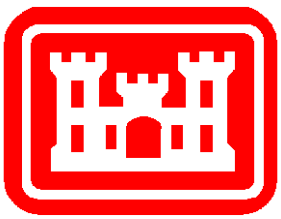
PUBLIC WORKS TECHNICAL BULLETIN 200-1-86
30 SEPTEMBER 2010

REGIONAL WATER AVAILABILITY ASSESSMENT GUIDANCE



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PWTB 200-1-86
30 September 2010

DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
441 G Street NW
Washington, DC 20314-1000

CECW-CE

Public Works Technical Bulletin 30 September 2010

No. 200-1-86

FACILITIES ENGINEERING
ENVIRONMENTAL

REGIONAL WATER-AVAILABILITY ASSESSMENT GUIDANCE

1. Purpose.

a. The objective of this bulletin is to inform installation staff about the watershed screening application of SIRRA and to highlight ways in which this assessment can support installation water planning and management. This report details how installations can become involved in this planning process without extensive and costly procurement and provisioning activities.

b. All PWTBs are available electronically in Adobe® Acrobat® portable document format [PDF]) through the World Wide Web (WWW) at the National Institute of Building Sciences' Whole Building Design Guide (WBDG) Web page, which is accessible through this Universal Resource Locator (URL):

http://www.wbdg.org/ccb/browse_cat.php?o=31&c=215

2. Applicability. This PWTB applies to engineering activities of all Continental U.S.(CONUS) Army facilities.

3. References.

a. *Energy Independence and Security Act of 2007.*

b. *Executive Order 13423, Strengthening Federal Environmental, Energy and Transportation Management,* 29 January 2007.

c. *Executive Order 13514, Federal Leadership in Environmental, Energy and Economic Performance,* 05 October 2009.

d. Department of Defense (DoD), Strategic Sustainability Performance Plan: FY 2010, 26 Aug 2010.

e. *Installation Management Campaign Plan, 5 Mar 2010,* U.S. Army Installation Management Command *(IMCOM).*

f. *The Army Energy Strategy for Installations,* 8 Jul 2003 and *Army Energy and Water Campaign Plan for Installations*, U.S. Department of the Army, 1 Dec 2007.

g. *ACSIM Memorandum DAIM-ZA,* 18 Mar 2003 and *Memorandum HQ IMCOM SFIM-OP-P,* 21 Apr 2004.

h. *Watershed Application of the Sustainable Installations Regional Resource Assessment Tool*. U.S. Army Corps of Engineers, Construction Engineering Research Laboratory. Technical Report ERDC/CERL TR-05-24, September 2005.

i. *Army Installations Water Sustainability Assessment: An Evaluation of Vulnerability to Water Supply*. U.S. Army Corps of Engineers, Construction Engineering Research Laboratory. Technical Report ERDC/CERL TR-09-38, September 2009.

j. *National Water Sustainability Analysis: A Characterization of U.S. Watershed Health*. U.S. Army Corps of Engineers, Actions for Change Theme 1. AFC 10-DRAFT, 2010.

4. Discussion.

a. The purpose of conducting a regional water assessment is to identify potential sustainability issues of concern on a watershed basis. Within a water system, it is important to identify critical issues and understand the implications of individual actions on that system. Regional water assessments provide valuable screening of water resources for which additional studies, planning, and actions may be recommended to ensure continued viability. Regional assessments also provides resources to improve the quality of planning and decision making for community planners, public works staff, environmental professionals, and local governments and are intended to enhance sustainable use and protection efforts for the Army’s water resources. It is the first level screening that helps inform national and broad regional stakeholders about how a local situation fits within a larger context. Similar resources are widely used in other programs, including land-use and stationing

planning. Strategic planning within the Army includes watershed objectives, new cooperative relationships between previously divergent groups, establishment of infrastructure inventories, improvements in modeling capabilities, and design and construction of new water management facilities. This information is useful to U.S. Army installation utility staff in meeting the requirement to produce and implement a comprehensive water management plan. It is also beneficial to organizations that wish to compare regional water indicators among different regions, watersheds, and installations.

b. New strategies on sustainability within the Department of Defense focus on addressing present and future needs while strengthening community partnerships. This “across-the-fenceline” strategic thinking requires innovative tools that engage a broad segment of the community and military interest groups. These tools help to visualize the pressure, state, and response of indicators of sustainability. One such tool is the Sustainable Installations Regional Resource Assessment (SIRRA), a database of 54 indicators in 10 sustainability issue areas. The watershed application is one specialized application of SIRRA and can inform decisions affecting regional water supplies. Integrating efforts between community and military planning is essential to the long-term sustainability of water supply and demand. Tools such as SIRRA are one means to bridge the gap between regional stakeholders and the military community.

c. Water is generally considered a renewable resource. A number of stressors are contributing to growing problems with adequate sustainable access to high quality water resources. These stressors are related to (a) population growth; (b) surface and groundwater contamination from human activities; (c) globally increased water usage for agricultural, industrial, and personal uses; (d) rising global and regional temperatures; and (e) rising water demands for electrical generation and alternate energy production options. Problems with access to adequate fresh water supplies vary spatially and temporally, but are growing in extent and duration and will contribute towards political strife and regional instability in many parts of the world. Over the past decade, about 50% of the United States has been experiencing drought and/or severe drought conditions. Water issues of concern include adequate supply, increased cost of production per unit volume, quality, habitat degradation, and salinity issues. These concerns are already impacting military installations and operations in many national and international locations.

d. The greatest water challenge for the Army is that the water resource supply and demand act across several geographic scales. Watersheds and aquifers cross political boundaries and require federal, state, and local agencies to work cooperatively in addressing water problems. Army installations represent just a fraction of regional water demand, and yet, the adverse impacts of water scarcity and degradation will be borne equally by all users.

