Bechtel Nevada

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THE
REMOTE
SENSING
LABORATORY
OPERATED BY BECHTEL NEVADA
FOR THE U.S. DEPARTMENT OF ENERGY

USING HISTORICAL AERIAL PHOTOGRAPHY AND SOFTCOPY PHOTOGRAMMETRY FOR WASTE UNIT MAPPING IN L LAKE

Aiken, South Carolina

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Aiken, South Carolina

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ABSTRACT

L Lake was developed as a cooling water reservoir for the L Reactor at the Savannah River Site. The construction of the lake, which began in the fall of 1984, altered the structure and function of Steel Creek. Completed in the fall of 1985, L Lake has a capacity of 31 million cubic meters and a normal pool of 58 meters. When L Reactor operations ceased in 1988, the water level in the lake still had to be maintained. Site managers are currently trying to determine the feasibility of draining or drawing down the lake in order to save tax dollars.

In order to understand the full repercussions of such an undertaking, it was necessary to compile a comprehensive inventory of what the lake bottom looked like prior to filling. Aerial photographs, acquired nine days before the filling of the lake began, were scanned and used for softcopy photogrammetry processing. A one-meter digital elevation model was generated and a digital orthophoto mosaic was created as the basemap for the project. Seven categories of features, including the large waste units used to contain the contaminated soil removed from the dam site, were screen digitized and used to generate accurate maps. Other map features include vegetation waste piles, where contaminated vegetation from the flood plain was contained, and ash piles, which are sites where vegetation debris was burned and then covered with clean soil. For all seven categories, the area of disturbance totaled just over 63 hectares.

When the screen digitizing was completed, the elevation at the centroid of each disturbance was determined. When the information is used in the Savannah River Site Geographical Information System, it can be used to visualize the various L Lake draw-down scenarios suggested by site managers and hopefully, to support evaluations of the cost effectiveness for each proposed activity.

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1.0 Introduction

Since 1988 when L Reactor operations ceased, the water level in its cooling water reservoir, L Lake, has been artificially maintained at a high annual cost. Recent discussions about lowering or completely draining the lake to cut costs and save tax dollars led to a study where the bottom features of L Lake were mapped to assess the feasibility of lowering or draining the water. The existence of contaminated waste units and debris piles in the lake bottom are known and were photographically documented before the lake was filled. This study relied on available oblique and vertical aerial photography acquired throughout the development of the lake. Additional ground photography, engineering as-built plans, and relevant reports also served as important sources of information during the process of mapping the lake bottom as it appeared nine days before filling began.

The main purpose of the study was to generate geographically accurate digital orthophotography as baseline imagery for input into a Geographic Information System (GIS). Digital photointerpretation techniques were then used to derive layers of information that can be used to accurately map the L Lake basin. In the process, a digital elevation model (DEM) was generated. The elevation information offered by this data set is intended to support efforts to estimate and model the exposed areas of potentially contaminated sites at any given water level. The GIS can be used for estimating the time and cost expenditures required for various draw-down and clean-up scenarios.

This report includes a description of the reservoir and its history, outlines the preplanning efforts for the study, and provides an overview of the processes used to generate the DEM and digital orthophotography. The last section of the report discusses the digital photointerpretation methods and results. Additional information regarding radiological studies, the vertical aerial photography used in the study, and area statistics for the mapped lake-bottom features is included in the appendices.

1.1 Study Area

This study was conducted on the portion of Steel Creek on the Savannah River Site (SRS) (formerly known as the Savannah River Plant [SRP] prior to 1989) in South Carolina, which was converted to L Lake in 1984–1985. The SRS lies on the upper Atlantic Coastal Plain and was established in the early 1950s by the U.S. government for the production of special nuclear materials, primarily to support the nuclear weapons program of the United States. Steel Creek is one of five major drainages on the SRS. This stream rises in the Aiken Plateau and flows approximately 18 kilometers south to the Savannah River floodplain that bounds the southern portion of the SRS. Steel Creek then flows approximately 4 kilometers through the Savannah River floodplain before entering the Savannah River. Figure 1 shows the locations of L Lake and Steel Creek as well as two production reactors located at the SRS.

1.2 Steel Creek and L Reactor History

Steel Creek is 18 kilometers in length and has a watershed of 90 square kilometers. From 1955 to 1973, approximately 284 curies of cesium-137 (^{137}Cs) were released into Steel Creek. Because ^{137}Cs has a strong affinity for sediments, a majority of the released material was absorbed and/or deposited in the sediments of the Steel Creek system before they reached the Savannah River. An estimate of the inventory of ^{137}Cs in Steel Creek, as decay corrected to 1991, lists 8 curies upstream from L Reactor, 30 curies between L Reactor and the Steel Creek Delta, 20 curies in the Steel Creek Delta, and

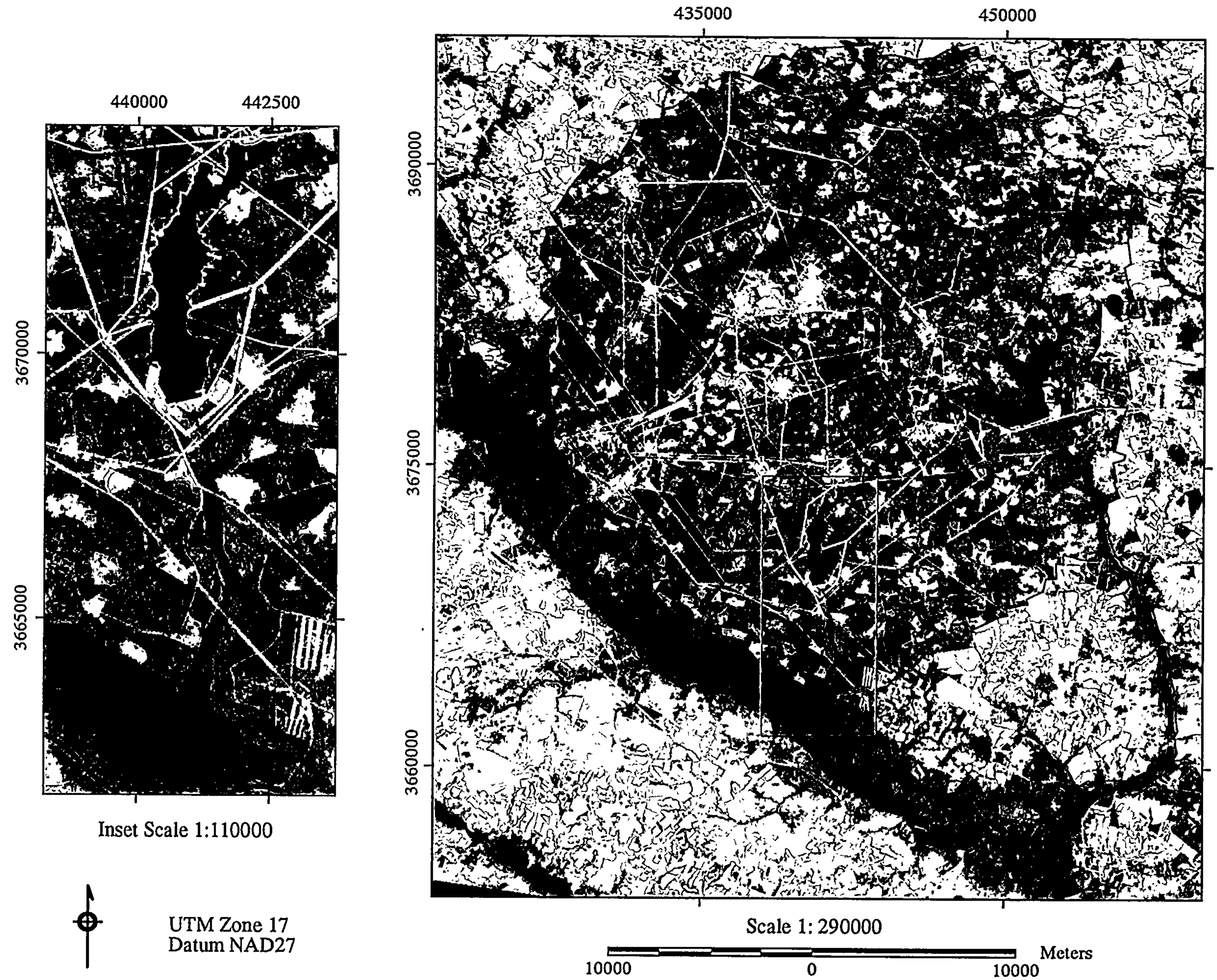


FIGURE 1. ***INSET ON THE LEFT SHOWS THE REACH OF L LAKE AND STEEL CREEK AT SRS AS IT HAS APPEARED SINCE SEPTEMBER 1986. Source imagery is a SPOT panchromatic image acquired October 1987.***

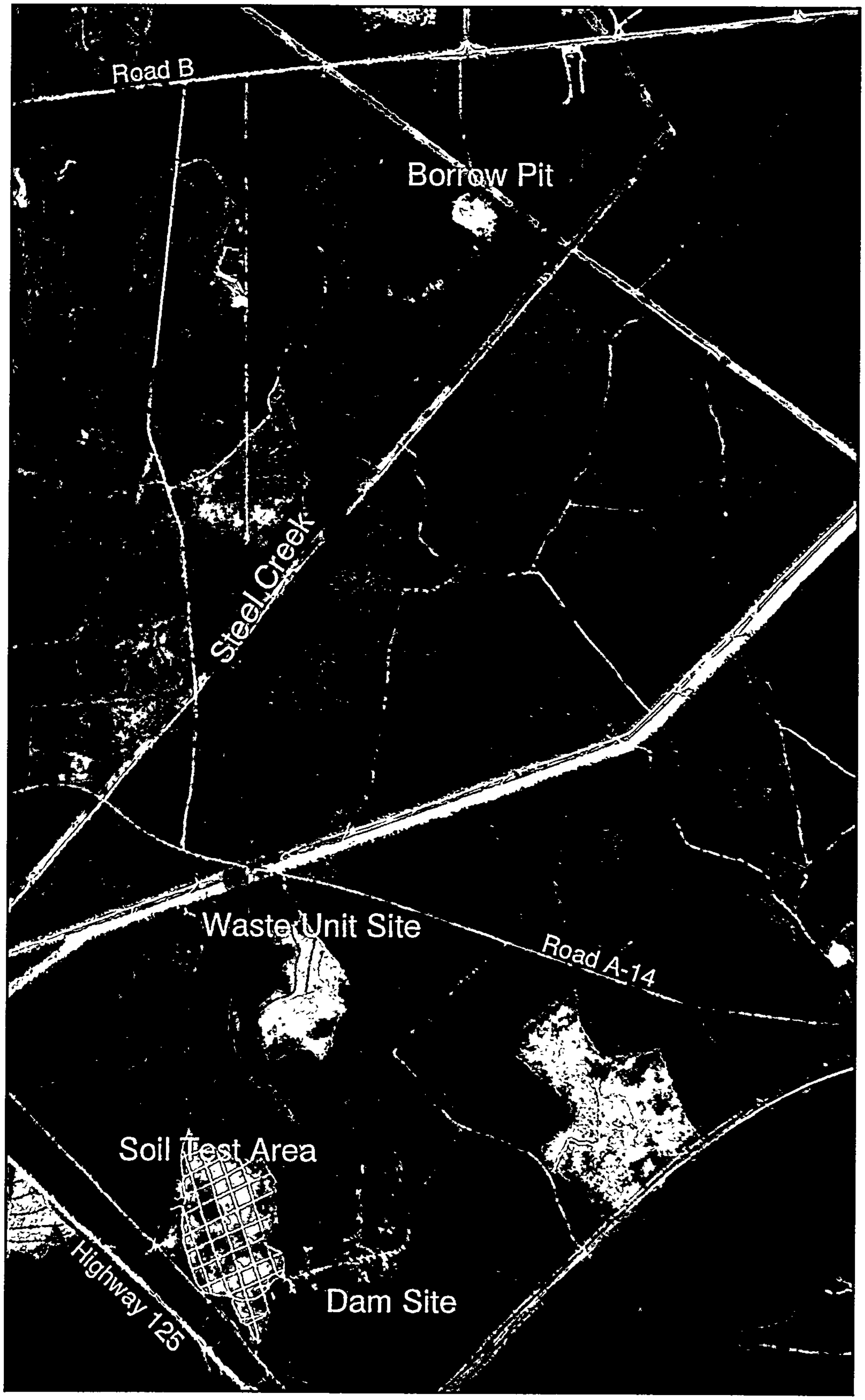
8 curies between the delta and the SRS boundary for a total of 66 curies in the Steel Creek system (Brisbin *et al.*, 1974; Gladden *et al.*, 1985; Carlton *et al.*, 1992). Cobalt-60 (^{60}Co) discharges to Steel Creek are summarized in Carlton and Denham, 1996.

Operations of the P and L Reactors began in 1954. Stream discharge in Steel Creek was increased from about 1 cubic meter per second to a maximum of 24 cubic meters per second with secondary cooling water effluent pumped from the Savannah River. This secondary cooling water was released at temperatures as high as 70°C to the streams of the SRS. These two reactors in the headwaters of Steel Creek greatly affected the hydrologic and thermal regimes of the stream. The results of the increased stream flow in Steel Creek included the inundation of the floodplain along the length of Steel Creek, erosion, loss of the original wetland plant communities, and deposition of radioactive contamination (Gladden *et al.*, 1985). Cooling water effluent from P Reactor was diverted to Par Pond in 1963, and a more normal (near natural) flow regime was reestablished in 1968 when L Reactor was placed on standby.

