



# DFI Rock Grouting Schema Workshop 4 Wrap-up

Allen Cadden - Schnabel Engineering

Dan Ponti - USGS ret.

# AGENDA

- 1) Quick overview of Rock Grouting structure (5 min)
  - a) how it fits into current Diggs schema
  - b) changes/additions in existing schema objects to support addition of Rock Grouting
- 2) Review of proposed Rock Grouting properties/definitions (30 min)
  - a) review spreadsheet items, fill-in or edit definitions
  - b) determine if some properties can be eliminated
  - c) identify any possible missing properties that need to be added
- 3) Supporting elements/loose ends (10 min)
  - a) Introduce water test procedure
  - b) Need for/ grouting specific equipment objects. If so, what equipment should be included?
  - c) Need for line-loss test procedure? (still to be developed if desired)
- 4) Example Application

## 5) Next steps (15 min)

- a) Report How does the group see this being used?
- b) What are next steps to advance this tool that the group sees will be needed?
- c) Future application of this to other grouting technologies and DFI technologies

# ROCK GROUTING SCHEMA DESIGN (v. 1)

DFI Rock Grouting Schema Workshop 4  
Dan Ponti, Scientist Emeritus, USGS



# Overview of Rock Grouting integration into DIGGS

## Changes to main Diggs structure to accommodate Rock Grouting

- a) Addition of a constructionActivity property within the top level Diggs element to contain RockGrouting feature and other future construction activity features
- b) Creation of AbstractConstructionActivity as base for all construction activity features
- c) Additional properties added to the Borehole backfill and casing properties to account for specific activities associated with grouting.
- d) Added “Ground Improvement” as an allowable investigationTarget value.

# Overview of Rock Grouting integration into DIGGS

## Backfill additions

- a) **backfillType** – annular space within borehole, annular space within casings, open hole, within casing

For each backfill layer:

- a) **backfillVolume** - The total volume of backfill material emplaced in this layer
- b) **groutingActivityRef** - If pressure and flow rate time series are recorded for this backfill layer, this information is stored in a grouting activity feature. This property points to the grouting activity corresponding to emplacement of this layer.
- c) **groutMixRef** - If information is recorded about components of a grout mix, as part of a RockGroutingActivity feature, this property points to the GroutMix object corresponding to the grout mix used in this backfill layer.

# Overview of Rock Grouting integration into DIGGS

## Casing additions

- a) **numberGroutPorts** – If casing is an overburden casing as sleeve pipe (OCSP) or other casing through which grout is injected, this property records the number of ports in the casing.'
- b) **timeCasingInstalled** – time interval during which casing was installed
- c) **timeCasingRemoved** – time interval during which casing was removed
- d) **casingAdvancement** (property type – 0 to unbounded)

### CasingAdvancement

- a) **advancementTime** - Time at start and end of the casing advancement interval
- b) **casingBaseAtStart** - The location of the bottom at the casing at the beginning of the casing interval.
- c) **casingBaseAtEnd** - The location of the bottom at the casing at the end of the casing advancement interval.

b)

# RockGroutingActivity

```
<Diggs>
...
<constructionActivity>
  <RockGroutingActivity>
    ...
    <groutMix> {0...unbounded}
    <GroutMix>
      ...
    </GroutMix>
    </groutMix>
    <groutStage> {0...unbounded}
    <GroutStage>
      ...
      <injectionTimeSeries> {0...unbounded}
      <InjectionTimeSeries>
        ...
      </InjectionTimeSeries>
      </injectionTimeSeries>
    </GroutStage>
    </groutStage>
  </RockGroutingActivity>
</constructionActivity>
</Diggs>
```



# Review of Rock Grouting properties

# Supporting Elements/Loose Ends

- a) Lugeon Test procedure
- b) Need for grouting specific equipment?
- c) Need for line-loss test procedure?

