# CIVIL ENGINEERING TECHNICAL ADVISORY COMMITTEE MEETING OF THE BOARD FOR PROFESSIONAL ENGINEERS, LAND SURVEYORS, AND GEOLOGISTS

**California Department of General Services**
**3737 Main Street, Second Floor Conference Room**
**Riverside, CA 92501**

**Tuesday, August 27, 2013, 1:00 P.M.**

**CIVIL ENGINEER TECHNICAL ADVISORY COMMITTEE**

| | |
|---|---|
| **Members**: | Neal Colwell, PE; James Foley, PE; Adam White, PE |
| **Board Liaisons**: | Robert Stockton, PE |
| **Staff Liaisons**: | Susan Christ, PE |

1. Roll Call
2. Orientation and Introduction of New TAC Members
3. Election of 2013/2014 Chair and Vice-Chair
4. Public Comment
5. Discussion and Possible Recommendation Regarding Request to Amend Title 16, California Code of Regulation section 424 (Experience Requirements – Professional Engineers) (Possible Action)
6. Discussion and Possible Recommendation Regarding Request to amend Business and Professions Code section 6731 (Civil Engineering Defined) (Possible Action)
7. Closed Session – Examination Procedures and Results, Review of Applications and Investigations, and Administrative Adjudication (As Needed) [Pursuant to Government Code sections 11126(c)(1), 11126(c)(2), and 11126(c)(3)] (Possible Action)
8. Open Session to Announce the Results of Closed Session
9. Board Liaison Report (Robert Stockton)
10. Staff Liaison Report (Susan Christ)
11. Date of Next CE-TAC Meeting
12. Other Business Not Requiring Committee Action
13. Adjourn

## Agenda Item 5:

## Discussion and Possible Recommendation Regarding Request to Amend Title 16, California Code of Regulation section 424 (Experience Requirements – Professional Engineers) (Possible Action)

At the December 7, 2012 Board meeting Craig Copelan, representing PECG, presented an item raised by a PECG member. The presentation was followed by correspondence dated January 4, 2013 requesting that the Board consider revising Board Rule 424 to facilitate licensure for a specific applicant or applicants. (Attachments A and B)

The situation presented is a civil engineer that qualified for licensing with six years of civil engineering work experience (applicant had an EIT and no engineering educational credit). This person now would like to obtain licensing as a traffic engineer and must therefore accrue another six years of work experience in traffic engineering to qualify for the second license.

PECG is requesting that Board Rule 424 be changed to accommodate this applicant so that this applicant and others will not be burdened by having to accrue additional work experience to qualify for a second license.

To qualify for professional engineering licensing in California, applicants with an EIT must verify a total of six years of experience. The six years may be a combination of education and work, or entirely work experience. Work experience must be in the area of practice in which they are applying for licensing, and cannot be used more than once. Please see Attachment C.

The primary purpose of a licensing board is to protect the public. Applicants are licensed based on their education, work experience and examination. The work experience quotient must provide evidence that the applicant is competent to practice in the branch of engineering in which they are applying for licensing (see section 6751(b)(2) of Attachment D). Civil engineering work experience must fall within the definition found in section 6731 and traffic engineering must fall within the definition found in Board Rule 404(qq) (Attachments C and D).

The examinations administered for licensing as a civil engineer include the NCEES Civil exam, the CA Engineering Surveying exam, and the CA Seismic Principles exam. The NCEES Civil exam has afternoon options in construction, geotechnical, structural, transportation, and water resources & environmental. Applicants may choose the afternoon option they prefer, and this option does not affect or restrict their engineering license to practice in CA. The test plans for these exams are included here as Attachments E (transportation option), F and G. The CA traffic engineering examination test plan is included as Attachment H.

At the December 2012 Board meeting the Board referred this issue to the Civil TAC for consideration and a recommendation.

# MINUTES OF THE BOARD FOR PROFESSIONAL ENGINEERS, LAND SURVEYORS, AND GEOLOGISTS

**2535 Capitol Oaks Drive, Suite 300**
**Sacramento, CA 95833**
**(916) 263-2222**

## Friday, December 7, 2012, beginning at 10:00 a.m.

**Board Members Present:** Paul Wilburn, President; Erik Zinn, Vice President; Carl Josephson; Mike Modugno; Ray Satorre; Jerry Silva; Robert Stockton; Patrick Tami; and Michael Trujillo

**Board Members Absent:** Kathy Jones Irish; Philip Quartararo; and Hong Beom Rhee

**Board Staff Present:** Ric Moore, (Executive Officer); Joanne Arnold (Assistant Executive Officer); Nancy Eissler (Enforcement Manager); Celina Calderone (Board Liaison); Susan Christ (Staff Civil Engineer); Ray Mathe (Staff Land Surveyor); Jeff Alameida (Budget Analyst); Erin LaPerle (Analyst, Geology Program); Larry Kereszt (Enforcement Analyst); Tiffany Criswell (Enforcement Analyst); Brooke Phayer (Outreach Coordinator); and Gary Duke (Legal Counsel).

I. **Roll Call to Establish a Quorum** – The meeting was called to order by President Paul Wilburn at 10:05 a.m. Roll call was taken, and a quorum was established.

II. **Public Comment**

Craig Copelan, representing PECG, presented two items to the Board. The first item was raised by a member of PECG regarding experience requirements for traffic engineering license. This person attained her license through work experience and had a degree in a related technical engineering area, not necessarily from an ABET accredited university. She earned her work experience and sat for the exam. It has now been a couple of years since she earned her license and is interested in obtaining an additional title act license in the area of traffic engineering and discovered that because she does not have a degree from an ABET accredited institution it is necessary for her to go through the work years of experience again. PECG is concerned and would like to see people advance in their area by obtaining their licenses. PECG is preparing correspondence recommending changes to Board Rule 424.

The second issue relates to employees within the Air Resources Board (ARB) who are interested in obtaining the necessary experience for licensure within the area of civil engineering but are being denied the opportunity to sit for the exam.

Mr. Copelan introduced Mr. Earl Withycombe and Jeremy Herbert who provided information about the academic institutions in California that have courses within the area of air resources and air quality.

Mr. Withycombe distributed a handout in reference to qualifying ARB engineers for admission to the California Civil examination. He indicated the applicants were denied admission to the civil engineering exam because work experience was not deemed to be civil engineering as it was not related to fixed works as specified in Business and Professions Code 6731.

Mr. Withycombe provided some history of Business and Professions Code 6731 adoption and air pollution control and recommend clarification of Business and Professions Code 6731.

He asked that the Board consider an interpretation for use by civil engineering graduates who work for the ARB, who want to know what types of qualifying experience they can gain with the ARB that would be credible and would be acceptable for admission to the examination. Another option would be to adopt regulation or change statute.

Mr. Withycombe stated that 48 states have adopted credentialing processes and registered environmental engineers with the exception of California and Hawaii. He recommends appointment of a task force to review the ARB civil examination decisions and recommend policies for interpreting 6731. Secondly, the task force should review the range of ARB engineer job duties and recommend a list of duties that qualify as acceptable work experience. In addition, he would like to have the task force review the definition of Civil Engineering adopted by other states and recommend changes to the 1931 definition.

Jeremy Herbert spoke with regards to his denial into the examination. He is a recent graduate from California State University, Sacramento. In his curriculum, he was provided with air pollution education. Once he discovered that there was evidence that civil engineering students being denied access to the PE exam with ARB experience, he began to research several universities for air quality classes in civil engineering.

He indicated that air quality does not fit in chemical engineering but that is what is being offered for licensure in lieu of the civil examination.

Mr. Stockton asked to confirm what Mr. Herbert said, that in order to further advance in the ARB you are required to obtain licensure. Mr. Herbert responded that in state service there are ranges A, B, C, and D. Depending on the experience one has in state service will determine the range you are in. One can promote as high as range C without licensure.

Mr. Herbert is currently finishing an analysis for assisting the Air Quality District with long-range planning. He is involved in the Transportation Conformity and General Conformity to make long range decisions.

President Wilburn directed the Civil TAC to review this issue and determine what actions, if any, the Board may want to consider.

Rick Keene representing the Geotechnical Engineers Association of California indicated that they are preparing legislative concepts which have been discussed with staff. There is an issue with the automatic referral cases to the Board. If someone has a settlement in a case that exceeds $50,000.00, they are automatically referred to the Board for a disciplinary review. The issue is that $50,000.00 is the deductible limit on most insurance policies. The insurance companies can settle those without permission of the engineer and, therefore, those cases are automatically referred to the Board for discipline. They would like to work out a solution and possibly moving the limit so that it is more than $50,000.00. He understands the Board is concerned about consumer protection. One idea is to drop the limit in some cases, perhaps an adjudication of liability in exchange for an adjustment.

Rob McMillan commended the Board staff for online renewals.

**V. Executive Officer's Report**

A. Legislation

1. Discussion of Legislation for 2013
   Currently, there is no new legislation.
2. Legislative Proposals
   a. Update on Amendments to Business and Professions Code Section 27 Regarding Address of Record Available Via the Website.

      Mr. Moore stated that at this time the Board has researched other boards within DCA and also discussed it with DCA's Policy Review Unit. They have indicated that they would not be in support of an amendment to Section 27. They believe that the way the current language reads is supporting the consumers and provides licensees an option to use an alternate address other than a home address. It was also discussed with GV Ayers, consultant for the Senate Business, Professions and Economic Development Committee. He provided some insight and indicated that it would not go much further. At this point, a sponsor is still needed. Mr. Duke added that the Department of Consumer Affairs is for transparency and added that there is a provision in the law that allows people to use an alternate address of record. Mr. Tami pointed out that the safety and wellbeing of the licensees should take precedence over transparency. Mr. Moore indicated that research with other boards could be done to gain joint interest. Ms. Arnold said that it will be next to impossible to obtain as

Attachment B

50 Years
PE PROFESSIONAL ENGINEERS
CG IN CALIFORNIA GOVERNMENT
1962 - 2012

RECEIVED JAN 0 8 2013

January 4, 2013

Board for Professional Engineers, Land Surveyors and Geologists
Attn: Ric Moore, Executive Officer
2535 Capitol Oaks Drive, Suite 300
Sacramento, CA 95833

Re: Recommendation to Amend Title 16, CCR § 424: Experience Requirements

Professional Engineers in California Government represents more than 13,000 engineers, land surveyors, and related professionals working for the State of California. The membership of PECG has raised concerns with the existing regulations which allow years of qualifying experience to be used only once, rather than allowing experience utilized in admittance to a civil engineering examination to also be used in meeting exam requirements to secure licensure in the overlapping title authority of traffic engineering.

