

**EF3 COL 2.0-28-A**

**2.5.3 Surface Faulting**

[Subsection 2.5.3](#) contains an evaluation of the potential for tectonic and nontectonic surface deformation at the Fermi 3 site. Information contained in this subsection, which was developed in accordance with Regulatory Guides 1.165 and 1.208, is intended to demonstrate compliance with 10 CFR 100.23, Geologic and Seismic Siting Criteria.

This subsection contains the following information:

- Potential surface deformation associated with capable tectonic sources.
- Potential surface deformation associated with nontectonic processes, such as glaciotectonic deformation, unloading (pop-ups), subsurface salt migration (salt domes), growth faults, dissolution and collapse (karst-related), volcanism, and man-induced deformation (e.g., mining collapse, subsidence due to fluid withdrawal).

The conclusions regarding the potential for surface deformation are summarized as follows:

- There are no capable tectonic fault sources within the site area (8-km [5-mi] radius) or vicinity (40-km [25-mi] radius). A capable tectonic source, as defined by Regulatory Guide 1.208, is a tectonic structure that can generate both vibratory ground motion and tectonic surface deformation, such as faulting or folding at or near the earth's surface in the present seismotectonic regime. There is no evidence of Quaternary tectonic surface faulting or fold deformation within the Fermi 3 site location (1-km [0.6-mi] radius).
- The potential for nontectonic deformation at the site is negligible.

The following subsections provide the data, observations, and reference citations to support these conclusions.

**2.5.3.1 Geological, Seismological, and Geophysical Investigations**

Information regarding the potential for surface faulting at the Fermi 3 site is documented in the following sources:

- Previous site investigations described in the Fermi 2 UFSAR, Section 2.5 ([Reference 2.5.3-201](#))
- Published and unpublished literature and data on structures and tectonics in southeast Michigan and northwest Ohio as discussed in [Subsection 2.5.1.1.4](#) and [Subsection 2.5.1.2.4](#)

- Seismicity data compiled and analyzed in publications and the updated seismicity catalog ([Subsection 2.5.2.1](#))

Additional investigations performed to assess the potential for future surface faulting and related deformation at the Fermi 3 site and surrounding site area included the following:

- Compilation and review of available site area data, with an emphasis on reports and information published since the original geologic investigation for the Fermi 2 FSAR and site-specific information collected for the Fermi 3 COLA. Mapped bedrock structures in the site vicinity are shown on [Figure 2.5.3-201](#).
- Interpretation of aerial photographs and remote sensing imagery. The most detailed topographic data available for the site vicinity (40-km [25-mi] radius from the site) is the USGS 10-m digital elevation model (DEM). A shaded relief model created using the DEM was used to conduct a visual lineament analysis for the site vicinity
- and to evaluate the elevations of paleoshoreline features across the site vicinity. In the site area (within the 8-km [5-mi] radius) U.S. Department of Agriculture (USDA) 1:20,000-scale, black and white photos from 1955 also were used in field reconnaissance and to aid in identifying potential lineaments. Color infrared aerial photographs with a two meter resolution of the site location also were used to identify lineaments. Observations based on the lineament analyses are discussed in [Subsection 2.5.3.2.3](#) and observations based on the elevations of paleoshoreline features are discussed in [Subsection 2.5.1.2.3.2](#).
- Field and aerial reconnaissance. Field investigations were conducted during August 2007, and involved consultations and field trips with local experts, examination of known faults in the site vicinity, examination of well-documented exposures of stratigraphic units as described in previous publications, examination of exposures in quarries, and aerial (helicopter) reconnaissance. Additional field investigations were conducted at Denniston Quarry in 2009 to evaluate the origin and timing of deformation features (paleokarst and minor faults) observed in the Silurian Bass Islands Group. [Figure 2.5.3-202](#) shows field localities visited and the helicopter reconnaissance route.

- Discussions with current researchers in the area. Local experts from the Ohio Geological Survey, the Michigan Geological Survey, the Geological Survey of Canada, and the Ontario Geological Survey were contacted to obtain the latest available information relevant to the site geology and tectonics of the region.

### 2.5.3.2 **Geological Evidence, or Absence of Evidence, for Surface Deformation**

#### 2.5.3.2.1 **Tectonic Deformation**

Based on a review of published literature and maps and field reconnaissance in the site area, there are no faults at or near the ground surface in Quaternary glacial or lacustrine sediments within 40-km (25-mi) of the site. The Fermi 2 UFSAR also concluded, based on a review of available literature, conferences with geological organizations, and onsite investigations, that no known faults exist within 40-km (25-mi) of the Fermi 2 site and that there are no capable faults within 320-km (200-mi) of the site.

No Quaternary faults are known within the site vicinity based on review of more recent publications and data, interpretation of remote sensing imagery (10-m DEM and 1:20,000 aerial photographs) and observations from field and aerial reconnaissance. Review of available data and published interpretations of boring and geophysical data obtained primarily from oil and gas exploration indicates, however, that faults are present within Paleozoic rocks in the subsurface in the site vicinity. The location of known and postulated structures within the site vicinity is shown on [Figure 2.5.3-201](#) and discussed in [Subsection 2.5.1.2.4](#). The Bowling Green fault and the Maumee fault are subsurface bedrock faults mapped within 40-km (25-mi) of the site ([Figure 2.5.1-246](#)). The Howell anticline and associated fault, is mapped to within 45-km (28-mi) of the site. A series of folds are recognized in subsurface bedrock units along the southeastern projected trend of the Howell anticline/fault structure. Two poorly documented possible fault trends, associated with the New Boston and Sumpter oil and gas pools, are postulated along the southwestern flank of this series of folds ([Figure 2.5.1-203](#), [Figure 2.5.1-230](#)). Additional shorter faults are mapped in southwestern Ontario, including two subparallel unnamed faults, one of which is associated with the Colchester oil and gas field. A summary of the evidence for the location, timing, and displacement on these structures is provided in

[Subsection 2.5.1.2.4.1](#) and [Table 2.5.1-201](#)Table 2.5.1-201. Two minor faults, each having less than 1.4 m (4.6 ft) displacement, also are observed in the Silurian Bass Islands Group at the Denniston Quarry, located 16 km (10 mi) south of the Fermi 3 site ([Reference 2.5.1-498](#)). Displacement on one of the two faults dies out within the Bass Islands Group. Although the second fault extends to the top of the Bass Island Group, latest Pleistocene (approximately 13 – 12 ka) Quaternary till and lacustrine deposits overlying the projected trends of both faults are not deformed.

Only one possible fault, the fault trend associated with the Sumpter pool as identified in a 1948 publication by Cohee ([Reference 2.5.1-410](#)) and subsequently postulated as a fault in a 1962 publication by Ells ([Reference 2.5.3-202](#)) (As discussed in [Subsection 2.5.1.2.4.1](#), Ells mislabeled the oil pools from Cohee, associating the label from the Sumpter Pool with the New Boston Pool), extends within the site area (8-km [5-mi] radius). However, as discussed in [Subsection 2.5.1.2.4.1](#), there is no documentation supporting the existence of this postulated structure; the location is known only from a small scale map (approximately one inch = 60 miles) ([Reference 2.5.3-202](#)). The folds, which are defined based on structure contours on the top of the Ordovician Trenton Formation ([Figure 2.5.1-247](#)), have gently dipping limbs (less than 0.9 degrees) and there is nothing in the character of the folds that suggests the folds are fault-cored. The folds are not well expressed in the structure contours on the Trenton Group as illustrated on [Figure 2.5.1-248a](#). The top of the Trenton Formation as recorded in logs for wells located along the traces of the possible faults and in a range of up to 20 km (12.5 mi) of the possible faults records no consistent vertical displacement. Ells does not show these postulated fault trends along the New Boston and Sumpter oil pools on his more recent compilation of fault or fold structures ([Reference 2.5.3-203](#)).

The shallow-dipping northwest-southeast-trending synclinal fold identified based on subsurface investigations for the Fermi 2 site ([Reference 2.5.3-201](#)) and confirmed by additional Fermi 3 borings ([Figure 2.5.1-237](#) and [Figure 2.5.1-249](#)) has a similar orientation to the other fold trends observed in Devonian bedrock units to the north of the site ([Figure 2.5.1-247](#)). These minor folds may be third-order structures that are structurally related to the distal end of the Howell anticline/fault structure as it dies out to the southeast. These minor folds and postulated

faults are assumed to be comparable in age to the Howell anticline/fault structure or other fold structures in the central Michigan Basin that experience most of their folding in the late Mississippian ([Subsection 2.5.1.1.4.3.2.9](#)).

Faults were not identified within the basement rocks or overlying sedimentary strata at the Fermi 2 site ([Reference 2.5.3-201](#)). As noted in the Fermi 2 UFSAR, competent bedrock strata were shown to underlie the site and there are no major solution cavities or zones of solution weathering in the site area. Subsequent to blasting operations during excavation of the Fermi 2 site, the exposed foundation bedrock was sluiced with high-pressure water jets and carefully examined by a qualified geologist to ensure that no excessive natural fracturing or blasting back-break existed that might be unsuitable for foundation support ([Reference 2.5.3-201](#)).