Refurbishment of L Reactor began in the early 1980s with plans to restart in 1985. With the cessation of thermal releases to Steel Creek, scrub-shrub and persistent and nonpersistent emergent plant communities colonized the Steel Creek floodplain and were in place when L Lake was constructed during 1984–1985 (Wein and McCort, 1988; Tinney *et al.*, 1987). The upland areas of L Lake had been managed largely as sustained-yield pine plantations by the U.S. Forest Service for the Department of Energy (DOE) (Tinney *et al.*, 1987). To provide thermal mitigation of secondary cooling water from the restart of L Reactor, L Lake was constructed by damming the middle reach of Steel Creek. L Reactor was restarted in the fall of 1985, following dam construction and lake filling, and continued operating until it was shut down in 1988.

1.3 L Lake Construction

In February 1984, the U.S. Army Corps of Engineers was given the responsibility through an interagency agreement with the DOE for designing and constructing a once-through cooling water reservoir, L Lake. The construction of L Lake altered the structure and function of the upper to middle portions of about one-third of Steel Creek from a riverine to a lacustrine ecosystem. The portion of Steel Creek affected by construction is shown in Figure 2. Construction of L Lake began in the fall of 1984, and L Lake was formed by damming the middle reach of Steel Creek between SRS Road B and Highway 125. The 405-hectare L Lake has a capacity of 31 million cubic meters and is 7000 meters long and 1200 meters wide at its widest point (average 600 meters). The dam, located at the southern end of the lake, is 1200 meters long. The normal pool of the lake is 58 meters above mean sea level (MSL). The top of the main embankment of the L Lake dam is 61 meters above MSL (Gladden *et al.*, 1989). Clear-cuts made during construction of the lake totaled 418 hectares including 144 hectares of bottomland hardwood and shrub wetlands, 146 hectares of upland hardwood and pine forest, and 50 hectares of other areas within the lake basin (Wein and McCort, 1988; Wein and Pierce, 1995). Estimates of land-cover types within L Lake proper were estimated in Ezra and Tinney, 1985, and are shown in Table 1. Timber growing above the floodplain of Steel Creek was cut for commercial sale. Outside of the lake basin, 78 hectares of mostly upland pine (approximately 60 hectares) and hardwood forests (approximately 18 hectares) were clear-cut for power-line right-of-ways and other construction-related activities (McCort *et al.*, 1988).



Source: EG&G 4655-006 acquired 3-31-84 at scale 1:34400.

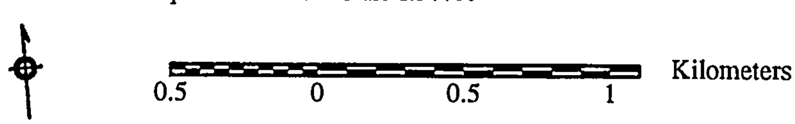


FIGURE 2. ***UPPER REACH OF STEEL CREEK PRIOR TO DEVELOPMENT. An existing borrow pit, the anticipated waste disposal unit, and the area where soil tests were performed to determine the adequacy of local material for construction use are shown.***

Table 1. Area Statistics for the L Lake Site[a]

Class	Hectares	Site Percent
Water	0.7	0.2
Nonpersistent Emergent	0.5	0.1
Scrub-Shrub	28.9	6.9
Bottomland Hardwood	109.5	26.0
Deciduous Forest	4.8	1.1
Evergreen Forest	114.2	27.0
Clear-Cut	0.4	0.1
Mixed Forest	124.9	29.6
Transitional	8.1	1.9
Industrial	1.7	0.4
Utilities	20.7	4.9
Roads	7.4	1.8
Total	**421.8**	**100.0**

[a] Source: Ezra and Tinney, 1985

During the construction of L Lake dam, dredged spoil from the floodplain of Steel Creek at the dam site was placed in a special waste disposal area, allowed to dry, leveled, and then covered with 1.5 meters of soil (Zeigler *et al.*, 1985). The area of the waste disposal site for the L Lake dam was estimated to be at least 5 hectares based on earlier interpretation of digitized non-georeferenced aerial photography from September 1985. Figure 3 shows the changes that occurred at the dam and waste burial sites between March 1984 and September 1985. Approximately 46,400 cubic meters of spoil material were removed from the dam site.

Although only the upper 1.2 meters of streambed material was considered to be radioactively contaminated, the streambed was excavated to a depth of about 3 meters (Gladden *et al.*, 1989). This spoil material was estimated to contain 0.2 curies of ^{137}Cs and 0.02 curies of ^{60}Co (Zeigler *et al.*, 1985). This buried spoil material was flooded over when the lake was filled (DOE, 1984).

Trees outside of the Steel Creek floodplain were sold through commercial timber harvests managed by the U.S. Forest Service. Trees within the floodplain were potentially contaminated from the radioisotopes in the soils (Gladden *et al.*, 1985; Briese *et al.*, 1975; Brisbin *et al.*, 1974). Vegetation growing in the floodplain area of Steel Creek covered by the lake was estimated to contain about 12 millicuries of ^{137}Cs (Zeigler *et al.*, 1985). Figure 4 shows that the woody vegetation in the Steel Creek floodplain was removed from the upper two-thirds of L Lake but was left standing in the lower one-third of the floodplain immediately upstream of the cofferdam used during construction of the L Lake dam (Dunn *et al.*, 1995).

Before L Lake was filled, 35 artificial reefs including 3 log reefs, 7 brush reefs, 12 tire reefs, 12 concrete block reefs, and 1 floating tire breakwater were constructed. The reefs were constructed to provide habitat diversity and structure in the lake before an aquatic plant community was established (Gladden

Source: EG&G 4655-006 acquired 3-31-84 at scale 1:34400

Source: EG&G 5108-094 acquired 9-6-85 at scale 1:13900

FIGURE 3. ***BEFORE AND AFTER CONSTRUCTION VIEWS OF THE DAM AND WASTE BURIAL UNITS.*** ***The clay-colored materials to the upper left of the dam are believed to be either source materials for dam construction or potential waste units.***

Source: EG&G 5108-088 acquired 9-6-85 at scale 1:39200

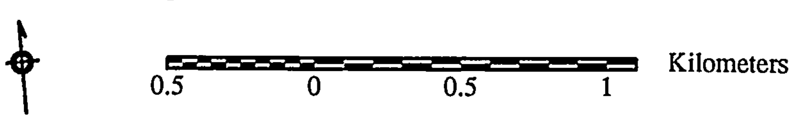


FIGURE 4. ***CLOSE EXAMINATION OF THE STREAM CHANNEL SHOWS THAT A MAJORITY OF VEGETATION WAS REMOVED FROM THE UPPER PORTIONS OF THE CHANNEL, BUT VEGETATION WAS LEFT STANDING IN THE LOWER THIRD OF THE BASIN, JUST NORTH OF THE DAM.***

et al., 1989). Several of these structures, shown in Figure 5, are evident in the aerial photography used in this report. The filling of L Lake began on September 15, 1985, and the lake reached a normal operating level of 58 meters above MSL on November 4, 1985 (Gladden *et al.*, 1989).

During the summer of 1986, a riprap diversion dike and canal were constructed in the northern end of L Lake just south of the SRS Road B to more effectively use the cooling capacity of the lake. The canal diverted the L Reactor effluent from the original discharge point in L Lake east to a point nearer the head of the lake. Surveying for the dike and canal began in July 1986 and construction was completed in September 1986 (Gladden *et al.*, 1989). Changes in the configuration of L Lake caused by the construction of the dike and canal are not included in this report.

1.4 Historical Photography

A review of historical photography available from the DOE Remote Sensing Laboratory (RSL) indicated that several aerial acquisitions of Steel Creek had occurred during 1984–1985. Pre-construction dates, when the presence of test drillings near the future dam site and an existing borrow pit in the upper portion of the lake were visually documented, include March 31, April 1, June 18, and September 19, 1984. The archeological pit is also visible in the photography. Construction began in the fall of 1984. Aerial photography of the Steel Creek conversion was acquired on the following dates: April 17, April 25, May 14, May 18–19, June 21, and September 6, 1985. Refer to Appendix A for details about these photographs. Based on the information in the photography, material appears to have been removed from the base of the dam within the Steel Creek floodplain and deposited in a large pit north of the dam site and east of the Steel Creek floodplain. Note that in the August 13–23, 1985 aerial gamma survey report of the Steel Creek floodplain, no ^{137}Cs activity is shown in close proximity to the L Lake dam construction site or to the likely area for the waste disposal site (Jobst, 1988). The distribution of ^{137}Cs is illustrated in Figure 6.

Commercial timber harvesting was widespread throughout the upland areas, or non-floodplain areas of the future lake bed. Following the tree harvest, the remaining debris appears to have been placed in piles and then burned. Debris and ash piles are visible in the photography shown in Figure 7. The ash piles, which are characteristically oval-shaped, were covered with local soil materials and numbered to several hundred.

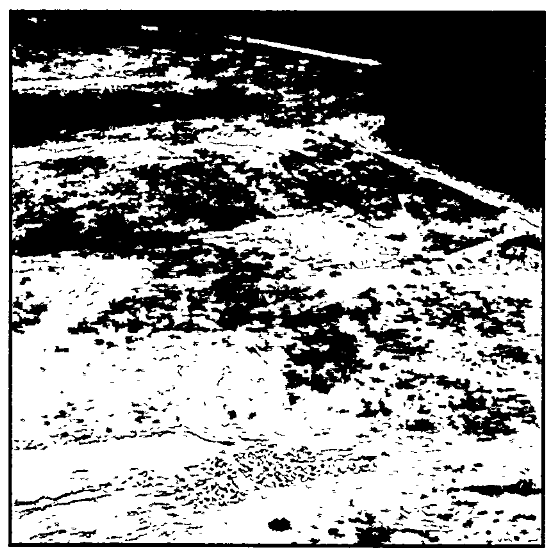
The time sequence of photography shows that after the upland areas were harvested, the floodplain was cleared of timber and a series of disturbances occurred lateral to or within the floodplain. This activity began in the northern portion of the lake bed and continued southward. These features appear at irregular intervals and are thought to be the locations of contaminated materials removed from the floodplain. They are less well-defined in shape and appear to "cast a shadow," which indicates that they may be "mound-like." It is estimated that there are more than 150 mounds; some may not have been used, especially in the lower one-third of the lake. The last date of RSL photographic coverage is September 6, 1985. Aerial photography acquired after September 1985 shows the lake at full pool.

1.5 Aerial Gamma Surveys

Numerous radiological surveys of the Steel Creek and L Lake area have been performed. For detailed information on the gamma activity within the Steel Creek drainage prior to L Lake construction, refer to the DOE documents listed in Appendix B.

Source photograph 42479-6 courtesy of SRS.

Source photograph 5076-16 courtesy of SRS.



Source photograph 5076-05 courtesy of SRS.

FIGURE 5. ***VEGETATION DEBRIS (TOP), CONCRETE BLOCKS (LOWER RIGHT), AND ANCHORED TREE TRUNKS (LOWER LEFT) WERE USED TO FACILITATE HABITAT DEVELOPMENT IN L LAKE.***

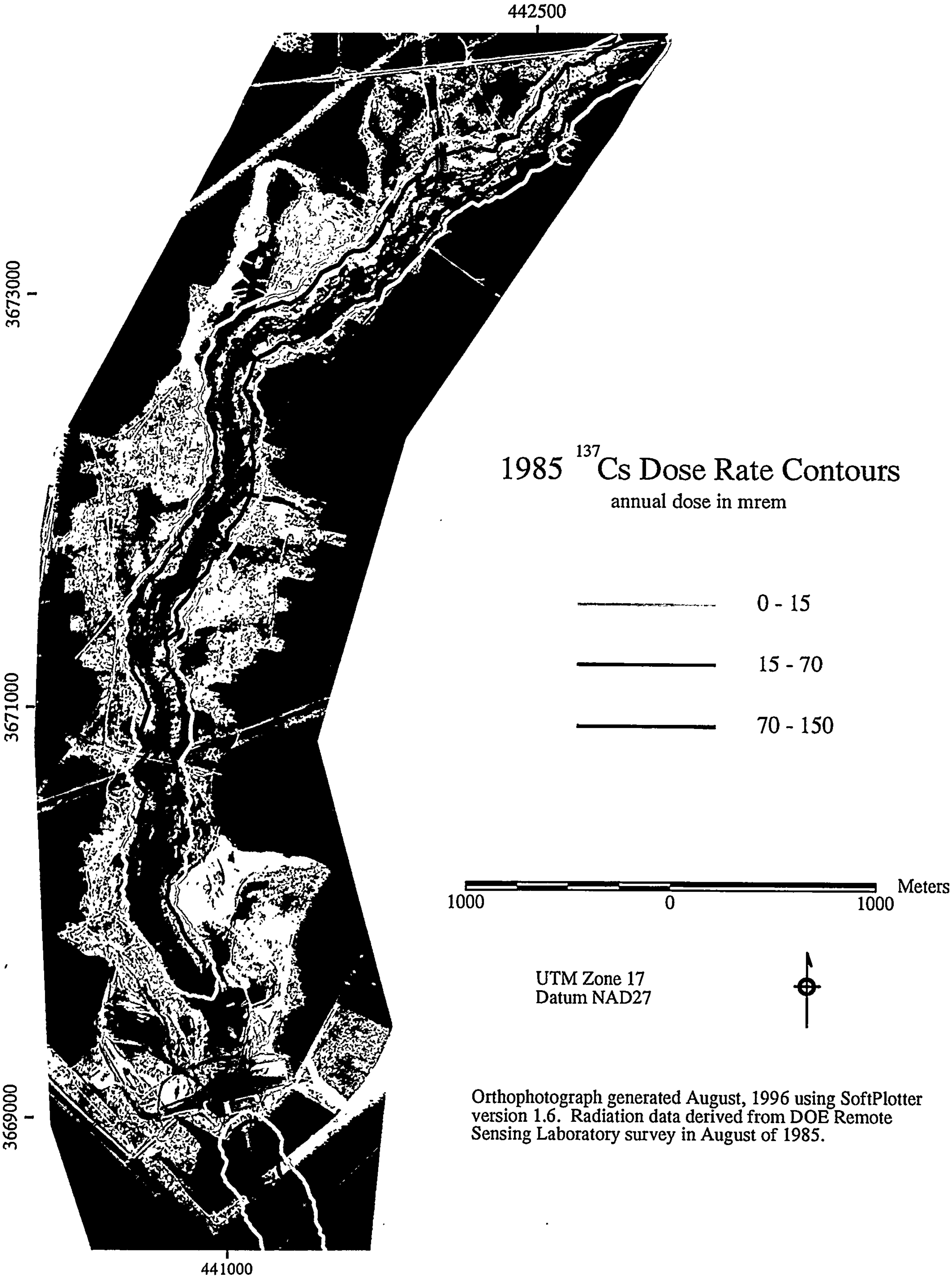


FIGURE 6. ***DOSE-RATE CONTOURS OF ^{137}Cs INDICATE THAT THE AREA AROUND THE DAM SITE SHOWED NO EVIDENCE OF RADIOLOGICAL ACTIVITY.***

