

Induced Seismicity Update

Presentation to the House Standing Committee on Energy, Utilities and Telecommunications

Ryan A. Hoffman, Director, Conservation Division

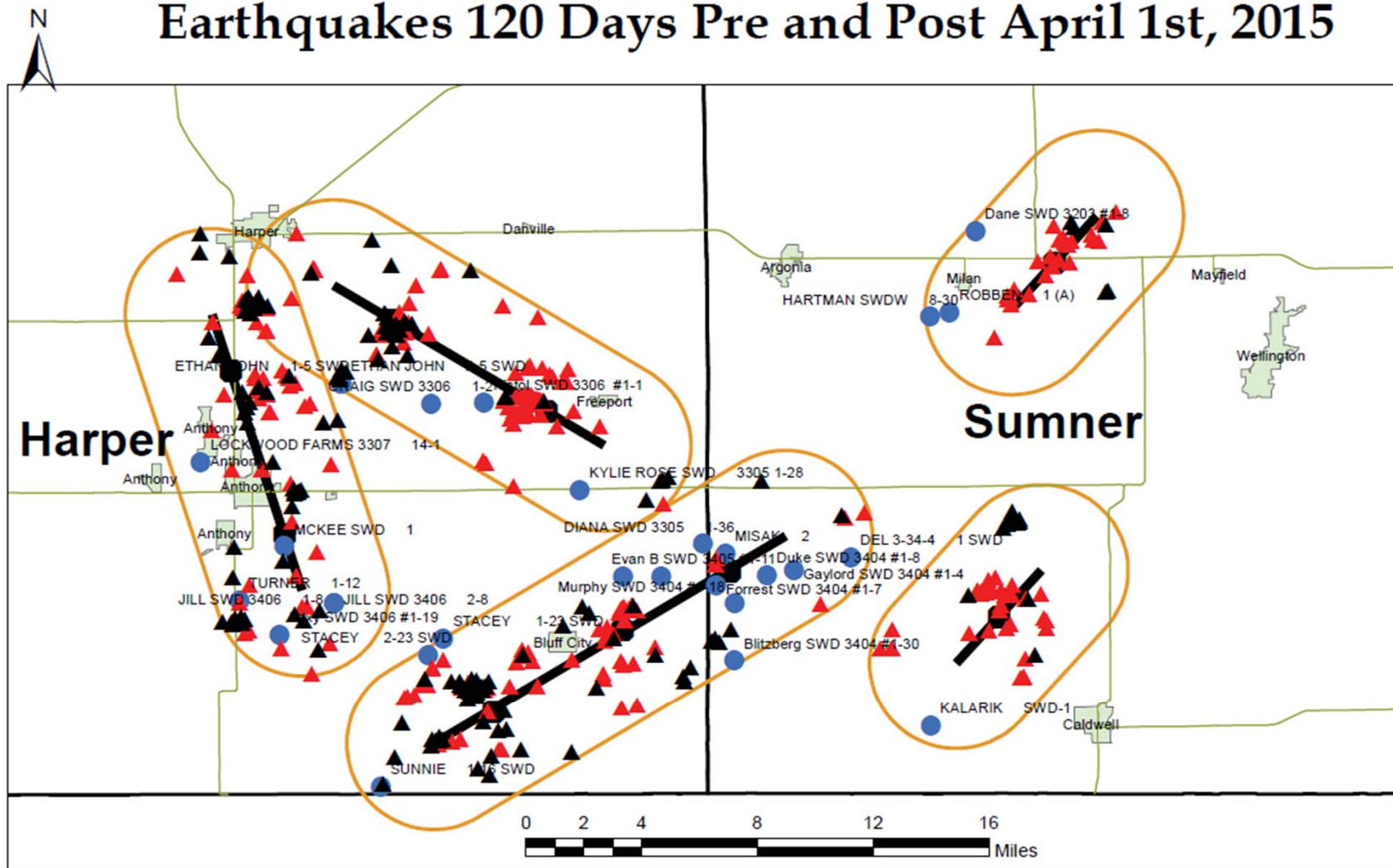
January 16, 2020



DISCLAIMER

*The views expressed herein
are solely those of the
presenter and not those of the
Kansas Corporation
Commission.*

Earthquakes 120 Days Pre and Post April 1st, 2015



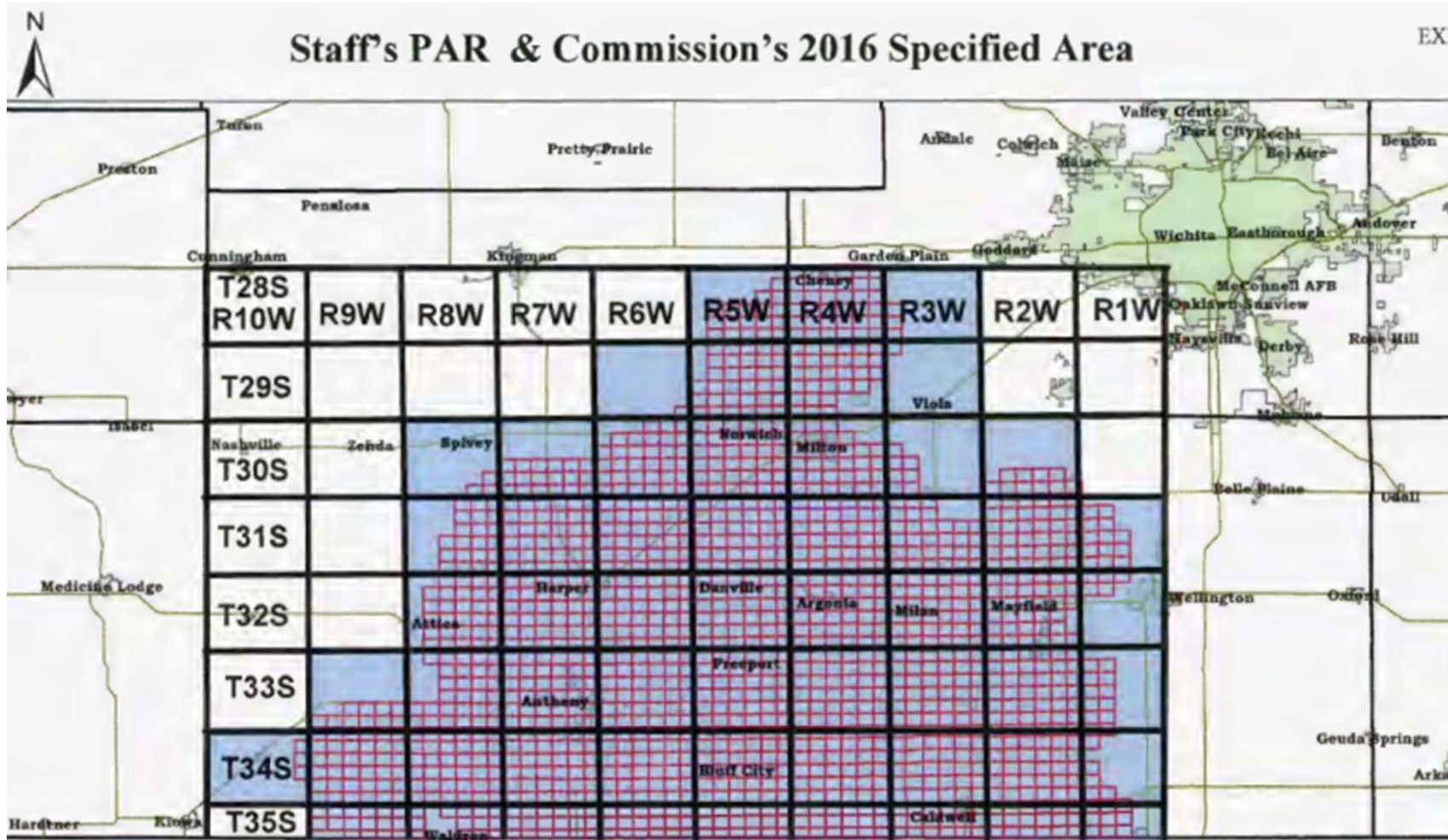
120 Days Pre April 1st, 2015 Total=289 Earthquakes

120 Days Post April 1st, 2015 Total=202 Earthquakes

- Area of Seismic Concern Boundary
- ▲ Earthquakes 120 Days Pre April 1st
- ▲ Earthquakes 120 Days Post April 1st
- Large Volume Arbuckle Disposal Wells