# Lugeon Test Procedure

- a) Lugeon test results (eg. hydraulic conductivity, Lugeon value) are reported in the Test feature
- b) Details of each pumping step given in an associated test procedure object

```
<measurement>
```

```
  <Test gml:id="lt2">
```

```
    <samplingFeatureRef xlink:href="#bh1"/>
```

```
    <constructionActivityRef xlink:href="#ca1"/>
```

```
    ...
```

```
      <ResultSet>
```

```
        <parameters>
```

```
          <PropertyParameters gml:id="lggr">
```

```
            <properties>
```

```
              ...
```

```
                <Property index="2" gml:id="lv">
```

```
                  <typeData>double</typeData>
```

```
                  <propertyClass codeSpace="lugeon_value">Lugeon value</propertyClass>
```

```
                </Property>
```

```
            </properties>
```

```
          </PropertyParameters>
```

```
        </parameters>
```

```
      <dataValues>
```

```
        0.049,4.7
```

```
      </dataValues>
```

```
    ...
```

```
  </procedure>
```

```
    <LugeonTest gml:id="lt1">
```

# Lugeon Test Procedure

## Properties

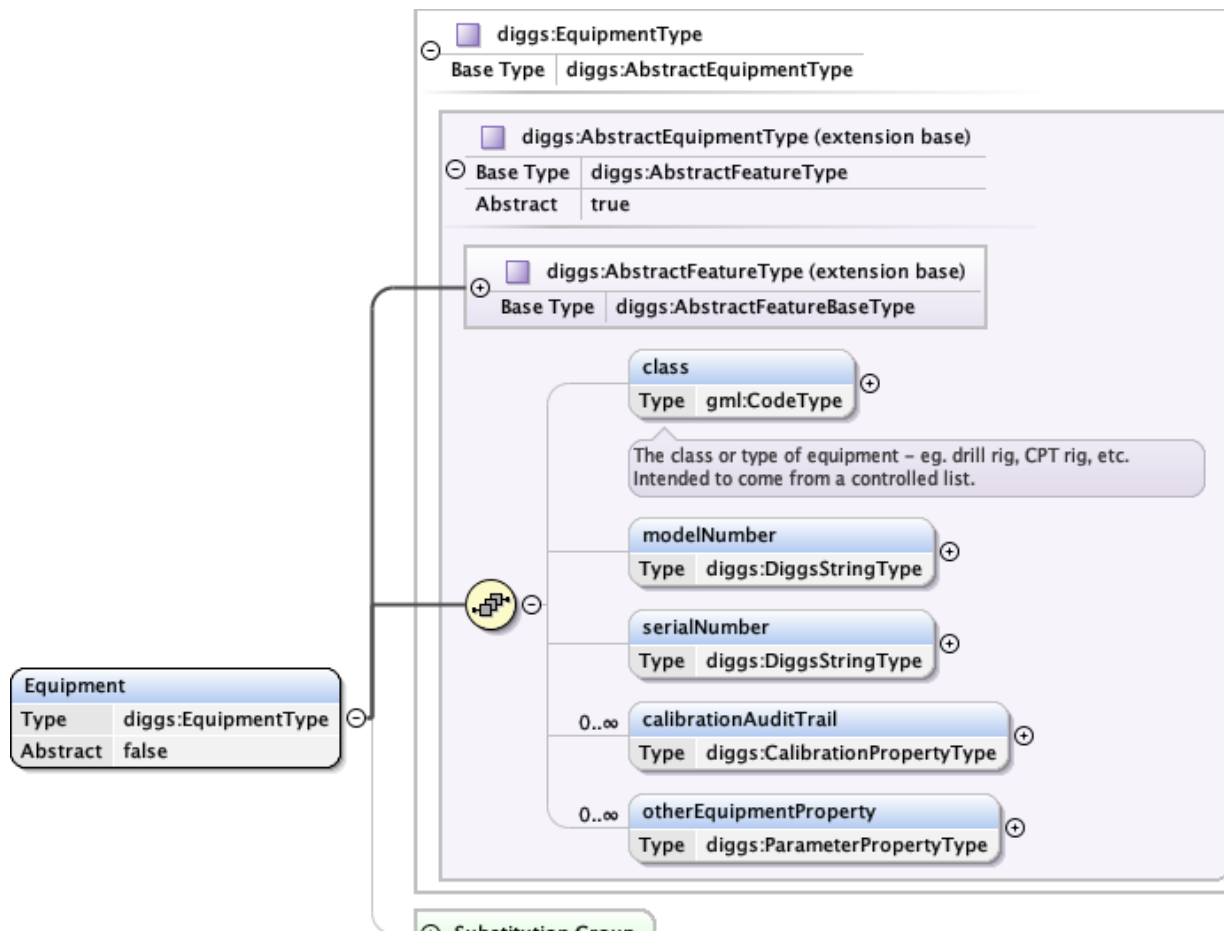
- a) depthToGroundWater
- b) pressureMeasurementConfiguration
- c) pressureGaugeHeight
- d) pMax
- e) lugeonStep {0...unbounded}
  - a) lugeonStepNumber
  - b) Pressure
  - c) avgFlowRate
  - d) coeffPermeability
  - e) lugeonValue
  - f) lugeonStepTimeSeries
  - g) totalElapsedTime
  - h) totalVolumeWater