#### 2.5.3.2.2 **Nontectonic Deformation**

Various glacial and periglacial processes may create geomorphic features that mimic surface tectonic fault rupture. The various types of faults observed in glaciated regions are classified into the following categories: ([Reference 2.5.3-204](#))

- **Glacio-isostatic** (commonly referred to as postglacial) faulting that occurs in regions of ice cover in response to changes in the glacial load, either as a result of deglaciation (crustal unloading) or glacial advance (crustal loading)
- **Glaciotectonic** faulting used to denote any deformation resulting from ice movement (ice push or ice drag)
- **Periglacial** faulting resulting from freeze-thaw processes
- **Shallow stress-relief** faulting resulting in formation of pop-up structures. Shallow stress-relief structures due to glacial loading/unloading will be spatially and temporally associated with the extent and timing of glaciers. Shallow stress-relief faulting also can result from non-glacial unloading mechanisms, both natural (i.e., erosion) and cultural (i.e., quarrying). Both mechanisms result from the relief of shallow stress in the regional compressive stress regime.

A summary of the characteristics of these types of structures and criteria for differentiating them from tectonic surface faulting is provided in Hanson et al. ([Reference 2.5.3-204](#)).

No evidence of surface deformation related to any of these mechanisms has been reported in the publications reviewed or was observed in the site area during the field reconnaissance investigation. [Subsection 2.5.1.1.3.3](#) of the Fermi 2 UFSAR and [Subsection 2.5.1.2.6.3](#) of the Fermi 3 FSAR state that actual pop-ups have not been noted in southeastern Michigan or adjacent portions of Ohio, Indiana, or Canada, but surficial folding of Devonian shales has been observed in northwestern Ohio. During the excavation process for Fermi 2, no rockbursts, pop-ups, or heaves were seen. This was attributed to a lack of compressive stresses and insufficient depth of excavation to reduce lithostatic loading sufficiently to cause such features to occur ([Reference 2.5.3-201](#)).

Other nontectonic mechanisms that have produced surface deformation, recognized elsewhere in the Michigan Basin region, are related to dissolution of carbonate rock leading to collapse and subsidence and dissolution and movement of salt bodies. Karst related problems have been reported for the (320-km [200-mi] radius) site region; in northwestern Ohio and adjacent Indiana and southeastern Michigan karst occurs in Silurian-age limestones and dolomites. As noted in [Subsection 2.5.1.1.5](#), certain problems have been identified in northwestern Ohio where the carbonate rocks are covered by less than 6 m (20 ft) of glacial deposits. Evaporative karst (karst in halite or gypsum deposits) occurs in the central portion of the Michigan Basin. However, as noted in [Subsection 2.5.1.2.6.7.3](#), no salt deposits exist in the (8-km [5-mi] radius) site area. Based on descriptions of voids and soft rock conditions encountered in the Fermi 2 borings ([Reference 2.5.3-201](#)) and Fermi 3 borings ([Subsection 2.5.1.2.3](#)), no major solution cavities or zones of solution weathering were encountered during subsurface investigations at the Fermi site.

#### 2.5.3.2.3 Results of Lineament Analyses

Faults and fractures can be expressed at the surface in a variety of ways, including regional lineaments, linear drainage lines, abrupt or anomalous changes in stream direction, vegetation changes, soil changes, changes in drainage density, abrupt topographic changes or scarps, and changes in land use. Lineaments can also be nontectonic in origin, relating to differential erosion, beach ridge formation, soil-type changes related to stratigraphic facies variations, and cultural features. Two different types of remote sensing imagery were used to identify lineaments in the site

vicinity and site area. Hillshade models, based on the USGS 10-m digital elevation model (DEM), were used to identify topographic and linear stream segments in the site vicinity. Interpreted and uninterpreted hillshade model maps are shown on [Figure 2.5.3-203](#) and [Figure 2.5.3-204](#), respectively. Within the 8-km (5 mi) site area, 1:20,000-scale black and white stereo aerial photograph pairs also were interpreted. Interpreted and uninterpreted aerial photograph mosaics are shown on [Figure 2.5.3-205](#) and [Figure 2.5.3-206](#), respectively. Lineaments identified in the 1955 aerial photographs were also compared to more recent color infrared aerial photographs of the site location ([Figure 2.5.3-207](#) and [Figure 2.5.3-208](#)). [Figure 2.5.3-209](#) presents recent color infrared aerial photographs for the site location.

As shown on [Figure 2.5.3-203](#), there are numerous topographic lineaments in the site vicinity that are evident on hillshade models derived from the USGS 10-m DEM. Most of the lineaments either coincide with linear stream segments or are shore-parallel lineations that appear to coincide with mapped paleo-shoreline features designated by  $n_1$ ,  $n_2$ , and  $n_3$  on [Figure 2.5.3-203](#) (see [Subsection 2.5.1.2.3.2.1](#) for discussion of paleoshoreline features). The majority of the lineaments generally trend N30W to N60W. Other trends are E-W, N-S, N30E, and N70E. These trends are consistent with regional joint and fracture trends described in [Subsection 2.5.1.2.4.3](#). The dominant trends of joints in the Bass Islands Group are N45° to 60°W and N40° to 50°E and are nearly vertical in dip ([Reference 2.5.3-201](#)). Mapping of the excavation for the Fermi 2 reactor/auxiliary building indicated trends of N45° to 60°W and N60° to 50°E.

Many of the lineaments parallel the trend of the Howell Anticline, N40° to 60°W. The subsurface Sumpter Pool and New Boston Pool possible faults ([Reference 2.5.3-202](#)) located to the north and west of the site also trend approximately N40W. However, with the possible exception of the possible New Boston Pool fault, none of the identified structures directly coincide with the identified lineaments. The postulated Sumpter Pool fault is not coincident with a mapped lineament, although a short segment of Swan Creek approximately 2.4 km (1.3 mi) to the north does subparallel the postulated structure. A regional joint trend also subparallels the orientation of this segment of Swan Creek and segments of other streams in the site area. Thus, the orientation of this linear segment of Swan Creek may be controlled by a regional joint trend. There is no

geomorphic evidence of recent surface deformation along any of the identified or postulated structures.

The actual channels of the drainages are very sinuous and appear to follow both northwest- and northeast-trending fracture and joint trends observed in bedrock elsewhere in the site area. However, bedrock in the site area generally is mantled by several meters of Quaternary glacial and glacio-lacustrine sediments, and it is not clear that present drainage channels are controlled by bedrock structure. Glacial (subglacial meltwater channels) and post-glacial shoreline features also may have influenced present drainage patterns.

Paleo-shoreline features cross the trend of the postulated Sumpter Pool and New Boston Pool possible fault trends with no apparent disruption ( $n_3$  on [Figure 2.5.3-203](#),). A series of maps highlighting different contour interval ranges, as well as a series of topographic profiles was developed from the USGS 10-m DEM to evaluate the continuity and variability of paleo-shoreline features across the site vicinity and mapped locations of the Sumpter Pool and New Boston Pool possible faults. [Figure 2.5.3-210](#) and [Figure 2.5.3-213](#) provide maps highlighting contour interval ranges of 2 m and 0.5 m, and showing the locations of a series of topographic profiles that are provided on [Figure 2.5.3-211](#), [Figure 2.5.3-212](#), and [Figure 2.5.3-214](#).

Shoreline features ( $n_1$ ,  $n_2$ , and  $n_3$ ) ([Figure 2.5.3-201](#)) identified in the lineament analysis correlate to the Lake Wayne strandline ( $n_1$ ), Lake Warren I and II strandlines ( $n_2$ ), and the Whittlesey strandline or highest Arkona strandline ( $n_3$ ). The elevations of specific features associated with mapped shorelines (e.g., the top of apparent deltas formed at the intersection of major drainages and the highest Arkona shoreline, which are all at consistent elevations of 216 – 218 m), indicate the absence of significant vertical deformation across the site vicinity since formation of the features shortly before about 13,000 years BP ([Figure 2.5.3-210](#), [Figure 2.5.3-211](#) and [Figure 2.5.3-212](#)). Geomorphic surfaces associated with the Arkona deltas, and the Warren and younger strandlines that formed at progressively lower levels are most easily correlated across the site vicinity.

Evidence for the absence of tilting and/or localized differential vertical movement across possible faults mapped in the site vicinity is illustrated by [Figure 2.5.3-213](#) and [Figure 2.5.3-214](#). The locations of topographic profiles on opposite sides of the Sumpter Pool and New Boston Pool



possible faults are shown on [Figure 2.5.3-213](#), with the topographic profiles shown on [Figure 2.5.3-214](#). The topographic profiles in [Figure 2.5.3-214](#) show three surfaces associated with the Grassmere Lake level (approximately 195 m (640 ft)). The elevations of the three surfaces are indicated on [Figure 2.5.3-213](#) in pink for elevations 193.6 – 194 m (635 - 636 ft) in white for elevations 194.6 – 195 m (638 – 640 ft), and in black for elevations 196.1 – 196.5 m (643 – 645 ft), with these surfaces separated by slight risers (blue intervals). The brown band in [Figure 2.5.3-214](#) corresponds to the range in estimated elevations from 193.6 to 196.5 m (635 – 645 ft) for the Grassmere Lake levels. The three surfaces identified on the topographic profiles; all lie within the brown band representing the estimated elevation range of Grassmere Lake ([Figure 2.5.3-214](#)).

The topographic profiles illustrate that although the published locations of the the individual shorelines may not consistently follow the same feature, the morphology of the features associated with the mapped shorelines is similar, and that these features occur at similar elevations across the postulated Sumpter Pool and New Boston Pool faults.

The majority of the surficial deposits and geomorphic surfaces in the site area are between 13,000 and 12,000 years old. These deposits, while not ideal for detecting long-term neotectonic strain deformation (on the order of hundreds of thousands of years), do provide a relatively complete postglacial and Holocene record across the entire site area and site vicinity. The USDA 1:20,000-scale color stereo photographs were examined to assess whether or not any significant structural trends could be identified. As shown on [Figure 2.5.3-205](#), there are several WNW- to NNW-trending lineaments in the site area. The lineaments generally consist of aligned linear features that include linear tonal contrasts, linear drainages, linear breaks in slope (e.g., the back edges of flood plains and alluvial terraces). The observed trends are consistent with the trends of the topographic lineaments identified in the site vicinity ([Figure 2.5.3-203](#)) and the lineaments are inferred to be the result of surficial erosional processes. No evidence was observed that would indicate the presence of post-glacial surface faulting or ongoing differential vertical tectonic deformation.

