Appendix F. Aerial Imagery, Remote Sensing Data

The SJRRP will use aerial imagery and remote sensing data when appropriate to aid in Reclamation's understanding of agricultural practices and changes in cropping patterns. There are multiple sources of data readily available for download. Three of the available sources of data presented in this appendix are:

- Landsat,
- Cropland Data Layer (CDL), and
- National Agriculture Imagery Program (NAIP).

F.1 Landsat

Landsat is a joint program of the USGS and the National Aeronautics and Space Administration (NASA). Landsat is the world's longest running continuous collection of satellite-acquired remote sensing data. Landsat data is available monthly from 1999 through the present via the USGS's "Global Visualization Viewer" internet portal (http://glovis.usgs.gov/). Figures F-1 through F-3 show Landsat data for June 2007. Figures F-4 through F-6 show the same images for June 2012. The data shown in Figures F-1 through F-6 can be zoomed in and shown at a more local scale. However, individual local-scale figures are not presented in this appendix.

The Landsat 7 satellite contained the Enhanced Thematic Mapper Plus (ETM+) with multiple bands capable of assessing various vegetation characteristics. Table F-1 lists the spectral bands available from the ETM+, as well as the Thematic Mapper (TM) on board Landsats 4 and 5. Landsat 8, which was launched in February 2013 and is now operational, carries two push-broom sensors: the Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS). Table F-2 provides information on the uses of the OLI and TIRS data.

Tables F-1 and F-2 provide the use for each of the spectral bands from Landsat. Comparisons of Landsat data over multiple years inform how cropping and production may have changed in differing hydrologic conditions.

Table F-1.
Landsat ETM+ and TM Band Designations and Uses

Spectral Band[1]	Resolution (meters)	Use
Band 1: blue-green	30	Bathymetric mapping; distinguishes soil from vegetation; deciduous from coniferous vegetation
Band 2: green	30	Emphasizes peak vegetation, which is useful for assessing plant vigor
Band 3: red	30	Emphasizes vegetation slopes
Band 4: reflected IR	30	Emphasizes biomass content and shorelines
Band 5: reflected IR	30	Discriminates moisture content of soil and vegetation; penetrates thin clouds
Band 6: thermal	120	Useful for thermal mapping and estimated soil moisture
Band 7: reflected IR	30	Useful for mapping hydrothermally altered rocks associated with mineral deposits. Band 8–panchromatic
Band 8: panchromatic	15	Useful in 'sharpening' multispectral images

Note:
1: Reproduced from: USGS. 2013. "Landsat – Global Land-Imaging Mission". Fact Sheet 2012-3072. May.

Table F-2.
Landsat OLI and TIRS Band Designations and Uses

Spectral Band[1]	Resolution (meters)	Use
Band 1–coastal/aerosol	30	Increased coastal zone observations.
Band 2–blue	30	Bathymetric mapping; distinguishes soil from vegetation; deciduous from coniferous vegetation.
Band 3–green	30	Emphasizes peak vegetation, which is useful for assessing plant vigor.
Band 4–red	30	Emphasizes vegetation slopes.
Band 5–near IR	30	Emphasizes vegetation boundary between land and water, and landforms.
Band 6–SWIR 1	30	Used in detecting plant drought stress and delineating burnt areas and fire-affected vegetation, and is also sensitive to the thermal radiation emitted by intense fires; can be used to detect active fires, especially during nighttime when the background interference from SWIR in reflected sunlight is absent.
Band 7–SWIR-1	30	Used in detecting drought stress, burnt and fire-affected areas, and can be used to detect active fires, especially at nighttime.
Band 8–panchromatic	15	Useful in 'sharpening' multispectral images.
Band 9–cirrus	30	Useful in detecting cirrus clouds.
Band 10–TIRS 1	100	Useful for mapping thermal differences in water currents, monitoring fires and other night studies, and estimating soil moisture.
Band 11–TIRS 2	100	Same as band 10

Note:
1: Reproduced from: USGS. 2013. "Landsat – Global Land-Imaging Mission". Fact Sheet 2012-3072. May.

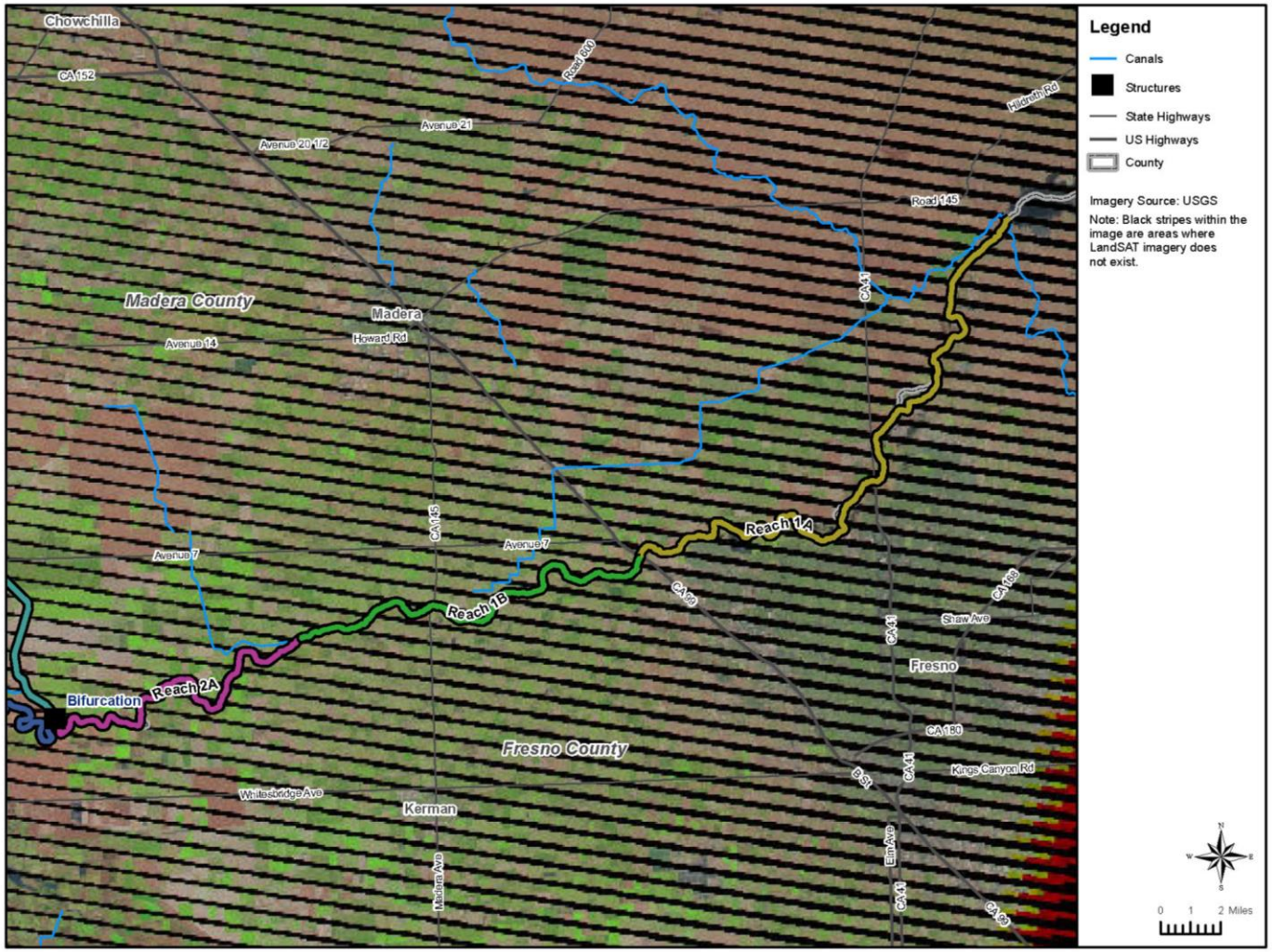

Figure F-1.
Landsat Imagery for SJRRP Area, June 2007 (Map 1 of 3)