## LugeonStepTimeSeries

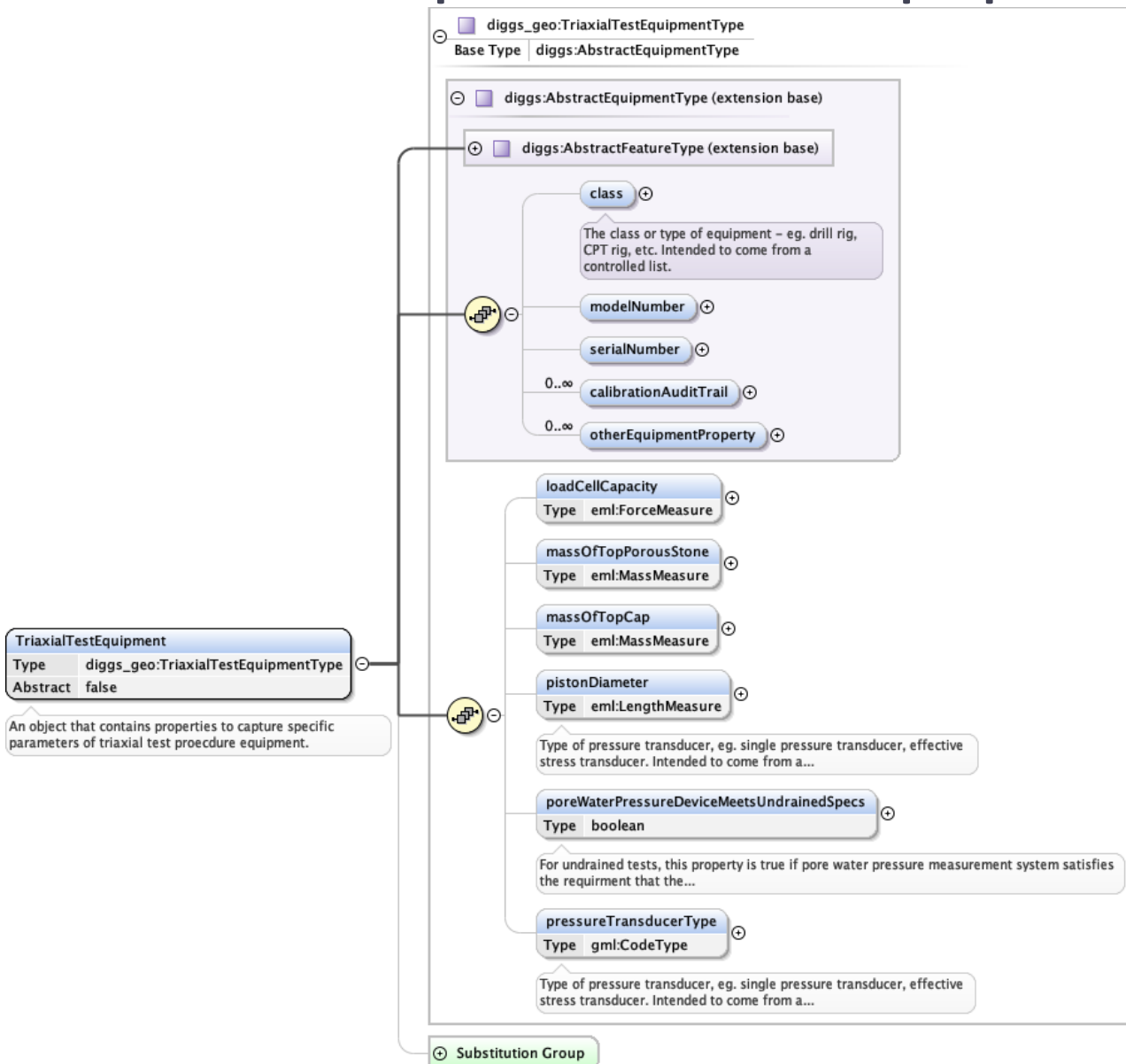
- a) Structured similarly to the grout stage time series
- b) Reports flow at discrete time intervals (usually 1 minute intervals)