e. The guidelines provided in this bulletin document the research sponsored by the U.S. Army Corps of Engineers (USACE) System-Wide Water Resource Program (SWWRP). One product of this program was a characterization of the nation's watersheds by using a sub-set of indicators from SIRRA. The result was a methodology to identify watersheds with potential sustainment problems and to rank the watersheds by their relative vulnerability to such problems. This work was published in ERDC/CERL TR-05-24 (Jenicek et al. 2005). Since publication, updates to this work have been sponsored by the USACE Actions for Change (AFC) program and the Army Environmental Policy Institute (AEPI). AFC has undertaken a renewed commitment to the systems approach of water resource management; in 2009, AFC supported the update of the watershed screening methodology with inclusion of 607 USACE dam locations. All data sources were updated, some indicator scales were modified, and new indicators were added. Following this update, AEPI sponsored the application of the watershed screening methodology to 2,252 hydrological unit code (HUC-8) watersheds. These results showed the locations of 411 Army installations on an overlay map. These updates were incorporated into the original methodology and made available for public use. Upon final publication of technical reports, all data and documentation will be included on the SIRRA Web site, http://datacenter.leamgroup.com/sirra/front-page/?searchterm=SIRRA.

f. Water efficiency requirements for Army facilities are found in the *Energy Independence and Security Act of 2007* (EISA 2007), *Executive Order 13423* (EO 13423), and *Executive Order 13514* (EO 13514).

i. Section 432 of *EISA 2007* establishes a framework for facility project management and benchmarking. Under this new requirement, Federal agencies must identify all "covered facilities" that constitute at least 75% of the agency facility's energy/water use. Each facility water manager is responsible for completing comprehensive energy/water evaluations of 25% of these covered facilities each year, implementing all identified water efficiency measures, and

following up on implemented measures by measuring and verifying water savings.

ii. *EO 13423* further requires a reduction of water consumption intensity of 2% annually through the end of Fiscal Year 2015, relative to a baseline of FY 2007.

iii. *EO 13514* extends this requirement through 2020 for a total reduction in water consumption intensity of 26%. In addition, implementation is required of water reuse strategies that are consistent with state laws.

iv. The Department of Defense's Strategic Sustainability Performance Plan promulgates the 26% reduction in water intensity to the individual services.

v. IMCOM's Installation Management Campaign Plan establishes energy efficiency and security objectives that encompass the water management program. Goals include reducing consumption, institutionalizing savings and conservation procedures, providing full-time trained managers, instilling a conservation culture in our communities, and increasing efficiency and modernizing infrastructure.

vi. The *Army Energy Strategy for Installations* sets the general direction in conservation of water resources while the *Army Energy and Water Campaign Plan for Installations* identifies tools, technologies, policies, management, and institutional requirements to achieve initiatives and approaches.

vii. National policy was further interpreted by IMCOM and ACSIM in memorandums that adopt the Department of Energy's 10 Best Management Practices (BMPs) for developing water management plans, increasing public awareness, and implementing conservation practices. In addition to developing water management plans, these plans must be reviewed and updated periodically.

All of these policy documents are available through the ACSIM Web site available at the following URL:
http://army-energy.hqda.pentagon.mil/policies/water_con.asp

g. Appendix A contains a description of the watershed screening application of SIRRA. This section highlights the components of effective and efficient regional planning and is intended to support the goals of long-term integrated water resource management.

h. Appendix B navigates through the development and use of the assessment data sets.

i. Appendix C is a set of instructions for applying the assessment results to a number of regional planning scenarios that might be encountered by Army installation staff.

j. Appendix D defines the acronyms and abbreviations used in this PWTB.

k. Appendix E cites related ERDC-CERL publications.

5. Points of Contact.

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APPENDIX A:
The National Watershed Sustainability Analysis

This national watershed screening methodology seeks to identify those watersheds containing Army installations for which additional studies, planning, or actions may be recommended for continued viability and sustainability of Army operations. Screening by itself does not provide a diagnosis of “at risk” watersheds, but it is the first key step in the process. Through application of the SIRRA tool, this methodology aims to identify watersheds with potential sustainment problems, rank watersheds by their relative vulnerability to such problems, and refer for further study those watersheds containing critical Army installations and which are flagged as potentially “at risk” during screening. National screening allows comparisons between regions through the use of color-coded maps for the set of water supply indicators, for the set of water demand indicators, and for overall watershed health.

Today’s water managers are tasked with securing adequate supplies of clean water for current and future needs. Yet, unlike land management programs which are guided by broad national policies and administered as continuing operations, water resource initiatives are traditionally developed as individual projects and each is separately justified. The objectives of individual water projects are usually sought by an intensive one-time effort. Additionally, rules that govern the right to use water are developed and administered at the state level, even though water resources do not respect state or international boundaries.

The Fort Bragg region of North Carolina is an example of traditional resource management. Due to severe droughts in 2003, Fort Bragg implemented strict water conservation guidelines. Within one year, the installation had reduced its water use by nearly 70%. Figure A-1 illustrates this reduction and also highlights Fort Bragg’s significance as a proportion of total regional water use. Prior to 2003, Fort Bragg consumed less than 1% of total regional water demand. While Fort Bragg successfully reduced its water demand, the regional residential and agriculture sector use increased by millions of gallons per year. Thus all watershed activity must be taken into account as installation staff seeks to ensure adequate future water supplies.

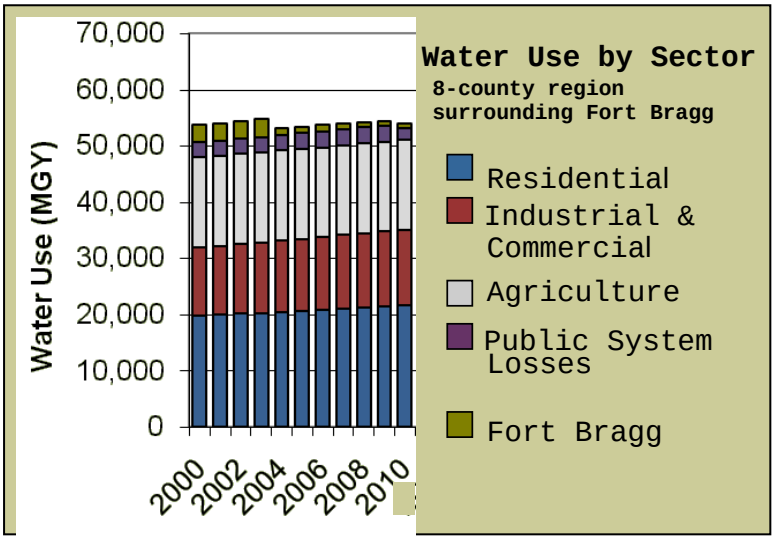

Figure A-1. Fort Bragg regional water demand.1

The Army Strategy for the Environment, along with other strategic documents such as the more recently published Strategic Plan for Army Sustainability, identifies the need for a system-wide approach to water management. Each emphasizes coordination between water suppliers and users in support of long-term integrated water resource management. The System-Wide Water Resource Program (SWWRP) was one initiative of USACE which was designed to assemble and integrate the diverse components of water resource management. The watershed application of SIRRA was one product of SWWRP. The watershed screening methodology examines water supply, demand, and policy issues at a regional level (HUC 8 watershed). Such screening facilitates the transfer of knowledge among Army program managers, installation Department of Public Works (DPW) staff, and community water resource managers; it also supports effective and efficient development of water management plans. Originally published in 2005, the watershed screening indicators were updated in 2009.