Currently, Title 16, California Code of Regulations, Division 5, Section 424 (Experience Requirements-Professional Engineers) allows experience credit for education to be used more than once, but prohibits years of qualifying experience from being used more than once. PECG here proposes the Board amend the experience requirements regulation to allow qualifying experience used for admittance to the Civil Engineering practice act examination to also be used to qualify for the traffic engineering examination.

Specifically, PECG proposes the following amendment:

**424. Experience Requirements – Professional Engineers.**

(a) The engineering branches and title authorities described in Section 404, herein, overlap and some activities are common to two or more engineering branches and title authorities. The minimum number of years of qualifying experience in such overlapping engineering branches and title authorities may be used in securing licensure in any applicable engineering branch or title authority but cannot be used more than once. The only exceptions to this are the experience credit for education and experience credit for the traffic engineering examination. Qualifying education entitles a candidate to experience credit and this experience credit may be used again even though it has already been used to qualify for another examination. Qualifying experience used for a practice act examination in Civil Engineering may also be used again to qualify for the traffic engineering examination.

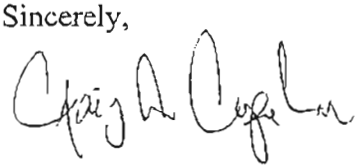
HEADQUARTERS: 455 Capitol Mall, Suite 501, Sacramento, CA 95814 • (916) 446-0400
LOS ANGELES: 215 N. Marengo Avenue, Suite 185, Pasadena, CA 91101 • (818) 500-9941
SAN FRANCISCO: 1 Sutter Street, Suite 800, San Francisco, CA 94104 • (415) 861-5720
TELEFAX: Headquarters (916) 446-0489; Los Angeles (818) 247-2348; San Francisco (415) 861-5360

The concerns regarding experience raised by our membership who are licensed civil engineers include candidates for a Traffic Engineer title act license who hold a degree in a related technical non-engineering field. These Engineers in state service who have earned a civil engineering license based upon their work experience are encountering an artificial barrier to their continued professional development when they seek an additional title act license in traffic engineering after having worked in this area for a period of years. After obtaining their practice act civil engineering license and subsequently seeking a title act license in traffic engineering, they find that their work experience can only be used once for their practice act license and accordingly they will be required to achieve up to an additional six years of work experience.

It is PECG's contention that the practice of civil engineering for the design, construction, operation and maintenance of highways provides a very practical introduction into the practice of traffic engineering as defined in Board regulation 404 and should be considered and allowed to serve as experience toward obtaining this title act license in traffic engineering.

The Board has wide latitude in adopting rules regarding experience requirements that implement the Professional Engineers Act and serve the public. Thank you for your consideration of this proposed change which we feel appropriately expands the ability of certain individuals to obtain and utilize the traffic engineering branch title without unnecessarily waiting up to six additional years.

Sincerely,



Craig Copelan
PECG Board of Registration Liaison

**Attachment C**

**Excerpts from the**

**Board Rules and Regulations Relating to the Practices of**

**Professional Engineering and Professional Land Surveying**

**California Code of Regulations**

**Title 16, Division 5**

**§§ 400-476**

404. Definitions.

For the purpose of the rules and regulations contained in this chapter, the following terms are defined. No definition contained herein authorizes the practice of engineering as defined in the Professional Engineers Act.

(qq) "Traffic engineering" is that branch of professional engineering which requires such education and experience as is necessary to understand the science of measuring traffic and travel and the human factors relating to traffic generation and flow; and requires the ability to apply this knowledge to planning, operating, and evaluating streets and highways and their networks, abutting lands and interrelationships with other modes of travel, to provide safe and efficient movement of people and goods. The above definition of traffic engineering shall not be construed to permit the practice of civil, electrical, or mechanical engineering.

424. Experience Requirements – Professional Engineers.

(a) The engineering branches and title authorities described in Section 404, herein, overlap and some activities are common to two or more engineering branches and title authorities. **The minimum number of years of qualifying experience in such overlapping engineering branches and title authorities may be used in securing licensure in any applicable engineering branch or title authority but cannot be used more than once. The only exception to this is experience credit**

**for education.** Qualifying education entitles a candidate to experience credit and this experience credit may be used again even though it has already been used to qualify for another examination.

(b) An applicant for licensure as a professional engineer shall be granted credit towards the experience requirement, as stated in subdivision (a), for the following education curriculum:

(1) Four (4) years experience credit for graduation from an approved engineering curriculum.

(2) Two (2) years experience credit for graduation from a non-approved engineering curriculum or from an approved engineering technology curriculum.

(3) Five (5) years of experience credit for graduation from an approved cooperative work-study engineering curriculum.

(4) Five (5) years of experience credit for graduation from an approved post-graduate engineering curriculum.

(5) One-half (1/2) year of education credit for each year of study completed in an approved engineering curriculum that did not result in the awarding of a baccalaureate degree, except that the maximum of such experience shall be two (2) years.

"Life Experience Degrees" are not acceptable and will not be counted towards the education credit.

The additional actual work experience required to meet the six (6) years of experience requirement shall have been gained after graduation, except for cooperative work study experience and post-graduate education.

The sum of qualifying experience credit for education and engineering teaching experience shall not exceed five years.

**(c) Qualifying experience is that experience satisfactory to the Board which has been gained while performing engineering tasks under the responsible charge of a person legally qualified to practice in an applicant's branch of engineering.**

(1) For the purposes of this section, "legally qualified" means having an appropriate license as a professional engineer; or by being an employee of the Federal Government; or, except for civil engineers, by virtue of being an employee of a manufacturing, mining, public utility, research and development, or other industrial corporation; or by, except for civil engineers, holding an appropriate license as a contractor.

(2) Qualifying experience shall be computed on an actual time worked basis, but not to exceed forty hours per week.

(3) Applied engineering research is an engineering task for the purposes of determining qualifying experience.

(d) Computation of qualifying experience for licensure as a professional engineer or for authority to use the title "structural engineer" or "geotechnical engineer" shall be to the date of filing of the application; or it shall be to the final filing date announced for the examination if the application is filed within a period of thirty (30) days preceding the final filing date announced for such examination.

# Attachment D

## Excerpts from the

## PROFESSIONAL ENGINEERS ACT

## (Business and Professions Code §§ 6700 – 6799)

## CHAPTER 7. PROFESSIONAL ENGINEERS

### Article 1. General Provisions

**6731. Civil engineering defined**

Civil engineering embraces the following studies or activities in connection with fixed works for irrigation, drainage, waterpower, water supply, flood control, inland waterways, harbors, municipal improvements, railroads, highways, tunnels, airports and airways, purification of water, sewerage, refuse disposal, foundations, grading, framed and homogeneous structures, buildings, or bridges:

(a) The economics of, the use and design of, materials of construction and the determination of their physical qualities.

(b) The supervision of the construction of engineering structures.

(c) The investigation of the laws, phenomena and forces of nature.

(d) Appraisals or valuations.

(e) The preparation or submission of designs, plans and specifications and engineering reports.

(f) Coordination of the work of professional, technical, or special consultants.

(g) Creation, preparation, or modification of electronic or computerized data in the performance of the activities described in subdivisions (a) through (f).

Civil engineering also includes city and regional planning insofar as any of the above features are concerned therein.

Civil engineers registered prior to January 1, 1982, shall be authorized to practice all land surveying as defined in Chapter 15 (commencing with Section 8700) of Division 3.

[NOTE: The last registration number issued to a civil engineer registered before January 1, 1982 was 33,965.]

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[NOTE: The last registration number issued to a civil engineer registered before January 1, 1982 was 33,965.]

**6751. Qualifications**

(a) The applicant for certification as an engineer-in-training shall comply with all of the following:

(1) Not have committed acts or crimes constituting grounds for denial of registration under Section 480.

(2) Successfully pass the first division of the examination. The applicant shall be eligible to sit for the first division of the examination after satisfactory completion of three years or more of postsecondary engineering education, three years or more of engineering experience, or a combination of postsecondary education and experience in engineering totaling three years.

The board need not verify the applicant's eligibility other than to require the applicant to sign a statement of eligibility on the application form.

**(b) The applicant for registration as a professional engineer shall comply with all of the following:**

(1) Not have committed acts or crimes constituting grounds for denial of registration under Section 480.

**(2) Furnish evidence of six years or more of qualifying experience in engineering work satisfactory to the board evidencing that the applicant is competent to practice the character of engineering in the branch for which he or she is applying for registration**, and successfully pass the second division of the examination.

(3) The applicant for the second division of the examination shall successfully pass the first division examination or shall be exempt therefrom.

NCEES
advancing licensure for engineers and surveyors

## Principles and Practice of Engineering
## CIVIL BREADTH and TRANSPORTATION DEPTH Exam Specifications

**Effective Beginning with the April 2008 Examinations**
(with design standards updated May 6, 2013)

- The civil exam is a breadth and depth examination. This means that examinees work the breadth (AM) exam and one of the five depth (PM) exams.
- The five areas covered in the civil examination are construction, geotechnical, structural, transportation, and water resources and environmental. The breadth exam contains questions from all five areas of civil engineering. The depth exams focus more closely on a single area of practice in civil engineering.
- Examinees work all questions in the morning session and all questions in the afternoon module they have chosen. Depth results are combined with breadth results for final score.
- The exam is an 8-hour open-book exam. It contains 40 multiple-choice questions in the 4-hour AM session, and 40 multiple-choice questions in the 4-hour PM session.
- The exam uses both the International System of Units (SI) and the US Customary System (USCS).
- The exam is developed with questions that will require a variety of approaches and methodologies, including design, analysis, and application. Some problems may require knowledge of engineering economics.
- The knowledge areas specified as examples of kinds of knowledge are not exclusive or exhaustive categories.
- The specifications for the **AM exam** and the **Transportation PM exam** are included here. The **design standards** applicable to the Transportation PM exam are shown on the last page.

