

Subject Area: ARCHITECTURE/ENGINEERING/PLANNING **Grade Level:** 9-12 **Date:** 8/4/15

❑ Abstract Lesson Overview

- Students will learn the process of taking a raw site into a developed parcel ready for a neighborhood. Emphasis will be on site selection and zoning; lot layout; traffic; utilities; storm water management; parks and schools; impact fees; water wise landscaping; and final neighborhood renderings.

❑ Instructional Materials Needed

- 3D modeling software (AutoCAD, Autodesk Revit, Sketchup-Free)
- Internet connectivity – research
- Connection with local building/planning department would be very helpful
- Graph paper
- Printer

❑ Instructional Materials Provided

- Links to local Sacramento area resources.
 - [Zoning Map](#)
 - [Sacramento Assessor's Office](#)
 - [Design Standards including Street layout, utilities, sewer, and road section views](#)
 - [Traffic Counts](#)
 - [Traffic Study](#)
 - [Development Fees](#)
 - [Caltrans Project Costs](#)
 - [Caltrans Individual Item Cost](#)

❑ Expected Student Outcomes

- **Understandings**
 - Codes are created to protect the health and safety of the public, dictate the minimum requirements that must be met in a building project, and constrain the location of structures, utilities, building construction, and landscape components placed on a site.
 - Utilities and systems must be properly sized to minimize cost and appropriately serve the project and the structure occupants.
 - Careful landscape design that takes into consideration local environmental conditions can improve energy efficiency, reduce noise, reduce water usage, reduce storm water runoff, and improve the visual impact of a building project.

- Storm water runoff from a site often increases when the site is developed and is frequently regulated by local jurisdictions.
- **Knowledge and Skills** - It is expected that students will:
 - Design an appropriate sewer lateral for wastewater management for a building that complies with applicable codes.
 - Create a site opportunities map and sketch a project site.
 - Choose an appropriate building location on a site based on orientation and other site-specific information.
 - Calculate the storm water runoff from a site before and after development.
 - Document the design of the neighborhood home using 3D architectural design software and construction drawings.
 - Calculate traffic demands and accessible routes for students to use park and school facilities.

□ **Student Deliverables**

- Site map
- Title and history review
- Cost Estimate for Streets/Sidewalk/Curb & Gutter
- Cost Estimate for hydrants, street lights
- Geometry for sewer lines from house to sewer main
- Renderings for student designed home
- Final cost estimate of impact fees and all improvements
- Safe route to schools and parks
- Storm water calculations

□ **Cost of Lesson:** All materials are available from local planning departments/county assessors. All work is done electronically.

□ **Duration of Lesson:** 10 Days – See lesson plan at the end

□ **Culminating Activity and/or Assessment**

- At the end of the lesson, students have created a neighborhood. Presentation to local developer or city planning commission.

□ **Enrichment Suggestions**

- Student can go deeper into any of the areas with additional research online.
 - Create a traffic flow plan
 - Ensure availability of accessibility for emergency vehicles
 - Survey the selected site
 - Develop a grading plan for the site and calculate in/off haul of materials

□ **Additional Resources**

- See links posted above. Additional materials will be developed during the instruction of this unit.

□ **CTE Pathway Standards**

○ **Engineering Design**

- **Foundation Skills (pg 140-153)**
 - 1.0 Academics
 - 2.0 Communication
 - 3.0 Career Planning
 - Technology
 - Problem solving
 - Health and Safety
 - Responsibility and flexibility
 - Ethics and legal responsibility
 - Leadership and Teamwork
 - Technical Knowledge
 - Demonstration and application
- C3.0 Students understand measurement systems as they apply to engineering design:
- C3.1 Know how the various measurement systems are used in engineering drawings.
- C3.2 Understand the degree of accuracy necessary for engineering design.
- C4.0 Students use proper projection techniques to develop orthographic drawings:
- C4.1 Understand the commands and concepts necessary for producing drawings through traditional or computer-aided means.
- C4.2 Understand the orthographic projection process for developing multiview drawings.
- C4.3 Understand the various techniques for viewing objects.
- C4.4 Use the concepts of geometric construction in the development of design drawings.
- C4.5 Apply pictorial drawings derived from orthographic multiview drawings and sketches and from a solid modeler.
- C5.0 Students know various object-editing techniques and CADD programs:
- C5.1 Understand the commands and concepts necessary for editing engineering drawings.
- C5.2 Know the various object-altering techniques.
- C5.3 Know the CADD components and the operational functions of CADD systems.
- C5.4 Apply two-dimensional and three-dimensional CADD operations in creating working and pictorial drawings, notes, and notations.
- C5.5 Understand how to determine properties of drawing objects.
- C6.0 Students understand and apply proper dimensioning to drawings:

