Municipality of Anchorage Geotechnical Advisory Commission Work Session

SEPTEMBER 13, 2022

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Agenda

- GAC Background: Roles of the Commission
- Goals of the Discussion
- 2018 M_W 7.1 Anchorage Earthquake Background
- BSSA Definition
- Earthquake Damage Poster
- EERI LFE Report

- Revisiting the Resolution

Roles of the Commission

- Title 21 (21.02.080)
  - The GAC has the responsibility "to make recommendations and give advice on geotechnical and natural hazards risk mitigation."
- GAC Charter
  - All of the GAC recommendations to the Anchorage Assembly shall be made by resolution (excerpt from 4.05.120)
- GAC Recommendations are only advisory and are acted on by other Bodies to establish policy, if/when desired (with public process)

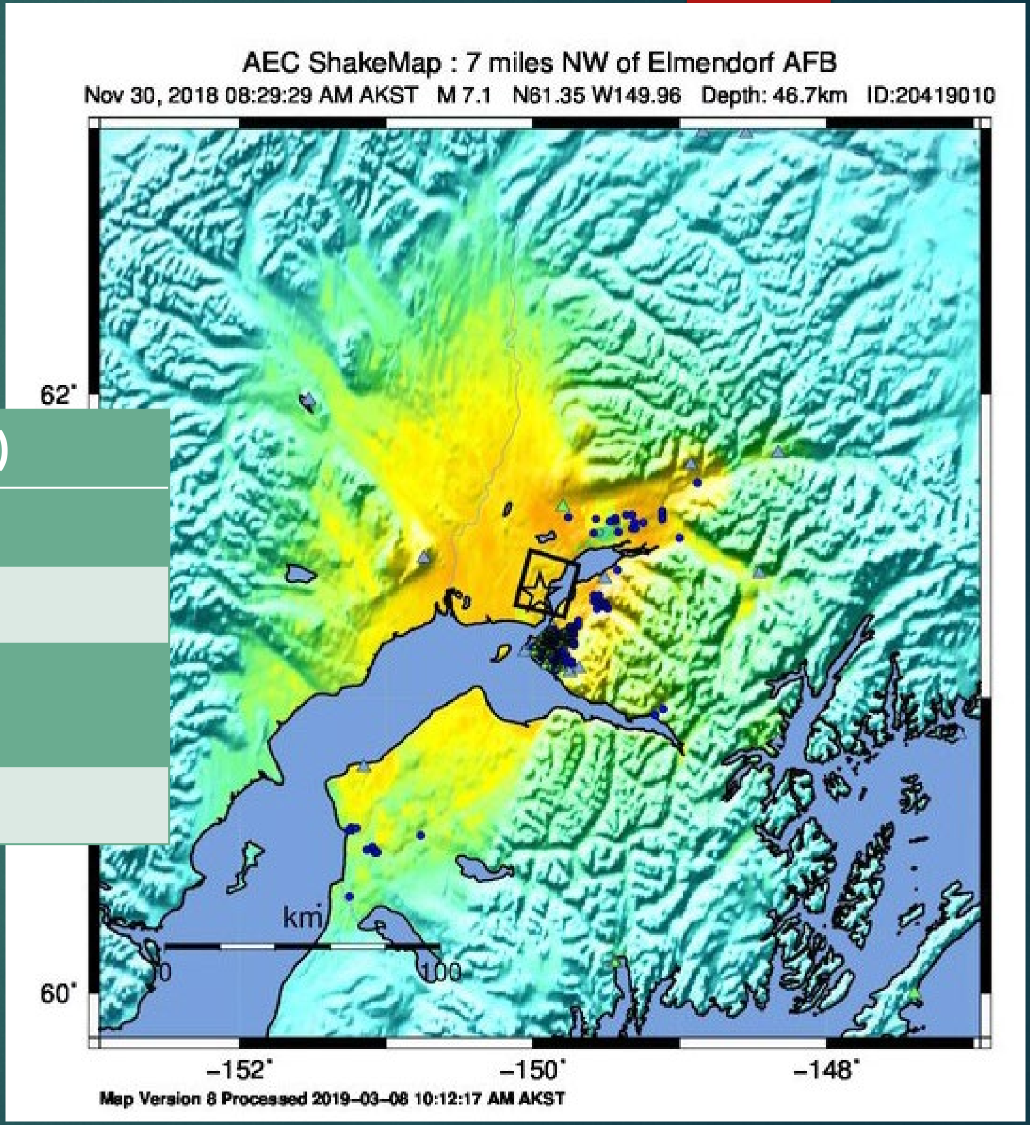
Goals of the Discussion

- Discuss a brief overview of the 2018 earthquake and subsequent damage
- Review the findings and recommendations of several groups
  - Alaska Earthquake Symposium Poster
  - Earthquake Engineering Research Institute (EERI) Learning from Earthquakes (LFE) Report
- Review of the working draft resolution
  - July draft resolution
  - Topic discussed in earnest since April 2022
  - One of the goals of the GAC for several years