The updated watershed screening methodology is comprised of the 27 water supply and demand indicators contained in SIRRA that are listed in Table A-1. The mapping of water data can make clear where issues are geospatially linked and can facilitate a

[1] Source: ERDC/CERL TR-10-DRAFT “Strategic Sustainability Assessment Pilot Study Final Results: Fall Line Region of the Southeast”

variety of practical actions. Geographic Information System (GIS) mapping also supports the development of effective policy and the emergence of research insights. Regions can be displayed by pointing and clicking on a map or by searching for an installation by name using the SIRRA tool at http://datacenter.leamgroup.com/sirra. This unique system visually links water data to geographical locations and to demographic and economic information about the region.

Each indicator datum is linked to the HUC8 watershed boundary layer. This enables viewing water resources at a common geospatial scale. Common mapping formats can help local, state, and national policy makers stay on top of changing water trends on a regional basis and anticipate future resource needs.

Table A-1. Water supply and demand indicators.

	Indicator	Source	Data Year
Water Supply			
A1	Streamflow Long-term Average	U.S. Geological Survey (USGS)	1901-2005
A2	Streamflow 5-year Change	U.S. Geological Survey (USGS)	2002, 2007
A3	Run-off Long-term Average	U.S. Geological Survey (USGS)	1901-2007
A4	Run-off 5-year Change	U.S. Geological Survey (USGS)	2002, 2007
A5	Presence of Groundwater	U.S. Geological Survey (USGS)	2006
A6	Low Flow Sensitivity	U.S. Geological Survey (USGS)	1901-2003
A7	Groundwater Depletion	U.S. Geological Survey (USGS)	2000
A8	Drought Sensitivity	National Drought Mitigation Center and National Climatic Data Center (NCDC)	2008
A9	Federally Declared Coastal Disasters	Federal Emergency Management Agency (FEMA)	1964-2008
A10	Coastal Sea-level Rise	U.S. Geological Survey (USGS)	2001
A11	Federally Declared Floods	Federal Emergency Management Agency (FEMA)	1964-2008
A12	Flood Risk	Journal of American Water Resources Association (JAWRA)	1996
A13	Federally Declared Disasters	Federal Emergency Management Agency (FEMA)	1964-2008
A14	Seismic Zones	U.S. Geological Survey (USGS)	2008
A15	TES Richness	NatureServe	2005
A16	TES Hotspot	NatureServe	2005
A17	Water Quality	Journal of American Water Resources Association (JAWRA)	1999
Water Demand			
D1	GW Withdrawals Long-term Average	U.S. Geological Survey (USGS)	1985-2000
D2	GW Withdrawals 5-year Change	U.S. Geological Survey (USGS)	1995, 2000
D3	Consumption Rate	U.S. Geological Survey (USGS)	1995-2000
D4	Water for Energy Production	U.S. Geological Survey (USGS)	2000
D5	Water for Energy 10-year Change	U.S. Geological Survey (USGS)	1990, 2000
D6	Regional Population Growth	U.S. Census Bureau	2000, 2007
D7	Regional Population Projection	U.S. Census Bureau	2000, 2030
D8	State Smart Growth Plans	American Planning Association (APA)	2002
D9	Proximity to MSA	U.S. Census Bureau	2008
D10	Institutional Flexibility	American Water Works Association (AWWA)	1990

APPENDIX B:
Accessing and Navigating Data sets

Methodology

The watershed screening methodology that evolved from SIRRA[2] focuses specifically on water resources. SIRRA is an indicator-based screening tool for assessing relative vulnerabilities and overall sustainability on a regional scale. The results identify regions and sustainability issues that require further study by using additional data sources. SIRRA was developed under the Strategic Environmental Research and Development Program (SERDP) and the Army's Research, Development, Test and Evaluation (RDT&E) program, and it was recognized as the 2006 SERDP Project of the Year. SIRRA provided auditable data for the Army stationing analysis for Base Realignment and Closure (BRAC) 2005, and has been used to evaluate existing installations' abilities to absorb additional forces and a region's capability to support new installations. It is also used to support the Installation Strategic Sustainability Planning (ISSP) process.

The analysis methodology consists of characterizing watershed supply and demand indicators at the HUC8 watershed level using the SIRRA issue-based indicator framework. Each indicator is linked to the watershed boundary file. For each watershed, indicator ratings are aggregated to form an overall vulnerability score (mapped in Figure B-5). The following steps were followed to accomplish this.

Step 1: Compile data for 27 indicators for all HUC8 watersheds. Collect indicator data from national sources. This data is reported at various scales. For example, the U.S. Geological Survey (USGS) reports withdrawals at the county level, the U.S. Census Bureau (USCB) reports population projections at the state level, and NatureServe reports threatened and endangered species at the ecoregion level. Intersect each indicator level with the HUC8 watershed boundaries (Figure B-1) and determine an overall indicator score for each watershed. Rules to accomplish this change in reporting level vary based on the indicator. Watershed values may be based on a weighted average, "worst" rating, or

[2] *The Sustainable Installations Regional Resource Assessment (SIRRA) Capability, Version 1, ERDC/CERL TR-04-9, available at http://libweb.wes.army.mil/uhtbin/hyperion/CERL-TR-04-9.pdf*; *Assessing Regional Sustainability with SIRRA*, published as PWTB 200-1-81, September 2010, available at http://www.wbdg.org/ccb/browse_cat.php?o=31&c=215.

most common value. Documentation can be found in the metadata on the SIRRA Web site.