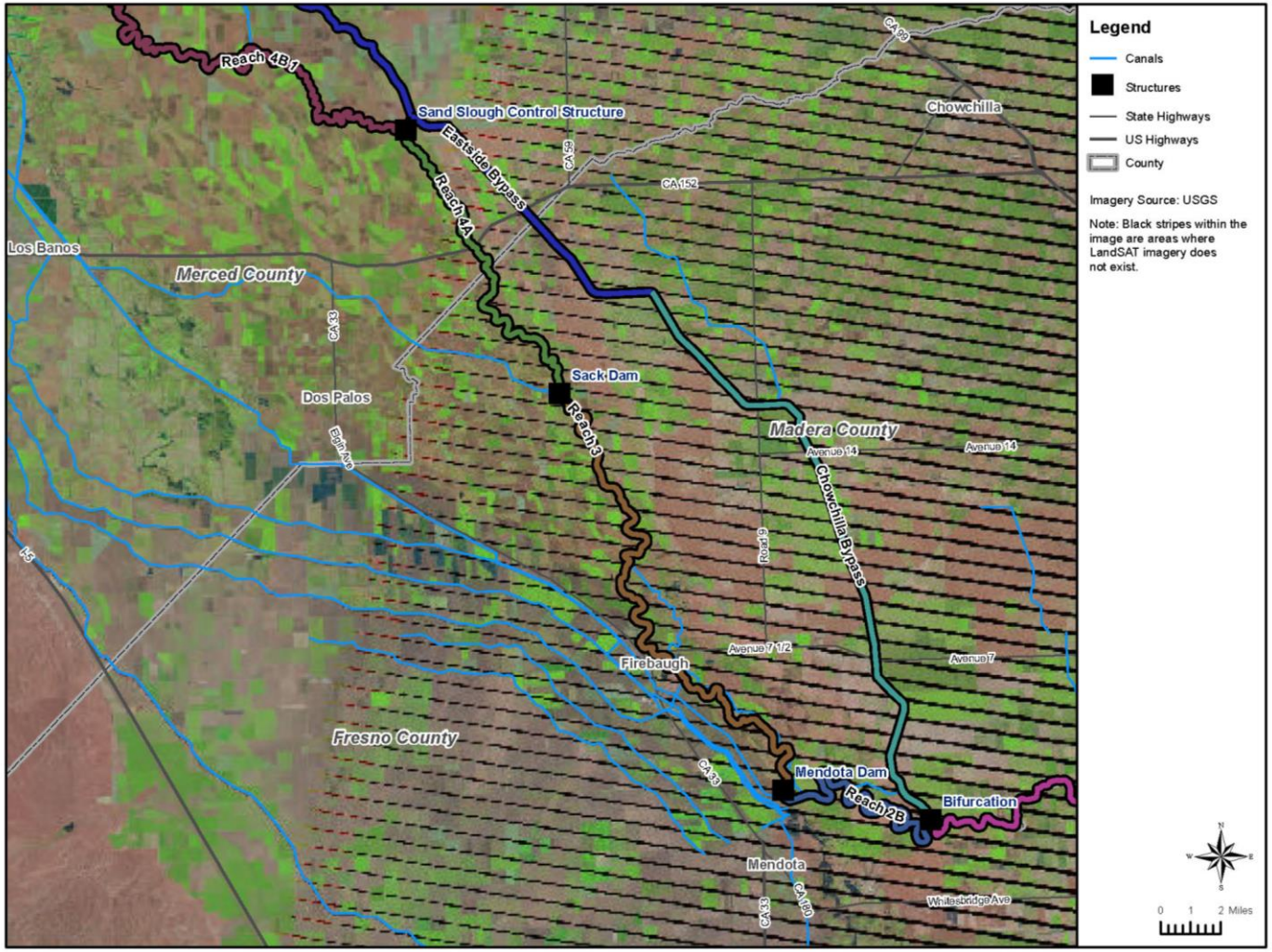

Figure F-2.
Landsat Imagery for SJRRP Area, June 2007 (Map 2 of 3)

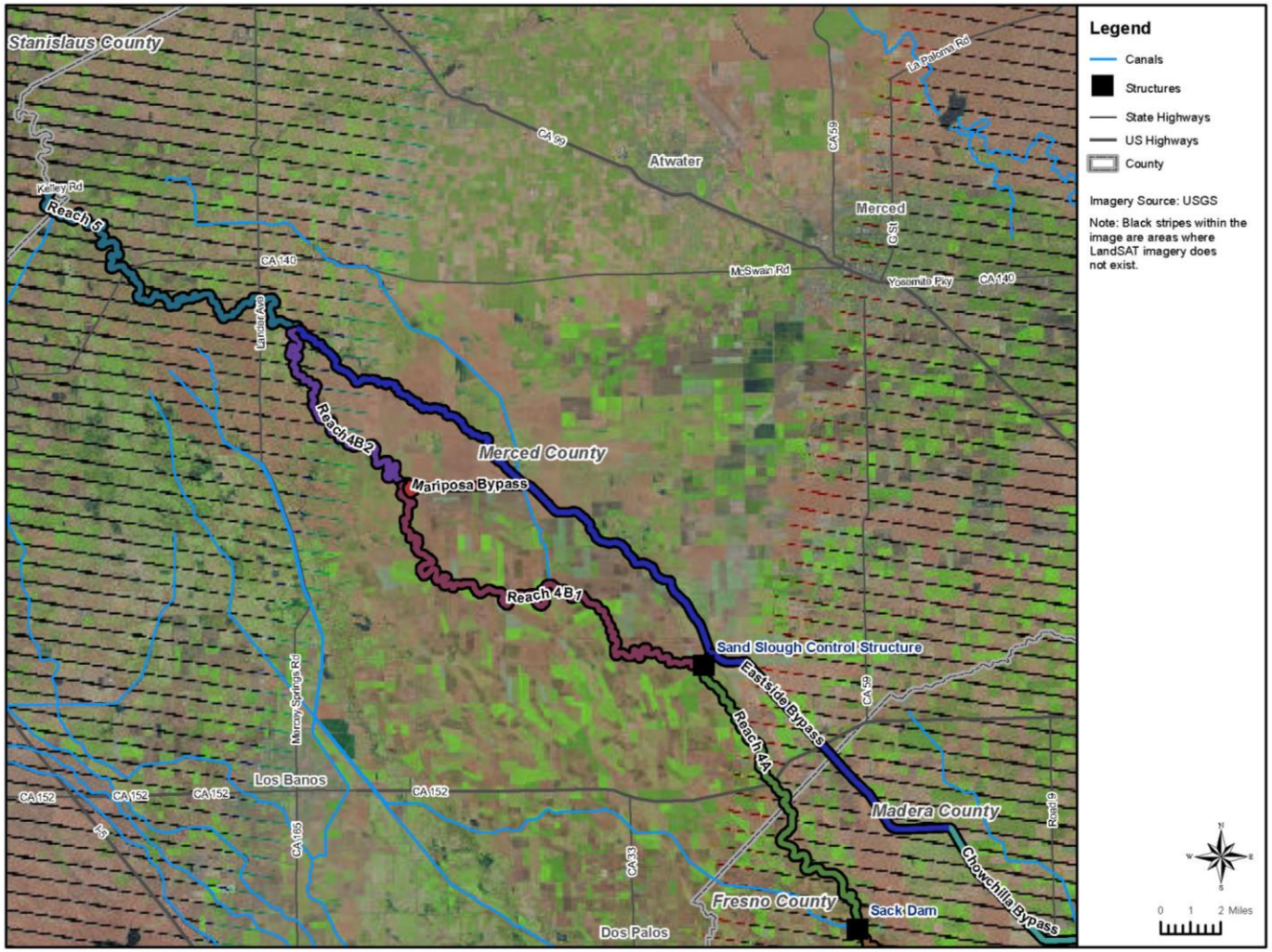

Figure F-3.
Landsat Imagery for SJRRP Area, June 2007 (Map 3 of 3)

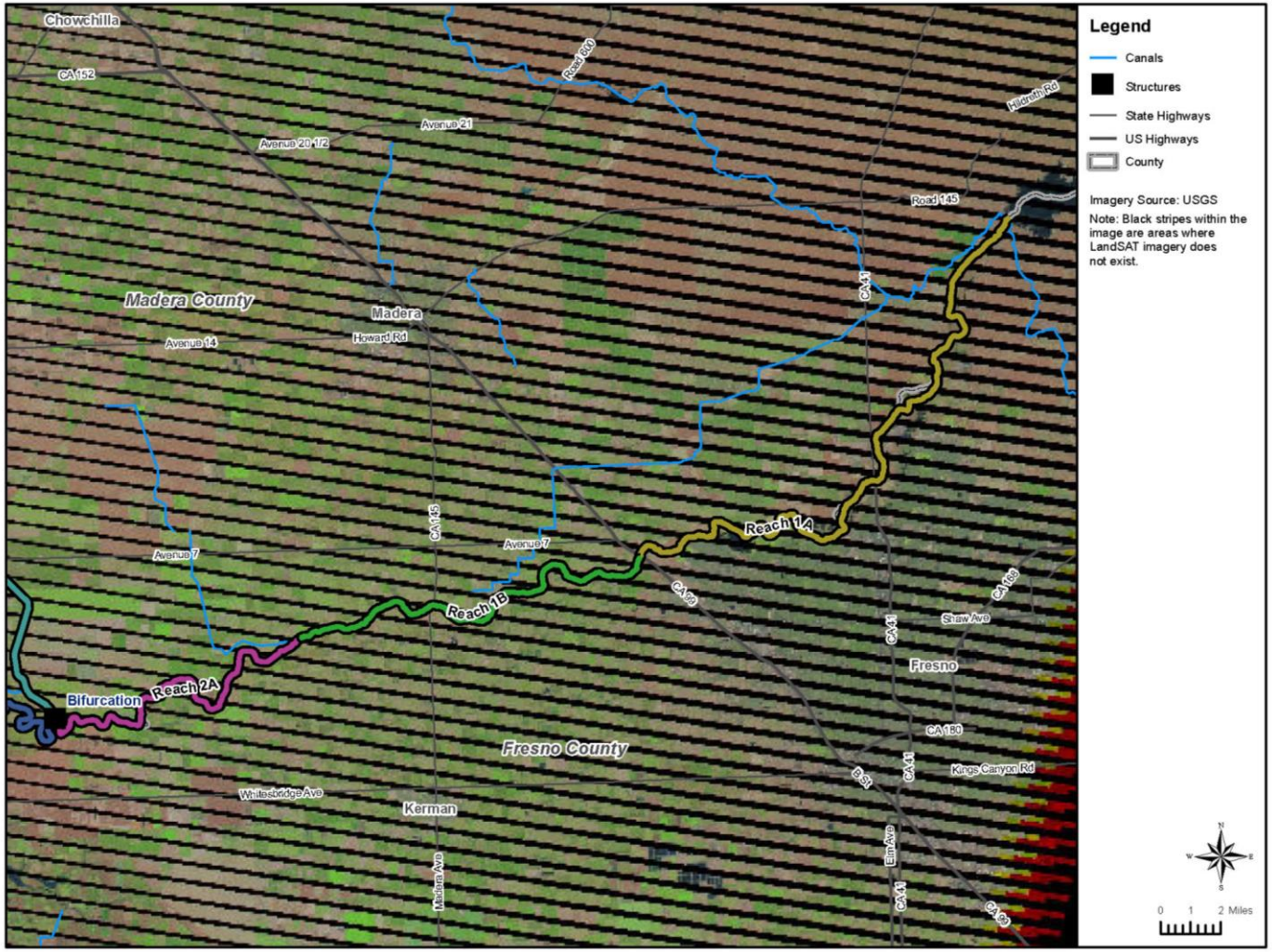

Figure F-4.
Landsat Imagery for SJRRP Area, June 2012 (Map 1 of 3)

