

## Channel Design Exercise – Provo River

This exercise is designed to give you experience with the steps involved in incorporating sediment transport into a channel design layout. The exercise is based on a section of the Provo River that was reconstructed in fall 2003 and spring 2004. You will visit this reach tomorrow to see what was actually built and how it has performed! You will hear from Tyler about the choices he made in designing the reach and hear about lessons learned.

The sequence of steps followed here use the principles covered in class. Although there are other approaches, we offer this sequence in order to bring practical application to some of the concepts and ideas discussed in the course.

*Please form groups of three. We encourage you to form a group with those who have a different background - whether through education, experience, or location. Each group should have someone with ArcGIS or ArcPro installed on their computer (and able to use it).*

### Step 1 – Goals and design strategy development

- a) The client's objectives are that you create a channel and floodplain that is natural in function and appearance. Yes, you have to figure out what that means. The design should be capable of maintaining a sustainable native riparian vegetation community and a recreational trout fishery. This will require that flows access the floodplain on a regular basis. The project area is intended to be a visual and recreation focal point for the Heber Valley. It is expected to attract both visitors and new residents. There is a clear economic incentive.
- b) The client's goals are very general and do not inform how the channel is to be built. You must develop a design strategy to achieve the project goals. This design strategy should be built on your interpretation of how these ecological and recreational goals can be achieved. You need to turn generalities into specific channel attributes. Be specific about how you want the channel to behave (e.g. static v. dynamic; sediment surplus v. deficit, etc.).
- c) The design reach has a specified supply of sediment at Midway, just upstream of the design reach (we will visit the site tomorrow). *You will need to design your channel to accommodate the sediment supply in a way that supports your objectives.*
- d) Frame your design strategy in the form of design hypotheses that link specific actions to predicted site properties or processes that achieve specific objectives.

### Step 2 – Examine the aerial photo of the project site (Photo 1).

Photo 1 shows the area to be restored in this exercise. It also shows the starting point (green) and ending point (red) of the channel segment that you will design. In the photo, flow is from top to bottom. Familiarize yourself with the features found in the area and the existing vegetation. The large trees in the middle part of the photo are crack willow (*Salix sp*) (approx 50-70 ft tall). The existing Provo River channel (right side of the photo) is lined with narrow leaf cottonwood (*Populus angustifolia*) trees that are quite old and in declining health (but these trees still produce seeds available for recruitment into a new population), as well as a few smaller shrubs, including willows, woods rose (*Rosa woodsii*), golden current (*Ribes aureum*), chokecherry (*Prunus virginiana*), and red osier dogwood (*Cornus sericia*). The oxbow wetlands located on the left side of the photo are mostly lined with hawthorn (*Crataegus douglasi*) and coyote willows (*Salix exigua*). There are numerous small springs located around the property (not visible on the photo) and there are many small ditches that distributed the spring water around the property for irrigation of the pasture grasses that were previously grown in the open meadow areas.

### Step 3 – Review the topographic data shown in Photo 2.

The contour interval is 1 ft. Red lines are at 5-ft contours. Use the scale bar at the bottom of the photo to get a feel for the size of the project area.

- The elevation of the floodplain surface at the starting point is approximately 5462 ft, and the elevation of the floodplain at the ending point is approximately 5435 ft.
- The straight-line distance between the starting and ending points is approximately 3950 ft.

### Step 4 – Choose a desired frequency of floodplain inundation.

Decide how frequently you want overbank flooding. Do you want annual flooding, something less frequent or more frequent? Do you want it to flood everywhere at the same time? How are ecological, recreational, or sustainability objectives tied to this desired frequency of flooding? Be specific.

### Step 5 – Determine discharges related to these desired frequencies of inundation.

You may wish to consider a range of channel-filling discharges, such that the channel will flood at different times at different locations. Flood frequency data are available in attached figures.

### Step 6 – Choose a layout for your restored channel.

The first step in channel design is to determine the necessary channel slope and width that will transport the sediment supplied to the reach. The elevation drop between starting and ending points, divided by the channel length, is the channel slope. So, realize that specifying a channel slope means you have determined both (i) the channel length as well as the sinuosity of the channel, which is channel length divided by the straight-line valley length.

How do you do this? Based on your assigned sediment supply, evaluate the slope needed to transport the supplied sediment at different flows. Plots have been provided giving this slope as a function of channel width. For your specific design flow, you can use the spreadsheet “iSURF.xls” to find the combination of channel slope and width that will transport the supplied sediment at the design discharge for your channel.

**Step 6a.** Choose a channel width. There is some flexibility in this choice. You may use information for typical channel widths in this area or you might consider other factors such as the amount of earth to be moved or the slope (and hence sinuosity) associated with various candidate widths. For the design discharge selected in Step 4, you use the iSURF results to evaluate the *combination* of channel width and slope needed to transport the supplied sediment at the design discharge. With a desired channel width, you now have the design data.