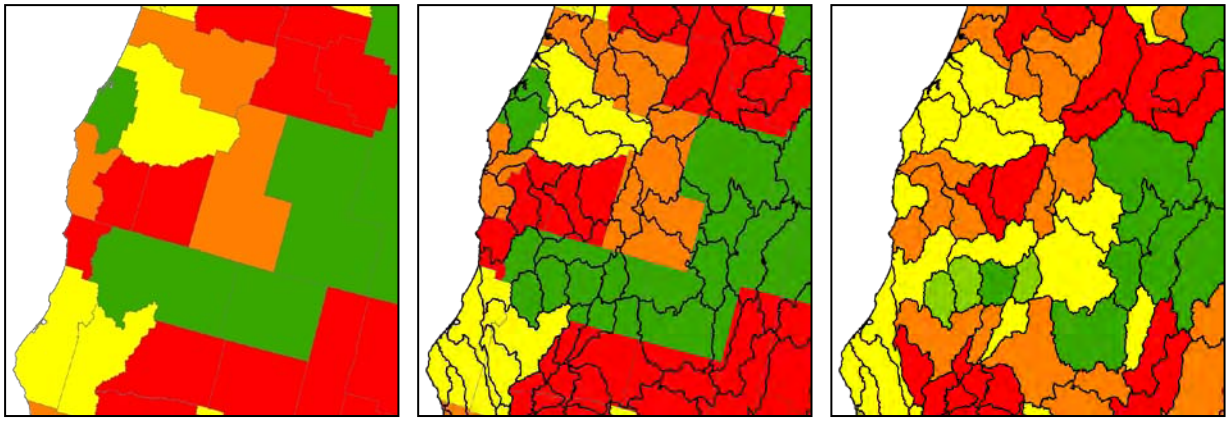

Figure B-1. Linking indicator data to watershed boundaries.

Step 2: Establish the vulnerability rating levels for indicator data. The SIRRA metadata includes the sustainment rating thresholds and the selection logic for the 27 indicators used in this application. Once sustainment ratings were determined, they were assigned numbers. This allowed indicators to be weighted and scored based on their criticality to watershed sustainment:

- very low vulnerability = 1
- low vulnerability = 2
- moderate vulnerability = 3
- vulnerable = 4
- high vulnerability = 5

Indicator sets often include “not-available” data values—specifically for water sustainment indicators in Alaska and Hawaii where the data source does not report conditions in these regions. To ensure that these “not-available” data values neither hurt nor help watersheds, these values were either entered as “moderately sustainable,” or the rating was interpolated from the surrounding nearby regions. Figure B-2 depicts vulnerability classifications and thresholds for indicator A1. The A1 benchmark thresholds were determined by the USGS Water Resources Department staff.

	Very Low Vulnerability (1)	Low Vulnerability (2)	Moderate Vulnerability (3)	Vulnerable (4)	High Vulnerability (5)
A1 Streamflow Long-term Average	>=1,799 ft^3/sec	<1,799->=1,349 ft^3/sec	<1,349->=900 ft^3/sec	<900->0 ft^3/sec	<=0 ft^3/sec

Figure B-2. Characterizing vulnerability for indicator A1.

Step 3: Sum the individual indicator ratings for each watershed to arrive at an overall score. To arrive at a final sustainment/vulnerability score for the watershed, simply add the indicator rating values (i.e., 1, 2, 3, 4, or 5). The higher this total, the more vulnerable the watershed is considered to be or the more stress it incurs due to development and key issue stresses. The lower the score, the less vulnerable the watershed is to environmental and key issue stresses. The indicator vulnerability score and final sustainment score for each watershed can be found on the SIRRA Web site. Figure B-3 shows the results of this summation process for a set of watersheds. Note that any subset can be summed for a specific application (i.e. total demand or supply vulnerability score.) Furthermore, additional attributes or weighting can be applied by the user. Appendix C discusses such applications.

NOTE: The indicators are not weighted and each is treated equally. There could be some weighting for certain indicators applied to a location, but that was not attempted for this application. Users are advised to review the indicators that lead to a high or low sustainability score and interpret the score based on specific local data sources and stakeholder knowledge.

Sum indicator vulnerabilities to arrive at *Total Vulnerability Score*

HUC	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	Total Vulnerability Score
01010001	1	4	1	3	1	3	1	2	1	1	1	3	1	1	1	3	1	1	1	5	1	1	1	3	3	1	4	50
01010002	1	4	1	3	5	4	1	2	1	1	1	3	1	1	1	2	2	1	1	5	1	1	1	3	3	1	4	55
01010003	4	4	1	4	5	3	1	2	1	1	1	3	1	1	1	2	1	1	1	5	1	1	1	3	3	3	4	59
01010004	1	4	1	4	1	3	1	2	1	1	1	3	1	1	1	2	2	1	1	5	1	1	1	3	3	5	4	55
01010005	4	4	1	3	1	3	1	2	1	1	1	3	1	1	1	3	3	1	1	5	1	1	1	3	3	1	4	55
01020001	4	4	1	4	5	3	1	2	1	1	1	3	1	1	2	3	1	1	1	5	1	2	3	3	3	5	4	66
01020002	1	4	1	4	5	3	1	2	1	1	1	3	1	1	2	3	2	1	1	5	1	5	3	3	3	5	4	67
01020003	1	4	1	4	1	3	1	2	1	1	1	3	1	1	1	2	1	1	1	5	1	5	1	3	3	5	4	58
01020004	4	4	1	4	5	4	1	2	1	1	1	1	1	1	1	2	1	1	1	5	1	2	2	3	3	5	4	62

Figure B-3. Example of summing to determine a watershed's vulnerability score.

Data sets and Results

The data set of 27 water indicators screens 2,252 U.S. watersheds for watershed vulnerability. The results are presented both in a sample spreadsheet and a national geospatial (map) form (Figures B-4 and B-5, respectively). Visualization of data allows users to identify environmental issues that are critical to sustainability and look at economic, social, and environmental characteristics.

				check box to expand Branch/Mission Categories	check box to expand Vulnerability Indicator Scores
WATER_BASIN	HUC	INSTALLATION NAME	STATE	☐ BRANCH/MISSION	☐ Total Vulnerability Index
New England Region	01010004	Caswell Training Site	Maine	Army	55
New England Region	01020005	Bangor Training Center	Maine	Army	65
New England Region	01020005	Frye Mountain Training Site	Maine	Army	65
New England Region	01030003	Camp Keyes Training Site	Maine	Army	65
New England Region	01030003	Frye Mountain Training Site	Maine	Army	65
New England Region	01030003	Gardiner	Maine	Army	65
New England Region	01030003	Plymouth Nat'l Guard Training Area	Maine	Army	65

Figure B-4. Sample spreadsheet of indicator screening for watershed vulnerability.