Source: EG&G 4966-073 acquired 4-17-85 at scale 1:11900

Source: EG&G 4991-011 acquired 5-14-85 at scale 1:11900

Source: EG&G 4993-104 acquired 5-18-85 at scale 1:19900

Source: EG&G 4997-068 acquired 5-19-85 at scale 1:13900

FIGURE 7. ***THIS PHOTOGRAPHIC TIME SERIES SHOWS THE TRANSITION FROM STANDING VEGETATION IN THE UPPER LEFT TO SOIL-COVERED VEGETATION ASH PILES IN THE LOWER RIGHT.***

2.0 Softcopy Photogrammetry Orthophoto Process

To accurately map the L Lake basin, vertical aerial photography acquired nine days before filling began was selected as the base imagery. It appears that most of the construction and clearing activities were either complete or nearly complete by this time. The timeliness and scale of the photography provided the most comprehensive visual record available for this site and, therefore, was used for the digital orthophoto mapping process described in the following sections.

2.1 Aerial Photography Preparation

The series of photographs used to support the digital orthophoto project for L Lake waste-unit mapping included frames 92 through 99 of EG&G film roll 5108. The photography was acquired between 9:45 and 9:49 a.m. on September 6, 1985, with a north heading and a flying height of 7000 feet above ground level (AGL). The photographic system was a Wild Heerburg RC-10, large-format, aerial camera equipped with a 153-millimeter lens and loaded with Aerocolor 2445 film.

To accommodate the project requirement of 1-meter pixel resolution, the original spool film was scanned at 50 microns on a Howtek flatbed scanner. This resulted in pixel resolution values of approximately 0.7 meters. The binary digital photographs were converted to .img files, rotated, and reviewed using ERDAS Imagine, Version 8.2, image-processing software (ERDAS, 1995). The images were rotated so that north (the direction of the flight line) was to the right. This rotation gives the best parallax for the correlation function employed during the orthorectification process. Based predominantly on overlap and scan quality, frames 92, 94, 96, 97, 98, and 99 were selected and imported into SoftPlotter™ Version 1.6, Vision International's softcopy orthophotogrammetric package (Vision International, Inc., 1996).

For best results from SoftPlotter, camera calibration information is required. Each camera and lens setup used in aerial acquisitions by the DOE RSL is sent at regular intervals to the manufacturer or the U.S. Geological Survey (USGS) for inspection, cleaning, and calibration. Lens calibration information for the camera configuration used for the L Lake photography was obtained from Leica NA, Inc. The camera calibration certificate lists important lens information including the calibrated focal length, the principal point of symmetry, and the radial distortion away from the principal point of symmetry. The manufacturer's fiducial mark locations with respect to the focal center of the camera frame are also given. All of these values are used by the SoftPlotter Interior Orientation routine to calculate the mathematical relationships between the camera and the lens and the lens and the ground.

2.2 Project Definition and Processing

In SoftPlotter, the "L Lake Project" was defined, the camera type and values were entered, and the six selected Imagine .img formatted images were imported. Interior orientation was performed and each image was reviewed. During this process, the operator has the opportunity to hand edit the fiducial locations by interactively selecting the best center for each fiducial. This iterative process tells the operator where problem areas may exist on each image due to poor scan quality, film damage, or mismeasurement. The user defines the maximum acceptable root mean square error (RMSE) for the solution and can modify the location and number of fiducials used to perform the interior orientation until the requirements are met. For this project, the allowable RMSE was kept to the equivalent of 1 meter or 1.4 pixels.

Once information pertaining to the camera-lens relationship has been determined, ground control points (gcps) are defined in order to calculate the photograph/ground relationship. Gcps for this project came from a variety of sources. Table 2 shows the type and source of each of the gcps used for the triangulation portion of the block adjustment.

Results of the triangulation process are dependant on several user defined constraints. These parameters are selected based on knowledge of the factors affecting photographic acquisition and film quality. Rigid constraints can be employed when optimum conditions such as the following are met: known flying height, good film quality, minor distortions in photography due to flight parameters, gentle topography, and adequate ground control. Optimum conditions were met for the L Lake project, so rigid constraints were used. Based upon image RMSE residuals for x, y, and z values, the triangulation process yielded acceptable results.

2.3 Stereopair Generation

Epipolar resampling of the triangulated overlapping imagery was performed using the proprietary algorithms provided in the Stereo Tool module in SoftPlotter. This process resulted in five stereopairs of images that were oriented such that y-parallax was removed and x-parallax was interpreted as differences in elevation. The stereopairs were displayed to quality check the apparent success of the resampling before the DEM was generated.

2.4 DEM Generation

The five stereopairs were used as the sources for the DEM. Collection parameters were defined with a ground spacing of 1 meter, and a DEM was produced for each stereopair. This was an iterative process and the most time-intensive because the software provides ample methods for improving posting results through the use of breaklines and other site-specific point and surface adjustments. For L Lake, the forest edge was the biggest consideration during the editing process. Special attention was given to those areas directly affecting the shoreline elevations.

When the DEMs for each stereopair were deemed acceptable, they were mosaicked using Imagine's Mosaic routine. The result of this process is shown in Figure 8. Based on known and map-measured check points, elevation errors of the DEM ranged from 0.037–1.700 meters. Horizontal accuracies were less than 10 meters.

Table 2. Control Point Information

Type	Number	Source
Horizontal	13	Differential GPS[a]
Vertical	7	USGS Quadrangles[b]
Tie Points	6	Frame Feature

[a] Global Positioning System provided by R.S. Riley and H. Mackey, Westinghouse Savannah River Company.

[b] Girard NW and Girard NE 7.5-minute series (USGS, 1964).

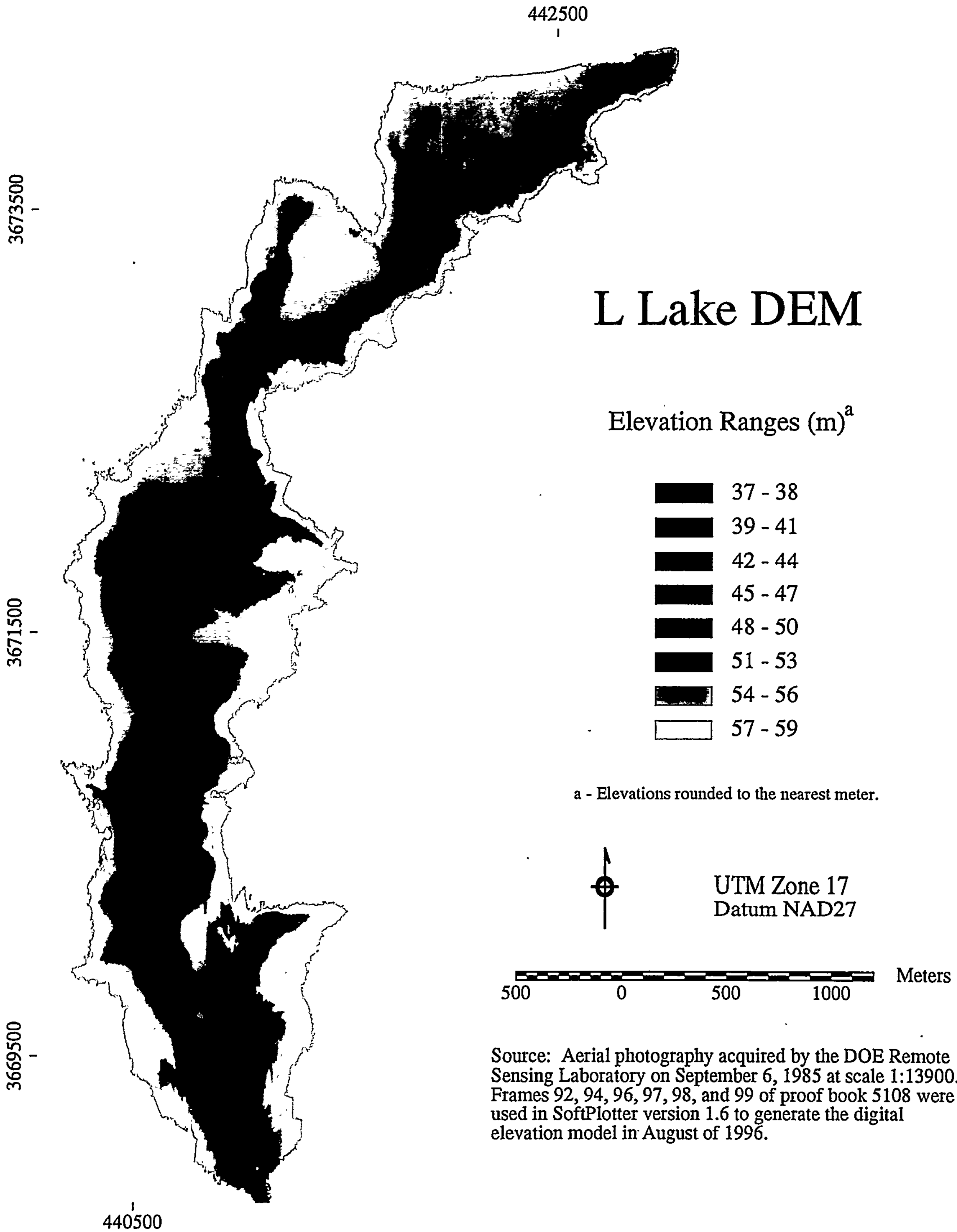


FIGURE 8. ***LEVEL-SLICED DEM SHOWING ELEVATION RANGES***

2.5 Digital Orthophoto Generation

Orthophotographs were derived from the six images and the DEM using a defined ground spacing of 1 meter in the Ortho Tool module in SoftPlotter. As with the DEMs, the orthophotos were merged using Imagine's Mosaic routine. The resulting orthorectified image is shown in Figure 9. This image and the DEM were subsequently used to generate raster products (ERDAS, 1995) and ARC/INFO vector coverages (ESRI, 1996) to help determine the location, extent, and type of disturbances that were visible in the lake bed on September 6, 1985, just prior to the initial fill date nine days later.

2.6 Digital Orthophotointerpretation Results

The seven categories of map features shown in Figure 10 were derived during the preliminary review of the source photography. A larger-scale map is also provided in Appendix C. Area statistical results of the digital orthophotointerpretation for these categories are listed in Table 3. In Figure 10, the large waste units shown in pink are evident, but there remains some confusion as to the absolute extent of where waste is actually buried and where soil was merely disturbed during the containment effort. The temporal sequence of both aerial and ground photography indicates that these were the primary areas used for the removal, transport, dumping, covering, and subsequent containment of the majority of the dam site materials believed to be contaminated. The dam site was constructed using imported materials in conjunction with the materials extracted from the borrow pits. The area occupied by the two waste units is just under 6 hectares.

The potential waste units, indicated in dark blue in Figure 10, depict those areas where it appears that other materials, perhaps those not suitable for construction purposes due to physical properties, have been deposited for containment. These 11 areas covered just over 19 hectares of the lake bed.

The vegetation waste piles, shown in red in Figure 10, are thought to contain contaminated vegetation not suitable for removal or burning. The photography indicates that the vegetation was bulldozed into piles and covered with soil for containment. A total of 154 of these areas occupies approximately 6.4 hectares of the lake bed closest to the floodplain. Some of the piles are actually in the floodplain.