Staff's PAR & Commission's 2016 Specified Area

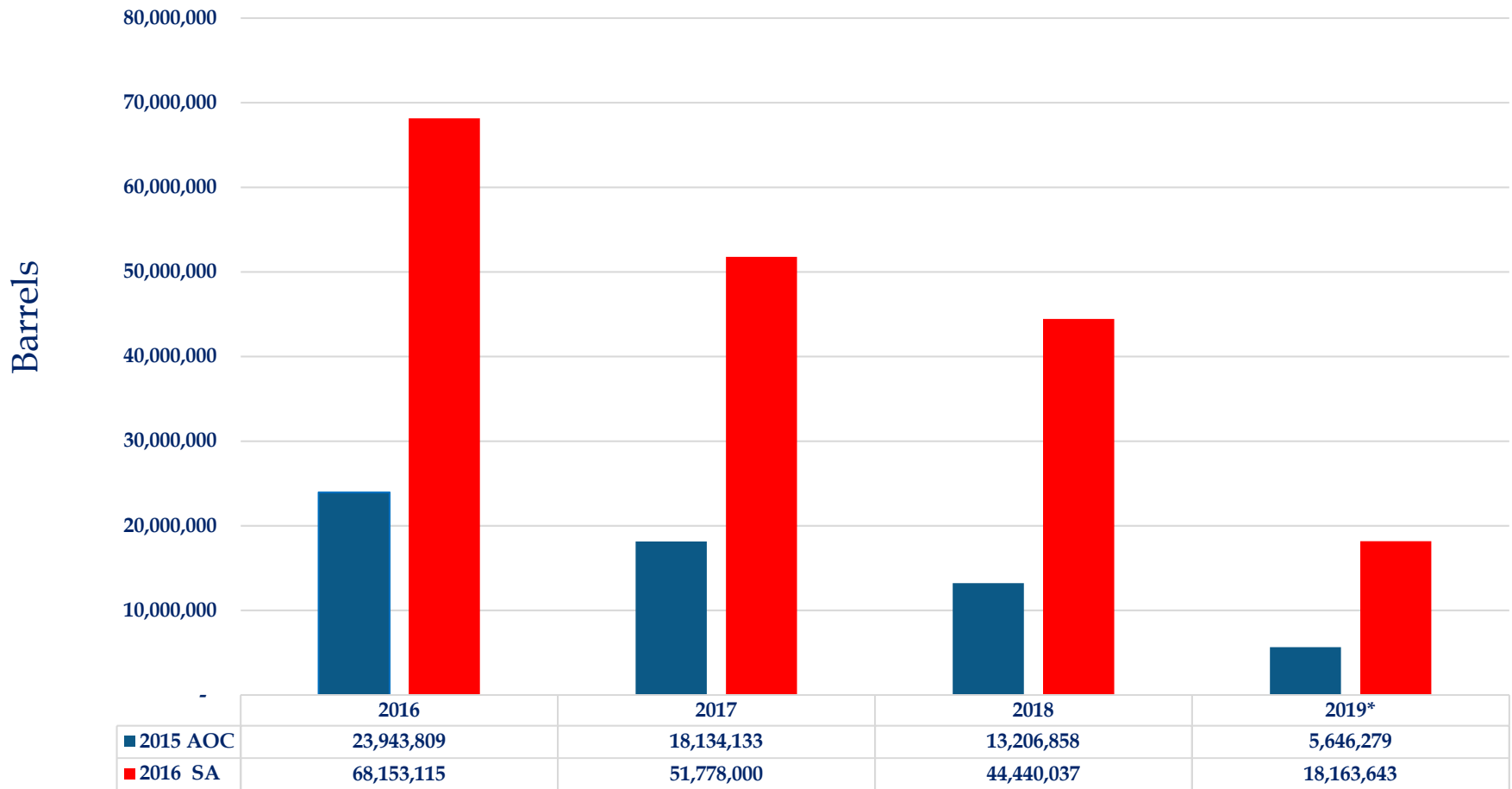
EX



3 6 12 18 24 Miles

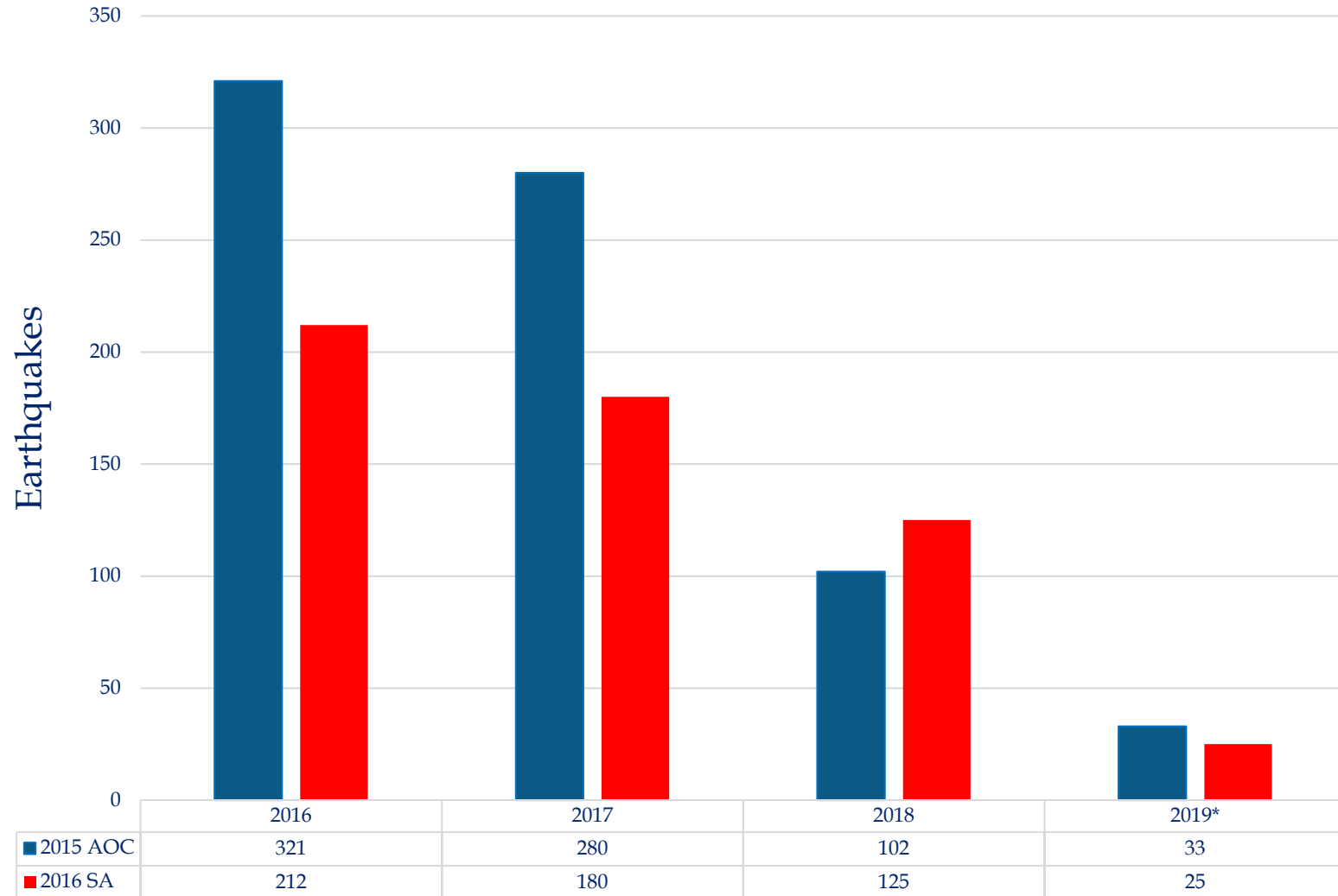
2016 Specified Area
Staff's PAR

Barrels Injected into Large Volume Arbuckle Wells by Commission Order Area



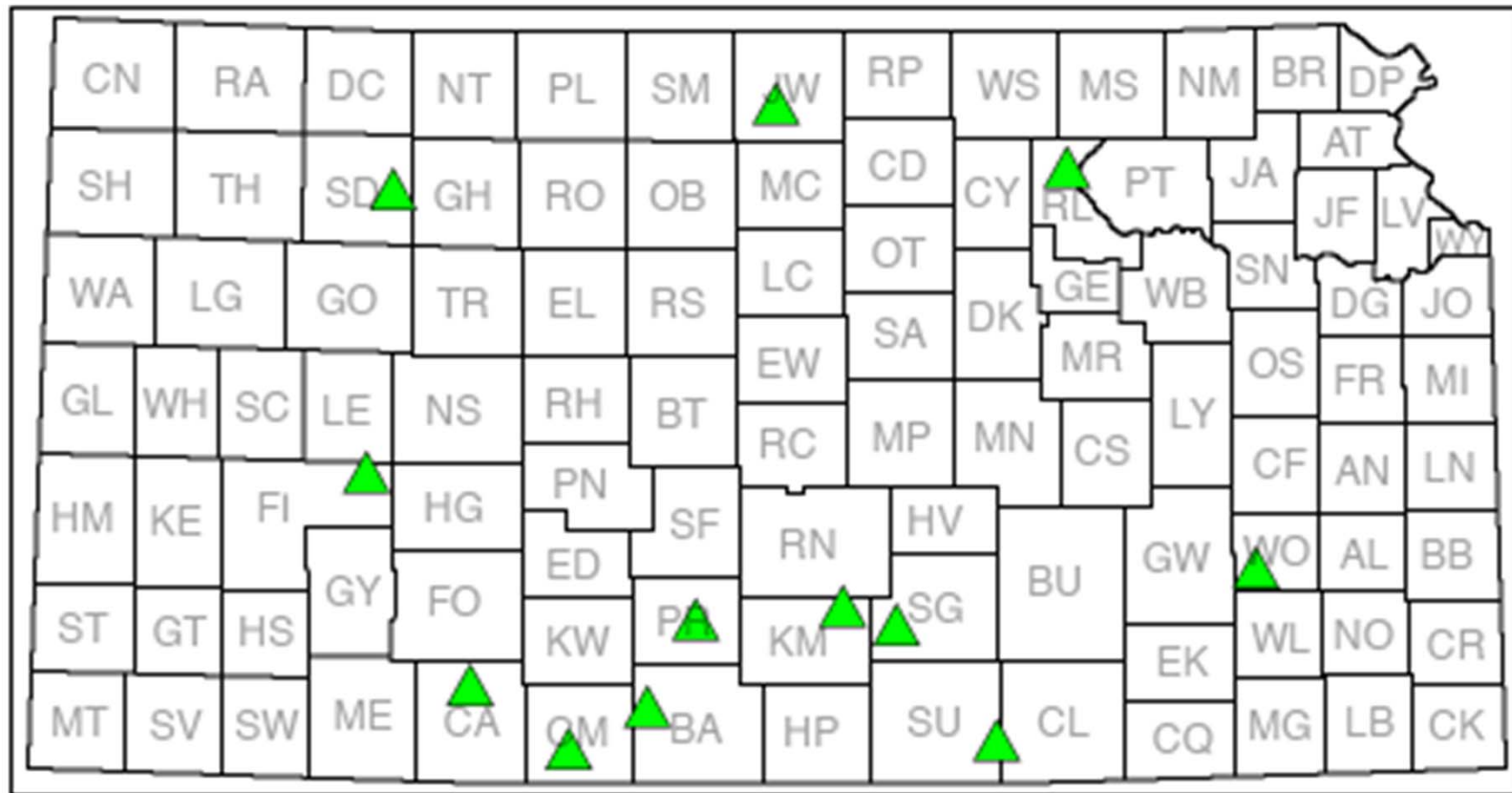
* Volumes through June 30, 2019.