2018 M_W 7.1 Anchorage Earthquake

- 46.7km deep
- Largest event since 1964 for Anchorage
- Duration: 20 to 25 seconds

Station	Epicentral Distance (km)	PGA (g)
Chugiak Fire Station	24.1	0.298
Mears Middle School	24.2	0.241
Fire Station #12 (Seward Highway)	22.5	0.463
Kincaid Park	22.1	0.326



*On a side note, additional strong motion stations have been installed in Eagle River

Peak ground acceleration (PGA)

Building Safety Service Area Definition: MOA Website

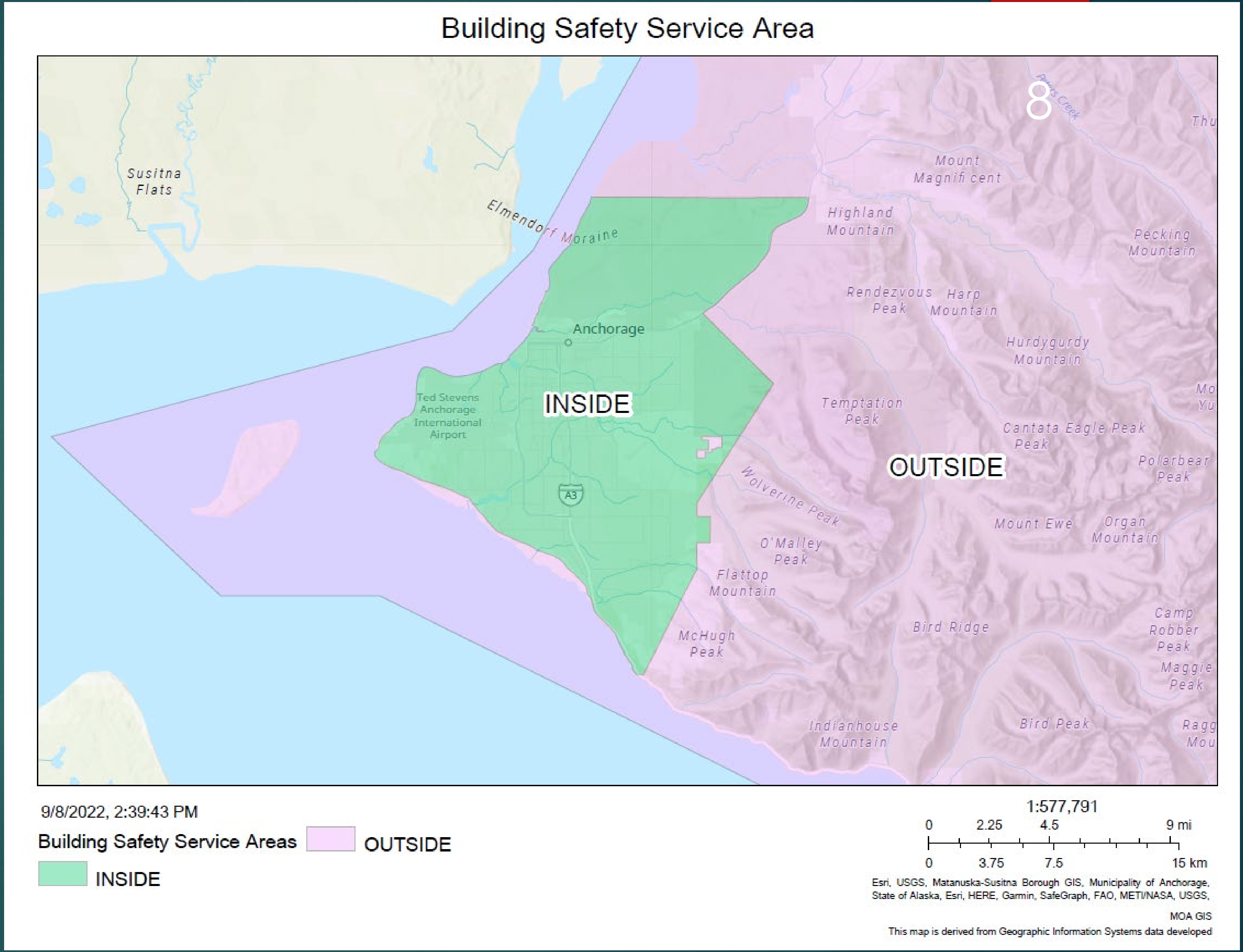
- There are 2 different types of Residential permits:
- Inside the Building Safety Service Area (BSSA) - Any owner or authorized agent intending to construct, enlarge, large, alter, repair, move, demolish, or change the occupancy of a building, structure or portion thereof, or to erect, install, enlarge, alter, repair, remove, convert or replace any electrical, gas, mechanical or plumbing system, the install of which is regulated by this code, or to cause any such work to be done, shall first make application to the building official and obtain the required permit unless work is specifically exempted by this code.
- Outside the Building Safety Service Area (BSSA) - Land use permits are required for new buildings, additions, a change in use/occupancy of the structure.