- C6.1 Know a variety of drafting applications and understand the proper dimensioning styles for each.
- C6.2 Apply dimensioning to various objects and features.
- C6.3 Edit a dimension by using various editing methods.
- C7.0 Students understand sectional view applications and functions:
- C7.1 Understand the function of sectional views.
- C7.2 Use a sectional view and appropriate cutting planes to clarify hidden features of an object.
- C8.0 Students understand the tolerance relationships between mating parts:
- C8.1 Understand what constitutes mating parts in engineering design.
- C8.2 Use tolerancing in an engineering drawing.
- C8.3 Interpret geometric tolerancing symbols in a drawing.
- C9.0 Students understand the methods of inserting text into a drawing:
- C9.1 Understand the processes of lettering and text editing.
- C9.2 Develop drawings using notes and specifications.
- C9.3 Understand the methods of title block creation.
- C10.0 Students understand the sketching process used in concept development:
- C10.1 Understand the process of producing proportional two- and three-dimensional sketches and designs.
- C10.2 Use sketching techniques as they apply to a variety of architectural and engineering models.
- C10.3 Use freehand graphic communication skills to represent conceptual ideas, analysis, and design concepts.
- **Construction and Building Industry Sector | Residential and Commercial Construction**
 - Foundation Skills (pg 66-78)
 - 1.0 Academics
 - 2.0 Communication
 - 3.0 Career Planning
 - Technology
 - Problem solving
 - Health and Safety
 - Responsibility and flexibility
 - Ethics and legal responsibility
 - Leadership and Teamwork
 - Technical Knowledge
 - Demonstration and application
 - D1.0 Students understand and apply measurement systems in the planning and layout process used in the residential construction industry:
 - D1.1 Identify design solutions for residential construction problems.

- D1.2 Calculate required materials for residential construction applications.
- D1.3 Convert scaled blueprint drawing measurements to full dimensions for a given construction project.
- D1.4 Apply conventional construction measurement processes accurately (geometric and trigonometric functions).
- D1.5 Know the use of conventional construction formulas to determine production requirements.
- D4.0 Students understand project management procedures and processes as they occur in a construction project:
 - D4.1 Interpret and use residential construction blueprints and specifications.
 - D4.2 Understand how to estimate materials from blueprints and specifications.
 - D4.3 Understand the sequencing of events for specific construction projects.
- D6.0 Students understand the variety of building phases, systems, and techniques used in residential and commercial construction:
 - D6.1 Develop building plans and schedules by using processes common to residential and commercial construction.
 - D6.2 Understand the processes and materials (e.g., structural, electrical, mechanical, finish) appropriate to the architectural design and residential construction.
 - D6.3 Prepare the site layout and the site, including the grading and engineering of the building pad.
 - D6.4 Understand the phases of residential and commercial construction.
- **Common Core Math I Geometry**
 - Similarity, Right Triangles, and Trigonometry: Define trigonometric ratios and solve problems involving right triangles.
 - 6. Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.
 - 7. Explain and use the relationship between the sine and cosine of complementary angles.
 - 8. Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.
 - 8.1 Derive and use the trigonometric ratios for special right triangles (30° , 60° , 90° and 45° , 45° , 90°). CA

□ Lesson Plan Relevance to Externship

- From this externship, I learned about the planning aspects prior to the development of a neighborhood. I'm taking a current lesson, where students design a house to client specifications and expanding to include all the homes in a neighborhood and allow students to see a variety of careers within civil engineering.

Description of Activities

- ❑ **Activity Day One:** Site Selection and zoning. Look at your local zoning map and find a parcel of 8-12 acres in size that could be used to house 30+ residential lots. Google Earth will help with this.
 - Discussion on zoning and zoning ordinances. Sample zoning map: <https://www.folsom.ca.us/civicax/filebank/blobdload.aspx?blobid=7400>
 - Zoning should be for residential or discuss the possibility of zoning change to lessen impact.