### 2.5.3.3 **Correlation of Earthquakes with Capable Tectonic Sources**

There have been no historically reported earthquakes or alignments of earthquakes within 40-km (25-mi) of the site that can be associated with a mapped bedrock fault ([Subsection 2.5.2.1](#) and [Figure 2.5.2-203](#)).

### 2.5.3.4 **Ages of Most Recent Deformations**

The major deformation on bedrock structures in the site vicinity appears to have occurred during the Paleozoic and most faults in the region are believed to have been dormant since late Paleozoic time, at least 200 million years ago ([Reference 2.5.3-201](#); [Figure 2.5.1-201](#) and [Subsection 2.5.1.1.4.3](#)). Earthquakes in the region are generally shallow events associated with reactivated Precambrian faults favorably oriented in the modern northeast-southwest compressive stress regime ([Reference 2.5.3-205](#), [Reference 2.5.3-206](#)). None of these events has associated surface rupture, and no faults in the site region exhibit evidence of movement since the Paleozoic. Evidence for Mesozoic extension resulting in reactivation of Precambrian rifts is present in the Mississippi embayment and the St. Lawrence Valley system, but is not reported in the site region. While it is acknowledged that there is a limited stratigraphic record of the Mesozoic in the site region ([Subsection 2.5.1.1.2.3.2](#)), there are no Mesozoic plutons or known rift-related sediments to suggest that Mesozoic extension affected the region. No evidence of paleoliquefaction is reported in the literature or was observed within the site vicinity or site region. Quaternary cover consists of glacial till and overlying lacustrine sediments of late Wisconsinan age (approximately 12,000 years BP, [Subsection 2.5.1.1.2.3.4.4](#)). No geomorphic expression of deformation of the broad, lacustrine plain overlying mapped or postulated faults in the site vicinity was observed during field or aerial reconnaissance. Paleo-shoreline features associated with the strandlines of the late glacial lakes are not vertically deformed across the mapped or postulated faults.

### 2.5.3.5 **Relationship of Tectonic Structures in the Site Area to Regional Tectonic Structures**

Second-order fold deformation of Silurian and Devonian age bedrock is recognized and documented at the Fermi 3 site. The exact timing of this deformation is not known, but it is likely that it occurred concurrently with deformation on other related northwest-trending plunging structures in

the southeastern part of the Michigan Basin that are referred to as the Washtenaw anticlinorium structures (including the Howell anticline/fault structure). In the Washtenaw anticlinorium region folding is recognized in Ordovician through late Mississippian bedrock units ([Reference 2.5.3-202](#), [Reference 2.5.3-203](#)). This series of folds along the southeastern margin of the Michigan Basin spatially coincides with the Mid-Michigan gravity high (MGA), which is associated with a Precambrian basement rift zone, the Midcontinent rift system ([Figure 2.5.1-220](#)).

#### 2.5.3.6 Characterization of Capable Tectonic Sources

A “capable tectonic source,” as defined by Regulatory Guide 1.208, is described by at least one of the following characteristics:

- Presence of surface or near-surface deformation of landforms or geologic deposits of a recurring nature within the last approximately 500,000 years, or at least once in the last approximately 50,000 years.
- A reasonable association with one or more moderate to large earthquakes or sustained earthquake activity that are usually accompanied by significant surface deformation.
- Structural association with a capable tectonic source having characteristics of either of the above two bullets, such that movement on one could be reasonably expected to be accompanied by movement on the other.

None of the mapped bedrock faults within a 40-km (25-mi) radius or lineaments within an 8-km (5-mi) radius of the Fermi 3 site is assessed to be a capable tectonic source. Stratigraphy that could be used to demonstrate the absence of multiple episodes of deformation during the past 500,000 years is not present in the site vicinity. There is, however, evidence to demonstrate the absence of latest Pleistocene to Holocene deformation. Geomorphic evidence suggests that late Wisconsinan till and the mantle of lacustrine deposits associated with late glacial lakes (13 to 12 ka) have not been deformed. Late glacial lake strandline features and depositional units are not tilted and/or displaced vertically across the possible Sumpter Pool and New Boston Pool faults (see [Subsection 2.5.3.2.3](#) and [Subsection 2.5.3.4](#)). The top of bedrock identified in oil and gas exploratory wells located on both sides and between the postulated Sumpter Pool and New Boston Pool faults is at a

similar elevation (see [Subsection 2.5.1.2.4](#)). There is no surface expression of faulting in the lacustrine plain across any of the mapped or postulated bedrock faults in the site vicinity (see [Subsection 2.5.3.2.3](#)). Till of probable late Wisconsinan age and overlying sand deposits that cross the projected trends of minor faults and paleo-karst features observed in the Bass Islands Group at the Denniston Quarry are not deformed (see [Subsection 2.5.3.1](#)).

Consideration of the other criteria used to assess fault capability (i.e., association with seismicity or structures with a capable tectonic source) does not indicate that structures in the site vicinity are capable tectonic sources. There is an absence of moderate-to-large earthquakes or alignments of seismicity in the site vicinity (see [Subsection 2.5.3.3](#)) that could suggest the presence of a capable tectonic source. Very few earthquakes are within 80 km (50 mi) of the Fermi site ([Figure 2.5.2-203](#)), and there is no known evidence for paleoearthquakes in the site region. Paleoliquefaction studies, which have focused on the areas of more concentrated seismicity, such as the Northeast Ohio seismic zone and the Anna seismic zone, have not identified evidence for large-magnitude earthquakes (see [Subsection 2.5.1.1.4.3.3.1](#) and [Subsection 2.5.1.1.4.3.3.2](#)). Significant tectonic deformation on structures in the southeastern part of the Michigan Basin that are referred to as the Washtenaw anticlinorium structures (including the Howell anticline/fault structure) occurred in the Paleozoic ([Reference 2.5.3-202](#), [Reference 2.5.3-203](#)) (see [Subsection 2.5.3.5](#)). No evidence is reported of significant Mesozoic extension occurring within the site region (e.g., Mesozoic plutons or formation of Mesozoic rift structures).

#### **2.5.3.7 Designation of Zones of Quaternary Deformation**

No zones of Quaternary deformation that would require additional investigation are identified within the Fermi 3 site region.

#### **2.5.3.8 Potential for Surface Deformation at the Site**

##### **2.5.3.8.1 Potential for Tectonic Surface Deformation at the Site**

The potential for tectonic deformation at the Fermi 3 site is negligible. None of the faults within the site vicinity is judged to be a capable tectonic source. The only mapped fault within the site location, the possible Sumpter Pool fault, is postulated on the basis of increased porosity associated with fractures along a possible fault at depth. Based on well

data, the postulated structure does not show consistent displacement of subsurface bedrock units at depth, and apparent vertical displacements between borings can be explained by gentle folding (less than 0.2 degree dip). The possible Sumpter Pool fault has no surface expression and does not deform geomorphic features or deposits formed by latest Pleistocene to Holocene glacial lakes. This postulated structure is not judged to be a capable tectonic source that has the potential to cause surface deformation at the Fermi 3 site.

#### 2.5.3.8.2 **Potential for Nontectonic Surface Deformation at the Site**

The potential for nontectonic deformation at the Fermi 3 site is negligible. There is no evidence of nontectonic deformation at the Fermi 3 site in the form of unloading phenomenon (i.e., pop-up features), glacially-induced faulting, salt migration, dissolution or collapse related to karst, or volcanic intrusion.