### CIVIL BREADTH Exam Specifications

| | | Approximate Percentage of AM Exam |
|---|---|---|
| I. | **Construction** | **20%** |

A. Earthwork Construction and Layout
   1. Excavation and embankment (cut and fill)
   2. Borrow pit volumes
   3. Site layout and control

B. Estimating Quantities and Costs
   1. Quantity take-off methods
   2. Cost estimating

C. Scheduling
   1. Construction sequencing
   2. Resource scheduling
   3. Time-cost trade-off

D. Material Quality Control and Production
   1. Material testing (e.g., concrete, soil, asphalt)

E. Temporary Structures
   1. Construction loads

## II. Geotechnical — 20%

A. Subsurface Exploration and Sampling
   1. Soil classification
   2. Boring log interpretation (e.g., soil profile)

B. Engineering Properties of Soils and Materials
   1. Permeability
   2. Pavement design criteria

C. Soil Mechanics Analysis
   1. Pressure distribution
   2. Lateral earth pressure
   3. Consolidation
   4. Compaction
   5. Effective and total stresses

D. Earth Structures
   1. Slope stability
   2. Slabs-on-grade

E. Shallow Foundations
   1. Bearing capacity
   2. Settlement

F. Earth Retaining Structures
   1. Gravity walls
   2. Cantilever walls
   3. Stability analysis
   4. Braced and anchored excavations

## III. Structural — 20%

A. Loadings
   1. Dead loads
   2. Live loads
   3. Construction loads

B. Analysis
   1. Determinate analysis

C. Mechanics of Materials
   1. Shear diagrams
   2. Moment diagrams
   3. Flexure
   4. Shear
   5. Tension
   6. Compression
   7. Combined stresses
   8. Deflection

D. Materials
   1. Concrete (plain, reinforced)
   2. Structural steel (structural, light gage, reinforcing)

E. Member Design
   1. Beams
   2. Slabs
   3. Footings

## IV. Transportation 20%

A. Geometric Design
   1. Horizontal curves
   2. Vertical curves
   3. Sight distance
   4. Superelevation
   5. Vertical and/or horizontal clearances
   6. Acceleration and deceleration

## V. Water Resources and Environmental 20%

A. Hydraulics – Closed Conduit
   1. Energy and/or continuity equation (e.g., Bernoulli)
   2. Pressure conduit (e.g., single pipe, force mains)
   3. Closed pipe flow equations including Hazen-Williams, Darcy-Weisbach Equation
   4. Friction and/or minor losses
   5. Pipe network analysis (e.g., pipeline design, branch networks, loop networks)
   6. Pump application and analysis

B. Hydraulics – Open Channel
   1. Open-channel flow (e.g., Manning's equation)
   2. Culvert design
   3. Spillway capacity
   4. Energy dissipation (e.g., hydraulic jump, velocity control)
   5. Stormwater collection (e.g., stormwater inlets, gutter flow, street flow, storm sewer pipes)
   6. Flood plains/floodways
   7. Flow measurement – open channel

C. Hydrology
   1. Storm characterization (e.g., rainfall measurement and distribution)
   2. Storm frequency
   3. Hydrographs application
   4. Rainfall intensity, duration, and frequency (IDF) curves
   5. Time of concentration
   6. Runoff analysis including Rational and SCS methods
   7. Erosion
   8. Detention/retention ponds

D. Wastewater Treatment
   1. Collection systems (e.g., lift stations, sewer networks, infiltration, inflow)

E. Water Treatment
   1. Hydraulic loading
   2. Distribution systems

## CIVIL–TRANSPORTATION Depth Exam Specifications

A competent transportation engineer should have a basic knowledge in drainage, soils, and pavement design. Culvert design and pavement design are knowledges that have not been tested previously under the current Civil exam specifications. **Beginning with the April 2010 exam, Section V of the Transportation module has been broadened to permit testing in these important transportation knowledges.**

| | | Approximate Percentage of PM Exam |
|---|---|---|
| I. | **Traffic Analysis**<br>A. Traffic capacity studies<br>B. Traffic signals<br>C. Speed studies<br>D. Intersection analysis<br>E. Traffic volume studies<br>F. Sight distance evaluation<br>G. Traffic control devices<br>H. Pedestrian facilities<br>I. Driver behavior and/or performance | 22.5% |
| II. | **Geometric Design**<br>A. Horizontal curves<br>B. Vertical curves<br>C. Sight distance<br>D. Superelevation<br>E. Vertical and/or horizontal clearances<br>F. Acceleration and deceleration<br>G. Intersections and/or interchanges | 30% |
| III. | **Transportation Planning**<br>A. Optimization and/or cost analysis (e.g., transportation route A or transportation route B)<br>B. Traffic impact studies<br>C. Capacity analysis (future conditions) | 7.5% |
| IV. | **Traffic Safety**<br>A. Roadside clearance analysis<br>B. Conflict analysis<br>C. Work zone safety<br>D. Accident analysis | 15% |
| V. | **Other Topics**<br>A. Hydraulics<br>1. Culvert design<br>2. Open channel – subcritical and supercritical flow<br>B. Hydrology<br>1. Hydrograph development and synthetic hydrographs<br>C. Engineering properties of soils and materials (e.g., index properties, identification of types of soils, suitable or unsuitable soil, boring logs) | 25% |

D. Soil mechanics analysis (e.g., soil behavior, soil classification, soil compaction)
E. Engineering economics
   1. Value engineering and costing
F. Construction operations and methods (e.g., erosion control measures, excavation/embankment)
G. Pavement structures (e.g., flexible and rigid pavement design)

## NCEES Principles and Practice of Engineering Examination

## TRANSPORTATION Design Standards

**Effective Beginning with the October 2013 Examinations**

| ABBREVIATION | DESIGN STANDARD TITLE |
|---|---|
| AASHTO | *A Policy on Geometric Design of Highways and Streets,* 6th edition, 2011, American Association of State Highway & Transportation Officials, Washington, DC. |
| AASHTO | *Guide for Design of Pavement Structures* (GDPS-4-M), 1993, and 1998 supplement, American Association of State Highway & Transportation Officials, Washington, DC. |
| AASHTO | *Roadside Design Guide,* 4th edition, 2011, American Association of State Highway & Transportation Officials, Washington, DC. |
| AASHTO | *Mechanistic-Empirical Pavement Design Guide: A Manual of Practice,* interim edition, July 2008, American Association of State Highway & Transportation Officials, Washington, DC. |
| AI | *The Asphalt Handbook* (MS-4), 7th edition, 2007, Asphalt Institute, Lexington, KY. |
| HCM | *Highway Capacity Manual* 2010, Transportation Research Board—National Research Council, Washington, DC. |
| MUTCD | *Manual on Uniform Traffic Control Devices,* 2009, including Revisions 1 and 2 dated May 2012, U.S. Department of Transportation—Federal Highway Administration, Washington, DC. |
| PCA | *Design and Control of Concrete Mixtures,* 15th edition, 2011, Portland Cement Association, Skokie, IL. |
| FHWA | *Hydraulic Design of Highway Culverts,* Hydraulic Design Series Number 5, Publication No. FHWA-HIF-12-026, 3rd edition, April 2012, U.S. Department of Transportation—Federal Highway Administration, Washington, DC. |

# Civil Engineer Examination
# Engineering Surveying Test Plan
# (Effective for October 2012 Examination)

## Definition of Engineering Surveying

Engineering Surveying is defined as those activities involved in the practice and application of surveying principles for the location, design, construction and maintenance and operation of engineered projects.

This area of practice is structured into five primary content areas:

- **I.** Standards of Practice (6%)
- **II.** Equipment and Uses (8%)
- **III.** Field Measurements (28%)
- **IV.** Calculations (33%)
- **V.** Data Application Procedures (25%)

## Glossary of Engineering Surveying Terms

As used in the test plan task statements, the following abilities are defined as:

| | |
|---|---|
| **Determine** | To establish or define after consideration, investigation, or calculation for use in an engineering surveying activity. |
| **Interpret** | To conceive and explain the meaning of engineering surveying terms, symbols and procedures. |
| **Perform** | To execute and complete a task in accordance with the requirements of engineering surveying practice. |
| **Prepare** | To put together or make by combining various existing or newly created elements for use in an engineering surveying activity. |
| **Recognize** | To know or identify the engineering surveying elements of a project from past experience or knowledge. |

## I. Standards of Practice (6%)

Standards of Practice include knowledge of the laws regulating engineering surveying and the standards of care required.

**T01. Practice in accordance to laws regulating engineering surveying and limits of practice**

K01. Characteristics and purposes of subdivision maps (Subdivision Map Act) as it applies to the Business and Professions Code 6731.1

K02. Professional Engineer's (PE) Act

## II. Equipment and Uses (8%)

Engineering surveying equipment and uses include the types of equipment used and their application for gathering and interpreting field data and for construction layout.

**T02. Distinguish the purposes and procedures of different survey types**

K03. Control surveys (purpose and procedures)

K04. Construction surveys (purpose and procedures)

K05. Route surveys (purpose and procedures)

K06. Topographic surveys (purpose and procedures)

**T03. Identify the capabilities and limitations of survey instruments and equipment**

K07. Total Station

K08. Leveling equipment

K09. Global Positioning System (GPS)

K10. Other surveying equipment (e.g., engineer's transit, survey prism, plumb bob, Electronic Distance Measurement (EDM)

## III. Field Measurements (28%)

Engineering surveying field measurements include the methods and procedures for determining distances, angles and elevations.

**T04. Perform construction surveying (e.g., construction staking)**

K11. Construction layout requirements

K12. Horizontal and vertical curve layout

K13. Horizontal and vertical control layout

K14. Line and grade layout

K15. Offset distance computations

K16. Procedures for establishing points on a line

K17. Procedures for locating a single point

K27. Geometric properties and equations of a curve

K28. Curve deflections

K29. Procedures for calculating a horizontal curve (e.g., beginning of a curve, end of a curve, intersection)

K30. Properties of compound and reversing curves

K31. Procedures for calculating the intersection of a curve and a straight line

K32. Procedures for calculating a vertical curve (e.g., stationing, highest/lowest point, rate of gradient)

K33. Procedures for calculating profile grade (slope) and elevations on the tangents

**T05. Perform the measurement of horizontal distances**

K18. Measuring horizontal distances

K19. Measuring slope distances

**T06. Perform the measurement of angles**

K20. Measuring horizontal angles

K21. Measuring deflection angles

K23. Relationships between azimuths, bearings, back bearings and angles

**T07. Perform the measurement of elevations**

K22. Measuring vertical (profile) distances

K24. Leveling methods (e.g., differential, profile, trigonometric, cross-section )

## IV. Calculations (33%)

Engineering surveying calculations are the analytical methods for applying the mathematical relationships between measured distances, angles and elevations.