Building Safety Service Area Definition: What this Means

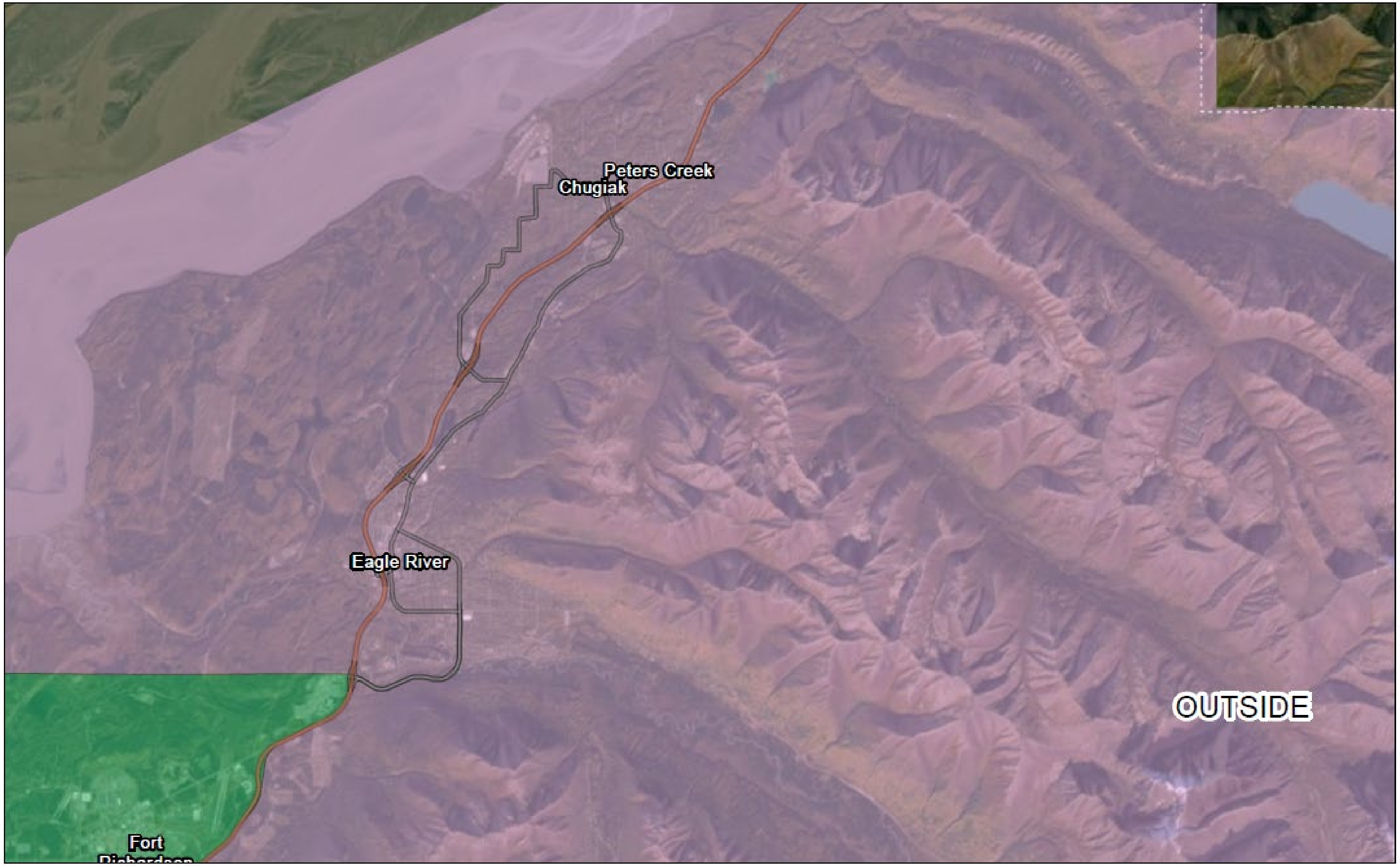
- Within the BSSA
  - Obtain Building Permit
    - Land use permit
    - Structural Plan Review (2 potential processes)
    - MOA Structural Inspections
- Outside the BSSA
  - Land use permit prior to construction
    - Land use inspection by MOA (not structural or fire/life safety)

Note: These are the requirements within the MOA Building Safety. This does not include other requirements that banks, or other loan institutions may have in place.

