

POTENTIAL RISKS OF FRACKING BENEATH LEWISVILLE LAKE DAM

My name is Jerry Bartz. I have 5 years experience in locating fractured geothermal reservoirs, 9 years in Oil and Gas exploration and 6 years experience in environmental risk assessments, which includes assessment drilling at a weapons grade US Nuclear site. I have been granted 4 patents, one involving fault detection and delineation. I was trained to use remote sensing and geographic features to detect the probable existence of underground features, including faults that localize natural resources. As a Senior Staff Exploration Geologist for a large Oil and Gas corporation, I used remote sensing to evaluate regional oil and gas lease acquisitions as well as optimize the placement of seismic surveys to define fault-influenced, successful, gas wells at depths greater than 13,000 feet. I currently serve as a full time tutor for as many as 16 courses in Geographic Information Systems (GIS). My GIS contributions are acknowledged in a widely used GIS textbook. GIS was used to create the maps used in this article.

The BLM is proposing oil and gas leasing that would allow the fracking of the Barnett shale on Parcel 43, on the west fork of Lewisville Lake (as known as Hickory Creek), Denton County, Texas (Figure 1). Because of the proximity of Parcel 43 to the Lewisville Lake dam this site needs to be evaluated as a site subject to human-triggered earthquakes.

This dam is already experiencing what the U.S. Army Corps of Engineers calls "some known safety issues."

In December of 2015, it was reported that a 160 foot long landslide let loose on the east side of the dam and proximal to a similar slide site in 1995, prompting some engineers to question the stability of the dam's foundation². The location of the slide is shown in Figure 4³. The slide followed a May 2015 observation of water and sand bubbling up near the west side of the dam, which dam engineers attributed to 'increasing seepage ... [that] created a passage under the base of the dam'. Two other areas of uncontrolled seepage have been reported⁹. An unreported repair of an upstream embankment was detected in 2005 aerial photography Figure 5. The repair area is approximately 83,000 square feet.

Prior to the December 2015, incident, the dam was classified as a High Hazard dam. A high-hazard dam is one with great potential for loss of life and property in case of a failure. It does not mean that a dam failure is likely. Lewisville Lake Dam is listed -by the Corps (of Engineers) as the “nation’s eight most hazardous dam.”¹

The geology of the Dallas Fort Worth area, and in particular, plate tectonic forces, may have impacted the stability of the Lewisville Lake Dam. The Lake Lewisville area is surrounded by 3 major, fault-causing events. These are the north trending Ouachita thrust belt to the east, the northwest trending Muenster Arch to the northeast and the northeast trending Mineral Wells Fault system to the west. These geologic events resulted in the creation of mountains, faulting and erosion of the created mountains.

Although geologists cannot directly see these deep faults at the surface, geologists trained in remote sensing and surface-pattern recognition can detect indirect evidence of probable faults. For example, river flow is sensitive to small changes in elevation. Many river channels contain wide sweeping curving patterns. If the channels are relatively straight, then the river might reflect a subsurface fault. A straight river channel can be called a **lineament**. If the lineament overlies a subsurface fault, the lineament could be subject to movement. Fault movement will vary with amount of stress put on the fault.

Now let’s examine the setting of the Lewisville Lake dam. The dam exists at the south end of the lake (Figure 2). The contact of the blue water and the labeled geologic map units (for example Qt and Kwb) on the geologic basemap of Texas⁵ demarks the dam location. The dam exists at the confluence of three, rather straight river channels or **lineaments** (1, 2, and 3) shown on the geologic basemap of Texas.

The geologic basemap has many lineaments near the dam. I drew five lineaments on the Geologic Map (Figure 2). Lineament Number 1 trends beneath Parcel 43 before intersecting the dam. Lineaments 2 and 3 also intersect the dam. Number 1 parallels Number 5 beneath Lake Grapevine. In addition, these two parallel and northwest trending lineaments also parallel the alignment of the Matador Arch suggesting the parallel lineaments are probably associated with below-the-surface faults.