USGS NEIC Earthquakes per Commission Order Area

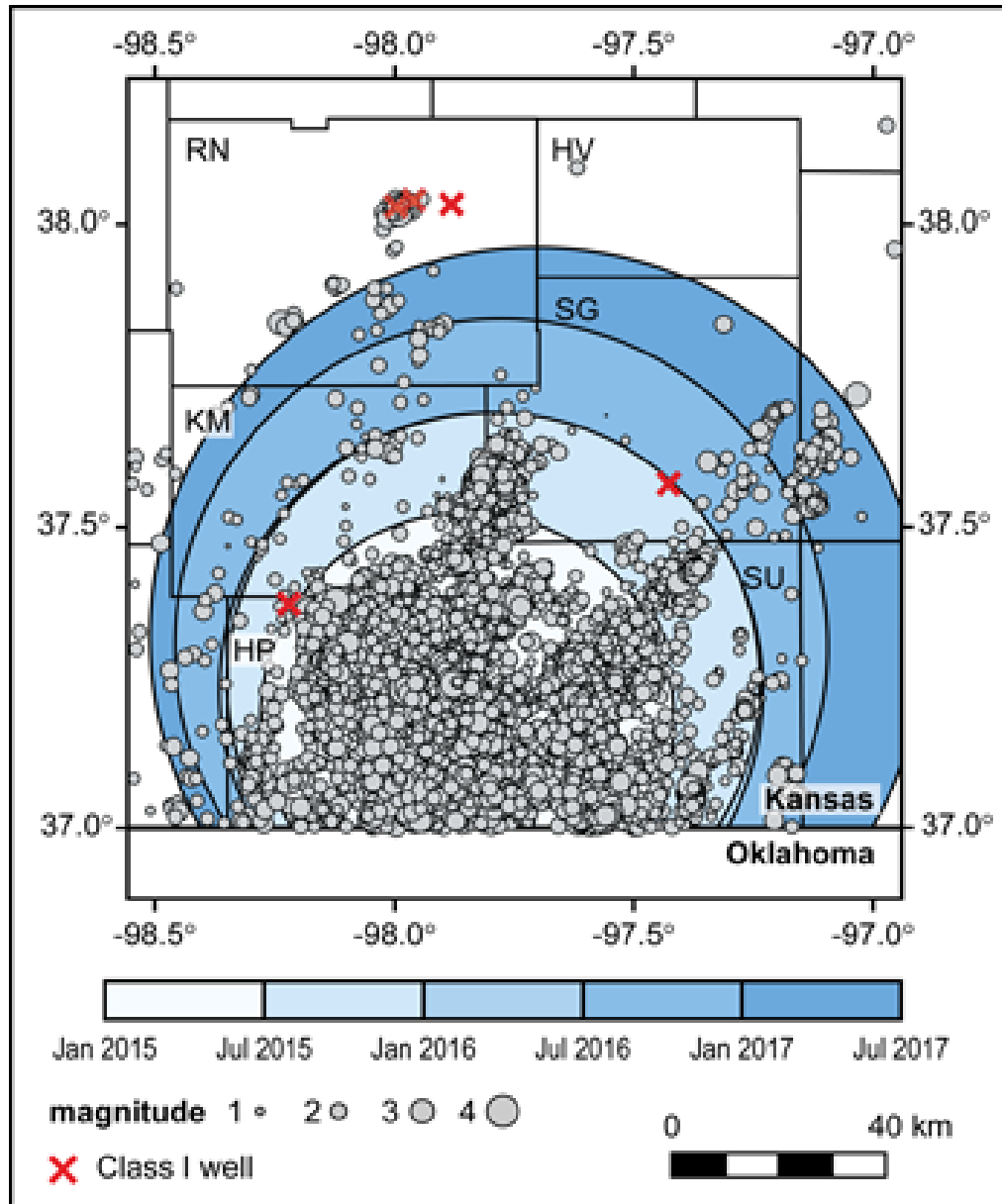


* Earthquakes through June 30, 2019.

KGS Seismometer Network

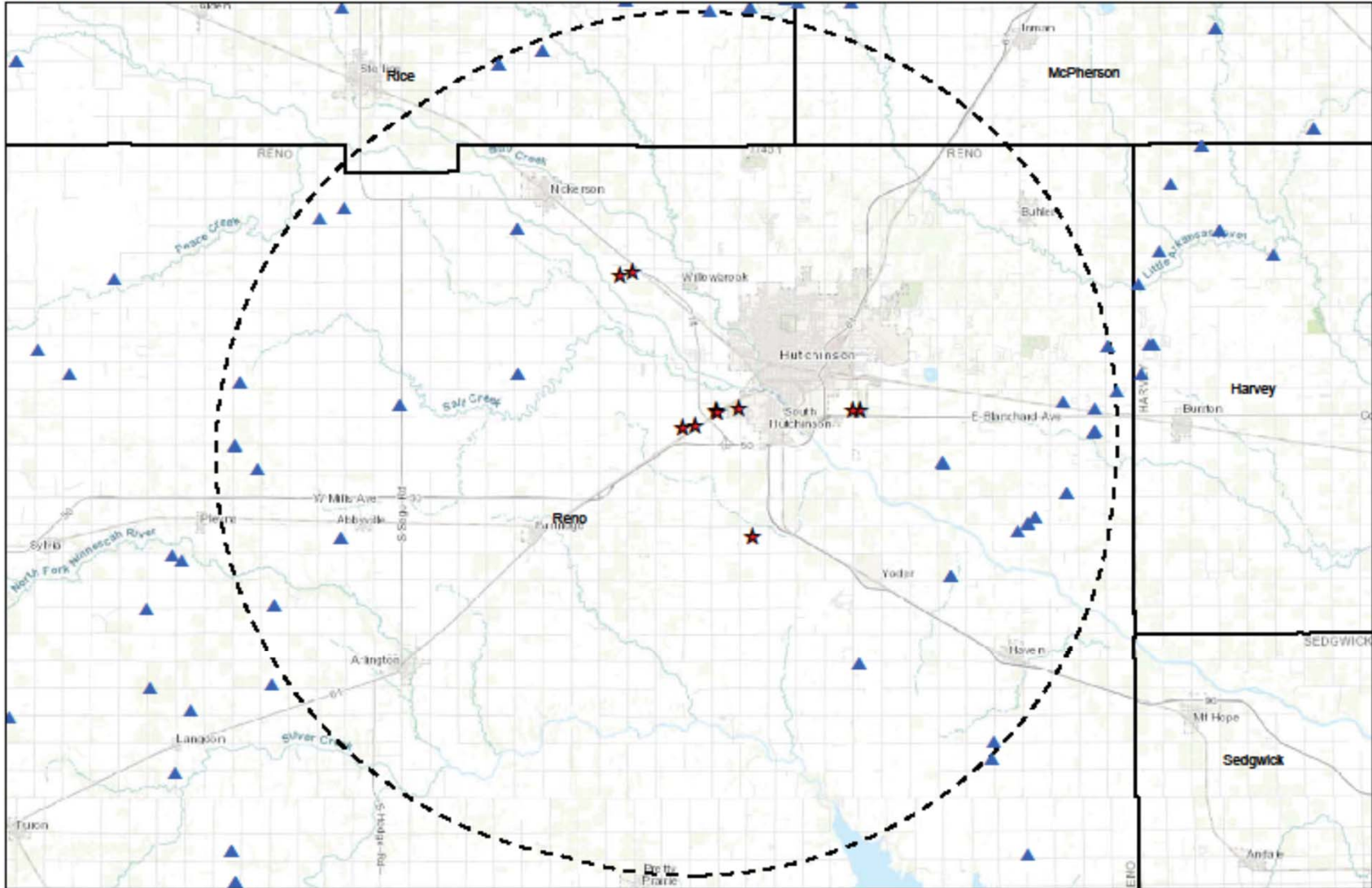


<http://www.kgs.ku.edu/Geophysics/Earthquakes/network.html>



EOS 99 Peterie: Fluid Injection Wells Can Have a Wide Seismic Reach, by Shelby L., Richard D. Miller, Rex Buchanan, and Brandy DeArmond, April 2018

15-Mile Search Radius With Associated Class I Disposal Wells & Class II Arbuckle Saltwater Disposal Well Locations