- Communities outside BSSA:
  - Eagle River
  - Chugiak
  - Part of Anchorage Hillside
  - Turnagain Arm
  - Girdwood



Building Safety Service Area



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Building Safety Service Areas — OUTSIDE

INSIDE

1:288,895

0 1 2 4 mi

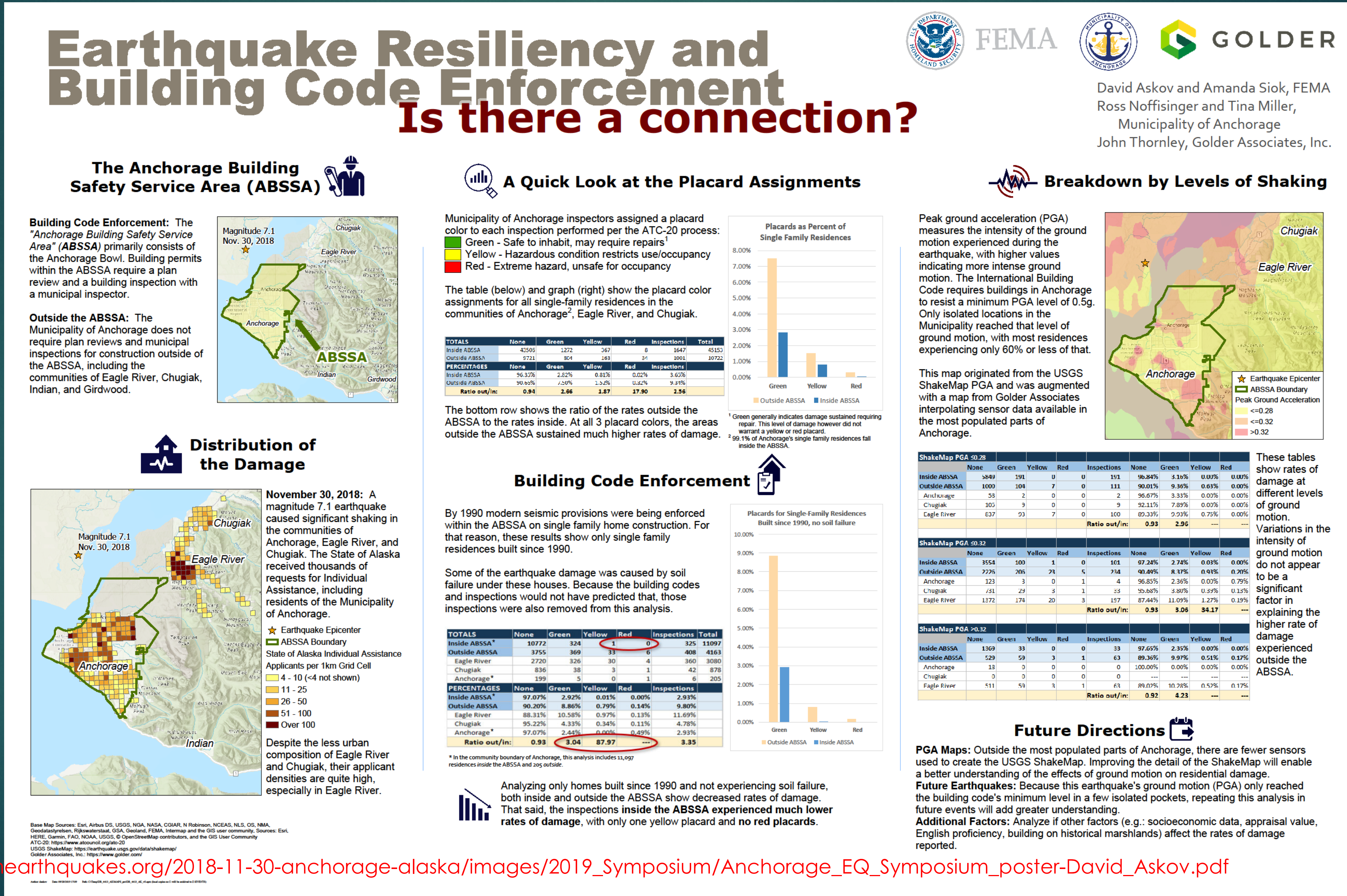
0 1.75 3.5 7 km

Earthstar Geographics, Matanuska-Susitna Borough GIS, Municipality of Anchorage, State of Alaska, Esri, HERE, Garmin, SafeGraph, METI/NASA,