**T08. Perform leveling calculations from field data to determine elevations**

K34. Leveling calculations (e.g., error analysis, checking and creating notes, adjusting)

**T09. Perform traverse survey calculations**

K25. General trigonometric and geometric formulas (triangles, angles and lines)

K34. Leveling calculations (e.g., error analysis, checking and creating notes, adjusting)

K26. Trigonometric relationships to determine the area of a polygon

K35. Procedures for calculating distances from coordinates

K36. Procedures for calculating bearings or azimuths from coordinates

K37. Coordinate geometry relationships (curves, points and lines)

K38. Procedures for calculating area

**T10. Perform rectangular coordinate system calculations**

K35. Procedures for calculating distances from coordinates

K36. Procedures for calculating bearings or azimuths from coordinates

K37. Coordinate geometry relationships (curves, points and lines)

**T11. Perform calculations to determine quantities of construction materials**

K39. Methods and procedures for calculating volumes of materials (e.g., mass diagrams, average end, cross-sections)

## V. Data Application Procedures (25%)

Engineering surveying data application procedures include the research and planning for field surveys and the conversion of field data to an engineering format.

**T12. Perform processing of field data**

K40. Field notes formats

K41. Plotting profiles

K42. Plotting cross-sections

K43. Plotting field points and data

K44. Applications of stationing

K45. Relationship between grade lines and cross-sections

**T13. Obtain information from legal descriptions and easement data pertinent to engineering surveying projects**

K46. Formats and terminology of legal descriptions as it applies to the Business and Professions Code 6731.1

K47. Different types of easement data

**T14. Use of datums for horizontal and vertical control**

K48. Different types of horizontal datums

K49. Different types of vertical datums (e.g., bench marks)

**T15. Prepare topographic and planimetric maps**

K50. Contour intervals

K51. Methods to plot contours from field information

K52. Methods for interpolating elevations

K61. Applications of Geographic Information Systems (GIS)

**T16. Interpret maps**

K53. Map scales

K54. Units of conversion

K55. Exaggerated scales

K56. Plan and profile as it applies to the Business and Professions Code 6731.1

K57. Characteristics and purposes of underground mapping

K58. Characteristics and purposes of topographic mapping

## V. Data Application Procedures (Continued)

K59. Characteristics and purposes of grading plans

K60. Characteristics and purposes of improvement plans (e.g., street, traffic signal, storm drain, water)

K61. Applications of Geographic Information Systems (GIS)

# Civil Engineer Examination
# Seismic Principles Test Plan
# (Effective for October 2012 Examination)

## Definition of Seismic Principles

Seismic Principles is defined as the fundamental principles, tasks and knowledges underlying those activities involved in the California practice of seismic design, seismic analysis or seismic evaluation of new and existing civil engineering projects such as:

- buildings
- non-building structures
- non-structural components, equipment and lifelines

This area of practice is structured into five primary content areas:

**I.** Seismic Data and Design Criteria (8%)
**II.** Seismic Characteristics of Engineered Systems (17%)
**III.** Seismic Forces (35%)
**IV.** Seismic Analysis Procedures (30%)
**V.** Seismic Detailing and Construction Quality Control (10%)

## Glossary of Seismic Principles Terms

Please note that these abilities are arranged hierarchically from the least complex to the most complex. That is, **recognize** constitutes the least complex ability in the hierarchy and **perform** constitutes the most complex. Each ability presupposes all abilities preceding it in the hierarchy. For example, the ability to **determine** presupposes the abilities to **recognize** and **understand.**

As used in the test plan task statements, the following abilities are defined as:

| | |
|---|---|
| **Recognize** | To know or identify seismic principles from past experience or knowledge. |
| **Understand** | To recognize and comprehend seismic principles. |
| **Determine** | To identify and select after consideration, investigation or calculation seismic forces or systems. |
| **Perform** | To execute and complete a task in accordance with seismic principles. |

(**NOTE:** As used throughout this test plan, the term **applicable code** refers to the **current adopted California Building Code**.)

## I. Seismic Data and Design Criteria (8%)

Tasks required for the development of the project seismic design methodology considering the effects that the seismic environment has on the civil engineering project.

**T01. Practice in accordance to laws, codes and standards governing seismic design**

K05. Laws regulating civil engineering/limits of practice

K06. Applicable codes for civil engineering construction

**T02. Identify design performance goals for a project**

K4. Seismic design philosophy of the applicable code

**T03. Determine site related coefficients**

K1. Geologic seismic hazards and geotechnical data that affect design, including liquefaction

K2. Site related seismic coefficients

K3. Natural period of the structure and the expected period of the seismic ground motion

**T04. Determine effects of site characteristics on a structure**

K1. Geologic seismic hazards and geotechnical data that affect design, including liquefaction

K2. Site related seismic coefficients

K3. Natural period of the structure and the expected period of the seismic ground motion

**T05. Determine seismic design category**

K7. Seismic design categories

K8. Building occupancy categories

K9. Seismic importance factors

## II. Seismic Characteristics of Engineered Systems (17%)

Tasks required selecting new seismic structural systems, to understand the methods of strengthening existing structural systems and to recognize seismic performance and damage vulnerability of structures.

**T06. Select appropriate seismic resisting structural system for a new or existing structure**

K10. Different structural systems and their design parameters

K11. Limitations of different structural systems

**T07. Identify effects of structural characteristics on seismic design/performance**

K12. Requirements for structure having plan irregularities (e.g., torsional response, re-entrant corner, out-of-plane offset)

K13. Requirements for a structure having vertical irregularities (e.g., vertical discontinuities, offsets, soft stories)

K14. Drift and P-Delta to control deflections

K15. Effects of ductility and damping on seismic performance

K16. Effects of redundancy on seismic performance

**T08. Evaluate vulnerability of structures with previous poor seismic performance**

K17. Anchorage and stability in unreinforced masonry (URM) bearing wall buildings

K18. Buckling or brittle connections in steel-braced frames

K19. Weak connections in precast concrete structures

K20. Punching shear problems in flat slab concrete structures

K21. Diaphragm to wall connection problems in tilt-up and masonry buildings

K22. Welded connection problems in steel moment frames

K23. Post-earthquake safety evaluation

**T09. Determine methods for improving seismic performance of existing structures**

K24. Methods to improve seismic performance and the effects on the existing structure

K25. Methods and effects of adding stiffness to protect brittle elements

K26. Methods and effects of improving ductility of brittle elements

K27. Methods and effects of strengthening connections in structural elements

## III. Seismic Forces (35%)

Tasks required for the determination and distribution of seismic forces.

**T10. Determine structural characteristics required to calculate seismic design forces**

K28. Mass and stiffness

K29. Methods to determine the structure's fundamental period

K30. Reliability, redundancy and other seismic factors

K32. Choice and application of structural system seismic coefficients

**T11. Determine seismic design forces for buildings**

K31. Static force procedures and formulas

K33. Choice and application of seismic importance factors

K34. Design base shear

K42. Design lateral force formulas

**T12. Perform vertical distribution of seismic forces for buildings**

K35. Vertical force distribution

**T13. Determine seismic diaphragm forces**

K36. Design seismic forces on diaphragms

**T14. Determine seismic forces for elements of structures**

K37. Design seismic forces on elements of structures

K38. Out-of-plane seismic forces on elements of structures

K39. Use of overstrength factor

**T15. Determine seismic forces for non-building structures**

K40. Choice and application of non-building structural system seismic coefficients

K43. Design seismic forces on non-building structures

**T16. Determine seismic forces for non-structural building components and equipment**

K41. Choice and application of non-structural building component seismic coefficients

K44. Design seismic forces on non-structural building components

## IV. Seismic Analysis Procedures (30%)

Tasks required for the analysis of engineered structures.

**T17. Perform analysis of lateral force resisting systems**

K45. Applicable load combinations

K47. Deflection and drift requirements

**T18. Perform the distribution of seismic forces to structural elements**

K46. Distribution of internal and external forces

K48. Methods used to calculate rigidities of structural elements

K49. Distribution of seismic forces based on rigidity

K50. Diaphragm chord forces, drag forces and diaphragm shear

K53. Methods to distribute shear forces to structural elements

**T19. Perform the seismic analysis of diaphragms (e.g., rigid and flexible)**

K51. Assumptions controlling the analysis for rigid diaphragms

K52. Methods to determine centers of rigidity and mass

K53. Methods to distribute shear forces to structural elements

K54. Torsional moment requirements in rigid diaphragms

K55. Assumptions controlling the analysis of flexible diaphragms

K56. Sub-diaphragm analysis

## V. Seismic Detailing and Construction Quality Control (10%)

Tasks required for the seismic detailing of structural elements and assemblies and for the quality control requirements necessary to assure seismic performance.