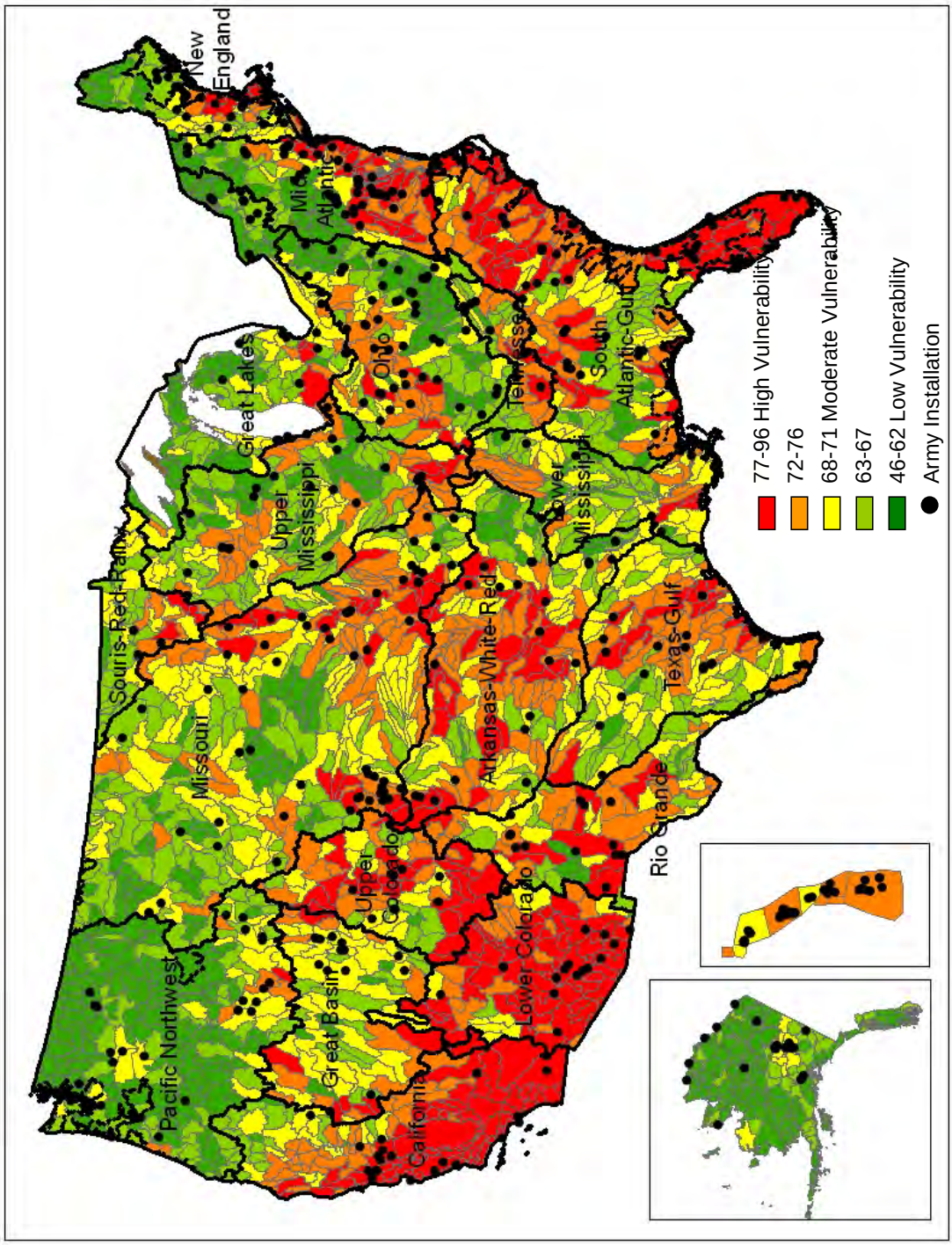

Figure B-5. Map of watershed vulnerability scores.

Watershed Vulnerability Scores

This analysis produced 27 indicator ratings as well as a synthesis “score” for each of 2,252 watersheds. Of the 567 Army installations studied, 160 (28%) lie within watersheds that are highly vulnerable to water crisis situations, whereas 59 installations (10%) are unlikely to face severe water shortages (e.g. lie within low vulnerability watersheds). Highly vulnerable installations tend to be in the South Atlantic-Gulf, Lower Colorado, Mid-Atlantic, and California basin regions.

All locations have some vulnerability to sustainability problems, as evidenced by the fact that the lowest rating score was still significantly higher than the lowest possible score. The highest scored watershed was much closer to the highest possible score. This indicates that watersheds do vary and that not all of the indicators are low for any given location. The national watershed screening identifies watersheds with potential sustainment problems, ranks watersheds by their relative vulnerability to such problems, and refers those watersheds identified during screening as containing critical Army installations and which are flagged as “at risk” for further evaluation and study

The watershed vulnerability scores underpin global water concerns previously discussed. Those concerns are (a) available supply is shrinking, (b) demand is growing, and (c) quality is being degraded. Although regions and installations may not yet encounter these effects, the watersheds and their basins are. Given the interconnectedness of watersheds, the local level threats are real. Installations may not yet be subject to local resource constraint, but supply, demand, quality, and water rights are all threatening the system.

Access

Updates to the Watershed Screening Methodology are available through the SIRRA Web site at: http://datacenter.leamgroup.com/sirra/. Indicator Maps include updated and additional indicator layers. Located within the “Applications” folder are the documentation, maps, and spreadsheets published for each application which are available for download (Figure B-6).