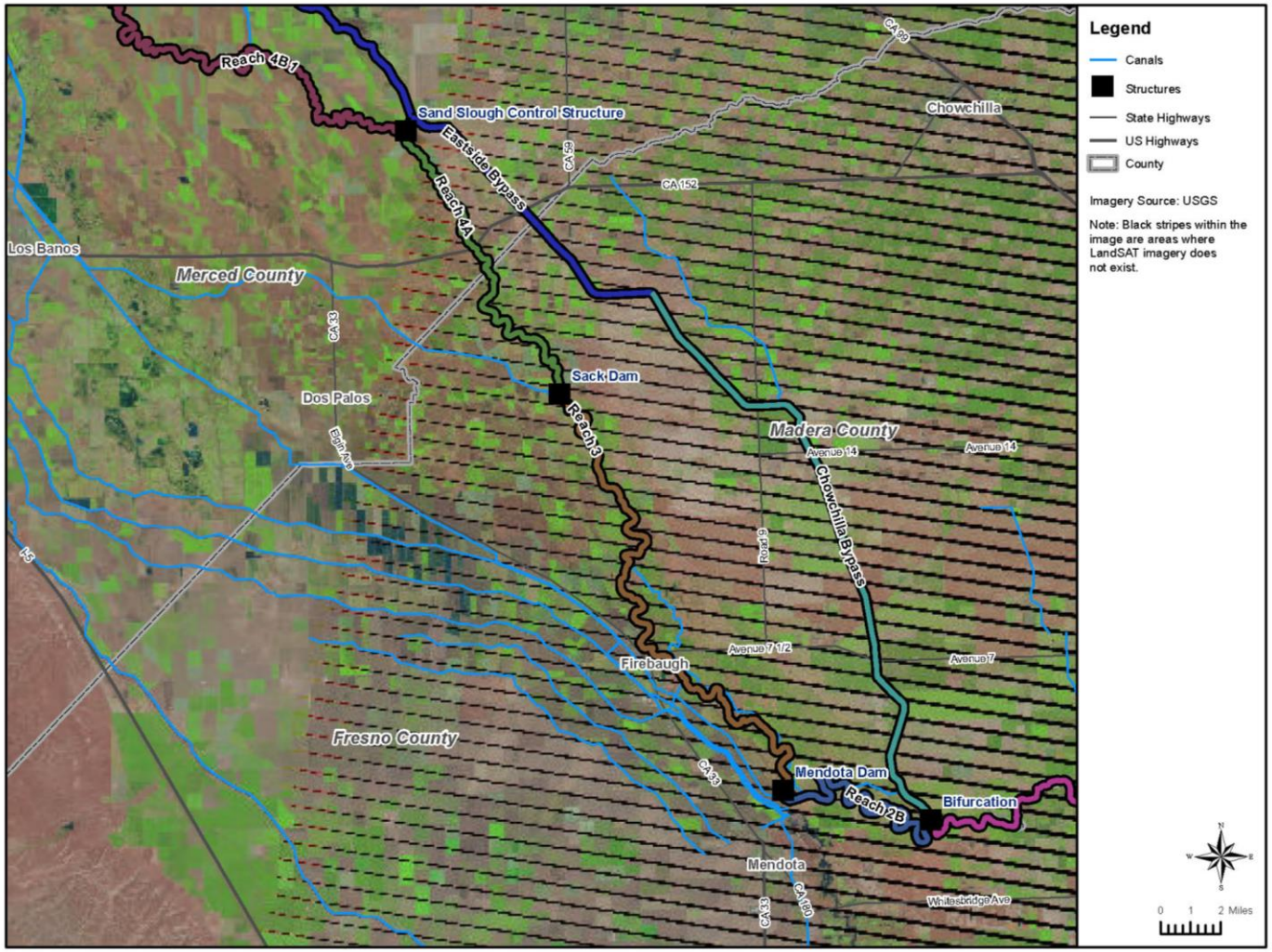

Figure F-5.
Landsat Imagery for SJRRP Area, June 2012 (Map 2 of 3)

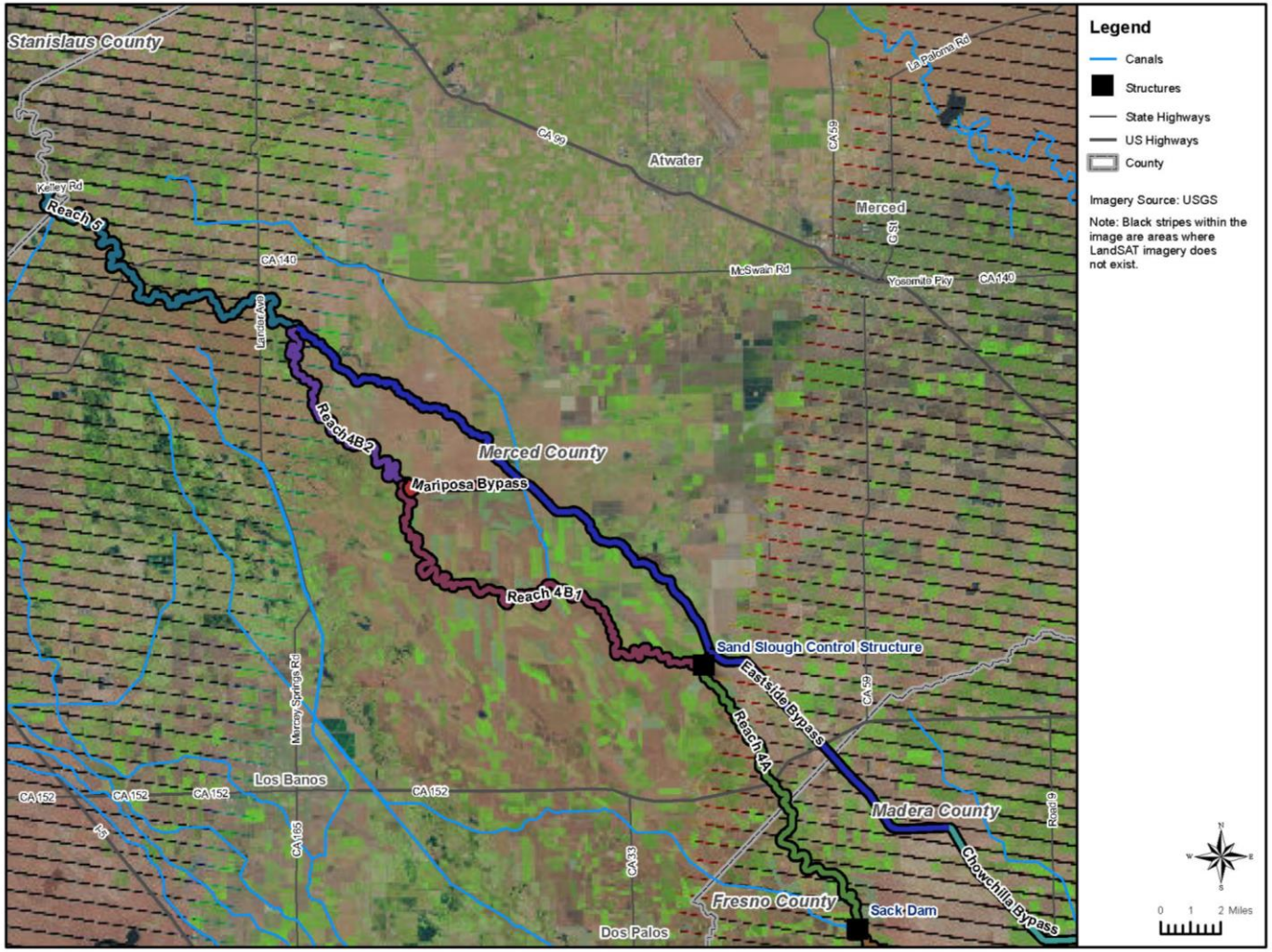

Figure F-6.
Landsat Imagery for SJRRP Area, June 2012 (Map 3 of 3)

F.2 Cropland Data Layer

The CDL is a product of the U.S. Department of Agriculture (USDA), National Agricultural Statistics Service (NASS). The CDL is available through the NASS's "CropScape" internet portal (http://nassgeodata.gmu.edu/CropScape/). The CDL program post-processes satellite imagery from the Landsat satellites to develop crop acreage estimates and a geo-referenced CDL data layer for use in GIS. CDL data is available annually from 1997 through 2012. Figures F-7 through F-9 show CDL data for 2007. Figures F-10 through F-12 show the same images for 2012. Figure F-13 shows the legend for the CDL images. CDL data is available at a resolution of 30 meters. The data shown in Figures F-7 through F-12 can be zoomed in and shown at a more local scale. However, individual local-scale figures are not presented in this appendix.

The primary purposed of CDL Program is to estimate agricultural acreage to the NASS Agricultural Statistics Board. Comparisons of CDL data over multiple years can be useful in assessing changes in crop production.