MOA GIS

This map is derived from Geographic Information Systems data developed

Eagle River Damage Comparison



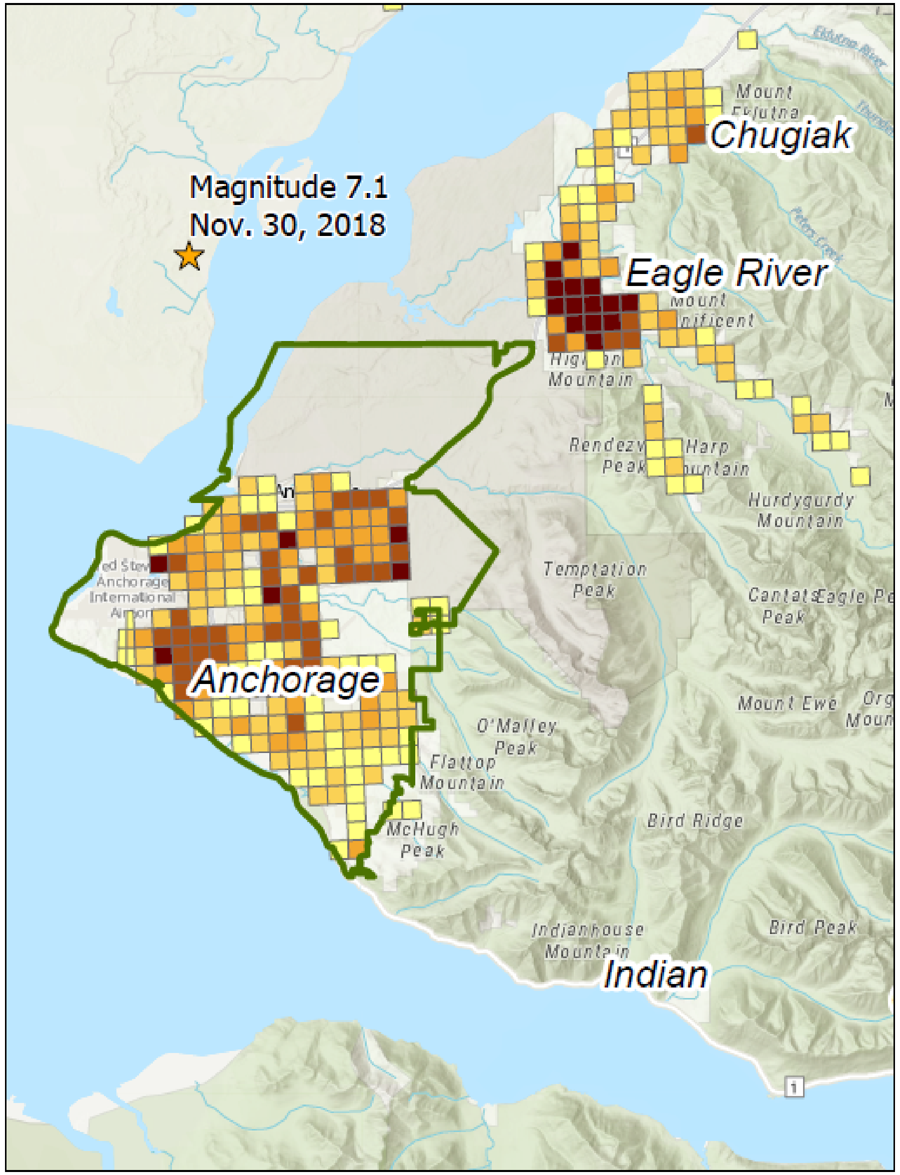
http://www.learningfromearthquakes.org/2018-11-30-anchorage-alaska/images/2019_Symposium/Anchorage_EQ_Symposium_poster-David_Askov.pdf

Damage Distribution

- Summary of the State of Alaska Individual Assistance requests

Image from Askov et al. 2019 Poster

Distribution of the Damage



November 30, 2018: A magnitude 7.1 earthquake caused significant shaking in the communities of Anchorage, Eagle River, and Chugiak. The State of Alaska received thousands of requests for Individual Assistance, including residents of the Municipality of Anchorage.

- ☆ Earthquake Epicenter
- ABSSA Boundary

State of Alaska Individual Assistance Applicants per 1km Grid Cell

- 4 - 10 (<4 not shown)
- 11 - 25
- 26 - 50
- 51 - 100
- Over 100

Despite the less urban composition of Eagle River and Chugiak, their applicant densities are quite high, especially in Eagle River.

