Introduction A good introduction to this activity is the Surface activity.

Student Conversations Some students will realize immediately how their surface ("town") fits on the contour map ("county"), but others may require help. (The maps do have marks for the colored points, which the instructor can use to determine the proper placement, with or without sharing that fact with the students.)

It is important for students to realize that the density of lead is essentially constant in the park (but not in the town). Thus, they need to estimate the density there, then multiply by the area of the park.

Most students figure out on their own what density they need to meet the target amount of lead, then look for a location with that density.

Wrap-up A discussion of the relative sizes of the park, town, and county is helpful. Most students will realize that this activity is setting up the idea of a double integral, emphasizing the "multiply" step (and the importance of dA, which can be emphasized later).

Extensions A natural followup question is to ask how students would determine the total amount of lead in the town. (Don't ask them to actually compute this quantity.) A natural followup activity that does something similar is the Cake activity.

0.1 Instructor FAQ

On Your Mark: Let students know the surfaces are about 6 inches tall. If students draw single points, ask if they've marked **ALL** the points. Keep at it until they've drawn points touching each other. *Discussion:* Help all students participate in the discussion about whether two curves could intersect. This vague question is designed to generate debate amongst students.

Get Set: Hand out the maps for **Get Set**. Pink side up! Locating the city is difficult for the Orange surface. Students use three strategies:

1. *Rings* of contours around peaks/valleys: Red, Yellow, Purple surfaces
2. Symmetry in the surfaces and contour maps: Blue, Green
3. Values of the contours: Blue, Green, Purple
4. Spacing between the contours: Orange (blue too)

Discussion: Have students show how they figured out where the town exists in the county. Choose an order based on technique (e.g. Rings: Purple, Red or Yellow; Symmetry: Green or Blue; Values: Blue, Green or Purple; Spacing between the contours: Orange)

Go and Challenge: Optional. Discuss scale for the park.

During the Wrap-up: Tell students *The City Council has asked you to find a great location for a down-hill Ski park. On three, point to the best place on the surface for this park. One. Two. Three.* Some students will point to high points, some to low points. Have students defend why they pointed where they did - starting with someone who points high. Point out that *height* on the surface is not elevation. (Note: It may be safer to bury lead under packed snow.)

0.2 Details

Student handout

On your Mark: You work for Granite Falls, a town which needs to move a playground due to harmful levels of lead (Pb) in the ground. The surface's height represents the concentration of lead (in $\frac{\text{g}}{\text{m}^2}$) in the topsoil at every location in Granite Falls. Lead levels range from $0.5\frac{\text{g}}{\text{m}^2}$ to $6\frac{g}{m^2}$.

1. The park is currently located at the red star. Mark all points on the surface with the same concentration of lead as the park.
2. Mark all points with lead concentrations $1\frac{\text{g}}{\text{m}^2}$ higher and $1\frac{\text{g}}{\text{m}^2}$ lower than at the park.
3. Could these curves intersect? Why or why not?
4. Sketch the curves by projecting them down onto a sheet of paper. Give appropriate labels.

Get Set: Granite Falls is a 10 km $\times$ 10 km town in the 15.5 km $\times$ 21.5 km Rock County. Find where the town is located in the county and place it there. Explain how you know you found the right location.
Go: The park measures 20 m $\times$ 20 m at the red star. Determine the total mass of lead at the current location. Give units.
Challenge: The town wants to guarantee the total amount of lead in the park is less than 600 g. Find a location near the red star that achieves this level. Explain how you found this new location.

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