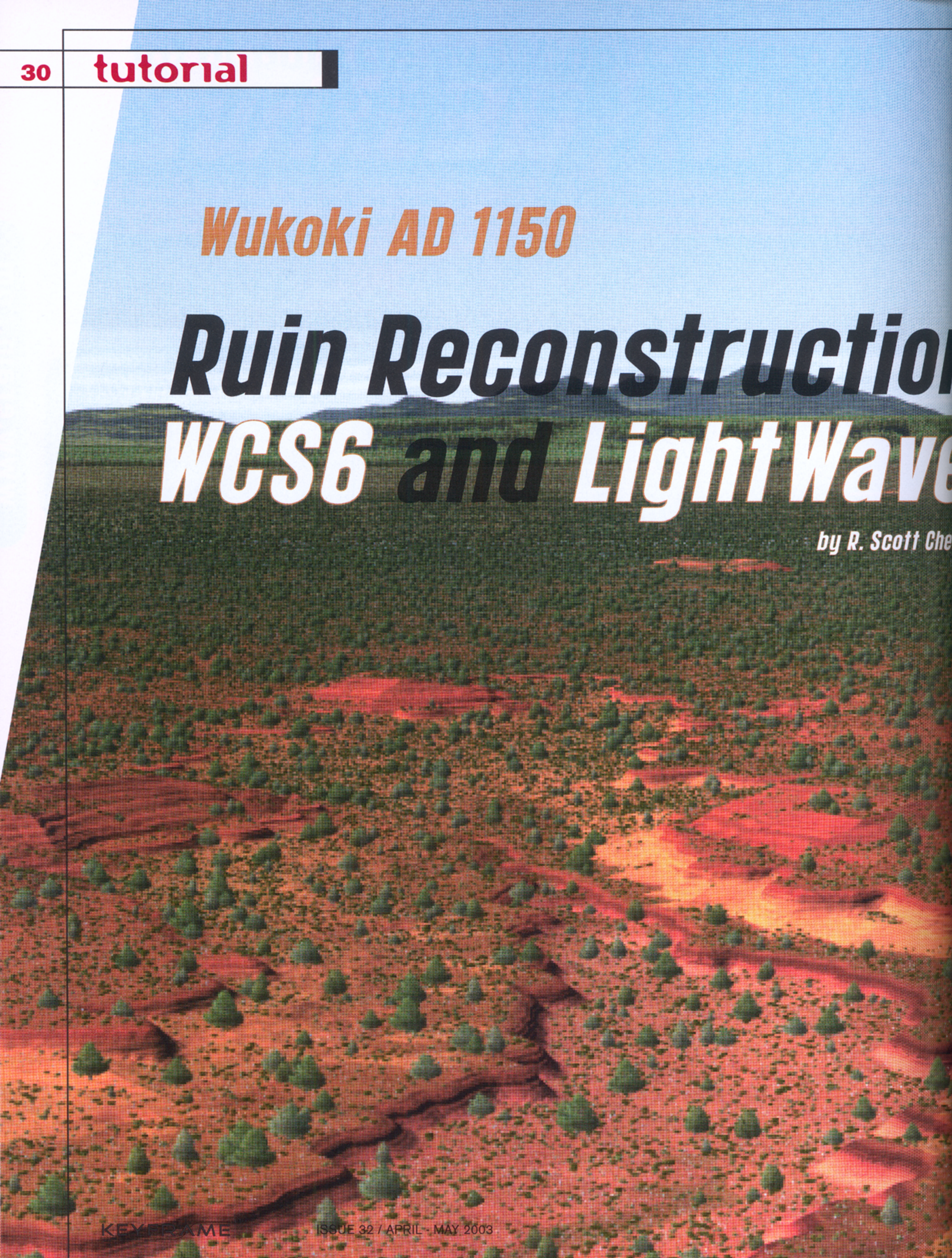
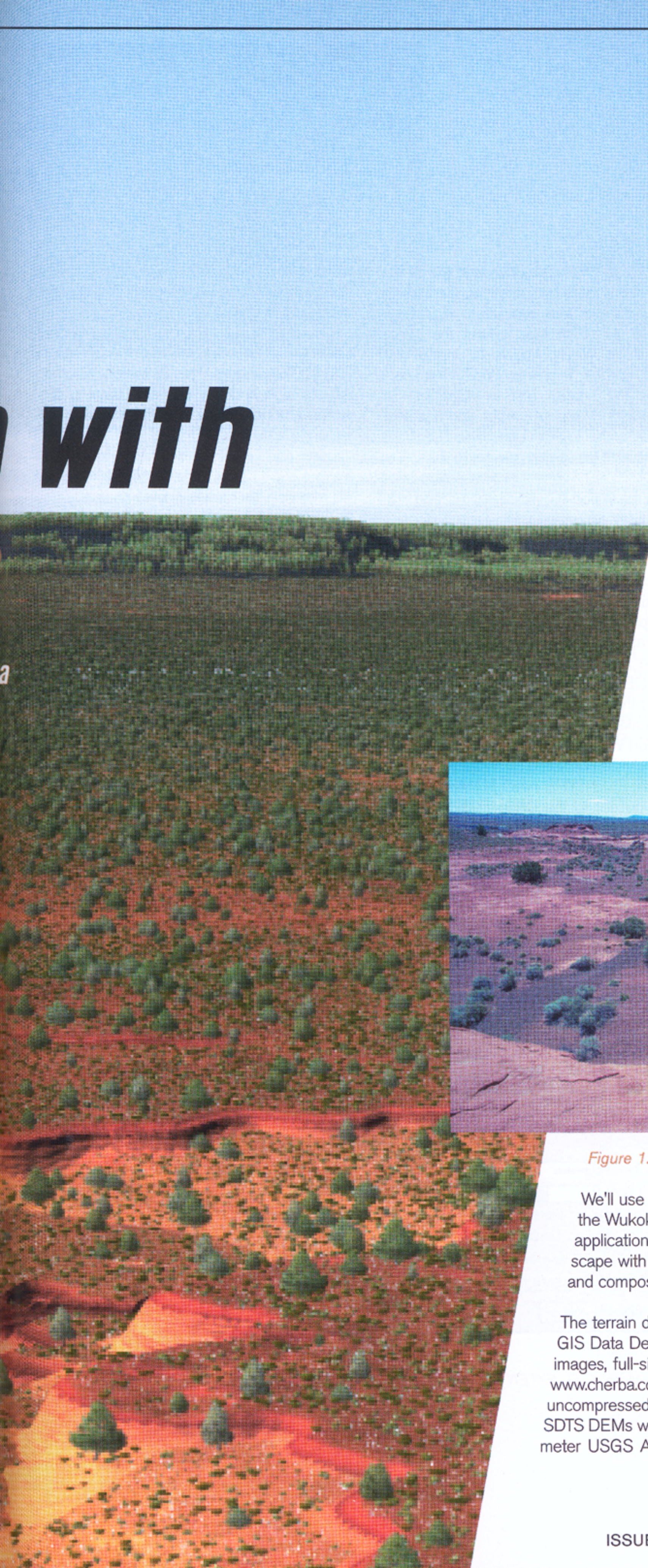
Wukoki AD 1150

Ruin Reconstructio
WCS6 and LightWave

by R. Scott Che





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AROUND 1064 AD, ACCORDING TO TREE-RING DATING, SUNSET CRATER ERUPTED NORTH OF MODERN-DAY FLAGSTAFF, ARIZONA. THE ERUPTION LEFT A BLANKET OF CINDERS AND ASH ACROSS THE HIGH DESERT REGION, INCLUDING THE AREA NOW BOUNDED BY WUPATKI NATIONAL MONUMENT. THESE DEPOSITS MADE LIMITED FARMING POSSIBLE AND ATTRACTED A MELTING POT OF CULTURES TO THE PREVIOUSLY UNINHABITED AREA. IT IS ESTIMATED THAT SEVERAL THOUSAND PEOPLE LIVED IN THE AREA DURING THE 12TH CENTURY UNTIL SOIL FERTILITY GAVE OUT. WUKOKI IS ONE OF SEVERAL ANASAZI AND SINAGUA STRUCTURES DOTTING THE AREA (FIGURE 1).

Figure 1. Photo view south to Wukoki ruin

We'll use both World Construction Set (WCS) and LightWave to recreate the Wukoki pueblo during the occupation stage and illustrate how the two applications can streamline workflow. In the first part, we'll create the landscape with WCS. In next issue's conclusion, we'll build the pueblo with LW and composite it in WCS.

The terrain data we need is freely available on the web from the USGS and GIS Data Depot. Links to the data used in this tutorial, as well as reference images, full-size figures and WCS Components, can be found on my site at www.cherba.com/resource. Download the Components.zip file and copy the uncompressed contents to your WCS\Components folder. 10-meter resolution SDTS DEMs will form the basis of the near landscape around Wupatki and 90-meter USGS ASCII DEMs will provide surrounding ground and skyline. That

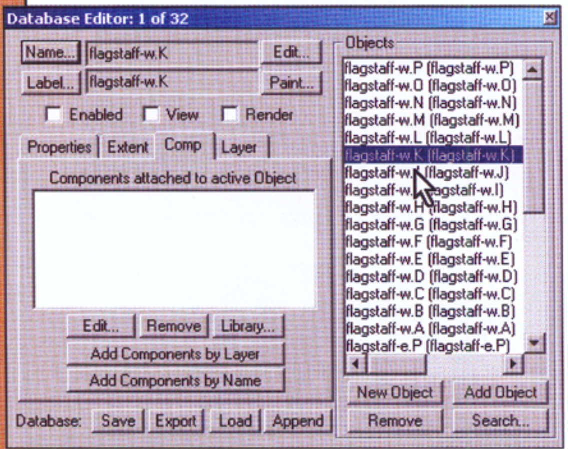


Figure 2. Database Editor, flagstaff-w.K DEM selected

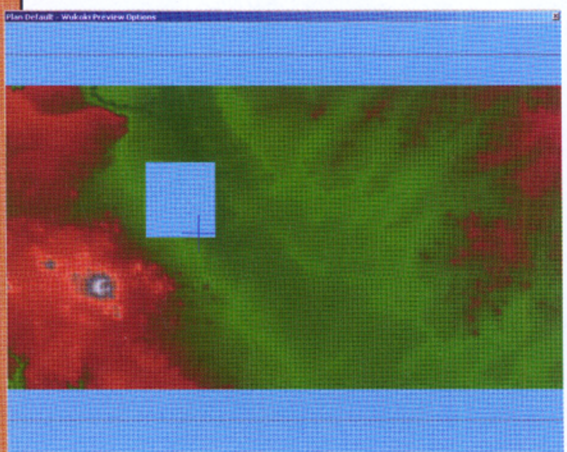


Figure 3. Plan view with DEM hole

means good detail nearby and fast rendering distant terrain. When I refer to10-meter and 90-meter resolution, that's the spacing of data points on the terrain grid. The same DEMs may be referred to as 7.5-minute and 1-degree DEMs, respectively, which refer to the geographic arc the DEMs cover.