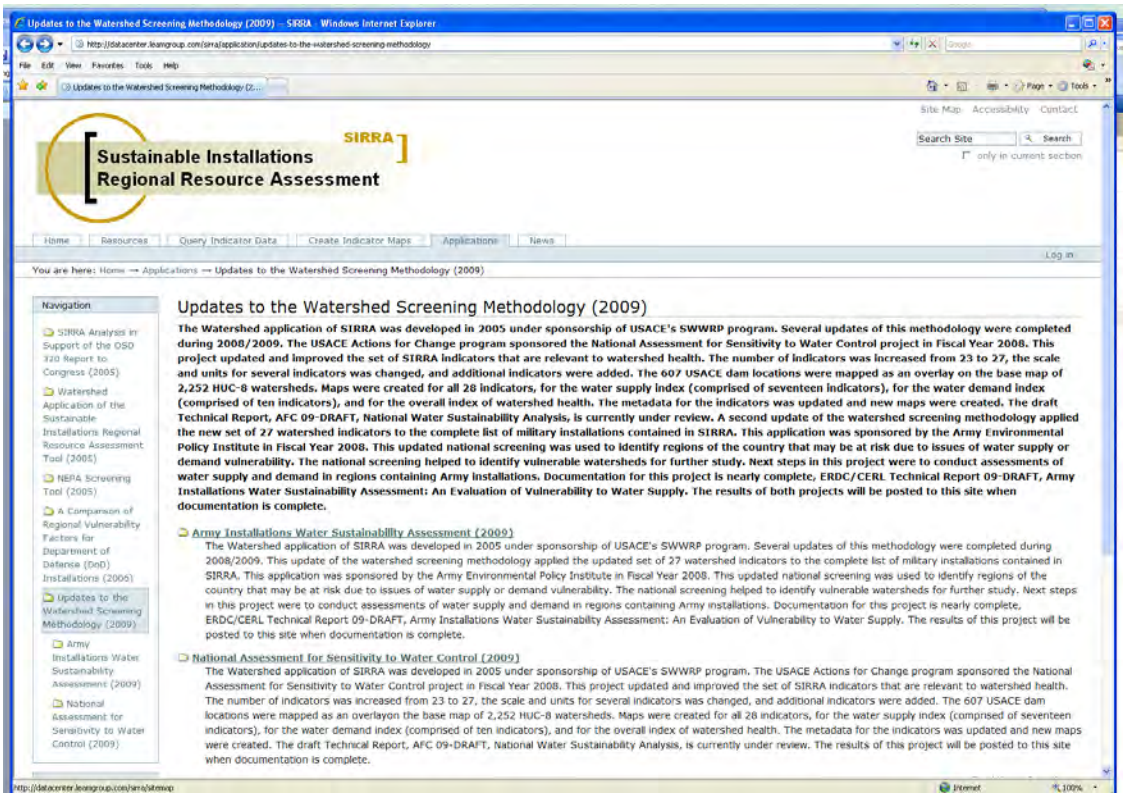

Figure B-6. The watershed screening application on the SIRRA Web site.

Framework Limitations

Users are encouraged to think of the watershed screening as an initial step in a series of increasingly localized studies. The national screening can help to prioritize local studies for regions with more critical water quantity and quality problems. It is also advisable to examine the individual indicator ratings when assessing a region's water sustainability, rather than roll-up scores. High and low ratings can balance each other and result in a satisfactory overall rating. Some indicators are critical to regional water sustainability and may outweigh all others, though they only comprise 1/27th of the roll-up score.

Vulnerability scores represent a generic evaluation of the potential for environmental problems and the general sustainability of any given watershed. The ranking methodology is meant to provide only a screening tool, not a final definitive evaluation of the sustainability of a watershed or a U.S. Army installation. The screened information requires further detailed studies which are specific to a watershed and its region. In other words, this methodology screens for certain issues and identifies watersheds considered to have potential

problems, as determined by the chosen set of indicators. A watershed may score high on an indicator that is statewide in scope, yet the vulnerability score could be inaccurate for that particular location.

The methodology of this analysis is based on national data sets and does not factor in unique or site-specific conditions. As a national level screening tool, the information represents entire counties, states, or ecoregions. As such, this data will not always agree with local data sources for specific watersheds or managed units within a county, watershed, or ecoregion. There are tradeoffs between using this standardized approach, which allows the use of national-level data to evaluate regional aspects of the watershed, and using an approach that considers solely watershed specific data. The best recommendation is to examine the scores to determine which data is most important and then evaluate its significance. Note that any decision relevant to a specific watershed location should always be informed by more than this analysis alone.

Vulnerability scores offer a view of watershed health at a given moment in time, a “snapshot view.” It would be advisable, therefore, to seek other historical snapshots and to track watershed ratings over time. This would show watersheds as degrading or improving over time and/or project life spans. In other words, looking at a watershed over time would show whether moderately vulnerable regions tend to become more or less vulnerable; whether policy choices or project implementation plans alter the vulnerability trend; and whether vulnerabilities tend to differ in different regions.

Time comparisons also could significantly expand the depth of vulnerability scores. These scores could potentially be improved by weighting specific indicators relative to their potential impact on mission sustainment. For example, streamflow levels may not be as critical to an installation with low water demand as compared to an installation with high water demand. In this situation, the low demand installation would put less emphasis on highly vulnerable streamflow when summing indicator vulnerability scores. Therefore, the regional sustainability ranking approach could provide a weighted summary of assessment indicators that determine an overall mission sustainment or vulnerability rating for each watershed. Both time comparisons and weighting applications are viewed as additional capabilities that may be added to this screening tool to assess watersheds containing installations where additional studies, planning, and actions are recommended to ensure continued mission support.

APPENDIX C:
Applications of the SIRRA Watershed Assessment

Regional screenings are a systematic, focused, interdisciplinary use of science to improve the quality of planning and decision making among diverse groups of stakeholders. There are several specialized applications of the watershed assessment using all or a sub-set of the 27 existing indicators, including assistance in meeting the requirements of EO 13423. These methods are captured in macro-enabled spreadsheets and GIS layers that can be queried to support the user's needs. The following are example applications aimed to provide assistance to installation Directors of Public Works as well as USACE Districts and Divisions for using this methodology to support long-term integrated water resource management.

Watershed Screening

Sample Questions:

In the Fort Bliss region, what are the critical issues to supporting EO 13423 water reduction goals and sustaining water supplies? What topics deserve the highest priority for regional collaboration?

Analysis Steps:

1. At the SIRRA Web site, create an Indicator Map zoomed into the region (watersheds) of Fort Bliss, TX.

2. Display each of the 27 water-related indicator layers and refer to the attributes while noting the vulnerability values for those that are "red" and "orange" within the selected watersheds. Red- and orange-colored indicators are those most critical to further investigation.