A Quick Look at the Placard Assignments

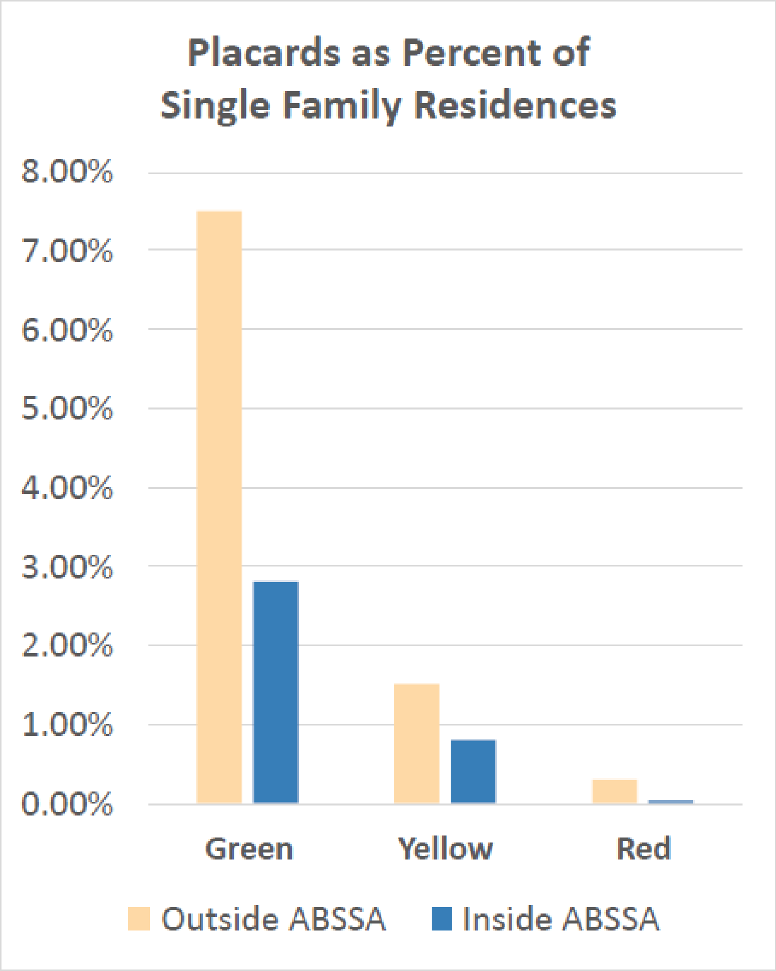
Municipality of Anchorage inspectors assigned a placard color to each inspection performed per the ATC-20 process:

- Green - Safe to inhabit, may require repairs[1]
- Yellow - Hazardous condition restricts use/occupancy
- Red - Extreme hazard, unsafe for occupancy

The table (below) and graph (right) show the placard color assignments for all single-family residences in the communities of Anchorage[2], Eagle River, and Chugiak.

TOTALS	None	Green	Yellow	Red	Inspections	Total
Inside ABSSA	43506	1272	367	8	1647	45153
Outside ABSSA	9721	804	163	34	1001	10722
PERCENTAGES	**None**	**Green**	**Yellow**	**Red**	**Inspections**	
Inside ABSSA	96.35%	2.82%	0.81%	0.02%	3.65%	
Outside ABSSA	90.66%	7.50%	1.52%	0.32%	9.34%	
Ratio out/in:	**0.94**	**2.66**	**1.87**	**17.90**	**2.56**	

The bottom row shows the ratio of the rates outside the ABSSA to the rates inside. At all 3 placard colors, the areas outside the ABSSA sustained much higher rates of damage.



[1] Green generally indicates damage sustained requiring repair. This level of damage however did not warrant a yellow or red placard.

[2] 99.1% of Anchorage's single family residences fall inside the ABSSA.