Uncompress the USGS ASCII DEMs, flagstaff-e.gz and flagstaff-w.gz, before import. Launch the Import Wizard and load flagstaff-e. When asked if you'd like to import another DEM, load flagstaff-w using the default settings. WCS will automatically tile each 1-degree DEM into sixteen 15-minute DEM tiles. WCS subdivides most DEM types into tiles during import. If any portion of a DEM is in camera view at render time, WCS makes render calculations for the entire DEM. Many smaller DEM tiles reduce unnecessary render time.

Disable the flagstaff-w.K DEM in the Database Editor (Figure 2). This hole is where the four 10-m SDTS DEMs will soon fit (Figure 3). When you download the SDTS DEMs, name them by something identifiable like quadrangle and resolution, e.g., Gray Mountain AZ 10m.tar.gz. Leave the .tar.gz extension so WinZip knows to ungzip and untar the archive. To prevent WinZip from corrupting the data, go to Options > Configuration > Miscellaneous and deselect "TAR file smart LR/LF conversion." Extract compressed files to separate folders.

Launch the Import Wizard again and load one of the Gray Mountain DDF files. It doesn't matter which one you pick, the Wizard will figure it out. When the Wizard asks if you want to import another DEM, choose one of the Wupatki NE DDFs. Repeat the process with the Wupatki SE and Wupatki SW data. WCS will create a single .elev DEM on import because it has to fill in the gaps between SDTS DEMs. Always import SDTS data together this way or you'll end up with noticeable breaks along dataset boundaries. Start the Import Wizard once again and load GRAY MOUNTAIN.elev. Name it Wupatki in the OUTPUT FILE TYPE AND NAME window. When you get to the DATA POSITIONING window, Change Settings.

You don't know it yet, but we're going to have a problem. Whenever you drop high-resolution data into holes in lower resolution terrain, you're going to have elevation gaps along the boundary. No matter how good your data is, it's just a fact of life that data points bordering a 90-m grid don't meet all the points along a 10-m grid. We'll use an old trick that's been around since early motion picture days and head off the problem early.

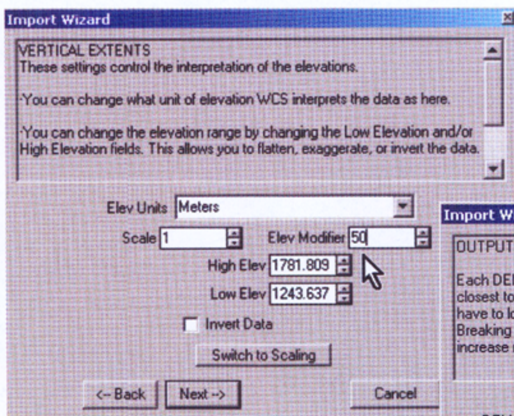


Figure 4. VERTICAL EXTENTS window

Continue to the Import Wizard VERTICAL EXTENTS window. The Elevation Modifier adjusts high and low elevation data by the same amount. Enter 50 to increase all imported data by 50 meters (Figure 4). Test imports and renders I did while developing the project showed elevation gaps of up to 40 meters. Fifty meters should raise our 10-m DEM high enough so we don't see any daylight under the surrounding 90-m DEM. Although it's not an issue with this project, keep in mind that this method changes the actual terrain data elevations.

Continue to the fifth window, OUTPUT DEMS, and change DEM Row-Wise and DEM Col-Wise to 2 (Figure 5). This will give us four DEMs with areas matching the Gray Mountain, Wupatki NE, Wupatki SE, and Wupatki SW DEMs we originally imported. When the Wizard is done, disable the GRAY MOUNTAIN DEM in the Database Editor. Use the Label button to relabel the DEMs according to their USGS quadrangle name (Figure 6). Wupatki.A is Wupatki SW, Wupatki.B is Gray Mountain, Wupatki.C is Wupatki SE, and Wupatki.D is Wupatki NE. This will make it easier to identify the DEMs and will simplify draping the DRGs. Run the Import Wizard one last time and multiple-select the Wupatki.A, Wupatki.B, Wupatki.C, and Wupatki.D elevation files. Import using the default settings. This will tile them to a size appropriate for rendering.

DRGs (Digital Raster Graphics, or digital topographic maps, if you will) make great references for placing features on terrain. Fortunately,

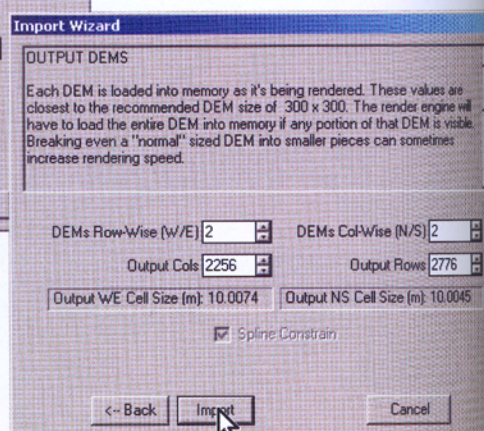


Figure 5. OUTPUT DEMS, and change DEM Row-Wise and DEM Col-Wise to 2

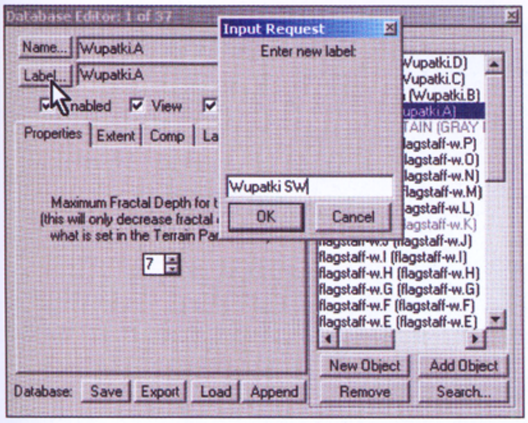


Figure 6. Database Editor with Wupatki.A being renamed.

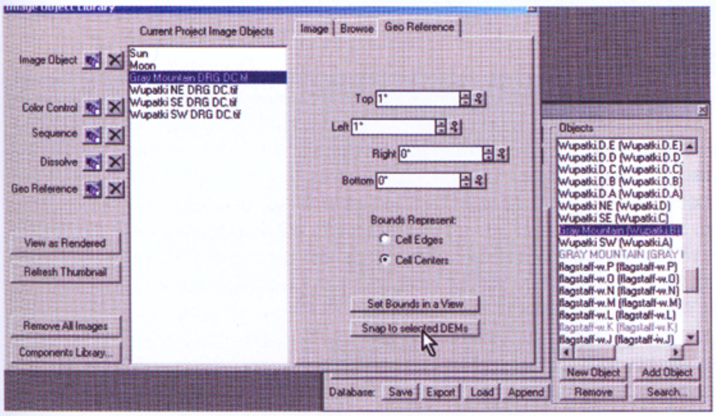


Figure 7. Image Object Library Gray Mtn GeoRef page and DBE Gray Mtn selected while Snap to DEM clicked.

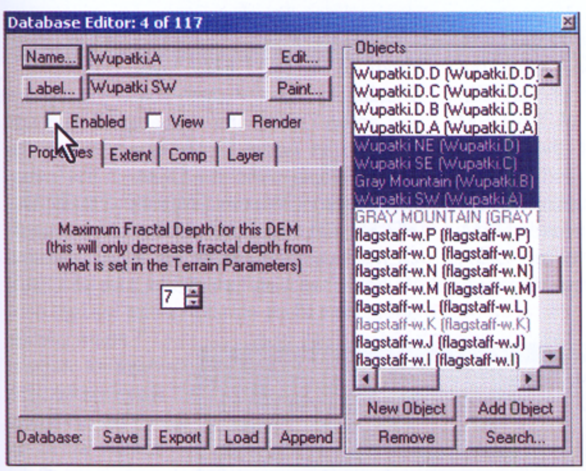


Figure 8. DBE Disabled 4.

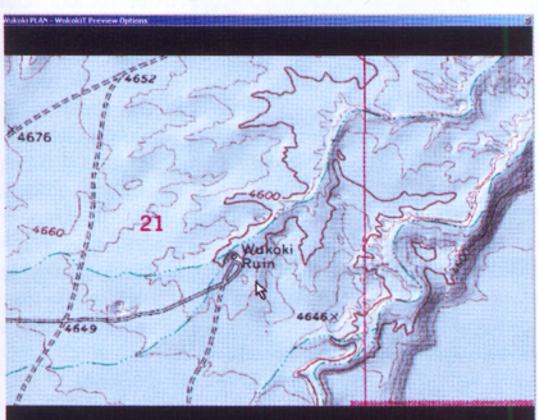


Figure 9. Gray Mtn Color Map Editor, select in dropdown.

Arizona DRGs are available free for download from the ARIA server at the University of Arizona in Tucson. The 1:24,000 scale DRG maps come in regular and decollared versions. The decollared versions have the map border and legend removed, so they'll save you a trip to Photoshop. On download, name them by quadrangle and type, e.g., Gray Mountain DRG DC.tif (DC stands for decollared). Open the Image Object Library, Add Image Object, and load the four DRGs. The PC version allows you to multiple-select all four images for loading. Select the Gray Mountain DRG DC.tif and Add Geo Reference Attribute. Select the Gray Mountain DEM in the Database Editor (the one you just labeled) and click Snap to selected DEMs in the Image Object Library (Figure 7). WCS will remind you of the process; OK to complete the snap. The latitude and longitude bounds will update. Repeat the process and georeference the remaining DRGs. The four quadrangle-named DEMs have served their purpose, so disable them in the Database Editor (Figure 8).

In the Land Cover Task Mode, create four Color Maps and name them Gray Mountain, Wupatki NE, Wupatki SE, and Wupatki SW. Choose Color by Pixel to render all of the image detail and load the corresponding DRGs from the Image Object dropdown list.

Go to the Render Task Mode and open the Component Gallery. Open the Cameras page and select the Keyframe32 tab. Load the Wukoki Plan Camera and open a view. Do not scale the loaded camera's position to current DEM bounds; we want it loaded right where it was originally created. Disable Atmospheres and key F9 to render a preview (Figure 9). Wukoki ruin is almost directly below us. We're done with the Color Maps, so disable them. Go back to the Render Task Mode, right-click the Cameras category in the Scene-At-A-Glance, and Add Component from Gallery. Flip to the Keyframe32 tab and load the Wukoki View SW Camera. Do not scale the loaded camera's position to current DEM bounds. Open a view.

Go to the Land Cover Task Mode, right-click the Ground Effects category and Add Component from Gallery. Go to the Cartography tab and load the GrnBrnGryWht Hypsographic Ground Effect. Turn to the Ground Editor Material Gradient & Driver page. Scale the Material Gradient Driver from 1440 to 1460 meters. Expand the Ground Effects category in the Scene-At-A-Glance. We can only have one global Ground Effect, so rather than let WCS choose one for us, enable GrnBrnGryWht Hypsographic only. Open the Terrain Parameter Editor from the lower Scene-At-A-Glance pane and increase the Maximum Fractal Depth to 5. Render a Wukoki View SW preview to get an idea of the topography (Figure 10). The knob left of center is where we'll build the Wukoki pueblo.

