Completion Memo

Friday, April 30th, 2021

To: Technical Advisory Committee, David Stevens – Research Project Manager, Utah Department of Transportation

From: Steven Bartlett

Subject: Task 7 – Completion Memo for Database Population, TPF-5(350) NGL Lateral Spread study

International Project Participants

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Background

The Next-Generation Liquefaction (NGL) project was launched to (1) substantially improve the quality, transparency, and accessibility of case history data related to ground failure; (2) provide a coordinated framework for supporting studies to augment case history data for conditions important for applications but poorly represented in empirical databases; and (3) provide an open, collaborative process for model development in which developer teams have access to common resources and share ideas and results during model development, to reduce the potential for mistakes and to benefit from best practices mutually. This approach is motivated in part by the success of the Next-Generation of Attenuation (NGA) models for ground motion prediction, which has followed this approach and has had substantial global buy-in and broad application.

The principal investigators for the lateral spread databasing efforts are Drs. Steven Bartlett (U. of Utah) and Dr. Kevin Franke (Brigham Young University). The technical advisory committee (TAC) currently includes representatives from Utah, California, Oregon, Washington State DOTs, and Dominion Energy. The MPC has also provided additional funding for the study.

The primary outcome of this research is a vetted and community database of seismic, topographical, geotechnical, and horizontal displacement measurements about case histories of liquefaction-induced lateral spread for further research and model development by other researchers and investigators under the auspices of the Pacific Earthquake Engineering Research (PEER) Center (http://peer.berkeley.edu/). Secondary outcomes are software development and support required to host and disseminate this database and supporting information.

Students from the University of Utah and Brigham Young University have gathered information about case histories of liquefaction-induced lateral spread. This effort has the following research objectives: (1) develop peer-reviewed and consistent methodology for data documentation and archiving of lateral spread case histories, (2) develop quality assurance protocols for assessing and documenting data quality, (3) develop methods and protocols to quantify uncertainties associated with the collected data, (4) populate the case history database with well-documented examples of liquefaction-induced lateral spread, (5) explore methods of integrating SPT and CPT data into analyses and evaluations, (6) disseminate this database for general use using web-based software tools.

Project Tasks

The following is a list of tasks assigned to Phase I of the project: Project Initiation, Database Screening, Structuring, and Population.

Tasks

1. Kickoff meeting and procurement of software
2. Development of data quality indicators/metrics, quality assurance, and database population protocols
3. Defining methods for quantifying the uncertainty of key inputs
4. Development and structuring of database
5. Selection of case histories
6. Obtaining and screening of case history information
7. Population of case history database (addressed by this memo)
8. Database dissemination

9. Screening criteria for lateral spread potential
10. Phase I Reporting

Table 1 shows those case histories that have been selected for inclusion in the NGL lateral spread database. These case histories are being populated and checked by students of the University of Utah and Brigham Young University under the supervision of Drs. Bartlett and Franke, respectively. The database consists of the earthquake, seismological, topographic, geology, and geotechnical information, which has been structured in the relational database.

Table 2 shows the number of data records that have been compiled for the various data types (e.g., displacement vectors, boreholes, soil information, topology, etc.) by the University of Utah.

Table 3 shows the same information for the data records compiled by Brigham Young University.

Table 1 – List of Case Histories for Databasing as part of Task 7

1906 San Francisco, California Earthquake	Coyote Creek Bridge near Milpitas California
	Mission Creek Zone in San Francisco
	Salinas River Bridge, Salinas California
	South of Market Street Zone in San Francisco
1964 Alaska Earthquake	Bridges 141.1, 147.4, 147.5, 148.3 on Matanuska River, Alaska
	Bridges 63.0, 63.5 on Portage Creek Alaska
	Highway Bridge 629 Placer River, Alaska
	Bridge 605A, Snow River, Alaska
	Bridges, 3.0, 3.2, 3.3, Resurrection River, Alaska
1964 Niigata, Japan Earthquake	Numerous lateral spreads within Niigata City
1971 San Fernando Earthquake	Jensen Filtration Plant, San Fernando, California
	Juvenile Hall, San Fernando, California
1979 Imperial Valley Earthquake	Heber Road near El Centro, California
	River Park near Brawley, California
1983 Borah Peak, Idaho Earthquake	Whiskey Springs near Mackay, Idaho
	Pence Ranch near Mackay, Idaho
1983 Nihonkai-Chubu, Japan Earthquake	Numerous lateral spreads within Noshiro City
1987 Superstition Hills, California Earthquake	Wildlife Instrumentation Array near Brawley, California
1989 Loma Prieta, California Earthquake	Pajaro River
	Moss Landing, Monterey
	Marina District, San Francisco
1990 Luzon Philippines Earthquake	Dagupan City
1991 Costa Rica Earthquake	Railroad and Highway Bridge sites
1994 Northridge, California Earthquake	King Harbor, Redondo Beach
	Balboa Blvd., San Fernando Valley
	Malden Street, San Fernando Valley
	Wynne Avenue, San Fernando Valley
	Potrero Canyon, San Fernando Valley
1995 Kobe, Japan Earthquake	Lateral Spreads on Port Island
	Lateral Spreads on Roko Island
1999 Kocaeli, Turkey Earthquake	Cark Canal Site
	Yakin Street Site