- ▲ Class II Arbuckle SWD Wells
- ★ Class I Arbuckle Disposal Wells

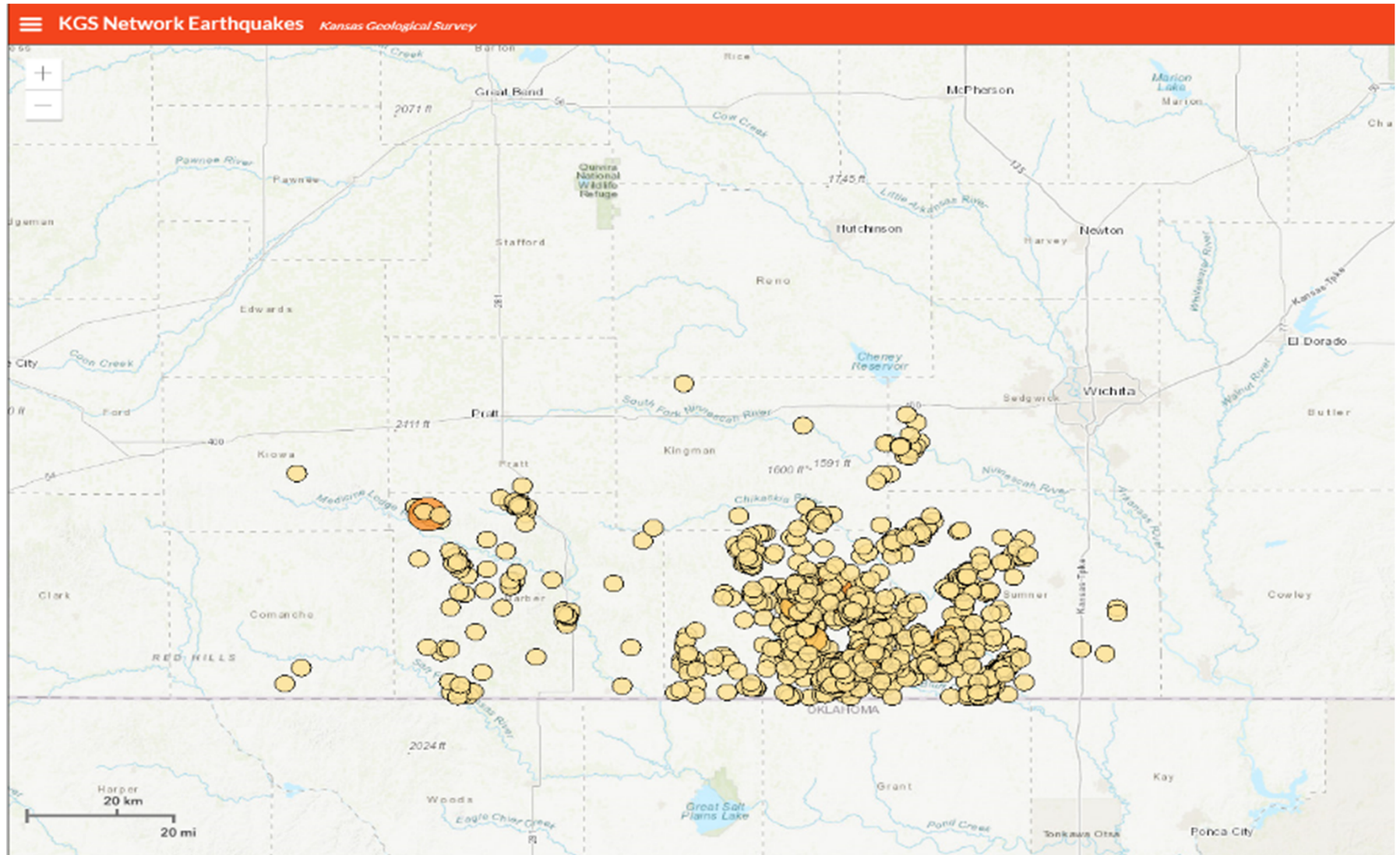
 15-Mile Search Radius Around Earthquake Cluster



Data Sources: ESR, RSDMS, KGS, DASC, USGS
Date: 06/23/2019

2015 KGS Network Earthquakes

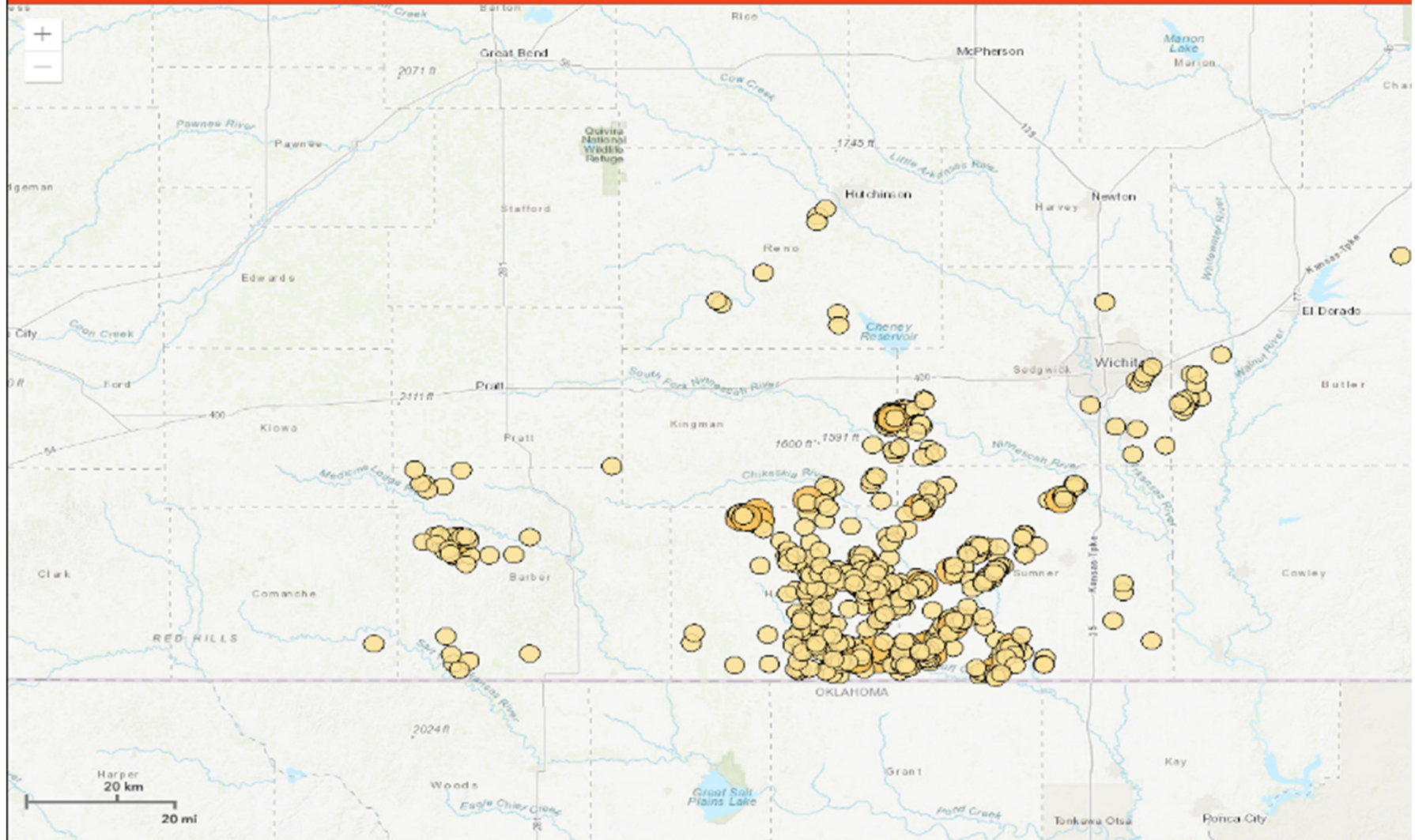
http://maps.kgs.ku.edu/earthquake_mini_viewer/



2016 KGS Network Earthquakes

http://maps.kgs.ku.edu/earthquake_mini_viewer/

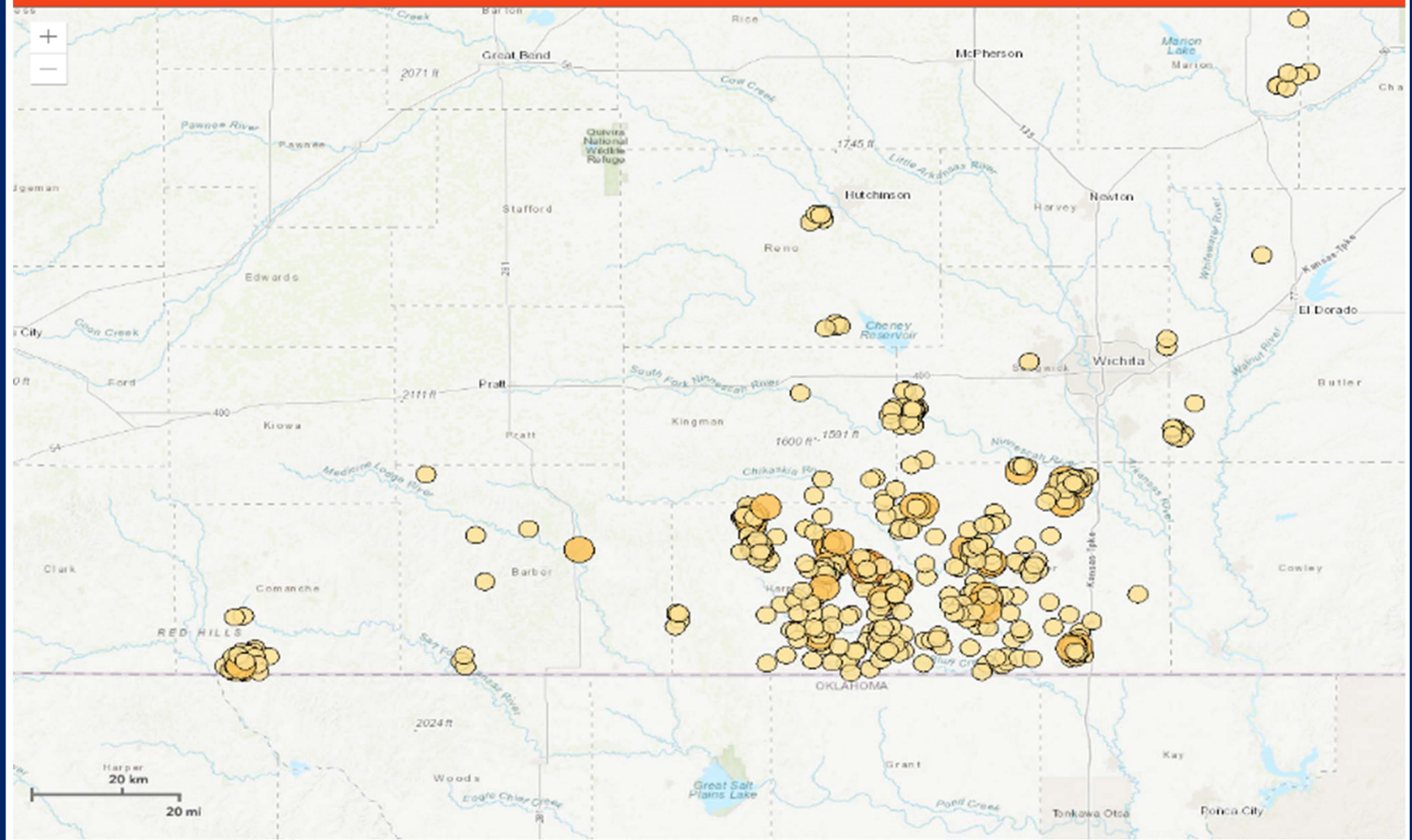
KGS Network Earthquakes *Kansas Geological Survey*