The ground here is the Moenkopi Formation of early Triassic age and is the next geologic unit up in the sequence exposed in the Grand Canyon to the northwest.

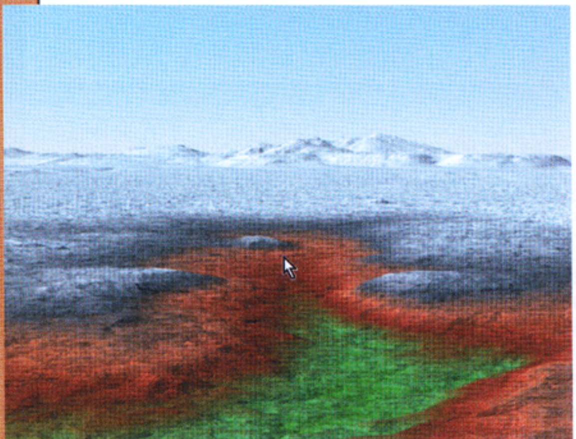


Figure 10. View SW with hypso Ground Effect, Fractal Depth 5

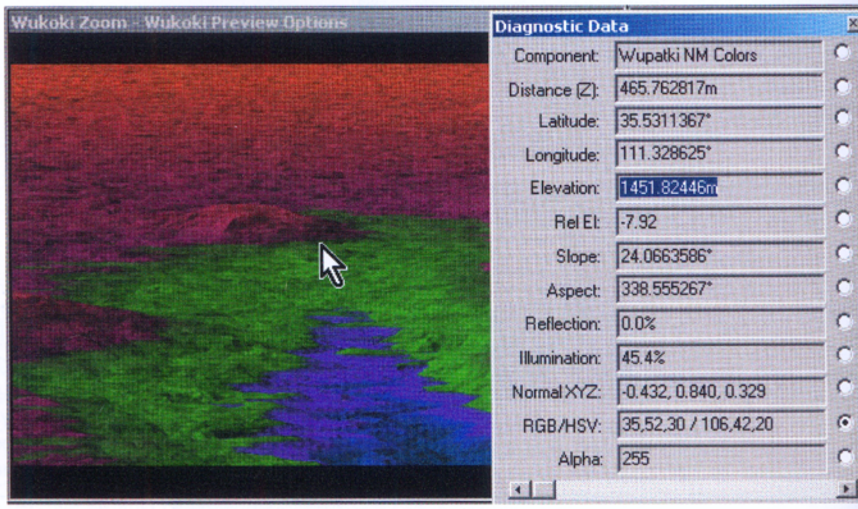


Figure 12. Wukoki Zoom preview render with pointer on slope, Diagnostic Data open, and 1402 elevation highlighted.

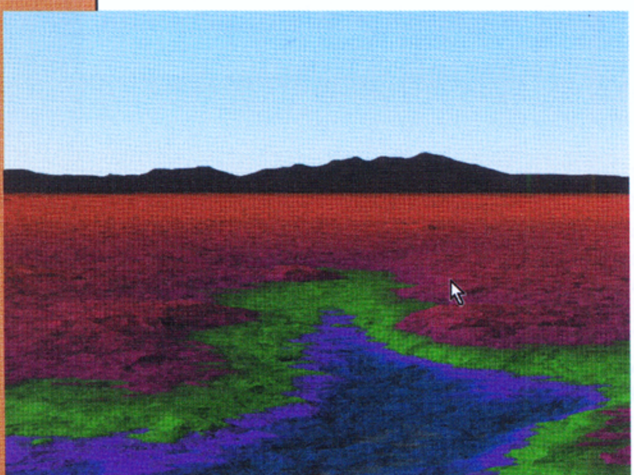


Figure 11. Main view with Wupatki NM Colors Ground Effect, Fractal Depth 5

These are terrestrial deposits of reddish sandstones (resistant cliffs) and mudstones (slopes). Select the Ground Effects category in the Scene-At-A-Glance and Add Component from Gallery. Go to the Keyframe32 tab, load the Wupatki NM Colors Ground Effect, enable it, and disable the others. Render a Wukoki View SW preview (Figure 11). Bright colors are great for quickly setting up Ground Effects.

Let's see how the Wupatki NM Colors Ground Effect places materials on the terrain. Select the Texture Operations button to the right of the Material Gradient Driver % field and Edit Texture. The Texture Editor uses an Elevation-driven Dynamic Parameter Texture to place materials in the gradient. The gradient goes from 1430 meters to 1550 meters. Materials are rendered according to their position in the gradient, in this case, elevation. Go to the Render Task Mode and load the Wukoki Zoom Camera from the Component Gallery Keyframe32 tab. Do not scale the loaded camera's position to current DEM bounds. Open a view and render a preview. If you click on the base of Wukoki's rocky knoll in the preview render, the Diagnostic Data gives an elevation of about 1452 meters (Figure 12). This is where we want Moenkopi 5 Cliff material to start rendering. 1452 meters is about 18.3% along the 120-m gradient. 18.5% was used because the Half Blend transition will slightly lower where the Moenkopi 5 Cliff starts rendering (Figure 13).

The Cliff materials will be cliff formers (small though they may be) and Slope materials will form slopes. Unfortunately, the 10-m terrain data shows everything as slopes. We'll use Area Terraffectors to raise some cliffs, but let's first increase the resolution of this DEM to 1 meter. Several iterations of the DEM Interpolater would work, but the Import Wizard will do it in one step and we can resample the DEM at a resolution of our choosing. Import the foreground DEM, Wupatki C.G. When you get to the DATA POSITIONING window, Change Settings. Continue to the fifth window, OUTPUT DEMS, and increase Output Cols and Output Rows by a factor of 10 to 2830 and 2780. The cell size will drop to about a meter. Import the data and disable the 10-m Wupatki C.G DEM we just resampled.

Render another Wukoki View SW preview and you'll see a smooth and more detailed 1-m terrain (Figure 14). We weren't looking for more realistic resampled terrain. Our goal was to have a finer grid for applying an Area Terraffector Elevation texture. To make life easier later on, multiple-select all Wupatki C.G.* DEMs in the Database Editor and add them to a 1m DEMs layer (Figure 15). Disable the layer. Multiple-select the remaining active DEMs and Wupatki.C.G and add them to an Active DEMs layer. Disable the layer. Multiple-select the DEMs in the immediate area of Wukoki (Wupatki C.G.BP, BQ, BR, BZ, CA, and CB), add them to a Wukoki DEMs layer, and enable the layer. Open the Wukoki Plan view and scale it so all DEMs are in view (Figure 16).

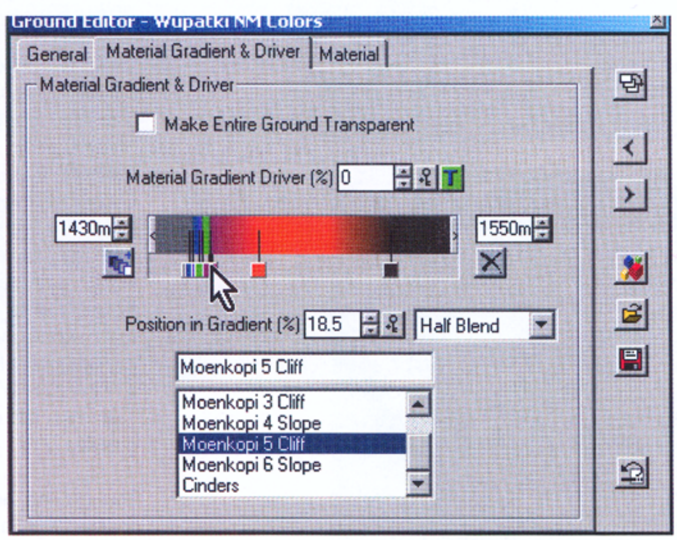


Figure 13. Ground Editor, Moenkopi 5 Cliff material selected, pointer at Position in Gradient field.

Area Terraffectors raise or lower terrain within an area defined by a vector. Our vector will bound the six DEMs. For extra credit, you can use my Elev1448m and Elev1453m Ground Effects to render grayscale planimetric views to disk where elevations above

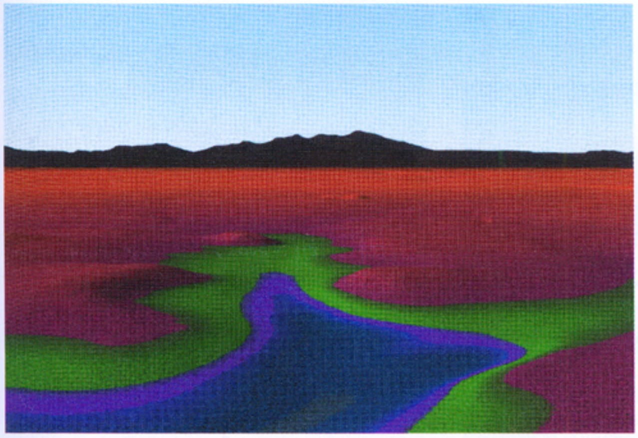


Figure 14. Wukoki View SW render with 1-m grid DEM

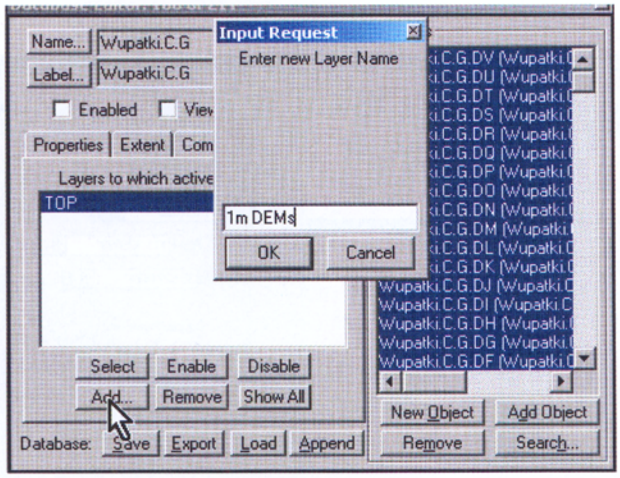


Figure 15. DBE adding 1m DEMs layer.

