Landfill Permits

Hydrogeologic Data used to Support Permitting

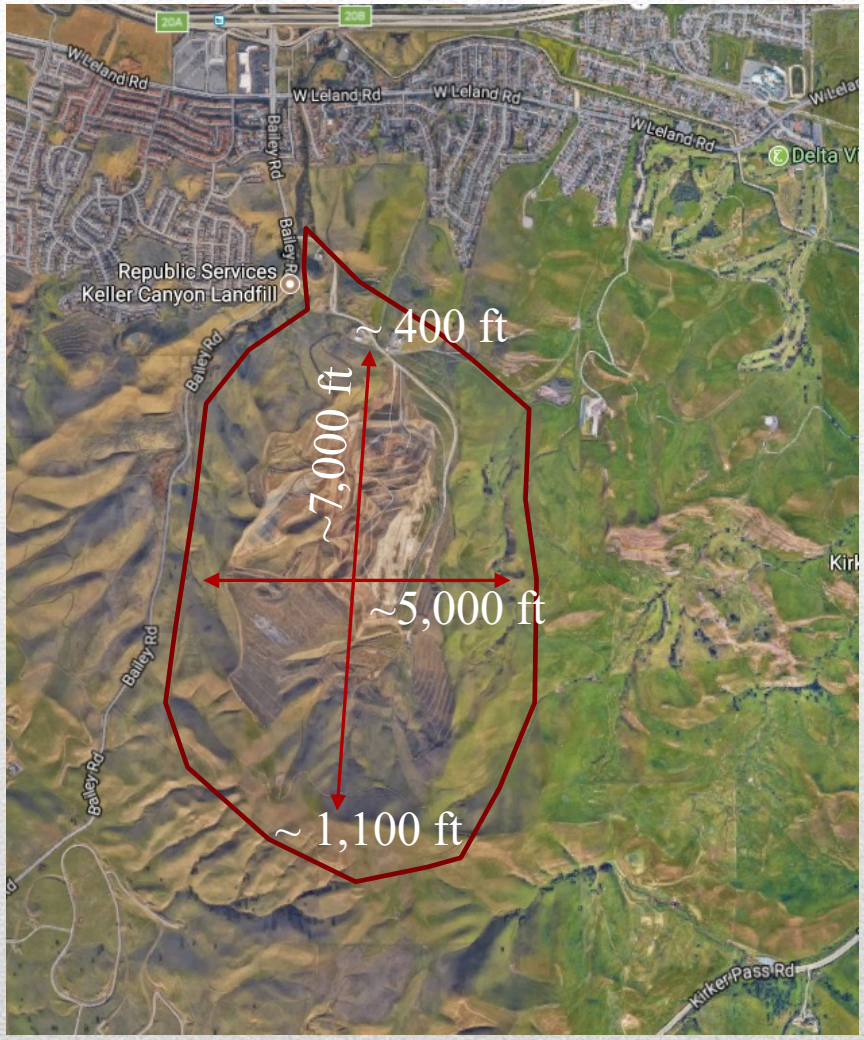
- Overview
  - Educational Background
  - Keller Canyon Landfill
  - Technology Change

Keller Canyon Landfill

- Late 1980's permitting process initiated (Browning Ferris Inc.)
- Operational Life ~ 35 years
- Canyon (Valley) Fill

Keller Canyon Landfill

- Near Pittsburg, CA
- Municipal Solid Waste
  - Area = 803 acres (1.25 sq.mi.)
  - Slope (Ridge to Outlet) = 0.1 (10% hydrologically steep)



- Today – Internet Access
- Then - Books

Permit Rules

(4) **Design and Construction Standards for all Sites**

(A) **General Design Parameters**--Describe how the site design accommodates or provides for the service area, climatological factors, physical setting, soils, drainage, and other pertinent information. The design shall be developed by a registered civil engineer or registered geologist. If the site is to be used by the general public, show how the design accommodates such use.

(B) **Design Responsibility**--Design of a new disposal site shall be under the direction of a registered civil engineer. The designer shall utilize expert advice as appropriate from persons competent in soils, hydrology, geology, landscape design, chemistry and other disciplines.

(C) **Construction Sequencing Plans**--Describe sequencing plans showing the anticipated phases of site development. A map showing the topographical contours prior to filling and the existing topographical contours of the permitted boundary.

(D) **Grading Plan**--Include a grading plan showing the proposed final elevations of the completed disposal site, and excavation depth, including existing and proposed borrow area.

(E) **Gas Management Plan**--The gas management plan shall include a description of the facility's gas control and monitoring systems. The site plan shall show locations of monitoring wells. The plan shall describe how the facility will comply with §20919 and §20919.5. Describe any possible use of landfill decomposition gases. Reference any additional information provided in the closure plans pursuant to Article 6.

Hydrogologic Needs

(b) **Geologic Setting.**

(1) MSW landfills are subject to the SWRCB-promulgated waste containment requirements of this subdivision and of SWRCB Resolution No. 93-62. New Class III and existing Class II-2 landfills shall be sited where soil characteristics, distance from waste to ground water, and of water beneath or adjacent to the landfill. Factors that shall be evaluated include:

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(A) size of the landfill:

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(D) background quality of ground water;

(E) current and anticipated use of the ground water; and

(F) annual precipitation.

(2) Where consideration of the factors in (b)(1) indicates that site characteristics alone do not ensure protection of the quality of ground water or surface water, Class III landfills shall be required to have a single clay liner with hydraulic conductivity of $1x10^{-6}$ cm/sec or less.

(c) **Flooding** — New Class III and existing Class II-2 landfills shall be designed, constructed, operated, and maintained to prevent inundation or washout due to floods with a 100 year return period. MSW landfills are also subject to any more-stringent flood plain and wetland siting requirements referenced in SWRCB Resolution No.93-62 (i.e., see Sections 258.11, 258.12, and 258.16 of 40CFR258).

