

**EnerQuest 2001 Panchromatic and Color-Infrared Image Data  
Review of Deliverables  
Contract 01-WRCN-0019**

**Panchromatic Image Data**

The Contractor was to provide panchromatic imagery for the entire 295.3-mile extent of the river corridor, from 2 km upstream from Glen Canyon Dam to Pierce Ferry in Lake Mead, as well as specified confluence segments of 6 major tributaries. Imagery was to be acquired with a 60-percent forward overlap at a pixel resolution of 18-24 cm. In addition, final products were to include image footprint index maps and FGDC-compliant metadata.

1. **Summary of coverage provided** (contract section 2.1.3.) – the contractor delivered imagery in TIFF format covering 181.52 miles (61.5 percent) of the river corridor, approximately 1 mile of the Little Colorado River and 0.6 mile of the Paria River. The following contract discrepancies are noted.
  - a. Imagery was not delivered for approximately 7.5 miles of the Little Colorado River and 2.4 miles of the Paria River.
  - b. Imagery was not delivered for any length of the Shinumo Creek, Kanab Creek, Tapeats Creek, or Havasu Creek.
  - c. Imagery was not delivered for 113.78 miles (38.5 percent) of the specified river corridor. Missing sections, identified by GCMRC river mile from the footprint index map, are as follow. Total missing miles are indicated in parentheses.
    - RM –10.6 to –10.4 (0.2)
    - RM –9.75 to –9.5 (0.25)
    - RM 14.1 to 14.45 (0.35)
    - RM 73.95 to 74.05 (0.1)
    - RM 101.8 to 102.4 (0.6)
    - RM 105.8 to 106.0 (0.2)
    - RM 109.0 to 109.1 (0.1)
    - RM 110.8 to 110.9 (0.1)
    - RM 111.9 to 164.1 (52.2)
    - RM 175.25 to 175.35 (0.1)
    - RM 184.5 to 184.7 (0.2)
    - RM 193.3 to 194.4 (1.1)
    - RM 195.65 to 197.1 (1.45)
    - RM 198.3 to 199.65 (1.35)
    - RM 201.05 to 202.73 (1.68)
    - RM 203.8 to 205.5 (1.7)
    - RM 207.37 to 208.82 (1.45)
    - RM 209.92 to 211.0 (1.08)
    - RM 211.93 to 212.62 (0.69)
    - RM 213.65 to 214.47 (0.82)

- RM 215.77 to 217.07 (1.3)
  - RM 218.05 to 218.4 (0.35)
  - RM 223.1 to 223.2 (0.1)
  - RM 229.38 to 229.7 (0.32)
  - RM 232.2 to 232.84 (0.64)
  - RM 233.9 to 279.5 (45.6)
2. **Images delivered** (contract section 12.2.3.) – 1180 panchromatic images were delivered in TIFF format. All were readable with the following exceptions.
    - a. A total of 30 images on one CD (cd9\_pan1jul\_2) were not readable.
  3. **Image parameter files** (contract section 12.2.3) – 9 text files (.eo) were delivered containing image positional information and camera parameters.
  4. **Image footprint index map** – an Arc/Info export file containing 1041 image regions was provided. The following problems were identified:
    - a. A total of 38 images indexed on the footprint map were not provided. The numbers are: jul032001a\_555 to 574 and jul032001a\_578 to 592.
    - b. All images for jul032001b (122 scenes) are not contained in the footprint index map.
    - c. Of the images documented in the jul032001b\_pan.eo file, 15 were not delivered. The numbers are: jul032001b\_0652 to 0656, jul032001b\_0663 to 0665, jul032001b\_0676 to 0677 and jul032001b\_0736 to 0740.
  5. **FGDC-compliant metadata** (contract section 12.2.5.) – Each of the 1180 panchromatic images was delivered with a metadata file (.xml). The following problems were noted.
    - a. A total of 30 files on one CD (cd9\_pan1jul\_2) were not readable.
    - b. Image-center coordinates contained in the metadata, which states that they were collected simultaneously with the photography, are coincident with center coordinates contained in the image parameter (.eo) files and with the centers of the index-map image regions. However, the actual image center does not coincide with the image-center coordinates for all images in the set jun302001a. Each image in this set has a photo-id that is one higher than the correct footprint in the index map and the correct centers documented in the .eo files and the metadata files. The contractor should rename all image files in the jun302001a set and resubmit them.
  6. **Swath width** (contract section 2.1.4.) - Individual images appear to cover approximately 700 by 700 meters based on the footprint index provided.
  7. **Pixel resolution** (contract section 2.1.1.) – Each TIFF image contains 4096 columns and 4096 rows. If individual images average 700 meters per side, then a rough calculation yields an approximate pixel resolution of 17 cm, which meets the contract specifications. The metadata claims a pixel resolution of 0.99 feet or about 25 cm.
  8. **Image quality** – The unstretched quality of the delivered TIFF images is, on average, quite dark. A qualitative evaluation of image quality rated by 5 classes yielded the following: Good (1.6%), Fair (15%), Dark (66.9%), Very Dark (15%), and Black (1.5%).
  9. **Image overlap** – Most of the images appeared to conform to the 60-percent overlap criteria with the following exceptions.