**Step 6b.** Compute the appropriate channel length to provide the slope computed in iSURF. Remember,  $\text{slope} = \text{rise/run}$ .... you have rise and slope, so solve for run. Now you need to lay out your channel making use, where possible, of existing features and vegetation. [*You may go analog and cut a piece of string to the run length (using the scale bar on the photo as a reference) and use string to lay out your channel. This is what Peter would do, but students in the class have not done so in years.*] Or you can use the ARC files and do this step digitally. For this step, work with a channel centerline only. Draw your channel from the starting point to the ending point on Photo 1. This is a key step in the design process. There are a variety of factors to consider, such as the dimensions (amplitude, radius of curvature) of bends and the orientation of each reach of the channel with respect to the downvalley gradient (running your channel uphill, or along a contour will probably not give a desirable result).

### Step 7 – Evaluate the long profile of your channel layout.

Load Extract-DEM-Profile.tbx into Arc. Use the version appropriate for ArcMap or ArcPro. Run the script on your long profile. Paste the resulting output from the .csv file into the spreadsheet LongProfile.xlsx. Evaluate the cut/fill associated with your profile.

**Step 8 – Turn In.**

Each group will submit a brief design summary.

- (a) In light of the general goals (e.g. sustainable native riparian vegetation community, recreational trout fishery, aesthetic and recreational focal point of Heber Valley), *In a few sentences*, state your strategy for flooding and bed material transport and the potential for storing or evacuating sediment. Basically, how did your group translate the general goals into specific stream channel attributes and sediment transport processes.
- (b) State the basis for your specific choice of design discharge and from that, your choice of design width and slope. Explain your strategy with respect to the specified sediment supply – over the range of discharges that the river will see. Discuss key features of your channel layout.
- (c) Figures. (1) Design layout (on provided air photo). (2) Long profile of channel.
- (d) Insta-review. To facilitate quick review of your designs before class on Friday, please fill out the InstaProvo\_*yourgroupname*.ppt, substituting your images and values.

**The InstaProvo Summary MUST be turned in on Thursday so we can review it prior to class Friday Morning. Email it to Peter ([wilcock@usu.edu](mailto:wilcock@usu.edu)) and to Tyler ([tyler@allred-restoration.com](mailto:tyler@allred-restoration.com)).**