**T20. Identify the detailing requirements that are critical for seismic performance (e.g., load path, wall anchorage, chord and collector)**

K57. Seismic detailing and inherent seismic performance characteristics for steel

K58. Seismic detailing and inherent seismic performance characteristics for concrete

K59. Seismic detailing and inherent seismic performance characteristics for masonry

K60. Seismic detailing and inherent seismic performance characteristics for wood

K61. Deformation compatibility requirements for structural and non-structural elements

K62. Required building separation

K63. Requirements for ties and continuity, collectors or drags

K64. Requirements for anchorage of concrete and masonry walls

**T21. Recognize need for construction quality control of the seismic design aspects of the project (e.g., testing, special inspection and observation requirements)**

K65. Testing requirements

K66. Special inspection requirements

K67. Structural observation requirements

TRAFFIC ENGINEER EXAMINATION CONTENT OUTLINE

CONTENT AREA: PLANNING (31%)

Summary of Activities: This area assesses the candidate's ability to apply knowledge of various techniques such as level of service analyses, trip generation, traffic distribution, and parking demand analyses of existing roadways to perform tasks involving, for example, capacity analyses, evaluation of traffic plans, estimating traffic volumes, access management, and parking analyses.

| TASK STATEMENTS | KNOWLEDGE STATEMENTS |
|---|---|
| 1. Perform capacity analyses of existing roadways to determine the need for reducing congestion.<br>2. Evaluate traffic plans to ensure accommodation of current and future peak-hour traffic volumes.<br>3. Estimate delays at intersections based on projected traffic volumes to evaluate the need to change roadway networks.<br>4. Estimate increased traffic volumes produced by new developments to evaluate the need for roadway mitigations.<br>5. Predict future parking demands of proposed developments to determine sizes of parking facilities.<br>6. Predict future traffic volumes using a forecasting model for traffic impact studies.<br>7. Determine the costs and benefits of proposed capital improvement projects to prioritize funding.<br>8. Perform level-of-service analyses (LOS) of facilities to determine the need for roadway mitigations.<br>9. Develop access management plans for public and private properties.<br>11. Perform analyses of the impacts of trip generation demands on roadways, railways, public transit, sidewalks, and bicycle facilities to minimize delays and congestion.<br>12. Conduct corridor analyses of alternative modes of travel to determine optimum transportation infrastructures.<br>13. Propose improvements to transportation infrastructures to | 1. Knowledge of techniques for performing level-of-service (LOS) analyses for transportation facilities.<br>2. Knowledge of techniques for calculating levels of service (LOS) for transportation facilities.<br>3. Knowledge of strategies used to reduce travel demand.<br>5. Knowledge of trip distribution techniques associated with traffic impact analysis.<br>6. Knowledge of the use of trip generation analysis techniques for various land uses.<br>7. Knowledge of the techniques needed to compute the highway capacity of roadways.<br>8. Knowledge of techniques for evaluating the current and projected traffic capacity of roadways.<br>9. Knowledge of techniques for calculating roadway segment capacity volumes.<br>10. Knowledge of techniques for calculating roadway segment capacity thresholds.<br>11. Knowledge of the effect of new developments on access to adjacent roadways.<br>12. Knowledge of roadway features that affect capacity.<br>13. Knowledge of access management principles related to the improvement of traffic flow.<br>14. Knowledge of techniques used to determine traffic impacts for existing and future conditions.<br>15. Knowledge of techniques used to select mitigation measures based on constraints.<br>16. Knowledge of techniques to measure the effectiveness of proposed roadway mitigations. |

| | |
|---|---|
| accommodate changes in travel demand due to new developments.<br>14. Conduct traffic impact studies to determine transportation improvements.<br>15. Identify constraints to proposed mitigation measures to evaluate their plausibility.<br>17. Perform analyses of roadways and ramp areas to identify delays and collision locations. | 17. Knowledge of essential elements needed for traffic impact studies.<br>18. Knowledge of methods for applying principles of the planning process to macro- and micro-simulation models.<br>19. Knowledge of techniques for conducting traffic flow studies.<br>22. Knowledge of the relationship between parking demand and individual land uses.<br>23. Knowledge of the effects of vehicle characteristics and volumes on roadway infrastructure. |

TRAFFIC ENGINEER EXAMINATION CONTENT OUTLINE

CONTENT AREA: ROADWAY DESIGN (19%)

Summary of Activities: This area assesses the candidate's ability to apply knowledge of principles, standards, and guidelines such as those needed to develop parking facilities, driveways, roadway improvements, design of spacing and other facets of roadway lighting, roadway and transportation facilities, roundabouts, bicycle facilities improvements, and Intelligent Transportation Systems.

| TASK STATEMENTS | KNOWLEDGE STATEMENTS |
|---|---|
| 18. Develop changes to roadway networks to mitigate the impacts of new developments on residential streets.<br>19. Select traffic calming devices to mitigate cut-through traffic, collisions, and speeding.<br>20. Verify that transportation facilities comply with Federal and State accessibility standards.<br>21. Implement Intelligent Transportation System (ITS) measures to reduce congestion.<br>22. Prepare plans, specifications, and estimates for traffic signal projects.<br>23. Design roundabouts to minimize delays and improve safety at intersections.<br>26. Design bicycle facilities improvements according to Federal and State standards and guidelines to promote alternative transportation modes.<br>27. Select roadway safety devices such as guardrails, barriers, and crash cushions to minimize injuries.<br>28. Develop roadway, interchange and intersection designs and constraints based on traffic demands and physical constraints to optimize safe travel.<br>29. Prepare parking facility layouts to maximize efficiency and circulation.<br>30. Develop lighting systems on roadways to optimize travel flow and safety.<br>32. Develop illuminated pedestrian and overhead pedestrian crossings for safe public travel. | 24. Knowledge of principles and standards for the development of parking facilities.<br>25. Knowledge of standards for non-motorized transportation facilities.<br>26. Knowledge of principles for the design of driveways.<br>27. Knowledge of the effects of the mixtures and sizes of vehicles on roadway geometric design.<br>29. Knowledge of applications of design standards to roadway improvements.<br>30. Knowledge of applications of sight distance principles to roadway design.<br>31. Knowledge of channelization guidelines to improve traffic flow.<br>32. Knowledge of statutes and guidelines regarding accommodations for the disabled related to the design of traffic-related facilities.<br>33. Knowledge of techniques for designing traffic facilities that takes into consideration roadway users with disabilities.<br>34. Knowledge of principles for the design of spacing and other aspects of roadway lighting.<br>37. Knowledge of techniques for implementing Intelligent Transportation Systems (ITS) technology to improve traffic flow and roadway safety.<br>39. Knowledge of principles of bicycle facilities design.<br>41. Knowledge of the design and application of traffic calming devices. |

TRAFFIC ENGINEER EXAMINATION CONTENT OUTLINE

CONTENT AREA: STUDIES AND ANALYSES (11%)

| Summary of Activities: This area assesses the candidate's ability to apply knowledge of methods for performing Engineering and Traffic Surveys; techniques for analyzing collision and other types of data; and laws, principles, and standards regarding safety and traffic control devices to conduct, for example, speed-zone surveys, studies of traffic collision data, parking studies, and various types of field investigations of roadway conditions. | |
|---|---|
| TASK STATEMENTS | KNOWLEDGE STATEMENTS |
| 34. Conduct speed-zone surveys to assess whether speed limits should be changed.<br>35. Conduct studies of traffic collision data to identify causes of collisions on roadways and at intersections.<br>36. Create diagrams of traffic collisions to support recommendations for their reduction at intersections and on roadways.<br>37. Perform parking studies of vehicle inventory and other types of data for parking management and regulations development.<br>38. Conduct field investigations of existing conditions to evaluate changes to traffic control devices and roadway designs. | 42. Knowledge of methods for performing Engineering and Traffic Surveys.<br>43. Knowledge of techniques for analyzing collision data for treatment identification and safety improvement.<br>44. Knowledge of laws governing traffic control devices.<br>45. Knowledge of principles and standards for pedestrian safety improvements.<br>46. Knowledge of techniques for conducting parking use studies.<br>47. Knowledge of techniques for conducting delay studies. |

TRAFFIC ENGINEER EXAMINATION CONTENT OUTLINE

CONTENT AREA: TRAFFIC CONTROL (39%)

Summary of Activities: This area assesses the candidate's ability to apply knowledge of existing laws, standards, and principles for evaluating and implementing the use of traffic control devices, signal design, signal operations, and parking regulations for such tasks as managing on-street parking, performing traffic engineering assessments, modifying traffic signal hardware, and developing channelization designs for turning movements at intersections.

| TASK STATEMENTS | KNOWLEDGE STATEMENTS |
|---|---|
| 39. Manage on-street parking by establishing parking regulations involving, for example, the California Vehicle Code, to promote the use of public parking spaces.<br>40. Perform traffic engineering assessments to recommend placements of traffic signs.<br>41. Evaluate signal timing to determine the need to improve the efficiency of traffic corridors.<br>42. Modify traffic signal hardware to improve safety and operations.<br>43. Evaluate the need for new traffic signals using warrants.<br>44. Evaluate traffic control devices to improve pedestrian safety, including those in school areas.<br>45. Design pavement markings on public/private property according to Federal and State standards.<br>46. Evaluate the horizontal and vertical alignment of roadways to determine the need for traffic control devices.<br>47. Determine signal phasing based on turning movement counts and collision history.<br>48. Synchronize signals using traffic counts and computer models to optimize traffic flow.<br>49. Design the placement and arrangement of traffic signals according to State standards for roadway safety.<br>50. Select appropriate traffic control devices for development of transit and railroad facilities.<br>51. Develop temporary traffic control and detour plans to minimize delay and address | 48. Knowledge of laws governing curb parking.<br>49. Knowledge of measures that remedy traffic safety and operational deficiencies.<br>50. Knowledge of State standards for the identification and placement of signing, striping, and marking elements.<br>51. Knowledge of warrants for the installation of traffic controls.<br>52. Knowledge of methods to optimize the use of traffic signals for traffic flow.<br>53. Knowledge of methods to factor transit priority into signal timing.<br>54. Knowledge of techniques to develop traffic signal timing plans.<br>55. Knowledge of principles of traffic signal design.<br>56. Knowledge of traffic signal coordination timing to improve traffic flow.<br>57. Knowledge of standards for guiding traffic through construction and maintenance zones.<br>58. Knowledge of types of traffic signal phasing to improve safety and operations.<br>59. Knowledge of principles governing the type and location of traffic signal detection systems.<br>60. Knowledge of principles of traffic signal preemption.<br>61. Knowledge of methods for traffic signal interconnection. |

| | |
|---|---|
| worker and road user safety.<br>52. Develop channelization designs for turning movements at intersections.<br>53. Calculate passing, stopping, and decision sight distances to determine the appropriate pavement markings and/or signs for roadway conditions.<br>54. Create signal timing plans to accommodate variable congestion, special events, and incident management.<br>55. Create preemption and priority signal timing plans for railroad, transit, and emergency vehicles.<br>57. Determine warning sign type, use, and placement based on roadway characteristics for safe roadway usage. | |

## Agenda Item 6:

## Discussion and Possible Recommendation Regarding Request to Amend Business and Professions Code section 6731 (Civil Engineering Defined) (Possible Action)

At the December 7, 2012 Board meeting Craig Copelan, representing PECG, and two employees from the California Air Resources Board (ARB) presented an item regarding professional engineering licensing and career advancement for ARB engineers. As presented, ARB staff are asking to be provided a pathway to licensure as a civil engineer so that they may be promoted at the ARB. The Board directed the Civil TAC to review this issue and determine what actions, if any, the Board may want to consider.