2017 KGS Network Earthquakes

http://maps.kgs.ku.edu/earthquake_mini_viewer/

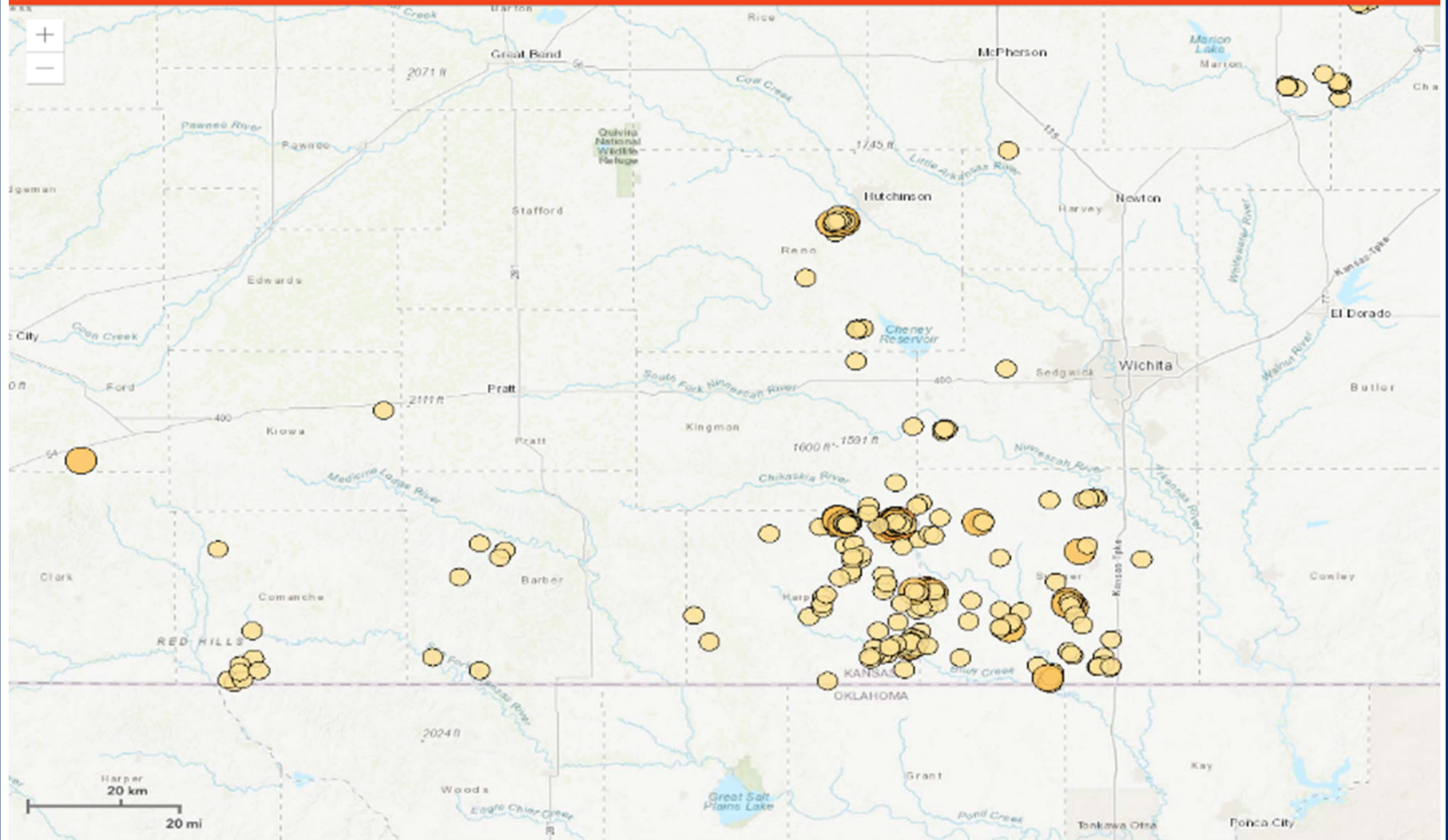
☰ KGS Network Earthquakes *Kansas Geological Survey*



2018 KGS Network Earthquakes

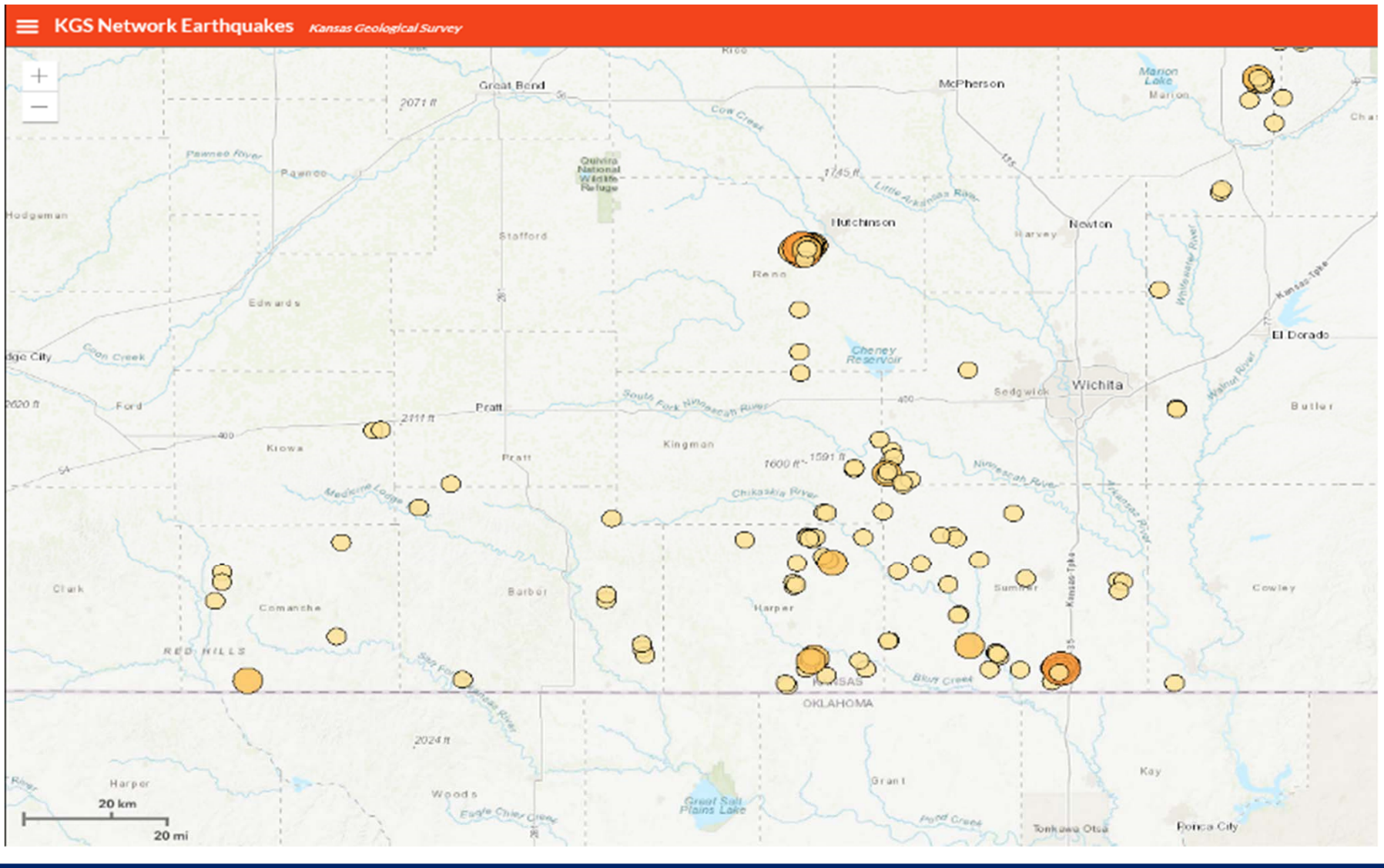
http://maps.kgs.ku.edu/earthquake_mini_viewer/