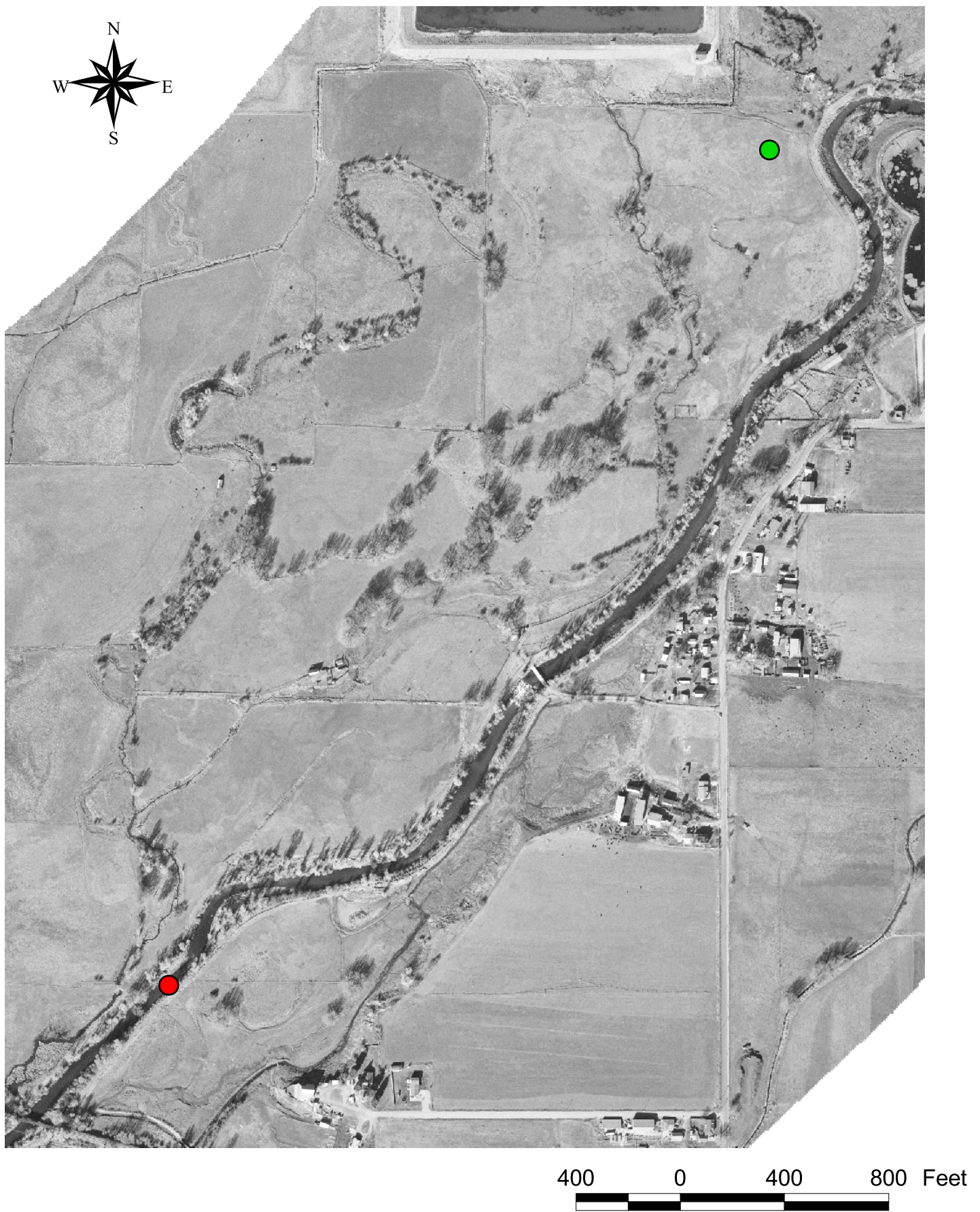


Photo 1. Aerial photo of the project area. Green dot represents the starting point for the restoration plan and the red dot represents the ending point.



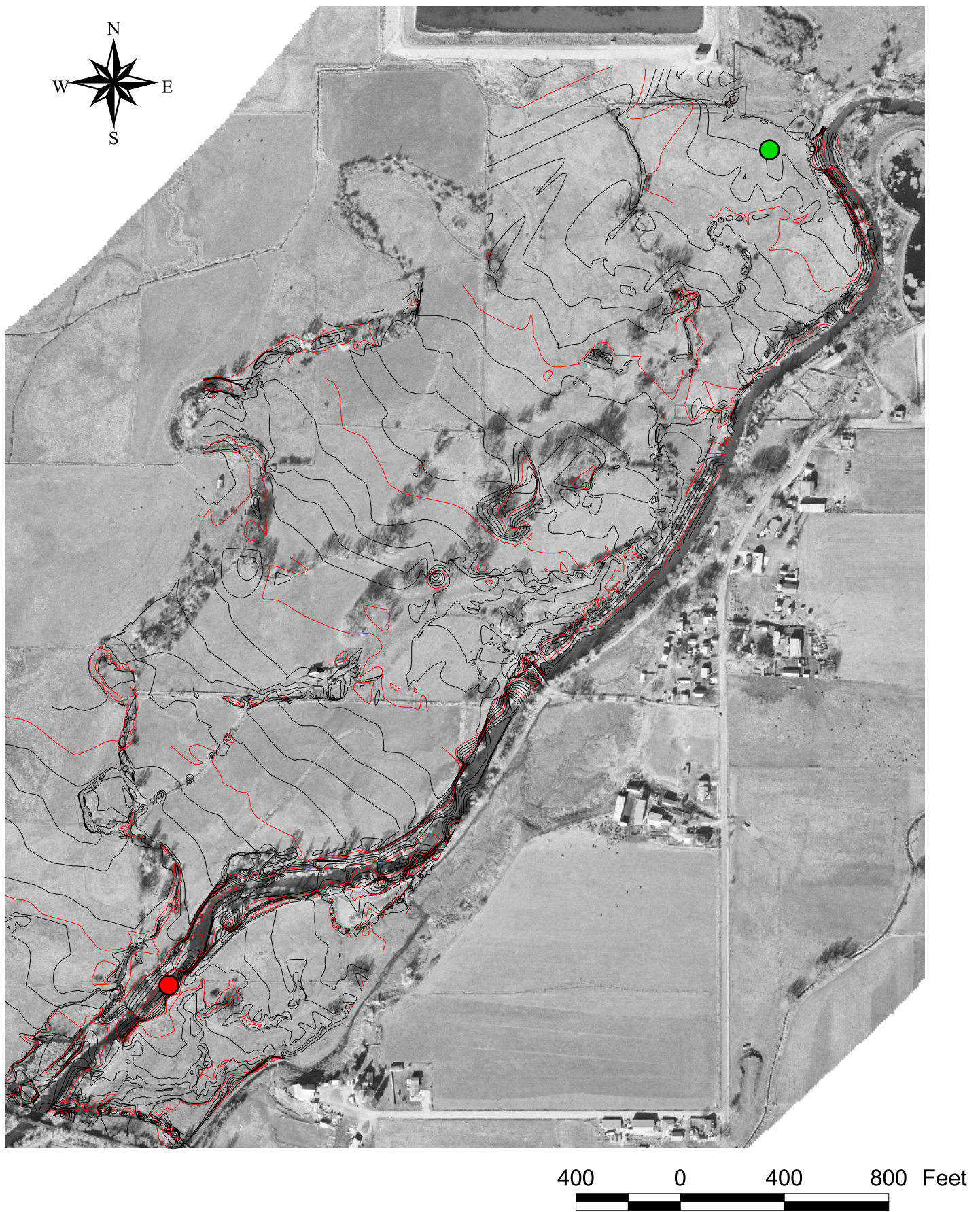


Photo 2. Aerial photo of the project area, with 1-foot contours (black) and 5-foot contours (red).