Image from Askov et al. 2019 Poster

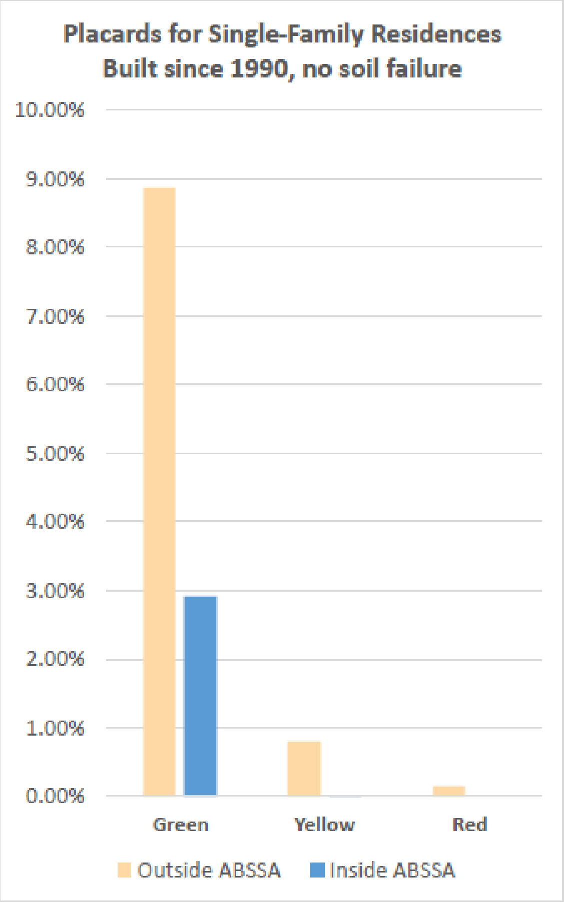
Building Code Enforcement

By 1990 modern seismic provisions were being enforced within the ABSSA on single family home construction. For that reason, these results show only single family residences built since 1990.

Some of the earthquake damage was caused by soil failure under these houses. Because the building codes and inspections would not have predicted that, those inspections were also removed from this analysis.

TOTALS	None	Green	Yellow	Red	Inspections	Total
Inside ABSSA*	10772	324	1	0	325	11097
Outside ABSSA	3755	369	33	6	408	4163
Eagle River	2720	326	30	4	360	3080
Chugiak	836	38	3	1	42	878
Anchorage*	199	5	0	1	6	205
PERCENTAGES	**None**	**Green**	**Yellow**	**Red**	**Inspections**	
Inside ABSSA*	97.07%	2.92%	0.01%	0.00%	2.93%	
Outside ABSSA	90.20%	8.86%	0.79%	0.14%	9.80%	
Eagle River	88.31%	10.58%	0.97%	0.13%	11.69%	
Chugiak	95.22%	4.33%	0.34%	0.11%	4.78%	
Anchorage*	97.07%	2.44%	0.00%	0.49%	2.93%	
Ratio out/in:	**0.93**	**3.04**	**87.97**	**---**	**3.35**	

* In the community boundary of Anchorage, this analysis includes 11,097 residences *inside* the ABSSA and 205 *outside*.



Analyzing only homes built since 1990 and not experiencing soil failure, both inside and outside the ABSSA show decreased rates of damage. That said, the inspections **inside the ABSSA experienced much lower rates of damage**, with only one yellow placard and **no red placards**.

Image from Askov et al. 2019 Poster

EERI Earthquake Reconnaissance Report:

M7.1 Anchorage Earthquake on November 30, 2018

EERI

Wael M. Hassan, John Thornley, Janise Rodgers, and Christopher Motter

July 2021

A product of the EERI Learning from Earthquakes Program

http://www.learningfromearthquakes.org/2018-11-30-anchorage-alaska/images/2018_11_30_Anchorage_Alaska/pdf/EERI-LFE-2018-Anchorage-Earthquake-Report-Final-web.pdf

EERI LFE Report Chapter 10: FEMA Study Recommendations (Relevant to today's discussion)

10.3.3 Recommendations to Strengthen Resilience to Earthquakes

1. Post-event inspections throughout declared boroughs found a patchwork of regulatory oversight and enforcement for compliance with state policy, regulations, local codes, and seismic standards. Transparency and consistency of minimum seismic standards should be accomplished by

   e) **Requiring independent third-party inspections of structural design and construction.** To ensure proper enforcement of compliance to minimum seismic standards, review of design and inspection of construction is needed prior to issuance of building permits and certificates of occupancy for all construction. Inspection duties should be delegated to local jurisdictional authorities and the state to avoid conflicts of interest between builder and inspector. Third-party inspections of design and construction practices will result in development of a more resilient building stock and reduce the costs of future disasters.

3. Because of the lack of code adoption and enforcement, the true seismic vulnerability of Alaska's building stock is unknown. Awareness and understanding of seismic vulnerabilities can be improved by

   a) **Conducting a public awareness campaign on building codes for earthquake safety.** There is a need for meaningful engagement of public officials, developers, realtors, contractors, building owners, and the general public about seismic hazards and building requirements. Targeting individual audiences with messages and attainable actions to take ownership of risk reduction will motivate investments in mitigation and build a culture of preparedness.