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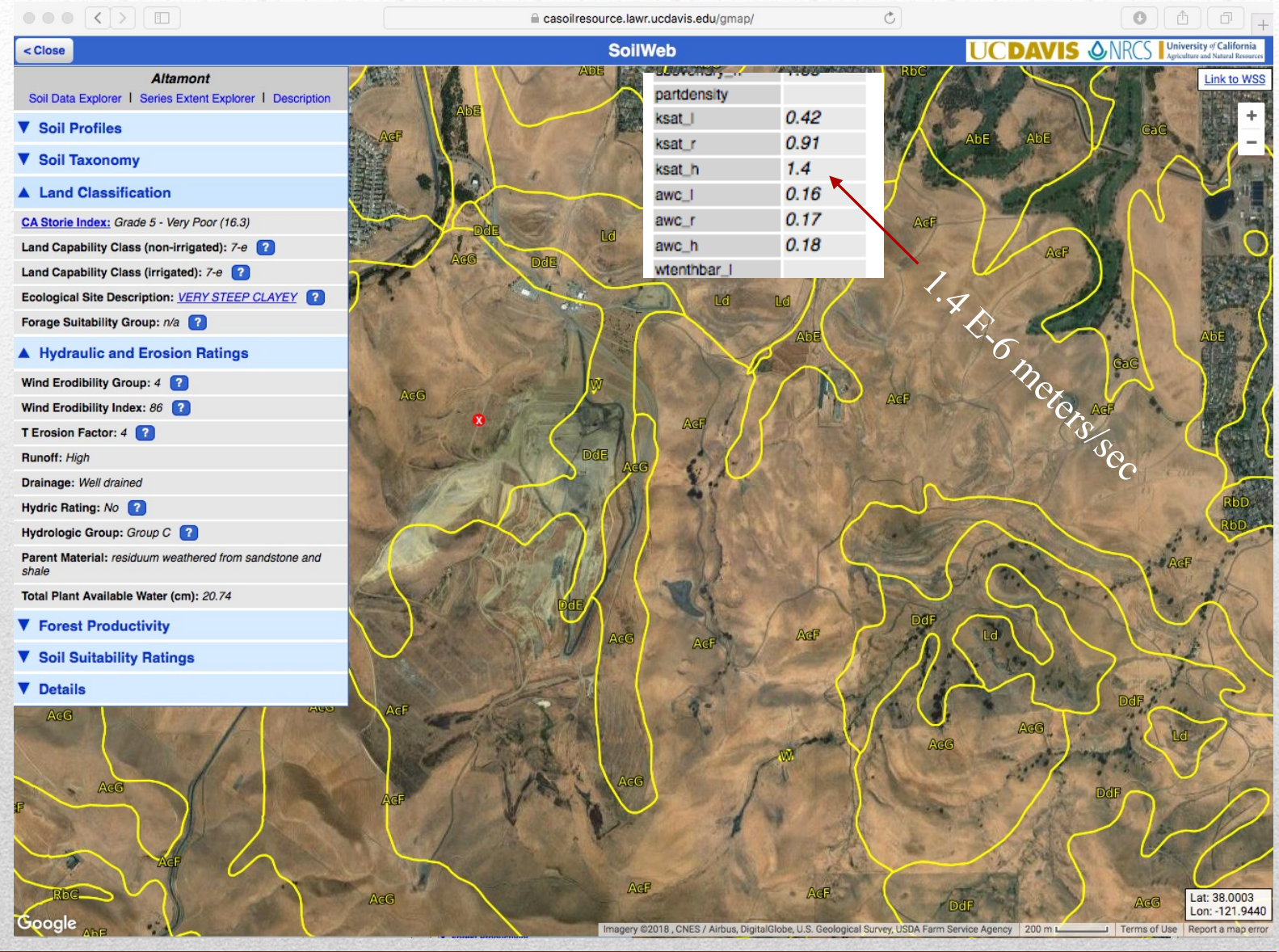
(e) **Rapid Geologic Change** — New Class III and unreclassified existing Class II-2 landfills can be located within areas of potential rapid geologic change only if the RWQCB finds that the Unit's containment structures are designed, constructed, and maintained to preclude failure. MSW landfills are also subject to any more-stringent unstable area siting requirements referenced in SWRCB Resolution No. 93-62 (see section 258.15 and Section 258.16 of 40CFR258).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SoilWeb
UCDAVIS NRCS University of California Agriculture and Natural Resources
Altamont
Soil Data Explorer | Series Extent Explorer | Description
Soil Profiles
Soil Taxonomy
Land Classification
CA Storie Index: Grade 5 - Very Poor (16.3)
Land Capability Class (non-irrigated): 7-e
Land Capability Class (irrigated): 7-e
Ecological Site Description: VERY STEEP CLAYEY
Forage Suitability Group: n/a
Hydraulic and Erosion Ratings
Wind Erodibility Group: 4
Wind Erodibility Index: 86
T Erosion Factor: 4
Runoff: High
Drainage: Well drained
Hydric Rating: No
Hydrologic Group: Group C
Parent Material: residuum weathered from sandstone and shale
Total Plant Available Water (cm): 20.74
Forest Productivity
Soil Suitability Ratings
Details
partdensity
ksat_l 0.42
ksat_r 0.91
ksat_h 1.4
awc_l 0.16
awc_r 0.17
awc_h 0.18