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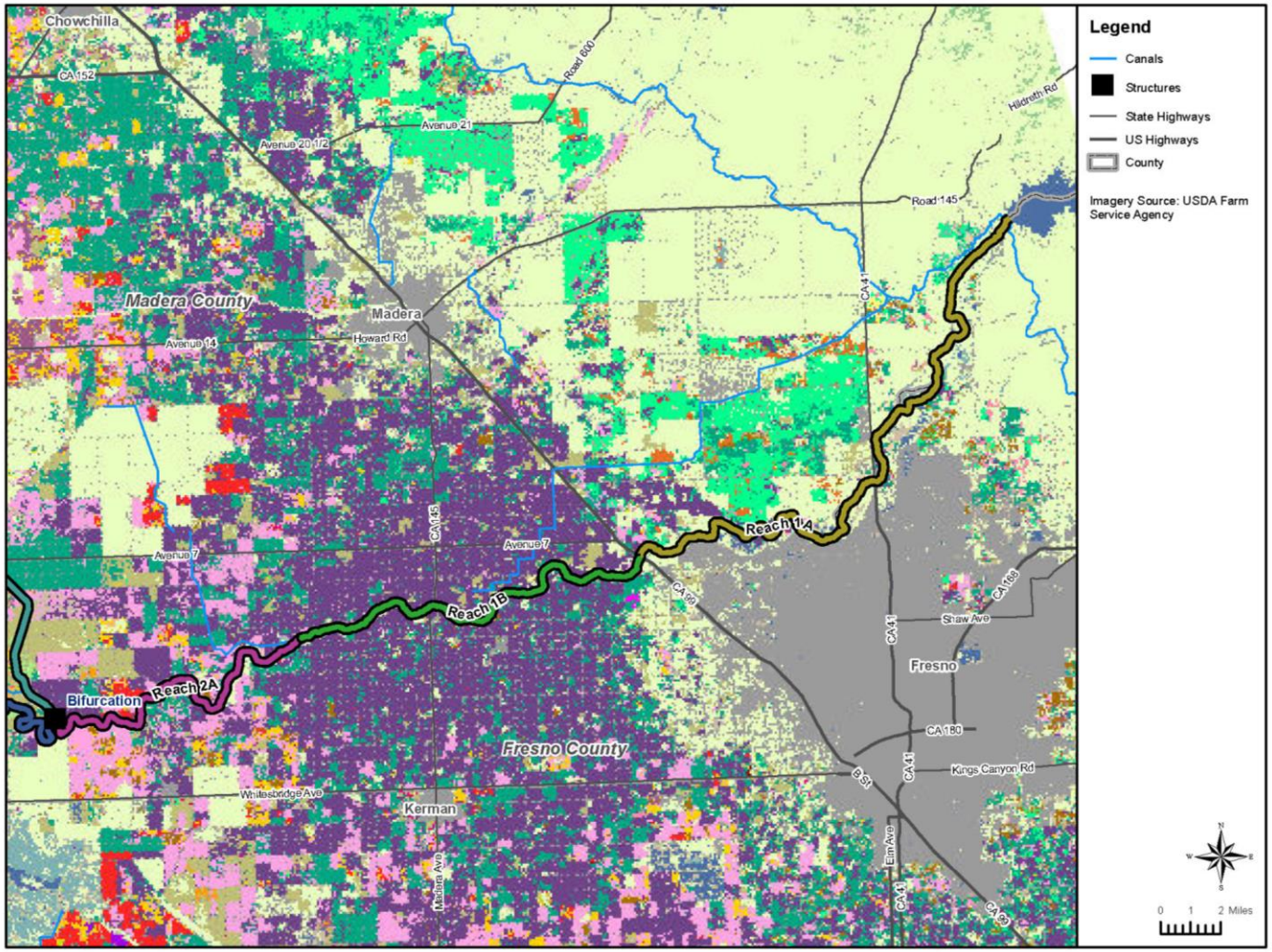

Figure F-7.
Cropland Data Layer for SJRRP Area, 2007 (Map 1 of 3)

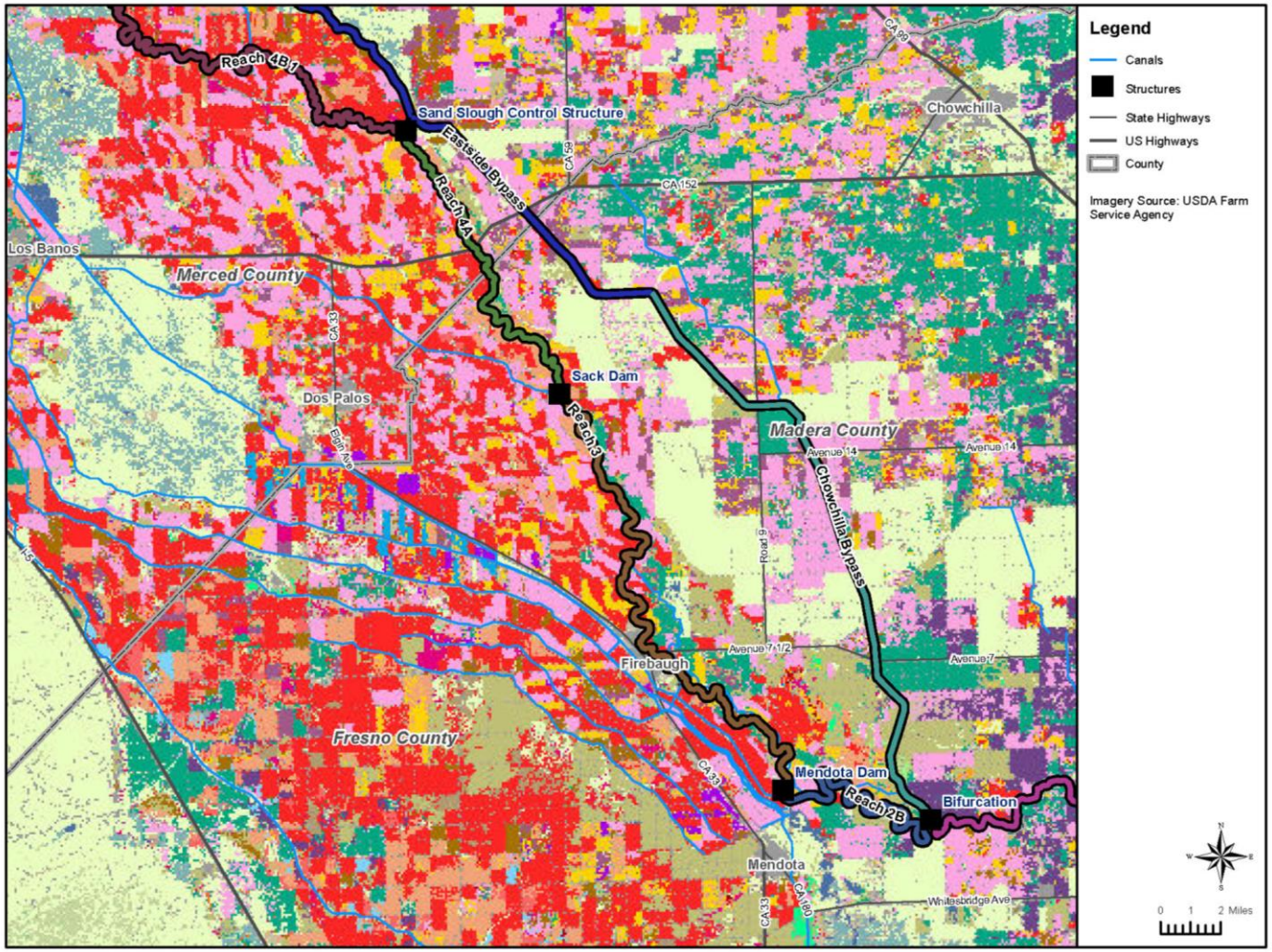

Figure F-8.
Cropland Data Layer for SJRRP Area, 2007 (Map 2 of 3)