Table 1 - List of case histories selected for databasing as part of Task 7 (continued)

1999 Kocaeli, Turkey Earthquake (continued)	Cumhuriyet Avenue Site
	Sapanca Hotel Site
	Police Station Site, East Izmit Bay
	Soccer Field Site. East Izmit Bay
	Degirmendere Nose Site
	Yalova Harbor Site
1999 Chi-Chi, Taiwan Earthquake	Wufeng Site C
	Wufeng Site C1
	Wufeng Site B
	Wufeng Site M
	Nantou Site N
	Leuw Mei Bridge
2010 Maule, Chile Earthquake	Port Coronel
	Valparaiso
	Llacolen Bridge
	Juan Pablo II Bridge, Concepcion
	La Mochita Bridge, Concepcion
	Tubul Bridge, Tubul
	Mataquito Bridge, Iloca
2011 Tohoku, Japan Earthquake	Several lateral spreads
2010 Darfield, New Zealand Earthquake	Several lateral spreads in and around Christchurch
2011 Christchurch, New Zealand Earthquake	Several lateral spreads in and around Christchurch

Table 2. Data Records Compiled by the University of Utah

Case history	Site	Displacement vectors	Boreholes	Subsurface data rows	Topology points	Cross-checked
1964 Niigata	F10	179	24	359	429	Completed
	G10	654	68	1574	256	Completed
	H9	155	4	92	235	Completed
	J9	442	45	192	297	Completed
	K8	285	4	62	302	
	Total	1715	145	2279	1519	Completed
1983 Noshiro	South	266	128	462	176	
	North	147	59	848	348	
	Total	413	187	1310	524	Completed
1971 San Fernando	Jensen water plant	69	33	494	flat file	
	Juvenile hall	79	6	121	flat file	
	Total	148	39	615		Completed
1964 Alaska	Total	14	20	411		Completed
1979 Imperial Valley	Heber road	29	7	135	flat file	
	River park site	NA	4	62	NA	
	Total	29	11	197		Completed
1983 Borah peak, Idaho	Whiskey springs	3	3	54	flat file	
	Pence Ranch	3	6	69	flat file	
	Total	6	3	54		Completed
1906 San Francisco	Mission creek zone	9	8	92	flat file	
	South of Market area	7	7	80	N.A.	
	Foot of market area	3			NA	
	Total	19	15	172		Completed
1987 Superstition Hills, California		7	2	53	flat files	

Table 2. Data Records Compiled by the University of Utah

Case history	Site	Displacement vectors	Boreholes	Subsurface data rows	Topology points	Cross-checked
1989 Loma Prieta, California		3	15	236	flat files	
1999 ChiChi Taiwan	Site C	20	15		flat files	
	Site C1	4	2			
	Site B	4	6			
	Site M	4	2			
	Site N	4	3			
	Total	34	23	2806		Completed
2010 Chile	Lo Rojas port		8	2494	in progress	Completed
	North and South Pier		7			
	Juan Pablo II Bridge		8			Completed
	La Mochita Bridge		2			Completed
	Llacolen Bridge		6			
	Mataquito Bridge		6			
	Tubul Bridge		6			
	Raqui 1 and Raqui 2 Tubul		1			
	Total	0	21	2494		
1990 Luzon Philippines	11	13	233			Completed
1994 Northridge, California						
1995 Kobe, Japan		3168	156	3273		Completed
1999 Kocaeli, Turkey		4				
Total:		**5564**	**627**	**14018**	**2043**	