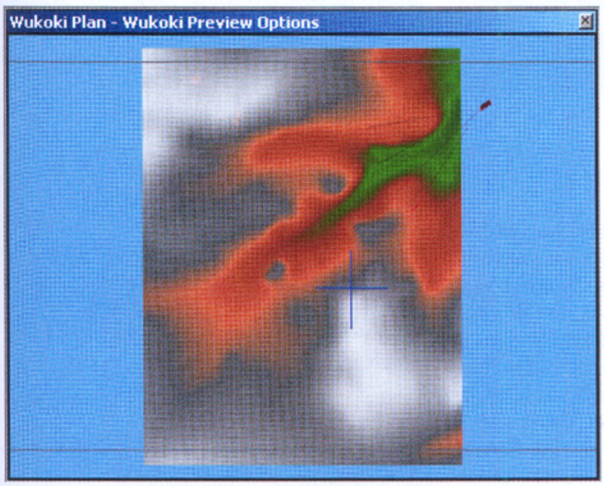


Figure 16. Plan OpenGL, Wupatki SE.G.BR, BQ, BP, BZ, CA, and CB DEMs only

Figure 17. Elev1453.iff

1448.5 and 1453 meters, respectively, are white and elevations below aren't. You can then open the renders in an image editor to create irregular cliff outlines. Or you can use my Elev1448 and Elev1453 images where I've done all the work for you. I'm going for a stylized terrain look, so there are no sharp corners on my cliff texture maps (Figure 17). Add the Elev1448.iff and Elev1453.iff images to the Image Object Library and add Geo Reference Attributes. Select the Wukoki DEMs layer in the Database Editor and snap the image bounds to the DEMs (Figure 18).

Go to the Terrain Task Mode, select the Area Terraffector category in the Scene-At-A-Glance, and Create from the icon toolbar. Click the four corners of the terrain in the Wukoki Plan view to define the bounding vector, starting with the upper left corner. Right-click when you're done and name the Area Terraffector and vector Elev1448. Close the Component Gallery when it opens. We could stop here and say the vector's close enough, but I don't want you to get into any bad habits. Alt+click the vector in the plan view to activate it and Show Points from the toolbar. Double-click the vector in the view to open its Vector Editor. Go to the Selected Points page and select Single Point. As you click the up arrow widget beside the First field you'll see the active points in red in the plan view.

Open the Image Object Library, select one of the Elev images, and turn to the Geo Reference page. The first vector point should match the upper left corner. Highlight the Top value on the Geo Reference page, Ctrl+C to copy, and paste it into the Y (Lat N-S) field in the Vector Editor. Highlight the Left value and copy it to the X (Lon W-E) (Figure 19). You'll see the point nudge in the view as new values are entered into the Vector Editor. Repeat the process for the remaining points according to the following table. Before we leave the Vector Editor, Create Copy and name it Elev1453.

	Y (Lat N-S)		**X (Lon W-E)**
Point 1	Top		Left
Point 2	Top		Right
Point 3	Bottom	Right	
Point 4	Bottom	Left	

Go to the Area Terraffector Editor > Elevation & Roughness page and make the elevation Absolute and Increase Only. Enter an Elevation of 1448.5 and create a. We'll use an image to drive the texture, so select Planar Image as the Selected Element and choose the Elev1448.iff from the Image Object dropdown list. The image is already georeferenced, so we're done. Clone the Elev1448 Area Terraffector in the Scene-At-A-Glance and name it Elev1453. Go to its Elevation & Roughness page and change the Elevation to 1453. Edit the texture and choose the Elev1453.iff from the Image Object dropdown list. Expand the Vectors category in the lower Scene-At-A-Glance pane. Click,

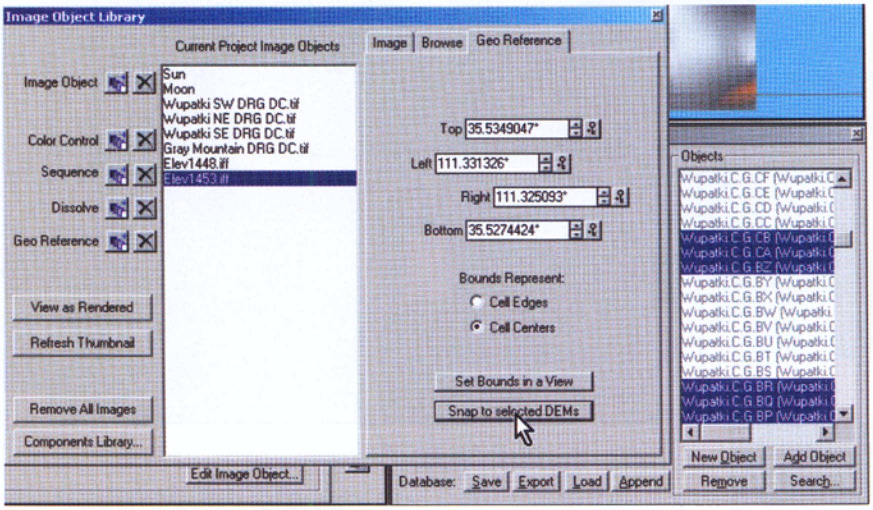


Figure 18. IOL and DBE snapping Geo Reference to Wukoki DEMs layer.

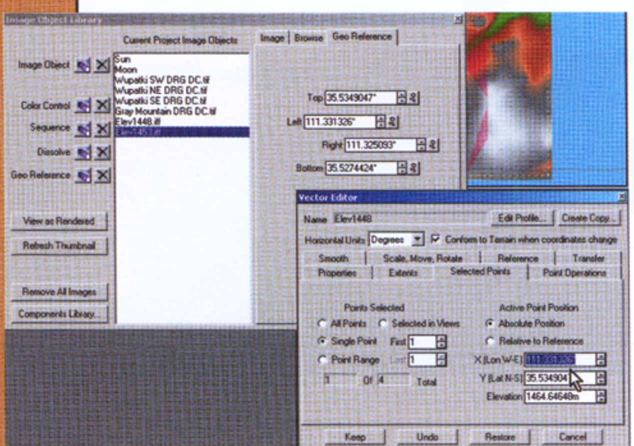


Figure 19. IOL and VE during paste.

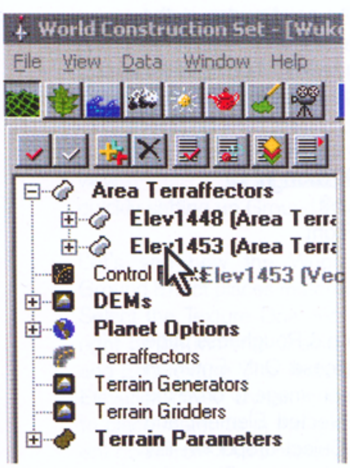


Figure 20. Drop Elev1403 vector on Elev1403 ATfx.

drag and drop the Elev1453 vector on the Elev1453 Area Terraffector (Figure 20). We now have cliffs set up at elevations of 1448.5 and 1453 meters.

In the Database Editor, activate the Wukoki DEMs layer, and Disable. Select a member of the Active DEMs layer (e.g., Wupatki.A.T), activate the Active DEMs layer, and Enable. Go to the Land Cover Task Mode and load the Wupatki NM Ground Effect from the Component Gallery Keyframe32 tab. Make it the only enabled Ground Effect. This is a textured version of the Wupatki NM Colors Component we've been using. It uses Fractal Noise textures stretched in the terrain XY plane (XZ in the LightWave world) for Diffuse Color and Bump Texture to simulate the stratified sedimentary rock of the Moenkopi Formation. Turn Atmospheres back on and render a Wukoki View SW preview to admire your handiwork (Figure 21).

That takes care of the ground. Now for the Ecosystems. Load the Boreal WNM and Upper Sonoran-Pinyon WNM Ecosystems from the Component Gallery Keyframe32 tab. Do not scale the loaded Ecosystem elevation lines to the current DEM elevation. Open the Environment Editor to the Ecosystems page and Grab All. The Upper Sonoran-Pinyon WNM Ecosystem should be first in render order. If it isn't, select it and use the red up arrow to increase its render priority. These are northern Arizona Ecosystems that use stock WCS images, so don't look too closely or you'll see that the desert scrub bushes aren't really creosote. If you were to render the scene as is, it would take almost two hours. That's because WCS would render each foliage object (in this case, image) as far as the camera can see.

When you have an expansive scene like this, rendering each foliage image is usually time wasted since it's nearly impossible to discern image detail in distant foliage. That's where Distance Dissolve comes in. It replaces the Ecotype Foliage Objects with Dissolve Color when the objects drop below a rendered pixel height. Go to the Boreal WNM Ecosystem Editor > Material & Foliage page. Select the Overstory Ecosystem Operations button and Edit Ecotype. Turn to the Ecotype Editor > Ecotype page, select Dissolve Enabled, and add a texture. Load Complete Texture in the Texture Editor. Go to the Component Gallery Keyframe32 tab and load the Boreal Dissolve Texture (Figure 22). Do the same for the Understory Ecotype; enable Dissolve, add a texture, and load the Boreal Dissolve Texture. Page to the Upper Sonoran-Pinyon WNM Ecosystem Editor, repeat the process for its Ecotypes, and load the Upper Sonoran-Pinyon Dissolve Texture. The key to a good Dissolve Texture is making the image-to-texture transition as seamless as possible. That sometimes means making view-specific Dissolve Textures as foliage renders differently with changes in camera and light position.

Let's add some clouds, adjust the light, and wrap up this tutorial. Go to the Sky Task Mode and load the Pastel Wispy Cloud Model from the Component Gallery. Scale the Cloud Model's position to the current DEM bounds. In a plan view, reset the camera to its default position and zoom back until you can see the shaded extent of the Cloud Model (Figure 23). As with most things 3D, more clouds take longer to render, so we only want them where the camera can see them. Set Bounds in a View in the Cloud Model Editor. WCS tells us that the next two points clicked in a view will be the new bounds. Click one corner behind the Wukoki View SW camera, north-

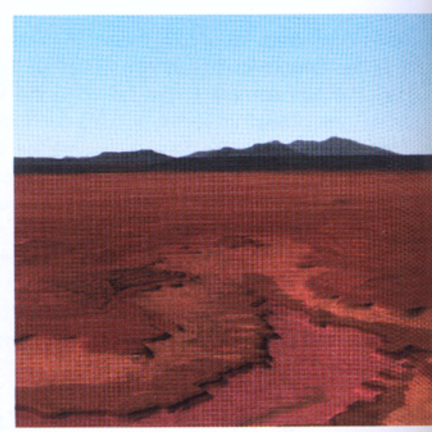


Figure 21. Wukoki View SW view, Wupatki NM Ground Effect.

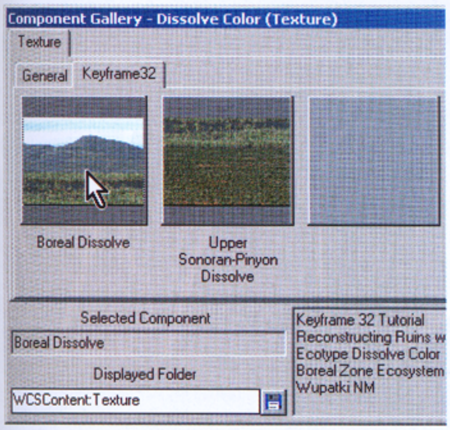


Figure 22. Component Gallery, Boreal Dissolve Texture.