- a. At the ends of missing sections.
  - b. Some flight-line ends show insufficient overlap.
10. **CDROM media duplicates** – The contract specifies that duplicate copies of all media are required at the time of delivery. Duplicates were provided for only one set of flightline images (jul012001a). Second copies of TIFF images and metadata files need to be provided for the following:
- jun302001a
  - jun302001b
  - jul012001b
  - jul022001a
  - jul022001b
  - jul022001c
  - jul032001a
  - jul032001b

### **Color-Infrared Image Data**

The Contractor was to provide color infrared imagery for the entire 295.3-mile extent of the river corridor, from 2 km upstream from Glen Canyon Dam to Pierce Ferry in Lake Mead, as well as specified confluence segments of 6 major tributaries. Imagery was to be acquired with a 20-percent forward overlap at a pixel resolution of 18-24 cm. In addition, final products were to include image footprint index maps and FGDC-compliant metadata.

1. **Summary of coverage provided** (contract section 2.1.3.) – the contractor delivered imagery in TIFF format covering 172.69 miles (58.5 percent) of the river corridor, approximately 1 mile of the Little Colorado River and 0.6 mile of the Paria River. The following contract discrepancies are noted.
- a. Imagery was not delivered for approximately 7.5 miles of the Little Colorado River and 2.4 miles of the Paria River.
  - b. Imagery was not delivered for any length of the Shinumo Creek, Kanab Creek, Tapeats Creek, or Havasu Creek.
  - c. Imagery was not delivered for 122.61 miles (41.5 percent) of the specified river corridor. Missing sections, identified by GCMRC river mile from the footprint index map, are as follow. Total missing miles are indicated in parentheses.
    - RM –10.77 to –10.4 (0.37)
    - RM –10.08 to –9.64 (0.44)
    - RM 2.15 to 2.2 (0.05)
    - RM 4.65 to 4.97 (0.32)
    - RM 13.99 to 14.59 (0.60)
    - RM 29.75 to 29.96 (0.21)
    - RM 48.2 to 48.6 (0.40)
    - RM 71.5 to 71.7 (0.20)
    - RM 73.85 to 74.18 (0.33)
    - RM 92.58 to 92.7 (0.12)