Lineament 4 was drawn along a river channel that intersects an area experiencing recent increased earthquake activity. Lineament 4 may be interpreted as a continuation of Lineament 2.

In Figure 3, a comparison of the Lineaments to seismic faults (red lines) (released by XTO energy⁶) and USGS earthquake data is presented. Based on the river channel patterns in Figure 2, Lineament 5 may be extended to the southeast. The resulting intersection of Lineaments 4 and 5 correlates well with the recent USGS defined earthquakes. Potentially, the intersection at the Lake Lewisville Dam of Lineaments 1 with either Lineaments 2 and 3 has already caused small movements in the dam and contributed to the dam's present classification as the "nation's eight most hazardous dam."¹

Fracking beneath Parcel 43 might, by itself, cause movement along Lineament #1 if it overlies an active fault. Movement of Lineament 1 by itself, or in combination with movement of Lineaments 2 and 3, may result in an earthquake and cause expensive structural damage to the dam. Such damage could result in a breach of the dam and impact downstream residents.

How large could the earthquake be.

Oklahoma has experienced a 5.6 magnitude earthquake, likely due to induced seismicity. Risk analysis by Mark Petersen^{6,7}, the head of a USGS effort to study the effect of human induced earthquakes, has projected that such earthquakes could have a magnitude of 6 and possibly as high as 7. The recent February 14, 2016 devastating Taiwan earthquake, which has so far resulted in 116 deaths, was a 6.4 magnitude earthquake⁴.

An earthquake of that predicted magnitude and associated with a structural element beneath the Lake Lewisville dam could cause catastrophic effects to both the human and economic municipal entities that depend on the Lake Lewisville flood control and water supply.

Again let's look at this from a historical perspective:

In 1889, the dam upstream from Johnstown, Pa failed. The ensuing flood killed over 2,000 people and caused catastrophic damage to the downstream communities. It is estimated that the Lewisville Dam

controls 125 times as much water as the Johnstown, Pa dam, and that a breach in the Lewisville Dam could inundate 431,000 people.

In an 2011 article, Army Corps Engineer Anita Branch has called attention to the potential risk that fracking could cause differential movement, or shifts along natural faults, weakening dam foundations.⁸

In my professional opinion, this risk of possible frack-induced movement at the dams with parcels for lease should be evaluated before opening up acreage beneath the lake to fracking. A seismic network is needed to detect microseismic movement that might damage the dam, to evaluate this risk. If microseismic movement is detected, the risk of breach and potential damage may be too high to allow fracking beneath a dam reservoir.

I further recommend that such risk be evaluated and survey monitoring be installed on all dam reservoirs that are subject to fracking below the reservoir and/or in areas surrounding the reservoir, including river channels that feed the reservoir.

Notes:

(1) Lewisville Lake A wellspring of Concern in *The Dallas Morning News*, Section A, pp. 1-2.

(2) <http://interactives.dallasnews.com/2015/lewisville-dam>

(3) Figure 4 ArcMap 10.3, Esri World Imagery Basemap.

(4) Taiwan earthquake: Search ends as death toll reaches 116, CNN,
<http://www.cnn.com/2016/02/13/asia/taiwan-earthquake/>

(5) <https://tnris.org/data-catalog/entry/geologic-database-of-texas/>

(6) <http://www.dallasnews.com/news/metro/20160122-xto-map-presents-detailed-if-unverified-picture-of-north-texas-faults.ece>

(7) <http://www.usgs.gov/newsroom/article.asp?ID=4202#.Vsc9p020iC>

(8) <http://www.dallasnews.com/news/community-news/grand-prairie/headlines/20110731-corps-worriesthat-fracking-gas-wells-might-hurt-dams.ece>.

(9) http://www.swf.usace.army.mil/Portals/47/docs/PAO/2013-08-20_Lewisville_Public_Meeting.pdf