Before coming to lab do the following:

**Water Forces**

- Moving water exerts pressure on objects.
- Pressure on an area becomes a force.
- The buoyant force on an object is equal to the weight of the fluid displaced by that object.
- Water weighs 62.4 lbs/cubic foot, and cars displace a lot of it.
- The pressure exerted by moving water increases with the square of its velocity.

Suppose you are driving through a heavy rain in a Jeep Cherokee with the following specifications:
  - Vehicle width = 5.5 ft.
  - Vehicle length = 14 ft.
  - Ground Clearance = 10 inches
  - Weight = 3,400 pounds

You encounter a flooded street with one foot of water. Here is the math:

\[(5.5 \text{ ft.} \times 14 \text{ ft.} \times 1 \text{ ft.} \times 62.4 \text{ lbs/cu.ft}) = 4,805 \text{ pounds}\]

(1) What will happen to you and the car? Explain.

(2) Is there a “safe limit” to the water depth on a street for vehicles to cross? Explain your answer.

(3) If another El Nino is on the way to California, how might this information apply to you?
PART A. TROPICAL STORM ALBERTO & THE FLOOD OF 1994  
GEORGIA & ALABAMA

HOW MUCH RAIN?

Examine Figures A and B. Figure A provides a brief summary of the wet season of 1994. Notice the "contour lines" on Figure B, indicating amount of rain between July 1-7, 1994. Locate Montezuma.

**Question 1.** a) How much total rainfall for Montezuma in the seven day period?

b) Calculate average rainfall per day.
   (for the 7 day period)

**Question 2.** Compare this to the normal amount of precipitation for Montezuma. Calculate the daily average for July using the normal precipitation records, then compare to the daily average you determined for question 1b above.

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Normal precipitation records (in inches) for 1961-1990

<table>
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<th>June</th>
<th>July</th>
<th>August</th>
</tr>
</thead>
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<tr>
<td>Montezuma, GA</td>
<td>3.58</td>
<td>4.30</td>
<td>3.63</td>
</tr>
<tr>
<td>Los Angeles, CA</td>
<td>0.03</td>
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<td>Sacramento, CA</td>
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<td>Orlando, FL</td>
<td>7.32</td>
<td>7.25</td>
<td>6.78</td>
</tr>
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**Question 3.** Use the topo map of Montezuma. Locate the gaging station along the east side of the Flint River near the center of the map, between the towns of Montezuma and Oglethorpe. The gaging station is located at an elevation of 262 feet, and the river is considered to be at flood stage when it is 20 feet above this level (282 feet). The old flood record was 27 feet above the gaging station, but the July 1994 flood established a new record at 35 feet above the gaging station, or 297 feet above sea level. Trace the imaginary contour line for this elevation on both sides of the Flint River on the map. The line will be just below the 300-foot contour line that is already drawn on the map. Label the area within these contours as Flood Hazard Zone.

**Question 4.** Assess the damage caused by the 1994 flood as follows:
List the specific features/structures that were under water in Montezuma during the flood.
   (consider -- highways, roads, schools, cemeteries, railroads)
A VERY WET SEASON
Over 60 counties were declared disaster areas (note shading) as a result of flooding brought on by Tropical Storm Alberto. A total of 52 flood events occurred in summer '94, costing $90 million in property damage and $11 million in crop damage.

EYEWITNESS ACCOUNT from Alton Fraiser, a resident of Telfair, Georgia.

"...It had been raining almost daily for several days. Then, with the ground already soggy, Alberto stalled out in middle Georgia. There was no place for the excess water to go. Highway 16 through Macon was underwater. The Macon city water supply was inundated and the city was without water for several days. They have since relocated the waterworks to a higher site. The flood of '94 is considered to be a '500-year flood.' No one had ever seen the likes of it in middle Georgia. Montezuma is located on the Flint River and it too was very hard hit. The whole town was virtually rebuilt after it was over..."
FIGURE B.  \( x = \text{Montezuma, GA} \)

TOTAL PRECIPITATION JULY 1–7, 1994

Tropical Storm Alberto
Units of measure in inches
PART B. URBANIZATION AND FLOODS

1. Baldwin Hills Reservoir

- Completed in April, 1951.
- Supplied drinking water to local area
- Design incorporated underdrain systems and a reservoir lining
- Size: 232 ft. (71 meters) high, 650 ft. (198 meters) long

LA Times news story, Dec. 11, 2003

Serene Hilltop Marks Site of Landmark Disaster

Nearly 40 years ago, a dam collapse destroyed a neighborhood. The impact was widespread.

The live telecast of the collapse from a KTLA-TV helicopter is considered the precursor to airborne news coverage that is now routine everywhere.