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#### 2.5.3.9 **References**

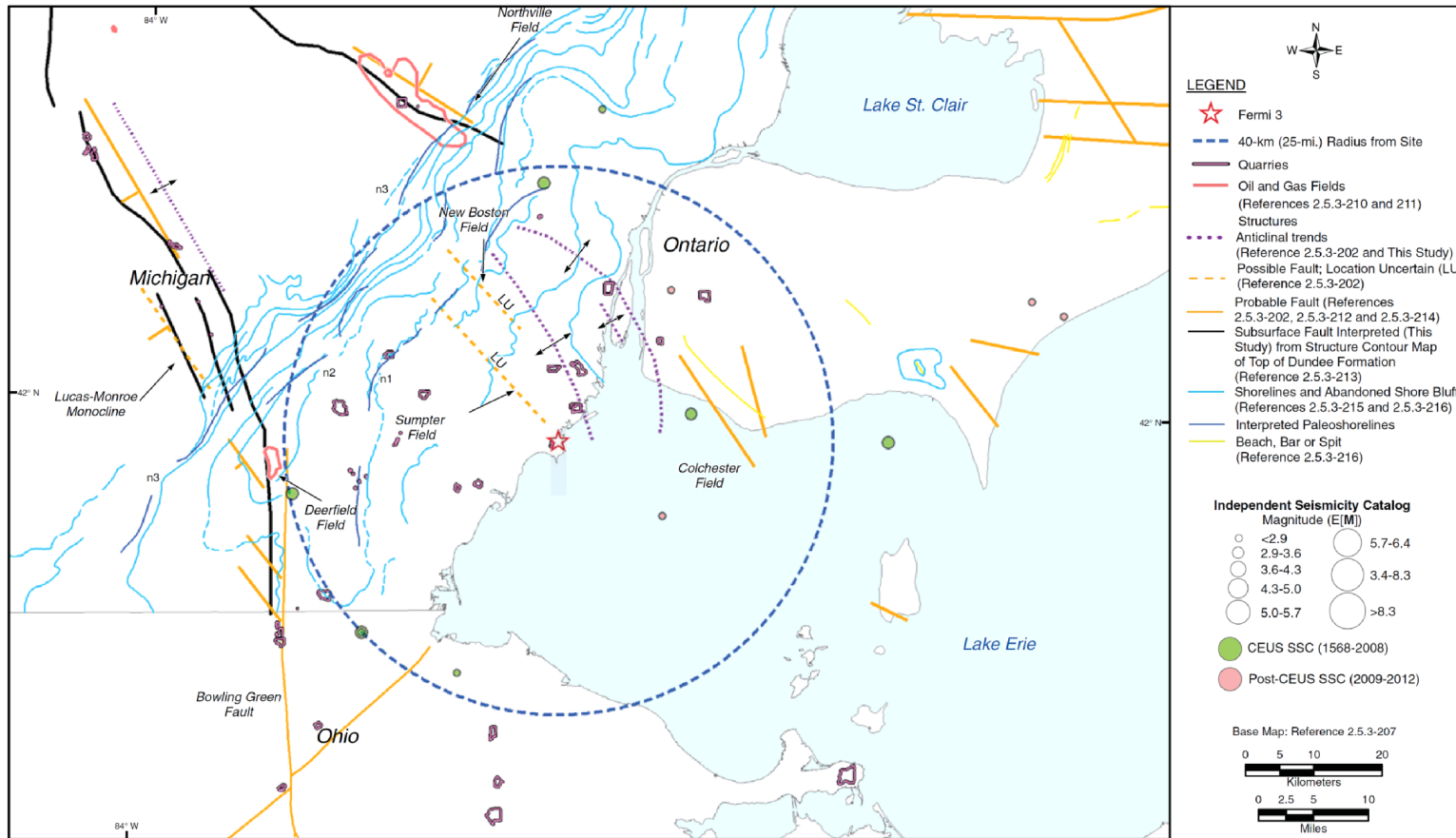
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(d) Sunbury Shale Structure Contour Map, scale 1:600,000.  
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- 2.5.3-215 Michigan Department of Natural Resources, "Quaternary Geology of Michigan," Edition 2.0, digital map, 1998.
- 2.5.3-216 Ontario Geological Survey, "Quaternary Geology, Seamless Coverage of the Province of Ontario," Data Set 14, 1997.

- 2.5.3-217 U.S. Geological Survey EROS Data Center, "National Elevation Dataset," <http://gisdata.usgs.net/ned/>, 1999.
- 2.5.3-218 Newcombe, R.B., *Oil and Gas Fields of Michigan: A Discussion of Depositional and Structural Features of the Michigan Basin*, Michigan Geological Survey, Publication 38, 1933.
- 2.5.3-219 U.S. Department of Agriculture (USDA), black- and white-aerial photographs, Monroe County, Michigan, 1:20,000 scale, flown 1955
- 2.5.3-220 U.S. Department of Agriculture (USDA), Digital Orthophotographs for Monroe, Washtenaw, Wayne Counties, Michigan and Lucas, Ottawa, and Wood Counties, Ohio, 2 m resolution, purchased from <http://datagateway.nrcs.usda.gov/>, flown 2006.

Figure 2.5.3-201 Map Showing Mapped Structures and Seismicity in the Site Vicinity

[EF3 COL 2.0-28-A]





**Figure 2.5.3-202 Map Showing Field Reconnaissance Sites, Quarries, and Aerial Reconnaissance Route**  
 [EF3 COL 2.0-28-A ]

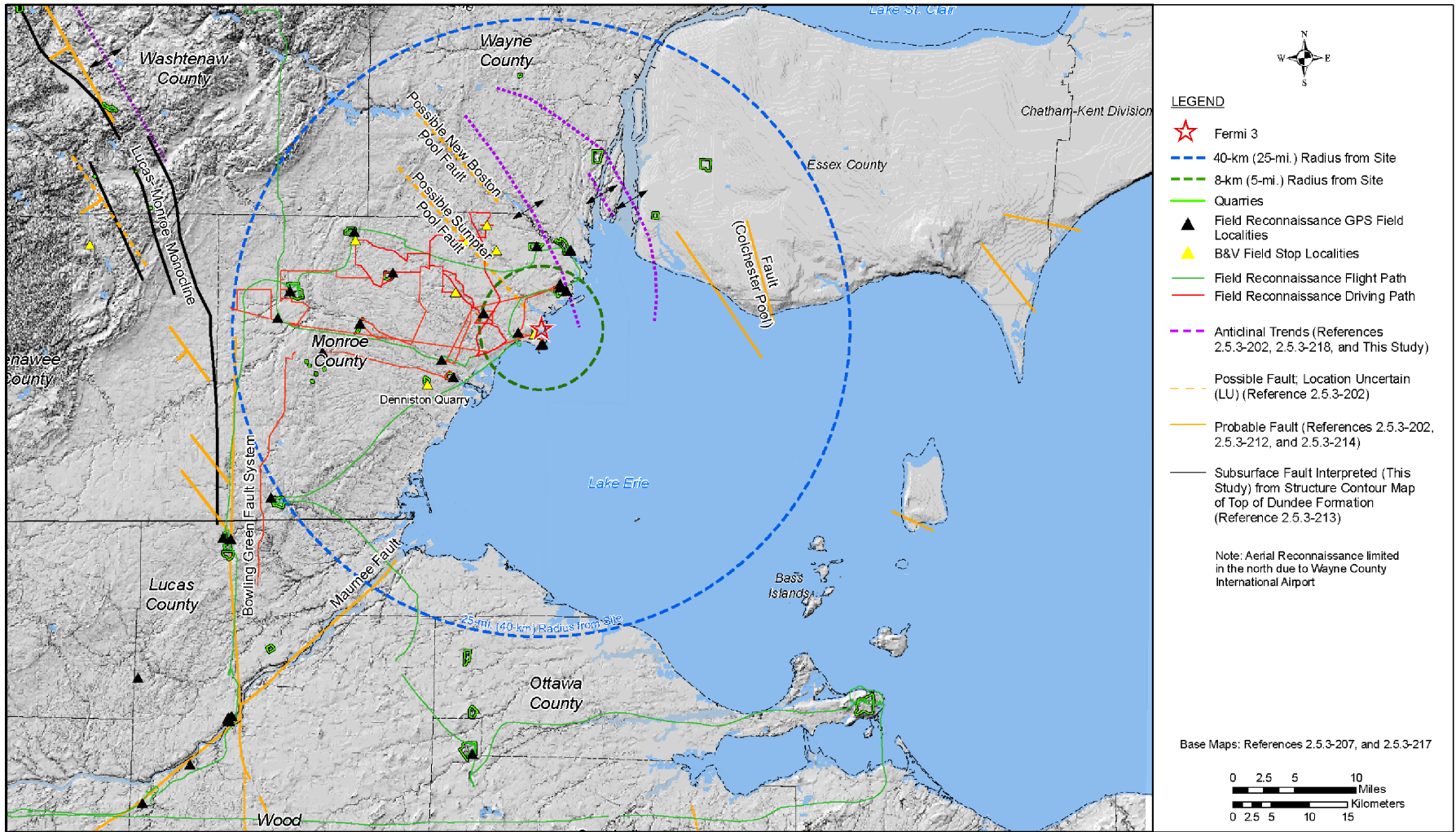


Figure 2.5.3-203 Interpreted Hillshade Model (10-m DEM) Showing Lineaments in the Site Vicinity

[EF3 COL 2.0-28-A]

