	Risk	Indicator	Risk	Indicator	Risk	Indicator	Risk	Indicator	Risk	Indicator	Risk	Indicator	Risk	Indicator	Risk
Issue: Water																					
Quality	WQ1	Water Quality	Index		4		4		4		4		2		4		0		2		4
Security	WS1	Sole-Source Aquifer	Yes/Partial/No		2		4		0		0		0		0		0		0		0
Availability	WV1	Water Vulnerability	Index		0		2		0		4		4		2		2		2		2
Issue: Socio-Economic																					
DoD Econ Presence	EP1	Military Employment%	mil emp/total emp	12.13%	2	17.41%	2	16.18%	2	3.90%	0	17.87%	2	8.71%	2	22.51%	4	18.46%	4	34.15%	4
Quality of Life	QL1	Crime Rate	crimes per 100,000 people	4,292	2	3,811	0	5,346	2	6,133	4	4,905	2	2,018	0	4,560	2	6,614	4	3,882	0
	QL2	Housing Availabilty	vacancy rate	9.40%	2	10.90%	0	9.10%	2	6.90%	2	7.40%	2	6.40%	2	7.60%	2	9.30%	2	7.40%	2
	QL3	Healthcare Costs	healthcare cost/person	$3,505	2	$3,742	4	$3,539	2	$3,320	2	$2,574	0	$3,711	4	$3,007	0	$2,271	0	$3,397	2
	QL4	Job Availability	unemployment rate	6.50%	2	8.90%	4	7%	2	9.30%	4	6.50%	2	5.10%	0	6.40%	2	7.90%	2	6.80%	2
	QL5	Educational Attainment	high school + college grad %	79.91%		75.72%	2	77.10%	2	67.66%	4	91.00%	0	79.54%	4	80.97%	2	82.29%	2	83.84%	2
	QL6	Commute Times	avg commute time in minutes	23.3	2	26.6	4	23.1	2	22.3	2	15.6	0	25.1	4	23.7	4	23.2	2	21.1	2
	QL7	Cost of Living	Avg Hsg Cost/Median Fam Inc	20.90%	2	22.20%	2	26.50%	2	29.50%	4	20.40%	2	14.10%	0	18.20%	0	23%	2	22.70%	2
	QL8	Community Economic Strength	Grade	C+	2	D+	4	B-	2	C+	2	C+	2	A-	0	C	2	C	2	C	2
Stakeholders	SH1	Lawsuits	$ in fines/settlements	0	0	0	0	$8,000	2	0	0	0	0	$5,000	2	$10,344	2	0	4	0	0
	SH2	Biological Opinions	no. of bio-opinions requested	1	2	2	4	1	2	0	0	1	2	1	2	$1	2	0	0	1	2
Issue: Infrastructure																					
Transportation	TA1	Proximity to commercial airport	Miles		4		0		2		4		4		4		4		4		4
	TA2	Capacity	Aircraft Operations/day	310	0	160	0	177	0	388	0	117	0	504	2	693	2	156	0	115	0
	TA3	Proximity to military airfield	Miles		0		0		0		0		0		0		0		0		0
	TRR1	Proximity	Miles	35.3	4	8.5	2	9.9	2	8.8	2	0.8	0	16.6	4	8.2	2	1.3	0	33.7	4
	TRR2	Capacity	Trains/crossing/day	5	0	12	4	4	0	3	0	9	2	15	4	12	4	3	0	12	4
	TR1	Proximity to interstate	Miles	19	0	63	4	5	0	3	0	7	0	22	0	2	0	18	0	19	0
	TR2	Congestion	Road Congestion Index	0.2	0	0.24	0	0.48	0	0.98	2	0.2	0	0.39	0	0.89	2	1.59	2	1.34	4
	TR3	Access	Bridging/traffic Volume	5,715	0	6,800	0	5,236	0	54,880	2	10,990	0	22,000	0	24,882	0	35,000	0	75,000	2
Security	SP1	Proximity to MSA	MSA Size	360,718	4	115,070	0	257,877	2	916,602	4	99,612	0	181,679	2	232,000	2	584,965	2	312,952	2

Risk Legend	
	Low
	Medium
	High

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5
5/02

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE (DD-MM-YYYY)	2. REPORT TYPE	3. DATES COVERED (From - To)
09-2002	Final	

4. TITLE AND SUBTITLE
Sustainable Installation Risk Assessment and Stationing Implications

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Donald F. Fournier, Brian M. Deal, Elisabeth M. Jenicek, and Adam J. Sagert

5d. PROJECT NUMBER
622784AT45

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Engineer Research and Development Center (ERDC)
Construction Engineering Research Laboratory (CERL)
PO Box 9005
Champaign, IL 61826-9005

8. PERFORMING ORGANIZATION REPORT NUMBER
ERDC/CERL SR-02-12

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Headquarters, U.S. Army Corps of Engineers (HQUSACE)
441 G St., NW.
Washington, DC 20314-1000

10. SPONSOR/MONITOR'S ACRONYM(S)
CEMP-IP

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT
Further distribution only as directed by Headquarters, U.S. Army Corps of Engineers (HQUSACE) or higher authority; 15 September 2002.

13. SUPPLEMENTARY NOTES
Copies are available from the Defense Technical Information Center, ATTN: DTIC-DDRB, Cameron Station, Alexandria, VA 22304-6145

14. ABSTRACT

New environmental laws combined with nearby urban development create significant pressures (termed "encroachment") to alter land use practices on military installations. The Army must now reconcile its need to sustain training and stationing requirements while addressing multi-faceted encroachment issues. At the same time, it must comply with environmental regulations and fulfill its role as a good steward of natural resources. Installation sustainability and mission sustainment are complementary; each relies on the other to comprise a complete whole. The development of a Sustainable Installation Risk Assessment (SIRA) methodology allows decisionmaking related to land use practice to proceed in a broader and more informed context. This is especially true when considering the changes required under Army Transformation. Encroachment issue should be viewed as a threat to mission sustainability so that the opportunity for informed decisions is used to avoid or mitigate future problems. This study reviewed the issue of installation sustainability in the context of defining risk and stressors that may complicate the stationing of forces under Army Transformation.

15. SUBJECT TERMS
Army Installations
compliance
environmental regulations
military training
risk assessment
sustainable facilities

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Brian M. Deal
Unclassified	Unclassified	Unclassified	SAR	48	19b. TELEPHONE NUMBER (include area code) (217)352-6511x7461