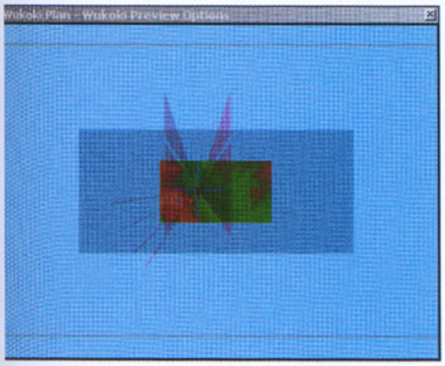


Figure 23. Plan view scaled Cloud Model bounds

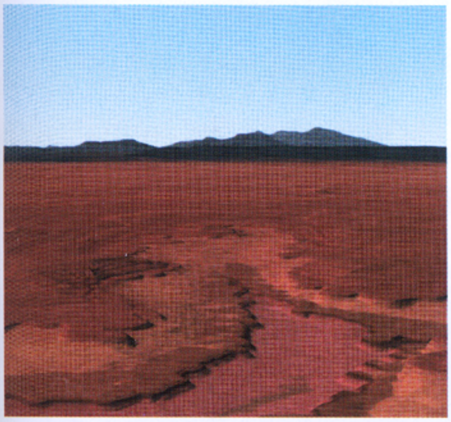


Figure 24. Plan view scaled Cloud Model bounds

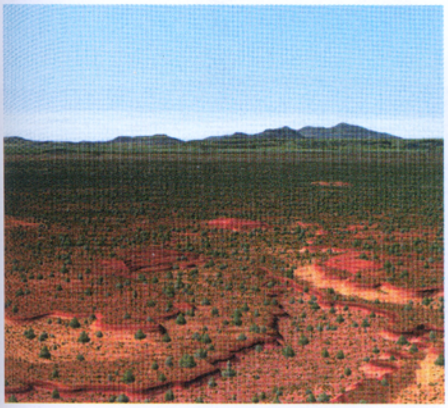


Figure 25. Main view, five minutes

east of the camera icon in the plan view. Click the opposite corner in the view direction to the southwest (Figure 24).

This is high desert with light-colored ground, so go to the Light Task Mode and open the Light Editor to the Color & Shadow page. Click the Light Color & Intensity color well to open its Color Editor. Increase the Intensity to 150% to brighten the scene a little. Render a Wukoki View SW preview and your scene is ready for pueblo construction (Figure 25). Stop by next time and see how the story turns out.

Glossary

Let's face it, there are just too many acronyms in terrain animation. Explanations are provided as a public service.

1-degree DEM DEM covering 1 degree of latitude and 1 degree of longitude.

15-minute DEM DEM covering 15 minutes of latitude and 15 minutes of longitude.

AD Anno Domini, Latin, "Year of God" translated literally.

ASCII American Standard Code for Information Exchange

ASCII DEM A DEM consisting of blocks of profiles (strips) of elevations and georeferencing information stored in a text format

Degree (latitude) Degrees of latitude are parallel so the distance between each degree remains almost constant. Each degree of latitude is approximately 69 miles (111 km). 1 degree = 60 minutes = 3600 seconds

Degree (longitude) 1/360th the Earth's circumference at the equator. Unlike latitude, lines of longitude converge at the poles so the distance between degrees of longitude decreases as you travel from equator to pole. A degree of longitude is approximately 69 miles (111 km) at the equator.

DEM Digital Elevation Model. A generic term for terrain data files which come in a dizzying array of flavors.

DRG Digital Raster Graphic

GIS Geographic Information System. Geographic data with a database twist.

SDTS Spatial Data Transfer Standard. The result of 12 years' intensive development by the USGS and industry that still has some of us scratching our heads.

SDTS DEM A DEM following the Spatial Data Transfer Standard.

Triassic Period First period in the Mesozoic Era, lasting from approximately 250 to 202 million years ago. Popularly known as the Age of Dinosaurs and prequel to the Jurassic.

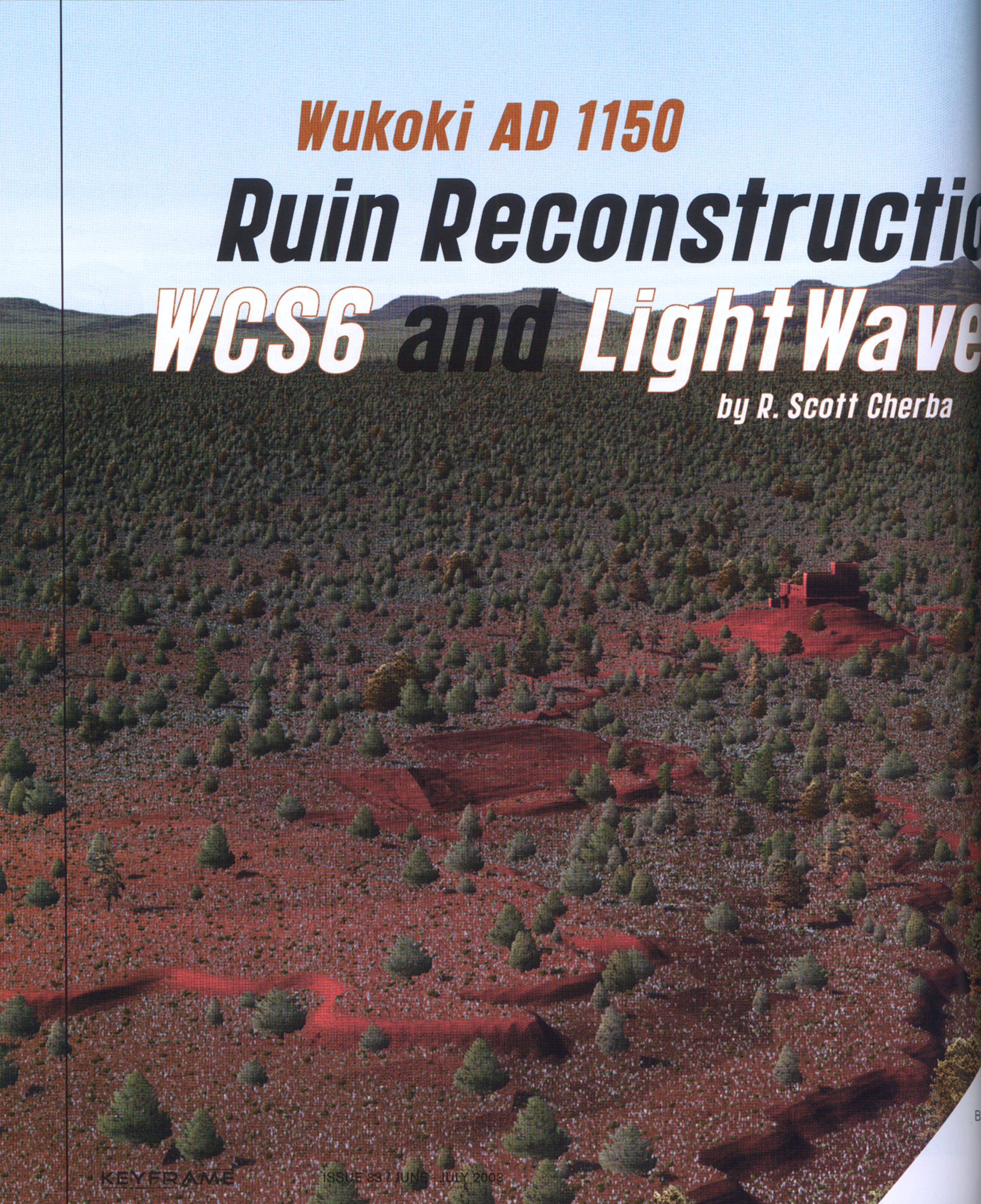
USGS United States Geological Survey

Scott Cherba is a photographer, animator, and trainer based in Tucson, Arizona, specializing in landscapes and historical recreations. He has produced several tutorial videos, CDs, and DVDs for World Construction Set and Visual Nature Studio. For more landscape animation resources, visit him on the web at www.cherba.com/wcs. You can e-mail him at rscott@cherba.com.

Wukoki AD 1150

Ruin Reconstructio[n]
WCS6 and LightWave

by R. Scott Cherba



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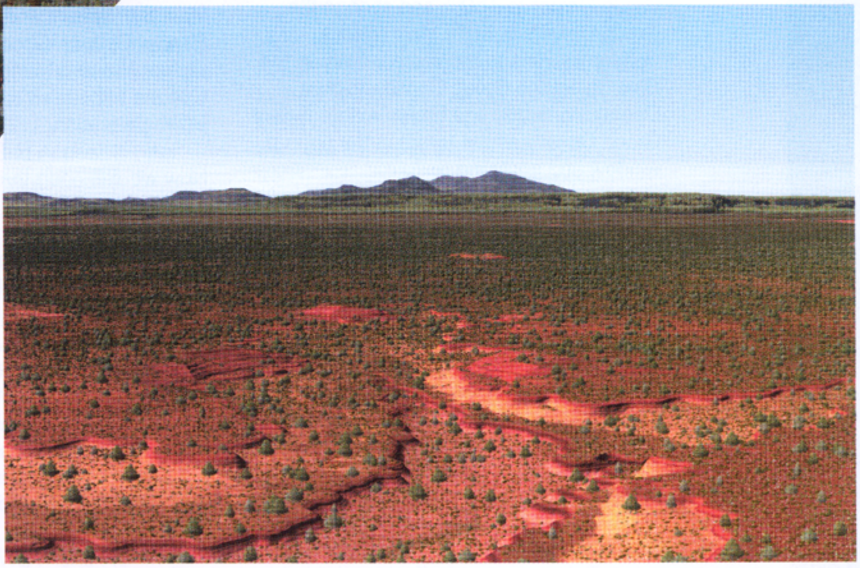
Part 2

At the end of our last show, we had a modern day Wukoki ready for our trip back to the 12th century and pueblo construction. We'll need some additional custom components, so visit http://www.cherba.com/resource/kf33 and download the compressed package. Copy the contents of the uncompressed WCS folder to your WCS folder.

Figure 1. Current day Wukoki site at the end of Part 1.



A couple of obvious environmental factors were different back then. According to pollen studies, the climate was wetter. We'll increase the understory grass and bush density, add a few Oak trees, increase the overstory Pinyon Pine height, and add Ponderosa Pine. Go to the Light Task Mode, open the Wukoki Sun Light Editor > Color & Shadow page, and decrease the color intensity to 100%. Switch to the Land Cover Task Mode, open the Upper Sonoran-Pinyon WNM Ecosystem Editor > Material & Foliage page, and edit the Understory Ecotype. On the Ecotype Editor > Ecotype page, increase the density to 20 stems per unit area, in this case, per square meter.

Turn to the Groups page and enable the Oak foliage group. The ecotype height range is set from 1 to 2 meters. We'd like Oak up to 6 meters tall, so increase the Group Height to 300%. Reduce the Group Density to 0.01%. This may seem small, but keep in mind that the ecotype density is 20 stems per square meter. 0.01% translates into one Oak per 500 square meters. Select the Grass group and increase its Group Density to 100%. We don't want the rendered Desert Bush group density to change much, so reduce it to 12%.