EERI LFE Conclusions (Relevant to today's discussion)

11.3.1 Building Stock and Damage Distribution

- Eagle River and Chugiak areas experienced the heaviest structural damage in Southcentral Alaska during the earthquake, especially single-family wood buildings and CMU buildings. The ratio of red-tagged buildings to building stock size in Northern Communities outside the ABSSA zone was 18-20 times higher compared with that within ABSSA. Many buildings in Northern Communities lacked a defined lateral load–resisting system. Anchorage Bowl and Mat-Su Borough experienced light structural damage except in some CMU buildings. Sand Lake and Jewel Lake neighborhoods in Anchorage exhibited relatively heavier damage than the rest of Anchorage; however, it was mostly soil failure related without serious structural damage. The highest PGA was recorded in Rabbit Creek (South Anchorage), yet minimal damage occurred there. Pre-1990 Anchorage buildings, especially those built 1975-1990, had more structural and nonstructural damage than those built after 1990. Short period low-rise and mid-rise buildings had more damage than relatively high-rise buildings in Anchorage.
- Based on these observations, the same old lesson of the importance of following building codes can be confidently reaffirmed. Following building codes should not be optional under any circumstances in any habitable building, or in nonbuilding structures serving the public. Building codes should be enforced, especially in areas with high seismic hazard.
- Based on structural damage and distribution observed, it is clear that nonengineered buildings in Southcentral Alaska constitute a significant seismic risk to the life or property of a large population in the region. Statistics on the number of people who live in nonengineered or poorly constructed buildings are not readily available, but a rough estimate based on this reconnaissance effort is that up to 50% of the 400,000 residents of the Municipality of Anchorage and the Mat-Su Borough live or work in nonengineered or potentially poorly-built buildings.

EERI LFE Conclusions (Relevant to today's discussion) – cont.

- Damage of residential wood buildings, especially single-family units, varied widely based on location. Structural damage in Anchorage Bowl was much less significant than in Northern Communities, especially Eagle River, which suffered widespread structural damage because of a lack of building code enforcement, as detailed previously. The magnitude of the problem of non-engineered buildings is not precisely known; however, the substantial structural damage during the earthquake, which is a relatively short-duration deep event with a relatively smaller shaking intensity compared to the 0.5g design earthquake, based on DYFI PGA of about 0.32g, is a good indicator that a large portion of the Northern Communities' non-engineered buildings with significant vulnerabilities may be at high risk of severe seismic damage (or even collapse) during a more significant event. Because shaking was not as strong, Girdwood and Turnagain did not suffer notable structural damage in wood-frame buildings.
- In Anchorage Bowl, most of the structural damage in wood buildings was due to geotechnical problems, nonengineered attachments, such as external balcony decks, and relatively older buildings constructed prior to the 1990s, when Municipality of Anchorage began to fully enforce building codes. Modern engineered buildings after 1994 suffered only cosmetic drywall cracking in most cases. In the Mat-Su Borough, some residential wood buildings and businesses suffered significant structural damage. About 19 residential wood buildings and 4 businesses suffered major structural damage.

EERI LFE Conclusions (Relevant to today's discussion) – cont.

11.3.4 Recommendations for Seismic Risk Mitigation in Alaska

11.3.4.1 Short-Term Needs

The Alaska State Seismic Hazards Safety Commission, or other policy bodies at the State and municipal/borough level, should consider policy changes based on the results of this study. Mitigation measures that would help mitigate the seismic risk in Alaska are listed in this section.

A. New Construction and Upgrades

- Immediate state legislation is needed to prescribe a mandatory building permitting process, engineering design and plan review, and construction inspection throughout Alaska, including all the communities and unincorporated areas outside the current jurisdiction of the Municipality of Anchorage ABSSA. This should apply to any new construction, building addition, or upgrade. The State of Alaska is encouraged to follow other states' experiences in this regard. For example, the State of Washington State Building Code Act (RCW 19.27): "Adoption of building codes initially was the discretion of individual cities and counties. Passage of the State Building Code Act in 1974 mandated the use of 1973 UBC building codes throughout the state. Since this time, local jurisdictions can make amendments to the code but changes cannot diminish code requirements."

Considerations for the GAC Moving Forward

- New Residential Construction is the focus of today's discussion
  - Key takeaways from the November 2018 Anchorage Earthquake
    - Building Codes are a minimum standard for construction
    - Building Codes save lives
    - Building Codes improve community resiliency
    - Enforcement of the Residential Code is different inside and outside of the BSSA
    - Damage levels and direct observations of both researchers and practicing engineers identify Residential Code enforcement as a key differentiator to home performance after the earthquake
    - The goal of our resolution is to provide the Assembly with recommendations

- Existing Construction should be a future topic of the GAC

Thank you for your time