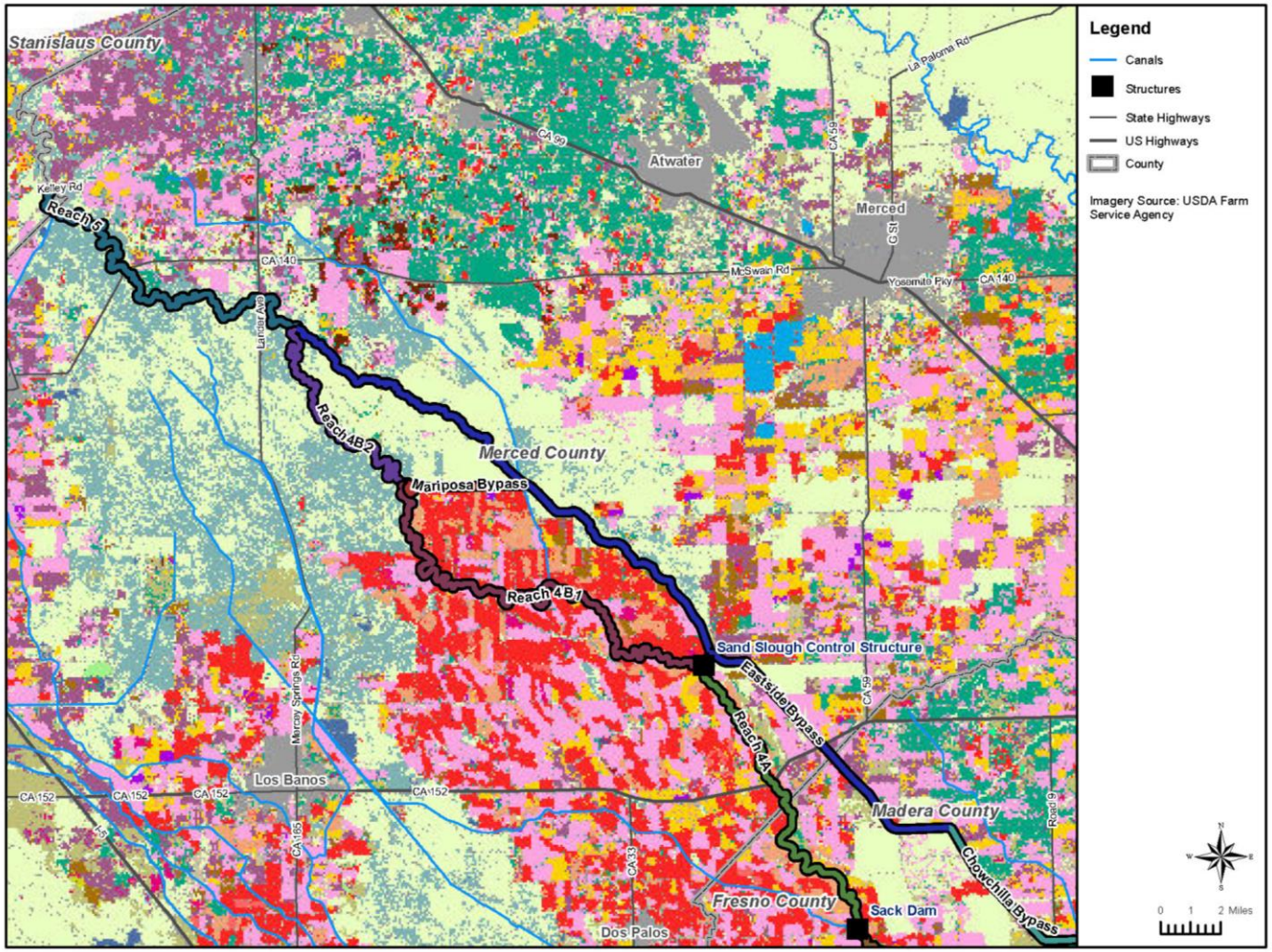

Figure F-9.
Cropland Data Layer for SJRRP Area, 2007 (Map 3 of 3)

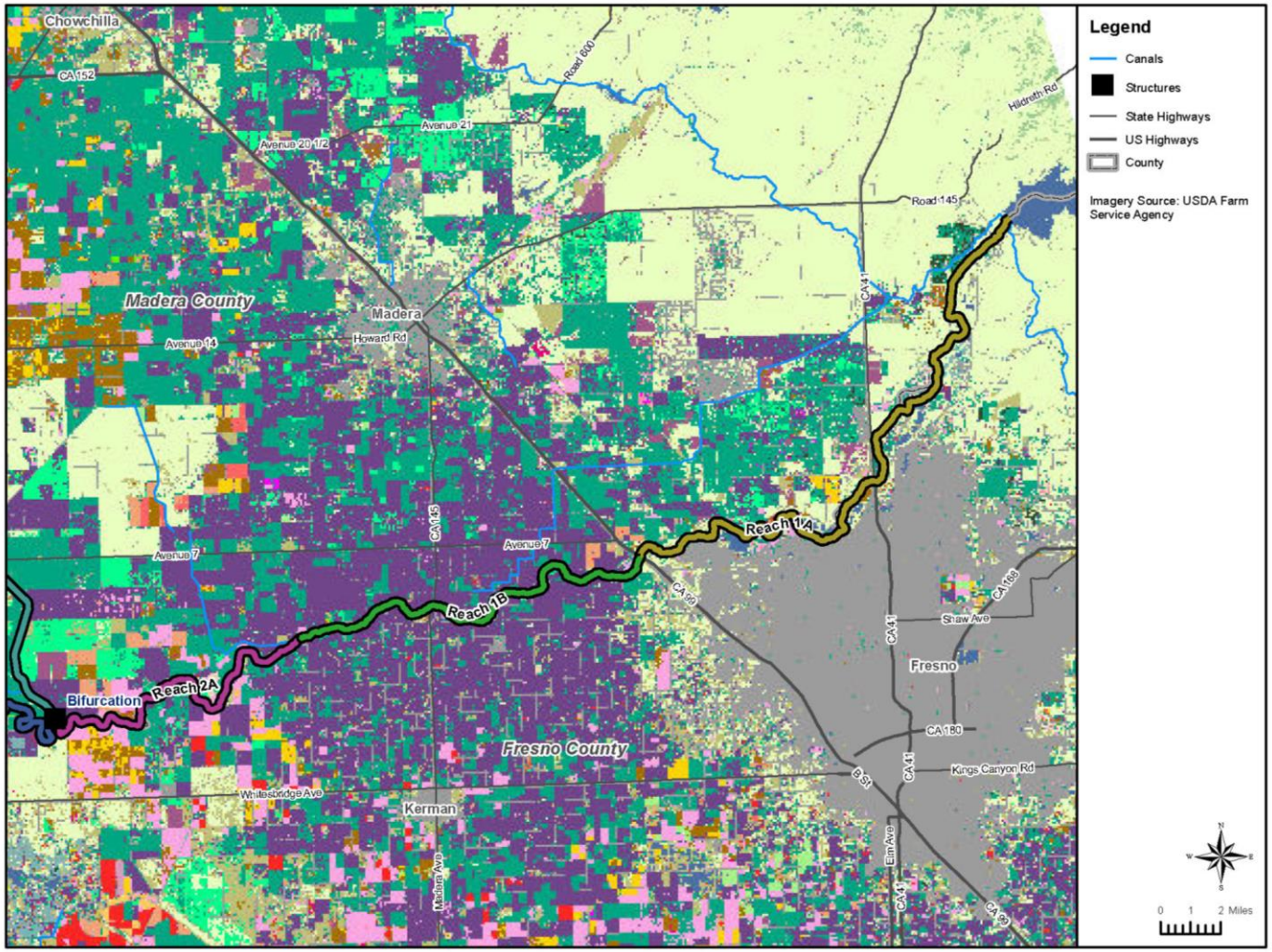

Figure F-10.
Cropland Data Layer for SJRRP Area, 2012 (Map 1 of 3)

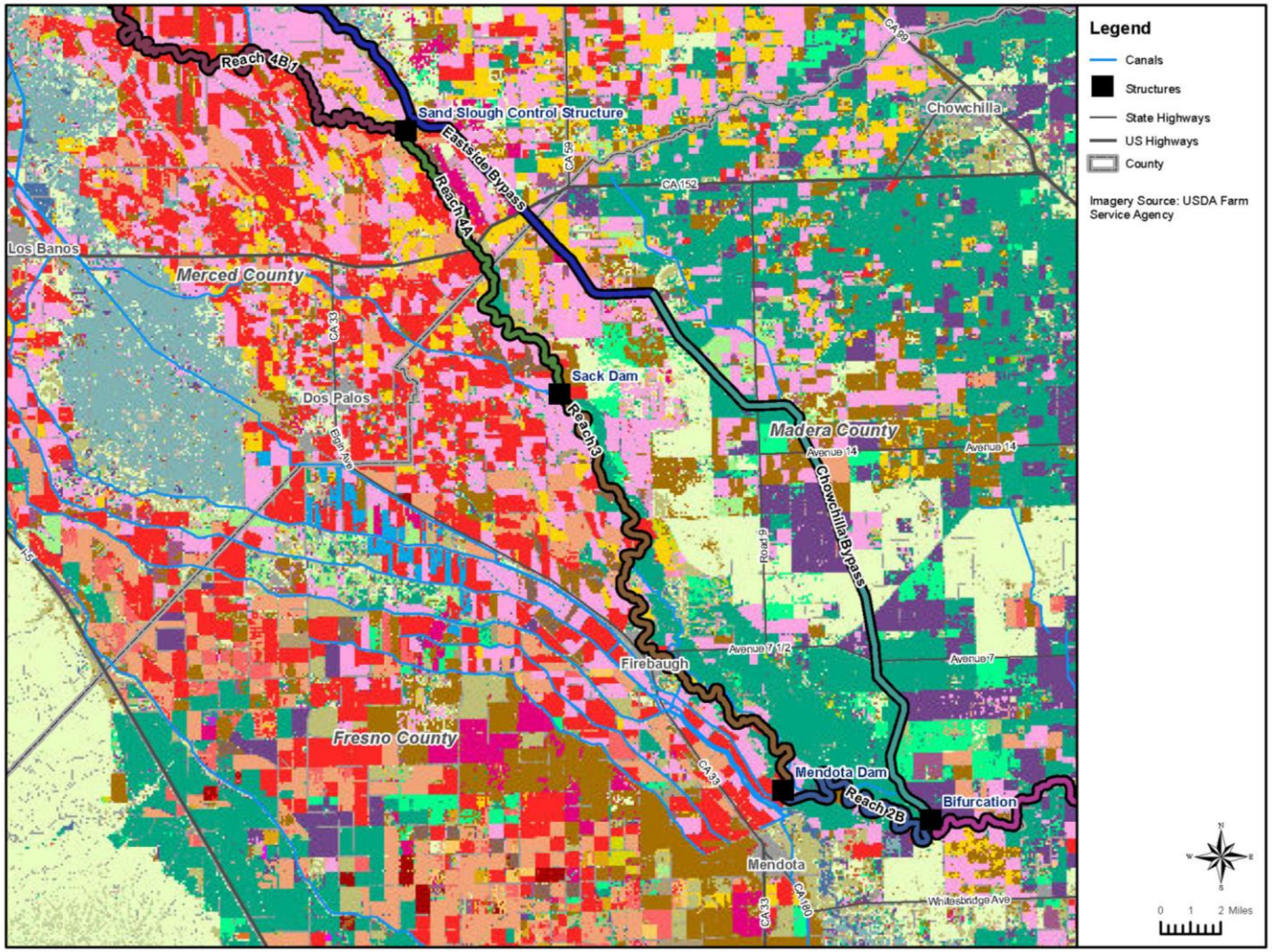

Figure F-11.
Cropland Data Layer for SJRRP Area, 2012 (Map 2 of 3)