# Need for custom equipment objects?

- a) Diggs provides for reporting information about equipment used for an activity
- b) Currently, there is a generic Equipment object with few properties:



# Example custom equipment object



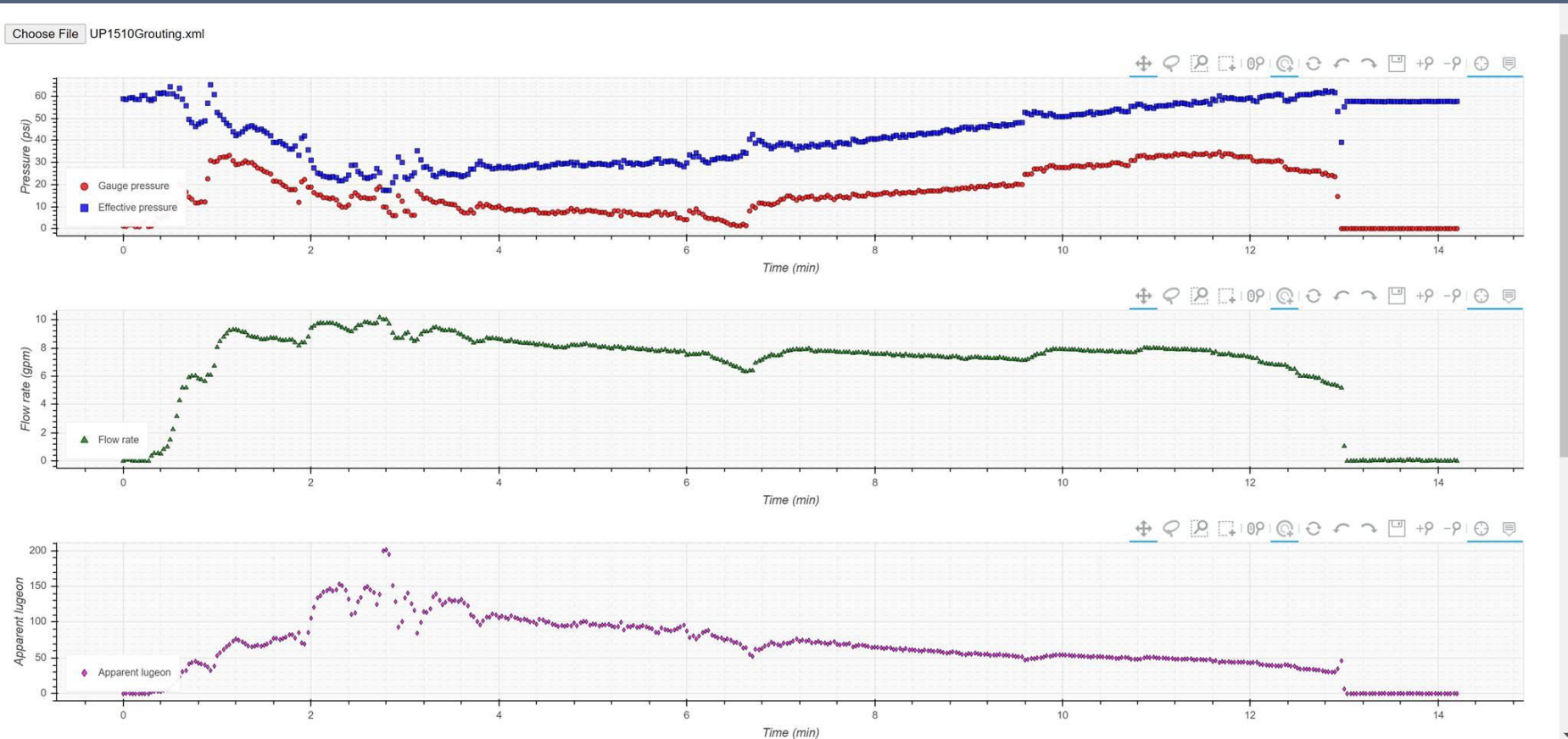
# Need to develop a line loss test?