☰ KGS Network Earthquakes *Kansas Geological Survey*

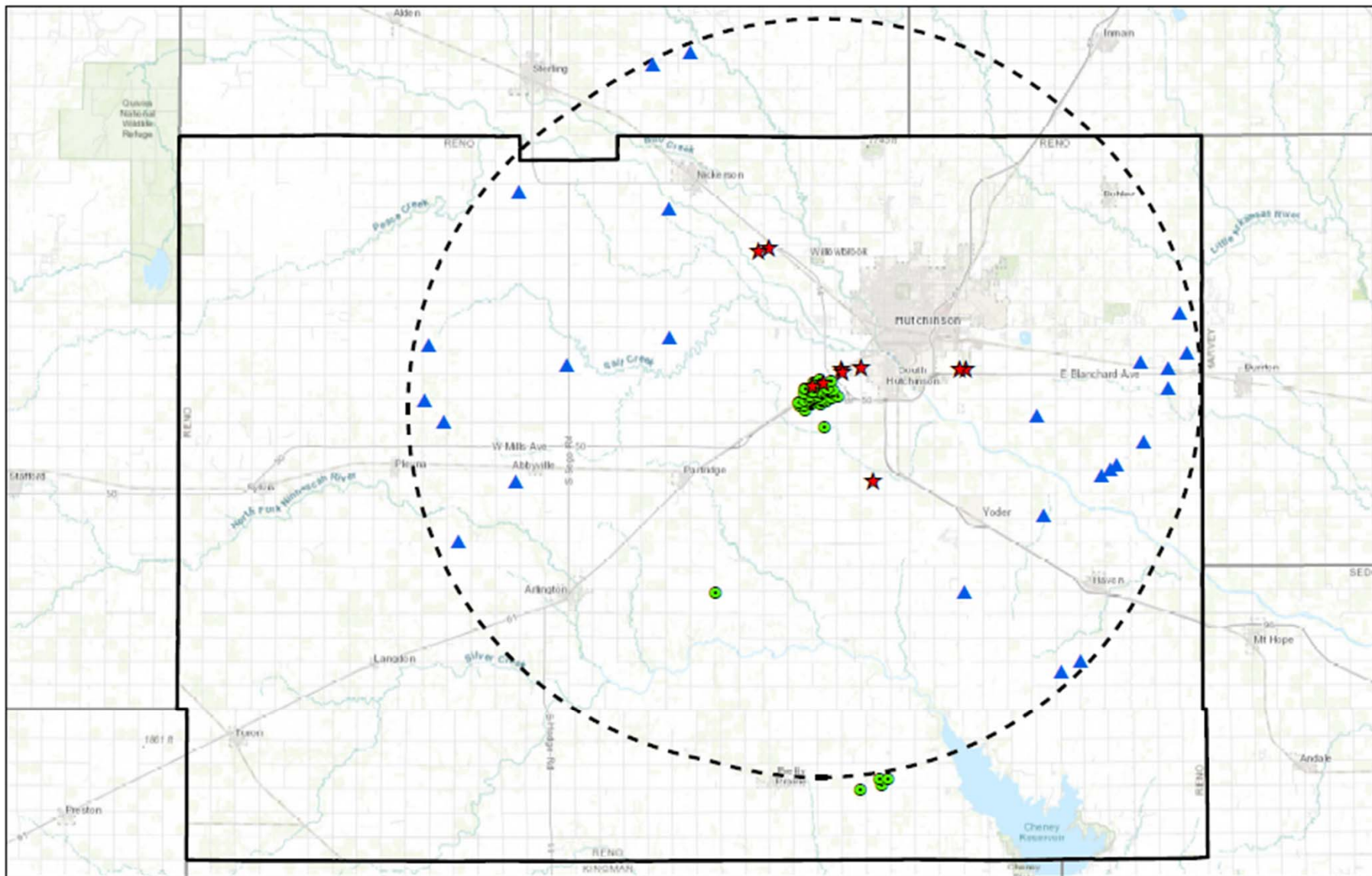








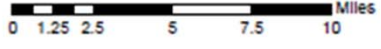

2019 KGS Network Earthquakes

http://maps.kgs.ku.edu/earthquake_mini_viewer/



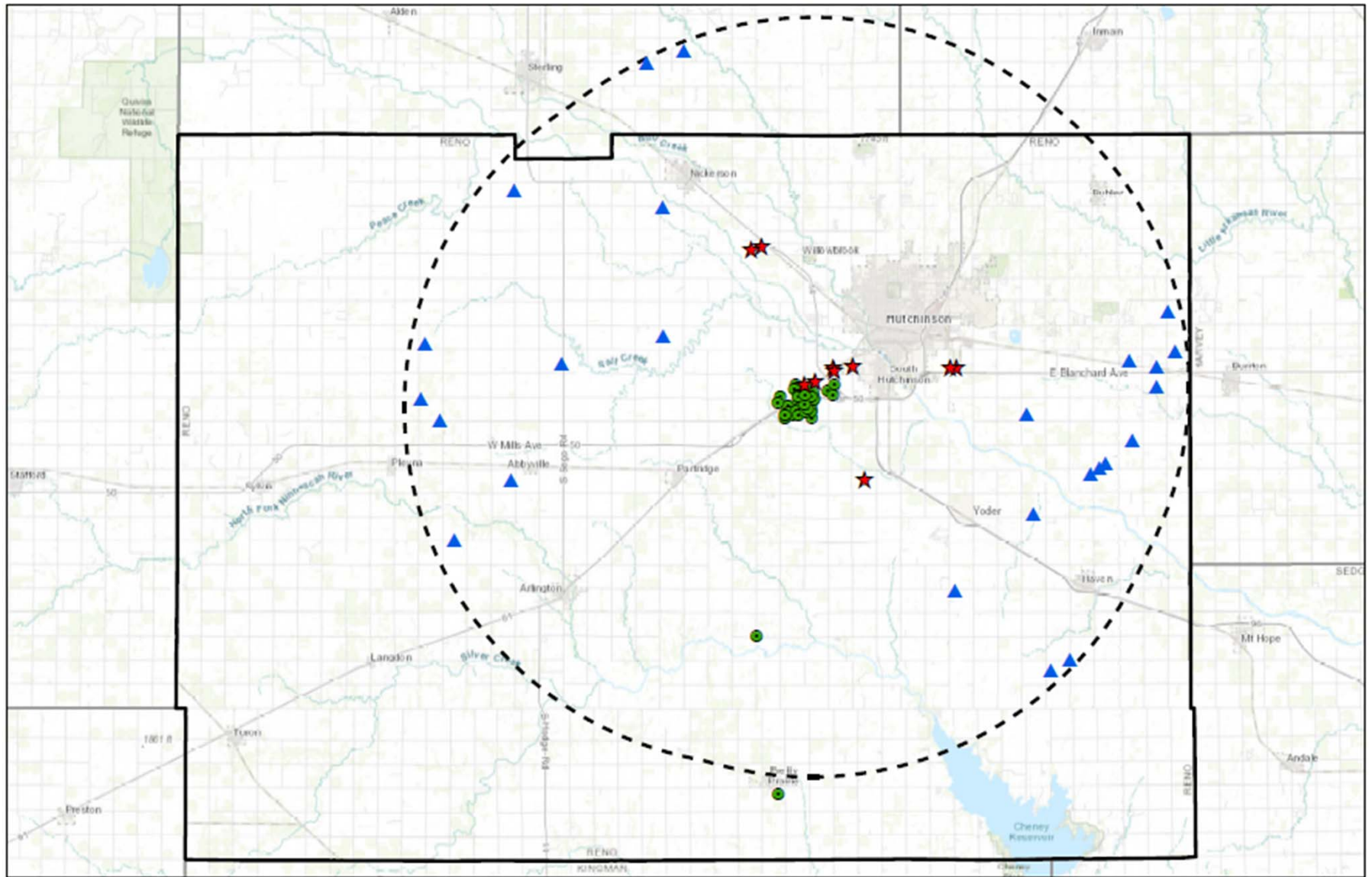
Reno County Class I & Class II Arbuckle SWD Well Locations Within the 15-Mile Radius of 2019 Earthquake Cluster With All 2018 Reno County Earthquakes



 2018 Earthquake Epicenters	 Class II Arbuckle SWD Wells	 Reno County Boundary			
 15-Mile Search Radius	 Class I Arbuckle SWD Wells	 Kansas County Boundaries			Date: 1/13/2020

Data Sources: ESRI, RBDMS, KGS, DASC, USGS, KDHE, KCC

Reno County Class I & Class II Arbuckle SWD Well Locations Within the 15-Mile Radius of 2019 Earthquake Cluster With All 2019 Reno County Earthquakes



<ul style="list-style-type: none"> ● 2019 Earthquake Epicenters ▲ Class II Arbuckle SWD Wells Reno County Boundary Kansas County Boundaries 	<ul style="list-style-type: none"> 15-Mile Search Radius ★ Class I Arbuckle SWD Wells 	<div style="text-align: right;"> <p>Miles</p> <p>0 1.25 2.5 5 7.5 10</p> </div> <div style="text-align: right;"> <p>N</p> </div>	<p>Date: 1/13/2020</p> <p>Data Sources: ESRI, RSDMS, KGS, DASC, UGGS, KDHE, KCC</p>
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Data Requests and Observations

- Volume Information - correlations
- Total vertical depths – well logs – basement penetration
- Well Testing
- Injection Constituents
- Well Maintenance

Volumes

Class I and Class II Volume* Comparison for 15-mile Radius Surrounding Reno County Earthquakes

Class I = 10 wells Class II = 25 wells

Year	Class I Annual Volume	Class II Annual Volume	Class I Monthly Average	Class II Monthly Average
2015	20,051,154	14,842,795	1,670,929.46	1,236,899.58
2016	20,291,175	13,863,791	1,690,931.29	1,155,315.92
2017	19,524,792	14,081,320	1,627,065.97	1,173,443.33
2018	19,435,893	14,017,617	1,619,657.77	1,168,134.75
2019**	13,368,187	7,586,087	1,671,023.38	948,260.88

* Volume is in barrels.