wtenthbar_l
1.4 E-6 meters/sec
Link to WSS
Lat: 38.0003
Lon: -121.9440
Google
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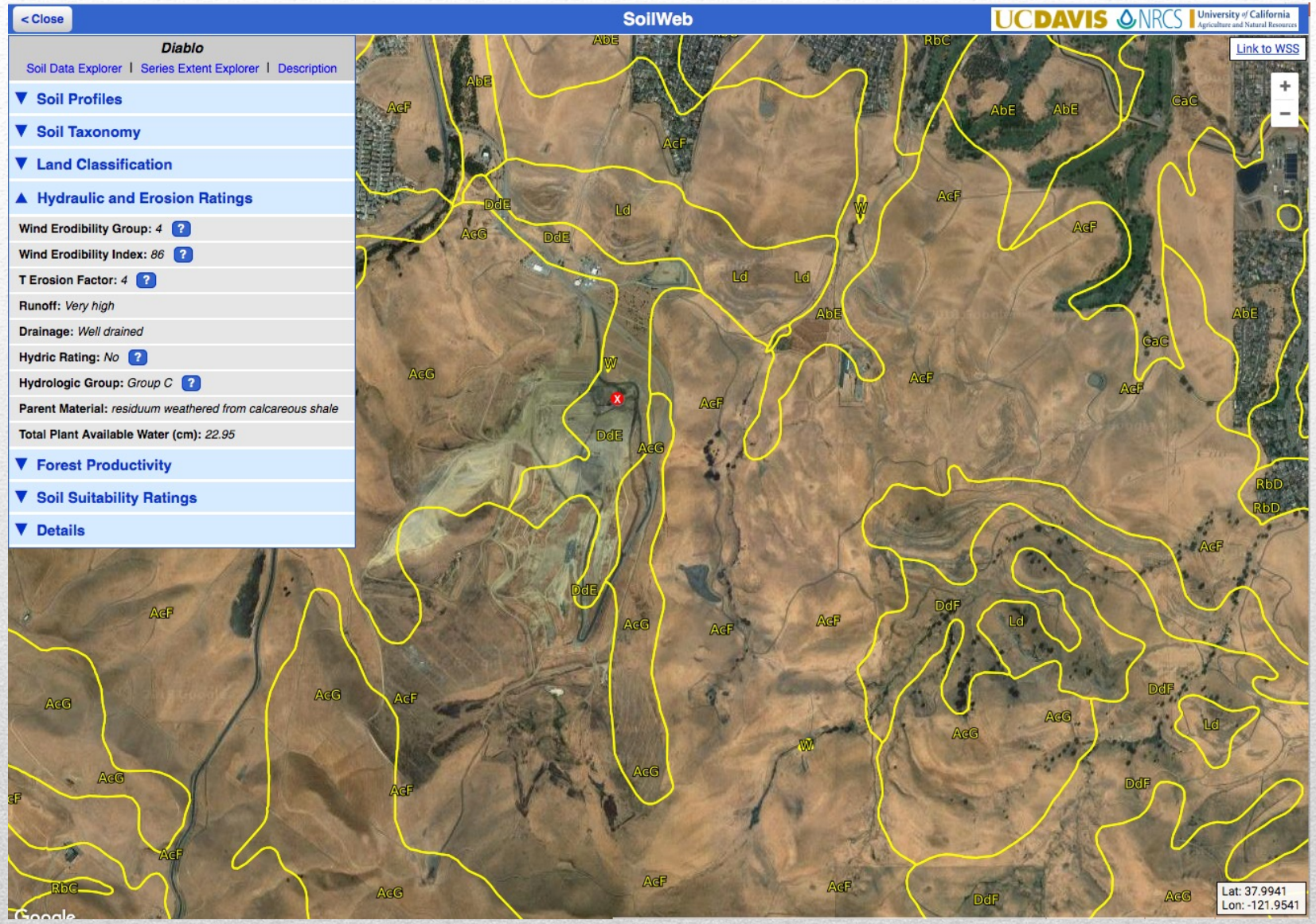
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SoilWeb
UCDAVIS NRCS University of California Agriculture and Natural Resources
Diablo
Soil Data Explorer | Series Extent Explorer | Description
Soil Profiles
Soil Taxonomy
Land Classification
Hydraulic and Erosion Ratings
Wind Erodibility Group: 4
Wind Erodibility Index: 86
T Erosion Factor: 4
Runoff: Very high
Drainage: Well drained
Hydric Rating: No
Hydrologic Group: Group C
Parent Material: residuum weathered from calcareous shale
Total Plant Available Water (cm): 22.95
Forest Productivity
Soil Suitability Ratings
Details
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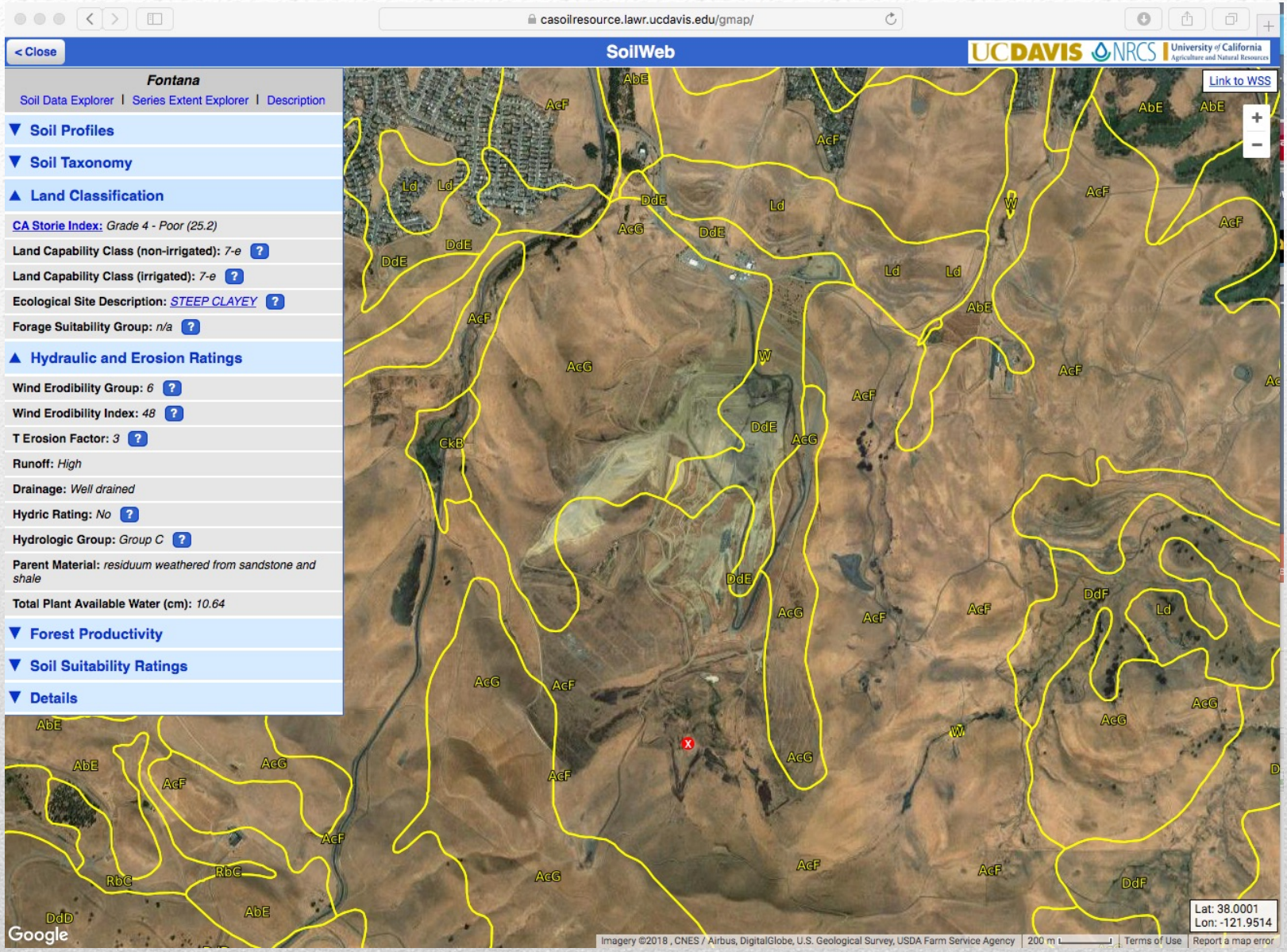
Lon: -121.9541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SoilWeb
UCDAVIS NRCS University of California Agriculture and Natural Resources
Fontana
Soil Data Explorer | Series Extent Explorer | Description
Soil Profiles
Soil Taxonomy
Land Classification
CA Storie Index: Grade 4 - Poor (25.2)
Land Capability Class (non-irrigated): 7-e
Land Capability Class (irrigated): 7-e
Ecological Site Description: STEEP CLAYEY
Forage Suitability Group: n/a
Hydraulic and Erosion Ratings
Wind Erodibility Group: 6
Wind Erodibility Index: 48
T Erosion Factor: 3
Runoff: High