PECG and the ARB employees are requesting that the Board review the way ARB staff applications for licensing as a civil engineer are evaluated; that the definition of civil engineering be clarified for use by ARB applicants; that the Board adopt a regulation or revise section 6731 (the definition of civil engineering) so that ARB staff may better qualify for civil engineering licensing and qualify for promotion within the ARB.

Board staff has contacted and corresponded with ARB personnel staff. In the information provided by ARB Personnel, licensing as a PE, no specific branch or discipline, is required for Range D of the Air Resources Engineer (ARE) position (Attachment I). In addition to the position classification, the Supplemental Application Examination for the ARE position is included as Attachment J. Licensing as a civil engineer is not a requirement for promotion to Range D of the ARE, however, licensing as a professional engineer is a requirement.

The ARB staff that attended the Board meeting also requested that ARB job duties be evaluated for a subset of duties that would qualify as acceptable work experience for licensing as a civil engineer. A quick sampling of the Air Resources Engineer duties include: quantifying emissions from heavy duty vehicles, engines and equipment; interacting with laboratory clients; conducting emission tests and analyzing emissions data; design of electrical instrumentation; and development of control systems instrumentation. In the Knowledge and Abilities required it mentions "mechanical, chemical, and electrical engineering as applied to testing and evaluating automotive exhaust control devices". None of these duties fall within the practice of civil engineering. Because the Air Resources engineer job specification specifically mentions mechanical, chemical, electrical and control systems engineering it appears that licensing in one of these branches may be more applicable to this position than civil engineering.

As discussed in this agenda, Item 5, applicants for licensing as a civil engineer must take and pass the NCEES Civil Exam in addition to the two CA Civil Exams. Included here as Attachment K are the exam specifications for the NCEES Civil Exam with the Water Resources and Environmental depth section. This exam would most likely be the option selected by ARB applicants for licensing as a civil engineer and does not include testing in air pollution.

California Environmental Protection Agenc
Air Resources Board

# AIR RESOURCES ENGINEER

Admin Agency Code: 7500 – Class Code: 3735 – Exam Code: 3PB06

| | |
|---|---|
| Department: | AIR RESOURCES BOARD |
| Opening Date: | 08/13/2013 |
| Final Filing Date: | CONTINUOUS |
| Type of Examination: | DEPARTMENTAL-OPEN |
| Salary: | $4,608.00 to $8,630.00<br>(See full ranges under Salary Information) |
| Tenure/Time-base: | Permanent Full-Time<br>Permanent Part-Time<br>Permanent Intermittent<br>Limited Term Full-Time<br>Limited Term Part-Time<br>Limited Term Intermittent |
| Exam Type | Statewide |

## EEO

An equal opportunity employer to all regardless of race, color, creed, national origin, ancestry, sex, marital status, disability, religious or political affiliation, age, or sexual orientation.

## DRUG-FREE STATEMENT

It is an objective of the State of California to achieve a drug-free State work place. Any applicant for State employment will be expected to behave in accordance with this objective, because the use of illegal drugs is inconsistent with the law of the State, the rules governing civil service, and the special trust placed in public servants.

## WHO SHOULD APPLY?

Applicants who meet the Minimum Qualifications as stated on this bulletin may apply for and take this Training and Experience Evaluation Examination at any time.

Once you have taken the Training and Experience Evaluation, you may not retake it for 12 months.

## FILING INSTRUCTIONS

**Final Filing Date:** Continuous

**Where to Apply:** Click the link at the bottom of this bulletin.

## SPECIAL TESTING ARRANGEMENTS

If you have a disability and need special assistance or special testing arrangements, contact the California Department of Human Resources (CalHR), Examination Services at (866) 844-8671, or via the California Relay Service for the Deaf or Hard of Hearing at (800) 735-2929 from TTY Phones and (800) 735-2922 from voice phones.

## SALARY INFORMATION

Monthly Ranged Salary:
Base Salary Range A – $4,608.00 to $5,494.00
Base Salary Range B – $5,276.00 to $6,601.00
Base Salary Range C – $6,504.00 to $8,136.00
Base Salary Range D – $6,897.00 to $8,630.00

## Eligible List Information

An open, merged eligible list will be established by the California Department of Human Resources for use by Air Resources Board. The names of successful competitors will be merged onto the eligible list in order of final score regardless of test date. Eligibility expires 12 months after it is established. Competitors must then retake the Training and Experience Evaluation to reestablish eligibility.

## Requirements for Admittance to the Examination

**NOTE:** All applicants must meet the education and/or experience requirements as stated on this examination bulletin as of the date the test is taken.

## Minimum Qualifications

**EDUCATION:** Equivalent to graduation from a curriculum accredited by the Accreditation Board for Engineering and Technology with major work in environmental, chemical, sanitary, civil, mechanical, air resources, or a related engineering field. (Registration as a senior in such a curriculum will admit the applicant to the examination, but the applicant must produce evidence of graduation before becoming eligible for appointment.) (Possession of a valid certificate as an engineer-in-training as issued by the California State Board of Registration for Professional Engineers may be substituted for the required education.)

## Position Description

An Air Resources Engineer performs field and office engineering duties related to air pollution programs; conducts investigations, inspections, and studies; prepares surveys and reports; designs electrical instrumentation; drafts and develops control systems instrumentation, tests and methods for measurement of air pollution and emissions of air contaminants; advises and consults with Federal, State, and local agencies involved in air pollution control, often involving extensive public and professional contacts; and may act as an expert witness in Board or court action.

## Examination Information

**TRAINING AND EXPERIENCE EVALUATION – Weighted 100%**

The examination will consist solely of a Training and Experience Evaluation. To obtain a position on the eligible list, a minimum score of 70% must be received. An applicant will receive his/her score upon completion of the Training and Experience Evaluation process.

**Click here to preview the Training and Experience Evaluation.**

## Knowledge and Abilities

Knowledge of:

1. Statistical analysis methods and techniques to interpret and understand air quality data.
2. Scientific research principles and methods to ensure the integrity and validity of collected data.
3. The principles of engineering, biology, chemistry, natural sciences, meteorology, and/or physics pertaining to air pollution to understand air quality data.
4. Problem-solving techniques and processes to facilitate the identification and resolution of issues related to the completion of work assignments.
5. Time management techniques to provide for efficient prioritization and completion of projects and assignments.

Ability to:

1. Review and interpret scientific and technical reports to make recommendations based upon documented data and information.
2. Identify and organize information obtained from research and data-gathering to evaluate

relevance.

3. Perform mathematical computations to conduct test procedures, analyze data, and/or produce results.
4. Analyze and reconcile discrepancies in data to extract or identify key issues and draw conclusions.
5. Read and evaluate written documents of varying complexity to learn, understand and/or clarify information pertaining to local State and federal programs.
6. Write and edit memos, reports, regulations, procedures, and letters for proper content, format, grammar, punctuation, and sentence structure to ensure quality and provide information.
7. Provide input and advice to others on appropriate courses of action to address given situations.
8. Identify and reconcile discrepancies in data and information pertaining to program/project activities to ensure valid conclusions.
9. Comprehend and interpret complex information and materials, including standards, procedures, and policies to apply work assignments.
10. Write clear and concise explanations of the contents of technical materials, (e.g., journals, regulations, procedures) to provide information for audiences with varying levels of expertise.
11. Work independently on projects or assignments as directed to complete the work of Air Resources Board programs.
12. Participate in and contribute to the effectiveness of a group or team to ensure cooperation.
13. Use word processing software to develop and format written documents, such as memos, letters, and reports.
14. Use spreadsheet software to organize and present tables, graphs, and charts.
15. Use presentation software to communicate to audiences.
16. Deliver oral presentations to audiences of varying levels of understanding to convey information.
17. Establish and maintain cooperative working relationships with staff, management, and stakeholders to efficiently and effectively carry out assignments.
18. Negotiate deadlines and timeframes to deliver products or services.
19. Be flexible to changes in priorities, assignments, and other interruptions to adapt to pre-established timelines and courses of action.
20. Verbally communicate clearly, concisely, and appropriately for audiences with varying levels of understanding to effectively convey information.
21. Exercise sound judgment when making decisions to comply with program or work unit goals and objectives.
22. Analyze situations or problems to determine and implement appropriate courses of action.
23. Remain fair and unbiased to demonstrate Air Resources Board neutrality.
24. Gain knowledge and skills through participation in organized training and/or independent study to enhance knowledge of job related functions and/or meet mandated requirements.

## VETERANS' PREFERENCE POINTS

Veterans' Preference Points will be added to the final score of all competitors who are successful in this examination, and who qualify for, and have requested, these points through the California Department of Human Resources. Due to changes in the law, effective January 1, 1996, veterans who have achieved permanent civil service status are not eligible to receive Veterans' Preference Points.

## CAREER CREDITS

Career Credits **will not** be added to the final score for this exam, because it does not meet the requirements to qualify for Career Credits.

## CONTACT INFORMATION

If you have any ***technical*** questions concerning this examination bulletin, please contact:

**California Department of Human Resources**
Attn: Examination Services
1810 16th Street, North Bldg Ste. 522n

# Air Resources Engineer

## California State Personnel Board Specification

- **Schematic Code:** IA84
- **Class Code:** 3735
- **Established:** 12/15/1977
- **Revised:** 01/08/1997
- **Title Changed:** --

## Definition

Under supervision, incumbents solve air pollution control problems using engineering skills expertise.

## Distinguishing Characteristics

Range A is the entry and first working level. Incumbents perform less difficult air pollution engineering work or motor vehicle pollution control engineering work under close supervision.

Range B is the intermediate working level at which the incumbent performs and assists higher level staff in air pollution-related engineering work of average difficulty.

Range C is the full (nonregistered) journeyperson level. Incumbents perform difficult air pollution engineering work or motor vehicle pollution control engineering work.