Table 3. Data Records Compiled by Brigham Young University

Case history	Site	Displacement vectors	Boreholes	Subsurface data rows	Cross-checked
2010 Maule, Chile	Port Coronel	37	11	6413	Cross Checked Waiting in NGL Queue for Data Entry
	Lo Rojas	13	6		
	Juan Pablo	1	7		
	La Mochita	3	2		
	Mataquito	2	6		
	Tubul Bridge	2	6		
	Tubul Raqui	2	1		
	Llacolen	18	5		
2011 Tohoku, Japan	Hitachinaka	11	2	856	Cross Checked Waiting in NGL Queue for Data Entry
	Isobe	17	3		
	Tone River	1	3		
	Sodegaura	1	3		
	Hokota City	1	2		
2010 Darfield, New Zealand	Avonside Loop	195	11	53404+	Cross Checked Waiting in NGL Queue for Data Entry
	Dallington Loop (Point Bar)	90	10		
	Bend at Locksley Avenue	58	7		
	Avon Park	23	3		
	Avondale	106	7		
	Bexley	120	4		
	Pleasant Point Yacht Club	3	4		
	St.Martins	68	13		
	Dallington Loop (Cut Bank)	46	3		

Table 3. Data Records Compiled by Brigham Young University

Case history	Site	Displacement vectors	Boreholes	Subsurface data rows	Cross-checked
2010 Darfield, New Zealand	Avonside Loop	202	11	53404+	Cross Checked Waiting in NGL Queue for Data Entry
	Dallington Loop (Point Bar)	127	10		
	Bend at Locksley Avenue	63	7		
	Avon Park	22	3		
	Avondale	108	7		
	Bexley	122	4		
	Pleasant Point Yacht Club	3	4		
	St.Martins	68	13		
	Beckenham	86	6		
	Anzac Bridge	66	5		
	Avon Loop	173	44		
	Central Business District	136	74		

Database Structure

The following items are needed to make a case history, event, site, and observations.

Figure 1 Definition of a case history

The database is accessed using a structured query language (SQL). It is the common language use to access relational database management systems. The database structure (i.e., schema) is shown in Figure 2. The relational databases (also called tables) have unique data fields to the specific table and other shared fields used to related or access information in different tables. The schema was the outcome of a broad community effort involving review by the NGL database working group and other attendees. A two-day workshop was held in July 2017 at UC Berkeley involving 50 participants where the schema was presented and modified.

The schema for the general table (i.e., the highest most table in the database structure) is shown in Figure 2. This overview database is used to access the event, site, and observation information for each case history. In this schema, there are primary keys and foreign keys. A **primary key** is a field or a set of fields in a table whose values uniquely identify a record in the table. In contrast, a **foreign key** is a field or a set of fields in a table whose values correspond to the primary key values in another table. The schemas for the site, observation, and event databases are shown in Figures 3 through 5, respectively.