- a) Test procedures are developed to “plug-in” to the Test feature as demonstrated with Lugeon test
- b) What properties should be recorded?
- c) What are the primary “results” of a line loss test beside the line-loss coefficients?

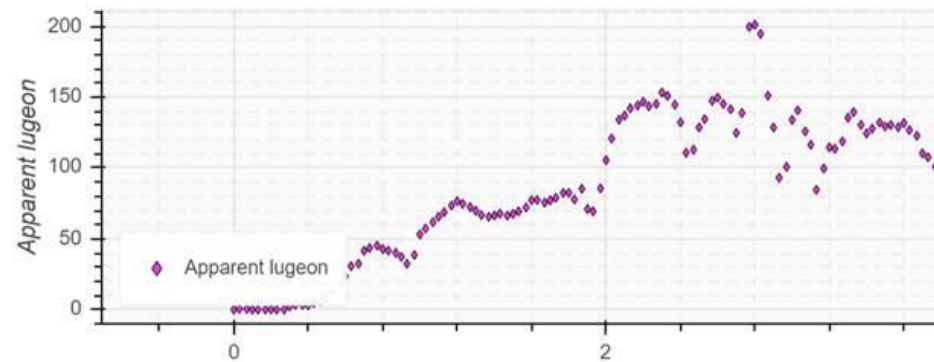
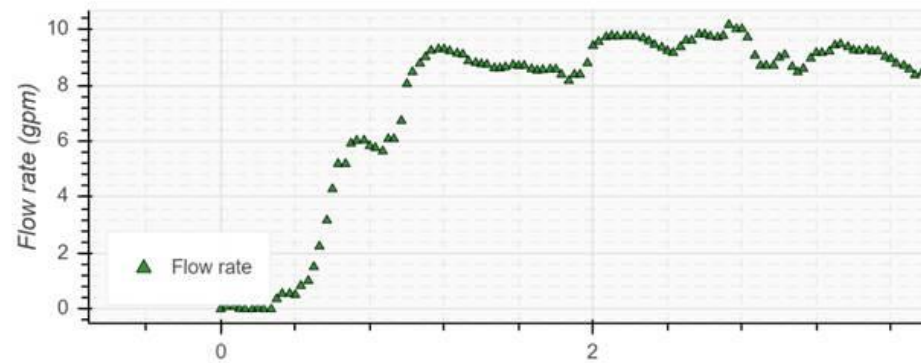
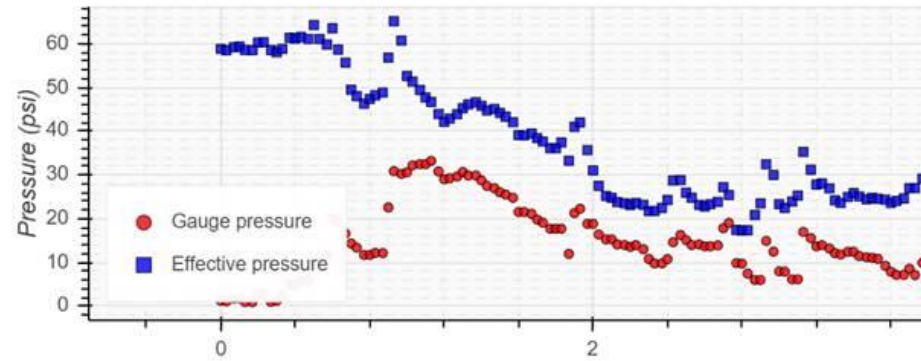
## **Others?**

- a) mud balance?
- b) optical televiewer?

# Example application - Xin Peng







## 5) Next steps (15 min)

- 1) Report - items the team recommends we address in the summary report/article?
  - a) Success successes of the committee in advancing the DIGGS Scheme into grouting technologies and deep foundation technologies in general
- 2) How does the group see this being used?
- 3) What are next steps to advance this tool that the group sees will be needed?
  - a) Review Body - grout committee from GI or DFI
- 4) Future application of this to other grouting technologies and DFI technologies