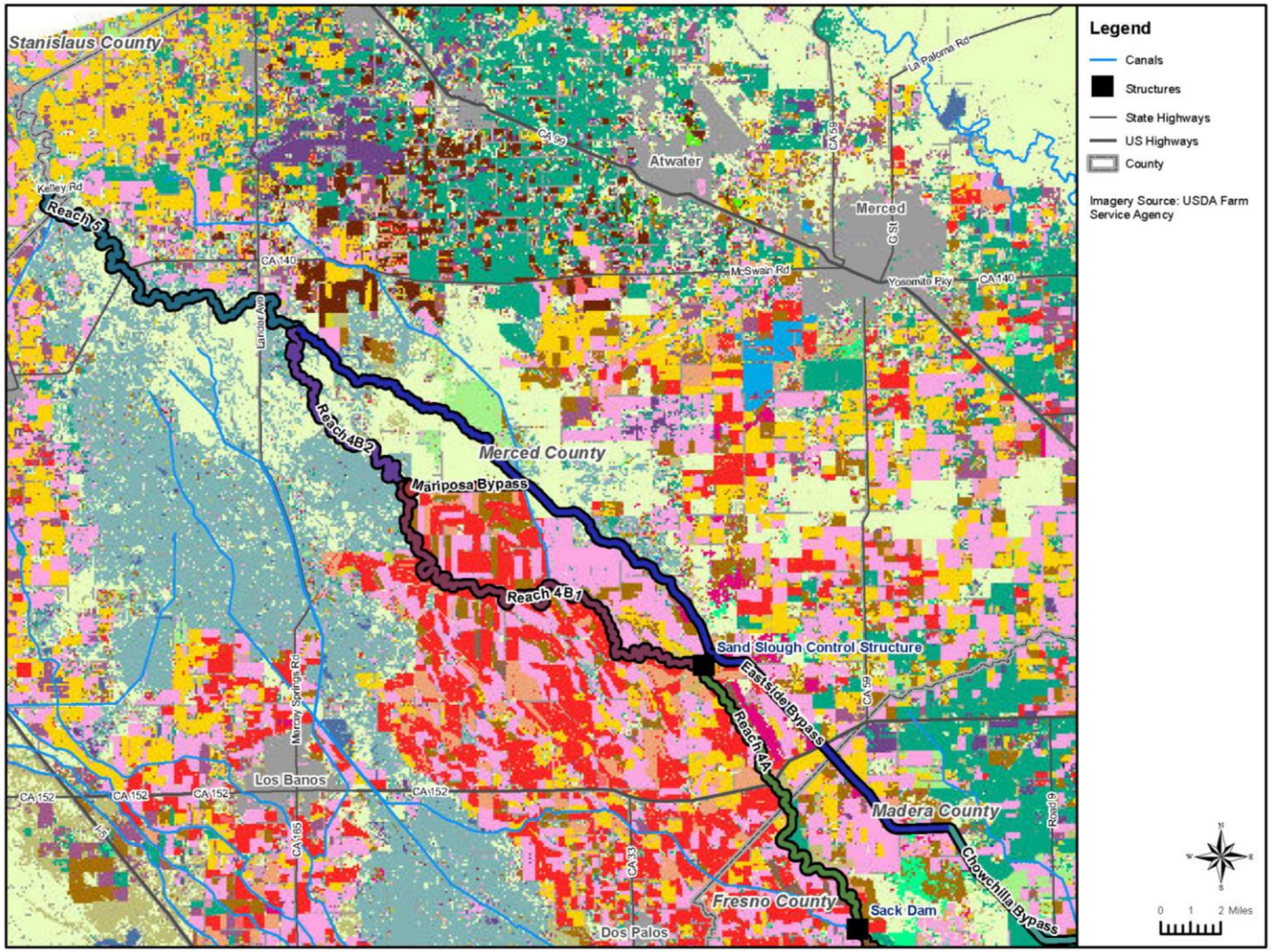

Figure F-12.
Cropland Data Layer for SJRRP Area, 2012 (Map 3 of 3)

Figure F-13.
Cropland Data Layer Legend

F.3 National Agriculture Imagery Program

The NAIP is run by the USDA's Farm Service Agency (FSA). The NAIP produces geo-referenced aerial imagery during the growing season for the continental United States. The NAIP data is available through the USDA's "GeoSpatialDataGateway" internet portal (http://datagateway.nrcs.usda.gov/GDGOrder.aspx). The NAIP's goal is to produce this imagery and make it available with a year of image acquisition. NAIP data for the SJRRP area is available the following years: 2004, 2005, 2006, 2009, 2010, and 2012. Figures F-14 through F-16 show NAIP imagery for 2006. Figures F-17 through F-19 show the same locations for 2012. The data shown in Figures F-14 through F-19 can be zoomed in and shown at a more local scale. However, individual local-scale figures are not presented in this appendix.

The NAIP collects leaf-on aerial imagery at 1 or 2 meter resolution. This imagery is used for estimating crop plantings and yields. Comparisons of NAIP data over multiple years can be useful in assessing crop yields and the change in cropping.

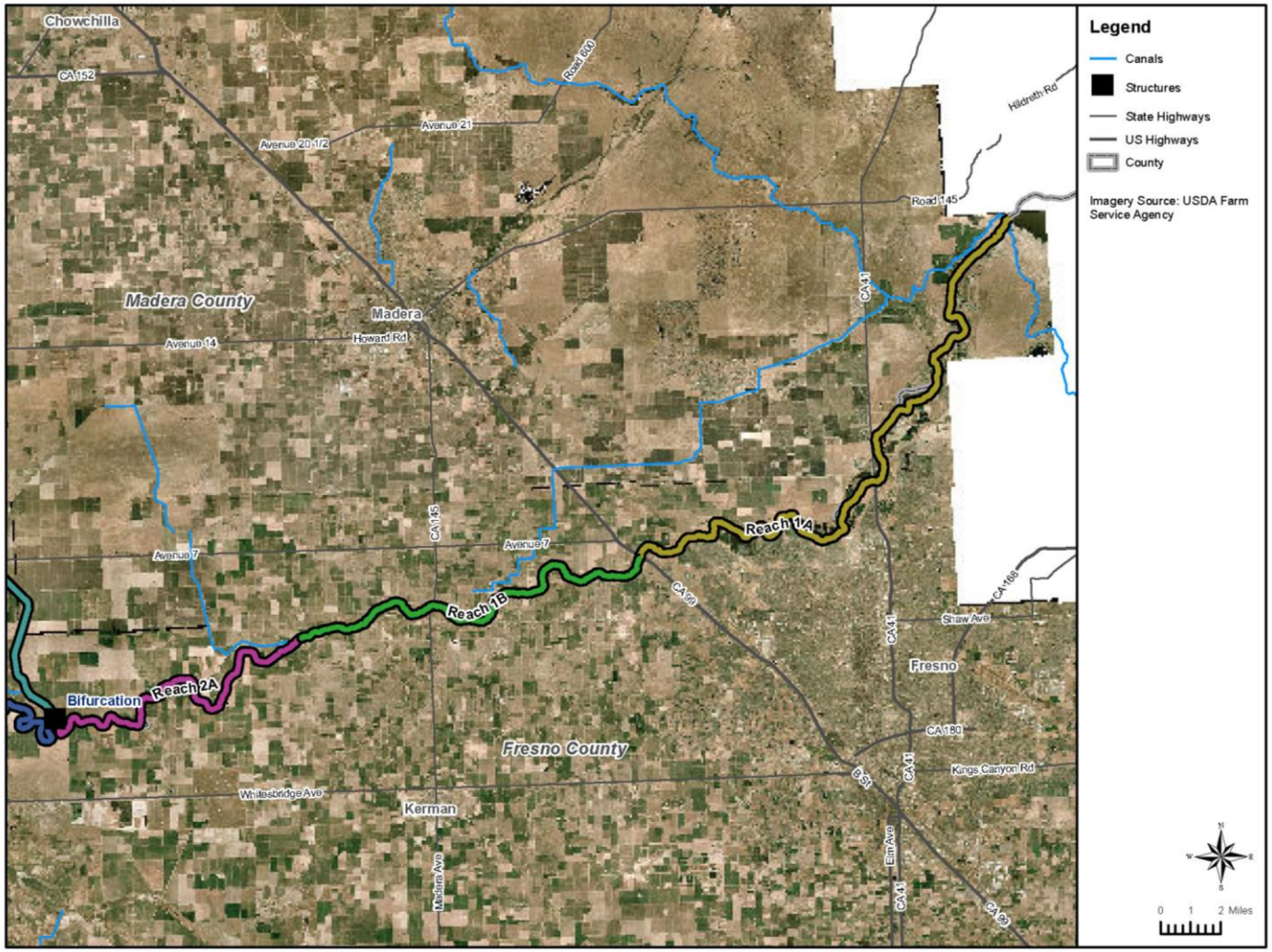

Figure F-14.
National Agriculture Imagery Program for SJRRP Area, 2006 (Map 1 of 3)