3. Use the SIRRA Indicator Data spreadsheet tool to highlight the Fort Bliss *vulnerability scores*. Note the high vulnerability watershed indicators. Figure C-1 is an example from the *Army Installations Water Sustainability Assessment* of a spreadsheet output that summarizes the strengths and weaknesses of watersheds surrounding Fort Bliss.

Installation	HUC8 Watershed	Streamflow Long-term Average A1	Streamflow 5-year Change A2	Run-off Long-term Average A3	Run-off 5-year Change A4	Presence of Groundwater A5	Low Flow Sensitivity A6	Groundwater Depletion A7	Drought Sensitivity A8	Federally Declared Coastal Disasters A9	Coastal Sea-level Rise A10	Federally Declared Floods A11	Flood Risk A12	Federally Declared Disasters A13	Seismic Zones A14	TES Richness A15	TES Hotspot A16	Water Quality A17	GW Withdrawals Long-term Average D1	GW Withdrawals 5-year Change D2	Consumption Rate D3	Water for Energy Production D4	Water for Energy 10-year Change D5	Regional Population Growth D6	Regional Population Projection D7	State Smart Growth Plans D8	Proximity to MSA D9	Institutional Flexibility D10
Fort Bliss	13030102	4	2	5	4	1	4	5	2	1	1	1	3	1	1	5	5	1	2	2	5	1	3	5	3	3	5	3
Fort Bliss	13040100	4	3	5	4	1	5	1	3	1	1	1	3	1	1	4	4	1	2	1	5	1	3	3	5	3	5	3
Fort Bliss	13050003	4	4	5	5	1	4	5	3	1	1	1	3	1	1	5	5	1	1	1	5	1	2	3	3	3	5	3
Fort Bliss	13050004	4	4	5	1	1	5	5	3	1	1	1	3	1	1	5	4	1	2	1	4	1	2	1	4	3	5	3
Fort Bliss	13030102	4	2	5	4	1	4	5	2	1	1	1	3	1	1	5	5	1	2	2	5	1	3	5	3	3	5	3
Fort Bliss	13040100	4	3	5	4	1	5	1	3	1	1	1	3	1	1	4	4	1	2	1	5	1	3	3	5	3	5	3
Fort Bliss	13050003	4	4	5	5	1	4	5	3	1	1	1	3	1	1	5	5	1	1	1	5	1	2	3	3	3	5	3
Fort Bliss	13050003	4	4	5	5	1	4	5	3	1	1	1	3	1	1	5	5	1	1	1	5	1	2	3	3	3	5	3

Figure C-1. Watershed screening application sample.

Discussion:

The watershed vulnerability scores form a helpful screening tool that links numerous sustainability data and provides relative characterizations of a region based on that information in a quick and efficient format. It supports a systems approach by focusing on hydrological and ecological linkages, rather than political boundaries. Users are encouraged to use the national screening as an initial step in a series of increasingly localized studies. The national screening can help prioritize local water issues of concern. It is also advised to examine the individual indicator ratings, rather than roll-up scores, when assessing a region's water sustainability and to identify the indicators that are critical to regional water sustainability. Regional watershed assessment is a first step toward balanced growth and collaboration within watersheds.

Installation Screening

Sample Questions:

What percentage of Army National Guard (ANG) installations is vulnerable to drought conditions? Of those installations, which are set for stationing increases due to BRAC 2005?

Analysis Steps:

1. Using the indicator spreadsheet from the *Army Installations Water Sustainability Assessment,* sort by *ANG* then by *A8* Drought Sensitivity indicator, then by *BRAC2005 Action*. This

is a ranked list of ANG installations by their associated watershed drought sensitivity. Count those with associated "5" or "4" A8 values to determine which are vulnerable to drought and divide that number by the total number of ANG installations to calculate the percentage vulnerable to drought conditions. Highlight those targeted for BRAC 2005 action[3].

2. From the SIRRA Web site, create an Indicator Map displaying the Drought Sensitivity (A8) indicator. Note "ANG" mission installations with BRAC 2005 gains. The result visualizes where ANG installations are located in relation to drought conditions (Figure C-2).

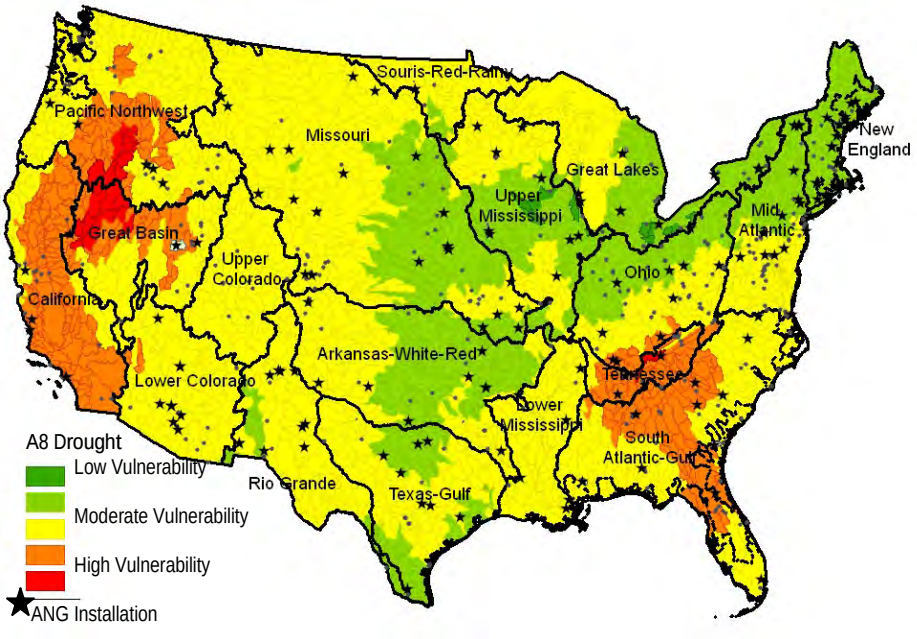

Figure C-2. Map relating installation screening application.