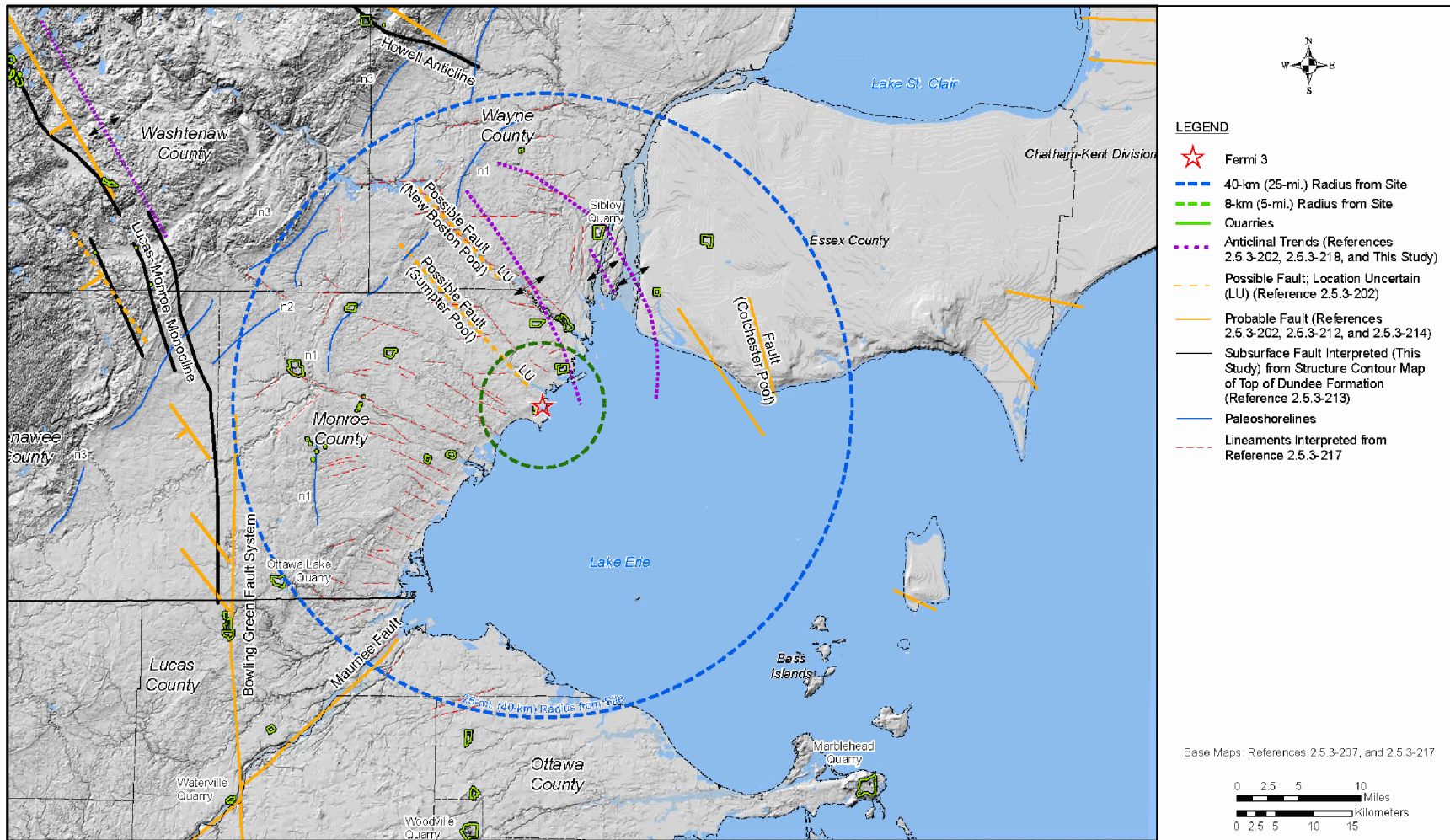
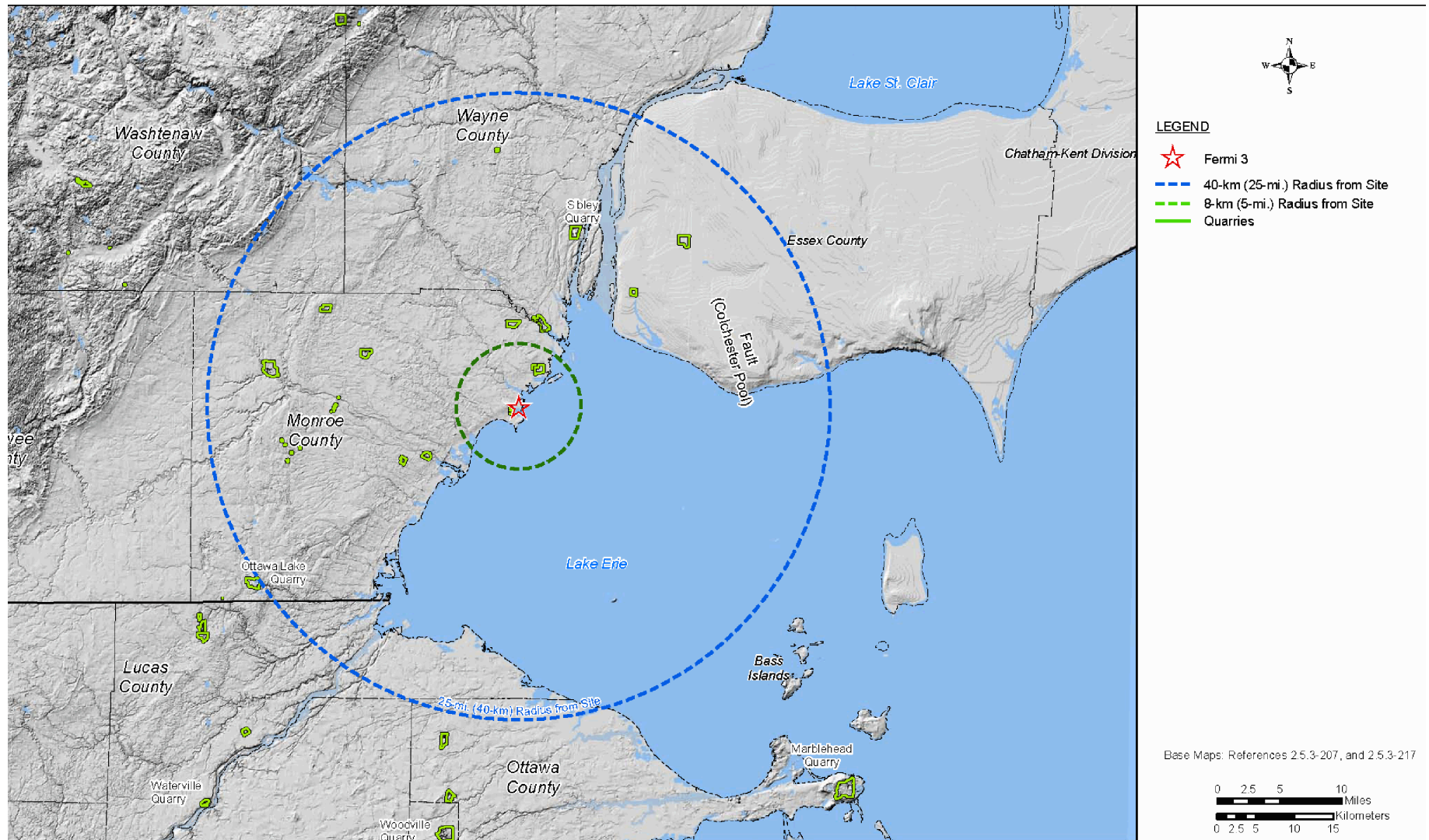


Figure 2.5.3-204 Uninterpreted Hillshade Model (10-m DEM) of the Site Vicinity

[EF3 COL 2.0-28-A]



**Figure 2.5.3-205 Interpreted 1955 1:20,000-scale Aerial Photograph Mosaic Showing Lineaments in the Site Area**  
 [EF3 COL 2.0-28-A]