Table 3. Area Statistics

Cover Type	Occurrences	Mean Size (ha)	Sum
Large Waste Units	2	2.94	5.87
Vegetation Waste Piles	154	0.04	6.42
Ash Piles	584	0.04	21.41
Potential Waste Units	11	1.74	19.17
Debris Piles	13	0.04	0.46
Borrow Pits	4	2.47	9.87
Fish Structures	27	0.01	0.21
		Total	**63.41**

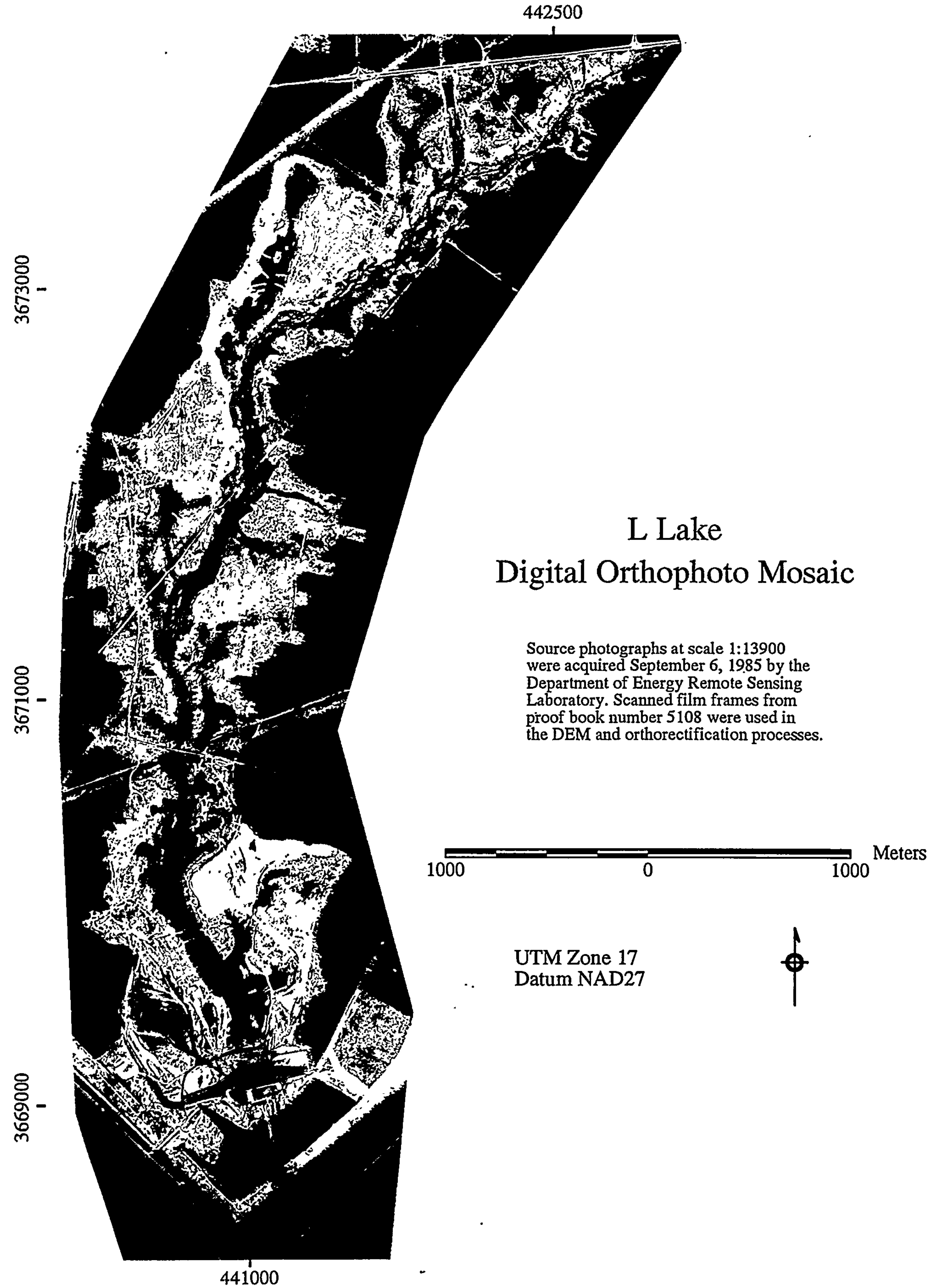


FIGURE 9. ***MOSAICKED DIGITAL ORTHOPHOTOGRAPH OF THE L LAKE BASIN DERIVED FROM FIVE SEPARATE PHOTOGRAPHS.***

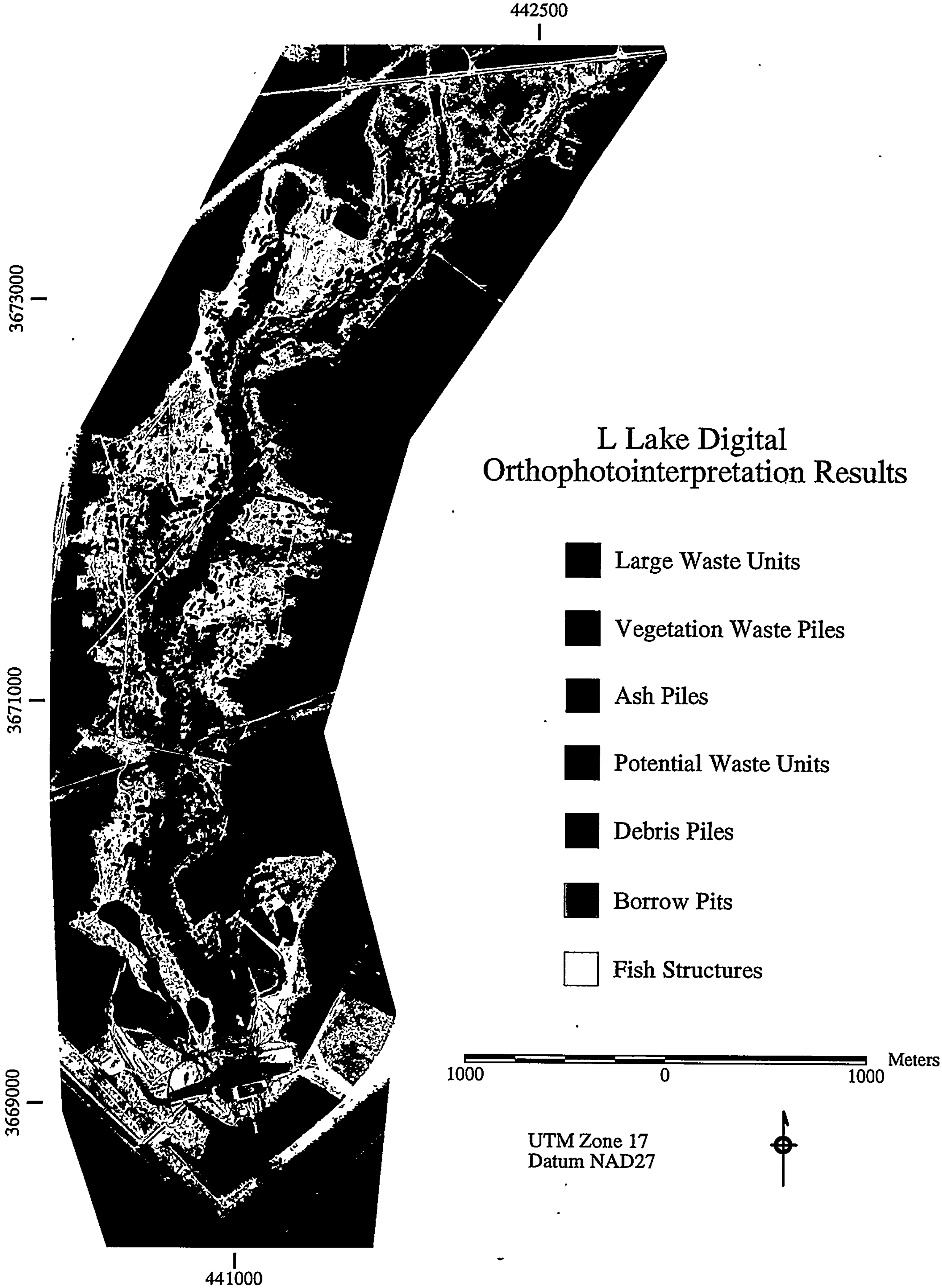


FIGURE 10. ***SEVEN TYPES OF FEATURES OF INTEREST WERE INTERPRETED FROM THE DIGITAL ORTHOPHOTOGRAPH.***

The locations of these piles are thought to be the result of the intent to keep them within reasonable distance of the "contamination line" shown in blue in Figure 11. The contamination line was determined by deriving acceptable levels of terrestrial radioactivity based on ground-based dosimeter measurements. The line data shown in Figure 11 were derived from the topographic map series designed in April 1984 by Baldwin and Cranston Associates, Inc., entitled *Cooling Reservoir Site, "L" Area, Savannah River Plant.* The four-map series was revised in September 1984 to include the contamination line.

The 584 ash piles, denoted in green in Figure 10, account for 21.41 hectares of the lake bed area. These features are the result of the vegetation-clearing effort where bulldozers were used to scrape the vegetation into piles. The piles were then burned, and the remaining ashes were covered with clean soil. The soil used to cover the ashes may have come from one of the four borrow pits shown in cyan in Figure 10 or, more than likely, was scraped from a cleared area nearby. Almost 10 hectares of the area cleared for L Lake was used for borrow pit materials.

To facilitate the establishment of fish and macrophyte populations in L Lake, approximately 40 concrete block and vegetation piles, including the trunks of trees deemed unsuitable for sale, were positioned throughout the lake bed as initial habitats. These fish structures and debris piles are shown as orange and purple polygons, respectively, in Figure 10.

As mentioned previously, soil-suitability tests were performed in areas in close proximity to the dam construction site. The locations of soils that had the correct physical properties for construction or for use in covering the waste and debris piles are denoted as cyan polygons and cover an area of approximately 9.9 hectares. The northernmost borrow pit existed prior to L Lake construction, but the photography suggests that it was also modified during L Lake development.

3.0 Summary

Based on the digital orthophotography, the aerial extent of disturbances within the L Lake basin is approximately 63.4 hectares. The seven categories of disturbances have been mapped and prioritized in the legend according to their likelihood of containing low-level radioactive materials. By using the digital maps in conjunction with the DEM, scientists can now use the information available in the L Lake GIS to reasonably model and estimate the extent to which these features will be exposed in the event that the lake is drawn down. The centroid locations and elevations for each feature type occurrence, which is identified with its ARC/INFO – id value, are listed in Appendix D.

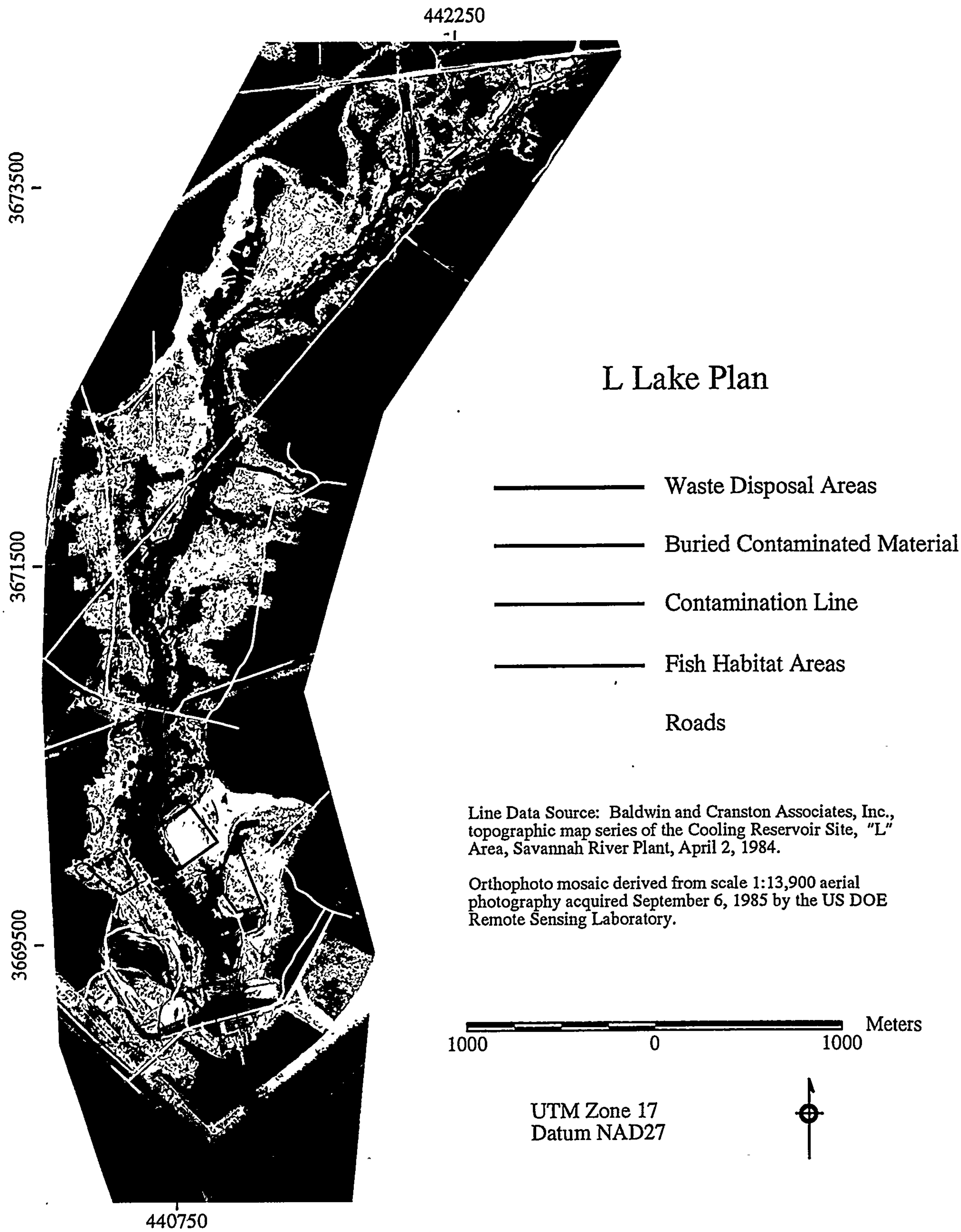


FIGURE 11. ***VECTOR LAYERS DIGITIZED FROM ENGINEERING PLANS OVERLAYED ON THE DIGITAL ORTHOPHOTOGRAPH.***

APPENDIX A

VERTICAL AERIAL PHOTOGRAPHY USED FOR PHOTOINTERPRETATION AND MAPPING

Table A-1 is a comprehensive list of the vertical aerial photography used for the photointerpretation and mapping processes for the L Lake project. Altitudes are given as above ground level in feet.