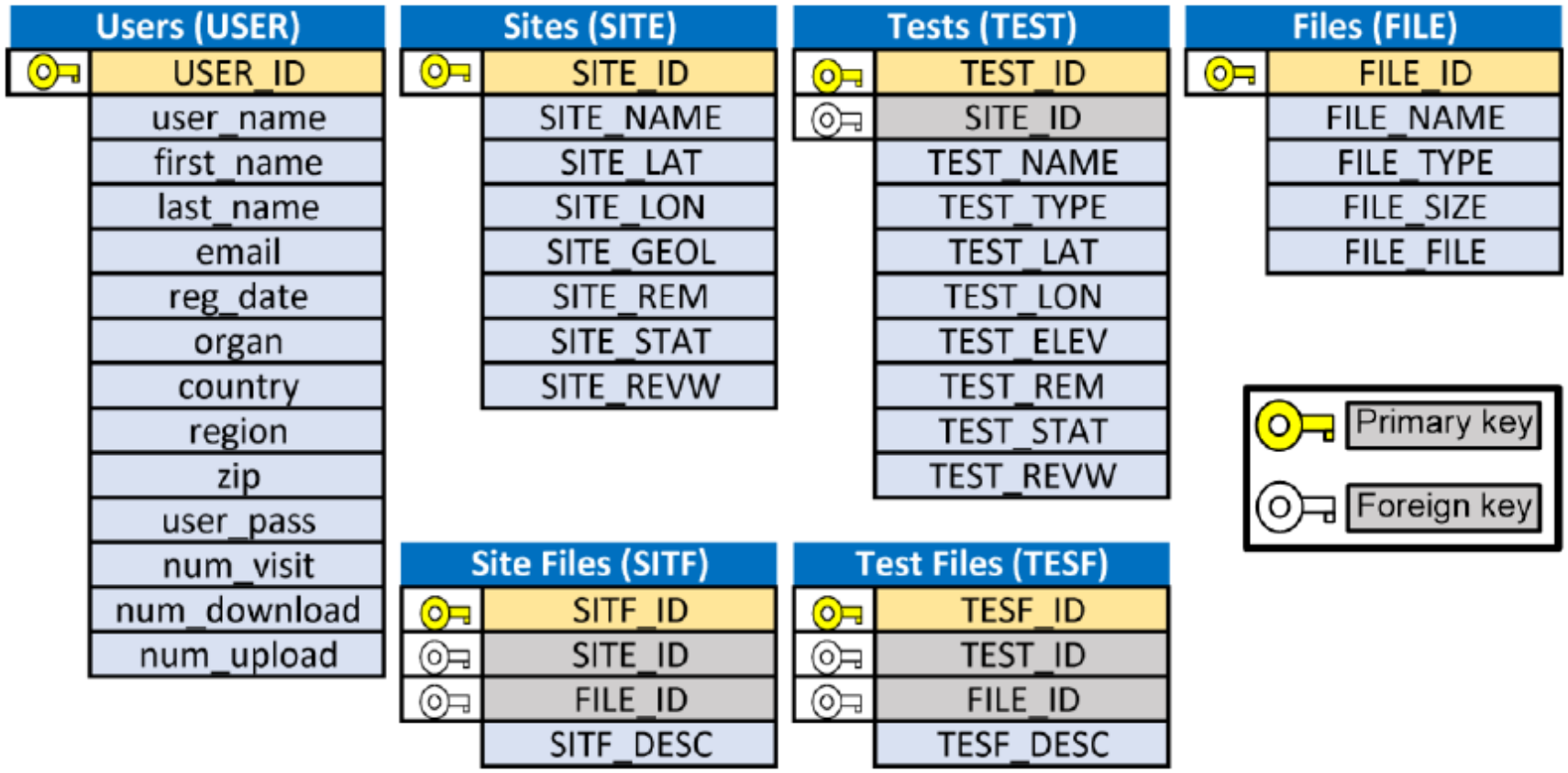

Figure 2 General Schema for NGL Database

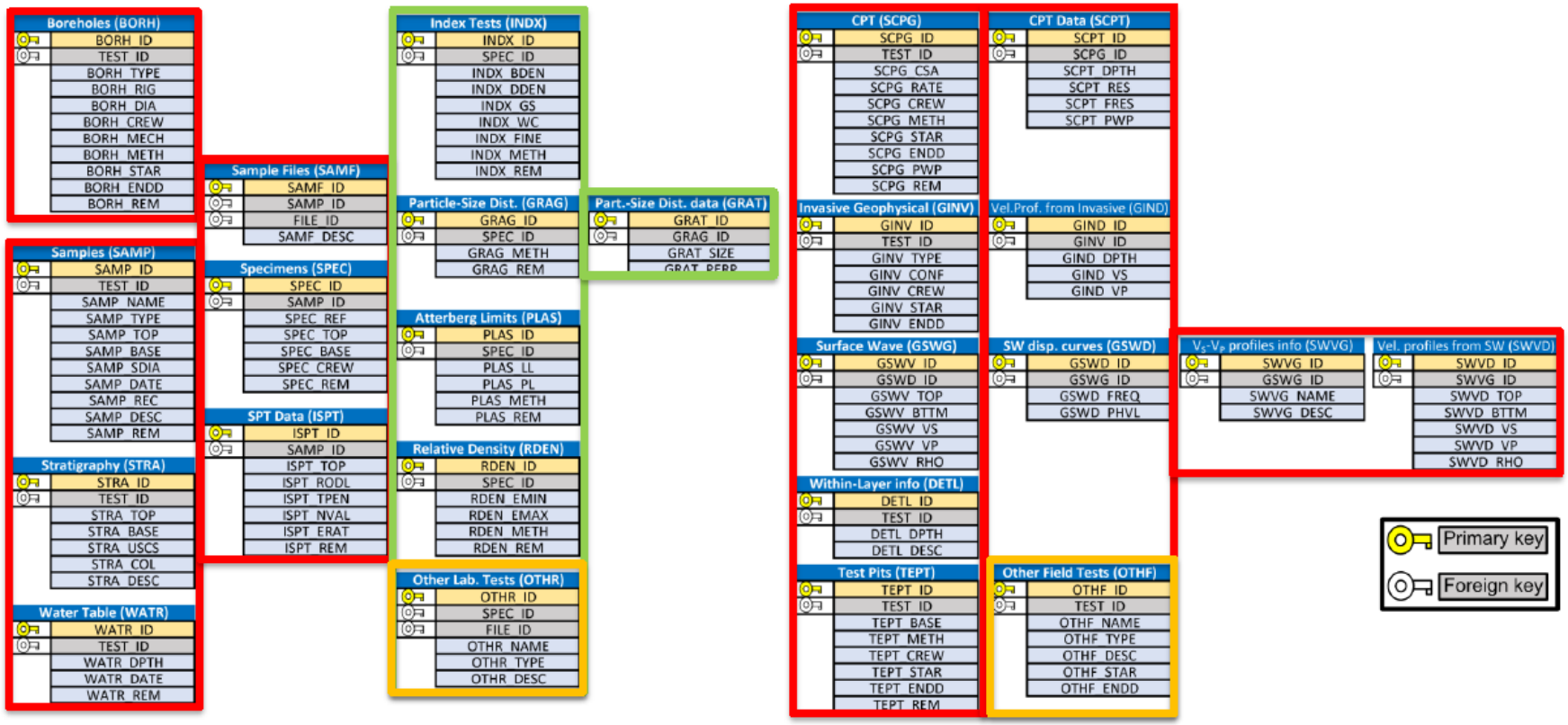

Figure 3 Schema for the Site Database

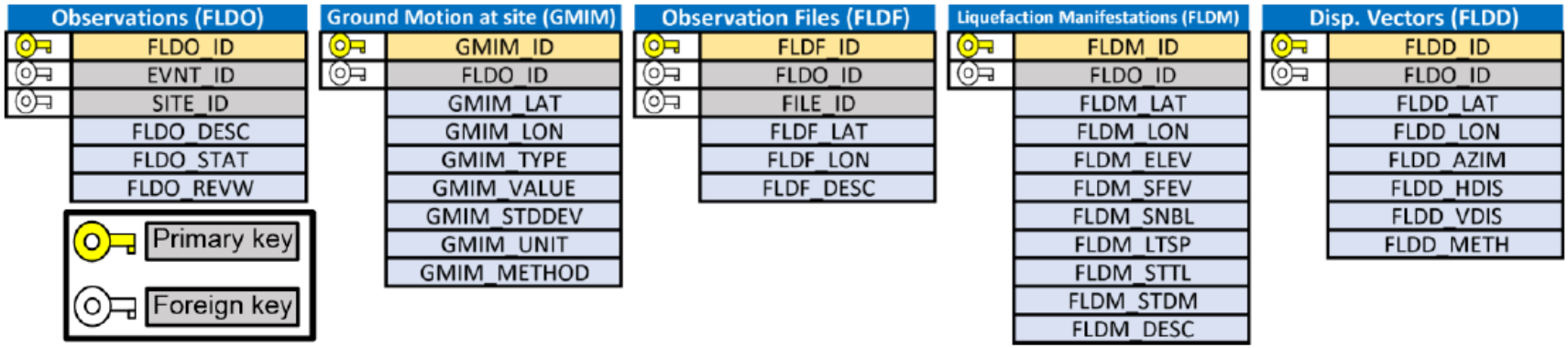

Figure 4 Schema for the Observation Database

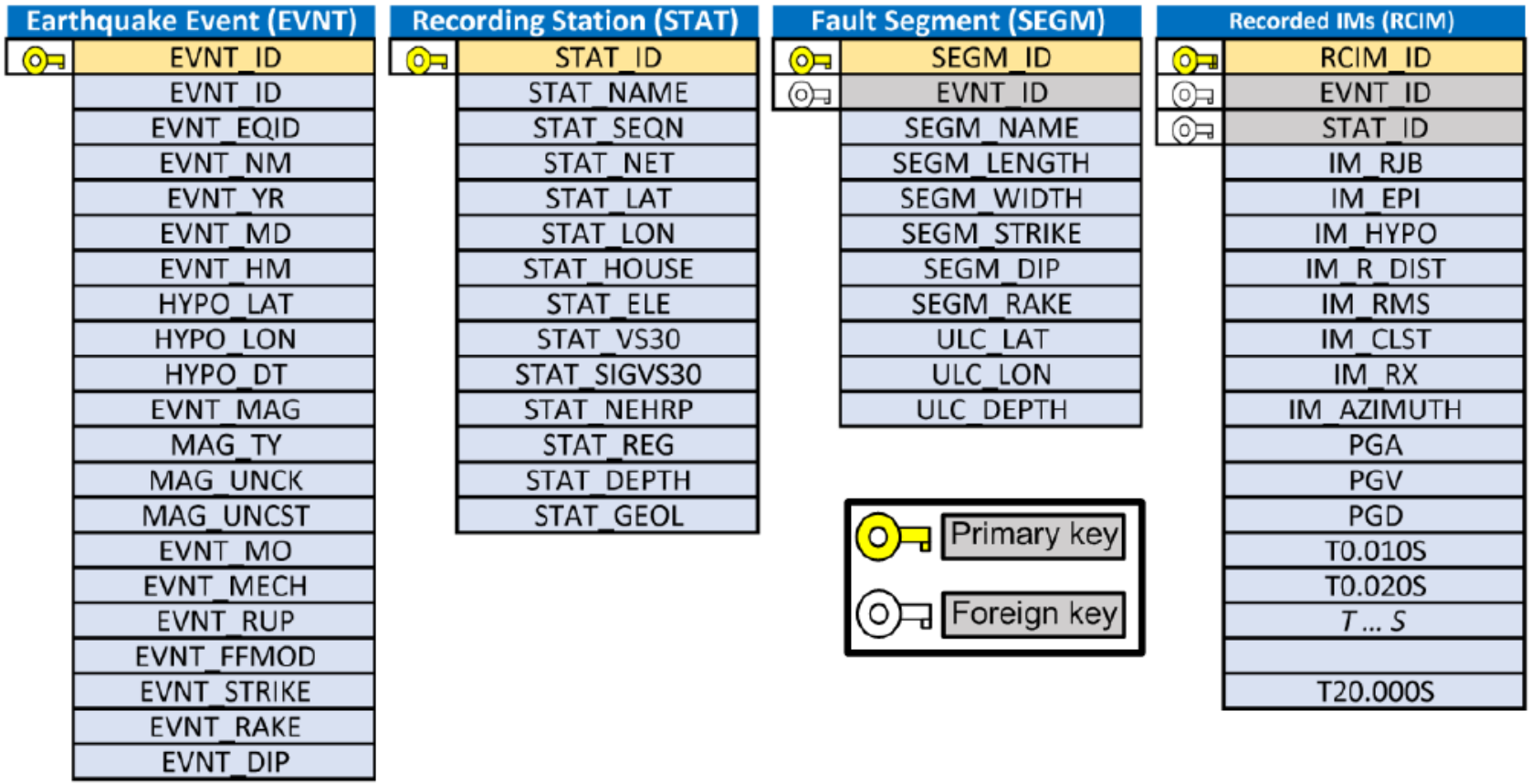

Figure 5 Schema for the Event Database

Accessing the Database

The database can be accessed using the following link http://www.nextgenerationliquefaction.org/

Status of the Lateral Spread Case Histories

The database information gathered by the University of Utah and BYU students has been cross-checked and sent to UCLA for further vetting. NGL will determine the timeline for their review and the public dissemination of the collected dataset. On February 3rd, 2021, we reported information to the TAC regarding Tasks 7, 8 and, 9. The delay of NGL in reviewing and publishing our dataset was discussed. Some TAC members (e.g., Tom Shantz, CALTRANS) expressed the Universities have met the TAC expectations in terms of populating the NGL dataset.

I would be happy to discuss this subject further if there are any questions.

Respectfully,

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