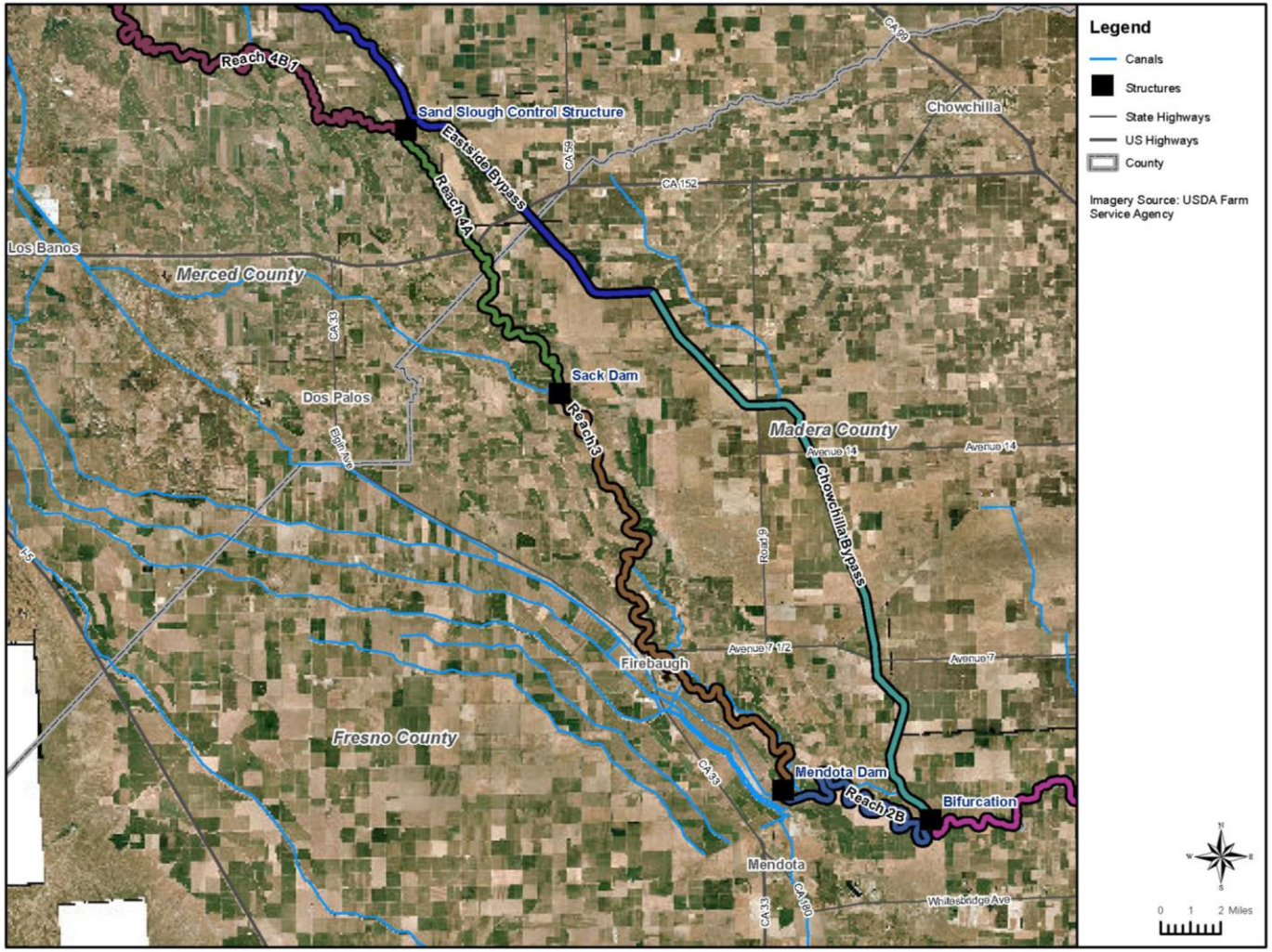

Figure F-15.
National Agriculture Imagery Program for SJRRP Area, 2006 (Map 2 of 3)

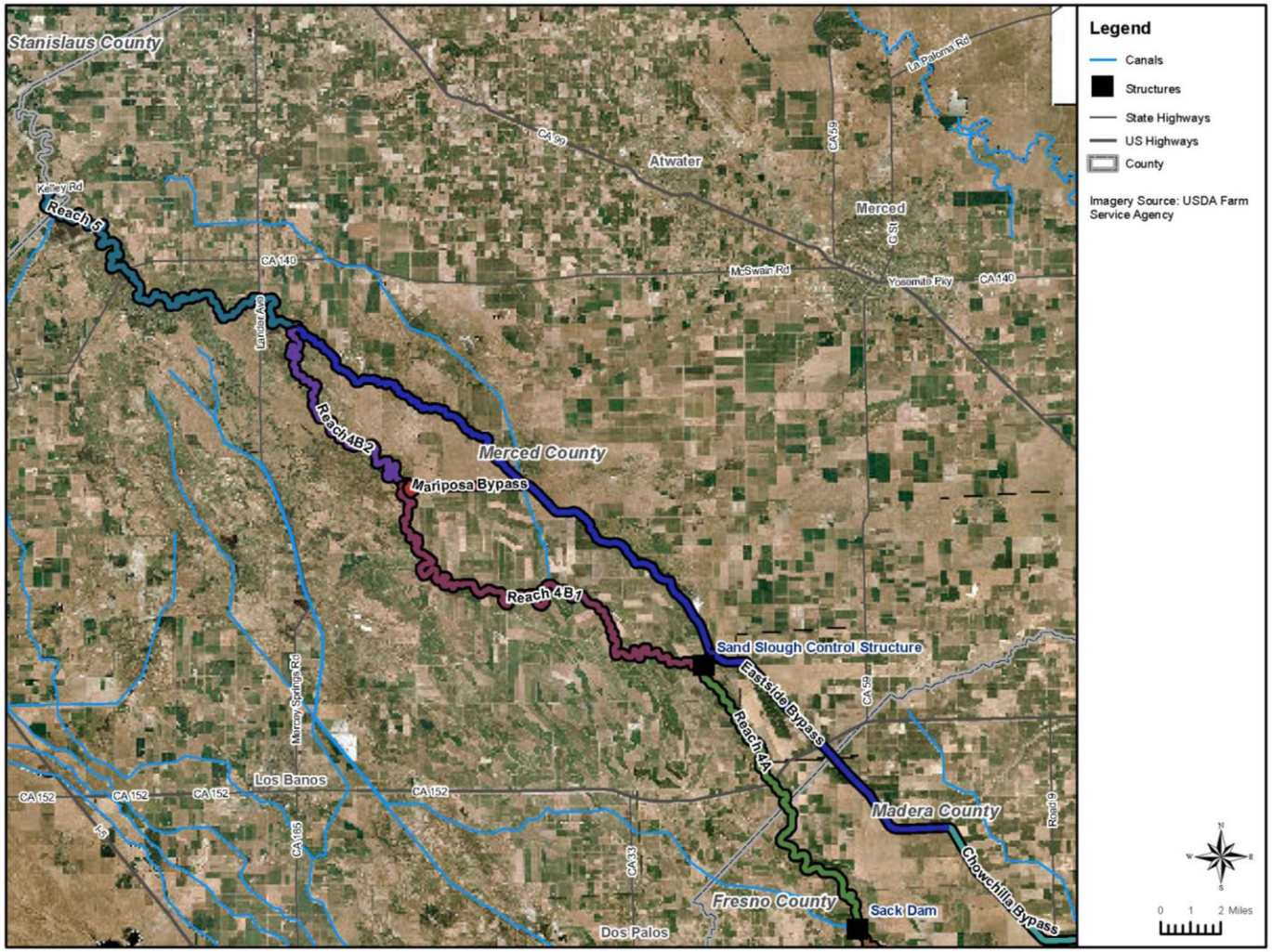

Figure F-16.
National Agriculture Imagery Program for SJRRP Area, 2006 (Map 3 of 3)