Table A-1. Vertical Aerial Photography

Proof No.	Frames	Date	Altitude (ft)	Scale	Film Type
EG&G 4655	006	03/31/84	17000	1:34400	color
EG&G 4644	006	03/31/84	17000	1:34400	color infrared
EG&G 4655	161–164	04/01/84	8000	1:15700	color
EG&G 4755	174, 194	06/18/84	10000	1:19900	color
EG&G 4840	16–22 63–86	09/19/84	20000 8000	1:39200 1:7960	color color
EG&G 4966	062–063 073	04/17/85	20000 6000	1:41400 1:11900	color color
EG&G 4973	105–112	04/25/85	4000	1:7960	color
EG&G 4991	010–019	05/14/85	6000	1:11900	color
EG&G 4992	010–019	05/14/85	6000	1:11900	color infrared
EG&G 4993	084–104	05/18/85	10000	1:19900	color
EG&G 4994	084–104	05/18/85	10000	1:19900	color infrared
EG&G 4997	066–073	05/19/85	7000	1:13900	color
EG&G 4998	066–073	05/19/85	7000	1:13900	color infrared
EG&G 5033	075–081 082	06/21/85	6000 17000	1:11900 1:33800	color color
EG&G 5108	088 092–100	09/06/85	20000 7000	1:39200 1:13900	color color

APPENDIX B

DOE RADIOLOGICAL SURVEY DOCUMENTS

Information regarding aerial gamma radiological surveys of the Steel Creek area before the L Lake fill date can be found in the following DOE reports:

Jobst, J.E. *An Aerial Radiological Survey of the Savannah River Plant Drainage Basins, Date of Survey: August 1982.* DOE/ONS-8312, Rev. 1, EG&G/EM, Las Vegas, Nevada, 1987.

Jobst, J.E. *An Aerial Radiological Survey of the L Lake and Steel Creek, Savannah River Plant, Survey Date: August 1985.* DOE(ONS-SRL)-8611, EG&G/EM, Las Vegas, Nevada, 1988.

Information regarding aerial gamma radiological surveys of the Steel Creek area after the L Lake fill date can be found in the following DOE reports:

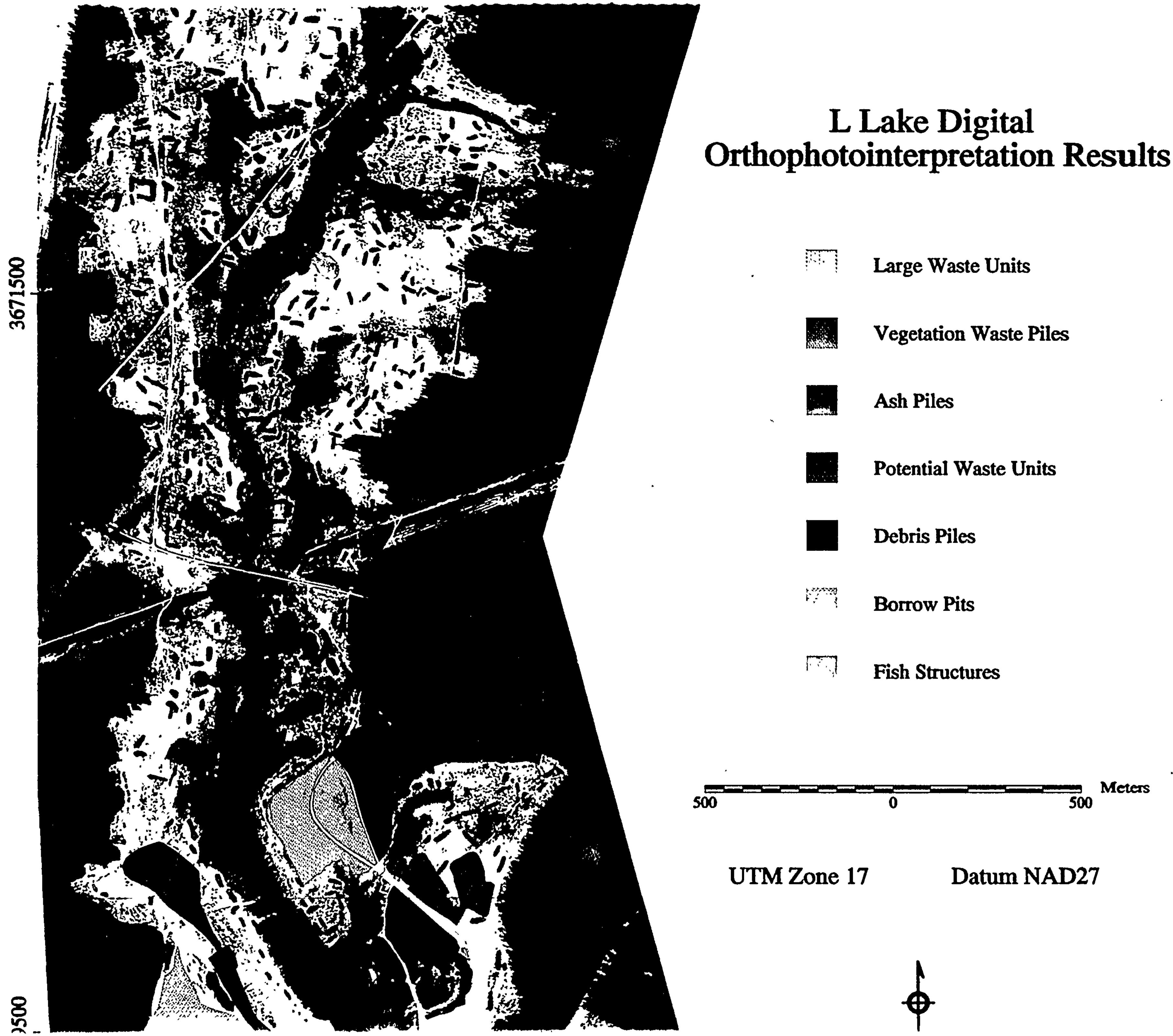
Feimster, E.L. *An Aerial Radiological Survey of the L Lake and Steel Creek, Savannah River Site , Date of Survey: July 1986.* EGG-10617-1146, EG&G/EM, Las Vegas, Nevada, 1992.

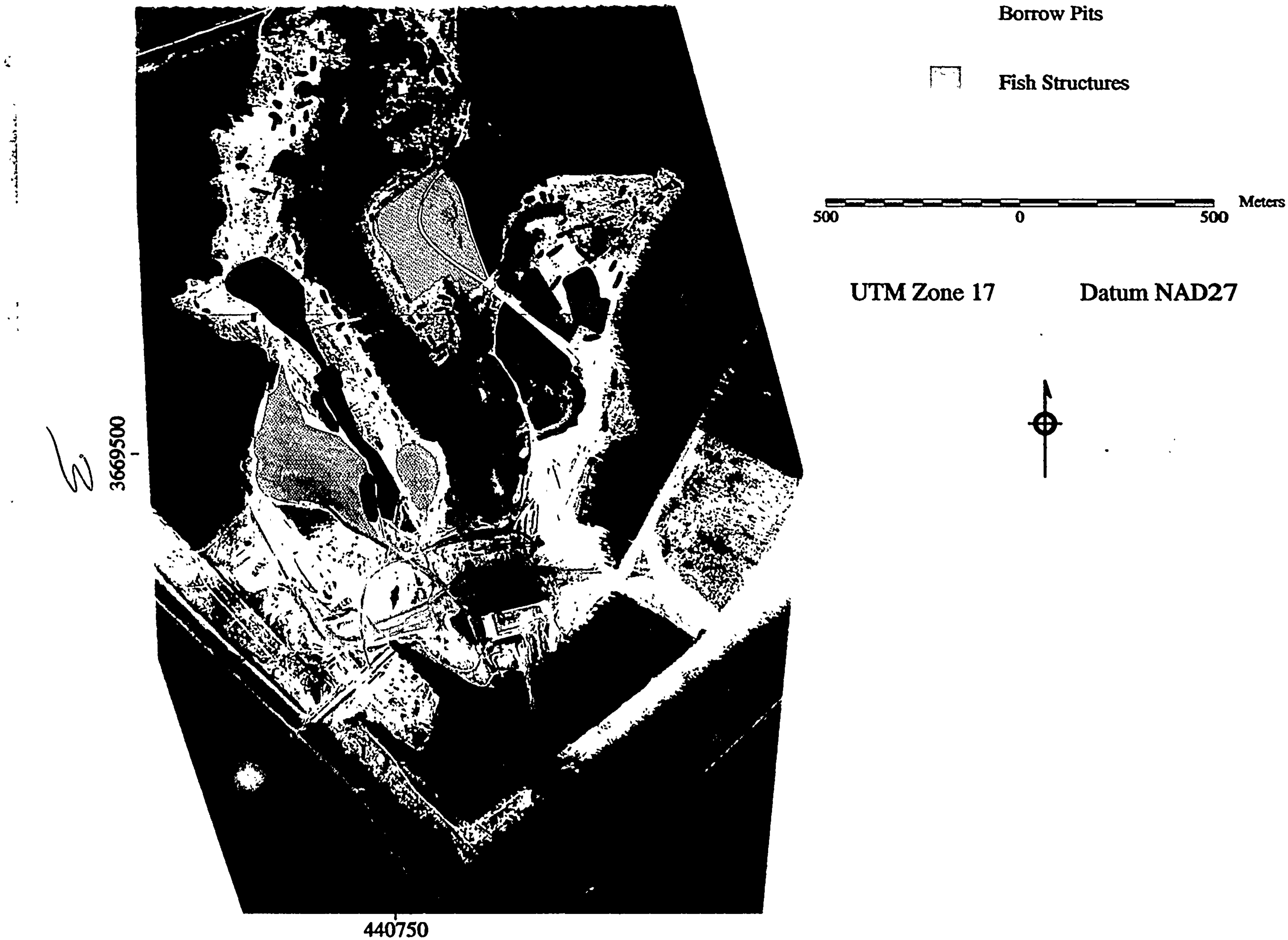
Feimster, E.L. *An Aerial Radiological Survey of Par Pond and Associated Drainage Pathways of the Savannah River Site, Aiken, South Carolina, Date of Survey: August 19-November 11, 1991.* EGG-10617-1227, EG&G/EM, Las Vegas, Nevada, 1992.

Vojtech, R.J. *An Aerial Radiological Survey of the Savannah River Site and Surrounding Area October-November 1991, Aiken, South Carolina.* EGG-11265-1236, EG&G/EM, Las Vegas, Nevada, 1993.

APPENDIX C
ENLARGED MOSAIC

L Lake Digital
Orthophotointerpretation Results


3671500
9500
L Lake Digital
Orthophotointerpretation Results
Large Waste Units
Vegetation Waste Piles
Ash Piles
Potential Waste Units
Debris Piles
Borrow Pits
Fish Structures
500
0
500
Meters
UTM Zone 17
Datum NAD27


Borrow Pits
Fish Structures
500
0
500
Meters
UTM Zone 17
Datum NAD27
3669500
440750

APPENDIX D

LOCATIONS AND ELEVATIONS OF PHOTOINTERPRETATED MAP FEATURES

The following tabular data are the listing of locations and elevations for the seven informations classes derived from the digital orthophotograph and DEM. The ID No. values correspond to the ARC/INFO coverage –id attribute. Information is given in meters above mean sea level.

Table D-1. Locations and Elevations of Large Waste Units

Unit ID No.	Easting UTM[a]	Northing UTM	Elevation NAD27
9	440,785.3	3,670,040.3	55.7
31	440,888.5	3,670,101.7	50.2

[a] Universal Transverse Mercator

Table D-2. Location and Elevations of Vegetation Waste Units

Unit ID No.	Easting UTM	Northing UTM	Elevation NAD27
2	442,824.0	3,674,052.9	50.5
3	442,773.7	3,674,029.9	51.3
4	442,713.4	3,673,962.9	53.7
5	442,679.9	3,673,946.5	53.6
6	442,657.4	3,673,938.4	52.5
7	442,650.1	3,673,922.7	53.9
8	442,559.4	3,673,906.2	52.0
9	442,608.9	3,673,893.6	52.2
10	442,539.6	3,673,877.2	51.1
11	442,601.8	3,673,857.8	51.3
12	442,516.0	3,673,851.9	51.4
13	442,585.8	3,673,827.5	53.1
14	442,465.3	3,673,791.2	50.9
15	442,624.4	3,673,766.2	54.7
16	442,429.6	3,673,769.0	52.4
17	442,026.1	3,673,761.9	51.6
18	442,559.7	3,673,760.8	51.8
19	442,458.2	3,673,757.0	51.7

Table D-2. Location and Elevations of Vegetation Waste Units (continued)