The Baldwin Hills Dam collapsed with the fury of a thousand cloudbursts, sending a 50-foot wall of water down Cloverdale Avenue and slamming into homes and cars on Dec. 14, 1963.

Five people were killed. Sixty-five hillside houses were ripped apart, and 210 homes and apartments were damaged. The flood swept northward in a V-shaped path roughly bounded by La Brea Avenue and Jefferson and La Cienega boulevards.

The earthen dam that created a 19-acre reservoir to supply drinking water for West Los Angeles residents ruptured at 3:38 p.m. As a pencil-thin crack widened to a 75-foot gash, 292 million gallons surged out. It took 77 minutes for the lake to empty.

Watch the 9-minute video, Engineering Disasters, and answer the following:

a. Where did the failure begin (what part of the structure)?

b. What factors combined to cause the failure?
c. What is the lesson(s) learned?

2. San Fernando Valley
Examine the posters on the bulletin board. Compare the development of the San Fernando Valley area (1902, 1919), and specifically the Northridge area (1952 and current). Discuss in a well-written paragraph the implication of the development in terms of flood control. Consider the consequences of this urbanization downstream from the San Fernando Valley. (if you would like a geographic overview of the entire L.A. Basin, view the geologic maps in the hallway).
PART C. ST. FRANCIS DAM DIASTER – March 12/13, 1928

References:
http://www.semp.us/biots/biot_376.html
http://web.umr.edu/~rogersda/st_fiancis_dam/
http://www.scvhistory.com/scvhistory/stfrancis.htm
Greg Davis, USC Dept. of Earth Sciences

At just before midnight on Monday, March 12, 1928, the towering St. Francis Dam in Los Angeles County broke apart and sent a massive wall of wind and water hurdling down the San Francisquito and Santa Clara valleys to the Pacific Ocean. More than five hours elapsed from the time the dam failed to when the roaring roiling water mass reached the ocean more than 50 miles away. Approximately 450 mostly sleeping people died.

This was the second largest loss of life in California; the first having been the 1906 San Francisco Earthquake and Fire.

Figure A. St. Francis Dam was completed in May 1926. 11 spillway panels were fitted on the crest. There were 5 outlet pipes. Note cars on top of dam for scale.

Figure B. St. Francis Dam with full reservoir, March 9, 1928.
St. Francis Dam on March 11, 1928.
Caption quote from the “Santa Clarita Valley History in Pictures” web site:
This new contender for the title of "last photo of the intact dam" is submitted (on April 16, 2005) by Gene W. Majors of Placentia, Calif., who writes: "My parents were at the dam on Sunday, March 11, 1928. They were on one of their many 'Sunday drives' that they took with my father's parents. They had been married less than a month and March 13, 1928, was my mother's 19th birthday. My grandfather noticed something strange about the dam and pointed it out to my father. The story I was told when I was young (I was born in 1946) is that my grandfather saw muddy water coming from the outlet in the dam and told my dad that they needed to get out of there right away. When they were down the road from the dam my dad stopped the car and my mother took a picture of the dam."

Figure C. Historic photo from a local resident.

Figure D. "Tombstone"  
The dam broke near midnight on March 12/13, 1928. This is what was left.

Figure E. Cross section and block diagram.
Questions

1. Examine Figure E. Notice the layering (technically referred to as foliation) of the Pelona Schist rock unit. Estimate the degree of inclination.

2. Examine the color plate topo map.
   - dark blue = reservoir
   - light blue = flood limits
   - red = paleolandslides developed within the Pelona Schist during the past 100,000 years

   What is your hypothesis on why the dam failed?
PART D. STREAM TABLE
Reference: Paul Wetmore, Dept. of Earth Sciences

This is likely to be the most fun you will have and still get a grade this semester. Today you will get to play with dirt and water to learn some of the forces driving stream formation and sediment deposition.

Things to look for:

• Stream patterns (braided, meandering)
• Point bars, meander migration
• Deposition, cutbank erosion
• Fluvial fans and deltas
• Movement of large and small grains

1. Build a hill of sand at the up-end of the stream table. Release water. There should be about a 1 to 2 foot gap between the stack of sand and the waterline.

2. A stream begins to form after a short time. The first pattern will change fairly quickly to a different, second pattern. Draw a quick sketch of the two patterns:
What are these two patterns called?
   a. 
   b. 

For your sketch of the second (i.e., the meandering) pattern, indicate on your sketch the area of deposition, and the area of erosion.

3. Note the development of the fluvial fan (delta). As the stream changes, so will the fan. Make a few sketches of this growing fan. Be sure to include observations about grain size and sorting (notice the big grains vs. the little grains, and what happens to each).

4. Make a flash flood. What happens?