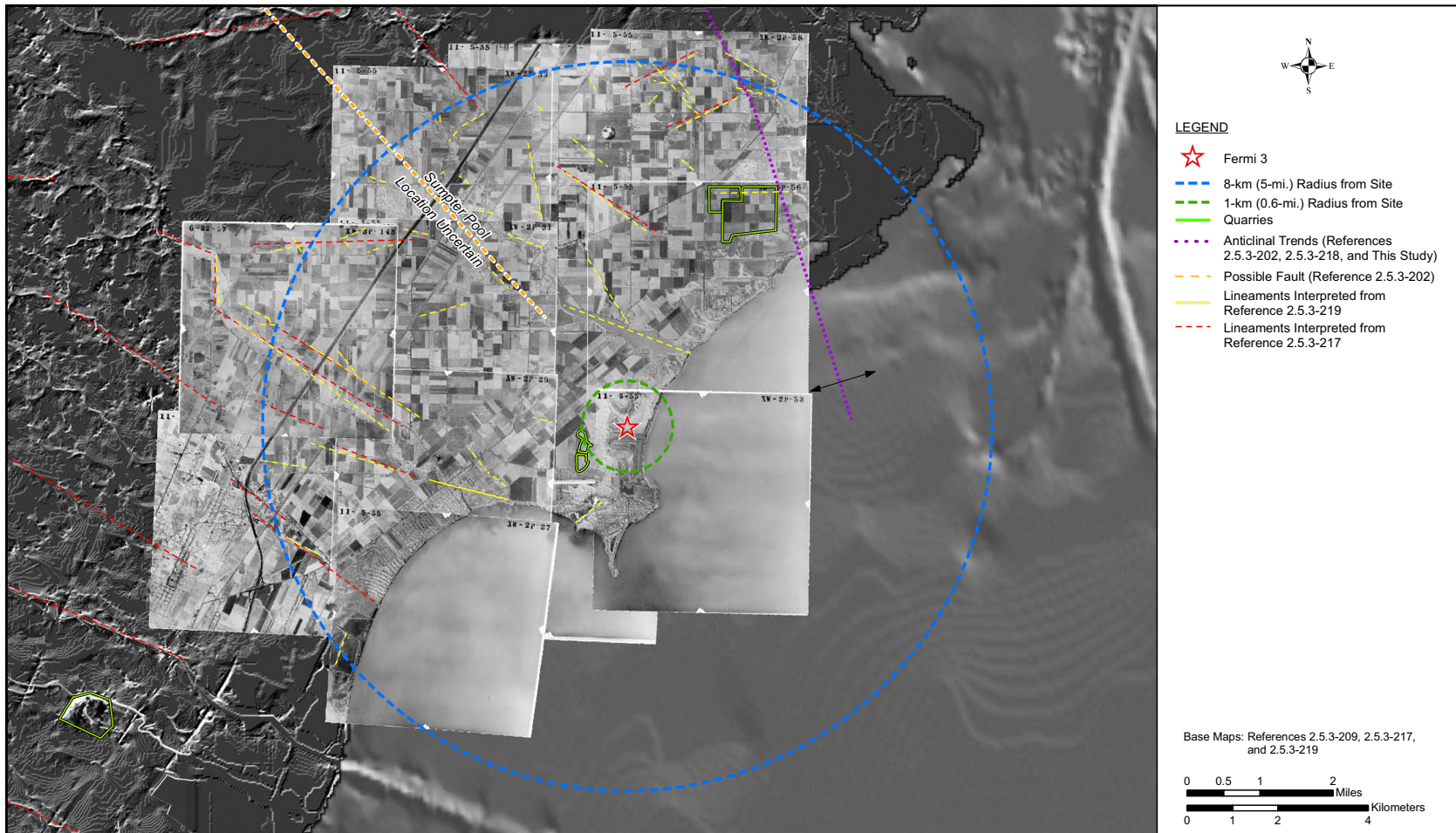
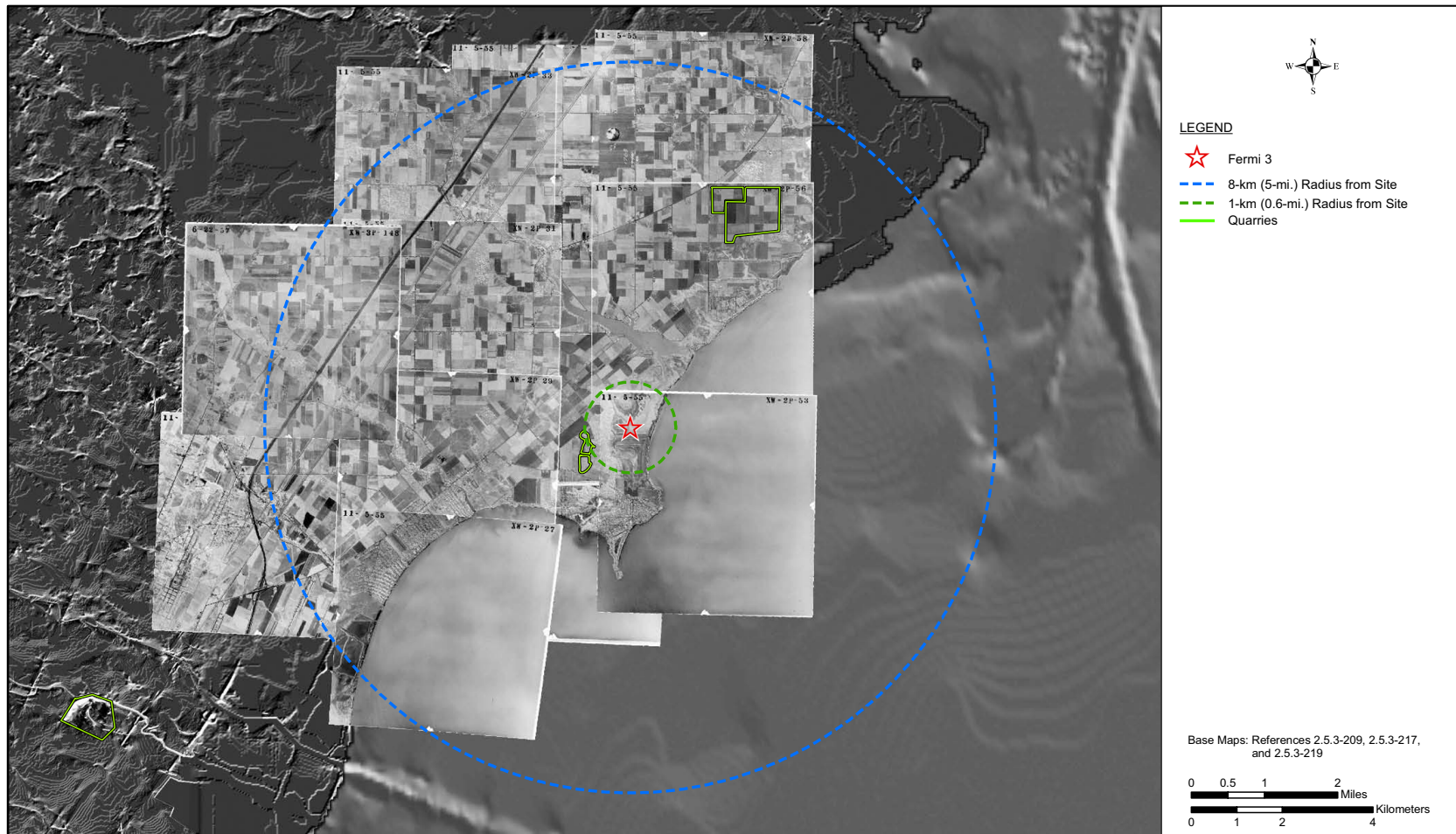


Figure 2.5.3-206 Uninterpreted 1955 1:20,000-scale Aerial Photograph Mosaic of the Site Area

[EF3 COL 2.0-28-A]



**Figure 2.5.3-207 2006 2-m resolution Color Infrared Photograph Showing Interpreted Lineaments in the Site Area**

[EF3 COL 2.0-28-A]

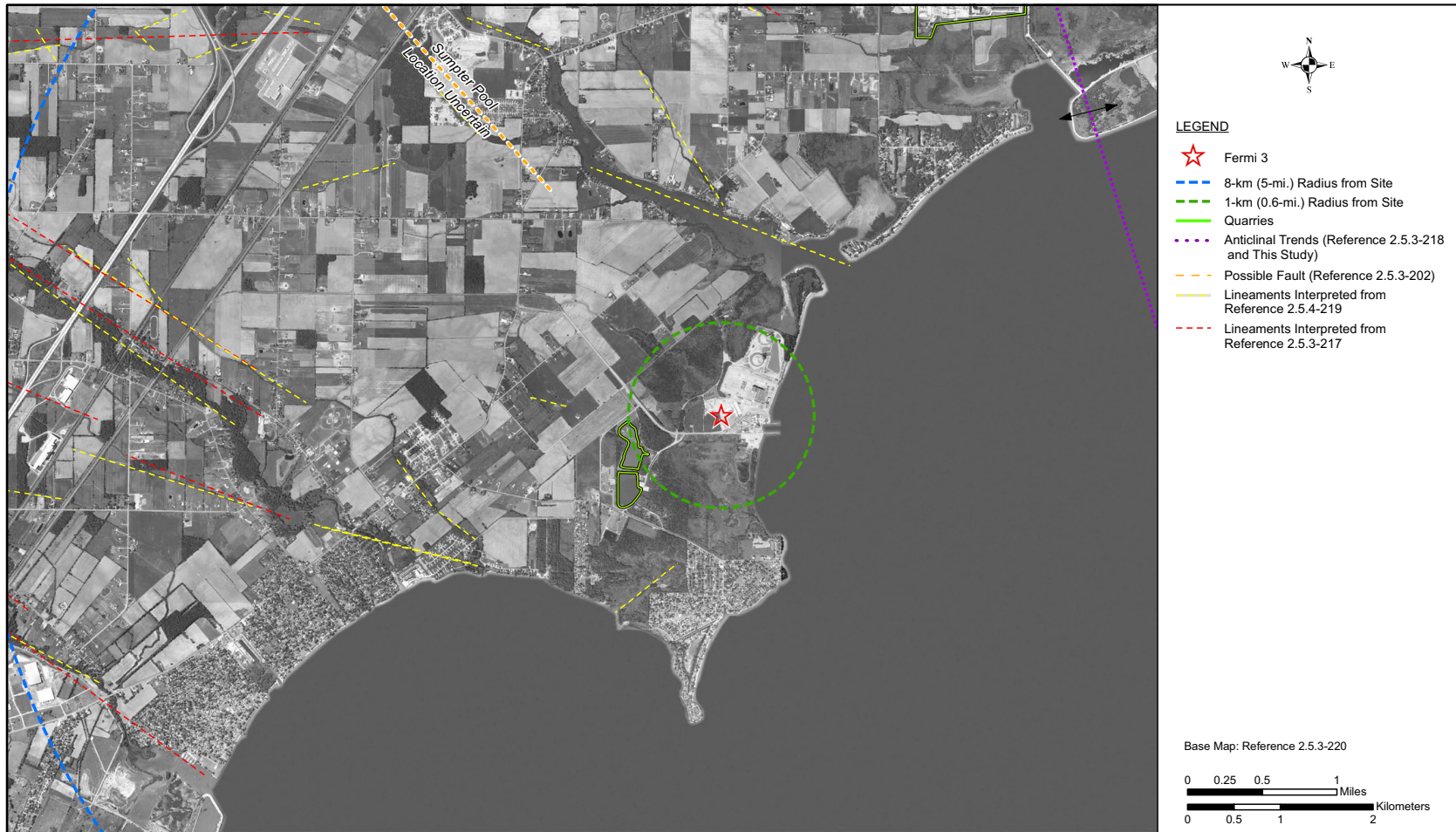
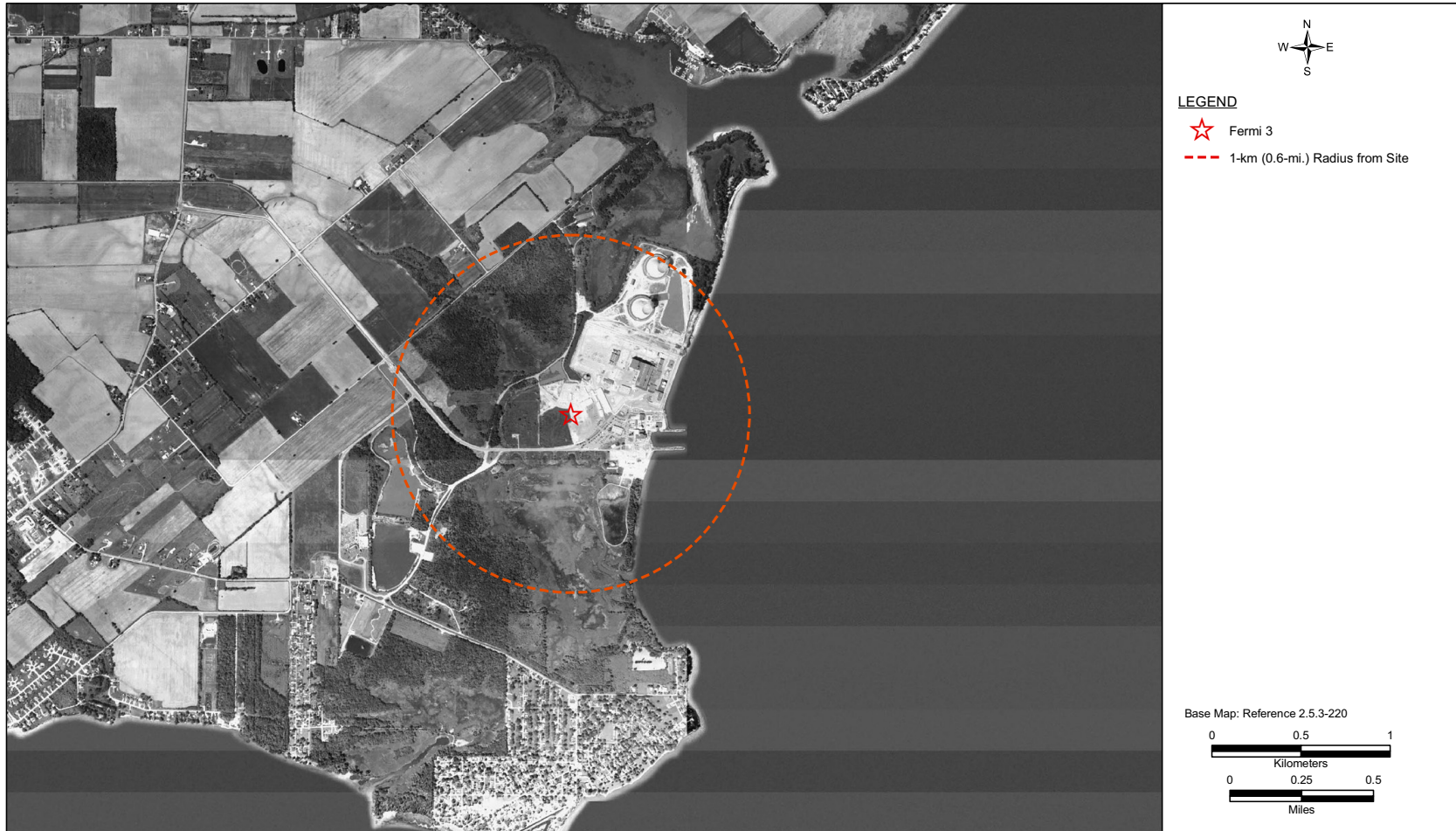