Oak prefers more moist soil, so we'll restrict it to locally depressed areas in the terrain. Create a Group Density texture and select Dynamic Parameter from the Selected Element dropdown list. Choose Relative Elevation from the Parameter dropdown list. Relative Elevation is negative in valleys and positive on ridges. Change the Input Low to -10 and the Input High to 0. Change the Out Low to 100% and the Out High to 0%. For relative elevations of -10 and below, the texture will return a 100% value of the group density. For relative elevations of 0 and above (flat and ridges), the texture will return a 0% value of the group density. Close the Texture Editor and copy Group Density texture; we'll need it again shortly.

k in the Ecosystem Editor, edit the Overstory Ecotype. On the Ecotype Editor > Ecotype page, increase the Maximum Height to 6 's and the Minimum Height to 2 meters.

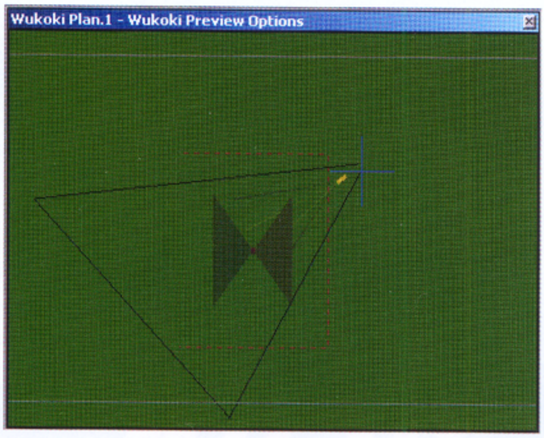


Figure 2. Shadow vector (black triangle) around the Wukoki Plan.1 camera (yellow icon)

Go to the Groups page and add a Ponderosa Pine foliage group. Increase the Group Height to 150% and change the Group Density to 50%. We'll restrict Ponderosa Pine to the same valleys as the Oak. Select the Group Density Texture Operations button and Paste Texture. Select Group Density as the target in the pop-up window and apply the texture.

Turn to the Objects page and add five Image Objects. Add the Ponderosa1, Ponderosa2, Ponderosa3, Ponderosa4, and Ponderosa5 images from the WCS\Components\Image\Foliage\Conifer folder.

One last thing and our time travel terrain is ready. Sunset Crater had recently erupted, showering the area with cinders and ash. That means we need to pepper the landscape with cinders. Load the Wupatki NM 1150 Ground Effect, enable it, and disable the Wupatki NM Ground Effect we've been using. The new ground effect has added a self-opaque black multifractal texture to each slope material.

Let's add some shadows. Reload the Wukoki Plan camera from the Component Gallery > Cameras > Keyframe32 section. It will come into WCS as Wukoki Plan.1 because we've already got a Wukoki Plan camera. Go to the Light Task Mode, select the Shadows category in the Scene-At-A-Glance, and create a new shadow component from the icon toolbar. Digitize a vector around the Wukoki View SW camera. Shadows take time to generate and we want the best quality for our quality-setting buck so we won't waste time with shadows we can't see. (Figure 2)

Shadow components control shadows cast and received by the terrain and foliage. Go to the Shadow Editor > Cast Shadows page and enable Cast. By default, the terrain is always set to receive shadows.

Up to now, we've been rendering with Variable Fractal Depth (Terrain Parameter Editor). For accurate shadow maps with foliage shadows aligned with the casting foliage, we need to use Fractal Maps, also called Fractal Depth Maps and FDMs. The fractal map generator uses enabled Render Job cameras to create FDMs. Go to the Render Task Mode and add a Render Job and Render Options. For easy identification, I suggest using the camera name to identify render jobs and options, in this case, Wukoki View SW. Open the Wukoki View SW Render Job and assign it the Wukoki View SW camera and Wukoki View SW Render Options. Choose a convenient File Output size and format in the Render Options, although it's not necessary for FDM generation.

Now we can open the Terrain Parameter Editor, choose Fractal Maps, and Create Fractal Maps. Confirm 0 as the first and last frame to scan. After the FDMs are generated, WCS will tell us the maximum fractal depth found and suggest a fractal depth for rendering. In this case, a fractal depth of 3 was suggested but we'll stick with 5 to maintain the foreground detail we've grown accustomed to. Fractal maps show up as FRD files in the Wukoki projects folder with the same root name as the elevation files to which they correspond.

Open WCS Render Control, disable all render jobs but Wukoki View SW and render. We could have run a preview render but they aren't as accurate as the real thing, especially where shadow offset is concerned. Preview renders often exaggerate shadow offset problems and may cause you to overcompensate, thereby giving up shadow detail unnecessarily. Figure 3 is a detail from a 1440x960 render and shows the black triangular facets typical of a shadow offset value that is too low. (Figure 3.)

Go to the Shadow Editor > Cast Shadows page and increase Shadow Offset from Terrain to 1.5 meters. There isn't any magic number here; you just have to gradually increase shadow offset until the facets disappear. Shadow facets are gone in Figure 4, the landscape looks great, and we're ready for the pueblo. (Figure 4.)

Let's get organized for LightWave work. I like to keep all project files together, so create images, objects and scenes folders in your WCS Wukoki project folder.

We'll export the terrain around the pueblo site as a LightWave object for reference. Go to the Render Task Mode and add a new camera from the Component Gallery. Load the Wukoki Plan CM camera from the Keyframe33 tab; don't scale its position to the current DEM bounds. Go to the Land Cover Task Mode and add a new color map from the Component Gallery. Load the Wukoki Plan color map from the Keyframe33 tab. Open a Wukoki Plan CM camera view and render a preview. (Figure 5.)

Figure 3. Detail of Wukoki View SW render showing shadow offset faceting

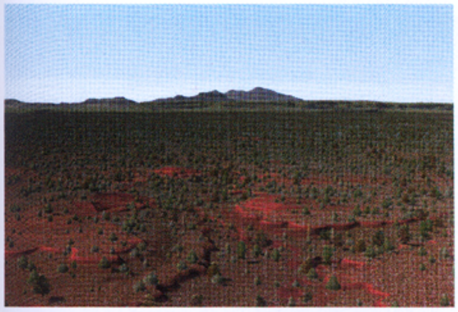


Figure 4. Wukoki View SW with a shadow offset of 1.5 meters

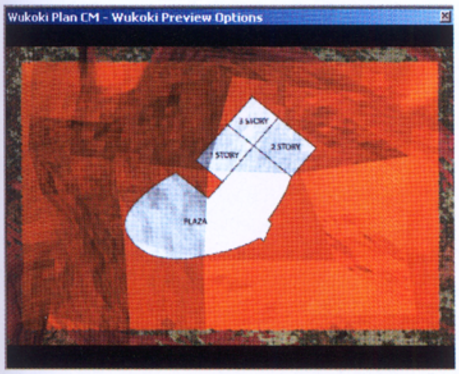


Figure 5. Planimetric view of pueblo location

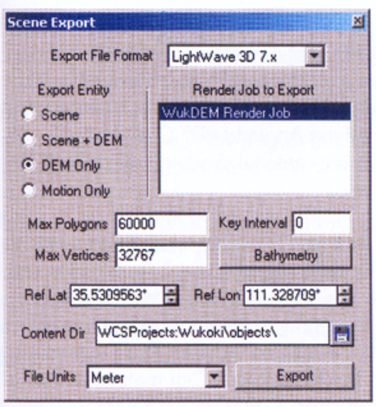


Figure 6. Scene Export set up for DEM export to LightWave object Open Modeler > General Options and change the Content Directory to the WCSProjects\Wukoki folder.

Go to the Vector Task Mode. Select the Vectors category in the Scene-At-A-Glance, and create a vector from the icon toolbar. Left-click once in the center of the Wukoki Plan CM view, right-click to stop digitizing, and name the vector Wukoki Pueblo. Don't worry about where the vector is; we'll reposition it momentarily. This vector will give us a LightWave modeling reference and allow for precise 3D Object import atop the WCS hilltop. Open the Vector Editor to the Selected Points tab in one matrix cell and the Wukoki Plan CM Camera Editor to the Position & Orientation page in another. Copy the Wukoki Plan CM camera latitude and paste it into the vector X (Lat N-S) field. Copy the Wukoki Plan CM camera longitude and paste it into the vector Y (Lon W-E) field. Change the vector Elevation to 1461 meters, which will be floor level in the pueblo.

Go to the Render Task Mode, add a new Render Job, and name it Wukoki DEM. Select the Wukoki Plan CM camera from the Camera dropdown list, add a new Render Options, Edit and name it Wukoki DEM. Bring the Wukoki Plan CM Camera Editor forward and move it aside if it's covering the Render Options Editor. The Camera Editor > Lens page shows a view width of 50 meters. To render a DEM with a grid size of 1 meter, enter an image size Width of 50 on the Render Options Editor > Size & Range page. This will cause each pixel to be rendered as a DEM grid cell that is 1/50th the size of the camera view width, in this case, 50 meters. 50 meters divided by 50 pixels is 1 meter per pixel (grid cell). Open the Database Editor, select one of the active DEMs, and go to the Extent tab. For DEM rendering to an ELEV file, think of the Pixel Aspect as the Grid Aspect. It's the ratio of the width of the grid cell to its height.

Pixel Aspect = Grid WE / Grid NS

If you don't get this right, the rendered DEM grid ratio will be different than the original DEM ratio, i.e., your new DEM will not match the original. We don't want to make that mistake here because our LightWave pueblo will be modeled on the rendered DEM and has to fit neatly in place atop the original DEM. For our rendered DEM:

Pixel Aspect = Grid WE / Grid NS = 10.0058037 / 10.0044839 = 1.00013... (Call it 1)

Go to the File Output page, add an Output Event, and choose the WCS DEM format. We're warned that this format only works with planimetric camera views, which is the kind of camera we're rendering. Name it Wukoki Plan CM and reduce the frame digits value to 0. Go to the Enabled 1 page and disable Other Foliage in the Vegetation section. If you don't, Ecosystem foliage will be rendered as knobs on the DEM. Create a Render Job named Wukoki DEM, select Wukoki Plan CM from the Camera dropdown list, and choose Wukoki DEM from the Render Options list.

Clone the Wukoki DEM Render Job and Render Options. This job will render a backdrop image for reference in Modeler. Open the cloned Render Job, rename it Wukoki DEM TIF, and select the cloned Render Options from the dropdown list. Edit the cloned Render Options and rename it Wukoki DEM TIF. Go to the File Output page, add a TIFF Output Event, name it Wukoki Plan CM, and reduce the frame digits value to 0. Open WCS Render Control, make Wukoki DEM and Wukoki DEM TIF the only enabled render jobs, check the settings and render.

Create a new WCS project and name it whatever you want. We'll only use it to export the newly rendered DEM as a LightWave object. Import data when asked and load the Wukoki Plan CM.elev file from the WCSFrames folder. After import is complete, the Status Log will show a maximum elevation of 1458.54 meters, which is the highest point in this section of terrain. The DEM doesn't fill the view north to south because it's using the Preview Options, which defaults to a 0.9 Pixel Aspect.