Drainage: Well drained
Hydric Rating: No
Hydrologic Group: Group C
Parent Material: residuum weathered from sandstone and shale
Total Plant Available Water (cm): 10.64
Forest Productivity
Soil Suitability Ratings
Details
Link to WSS
AbE
AcF
AcG
Ld
DdE
W
CkB
RbC
DdD
DdF
Lat: 38.0001
Lon: -121.9514
Google
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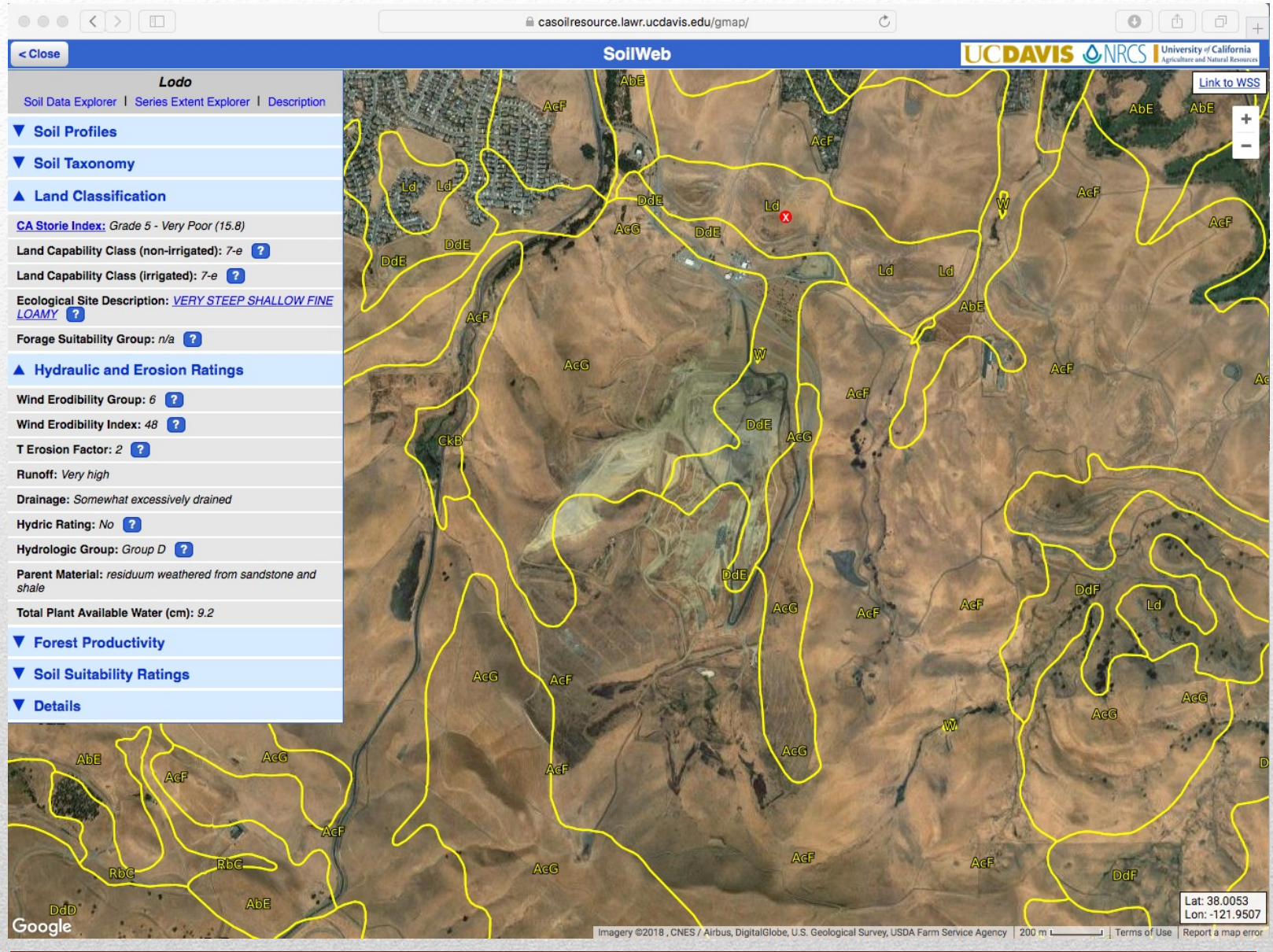
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SoilWeb
UCDAVIS NRCS University of California
Lodo
Soil Data Explorer | Series Extent Explorer | Description
Soil Profiles
Soil Taxonomy
Land Classification
CA Storie Index: Grade 5 - Very Poor (15.8)
Land Capability Class (non-irrigated): 7-e
Land Capability Class (irrigated): 7-e
Ecological Site Description: VERY STEEP SHALLOW FINE LOAMY
Forage Suitability Group: n/a
Hydraulic and Erosion Ratings
Wind Erodibility Group: 6
Wind Erodibility Index: 48
T Erosion Factor: 2
Runoff: Very high
Drainage: Somewhat excessively drained
Hydric Rating: No
Hydrologic Group: Group D
Parent Material: residuum weathered from sandstone and shale
Total Plant Available Water (cm): 9.2
Forest Productivity
Soil Suitability Ratings
Details
Link to WSS
AbE
AcF
AcG
Ld
DdE
W
CkB
DdF
RbC
DdD
Lat: 38.0053
Lon: -121.9507
Google
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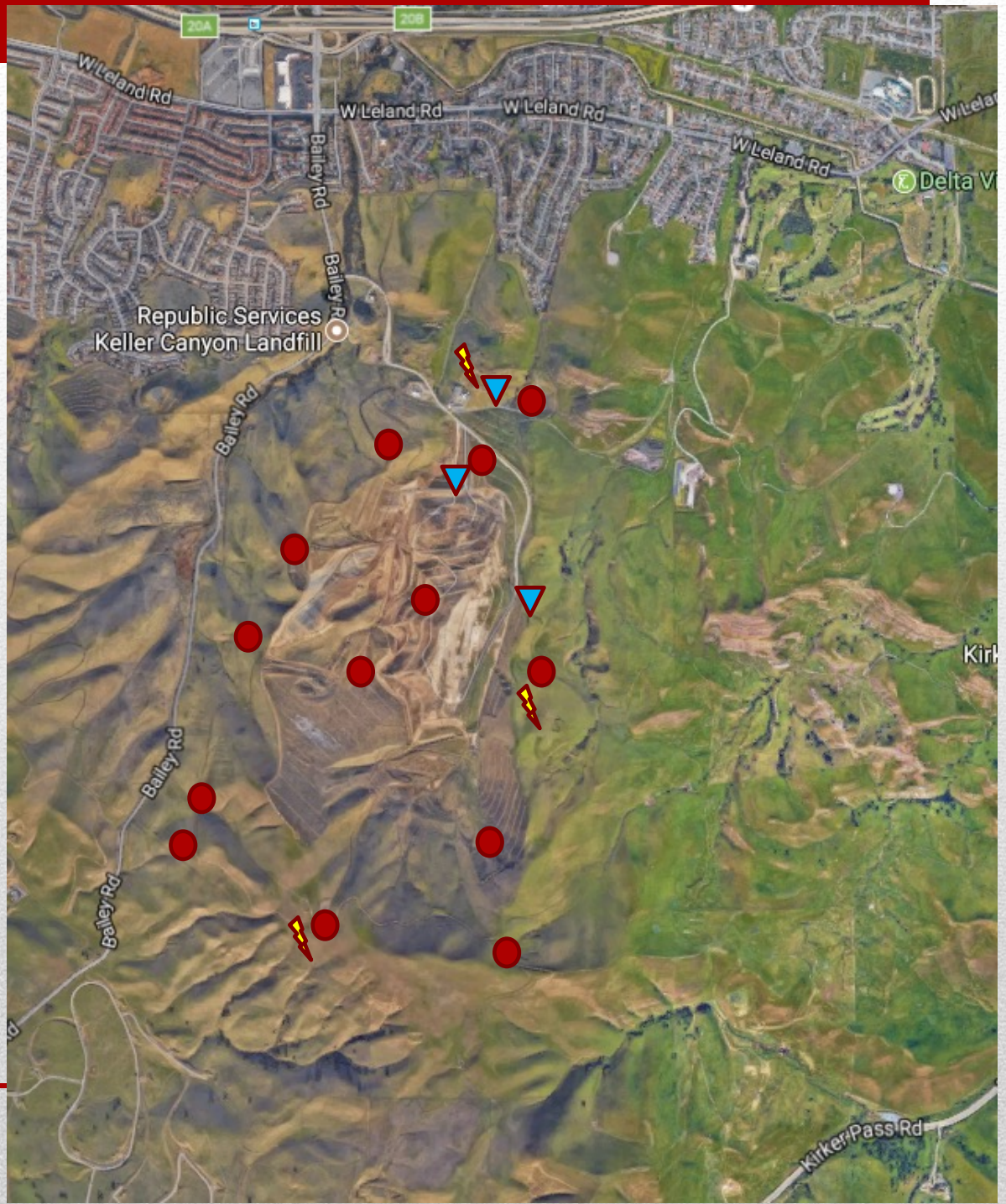
- Monitoring
  - Wells
  - Stream gages
  - Meterological Stations