Figure 2.5.3-208 Uninterpreted 2006 2-m resolution Color Infrared Photograph of Site Area

[EF3 COL 2.0-28-A]

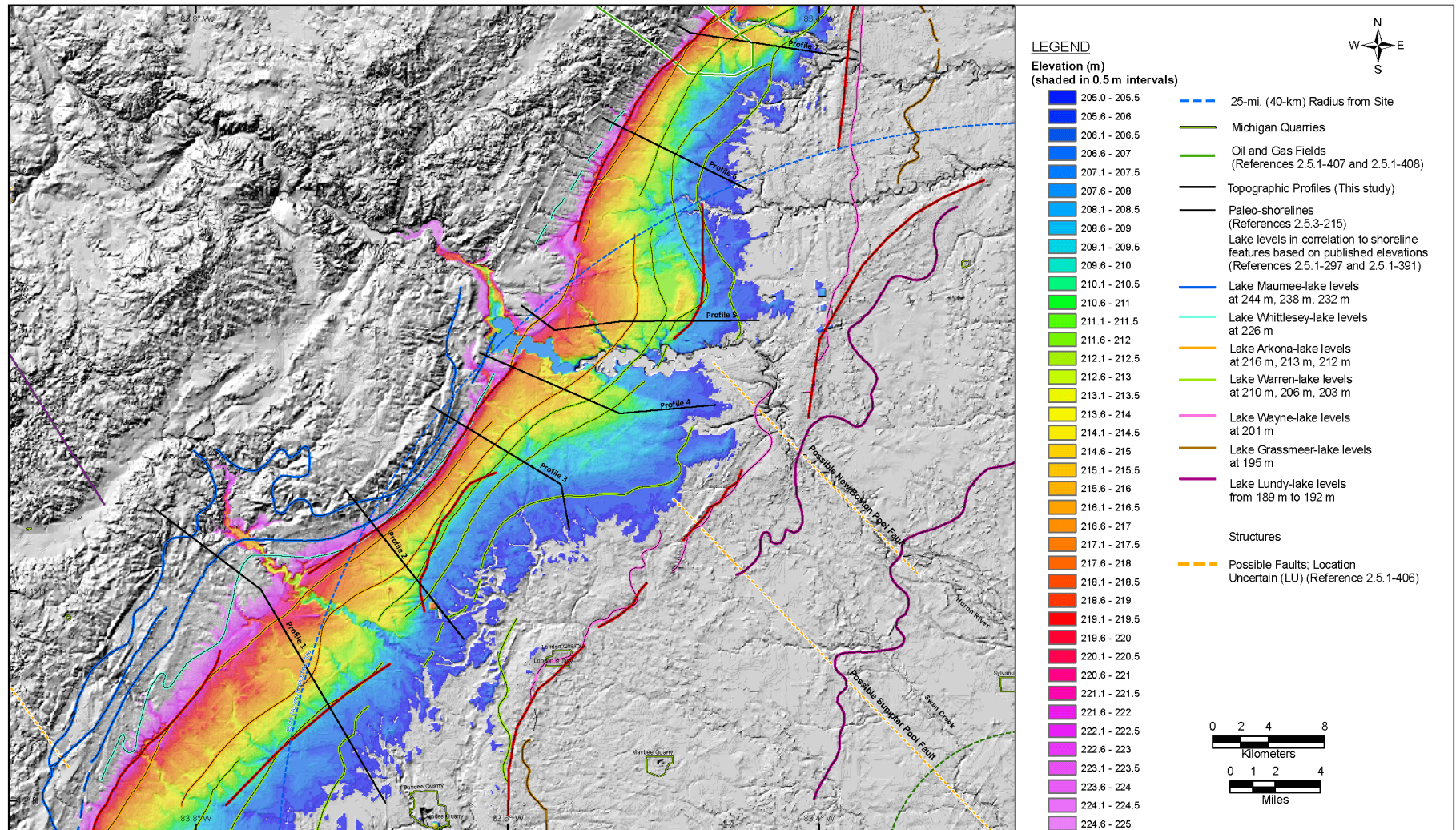


Figure 2.5.3-209 Uninterpreted 2006 2-m resolution Color Infrared Photograph of the Site Location [EF3 COL 2.0-28-A]