Discussion:

The Army's post-event reviews of hurricanes Rita and Katrina stressed the need to incorporate new and changing information into planning and decision-making on the watershed scale. Federal agencies are faced with the challenge of making choices that simultaneously serve their mission, adhere to policies and laws, and avoid or mitigate negative effects. Agency analysts need the ability to create multiple scenarios based on the best

[3] Base Realignment and Closure (BRAC) 2005 actions were acquired from *DoD Base Closure and Realignment Report*, 2005. Actual actions may differ.

information available, propose and evaluate alternatives, and measure the impacts. Regional watershed assessment supports expanded inputs to decision-making in a cost-effective manner through the use of geospatial tools. Clear and concise maps of emerging risk factors (such as drought) can effectively help evaluate the distribution of impacts on mission activities and inform mitigation or adaptation actions and priorities.

Ranking is yet another option to prioritize decision making. The results of this analysis can be further disaggregated to look only at installations with specified primary missions or to look at individual watershed indicators that are critical to mission sustainment. A caution when doing this is that data is regional in scope and may not reflect localized conditions.

Topic Screening

Sample Questions:

What region and/or specific installations would potentially have the greatest benefit from implementation of a new-construction water-efficiency BMP pilot study?

Analysis Steps:

1. Using the indicator spreadsheet from the Army Installations Water Sustainability Assessment, expand Total Demand Vulnerability Score. Sort data by Water Basin and calculate subtotals by averaging D3 Consumption Rate and D7 Population Projection. Highlight those basins where both D3 and D7 are vulnerable. These are regions where water conservation for new or existing construction may have the greatest impact due to the fact that population is projected to increase significantly and per capita consumption rates are currently above the national average.

2. From the SIRRA Web site, create an Indicator Map displaying those basins noted as vulnerable from step 1. For those installations within a vulnerable basin, note those installations where the sum of attribute D3 and D7 is equal to or greater than 8. These installations are those where water conservation for new or existing construction may have the greatest impact (Figure C-3).

Water Basin	D3	D7
Upper Mississippi Region Average	2	3
Upper Colorado Region Average	3	4
Texas-Gulf Region Average	5	5
Tennessee Region Average	5	4
South Atlantic-Gulf Region Average	2	4
Souris-Red-Rainy Region Average	3	1
Rio Grande Region Average	3	3
Pacific Northwest Region Average	2	4
Ohio Region Average	3	2
New England Region Average	5	3
Missouri Region Average	2	3
Mid Atlantic Region Average	3	3
Lower Mississippi Region Average	3	3
Lower Colorado Region Average	2	5
Hawaii Region Average	5	2
Great Lakes Region Average	3	2
Great Basin Region Average	4	4
California Region Average	1	4
Arkansas-White-Red Region Average	3	3
Alaska Region Average	1	4
Grand Average	3	3

Figure C-3. Topic screening application for two attributes.

Discussion:

The U.S. Army owns millions of square feet of facilities. Therefore, effective asset management and planning is a priority. Regional watershed assessment identifies strengths and weaknesses of watersheds to inform stationing and infrastructure decisions and prioritization actions. With accurate knowledge of the systems, sustainment problems can be addressed with effective allocation of resources. It is also advised to weight critical indicators when conducting specific analyses. Ranking risk factors helps to determine the most appropriate pathway to a sustainable future given regional conditions and also promotes long-term integrated planning.

Appendix D
Acronyms and Abbreviations

Term	Spellout
AFC	Actions for Change
ACSIM	Assistant Chief of Staff for Installation Management
AEPI	Army Environmental Policy Institute
ANG	Army National Guard
APA	American Planning Association
AWWA	American Water Works Association
BMPs	best management practices
BRAC	Base Realignment and Closure
CERL	Construction Engineering Research Laboratory
DA	Department of the Army
DAIM	Department of the Army Internal Memorandum
DOD	Department of Defense
DPW	Department of Public Works
EIA	Energy Information Administration
EISA	Energy Independence and Security Act (2007)
EO	Executive Order
ERDC	Engineer Research and Development Center
FEMA	Federal Emergency Management Agency
GIS	geographic information system
GW	groundwater
HQUSACE	Headquarters, U.S. Army Corps of Engineers
HUC	hydrologic unit code
IMCOM	Installation Management Command
ISSP	Installation Strategic Sustainability Planning
JAWRA	Journal of American Water Resources Association
MSA	metropolitan statistical areas
MTR	military training routes
NCDC	National Climate Data Center
NEPA	National Environmental Policy Act
PDF	portable document format
PE	professional engineer
POC	point of contact
PWTB	Public Works Technical Bulletin
RDT&E	Research, Development, Test and Evaluation
SERDP	Strategic Environmental Research and Development Program
SIRRA	Sustainable Installations Regional Resource Assessment
SWWRP	System-Wide Water Resources Program
TES	threatened and endangered species
TR	technical report
URL	universal resource locator
USACE	U.S. Army Corps of Engineers
USCB	U.S. Census Bureau
USGS	U.S. Geological Survey
WWW	World Wide Web

Appendix E:
Related ERDC-CERL Publications

Jenicek, Elisabeth M., Donald F. Fournier, Natalie R. Downs, and Brad Boesdorfer. 2005. *Watershed application of the sustainable installations regional resource assessment tool*. ERDC/CERL TR-05-24. Champaign, IL: U.S. Army Engineer Research and Development Center – Construction Engineering Research Laboratory (ERDC-CERL). Available at (accessed September 2010): http://libweb.wes.army.mil/uhtbin/hyperion/CERL-TR-05-24.pdf.

Jenicek, Elisabeth M., Natalie R.D. Myers, Donald F. Fournier, Kevin Miller, MeLena Hessel, Rebecca Carroll, and Ryan Holmes. 2009. *Army installations water sustainability assessment: An evaluation of vulnerability to water supply*. ERDC/CERL TR-09-38. Champaign, IL: U.S. Army Engineer Research and Development Center – Construction Engineering Research Laboratory (ERDC-CERL). Available at (accessed September 2010): http://www.cecer.army.mil/techreports/Jenicek_SIRRA_Watershed__TR/Jenicek_SIRRA_Watershed__TR.pdf.

Myers, Natalie R.D., Elisabeth M. Jenicek, and Donald F. Fournier. In process 2010. *National water sustainability analysis: A characterization of U.S. watershed health*. AFC 10-DRAFT. Washington, DC: Headquarters, U.S. Army Corps of Engineers (HQUSACE), Actions for Change (AFC), Theme 1.