Choose Export Scene from the File menu. Select LightWave 3D 7.x as the Export File Format, select Export DEM Only, and point the Content Directory to WCSProjects\Wukoki\objects. Export the DEM. Select the DEM to be exported in the 'DEM file to export' file requester, in this case, Wukoki Plan CM.elev. Confirm the name of the new LightWave object DEM name and path in the 'LW Object path/file' file requester. That's it for this WCS project. (Figure 6.)

Open Wukoki Plan CM.lwo in Modeler. The southwest corner of the terrain will import at the origin. The 10-meter terrain grid is clearly visible at this scale. Center the terrain object at the origin. Open Display Options to the Backdrop page, select the viewport that corresponds to your top view (TL by default), and load the Wukoki Plan CM.tif image. Automatic Size it.

Recall that we assigned the WCS Wukoki Pueblo vector an elevation of 1461 meters. This is where our LightWave model origin needs to be, too. Select the uppermost point in the terrain and open point Info from the Display menu; the Y value is 3.6043 meters. If the Modeler origin corresponds to an elevation 1461 meters in WCS and the top of this terrain section is 1458.54 meters, then

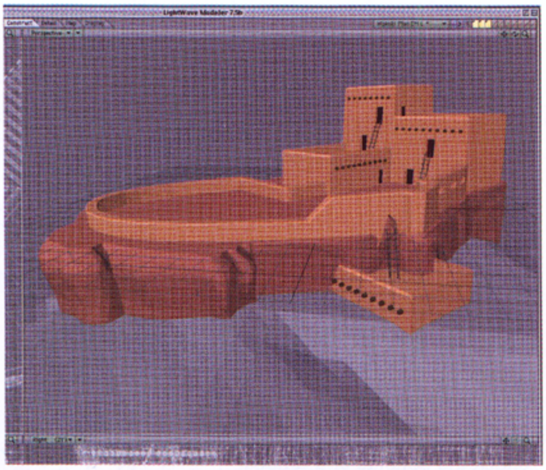


Figure 7. Reference DEM, Wukoki Rock, and Wukoki Pueblo objects

the top of the terrain in Modeler needs a Y value of -(1461-1458.54) or - 2.46 meters. Move the terrain down 6.0643 meters to drop the terrain top from 3.6043 to - 2.46 meters.

The LightWave models we need are included in the resource download: Wukoki Rock W and Wukoki Pueblo W. The 'W' tagged onto the end reminds me these are WCS-ready objects collapsed onto a single layer. WCS does not import multiple layer objects and will tell you so when you try. The rocky platform on which the pueblo was built and the pueblo itself are separate objects to allow control over object settings (like shadows) in WCS. Load the objects into layers in the Wukoki Plan CM object to get an idea how everything fits together (Figure 7).

Relative to the terrain resolution, this pueblo is a small feature on the landscape. A highly detailed model would be incongruous with the style we've already established for the landscape. The rocky outcrop and pueblo have enough detail to define the structures and blend them stylistically into the scene. LightWave objects need little preparation for import into WCS, with a notable exception. Boolean operations can leave odd polygons that WCS has problems understanding, especially subtractions. Triple polygons in the WCS object version to avoid problems.

Load the Pueblo View North and Pueblo View SW Render Jobs from the Component Gallery > Keyframe33 section. Render Job components import with their associated cameras and Render Options. You'll see the reason for this shortly. Don't scale the camera positions to the current DEM bounds. Open a Pueblo View North view. Go to the Vector Task Mode and open the Wukoki Pueblo Vector Editor. We need a copy of this vector for the rock object so Create Copy and name it Wukoki Rock.

Go to the 3D Object Task Mode and add a generic 3D Object. Deselect Render a Geographic Instance on the 3D Object Editor > General page; we'll use a vector to place the object. Select the Load Component from Disk button along the right margin of the editor, navigate to the WCSProjects\Wukoki\objects folder, and open Wukoki Pueblo W.lwo. The 3D Object name will update with the loaded object name. Go to the 3D Editor > Size & Position page and make the geographic position Relative to Vector. Clone the Wukoki Pueblo 3D Object in the upper Scene-At-A-Glance and load Wukoki Rock W.lwo.

Slide down the lower Scene-At-A-Glance pane and expand the Vectors category. Click, drag and drop the Wukoki Pueblo vector on the Wukoki Pueblo 3D Object in the upper Scene-At-A-Glance pane. When WCS asks if you want to use the vector for position or alignment, choose position. Click, drag and drop the Wukoki Rock vector on the Wukoki Rock 3D Object. The 3D Objects are set to box preview, so that's what we see in the Pueblo View North view.

There are a few changes we need to make to 3D Object materials right off the bat. Open the Material Editor > General page, change Shading to Phong, and increase the Smoothing Angle to 89°. Change the remaining material shading and smoothing angles.

The Wukoki Rock object has three materials: Rock Bottom (unseen), Rock Sides and Rock Top. We want Rock Sides and Rock Top to blend into the surrounding terrain since the rock outcrop is just an extension of it. The Moenkopi 5 Cliff material in the Wupatki NM 1150 Ground Effect renders the exposed rock around the Wukoki site. Go to the Land Cover Task Mode and open the Ground Editor to its Material page.

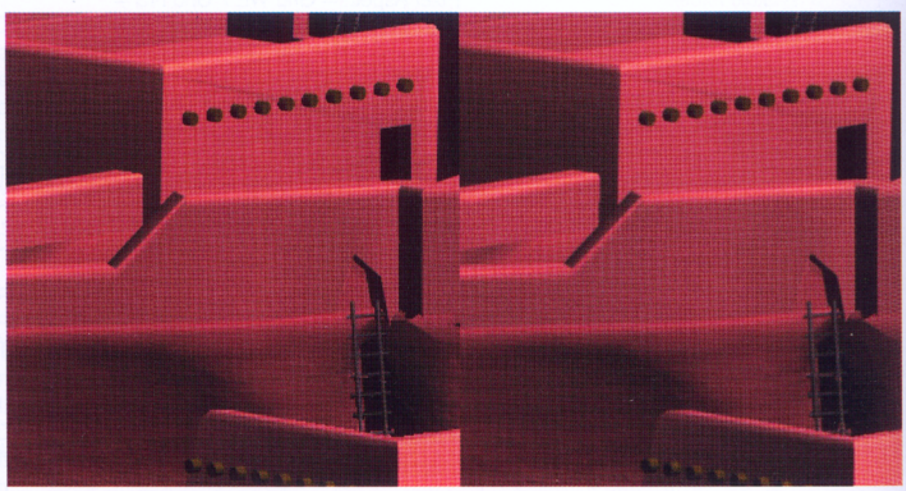


Figure 8. 3D Objects rendered at Normal (left) and High (right) Render Quality

Bid & Build

Unlike many historical reconstructions, Wukoki still exists as a ruin. Other pueblos in the southwest survive in better condition and provide a valuable guide to building style. Even so, a great deal of educated guessing was involved. Historical reconstructions rarely have detailed plans to guide modeling. Even with the client's assistance, you'll have to do extensive research on your own. The first iteration is always the toughest. Once you get something rendered to show, you'll be amazed how many things the client will find wrong. Which is good! Keep this in mind when you propose the project, too. Request reference material and terrain data before you bid the project so you know how much work you'll have to do on your own.

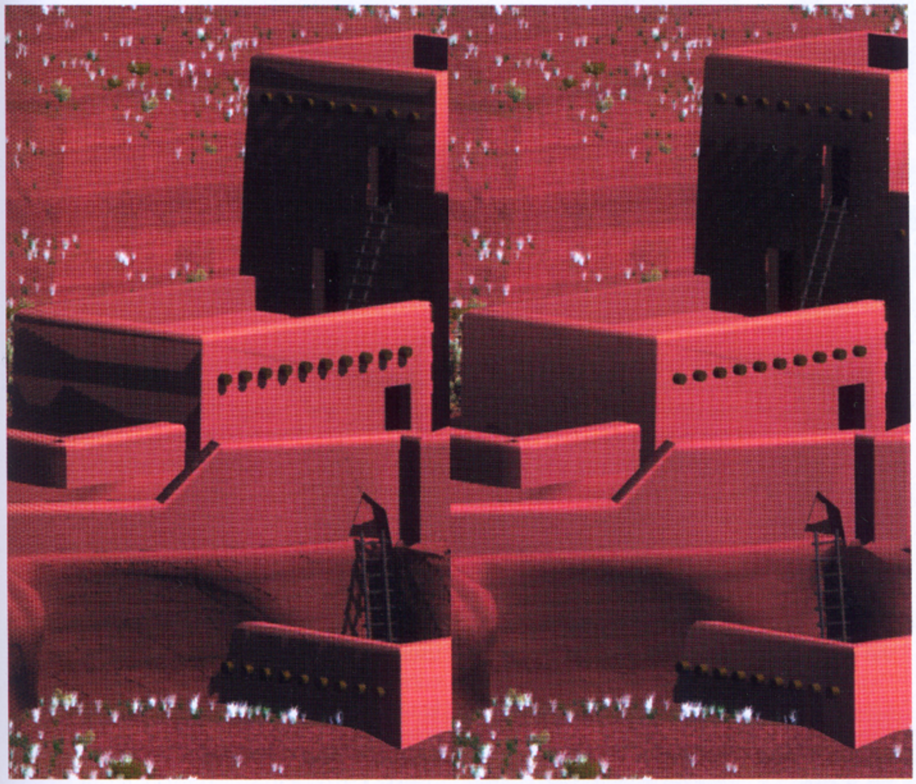


Figure 9. 3D Object shadow offset at 0.05 m (left) and 1.1 m (right)

Select the Moenkopi 5 Cliff material, click the Diffuse Color Texture Operations button, and Copy Texture. The 3D Object Material Editor should still be open, it's just hidden. Go to the Window menu and select the Material Editor to bring it forward in this task mode. Cycle through the materials with the Edit Next button until you get to the Rock Sides material. Turn to the Properties 1 page; select the Diffuse Color texture button and Paste Texture. Select Diffuse Color as the target in the pop-up copy window.

Edit the texture you just copied. WCS 6 added the Coordinate Space option, which can cause confusion when copying terrain textures to 3D Objects. This texture was copied from a Ground Effect so it retained the terrain XYZ orientation and coordinate space, where Z is elevation. However, the thumbnail shows the texture in object space where Y is the elevation. We can leave everything as is and the texture will render correctly on the 3D Object material. I prefer to work in object space where thumbnails show proper orientation and axes are consistent with LightWave convention. Select Object Cartesian from the Coordinate Space dropdown list, change the Size Y value to 1 meter, and Z value to 1000 meters.

Select the Material Editor Diffuse Color texture button and Copy Texture. Cycle to the Rock Top material and paste the texture to its Diffuse Color. Edit the Rock Top diffuse color texture and change the X, Y, and Z size values to 50 meters. If you can't see the Ground Editor, move the Material Editor aside. Turn to the Rock Top Material Editor > Properties 2 page and add a bump map texture. Load the Wukoki Rock Bump material from the Component Gallery > Keyframe33 tab. Copy the Rock Top bump map texture, click the Edit Previous button, and past it onto the Rock Sides bump map texture.