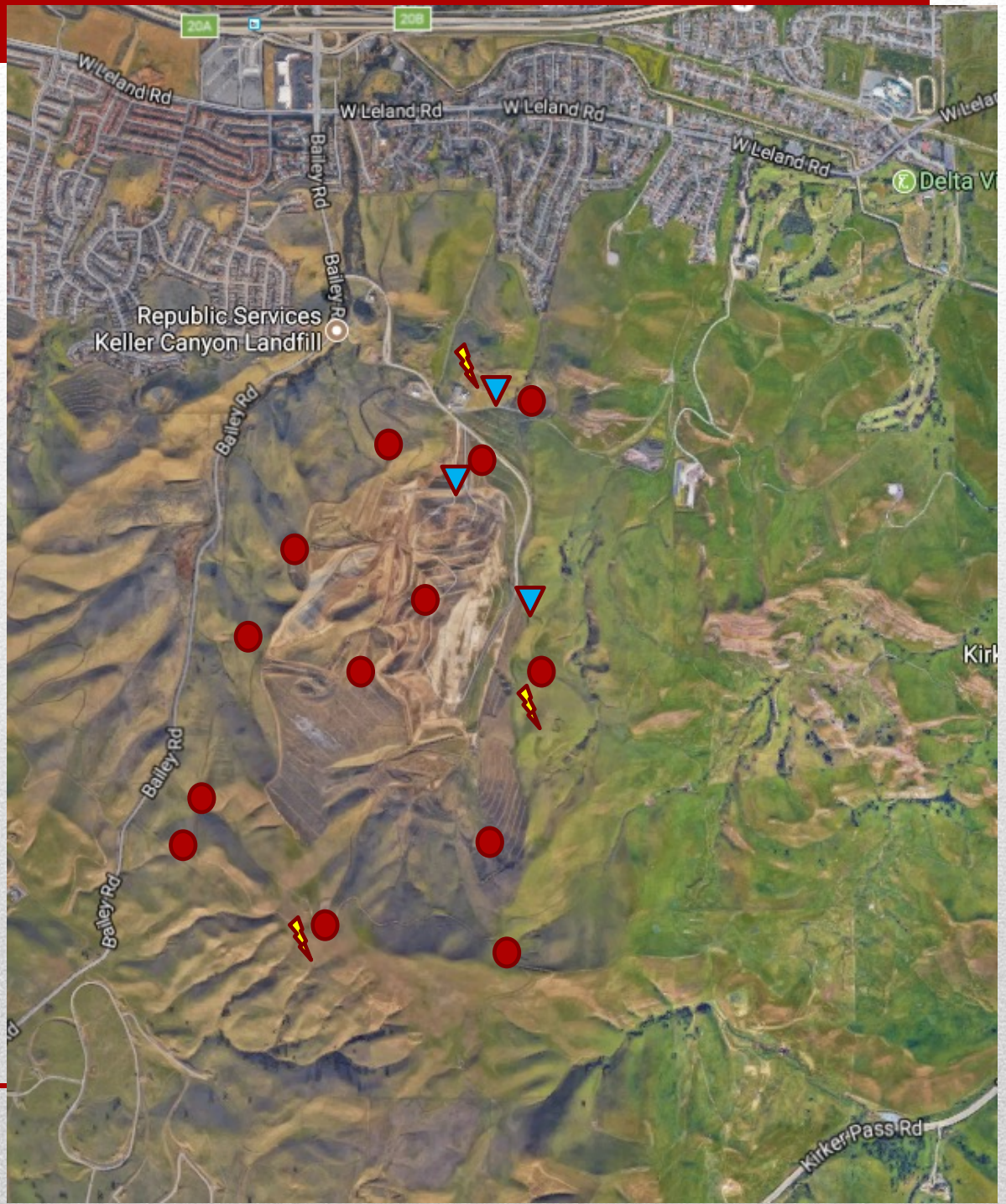


Keller 1939

Keller 1989

Keller 2017

- Monitoring
  - Wells
  - Stream gages
  - Meterological Stations



Keller 1989

Keller 2017

Keller 1989

Keller 2017

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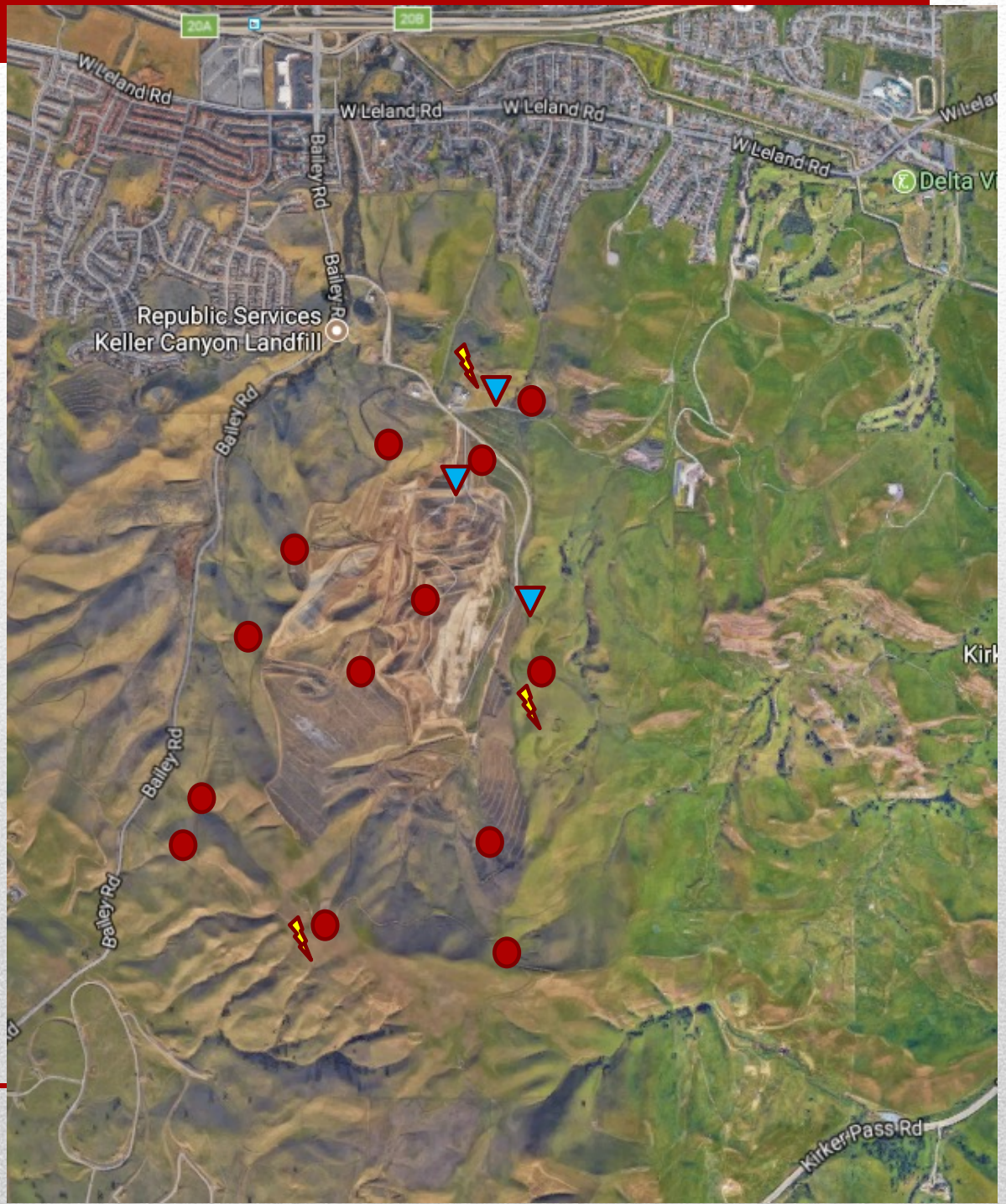
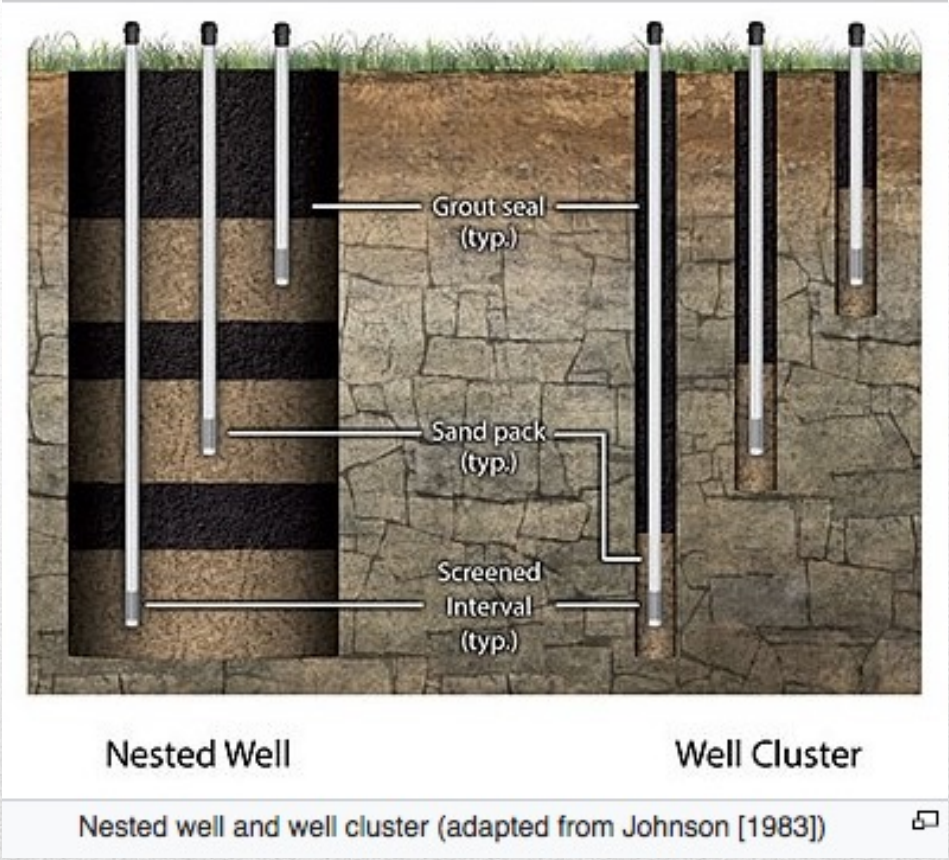