**Through August 31, 2019.

**City of Hutchinson #1
Geologist Report 2005:
TVD ~ 4,730'**

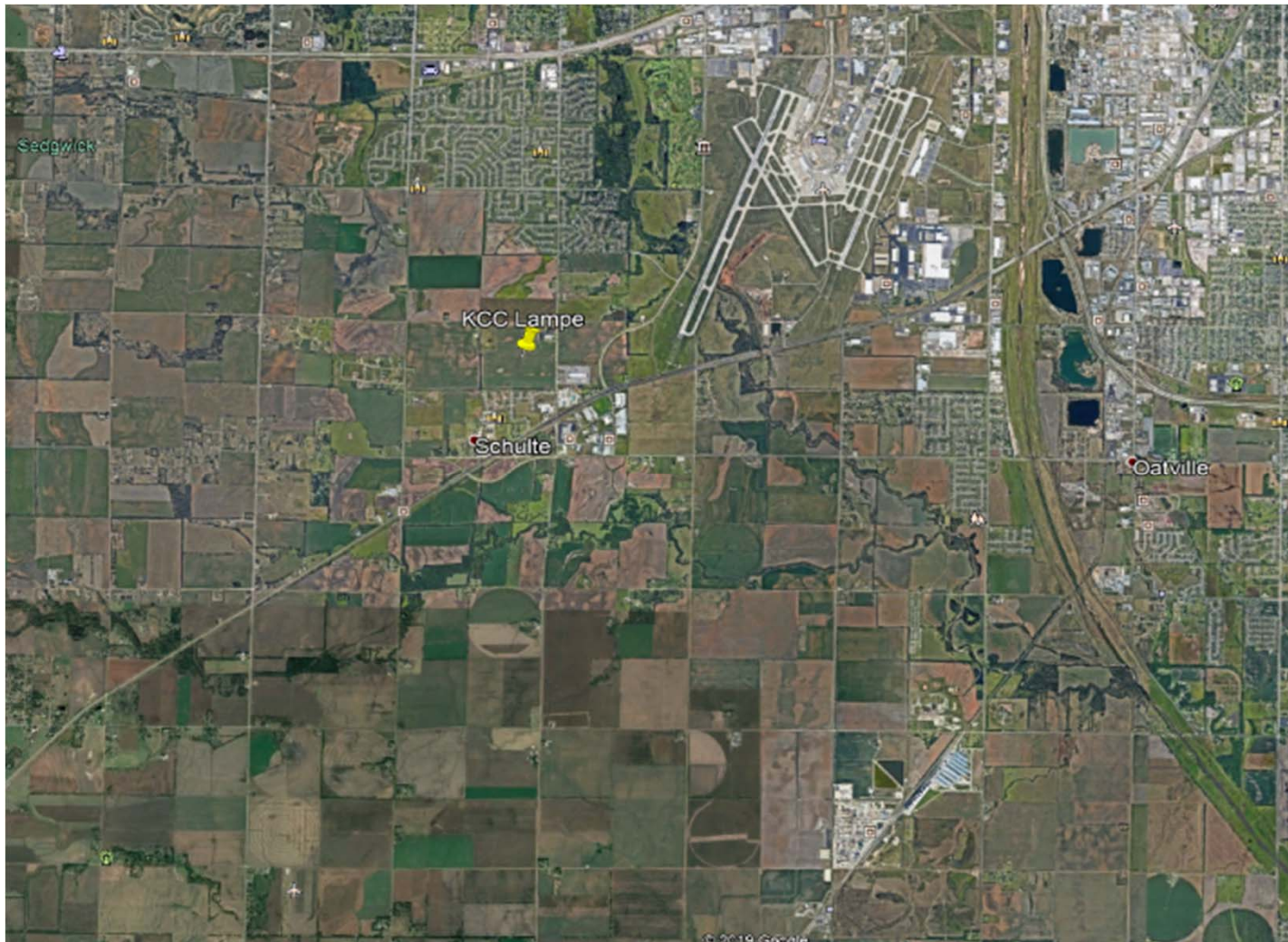


← Top of Arbuckle 3,979'

← Reagan Sand 4,617'

← Granite Wash 4,705'

Well Maintenance



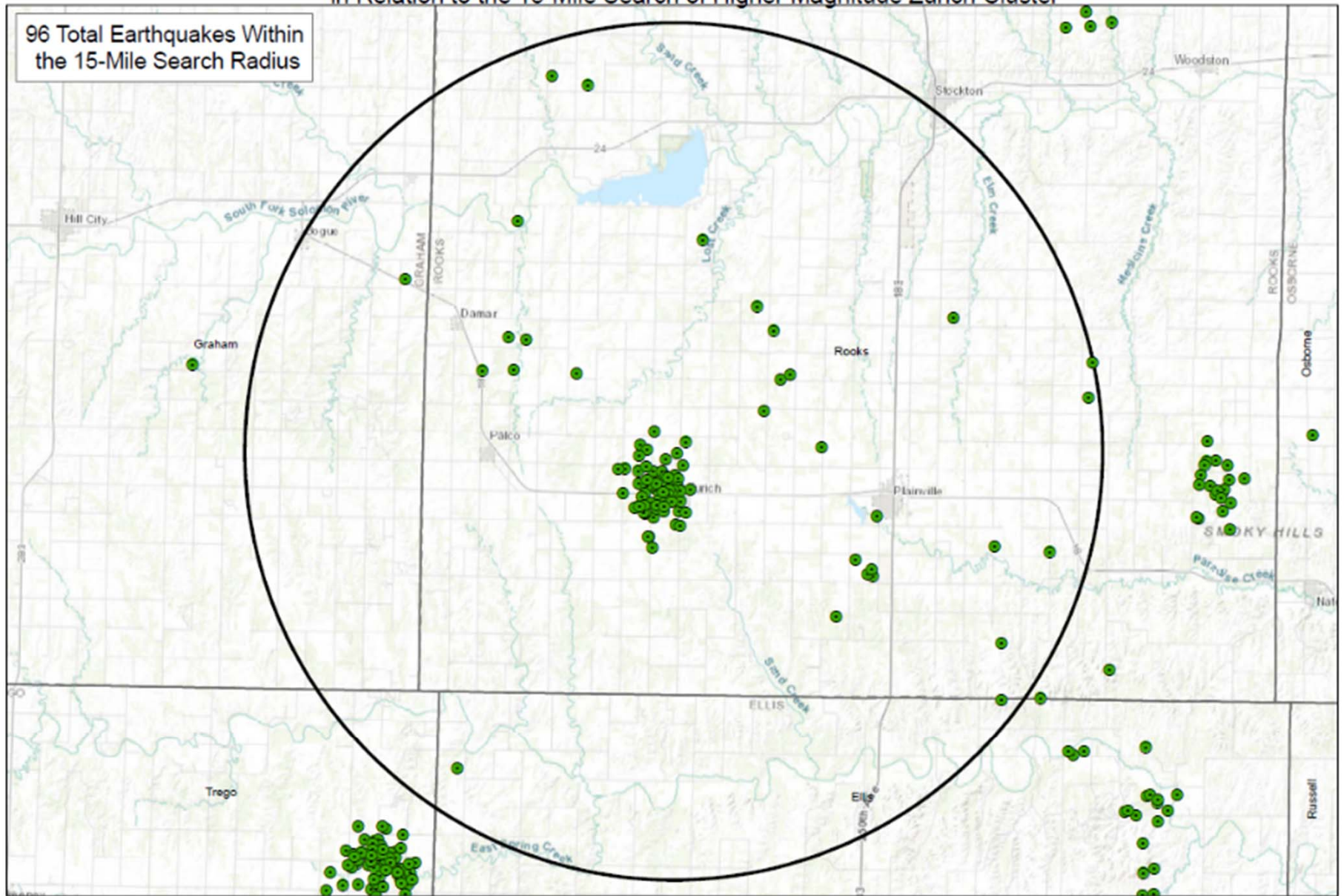
Well Maintenance



- 2018: The KCC contracted for workover operations to clean up formation.
- SFL: 129'
- BHP: 1,584.5 psig
- 2019: Re-ran SFL and BHP.
- SFL: 190'
- BHP: 1,611.1 psig

All Earthquakes of Magnitude 2.0 or Greater Occurring From 2016-Present
in Relation to the 15-Mile Search of Higher Magnitude Zurich Cluster