Unit ID No.	Easting UTM	Northing UTM	Elevation NAD27
20	442,553.0	3,673,746.5	51.1
21	442,375.9	3,673,745.1	52.7
22	442,541.3	3,673,737.0	51.6
23	441,993.3	3,673,728.2	52.1
24	442,394.1	3,673,731.7	51.4
25	442,364.7	3,673,717.9	52.6
26	442,478.5	3,673,698.5	52.6
27	442,276.3	3,673,675.5	51.7
28	442,227.2	3,673,652.7	52.5
29	442,439.5	3,673,669.8	52.0
30	442,116.1	3,673,619.8	51.4
31	441,972.5	3,673,610.5	53.1
32	442,377.4	3,673,597.8	52.5
33	442,101.0	3,673,596.5	50.8
34	441,901.7	3,673,595.2	51.9
35	441,969.2	3,673,577.0	52.7
36	442,098.3	3,673,525.4	50.5
37	442,061.3	3,673,499.4	52.3
38	442,142.2	3,673,480.5	52.8
39	441,979.2	3,673,407.5	50.6
40	441,944.8	3,673,358.4	51.2
41	441,808.6	3,673,333.1	52.5
42	441,920.5	3,673,272.6	52.1
43	441,672.5	3,673,142.7	50.9
44	441,547.0	3,673,139.8	55.4
45	441,595.1	3,673,127.6	53.4
46	441,791.0	3,673,110.8	52.8
47	441,735.0	3,673,105.2	51.3
48	441,496.8	3,673,092.8	54.0
49	441,473.0	3,673,061.4	52.0
50	441,697.7	3,673,052.8	51.6
51	441,400.3	3,672,969.6	51.0
52	441,511.3	3,672,897.9	53.8

Table D-2. Location and Elevations of Vegetation Waste Units (continued)

Unit ID No.	Easting UTM	Northing UTM	Elevation NAD27
53	441,203.4	3,672,900.8	52.0
54	441,304.2	3,672,890.8	51.8
55	441,092.4	3,672,838.8	50.8
56	441,059.9	3,672,805.2	50.1
57	441,316.3	3,672,798.9	51.2
58	441,189.8	3,672,794.1	51.7
59	441,390.5	3,672,792.3	51.6
60	441,031.8	3,672,780.3	49.8
61	441,146.6	3,672,761.1	51.1
62	441,005.5	3,672,762.2	49.0
63	440,945.8	3,672,702.0	50.5
64	440,914.9	3,669,304.5	44.5
65	440,963.9	3,672,695.5	49.8
66	441,012.4	3,672,501.7	51.6
67	441,029.7	3,672,408.5	51.6
68	440,934.4	3,672,318.6	48.3
69	441,068.5	3,672,290.5	51.7
70	440,963.7	3,672,269.4	47.6
71	441,087.3	3,672,237.4	50.5
72	441,102.6	3,672,174.5	50.3
73	441,111.6	3,672,110.2	47.0
74	441,097.6	3,672,058.9	47.0
75	440,942.6	3,672,016.5	45.0
76	441,059.5	3,672,003.7	45.5
77	441,014.2	3,671,953.7	46.7
78	440,970.2	3,671,905.1	46.7
79	440,840.4	3,671,882.2	45.0
80	440,957.0	3,671,854.5	49.2
81	440,749.0	3,671,759.9	46.8
82	440,973.6	3,671,736.4	49.6
83	440,883.0	3,671,704.4	47.6
84	440,717.1	3,671,649.0	46.5
85	440,841.0	3,671,631.7	47.4

Table D-2. Location and Elevations of Vegetation Waste Units (continued)

Unit ID No.	Easting UTM	Northing UTM	Elevation NAD27
86	440,797.5	3,671,564.0	46.7
87	440,600.1	3,671,547.9	45.3
88	440,743.9	3,671,519.5	47.8
89	440,719.9	3,671,487.2	47.9
90	440,580.9	3,671,469.8	44.3
91	440,711.8	3,671,449.7	49.5
92	440,576.9	3,671,453.4	44.6
93	440,717.9	3,671,406.1	48.0
94	440,504.5	3,671,326.2	46.8
95	440,690.0	3,671,319.9	44.8
96	440,508.8	3,671,279.5	46.8
97	440,653.2	3,671,281.1	44.6
98	440,647.7	3,671,243.3	45.1
99	440,505.3	3,671,217.5	46.7
100	440,546.1	3,671,171.1	44.1
101	440,648.7	3,671,184.9	44.4
102	440,658.5	3,671,162.3	45.1
103	440,569.0	3,671,139.9	43.2
104	440,704.2	3,671,132.1	44.5
105	440,601.4	3,671,075.3	44.8
106	440,726.3	3,671,051.2	43.2
107	440,746.4	3,671,038.4	44.0
108	440,613.7	3,671,037.4	44.0
109	440,736.8	3,671,013.0	43.7
110	440,623.5	3,670,968.3	44.4
111	440,732.3	3,670,938.4	43.7
112	440,624.1	3,670,906.8	43.2
113	440,727.9	3,670,885.5	44.7
114	440,723.6	3,670,847.3	41.8
115	440,607.4	3,670,782.3	41.5
116	440,586.1	3,670,780.4	41.7
117	440,675.0	3,670,772.1	41.2
118	440,658.8	3,670,769.4	41.1

Table D-2. Location and Elevations of Vegetation Waste Units (continued)

Unit ID No.	Easting UTM	Northing UTM	Elevation NAD27
119	440,723.7	3,670,656.3	47.0
120	440,812.7	3,670,622.8	53.2
121	440,560.6	3,670,598.2	46.4
122	440,540.7	3,670,528.1	46.6
123	440,873.9	3,670,495.2	54.2
124	440,756.3	3,670,456.6	49.0
125	440,738.6	3,670,397.7	47.1
126	440,521.4	3,670,388.0	47.5
127	440,486.2	3,670,351.4	48.6
128	440,740.9	3,670,302.4	46.0
129	440,462.2	3,670,163.0	46.2
130	440,727.9	3,670,164.5	51.8
131	440,690.2	3,670,119.4	50.1
132	440,494.5	3,670,048.6	46.4
133	440,673.6	3,670,061.3	46.1
134	440,495.9	3,669,996.2	46.5
135	440,684.9	3,669,997.0	44.2
136	440,756.0	3,669,963.3	50.8
137	440,531.9	3,669,957.7	44.4
138	440,564.4	3,669,911.9	45.2
139	440,782.2	3,669,907.3	51.1
140	440,595.7	3,669,905.0	43.6
141	440,597.8	3,669,870.9	45.1
142	440,793.8	3,669,849.2	47.6
143	440,605.5	3,669,831.8	46.0
144	440,626.2	3,669,798.4	46.8
145	440,665.8	3,669,784.0	44.2
146	440,831.3	3,669,779.2	46.6
147	440,884.7	3,669,738.2	44.1
148	440,679.7	3,669,712.5	48.4
149	440,962.4	3,669,656.3	42.7
150	440,698.9	3,669,653.0	47.0
151	440,749.9	3,669,602.1	44.0

Table D-2. Location and Elevations of Vegetation Waste Units (continued)

Unit ID No.	Easting UTM	Northing UTM	Elevation NAD27
152	441,013.3	3,669,557.9	42.8
153	440,896.2	3,669,448.1	41.9
154	440,889.9	3,669,386.0	41.6
155	440,903.0	3,669,317.3	42.0

Table D-3. Location and Elevations of Ash Piles

Pile ID No.	Easting UTM	Northing UTM	Elevation NAD27
1	442,803.5	3,674,130.1	53.0
2	442,748.7	3,674,120.3	52.7
3	442,594.3	3,674,103.8	54.9
4	442,667.6	3,674,077.9	51.7
5	442,527.5	3,674,081.2	55.1
6	442,350.3	3,674,081.1	54.8
7	442,244.1	3,674,046.8	57.5
8	442,604.0	3,674,036.3	54.7
9	441,879.0	3,674,024.7	59.1
10	442,454.7	3,674,031.3	55.2
11	442,283.1	3,674,019.6	55.9
12	442,111.9	3,674,010.8	57.1
13	442,524.4	3,673,974.6	54.0
14	442,566.3	3,673,980.7	53.2
15	442,494.4	3,673,953.2	54.4
16	442,022.1	3,673,953.6	55.8
17	442,165.8	3,673,951.5	55.1
18	442,149.9	3,673,939.3	55.2
19	442,510.7	3,673,941.7	54.0
20	442,300.1	3,673,921.8	54.8
21	442,455.1	3,673,916.7	53.4
22	442,492.4	3,673,912.9	53.8
23	442,093.7	3,673,870.8	55.1
24	442,426.8	3,673,863.3	53.8

Table D-3. Location and Elevations of Ash Piles (continued)

Pile ID No.	Easting UTM	Northing UTM	Elevation NAD27
25	442,048.4	3,673,862.5	54.4
26	442,465.1	3,673,854.0	52.8
27	442,362.0	3,673,854.2	53.4
28	441,785.9	3,673,832.1	54.7
29	442,374.3	3,673,831.9	53.6
30	442,232.7	3,673,827.2	53.7
31	441,656.8	3,673,823.7	56.7
32	442,636.1	3,673,802.0	54.5
33	441,925.5	3,673,798.4	55.7
34	441,693.0	3,673,775.9	54.9
35	442,386.6	3,673,797.0	52.5
36	442,410.8	3,673,794.8	52.2
37	442,183.4	3,673,789.5	53.3
38	441,873.1	3,673,775.9	53.8
39	441,939.9	3,673,737.6	52.3
40	442,130.1	3,673,745.8	52.7
41	442,078.3	3,673,733.8	54.2
42	441,849.3	3,673,719.8	52.7
43	442,238.3	3,673,715.0	53.0
44	441,725.3	3,673,702.0	55.5
45	442,639.4	3,673,691.7	55.0
46	442,326.2	3,673,696.6	51.8
47	442,098.5	3,673,691.9	52.3
48	441,877.8	3,673,669.2	52.0
49	441,966.6	3,673,657.7	53.5
50	441,918.6	3,673,663.5	52.7
51	442,090.8	3,673,651.9	52.6
52	441,719.3	3,673,619.7	54.3
53	442,153.8	3,673,624.6	51.8
54	441,371.2	3,673,574.5	57.2
55	441,846.3	3,673,567.8	52.0
56	441,881.9	3,673,555.6	52.3
57	442,349.9	3,673,563.8	55.2

Table D-3. Location and Elevations of Ash Piles (continued)

Pile ID No.	Easting UTM	Northing UTM	Elevation NAD27
58	441,723.7	3,673,519.6	54.0
59	442,286.2	3,673,522.2	53.2
60	441,848.0	3,673,517.3	52.4
61	441,150.1	3,673,514.6	59.1
62	441,891.7	3,673,519.4	51.2
63	441,365.2	3,673,515.4	55.4
64	441,140.9	3,673,481.4	56.8
65	441,886.5	3,673,485.9	51.5
66	441,168.2	3,673,464.9	55.4
67	441,842.3	3,673,483.4	52.4
68	441,340.4	3,673,452.7	55.1
69	441,821.5	3,673,454.3	52.1
70	441,135.2	3,673,445.8	56.1
71	441,455.9	3,673,448.7	57.3
72	441,443.6	3,673,425.6	57.1
73	441,418.8	3,673,414.5	56.8
74	441,836.6	3,673,430.4	51.7
75	441,812.4	3,673,398.8	51.6
76	441,706.2	3,673,399.8	53.9
77	442,032.6	3,673,398.8	54.0
78	441,151.1	3,673,368.2	54.7
79	441,761.8	3,673,368.3	51.9
80	441,728.8	3,673,368.2	52.5
81	441,267.2	3,673,342.7	55.3
82	441,090.2	3,673,334.8	57.0
83	441,971.0	3,673,327.5	51.8
84	441,231.5	3,673,336.7	54.3
85	441,289.7	3,673,317.9	57.4
86	441,074.3	3,673,300.9	56.9
87	441,329.7	3,673,312.6	57.7
88	441,113.4	3,673,293.7	54.2
89	442,062.3	3,673,298.2	56.6
90	441,163.5	3,673,286.4	53.8

Table D-3. Location and Elevations of Ash Piles (continued)

Pile ID No.	Easting UTM	Northing UTM	Elevation NAD27
91	441,395.7	3,673,278.1	57.8
92	441,728.4	3,673,280.8	51.9
93	441,116.1	3,673,256.5	54.5
94	441,728.4	3,673,259.9	51.8
95	441,249.7	3,673,232.1	54.5
96	441,360.5	3,673,253.5	57.7
97	441,738.7	3,673,239.2	51.2
98	441,514.3	3,673,238.9	57.9
99	441,689.3	3,673,243.1	52.4
100	441,661.1	3,673,220.1	54.0
101	441,702.3	3,673,210.1	51.5
102	441,672.4	3,673,194.2	52.1
103	441,613.5	3,673,190.7	55.9
104	441,586.6	3,673,191.1	57.2
105	441,129.7	3,673,169.0	52.9
106	441,076.4	3,673,162.4	53.0
107	441,228.3	3,673,141.6	54.2
108	441,926.7	3,673,144.7	55.2
109	441,507.2	3,673,137.0	56.1
110	441,304.1	3,673,140.6	56.8
111	441,129.7	3,673,134.7	52.6
112	441,386.7	3,673,104.3	57.1
113	441,046.2	3,673,081.9	54.7
114	441,448.7	3,673,080.5	54.5
115	441,152.2	3,673,067.5	51.3
116	441,194.5	3,673,049.4	54.0
117	441,404.4	3,673,060.9	55.4
118	441,466.6	3,673,026.6	51.1
119	441,038.3	3,673,019.8	53.0
120	441,151.9	3,673,011.9	51.3
121	441,368.2	3,673,005.6	54.0
122	441,053.7	3,672,992.0	52.6
123	441,203.5	3,672,983.6	54.6

Table D-3. Location and Elevations of Ash Piles (continued)