Well Cluster

- Quantify vertical hydraulic gradients Upward/Downward Flow
- On ridge all were down
- At base near creek bed upward



Nested well and well cluster (adapted from Johnson [1983])

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Data Collected

- 1 days/week – I measured depth to water in 11 clusters.
- 1 days/week – I collected several vials of water from each well, logged the bottles, exchanged them with a technician from another company; and exchanged chain-of-custody documents. Every well had a blind (fake) sample and a spiked sample + the real samples.
- 1 day/2 weeks – Changed batteries on data loggers, downloaded data to a tape recorder, manually recorded register values in the logger (like a checksum), reset and restarted the logger program (I entered series of instructions like (F87A001, FF7A001 …) these played the role of "RELOAD" that one might use today.
- All site visits I would record instantaneous flow rate for each of the stream sites, and download data from their data loggers.
- All site visits I would record the total rainfall in the various back-up gages, empty them and replace them.
- All site visits would repair thing that were damaged
- All sites visits I would photograph the landslide from a specific location
- Field notebook that I would sign out from, and sign back in to the geologist

- Water samples – (D) background quality of ground water;
- Water depths – (C) depth to ground water and variations in depth to ground water;
- Precipitation + Water Depths + Streamflow – (B) hydraulic conductivity and transmissivity of underlying soils;
- Meterology –
  - Wind speed and direction for flyway trash considerations Generally used to determine tipping direction

What we did with all that data?

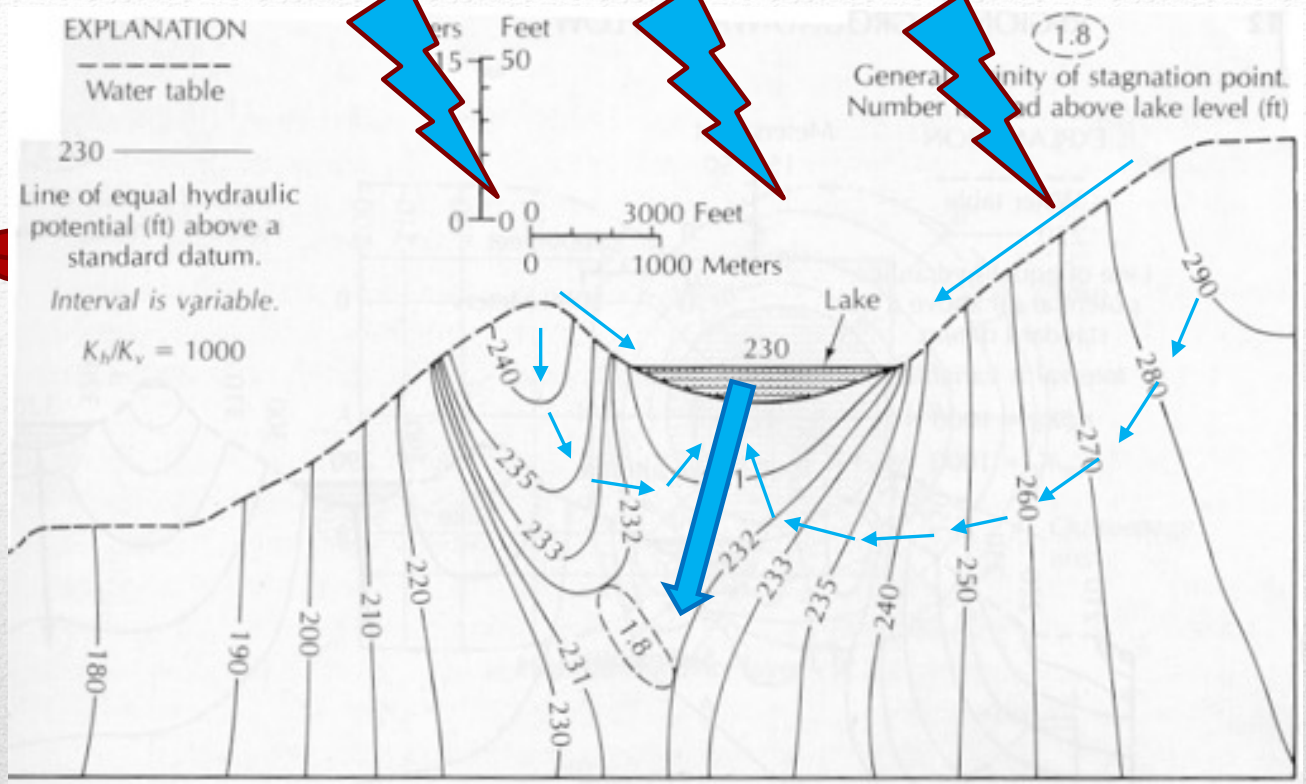
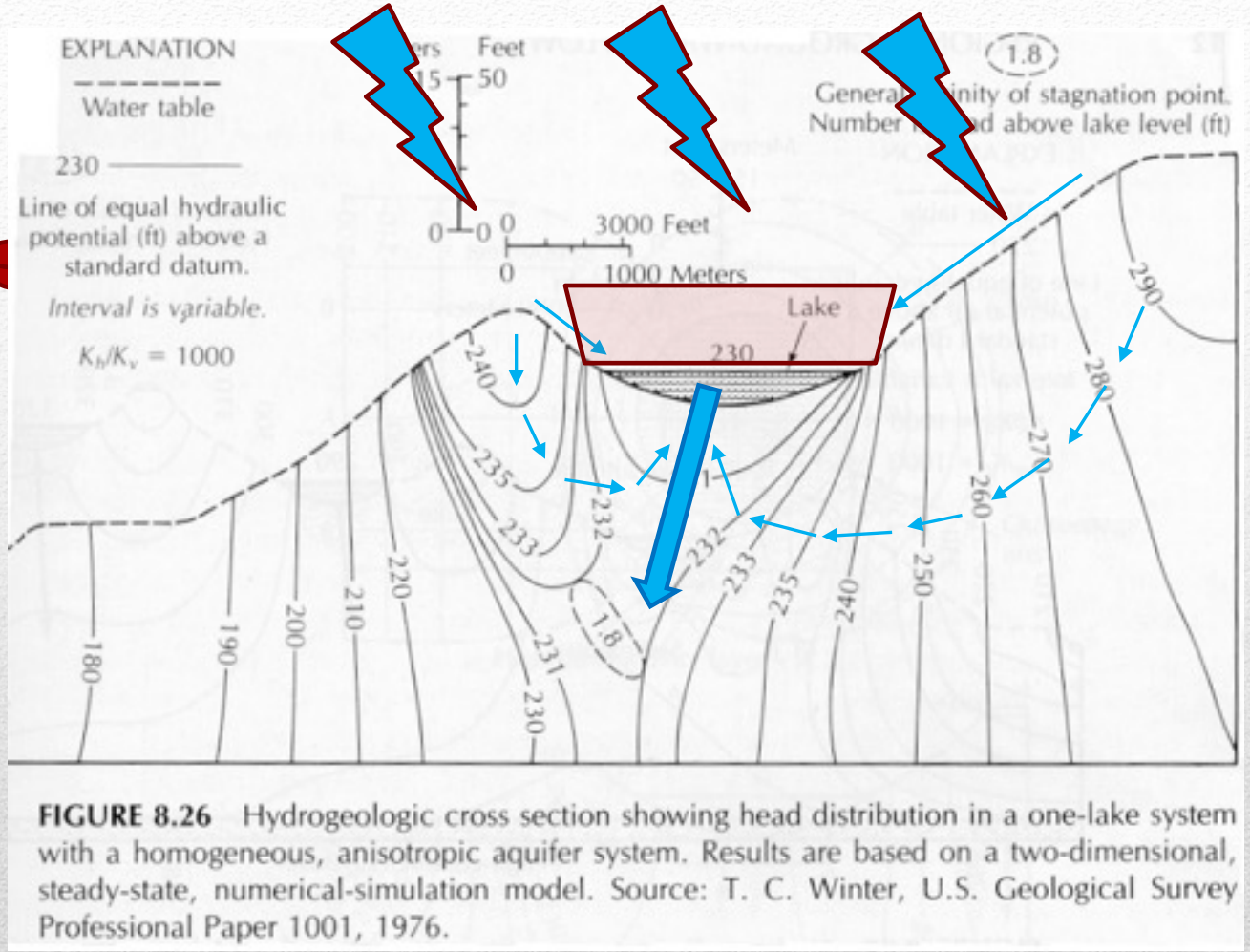