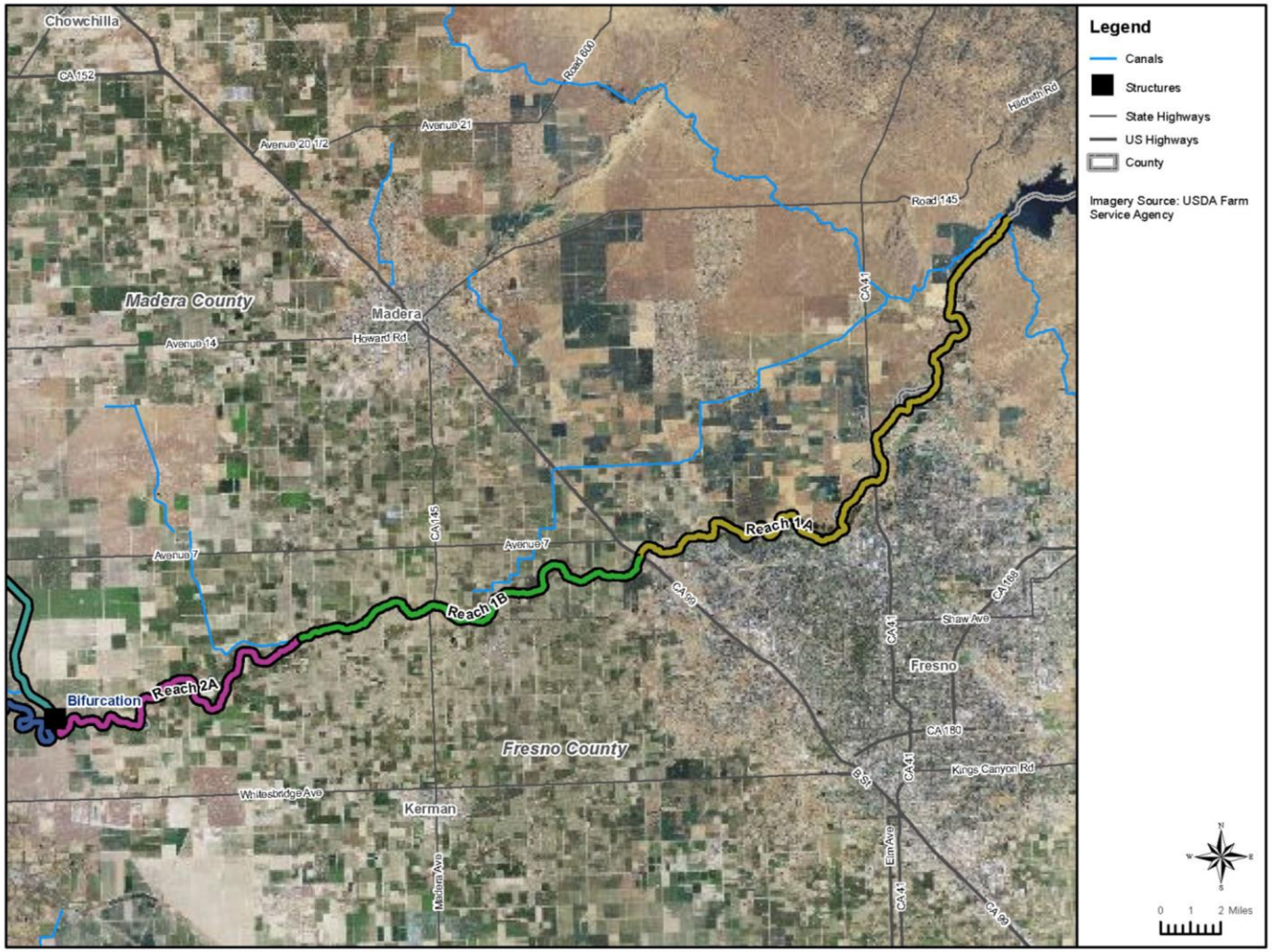

Figure F-17.
National Agriculture Imagery Program for SJRRP Area, 2012 (Map 1 of 3)

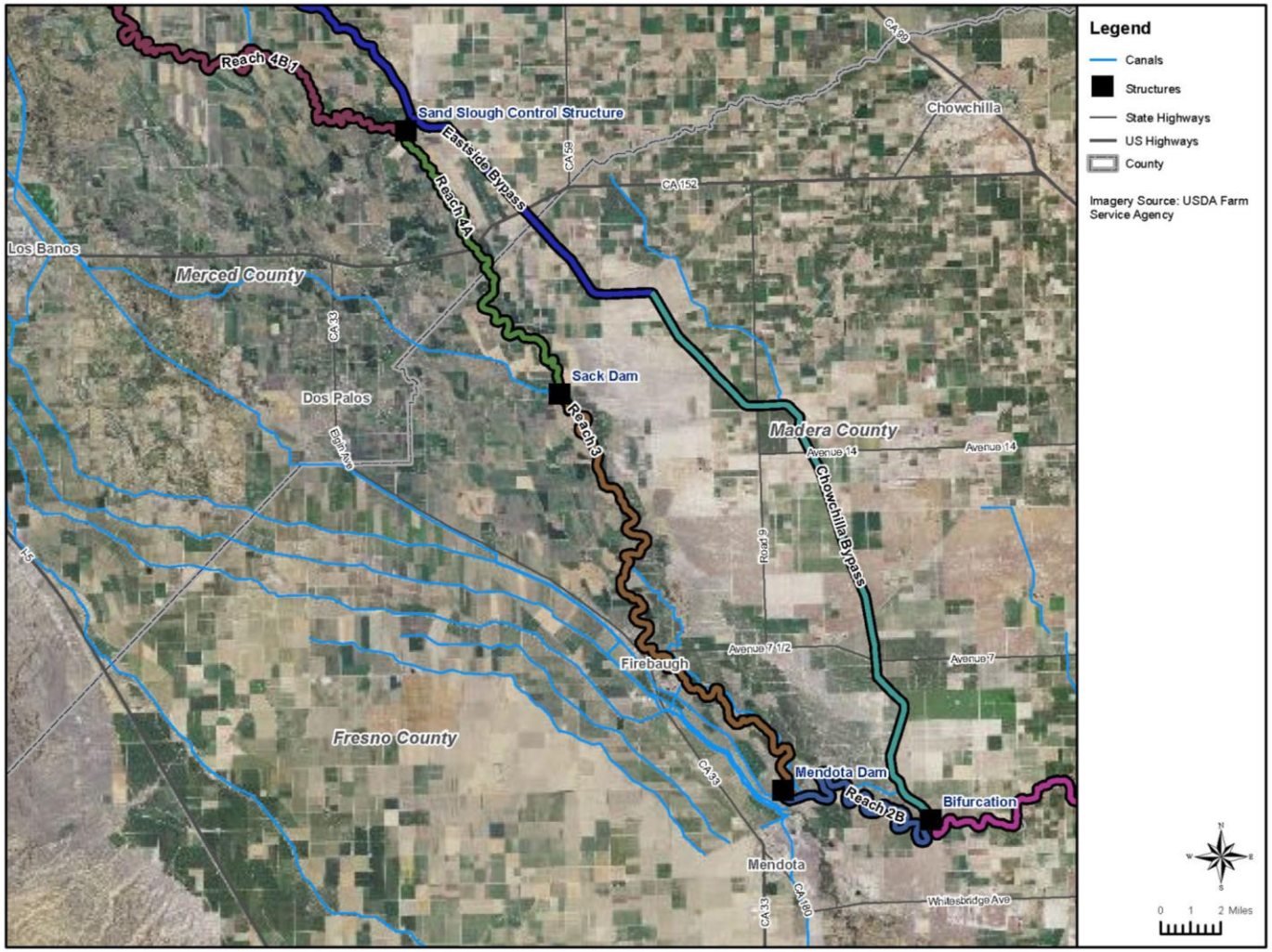

Figure F-18.
National Agriculture Imagery Program for SJRRP Area, 2012 (Map 2 of 3)

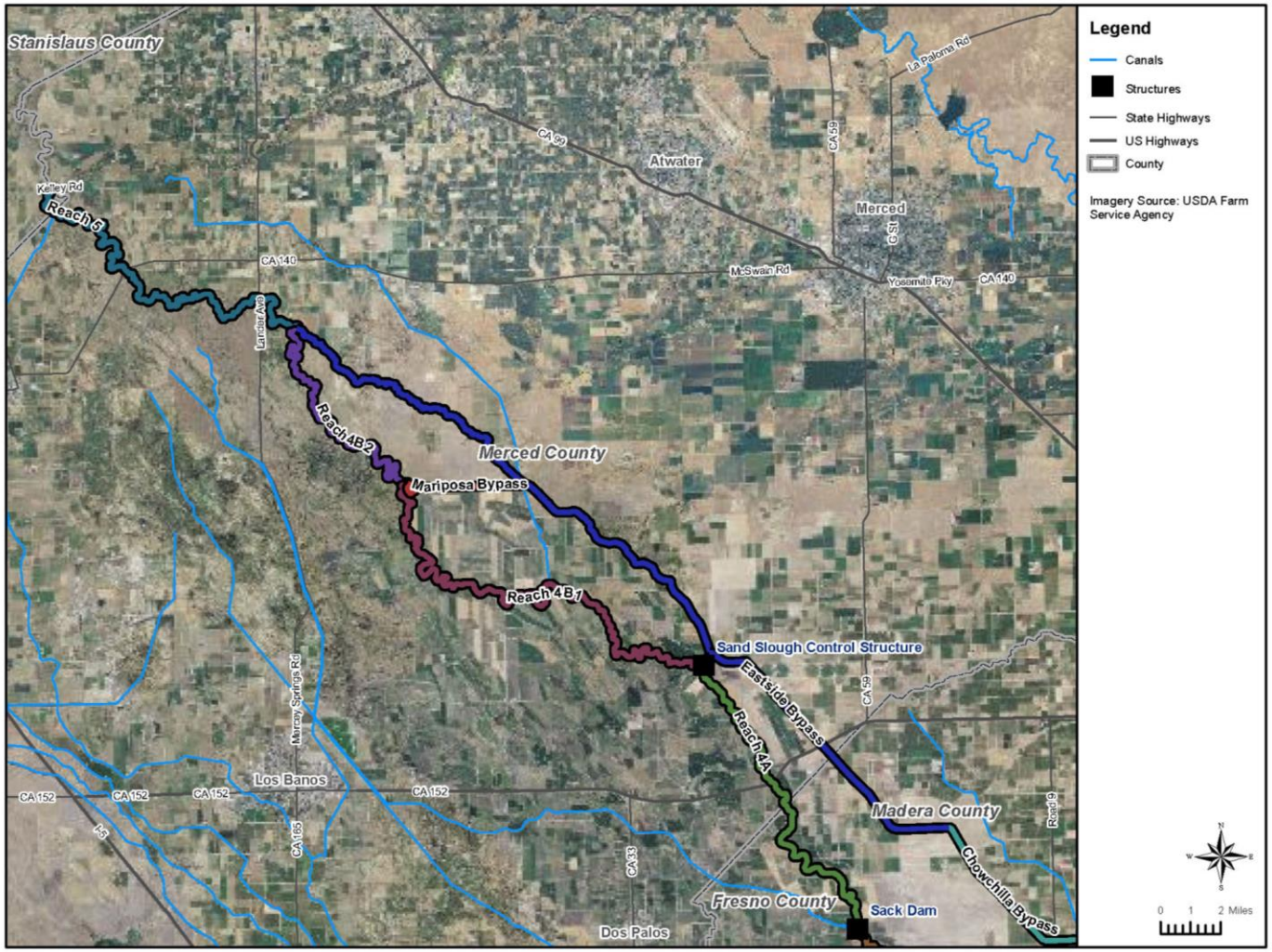

Figure F-19.
National Agriculture Imagery Program for SJRRP Area, 2012 (Map 3 of 3)