Pile ID No.	Easting UTM	Northing UTM	Elevation NAD27
124	441,338.5	3,672,979.0	51.7
125	440,912.8	3,672,982.0	59.0
126	441,653.9	3,672,980.3	55.3
127	441,622.2	3,672,976.4	55.0
128	441,019.2	3,672,974.5	54.7
129	441,609.2	3,672,949.5	55.4
130	441,153.1	3,672,953.0	52.1
131	441,174.7	3,672,947.7	52.6
132	440,846.8	3,672,938.2	58.2
133	440,886.6	3,672,944.0	56.9
134	441,344.6	3,672,944.2	51.3
135	441,581.8	3,672,919.2	56.6
136	440,886.9	3,672,912.7	54.3
137	441,661.2	3,672,918.8	57.1
138	440,859.3	3,672,921.6	57.1
139	441,281.4	3,672,914.1	51.7
140	441,125.6	3,672,908.1	51.5
141	441,601.5	3,672,895.1	58.8
142	441,698.0	3,672,887.3	58.2
143	441,113.2	3,672,878.9	51.4
144	440,856.5	3,672,840.5	58.1
145	441,515.0	3,672,811.4	56.2
146	440,906.5	3,672,792.0	53.6
147	440,846.8	3,672,774.6	54.2
148	441,001.9	3,672,781.4	50.8
149	441,237.4	3,672,775.7	54.8
150	441,276.4	3,672,756.9	56.2
151	441,383.4	3,672,753.8	57.0
152	441,253.4	3,672,758.6	56.1
153	441,177.8	3,672,734.3	55.2
154	440,793.4	3,672,736.1	59.8
155	441,267.3	3,672,721.8	57.8
156	441,187.7	3,672,705.5	57.2

Table D-3. Location and Elevations of Ash Piles (continued)

Pile ID No.	Easting UTM	Northing UTM	Elevation NAD27
157	440,817.4	3,672,707.2	54.4
158	441,301.2	3,672,700.5	58.6
159	441,221.9	3,672,695.1	59.1
160	440,836.4	3,672,649.4	53.4
161	440,929.3	3,672,617.4	50.4
162	440,737.7	3,672,579.7	59.4
163	440,715.2	3,672,576.2	59.8
164	440,774.9	3,672,568.2	59.0
165	440,858.6	3,672,531.4	53.7
166	440,897.3	3,672,525.0	51.0
167	440,635.3	3,672,482.1	59.0
168	440,723.6	3,672,470.4	57.0
169	440,891.2	3,672,454.2	50.5
170	440,711.4	3,672,446.3	57.4
171	440,791.1	3,672,430.6	57.2
172	440,640.4	3,672,425.3	58.4
173	440,941.0	3,672,410.3	49.2
174	441,071.2	3,672,407.8	57.1
175	440,700.5	3,672,394.5	57.4
176	440,735.0	3,672,368.5	56.5
177	440,586.5	3,672,342.6	57.8
178	440,641.1	3,672,340.6	56.1
179	440,696.5	3,672,336.0	55.9
180	441,139.8	3,672,289.3	58.4
181	440,291.4	3,672,298.9	61.6
182	440,337.3	3,672,288.3	60.2
183	440,452.9	3,672,270.7	60.3
184	440,366.6	3,672,272.4	60.3
185	440,498.2	3,672,254.0	58.6
186	440,744.5	3,672,257.6	55.0
187	441,211.1	3,672,254.6	59.5
188	440,774.6	3,672,249.2	55.2
189	441,154.3	3,672,250.0	58.2

Table D-3. Location and Elevations of Ash Piles (continued)

Pile ID No.	Easting UTM	Northing UTM	Elevation NAD27
190	440,606.8	3,672,242.0	55.0
191	440,680.5	3,672,246.2	55.6
192	441,113.7	3,672,228.9	53.4
193	440,548.1	3,672,239.4	56.7
194	441,200.7	3,672,229.1	56.6
195	440,889.9	3,672,214.3	50.9
196	440,496.9	3,672,205.7	57.2
197	440,628.9	3,672,209.4	52.8
198	441,163.0	3,672,208.7	54.2
199	440,568.3	3,672,196.1	53.8
200	440,364.1	3,672,196.0	57.3
201	440,748.9	3,672,172.2	52.0
202	440,833.2	3,672,172.9	50.7
203	440,905.7	3,672,153.6	48.4
204	440,317.1	3,672,178.4	58.4
205	440,691.9	3,672,165.5	52.4
206	440,422.7	3,672,168.1	56.4
207	440,406.2	3,672,157.7	55.6
208	440,465.2	3,672,153.6	55.4
209	440,328.4	3,672,154.3	59.2
210	440,432.6	3,672,154.3	55.4
211	440,860.0	3,672,146.7	49.8
212	441,153.2	3,672,127.3	51.7
213	440,640.4	3,672,105.6	51.3
214	440,802.4	3,672,104.4	50.4
215	440,707.3	3,672,103.3	50.8
216	440,560.4	3,672,104.4	50.7
217	440,513.7	3,672,097.7	50.8
218	441,199.2	3,672,083.9	56.7
219	440,614.4	3,672,075.7	49.4
220	440,671.5	3,672,041.2	49.8
221	440,476.2	3,672,058.7	51.0
222	440,544.3	3,672,071.1	48.4

Table D-3. Location and Elevations of Ash Piles (continued)

Pile ID No.	Easting UTM	Northing UTM	Elevation NAD27
223	440,635.4	3,672,049.1	49.6
224	441,197.4	3,672,065.8	56.0
225	441,143.5	3,672,052.9	52.3
226	440,443.4	3,672,039.1	53.0
227	440,843.5	3,672,027.2	47.4
228	440,517.7	3,672,019.6	49.0
229	441,206.3	3,672,029.0	49.7
230	440,800.2	3,672,018.7	48.0
231	440,735.3	3,672,007.1	48.5
232	440,439.5	3,671,991.4	52.8
233	441,084.2	3,671,994.6	48.7
234	440,843.2	3,671,978.0	46.6
235	441,326.3	3,671,977.9	52.4
236	441,199.5	3,671,965.3	52.9
237	441,293.3	3,671,962.0	52.8
238	440,358.5	3,671,967.8	55.4
239	440,509.9	3,671,941.6	49.1
240	441,366.7	3,671,968.4	55.6
241	441,265.2	3,671,957.2	52.6
242	440,804.8	3,671,952.6	47.3
243	440,362.8	3,671,950.9	53.1
244	440,286.4	3,671,941.5	59.0
245	441,336.5	3,671,945.1	52.4
246	440,761.4	3,671,934.3	47.2
247	441,046.6	3,671,937.2	50.2
248	440,529.8	3,671,940.1	47.9
249	440,781.5	3,671,936.5	47.3
250	440,729.0	3,671,924.7	47.5
251	441,410.6	3,671,928.4	55.9
252	441,179.2	3,671,926.4	54.4
253	441,355.0	3,671,927.2	54.8
254	441,253.1	3,671,925.5	54.4
255	441,087.0	3,671,923.5	52.0

Table D-3. Location and Elevations of Ash Piles (continued)

Pile ID No.	Easting UTM	Northing UTM	Elevation NAD27
256	440,336.7	3,671,911.6	52.8
257	441,122.8	3,671,921.9	53.7
258	440,434.3	3,671,921.2	50.7
259	440,828.9	3,671,908.7	46.8
260	441,037.6	3,671,909.3	49.9
261	440,245.8	3,671,903.3	58.7
262	440,454.6	3,671,903.2	49.8
263	440,363.9	3,671,911.5	51.7
264	440,498.8	3,671,894.9	48.4
265	440,704.1	3,671,907.9	47.4
266	440,670.6	3,671,896.8	47.5
267	441,167.9	3,671,895.3	55.4
268	441,265.7	3,671,893.3	55.9
269	440,357.0	3,671,876.8	51.2
270	440,744.0	3,671,881.4	47.9
271	440,277.0	3,671,867.5	57.5
272	440,643.1	3,671,879.3	47.9
273	440,678.5	3,671,868.4	47.9
274	441,259.4	3,671,875.2	56.3
275	440,349.2	3,671,848.1	51.7
276	440,648.9	3,671,860.4	48.3
277	441,014.6	3,671,857.6	51.2
278	440,798.9	3,671,852.4	46.6
279	441,442.6	3,671,842.0	58.6
280	441,306.0	3,671,848.9	57.6
281	441,243.4	3,671,846.4	57.6
282	441,419.3	3,671,839.2	58.5
283	441,527.7	3,671,843.1	61.4
284	440,675.1	3,671,835.3	47.4
285	440,624.0	3,671,834.3	47.3
286	441,503.7	3,671,825.5	58.9
287	441,336.4	3,671,827.4	57.1
288	441,471.1	3,671,821.2	58.5

Table D-3. Location and Elevations of Ash Piles (continued)

Pile ID No.	Easting UTM	Northing UTM	Elevation NAD27
289	440,757.4	3,671,808.9	46.6
290	441,051.6	3,671,816.1	52.6
291	440,670.8	3,671,818.9	46.7
292	441,119.6	3,671,812.4	55.0
293	440,196.8	3,671,817.4	59.7
294	441,175.3	3,671,807.8	55.3
295	440,331.9	3,671,798.5	53.0
296	441,432.3	3,671,808.0	57.3
297	440,641.6	3,671,807.9	47.2
298	440,355.2	3,671,759.7	53.8
299	440,250.8	3,671,778.5	57.3
300	440,428.2	3,671,782.2	50.0
301	441,498.2	3,671,795.6	63.5
302	440,630.1	3,671,794.8	46.3
303	441,382.2	3,671,785.8	56.7
304	440,933.4	3,671,783.0	46.6
305	441,369.4	3,671,777.6	56.1
306	441,541.1	3,671,784.1	59.9
307	440,160.2	3,671,777.1	59.8
308	440,625.1	3,671,780.5	46.1
309	441,236.3	3,671,762.2	53.3
310	440,294.8	3,671,744.7	56.0
311	440,332.6	3,671,753.1	54.7
312	440,609.8	3,671,760.0	46.3
313	440,551.4	3,671,755.3	46.7
314	441,303.7	3,671,751.2	55.1
315	441,377.8	3,671,745.8	57.7
316	440,619.5	3,671,744.1	46.2
317	440,713.2	3,671,718.7	46.1
318	440,624.4	3,671,729.9	46.6
319	441,030.7	3,671,721.5	49.4
320	440,426.5	3,671,709.8	49.0
321	440,534.6	3,671,719.8	47.5

Table D-3. Location and Elevations of Ash Piles (continued)

Pile ID No.	Easting UTM	Northing UTM	Elevation NAD27
322	440,558.9	3,671,716.4	46.8
323	440,920.4	3,671,710.3	47.8
324	441,064.4	3,671,708.1	51.5
325	440,527.9	3,671,695.2	47.3
326	441,291.9	3,671,686.2	56.2
327	440,563.8	3,671,679.0	46.2
328	440,995.2	3,671,676.3	51.1
329	441,265.5	3,671,681.0	56.6
330	440,934.5	3,671,684.8	50.4
331	441,149.3	3,671,680.5	53.0
332	441,349.3	3,671,680.7	59.1
333	441,202.5	3,671,678.5	55.2
334	440,643.9	3,671,648.0	46.0
335	441,324.6	3,671,672.7	57.8
336	440,536.8	3,671,663.5	47.1
337	440,896.3	3,671,664.2	53.1
338	440,948.4	3,671,663.7	51.1
339	441,264.8	3,671,648.8	58.0
340	441,094.2	3,671,648.5	54.3
341	441,361.7	3,671,637.0	58.3
342	441,193.3	3,671,639.1	56.3
343	441,249.2	3,671,641.8	57.3
344	440,886.4	3,671,634.3	53.3
345	441,007.1	3,671,633.7	52.7
346	441,037.9	3,671,629.4	53.3
347	440,912.1	3,671,619.3	53.0
348	440,990.8	3,671,618.8	53.0
349	440,258.8	3,671,605.7	58.6
350	440,965.5	3,671,595.4	53.7
351	440,417.5	3,671,579.1	49.8
352	440,995.1	3,671,591.8	53.7
353	440,590.7	3,671,600.1	45.5
354	440,441.3	3,671,578.3	48.7

Table D-3. Location and Elevations of Ash Piles (continued)

Pile ID No.	Easting UTM	Northing UTM	Elevation NAD27
355	440,593.0	3,671,581.1	45.2
356	440,260.3	3,671,579.2	58.9
357	440,330.8	3,671,571.9	55.3
358	441,198.0	3,671,569.9	58.0
359	440,314.5	3,671,546.8	56.0
360	441,070.5	3,671,548.3	56.0
361	440,647.2	3,671,532.6	44.1
362	441,091.3	3,671,534.0	56.8
363	440,370.4	3,671,535.7	54.5
364	440,887.8	3,671,526.9	56.1
365	441,012.3	3,671,519.2	56.4
366	441,252.5	3,671,524.1	60.3
367	441,081.3	3,671,511.9	56.6
368	440,647.4	3,671,491.9	44.5
369	440,419.2	3,671,492.8	52.0
370	441,143.7	3,671,509.0	57.2
371	441,110.1	3,671,505.7	56.9
372	441,231.6	3,671,495.1	58.6
373	440,352.7	3,671,501.1	55.6
374	440,815.8	3,671,503.8	55.3
375	440,924.0	3,671,488.8	56.2
376	440,967.9	3,671,492.7	56.5
377	441,122.1	3,671,499.6	56.8
378	441,068.2	3,671,485.2	56.5
379	440,769.6	3,671,476.0	53.8
380	441,172.6	3,671,489.6	57.1
381	440,816.6	3,671,476.9	55.4
382	441,259.4	3,671,472.1	59.8
383	440,618.5	3,671,453.8	45.2
384	441,139.2	3,671,460.6	56.9
385	440,853.5	3,671,461.2	55.2
386	440,820.1	3,671,447.7	54.7
387	440,455.4	3,671,440.7	50.7

Table D-3. Location and Elevations of Ash Piles (continued)