FIGURE 8.26 Hydrogeologic cross section showing head distribution in a one-lake system with a homogeneous, anisotropic aquifer system. Results are based on a two-dimensional, steady-state, numerical-simulation model. Source: T. C. Winter, U.S. Geological Survey Professional Paper 1001, 1976.

Vertical Gradients



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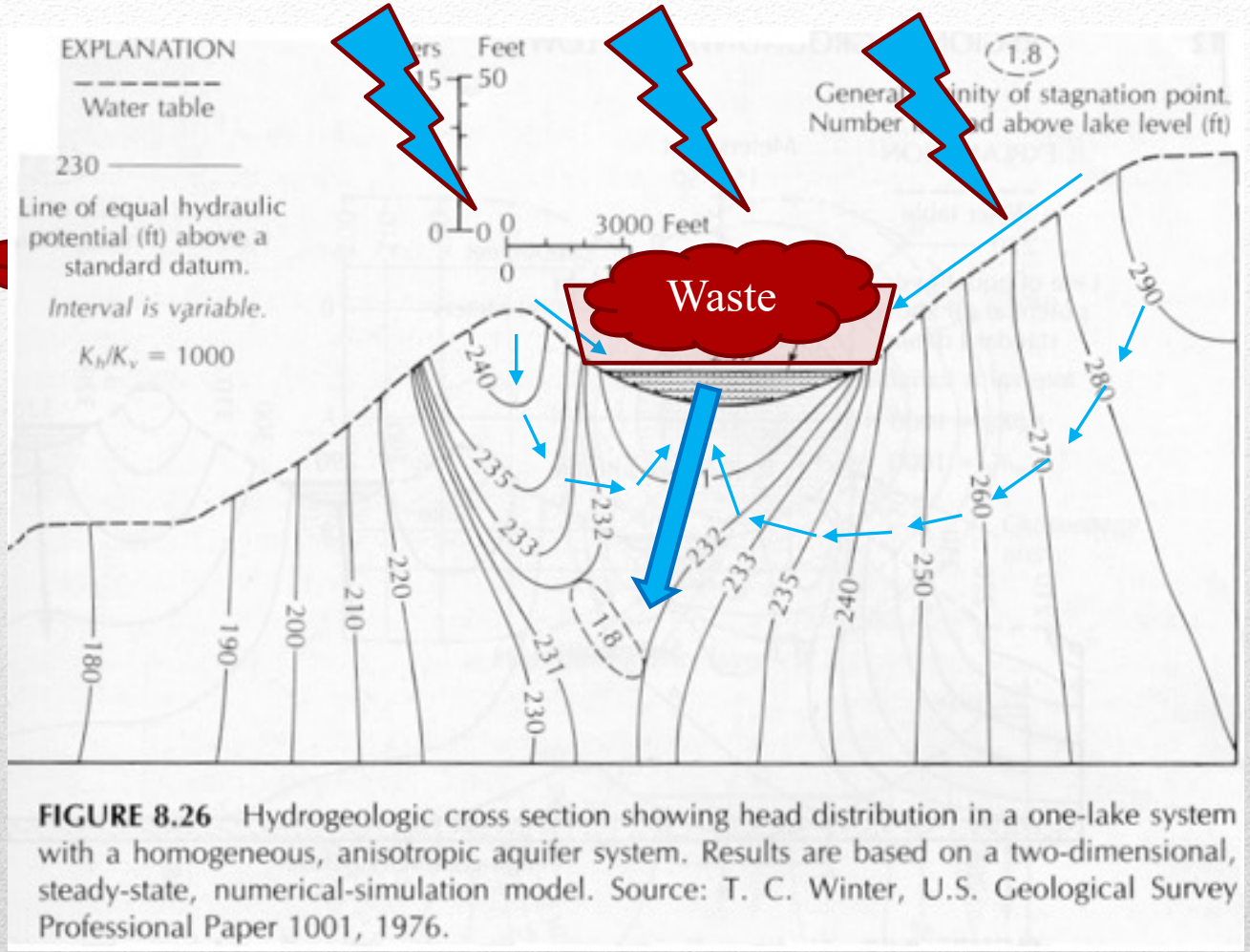