- ❑ **Activity Day Two:** Look into the history of the site. Title lookup through county assessor office. Research history of the land. If this is a new area, it may be helpful to show another local site with more history.
 - Discussion on exact location and surveying. What happens if a piece of land is promised to more than one party.

- ❑ **Activity Day Three:** Lot layout and geometry of the site. How can you fit the most lots into the given site to fit all the houses.
 - Layout a large print of the site area. Have students cut out stencil pieces and physically layout. Rough sketch street paths. Look at the geometry of the road designs from the design standard ([Design Standards](#)) pg 148-151

- ❑ **Activity Day Four:** Traffic Counts and Public Transit Map
 - Look at local traffic counts for the selected sites. Discuss where traffic will flow to and from. ([Traffic Count Map](#)) ([Traffic Study Report](#)). Find local public transit and walking routes. Are there bike paths nearby?

- ❑ **Activity Day Five:** Utilities layout
 - Look at local design standards for utilities including street lights and fire hydrants. Find appropriate locations for these facilities to be located. Based on the size of the development, site sewer and waste water pipes. Students should use the location of the waste water main and slope of this main to ensure adequate drainage from their home site to the street main. ([Design Standards](#)) pg 221

- ❑ **Activity Day Six: Where is the water and where are the drains.**
 - Find where your local water comes from. Look up rainfall intensities from NOAA and calculate the current drainage/retention as well as the drainage for post-development. Calculate the amount of runoff that will need to be captured, convert to acre-feet and design a retention basin on the property site to capture this storm water runoff.

- ❑ **Activity Day Seven:** Parks and Routes to School
 - Select an empty area of the project site to be a neighborhood park. Allow the students to design appropriate elements for this park. If time and resources allow, they can design the park on CAD software. Locate and draw a map of safe routes to neighborhood schools using residential streets and public transit.

- ❑ **Activity Day Eight:** Continue Park design from Day 7 . Students should also make sure the landscaping is complete for their home sites and the park.

- ❑ **Activity Day Nine:** Place homes on lots and complete CAD renderings of homes and neighborhoods. Share the rendering finals into a final presentation. If time students can practice their presentation with their classmates.

- ❑ **Activity Day Ten:** Calculate the final cost of the neighborhood including the cost to build each house, the street utilities and impact fees ([Impact Fee Schedule](#)) [Caltrans Project Costs](#) [Caltrans Individual Item Cost](#)

Grading Rubric

Student Deliverables	4 Exceeds Expectations	3 Meets Expectations	2 Approaches Expectations	1 Fails to meet Expectations
Site Map	Exceeds standards with thoughtful plan and organized flow. All lots fit with space for park.	Site map meets expectations. Streets are appropriate and park is included along with all lots.	Site map conforms to minimum standards. Street geometries may not be the best plan. May be missing area for neighborhood park.	Site map does conform to design standards. Not enough lots.
Title History		Students locate correct title history		Students are unable to accurately locate appropriate title history
Cost Estimates for Utilities, Streets, and Final fees	Students complete full, interactive spreadsheet for all costs	Student create final cost showing each line item and references	Students create cost showing the majority of the items. Missing few items or references	Student complete inaccurate cost estimation.
Renderings of home and neighborhood	Student complete outstanding renderings-panorama, 3D walkthroughs	Student create rendered elevations and interiors	Students create 1-2 renderings showing some of house/neighborhood	Students do not submit any renderings or do submit of very low quality
Sewer and wastewater geometry calculation	To scale drawing and math calculations showing slope and drainage from home to street main. All	Sewer plan does work in connecting with street main. Poor drawings included.	Sewer plan does not work in connecting with street main. Scaled drawings included.	Sewer plan does not work in connecting with street main. No drawings.

	sketches labeled as needed.			
Safe routes to school map	Students design and detail map to school	Students design basic route to school	Student design poor or unsafe route to school.	Student fail to complete even basic map to school
Storm water calculation and retention basin	Storm water math is correct. No miscalculations in retention basin or runoff.	Storm water math is close. Minor miscalculations in retention basin or runoff.	Storm water math does not work. Miscalculations in retention basin or runoff.	Storm water math does not work. Gross miscalculations in retention basin or runoff.