The Wukoki Pueblo has five materials: Base (unseen), Doorway, Ladder, Roof Beams, Roof Exterior and Exterior Wall. We won't get close enough in renders to see any detail in the doorways, ladders, and roof beams, so we'll stick with the diffuse colors chosen for that purpose. The roof and exterior walls will share the same diffuse color and walls will have a hint of abode bump. Open the Wall Exterior Material Editor and load the Wukoki Exterior Wall material from the Component Gallery > Keyframe33 tab. Change the Roof Exterior material diffuse color to R 216, G 137, and B 092. That takes care of the rock and pueblo object materials.

Before rendering, don't forget that we've added three new cameras and need to regenerate fractal maps. If you forget, WCS will remind you when it runs out of FDMs during rendering. Open the Terrain Parameter Editor and increase the Maximum Fractal Depth to 7. The Render Jobs we loaded with the new cameras are ready to go, so Create Fractal Maps. Render a Pueblo View North preview. If you get large terrain polygons in the background, delete all FRD files from your Wukoki folder, regenerate fractal maps, and render another preview.

You may not notice it in preview renders, but larger renders will show a sharpness between 3D Object elements and between 3D Objects at the normal render quality default. Go to the 3D Object Editor > General page for each object and change Render Quality to High. Figure 8 shows details from 1440x960 renders of the view in Figure 11. The left section was rendered at a 3D Object Render Quality setting of Normal and edges show a roughness. The right half was rendered at the High render quality and shows the edge softening of additional render passes. (Figure 8.)

Now let's add 3D Object shadows. The terrain around the pueblo is set to receive shadows via the Wukoki Foliage shadow component we created earlier. If you open the Shadow Editor > Receive Shadows page, you'll see the terrain receives shadows from everything but volumetrics. To make the 3D Objects cast shadows, go to the 3D Object Editor > Shadows page and set the pueblo and rock to cast shadows. Change the Shadow Map Quality to Very High. Render another Pueblo View North preview.

As with the terrain shadows early in the tutorial, the default shadow offset value turns out to be too low for the 3D Objects. Increase the Shadow Offset from Object value until renders no longer show shadow artifacts. You don't want to increase offset any more than necessary because it moves shadows away from features casting them. Try values of 1.1 meters for the pueblo and 1.5 meters for the rock object. This was the primary reason the pueblo and rock outcrop were imported as separate objects. Figure 9 shows the effect of shadow offset. The left view was rendered at the 0.05 meter offset default. Shadows are attached to their casting elements (e.g., roof beams and ladder) but walls in shadow show artifacts. The rock object reveals some polygon edges. The right view was rendered at a shadow offset of 1.1 meters. Shadows have detached from their casting elements but artifacts are gone. (Figure 9.)

While we're on the subject of shadows, you may have noticed that the foliage shadows appear blocky in the Pueblo View North

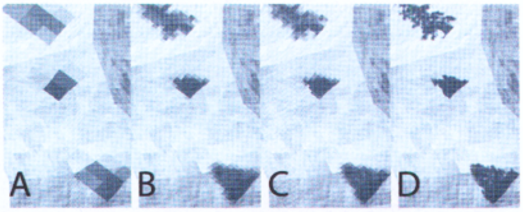


Figure 10. Shadow map quality comparisons. Normal (A) and Very High quality (B) in 700,000 m_ vector area. Normal (C) and Very High quality (D) in 40,000 m_ vector area.

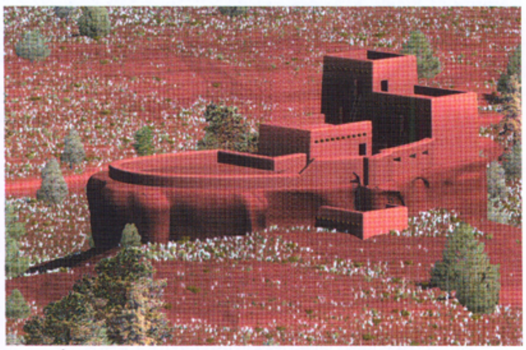


Figure 11. Pueblo View North with 3D Object shadow casting enabled.

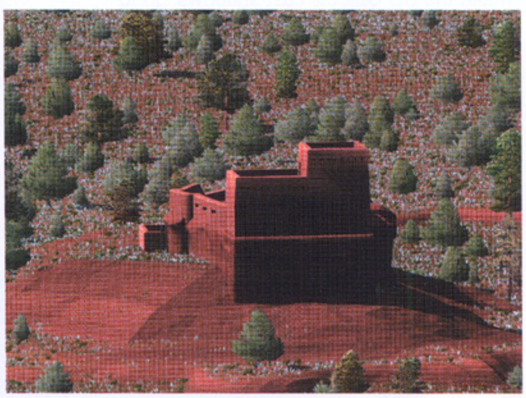


Figure 12. Pueblo View SW before terraffector rock dome added.

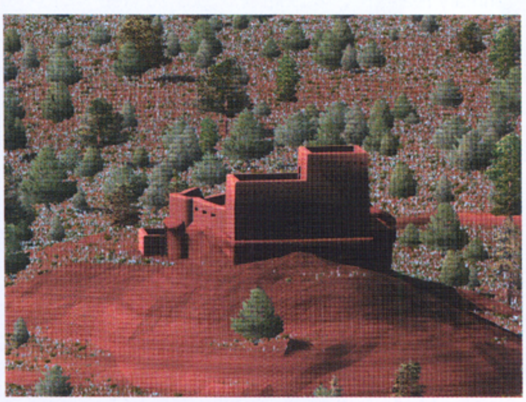


Figure 13. Pueblo View SW after terraffector rock dome added.

preview renders. The Wukoki Foliage shadow component has normal shadow map quality and is controlled by a vector covering about 700,000 square meters. Figure 10A shows a planimetric view of the foliage shadows west of the pueblo. Shadow map quality is a function of both quality and area. Figure 10B is the same vector area rendered at a shadow map quality of Very High. Figure 10C is the same shadow component, normal quality, but attached to a vector encompassing a much smaller area, about 40,000 square meters. Figure 10D shows the smaller vector area rendered at Very High shadow map quality. Here you can see the effect of the 1.5 meter shadow offset. The moral of the story? Make your foliage shadow vectors cover as small an area as necessary and use the highest shadow map quality setting your memory will allow. (Figure 10.)

Our final render will be back at the Wukoki View SW camera we created the shadow vector for, so keep the existing vector and change the Shadow Map Quality to Very High. Render another Pueblo View North preview (Figure 11). Shadow offset is a good news-bad news story. You eliminate shadow artifacts but increase shadow separation from the shadow casting features. When accurate self-casting shadows are required, go the compositing route and render your 3D Objects in LightWave. We won't be rendering close enough to the pueblo to see the offset, so it's not an issue in this project. (Figure 11)

Open a Pueblo View SW view and render a preview (Figure 12). We need a dome-shaped section of rock under the northeast end of the pueblo. This could have been modeled in LightWave, but there's a disadvantage to terraforming with 3D Objects that I haven't mentioned. While we can copy Ground Effect materials to 3D Objects, we can't make Ecosystems grow on them. Fortunately, a dome feature is easy to terraform in WCS. (Figure 12.)

Open a Wukoki Plan CM view and render a preview to digitize on. Go to the Terrain Task Mode, select the Terraffectors category in the Scene-At-A-Glance, and create from the icon toolbar. Terraffectors are normally linear features, but a single vertex terraffector creates a point effect. Left click a vertex in the plan view between the two northeast rooms, right-click to stop digitizing, and name the vector and terraffector Wukoki Dome. Go to the Wukoki Dome Vector Editor > Selected Points tab and change the elevation to 1463 meters. This may seem a bit high, but once we get done with the terraffector it'll be just right.

Go to the Terraffector Editor > Elevation page and select Relative to Vector Elevation and Increase Only. Edit Cross-section Profile to open the Profile Editor. This terraffector uses a single point so the profile shows the curve that will spin around it to modify the terrain. Add 5 points to the profile and select the rightmost point. Enter a distance 25 meters, a value of -14 meters, and a tension of 1. Select the next point left in the profile and enter its values from the table below. Repeat the process for the remaining points in the profile and keep the changes when you're done.

Distance	Value	Tension
25 m	-14 m	1
13 m	-7 m	0
5 m	-2 m	0.5
2 m	-0.5 m	-1
1 m	0	0

A Pueblo View SW preview render shows the rocky dome we want, but it's a little too perfect. Features like this do occur in nature, but this is not one of them. Go to the Terraffector Editor > Elevation page and create an Effect Intensity texture. Load the Wukoki Dome Tfx Intensity texture from the Component Gallery > Keyframe33 tab. The effect intensity texture uses a soft fractal noise element to modify the terraffector. (Figure 13.)

Ecosystems don't respect 3D Objects and will render foliage within them if left to their own devices. Go to the Land Cover Task Mode, select the Ecosystems category, and create from the icon toolbar. Digitize a vector around the rock object in the Wukoki Plan CM preview render. Right-click when you're done and name it Eco Exclusion. Turn to the Ecosystem Editor > Material & Foliage page and make the Material Ground Overlay Transparency 100%. We have no Ecotypes so this will render Ground Effect. The Ecosystem is vector bounded which gives it render priority over the Environment

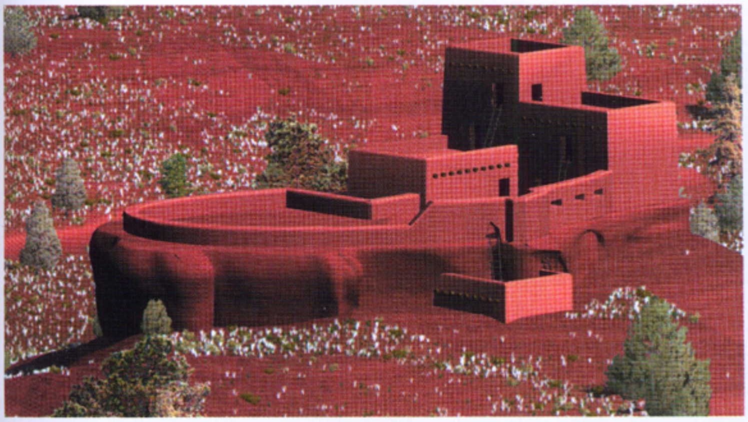


Figure 14. Pueblo View North, final disposition.

Ecosystems. To make a last check of the final pueblo product, open WCS Render Control, enable the Pueblo View North and Pueblo View SW render jobs only and render.
(Figure 14.)

The pueblo looks good so let's render our final Wukoki View SW view.
(Figure 15.)

Figure 15. Wukoki View SW complete with pueblo

Scott Cherba is a photographer, animator, and trainer based in Tucson, Arizona, specializing in landscapes and historical recreations. He has produced several tutorial videos, CDs, and DVDs for World Construction Set and Visual Nature Studio. For more landscape animation resources, visit him on the web at www.cherba.com/wcs. You can e-mail him at rscott@cherba.com.