- RM 93.67 to 93.9 (0.23)
- RM 95.1 to 95.3 (0.20)
- RM 96.25 to 96.5 (0.25)
- RM 97 to 97.2 (0.20)
- RM 101.7 to 102.46 (0.76)
- RM 103.2 to 103.48 (0.28)
- RM 104.38 to 104.48 (0.10)
- RM 105.7 to 106.06 (0.36)
- RM 107.75 to 107.8 (0.05)
- RM 111.8 to 164.2 (52.4)
- RM 175.2 to 175.45 (0.25)
- RM 184.4 to 184.75 (0.35)
- RM 193.2 to 194.5 (1.30)
- RM 195.55 to 197.23 (1.68)
- RM 198.15 to 199.75 (1.60)
- RM 200.9 to 202.8 (1.90)
- RM 203.7 to 205.8 (2.10)
- RM 207.3 to 208.93 (1.63)
- RM 209.9 to 211.1 (1.20)
- RM 211.8 to 212.75 (0.95)
- RM 213.5 to 214.65 (1.15)
- RM 215.7 to 217.2 (1.50)
- RM 217.93 to 218.4 (0.47)
- RM 219.7 to 219.8 (0.10)
- RM 220.6 to 220.7 (0.10)
- RM 221.2 to 221.4 (0.20)
- RM 223 to 223.3 (0.30)
- RM 224.7 to 224.9 (0.20)
- RM 227.1 to 227.2 (0.10)
- RM 229.25 to 229.8 (0.55)
- RM 232.1 to 232.95 (0.85)
- RM 233.43 to 233.6 (0.17)
- RM 233.86 to 279.5 (45.64)

2. **Images delivered** (contract section 12.2.3.) – 1210 color-infrared images were delivered in TIFF format. All were readable.
3. **Image parameter files** (contract section 12.2.3) – 9 text files (.eo) were delivered containing image positional information and camera parameters.
4. **Image footprint index map** – an Arc/Info export file containing 1041 image regions was provided. The following problems were identified:
  - b. A total of 20 images indexed on the footprint map were not provided. The numbers are: jun302001a\_0087, 0102, 0123, 0164, 0191; jul032001b\_0652 to 0656, 0663 to 0665, 0676 to 0677, and 0736 to 0740.
  - c. All images for jul032001b (171 scenes) are not contained in the footprint index map.
  - d. Of the images documented in the jul022001b\_cir.eo file, 3 were not delivered. The numbers are: jul022001b\_0324 to 0326.

5. **FGDC-compliant metadata** (contract section 12.2.5.) – Each of the 1180 panchromatic images was delivered with a metadata file (.xml). The following problems were noted.
  - a. Image-center coordinates contained in the metadata, which states that they were collected simultaneously with the photography, are coincident with center coordinates contained in the image parameter (.eo) files and with the centers of the index-map image regions. However, the actual image center does not coincide with the image-center coordinates for all images in the set jun302001a. Each image in this set has a photo-id that is one higher than the correct footprint in the index map and the correct centers documented in the .eo files and the metadata files. The contractor should rename all image files in the jun302001a set and resubmit them.
6. **Pixel resolution** (contract section 2.1.1.) – Each TIFF image contains 3060 columns and 2036 rows. The metadata claims a pixel resolution of 0.90 feet.
7. **Image quality** – The unstretched quality of the delivered TIFF images is, on average, good. A qualitative evaluation of image quality rated by 5 classes yielded the following: Good (62.4%), Fair (18.1%), Shadow (16.8%), Poor (1.2%), and Dark (1.5%). An image was classified as shadow where any portion of the near-shore river corridor was obscured in shadow, but the overall quality of the rest of the image was fair or good.
8. **Image overlap** – Most of the images appeared to conform to the 20-percent overlap criteria with the following exceptions.
  - a. At the ends of missing sections
  - b. Some flight-line ends show insufficient overlap.
9. **CDROM media duplicates** – The contract specifies that duplicate copies of all media are required at the time of delivery. Duplicates were provided for only one set of flightline images (jul012001a). Second copies of TIFF images and metadata files need to be provided for the following:
  - jun302001a
  - jun302001b
  - jul012001b
  - jul022001a
  - jul022001b
  - jul022001c
  - jul032001a
  - jul032001b