Notes to Ancient Civilizations Lesson Three PowerPoint Presentation

1) What might these photos have in common with each other?

Images (from left to right):

1) Bust of Apollodorus of Damascus, architect of the Pantheon, 130-140 CE, Glypothek, Munich, Germany
2) William Randolph Hearst and Julia Morgan, architect of Hearst Castle

2) What ***is*** a legacy? Consider the panoramic views of New York City and Pompeii on this slide. You may have heard that we have been left a legacy by the ancient Romans, but what exactly did they leave us?

3) Here are some thoughts on Rome's greatest achievements and legacy written by ancient Romans. Do you agree with them? Many other ancient Romans and visitors to Rome were equally impressed with the great temples, palaces, and engineering projects of Rome. Consider the second quote comparing Roman engineering projects to the art of the Egyptians and Greeks; what virtues and traits do you think the Romans valued? Why?

Image: Statue of Augustus, first Roman emperor

4) The legacy of Rome would be very different if it weren't for concrete. Romans used it extensively in their engineering projects and in many of their buildings as well.

Images (from left to right):

1) Via Appia, first major road built by Romans. Started in 312 BCE, portions of it are still used today
2) Roman bridge in Vaison la Romaine, France, 1st century BCE
3) Coliseum in Rome, largest amphitheater in the world, 1st century CE

5) Romans didn't invent concrete, but they perfected it. The strength of their concrete is one of the reasons why many ancient Roman structures still stand. Ancient Roman concrete is a match for today's concrete (Portland concrete) and in some ways is even superior to it. Some ancient Roman concrete breakwaters have lasted 2,000 years or more whereas Portland concrete has a service life of less than 50 years in sea water. (Source: http://mobile.businessweek.com/articles/2013-06-14/ancient-roman-concrete-is-about-to-revolutionize-modern-architecture)

6) Besides standing up to water, concrete is also resistant to damage from erosion, earthquakes, and fire. Because concrete is resistant to all of these things, it is also resistant to the passage of time.

7-8) The knowledge of concrete was lost for centuries after the Roman Empire fell, and only reinvented in the 1800s. Concrete was then improved on with the invention of reinforced concrete—steel bars, or other strong materials, inserted or mixed with the concrete to strengthen it further. This technique was just coming into use when Julia

Morgan was beginning her career as an architect and she became an expert in it. Many of her designs, including Hearst Castle, were built with reinforced concrete.

Images on slide 7 (from left to right):

1) Portrait of Julia Morgan
2) Photo slideshow of destruction caused by 1906 earthquake and fire in San Francisco

Images on slide 8 (from left to right):

1) Ceiling of Pantheon. Although it may look decorative, the square coffers in the ceiling were made to lighten the weight of the dome.
2) Cast stone lion statue on the grounds of Hearst Castle
3) Cast stone decorative railing on the grounds of Hearst Castle

9) Here are some historic photos of the construction of Hearst Castle. Notice the wooden scaffolding and casting forms around the building the workers used to access the structure and pour the concrete into. In the photos of the rear courtyard, the piles of rubble that were used to make the concrete can easily be seen as well as the mixer and the pump used to pour the concrete into place. Ancient Romans would also have used casting forms to shape the poured concrete, but they had to mix all their concrete by hand! All the finished buildings at Hearst Castle have a limestone façade; the Romans would cover their concrete structures with an attractive façade too, usually marble or brick. Many of the techniques used at Hearst Castle are common in today's reinforced concrete construction. Can you see the thread of continuity between ancient Rome, Hearst Castle, and the buildings of today?

10) The Roman engineer's job duties were much broader than an engineer of today. Many engineers learned their craft through hands-on experience while serving in the army. Military expansion was the motivation for many of the new inventions and improvements the Romans came up with. There were also books written on the subject, like Vitruvius's *De Architectura*, that engineers could refer to. Here is your chance to see what it would've been like to be an ancient Roman engineer! We will read the short story "The Aqueduct of Aquila" together. At the end of each chapter, we have two choices for how the story can continue. We'll vote on which choice to pick and go from there.

11) Always having plenty of water for their diverse needs was an important factor in Rome's successful expansion. Water quality was very important to the Romans. Their options for cleaning and sanitizing water sources was limited compared to today, so they were very careful about picking a water source when starting a new hydraulic engineering project.
Image: natural spring on Mackinac Island, Michigan

12) Although Roman aqueducts are most famous for their arcades and bridges, many of the aqueducts run mostly, or even entirely, through underground tunnels. It was easier to dig down to the water than to try and pump it up to the surface. Keeping the water underground could also protect it from vandalism and enemy armies.

13) Roman engineers didn't have any way to test materials for strength and durability like modern engineers do. The Romans learned what worked through trial and error. Because of this, they used the best quality materials and built their structures to be as rugged as possible to make sure that they would last as long as possible. Because of the weight of the materials used, aqueduct arches could not be made much higher than 70 feet without collapsing. When an aqueduct bridge needed to be higher, multiple rows of arches would be stacked on top of each other, as with the famous Pont du Gard in Vers-Pont-du-Gard, France. Building high aqueduct bridges had the added benefit of being another means of protecting the water supply during times of war or civil unrest.

Images:

Top: Ponte delle Torri, Spoleto, Italy, mostly 13th century CE, but built on Roman foundations

Bottom: Pont du Gard, Vers-Pont-du-Gard, France, 1st century CE

14) The Romans had many options for dealing with difficult landscape features when building aqueducts. One solution to a deep or wide valley would be an inverted siphon. A siphon can be used to move water (or any other liquid) from one location to another by taking advantage of atmospheric and gravitational pressure. As long as the destination is lower in elevation than the beginning point, the water will flow down and then up through the piping, no matter how steep a climb it might be. The Romans had to keep in mind that the more severe the depth and angles of the piping, the more pressure would build up. This could lead to leakage, blow outs of the pipes and aqueduct failure. To avoid this, they would sometimes build a series of inverted siphons to transport water over a long distance. Let's watch the video on the next slide to gain a better understanding of how inverted siphons work.

16) An aqueduct would have taken several years to build, but once it was complete, it could work for centuries with continued maintenance. In fact, some of the ancient Roman aqueducts still work in a limited capacity today!

The Latin word *pietas* is where are modern English 'piety' is derived from, and it has a similar meaning. Civic, familial, and religious duty were intertwined in the Roman mind, and *pietas* was one of the most important virtues a Roman could have.

17) The water system at Hearst Castle uses some of the same engineering features that an ancient Roman water system would, proving that Roman ingenuity is still relevant to engineers and architects today.

18) Now that we've learned about the ancient Romans' engineering and construction skills, you'll complete an example aqueduct. (**Hand out aqueduct worksheet.)** This worksheet has a landscape rendering on it that you need to draw an aqueduct for, using the techniques of the Roman engineers. Make sure to note what material/s you would use to build your aqueduct and why as well.

19) Tomis was a Roman colony on the Black Sea. It's where the poet Ovid was banished to after he offended Emperor Augustus.
Image: sarcophagus, 2nd century CE Roman, Hearst Castle

20) Image: Goodell Creek landslide in Washington

21) Image: *The Course of Empire: Destruction*, 1836, Thomas Cole. Now located at the New York Historical Society, New York City

22) Image: *Pollice Verso*, 1872, Jean-Leon Gerome. Now located at the Phoenix Art Museum, Phoenix, Arizona. Hearst Castle has several Jean-Leon Gerome pieces in the art collection