96 Total Earthquakes Within
the 15-Mile Search Radius

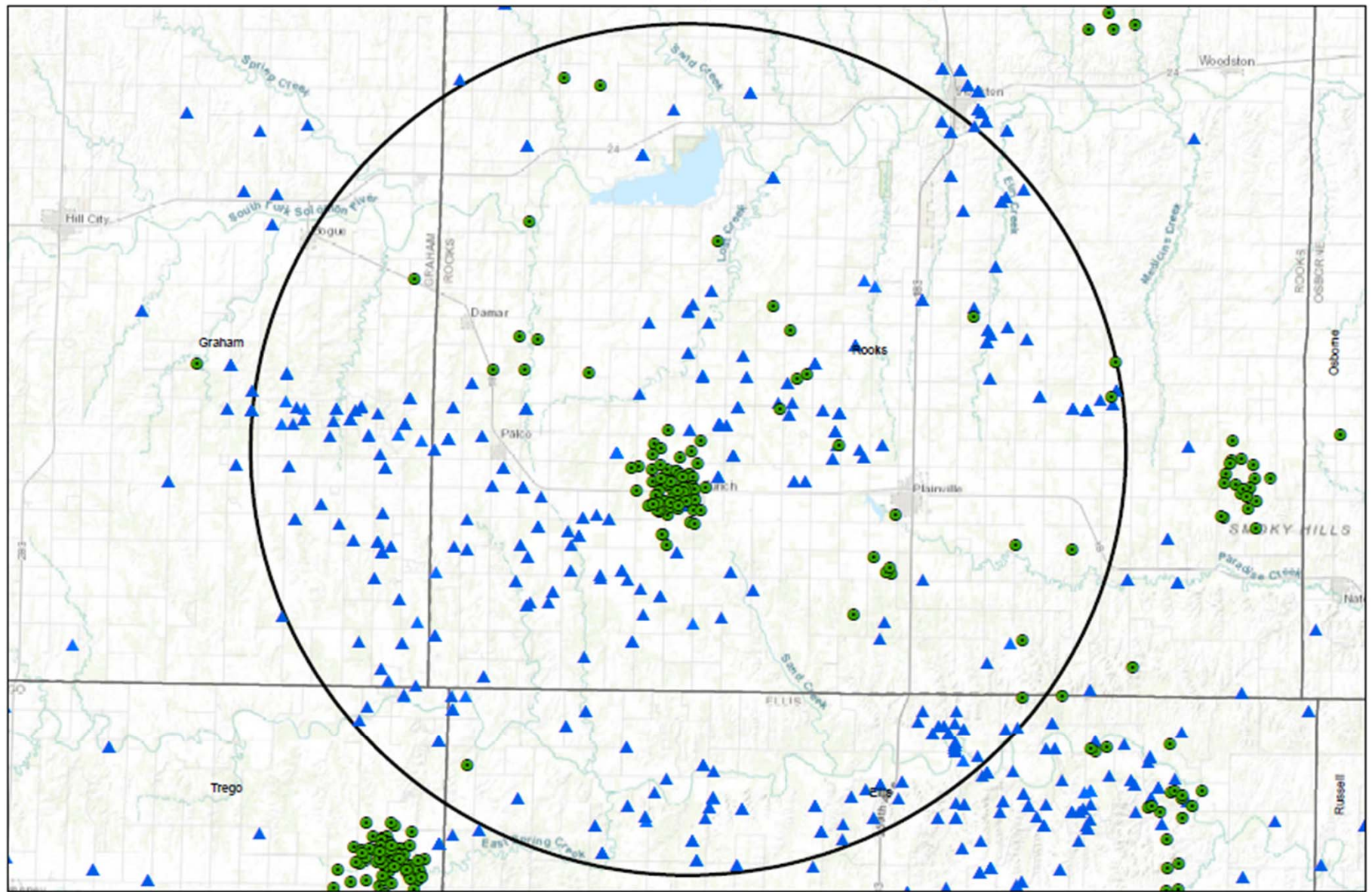


● Earthquake Epicenters □ County Boundaries

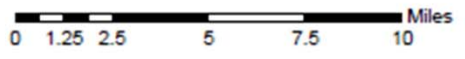


Data Sources: EDR1, RBDMG, KGS, DASC, USGS, KDHE, KCC
Date: 12/11/2019

Arbuckle SWD Wells and All Earthquakes Occurring from 2016-2019

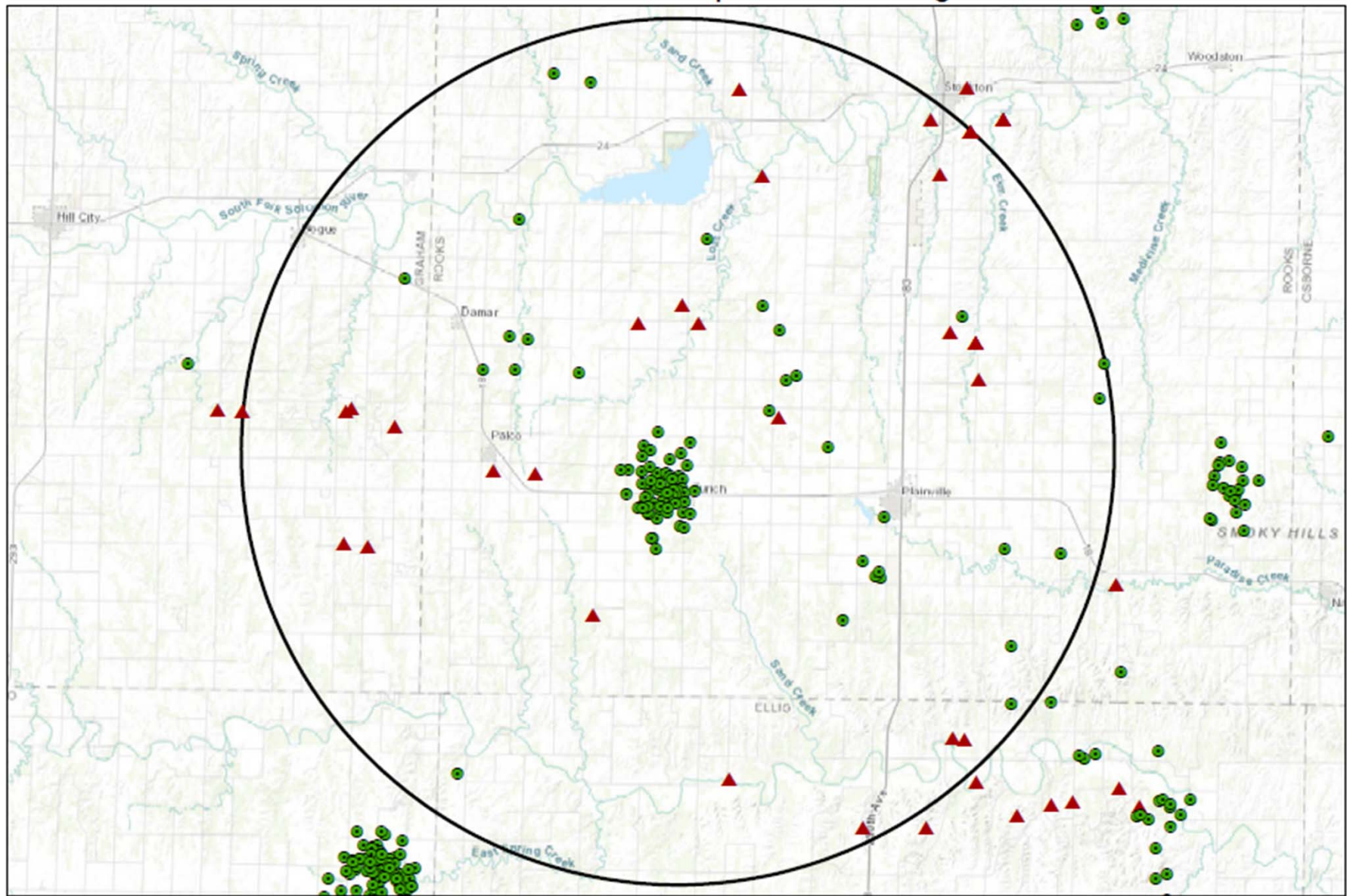


- Earthquake Epicenters
- ▲ Arbuckle SWD Wells
- County Boundaries



Data Sources: ESRI, RBOMS, KGS, DASC, USGS, KDHE, KCC
Date: 12/11/2019

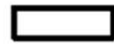
Granite Wash SWD Wells and All Earthquakes Occurring from 2016 - 2019



Earthquake Epicenters



Granite Wash SWD Wells



15-Mile Search Radius

0 1.25 2.5 5 7.5 10 Miles

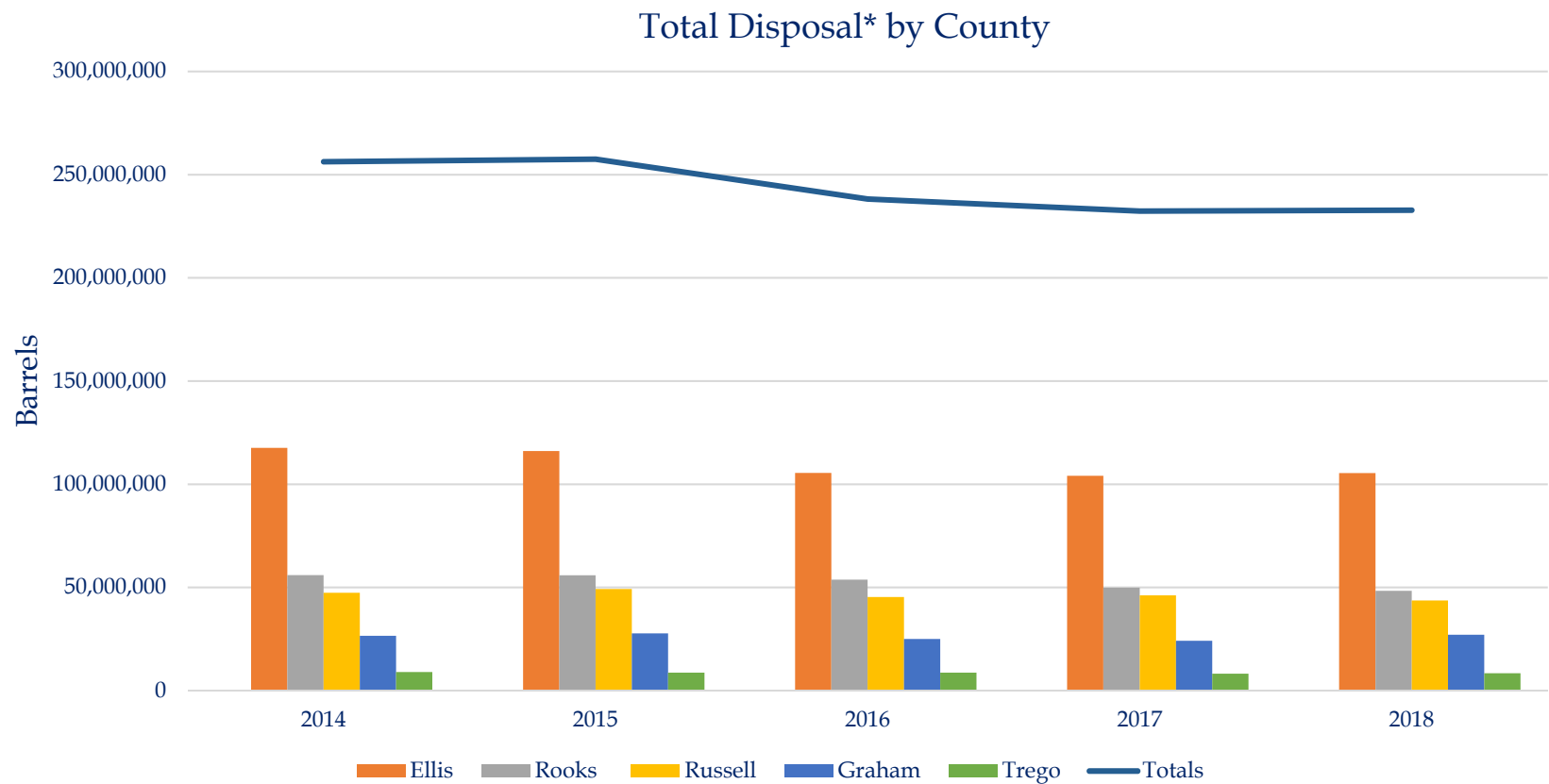


Data Sources: ESRI, RSDMS, KGS, DASC, USGS, KDHE, KCC
Date: 12/11/2019

Rooks County Area Volumes

County	2014	2015	2016	2017	2018
Ellis	117,593,773	116,027,906	105,442,931	104,071,954	105,373,687
Rooks	55,902,699	55,890,565	53,762,838	49,861,275	48,318,689
Russell	47,364,859	49,210,114	45,360,589	46,131,512	43,654,056
Graham	26,493,305	27,698,516	25,006,260	24,120,299	27,062,568
Trego	8,953,171	8,706,150	8,647,690	8,160,765	8,397,911
Total	256,307,807	257,533,251	238,220,308	232,345,805	232,806,911

Rooks County Area Volumes



*Includes all disposal zones.

Ryan A. Hoffman

Director, Conservation Division

Conservation Division

Kansas Corporation Commission

266 N. Main, Suite 220 Wichita, KS 67202

Phone (316) 337-6200 | Fax (316) 337-6211

<http://kcc.ks.gov/>

