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CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES
QUALITY ASSURANCE
SURVEILLANCE REPORT

PROJECT NO.: 20.01402.471	REPORT NO.: 2002-24	PAGE 1 OF 3

SURVEILLANCE SCOPE: Monitor IKONOS satellite image processing and production of prints for the CNWRA.

REFERENCE DOCUMENTS: SwRI Purchase Order 609637 and Associated 08/05/2002 Quotation by Earth Satellite Corp. QAP-004 Surveillance Control

STARTING DATE: 08/30/2002 ENDING DATE: 08/30/2002

QA REPRESENTATIVE: John L. Russell, Director of Washington Technicial Support Office, Center for Nuclear Waste Regulatory Analyses, Rockville, MD. John L. Russell 09/4/2002

PERSONS CONDUCTING TEST/EXAM/ACTIVITY: Michael Obrien and Christopher M. Jengo, Earth Satellite Corporation, Rockville, MD.

SATISFACTORY FINDINGS: IKONOS satellite image processing and production of prints was being conducted by qualified staff using established procedures. The equipment, procedures and software utilized are acceptable for similar work for the NASA, USGS, and DOD. The work should be reproduceable. Processing of the geospatial data includes steps involving human interaction, e.g., selection of specific areas to be processed in tonal balancing. The surveillance indicates this was done correctly. The final prints were examined immediately after production. Edge effects in the raw data, an artifact of creating individual mosaics (of the north area and the south area of the Yucca Mountain region) fom several tiles (images), were corrected in the processing by Earth Satellite Corp. Balancing of the tone of the images between the two mosaics was done appropriately, but was hampered by lack of significant overlap of the areas imaged and difference in data of imgery collection. Tonal differences were least for the eastern portion of the two mosaics.

UNSATISFACTORY FINDINGS: None.

NONCONFORMANCE REPORT NO.: None.

ATTACHMENTS: One page description of the Minium Noise Fraction transform used to process the data.

RECOMMENDATIONS/ACTIONS: The CNWRA should obtain a brief summary of the image processing, including version numbers of software used by Earth Satellite Corp., by requesting the information from the firm. Comparisons of the data within two areas adjacent to each other, such as the IKONOS data for the north and south regions of Yucca Mountain, can be improved by significantly overlapping the two areas and collecting the data at the same or nearly the same time/date. The data processed did not overlap or overlapped only a few pixels and was taken at a widely different dates. Future acquisition of satellite imagery should consist of data collected in such a manner as to avoid these two difficulties. 9/17/02

See page 2 of 3 of this surveillance report for a brief image processing summary.

APPROVED: Bruce Mabrito

CENTER DIRECTOR OF QUALITY ASSURANCE

DATE: 9/18/2002

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4.6 Minimum Noise Fraction

The minimum noise fraction (MNF) transform is used to determine the inherent dimensionality of image data, to segregate noise in the data, and to reduce the computational requirements for subsequent processing (see Boardman and Kruse, 1994). This method is similar to principal component (PC) analysis that is commonly used in multispectral image processing, but involves an extra preceding step. The MNF algorithm used by ENVI is modeled after that created by Green *et al.* (1988). The first transformation applied to the data decorrelates and rescales the noise in the data based on an estimated noise covariance matrix calculated for the scene prior to MNF transformation. This results in transformed data in which the noise has unit variance and no band-to-band correlation. A standard PC transformation is then applied to the noise-whitened data.

The data can be divided into two parts: one part associated with large eigenvalues and coherent eigenimages, and a complementary part with near-unity eigenvalues and noise-dominated images. Subsequent image processing based on the MNF results is improved by the removal of the noise. In this study, however, the lower eigenvalue images were retained for analysis because subtle spectral variations, such as those presumably caused by hydrocarbon seepage, could reside in them.

The MNF transformed data can then be used for classification using any standard classification scheme or by manually choosing training classes on scatter plots. However, as the transformed bands are eigenimages, there is no direct correlation between brightness and composition. Therefore, band to band correlations between pixels imply spectral similarity, but the specific material responsible for it cannot be identified directly.

Boardman, J.W., and F.A. Kruse, 1994, Automated Spectral Analysis: A Geologic Example using AVIRIS Data, North Grapevine Mountains, Nevada, in proceedings, Tenth Thematic Conference on Geologic Remote Sensing, Environmental Research Institute of Michigan, Ann Arbor, MI, p. I-407 - I-418.

Green, A.A., M. Berman, P. Switzer, and M.D. Craig, 1988, A Transformation for Ordering Multispectral Data in Terms of Image Quality with Implications for Noise Removal, IEEE Transactions on Geoscience and Remote Sensing, v. 26, no. 1, p. 65-74.

File with Surveillance.

Bruce Mabrito

To: Mark Ehnstrom; Randolph W. Folck; Thomas A. Mayces; Maria Padilla; Bruce Mabrito
Subject: Assignment of John Russell to Perform Surveillance at Earth Satellite Corp. 3 of 3

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The purpose of this memorandum is to authorize Dr. John Russell to perform a surveillance at the Earth Satellite Corporation in Rockville, MD.

In addition, this e-mail message will be printed out and placed in the "QA Memos" folder as further documentation that this surveillance supports the procurement of services from the Earth Satellite Corporation. This is in addition to those provisions in CNWRA Quality Assurance Procedure-016, Procurement, section 6.3, Qualification of Non-Approved Suppliers List of Services and Software, and 7.2., Acceptance of Quality-Affecting Goods from Non-Approved Suppliers List Suppliers.

Training has been provided to Dr. Russell through his reading and discussion of QAP-004, Surveillance Control, and through questions asked by Dr. Russell before the surveillance and specific responses provided as he wrote up his surveillance report.

If there are any questions regarding this surveillance assignment, please direct them to me at ext. 5149. Bruce Mabrito, CNWRA Quality Assurance