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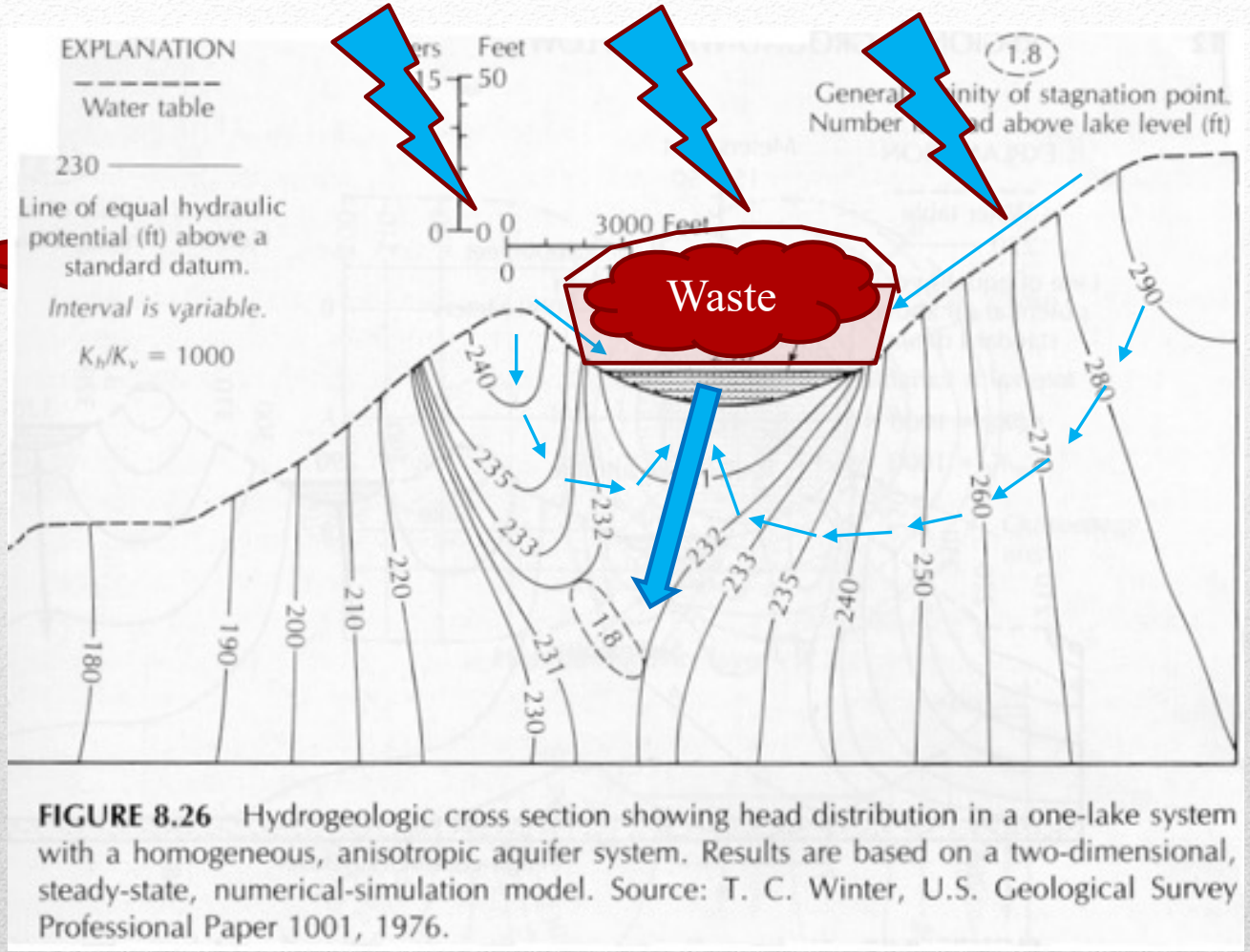

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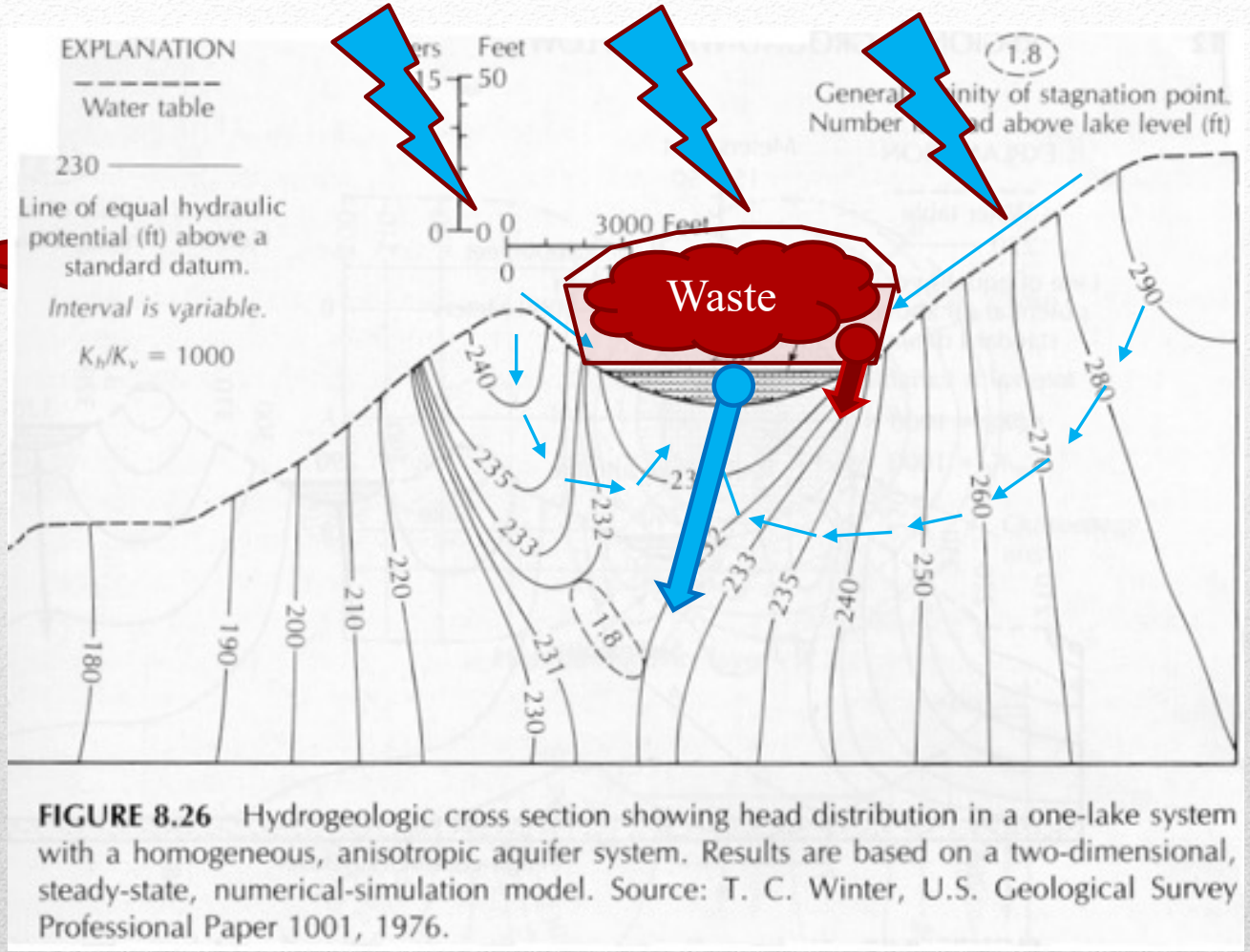

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Predominant Wind