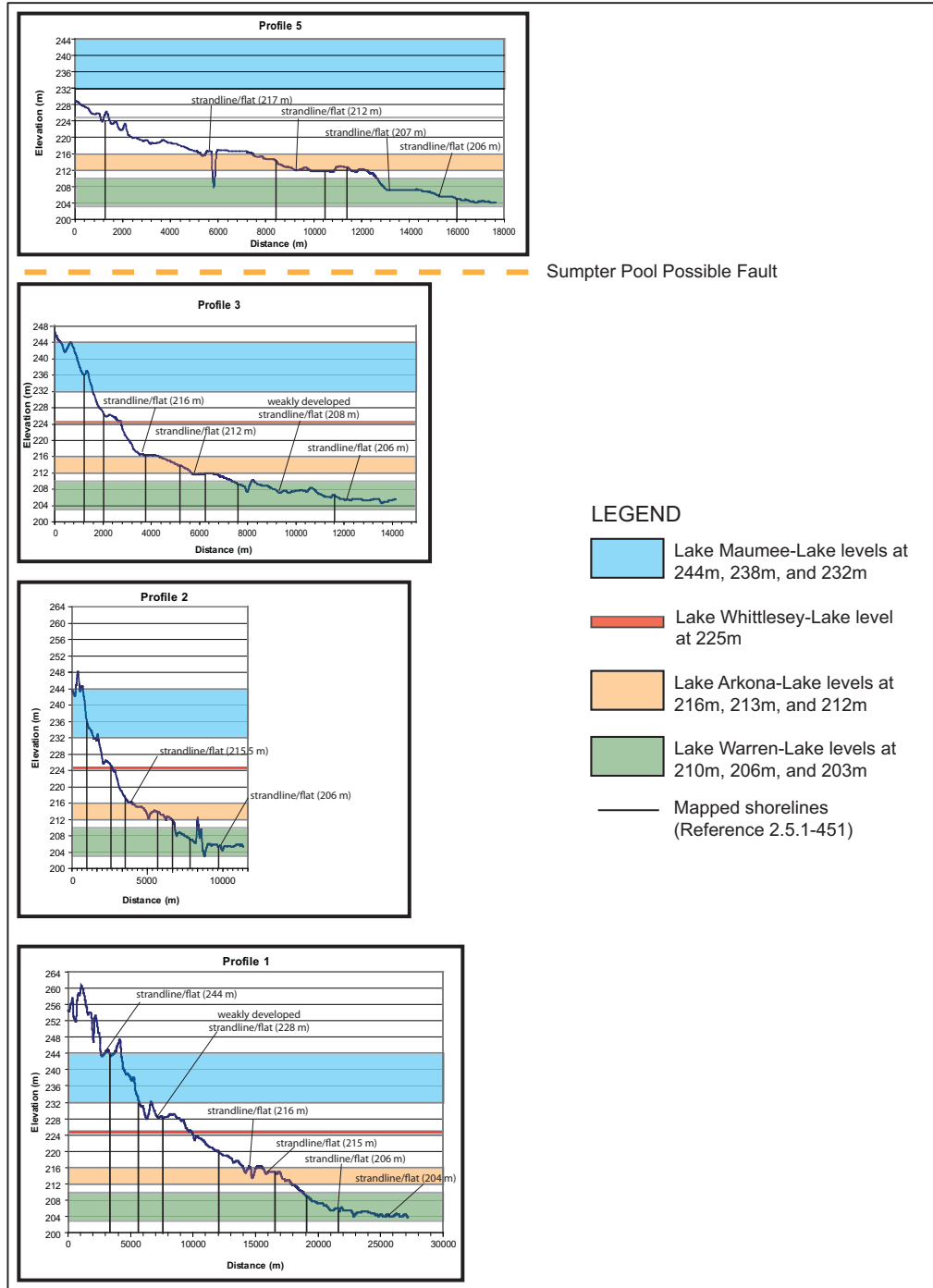




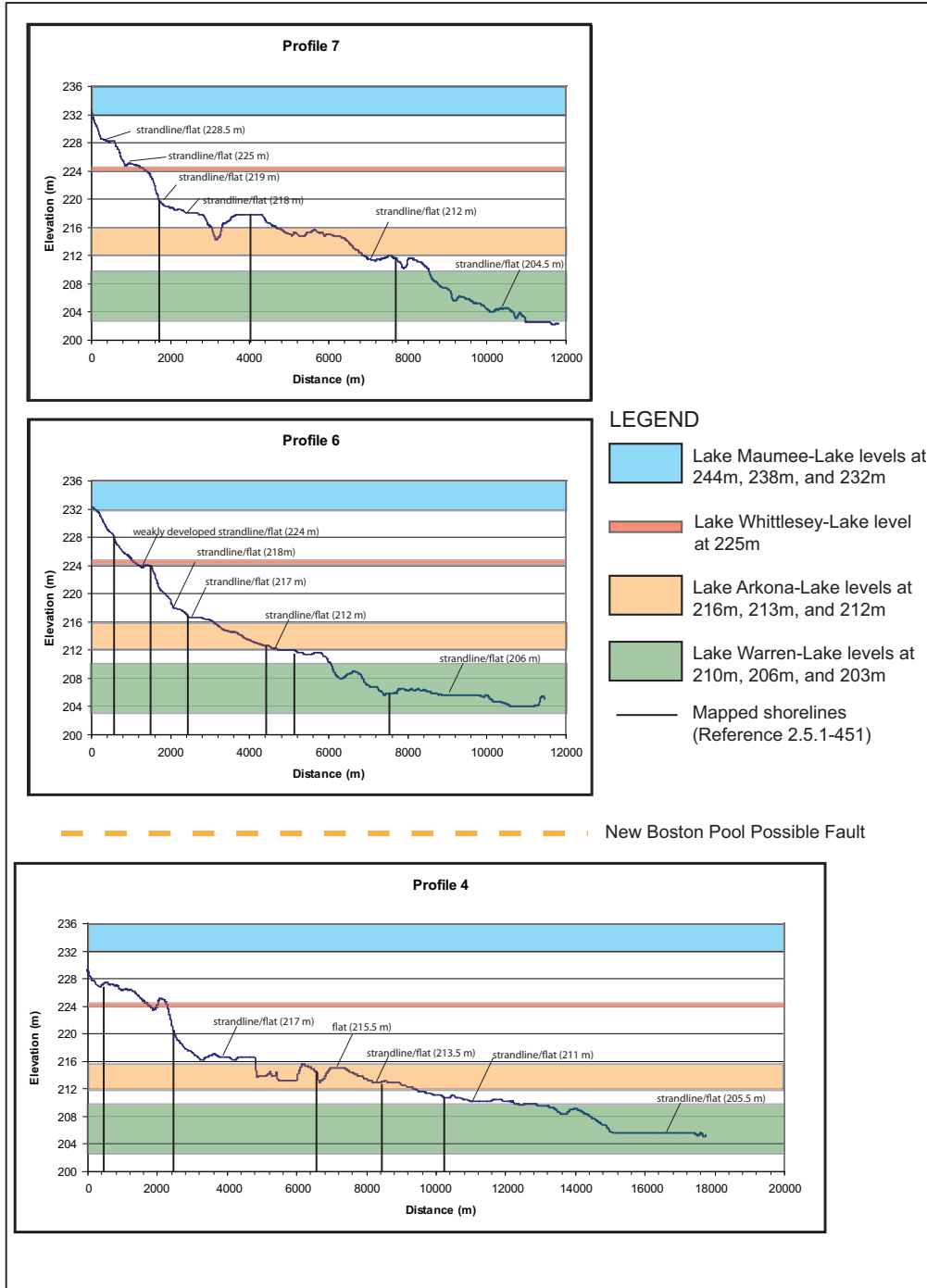
**Figure 2.5.3-210 Colored Contour Interval (0.5-m Increments) Map Highlighting Surfaces Associated with the Arkona Lake Level (Elevation 212 - 216 m) [EF3 COL 2.0-26-A]**



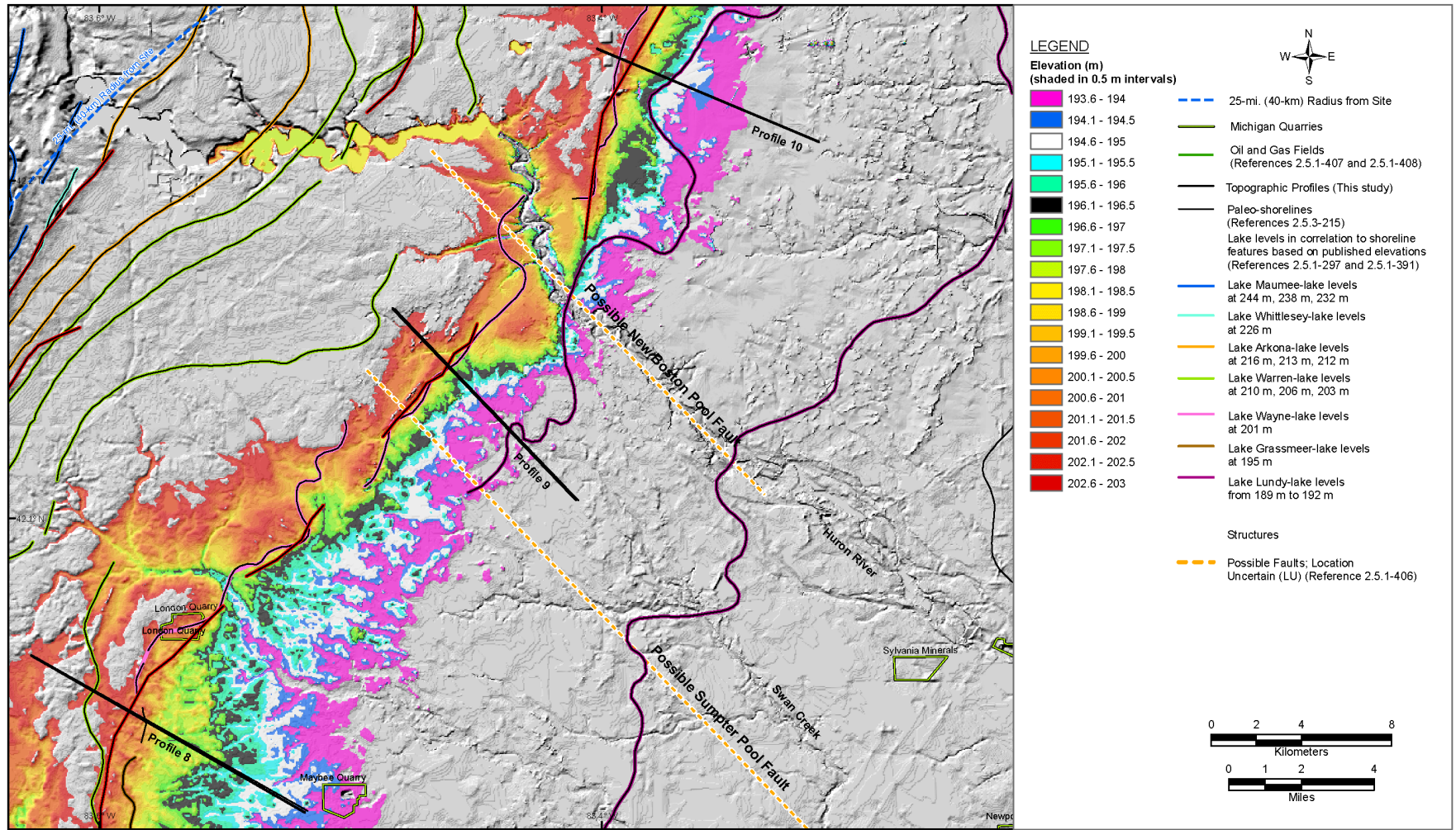
**Figure 2.5.3-211 Topographic Profiles 1, 2, 3, and 5 Across the Sumpter Pool Possible Fault**  
 [EF3 COL 2.0-26-A]



**Figure 2.5.3-212 Topographic Profiles 4, 6, and 7 Across the Boston Pool Possible Fault**  
 [EF3 COL 2.0-26-A]



**Figure 2.5.3-213 Colored Contour Interval (0.5-m Increments) Map Highlighting Surfaces Associated with the Lake Grassmere Lake Level (Elevation 195 m) [EF3 COL 2.0-26-A]**



Dundee Quarry

**Figure 2.5.3-214 Topographic Profiles 8, 9, and 10 across the New Boston Pool and Sumpter Pool Possible Faults** [EF3 COL 2.0-26-A]