Pile ID No.	Easting UTM	Northing UTM	Elevation NAD27
388	440,371.6	3,671,436.9	56.1
389	441,197.3	3,671,432.4	58.0
390	440,748.6	3,671,435.1	51.6
391	440,261.9	3,671,428.6	59.8
392	440,323.6	3,671,412.5	57.8
393	440,779.5	3,671,421.2	52.0
394	440,962.5	3,671,413.6	53.0
395	440,282.7	3,671,396.7	59.5
396	440,884.5	3,671,406.4	51.2
397	441,200.0	3,671,393.4	57.8
398	440,735.4	3,671,386.0	48.1
399	440,345.7	3,671,380.3	56.
400	441,064.9	3,671,390.9	55.3
401	440,416.0	3,671,384.4	52.2
402	441,115.8	3,671,387.1	56.9
403	441,096.0	3,671,371.2	56.5
404	441,180.4	3,671,377.2	57.6
405	441,045.5	3,671,368.3	54.3
406	441,194.6	3,671,368.0	58.0
407	440,822.7	3,671,358.8	49.0
408	440,996.9	3,671,350.5	52.7
409	440,412.8	3,671,364.0	52.0
410	440,937.8	3,671,348.4	50.2
411	440,977.7	3,671,351.3	52.5
412	440,726.7	3,671,341.9	45.4
413	440,368.6	3,671,337.7	54.6
414	441,210.2	3,671,327.8	58.0
415	440,966.1	3,671,323.7	52.7
416	441,107.4	3,671,325.7	56.9
417	441,174.2	3,671,321.4	58.1
418	440,723.6	3,671,309.7	45.7
419	440,417.9	3,671,313.2	53.5
420	440,983.8	3,671,303.8	53.4

Table D-3. Location and Elevations of Ash Piles (continued)

Pile ID No.	Easting UTM	Northing UTM	Elevation NAD27
421	441,116.4	3,671,302.3	57.4
422	441,043.0	3,671,301.9	55.1
423	440,709.2	3,671,290.4	45.6
424	440,326.6	3,671,284.3	57.8
425	441,065.4	3,671,290.6	55.8
426	441,088.4	3,671,284.6	56.7
427	441,211.9	3,671,286.9	58.7
428	440,395.3	3,671,258.9	55.0
429	440,746.5	3,671,270.5	45.4
430	440,712.7	3,671,259.3	45.5
431	440,467.7	3,671,248.7	52.5
432	440,914.9	3,671,247.4	48.9
433	440,356.6	3,671,246.7	57.1
434	440,761.6	3,671,256.7	45.3
435	440,281.8	3,671,241.9	60.1
436	440,691.6	3,671,250.0	45.3
437	440,965.8	3,671,239.1	53.6
438	440,989.5	3,671,227.9	54.3
439	440,749.8	3,671,228.8	44.7
440	440,707.8	3,671,205.2	44.6
441	440,956.0	3,671,194.7	53.7
442	440,727.0	3,671,206.0	44.7
443	440,923.8	3,671,207.3	51.4
444	440,468.6	3,671,195.8	53.6
445	440,394.8	3,671,199.5	56.6
446	441,002.8	3,671,195.4	56.9
447	440,845.7	3,671,184.5	48.0
448	440,863.7	3,671,177.8	49.0
449	440,490.3	3,671,170.3	54.0
450	440,942.7	3,671,150.3	55.9
451	441,002.6	3,671,150.0	59.3
452	440,535.9	3,671,130.1	52.1
453	440,891.8	3,671,141.6	52.6

Table D-3. Location and Elevations of Ash Piles (continued)

Pile ID No.	Easting UTM	Northing UTM	Elevation NAD27
454	440,392.2	3,671,139.4	58.6
455	440,779.7	3,671,139.7	45.9
456	440,993.6	3,671,133.6	59.2
457	440,730.9	3,671,117.3	44.5
458	440,883.1	3,671,119.8	53.6
459	440,402.8	3,671,100.5	58.3
460	440,501.0	3,671,115.2	54.4
461	440,743.8	3,671,104.0	44.3
462	440,456.2	3,671,109.0	55.3
463	440,702.7	3,671,111.2	43.9
464	440,876.9	3,671,097.5	53.8
465	440,824.9	3,671,088.4	48.8
466	440,538.6	3,671,086.5	52.7
467	440,387.5	3,671,065.6	60.3
468	440,501.0	3,671,069.3	53.3
469	440,480.9	3,671,059.9	54.4
470	440,567.7	3,671,045.6	50.9
471	440,518.7	3,671,044.7	52.4
472	440,837.0	3,671,027.4	49.0
473	440,551.5	3,671,023.3	50.1
474	440,905.7	3,671,022.4	55.3
475	440,484.4	3,671,006.7	52.8
476	440,827.4	3,671,007.0	47.2
477	440,395.0	3,671,003.5	59.7
478	440,593.5	3,671,000.0	49.0
479	440,516.9	3,670,998.5	50.5
480	440,848.7	3,670,998.1	48.9
481	440,875.2	3,670,992.4	49.4
482	440,387.4	3,670,950.2	59.9
483	440,535.5	3,670,959.0	47.0
484	440,455.0	3,670,941.5	49.5
485	440,472.7	3,670,953.5	48.0
486	440,566.4	3,670,949.8	47.2

Table D-3. Location and Elevations of Ash Piles (continued)

Pile ID No.	Easting UTM	Northing UTM	Elevation NAD27
487	440,361.3	3,670,946.0	60.6
488	440,480.2	3,670,945.3	46.7
489	440,573.5	3,670,918.4	45.6
490	440,983.5	3,670,930.8	56.9
491	440,755.4	3,670,914.7	44.2
492	440,440.6	3,670,912.5	50.3
493	440,857.6	3,670,890.2	46.9
494	440,459.3	3,670,871.9	46.5
495	440,369.9	3,670,864.8	57.7
496	440,427.1	3,670,849.1	50.8
497	440,494.3	3,670,850.6	46.1
498	440,341.3	3,670,850.2	58.8
499	440,746.4	3,670,848.4	42.1
500	440,842.2	3,670,837.8	45.9
501	440,522.8	3,670,824.6	43.8
502	440,552.8	3,670,825.7	42.2
503	440,822.2	3,670,824.9	45.9
504	440,444.2	3,670,818.2	49.3
505	440,544.5	3,670,803.2	43.0
506	440,339.4	3,670,800.2	56.6
507	440,948.2	3,670,770.0	56.7
508	440,557.6	3,670,756.4	43.5
509	440,407.0	3,670,746.8	52.0
510	440,750.8	3,670,671.8	49.7
511	440,536.5	3,670,640.0	48.6
512	440,880.3	3,670,619.2	56.9
513	440,818.2	3,670,609.7	52.6
514	440,507.4	3,670,610.8	48.6
515	440,792.7	3,670,603.0	49.7
516	440,464.8	3,670,602.1	49.7
517	440,776.6	3,670,507.3	48.8
518	440,508.5	3,670,500.5	49.4
519	440,754.1	3,670,486.6	47.5

Table D-3. Location and Elevations of Ash Piles (continued)

Pile ID No.	Easting UTM	Northing UTM	Elevation NAD27
520	440,456.8	3,670,468.5	51.5
521	440,495.3	3,670,453.6	48.2
522	440,771.1	3,670,421.3	48.9
523	440,516.0	3,670,420.5	47.5
524	440,916.9	3,670,409.0	56.7
525	440,446.5	3,670,419.3	51.7
526	440,863.2	3,670,401.2	49.7
527	440,440.1	3,670,378.8	52.5
528	440,867.0	3,670,348.7	52.8
529	440,899.7	3,670,335.0	56.1
530	440,830.2	3,670,352.2	49.0
531	440,786.1	3,670,328.3	48.1
532	440,831.3	3,670,310.2	49.6
533	440,855.5	3,670,305.9	53.2
534	440,350.0	3,670,287.9	55.0
535	440,824.4	3,670,282.2	46.8
536	440,856.9	3,670,277.6	53.7
537	440,351.2	3,670,255.7	53.8
538	440,868.6	3,670,252.9	56.4
539	440,781.1	3,670,225.1	49.7
540	440,442.7	3,670,198.3	46.9
541	441,476.3	3,670,212.0	59.1
542	441,451.8	3,670,202.0	58.1
543	441,339.1	3,670,192.5	55.7
544	440,397.3	3,670,189.1	49.6
545	441,138.1	3,670,175.4	51.8
546	441,158.8	3,670,174.2	51.2
547	441,193.5	3,670,174.6	52.6
548	441,371.0	3,670,164.6	55.3
549	441,434.9	3,670,166.8	57.3
550	441,101.7	3,670,167.1	53.1
551	441,348.2	3,670,164.2	54.5
552	441,234.0	3,670,151.7	52.0

Table D-3. Location and Elevations of Ash Piles (continued)

Pile ID No.	Easting UTM	Northing UTM	Elevation NAD27
553	441,072.7	3,670,147.2	52.4
554	441,299.9	3,670,115.0	55.0
555	441,190.4	3,670,110.3	51.5
556	441,433.5	3,670,110.7	60.3
557	441,243.0	3,670,097.2	53.2
558	441,053.4	3,670,075.3	48.1
559	441,197.5	3,670,079.4	53.2
560	440,431.7	3,670,061.8	47.9
561	441,168.7	3,670,032.7	53.7
562	441,243.2	3,670,025.4	56.7
563	441,128.7	3,670,023.1	50.7
564	441,314.7	3,669,992.4	58.8
565	441,327.2	3,669,956.0	59.6
566	441,169.5	3,669,948.0	57.6
567	440,879.6	3,669,909.1	46.6
568	440,821.1	3,669,885.7	48.7
569	440,867.9	3,669,878.0	46.6
570	440,896.0	3,669,852.2	45.7
571	440,815.0	3,669,861.0	48.2
572	440,819.2	3,669,834.0	48.6
573	440,897.6	3,669,807.0	46.0
574	441,262.8	3,669,803.4	58.2
575	440,844.8	3,669,795.7	47.4
576	440,862.3	3,669,775.2	46.5
577	441,327.9	3,669,779.9	60.4
578	440,871.1	3,669,755.4	45.2
579	441,317.3	3,669,694.2	58.5
580	441,333.8	3,669,678.7	59.0
581	441,209.5	3,669,660.8	47.3
582	441,192.0	3,669,616.1	46.9
583	441,294.9	3,669,583.7	57.7
584	441,326.7	3,670,156.9	54.1

Table D-4. Location and Elevations of Potential Waste Units

Unit ID No.	Easting UTM	Northing UTM	Elevation NAD27
9	441,134.7	3,669,895.8	57.3
10	440,916.8	3,670,896.3	49.2
11	441,096.1	3,672,570.1	58.1
31	440,959.7	3,670,149.2	50.1
51	441,196.6	3,669,572.1	53.7
54	441,245.1	3,669,896.3	59.1
55	441,018.1	3,669,694.4	45.4
56	441,099.4	3,669,762.0	52.9
60	440,485.6	3,669,877.8	55.1
62	440,681.8	3,669,385.9	53.4
63	440,578.0	3,669,586.1	57.2

Table D-5. Location and Elevations of Debris Piles

Pile ID No.	Easting UTM	Northing UTM	Elevation NAD27
2	441,191.1	3,672,684.7	59.3
3	440,827.3	3,670,602.1	53.8
4	440,400.5	3,672,171.1	55.9
5	441,051.1	3,671,253.7	55.9
6	440,841.7	3,672,854.4	58.8
7	440,822.1	3,672,248.2	54.9
8	440,843.6	3,672,350.4	55.5
9	440,310.9	3,671,293.7	58.4
10	440,381.2	3,671,009.8	61.0
11	441,203.9	3,671,891.7	56.2
12	441,137.9	3,670,214.0	56.2
13	440,379.2	3,669,856.4	60.5
14	440,340.3	3,670,380.2	58.2

Table D-6. Location and Elevations of Borrow Pits

Pit ID No.	Easting UTM	Northing UTM	Elevation NAD27
1	441,565.0	3,673,381.8	53.9
2	440,811.0	3,669,448.2	48.5
3	440,506.9	3,669,463.5	59.1
4	440,858.2	3,671,575.3	49.3

Table D-7. Location and Elevations of Fish Structures

Structure ID No.	Easting UTM	Northing UTM	Elevation NAD27
7	440,257.2	3,669,873.6	61.2
8	440,231.1	3,669,891.1	59.4
9	440,221.2	3,669,924.4	59.6
10	440,225.1	3,669,943.9	61.6
11	440,222.2	3,669,951.9	65.7
12	440,308.7	3,670,061.3	59.6
13	440,321.0	3,670,130.9	58.9
14	440,319.9	3,670,149.6	58.4
15	440,314.4	3,670,166.9	58.4
16	440,312.4	3,670,183.6	58.2
17	440,308.4	3,670,197.9	58.7
18	440,290.9	3,670,333.6	59.7
19	440,373.6	3,670,767.2	55.0
20	440,354.7	3,670,763.8	55.1
21	440,371.5	3,670,785.7	54.9
22	440,361.3	3,670,775.1	54.8
23	440,345.2	3,670,781.6	55.9
25	440,440.6	3,671,114.5	56.1
27	441,010.2	3,671,196.2	56.9
27	440,828.9	3,670,601.7	54.1
28	440,906.4	3,670,789.8	54.5
29	440,927.0	3,670,375.2	57.9
30	441,038.7	3,670,215.4	56.4
31	441,187.0	3,670,232.1	57.1

Table D-7. Location and Elevations of Fish Structures (continued)

Structure ID No.	Easting UTM	Northing UTM	Elevation NAD27
32	441,178.7	3,670,225.4	56.8
34	441,229.0	3,669,715.9	54.9
35	441,237.2	3,669,698.4	54.5

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