Range D is the full (registered) journeyperson level. Incumbents perform the full range of the more difficult professional air pollution-related work and motor vehicle pollution control engineering work for the Air Resources Board.

## Typical Tasks

Incumbents perform field and office engineering duties related to air pollution programs; conduct investigations, inspections, and studies; prepare surveys and reports; design electrical instrumentation; draft and develop control systems instrumentation, tests, and methods for measurement of air pollution and emissions of air contaminants; advise and consult with Federal, State, and local agencies involved in air pollution control, often involving extensive public and professional contacts; and may act as expert witnesses in Board or court action.

## Minimum Qualifications

Education: Equivalent to graduation from a curriculum accredited by the Accreditation Board for Engineering and Technology with major work in environmental, chemical, electrical, sanitary, civil, mechanical, air resources, or a related engineering field. (Registration as a senior in such a curriculum will admit the applicant to the examination, but the applicant must produce evidence of graduation before becoming eligible for appointment.) (Possession of a valid certificate as an engineer-in-training as issued by the California State Board of Registration for Professional Engineers may be substituted for the required education.)

## Knowledge and Abilities

Knowledge of: Engineering principles relating to air resources; engineering sciences and mathematics; instrumentation, methods, and techniques of air sampling and determination of physical and chemical characteristics; pollutants; factors contributing to air pollution in metropolitan areas and available control measures; design and operation of air monitoring stations; scientific computer programming/modeling applications; air pollution control measures, laws, and regulations in California; problems of industrial waste disposal and refuse disposal; factors involved in the control of vehicular and stationary source emissions from internal combustion sources; mechanical, chemical, and electrical engineering as applied to testing and evaluating automotive exhaust control devices; analysis, development, design, optimization, operation, testing, and maintenance of control systems as related to air pollution

control; meteorology as related to air pollution; theory, practices, and methods used in engineering work as related to air pollution control; design and use of atmospheric pollution control devices and surveillance instruments, statistical techniques employed in the analysis of air pollution and meteorological data; economic and health effects of the discharge of pollutants into the atmosphere.

Ability to: Analyze, review, check, and interpret air pollution control engineering plans, test data, estimates, and specifications; develop and adapt instrumentation and operating procedures for automotive engine and exhaust control device testing; plan and carry out comprehensive automotive engineering studies and investigations; interpret and apply laws, rules, and regulations pertaining to air pollution in California; design, develop, and adapt instrumentation and operating procedures for air monitoring stations and other air quality measuring complexes; calibrate complex air monitoring equipment; apply computer programming and modeling skills; conduct research and special studies on, and make recommendations for, the elimination or control of air pollution sources; assist in research work and in the analysis of technical information pertaining to automatic control systems; establish and maintain cooperative working relationships; communicate effectively, analyze situations accurately, and adopt an effective course of action; operate in a lead capacity for special studies and projects.

Updated 6/3/2012

ALTERNATE RANGE CRITERIA 37

Established 12/15/77

Revised 9/17/96

Range A. This range shall apply to persons who do not meet the criteria for Range B, Range C, or Range D.

Range B. This range shall apply to persons who have satisfactorily completed either: (1) one year in the California State service performing air pollution engineering work comparable in level, duties, and responsibilities to an Air Resources Engineer, Range A; or (2) two years of experience in air pollution Resources Engineer, Range A; or (3) a Master's Degree in Engineering.

Range C. This range shall apply to persons who have satisfactorily completed either: (1) two years of experience in the California State service performing air pollution engineering work comparable in level, duties, and responsibilities to an Air Resources Engineer, Range B; or (2) three years of increasingly responsible experience performing air pollution engineering work in a position comparable in level, duties, and responsibilities to an Air Resources Engineer, Range B; and education equivalent to graduation from college with major work in engineering. (Possession of a Doctorate Degree in Engineering may be substituted for two years of experience; possession of a Master's Degree in Engineering may be substituted for one year of experience.)

Range D. This range shall apply to persons who possess a valid certificate of registration as a professional engineer issued by the California State Board of Registration for Professional Engineers.

When the requirements for the particular criteria are met and upon recommendation of the appointing power, the employee shall receive a rate under the provisions of DPA Rule 599.676.

STATE OF CALIFORNIA
CALIFORNIA AIR RESOURCES BOARD

# SUPPLEMENTAL APPLICATION EXAMINATION

## AIR POLLUTION SPECIALIST

## AIR RESOURCES ENGINEER

## QUESTIONNAIRE

(Revised October 2011)

**IT IS EXTREMELY IMPORTANT THAT YOU COMPLETE YOUR CANDIDATE INFORMATION BELOW.**

| | | |
|---|---|---|
| **Applicant's Name (Last)** | **(First)** | **(M.I.)** |
| **Social Security Number** | **Easy ID** | |
| **Home Phone #** | **Cell Phone #** | **Work Phone #** |
| **E-Mail Address** | | |

►►►►► **DO NOT REMOVE THIS COVER SHEET FROM BOOKLET** ◄◄◄◄◄

If you were dismissed and do not have permission from the State Personnel Board to take this examination, STOP HERE!!

RULE 211: Provides that a dismissed State employee may only participate in State civil service examinations if she/he has obtained prior consent from the State Personnel Board.

►►►►► DO NOT FOLD OR STAPLE THIS APPLICATION ◄◄◄◄◄

# MINIMUM EDUCATION/EXPERIENCE REQUIREMENTS

I. INDICATE DEGREE(S) OBTAINED FROM AN ACCREDITED COLLEGE/UNIVERSITY:

☐ Bachelor's Degree — Major: _____
- Completed — Graduation Date: _____
- In Progress — Anticipated Graduation Date: _____

☐ Master's Degree — Major: _____ Flag U1
- Completed — Graduation Date: _____
- In Progress — Anticipated Graduation Date: _____

☐ Doctorate Degree — Major: _____ Flag U0
- Completed — Graduation Date: _____
- In Progress — Anticipated Graduation Date: _____

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☐ Engineer-in-Training Certificate (EIT) # _____ Date Obtained: _____

☐ Two Years as an Air Resources Technician II Start Date: _____ through: _____

LIST ANY ADDITIONAL DEGREES

Major _____ Major _____

II. PLEASE IDENTIFY THE NAME AND LOCATION OF COLLEGE(S)/UNIVERSITIES YOU ATTENDED:

Bachelor's Degree was obtained at _____ City _____ State _____

Master's Degree was obtained at _____ City _____ State _____

Doctorate Degree was obtained at _____ City _____ State _____

# SPECIFIC RELATED EDUCATION/EXPERIENCE INFORMATION

## III. IDENTIFY YOUR MAJOR(S) OBTAINED (AS NOTED ON DIPLOMA):

| | | | |
|---|---|---|---|
| Flag UA | ☐ Automotive Technology | ☐ Fermentation Science | |
| | ☐ Agriculture Science | ☐ Food Service/Nutrition | |
| | ☐ Anatomy | ☐ Forensic Science | Flag UV |
| | ☐ Aquatic Biology | ☐ Forest Management | |
| | ☐ Astronomy | ☐ Geography (Physical) | |
| Flag UB | ☐ Atmospheric Science | ☐ Geology | |
| Flag UC | ☐ Biology | ☐ Genetics | |
| | ☐ Botany | ☐ Health Risk Assessment | Flag UW |
| Flag FX | ☐ Chemistry | ☐ Health Science and Safety | |
| Flag F8 | ☐ Computer Science | ☐ Hydrology | |
| | ☐ Dairy Husbandry | ☐ Industrial Toxicology | Flag UX |
| | ☐ Earth Science | ☐ Industrial Hygiene | |
| Flag UD | ☐ Ecology (Ecosystem) | ☐ Mathematics | Flag UY |
| Flag UE | ☐ Ecology & Systematic Biology | ☐ Medicine | |
| | ☐ Economics | ☐ Meteorology | Flag UZ |
| Flag WI | ☐ Engineering (Chemical) | ☐ Metallurgy | |
| Flag WF | ☐ Engineering (Civil) | ☐ Microbiology | Flag FW |
| Flag UL | ☐ Engineering (Computer) | ☐ Natural Resources | Flag VA |
| Flag WO | ☐ Engineering (Electrical) | ☐ Physics | Flag VB |
| Flag UM | ☐ Engineering (Electronics) | ☐ Physiology | Flag VD |
| Flag WG | ☐ Engineering (Environmental) | ☐ Plant Physiology | Flag E1 |
| Flag WK | ☐ Engineering (Mechanical) | ☐ Policy and Natural Resources | Flag VE |
| Flag VG | ☐ Engineering (Sanitary) | ☐ Soil Science | |
| Flag VH | ☐ Engineering Technology | ☐ Statistics | Flag VF |
| | ☐ Engineering (Other) | ☐ Textile Science | |
| Flag FY | ☐ Entomology | ☐ Toxicology | Flag JA |
| Flag UF | ☐ Environmental Biology | ☐ Wildlife Zoology | |
| Flag UG | ☐ Environmental Chemistry | ☐ | _____ |
| Flag UH | ☐ Environmental Health | ☐ _____ | |
| Flag UI | ☐ Environmental Policy Analysis & Planning | ☐ _____ | |
| Flag UJ | ☐ Environmental Science | ☐ _____ | |
| Flag UK | ☐ Environmental Studies | ☐ _____ | |
| Flag UU | ☐ Environmental Toxicology | | |

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## IV. HAVE COMPLETED COURSES AND/OR HAVE WORK EXPERIENCE IN:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Flag U2 | Public Speaking | ☐ Yes | ☐ No | Statistics | ☐ Yes | ☐ No | Flag US |
| Flag UQ | Word Processing | ☐ Yes | ☐ No | Engineering | ☐ Yes | ☐ No | Flag U8 |
| Flag U3 | Technical Writing | ☐ Yes | ☐ No | Leadership | ☐ Yes | ☐ No | Flag UR |
| Flag UP | Database Design | ☐ Yes | ☐ No | Project Management | ☐ Yes | ☐ No | Flag UT |
| Flag U6 | Petroleum Refining | ☐ Yes | ☐ No | Atmospheric Processes | ☐ Yes | ☐ No | Flag U7 |

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V. IDENTIFY COMPLETED COURSES AND/OR LENGTH OF WORK EXPERIENCE:

Preparing written reports. Flag U3

| | | | |
|---|---|---|---|
| Education: | ☐ Rarely | ☐ Occasionally | ☐ Regularly |
| Experience: | ☐ Rarely | ☐ Occasionally | ☐ Regularly |

Giving oral presentations. Flag U2

| | | | |
|---|---|---|---|
| Education: | ☐ Rarely | ☐ Occasionally | ☐ Regularly |
| Experience: | ☐ Rarely | ☐ Occasionally | ☐ Regularly |

Using a computer for any of the following: e-mail; internet; database; graphics; WP or spreadsheets. Flag VL

| | | | |
|---|---|---|---|
| Education: | ☐ None | ☐ 1 course | ☐ 2 or more courses |
| Experience: | ☐ None | ☐ 6 Months | ☐ More than 6 months |

In data review and analysis (e.g., data collection, data reporting, statistics). Flag X3

| | | | |
|---|---|---|---|
| Education: | ☐ None | ☐ 1 course | ☐ 2 or more courses |
| Experience: | ☐ None | ☐ 6 Months | ☐ More than 6 months |

In environmental related fields. Flag U7

| | | | |
|---|---|---|---|
| Education: | ☐ None | ☐ 1 course | ☐ 2 or more courses |
| Experience: | ☐ None | ☐ 6 Months | ☐ More than 6 months |

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VI. IDENTIFY THE NUMBER OF SEMESTER UNITS YOU HAVE COMPLETED:

*(NOTE: Refer to information regarding conversion of semester units on page iii.)*

That relates to the federal, state and local air pollution control laws and regulations (e.g., Federal Clean Air Act, National Environmental Policy Act [NEPA], Code of Federal Regulations [CFR], California Clean Air Act, California Environmental Quality Act [CEQA], California Code of Regulations [CCR], or local air pollution district regulations. Flag X2

☐ Zero units ☐ 1-6 units ☐ 7 or more units ☐ Other training

That relates to automotive technology which includes spark and compression cycle engines, their emissions and controls, and the laws and regulations governing them. Flag U9

☐ Zero units ☐ 1-6 units ☐ 7 or more units ☐ Other training

That relates to the California Air Toxic Program and/or California Motor Vehicle Control Program. Flag X2

☐ Zero units ☐ 1-6 units ☐ 7 or more units ☐ Other training

That relates to the measurement of atmospheric pollution levels, measurement of mobile or stationary source pollution, chemical and physical characteristics of air pollutants, and their impact on health and the environment, or principles of air quality management. Flag X1

☐ Zero units ☐ 1-6 units ☐ 7 or more units ☐ Other training

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VII. IDENTIFY SPECIFIC NAME OF COMPLETED COURSES IN:

Upper division and graduate level courses you have taken in chemistry or statistics. Flag US

Education: ☐ None ☐ 1 course ☐ 2 or more courses

List Course(s): _____ _____

_____ _____

_____ _____

_____ _____

_____ _____

Other courses or formal training in chemistry, statistics, environmental sampling, or similar areas which you have completed (e.g., ACS, AOAC, or AWMA short courses; University Extension courses; or, instrument training). Flag X1

Education: ☐ None ☐ 1 course ☐ 2 or more courses

List Course(s): _____ _____

_____ _____

_____ _____

_____ _____

_____ _____

VIII. INDICATE THE LENGTH OF WORK EXPERIENCE YOU HAVE:

In an analytical chemistry laboratory performing production analyses. Flag X1

☐ None ☐ Less than 1 year ☐ 1-5 years ☐ More than 5 years

Please describe: _____

_____

_____

_____

_____

Developing methods of chemical analysis. Flag X1

☐ None ☐ Less than 1 year ☐ 1-5 years ☐ More than 5 years

Please describe: _____

_____

_____

_____

_____

Monitoring pollutant levels in ambient air or collecting air samples. Flag X1

☐ None ☐ Less than 1 year ☐ 1-5 years ☐ More than 5 years

Please describe: _____

_____

_____

_____

_____

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Collecting stack gas samples. Flag X1

☐ None ☐ Less than 1 year ☐ 1-5 years ☐ More than 5 years

Please describe: _____

Developing sampling or monitoring methods (e.g., writing standard operating procedures). Flag X1

☐ None ☐ Less than 1 year ☐ 1-5 years ☐ More than 5 years

Please describe: _____

Analyzing environmental data. Flag X3

☐ None ☐ Less than 1 year ☐ 1-5 years ☐ More than 5 years

Please describe: _____

Designing, conducting, or evaluating data quality control and quality assurance programs or activities. Flag X3

☐ None ☐ Less than 1 year ☐ 1-5 years ☐ More than 5 years

Please describe: _____

Performing extensive fieldwork involving overnight travel. Flag --

☐ None ☐ Less than 1 year ☐ 1-5 years ☐ More than 5 years

Please describe: _____

In laboratory data management (e.g., LIMS), PC and server hardware and software. Flag VJ

☐ None ☐ Less than 1 year ☐ 1-5 years ☐ More than 5 years

Please describe: _____

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With an air pollution control district or air quality management district. Flag –

Experience: ☐ None ☐ Less than 1 year ☐ 1-5 years

Please describe: _____

As a Student Assistant/Intern/Volunteer with the Air Resources Board performing air pollution control duties. Flag --

Experience: ☐ None ☐ Less than 1 year ☐ 1-5 years

Please describe: _____

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☞ PLEASE REVIEW YOUR RESPONSES THOROUGHLY BEFORE YOU PROCEED.

☞ READ THE INSTRUCTIONS CAREFULLY BEFORE YOU ANSWER THE FOLLOWING QUESTIONS REGARDING YOUR WORK EXPERIENCE (PAID AND/OR VOLUNTARY).

☞ COMPLETION OF THE FOLLOWING QUESTIONS IS MANDATORY. YOUR RESPONSES WILL BE MADE AVAILABLE TO HIRING SUPERVISORS/MANAGERS.

## WORK EXPERIENCE

PLEASE INDICATE THE LENGTH OF YOUR EXPERIENCE IN THE FOLLOWING AREAS:

1. Air quality modeling. Flag U7
   ☐ None ☐ Less than 1 year ☐ More than 1 year
2. Air pollution planning. Flag X2
   ☐ None ☐ Less than 1 year ☐ More than 1 year
3. Air quality research. Flag U7
   ☐ None ☐ Less than 1 year ☐ More than 1 year
4. Calibration and maintenance of emissions or electronic test equipment. Flag X1
   ☐ None ☐ Less than 1 year ☐ More than 1 year
5. Enforcement of environmental laws and regulations. Flag X2
   ☐ None ☐ Less than 1 year ☐ More than 1 year
6. Enforcement of mobile and/or stationary source pollution control regulations. Flag X2
   ☐ None ☐ Less than 1 year ☐ More than 1 year
7. Measurement of atmospheric conditions. Flag X1
   ☐ None ☐ Less than 1 year ☐ More than 1 year
8. Measurement of mobile and/or stationary sources. Flag X1
   ☐ None ☐ Less than 1 year ☐ More than 1 year
9. Preparation or edit of technical reports. Flag U3
   ☐ None ☐ Less than 1 year ☐ More than 1 year
10. Preparation and review of environmental impact reports/studies. Flag U3
    ☐ None ☐ Less than 1 year ☐ More than 1 year
11. Preparation, review and promulgation of environmental laws or regulations. Flag X2
    ☐ None ☐ Less than 1 year ☐ More than 1 year
12. Review, analyze and comment on environmental legislation. Flag X2
    ☐ None ☐ Less than 1 year ☐ More than 1 year
13. Design mobile or stationary source emission control system. Flag U8
    ☐ None ☐ Less than 1 year ☐ More than 1 year
14. Design of an air-monitoring instrument. Flag U8
    ☐ None ☐ Less than 1 year ☐ More than 1 year
15. Design of a sampling system for vehicle exhaust. Flag U8
    ☐ None ☐ Less than 1 year ☐ More than 1 year
16. Design of an ambient air-monitoring site that meets state and federal requirements. Flag U8
    ☐ None ☐ Less than 1 year ☐ More than 1 year
17. Review of environmental reports (noise studies, air studies, traffic studies, negative declarations, environmental impact reports, etc.). Flag X2
    ☐ None ☐ Less than 1 year ☐ More than 1 year

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## WORK EXPERIENCE (Cont.)

18. Assessed new technology such as on-board diagnostics for motor vehicles. Flag U9
☐ None ☐ Less than 1 year ☐ More than 1 year

19. Operating a mobile air monitoring station. Flag X1
☐ None ☐ Less than 1 year ☐ More than 1 year

20. Read and interpreted electronic schematics. Flag U8
☐ None ☐ Less than 1 year ☐ More than 1 year

21. Calculated the amount of particulate matter emissions from an air pollution source. Flag X3
☐ None ☐ Less than 1 year ☐ More than 1 year

22. Calculated the concentration of a specific hydrocarbon using gas chromatography. Flag X1
☐ None ☐ Less than 1 year ☐ More than 1 year

23. Used statistical methods to determine the relationship of multiple data sets. Flag US
☐ None ☐ Less than 1 year ☐ More than 1 year

24. Designed, constructed or serviced an air pollution analyzer. Flag U8
☐ None ☐ Less than 1 year ☐ More than 1 year

25. Collected data to determine the origin and destination of a specific air pollutant. Flag U7
☐ None ☐ Less than 1 year ☐ More than 1 year

26. Analyzed the effects of a congested roadway on air quality. Flag X3
☐ None ☐ Less than 1 year ☐ More than 1 year

27. Analyzed the effect of traffic operations on vehicle emission concentrations. Flag X3
☐ None ☐ Less than 1 year ☐ More than 1 year

28. Designed an emissions control system using absorption, condensation or incineration. Flag U8
☐ None ☐ Less than 1 year ☐ More than 1 year

29. Used a particle-sized cascade impactor. Flag X1
☐ None ☐ Less than 1 year ☐ More than 1 year

30. Analyzed the efficiency of cyclones or inertial separators. Flag U8
☐ None ☐ Less than 1 year ☐ More than 1 year

31. Analyzed or developed solutions for a specific air quality problem. Flag X2
☐ None ☐ Less than 1 year ☐ More than 1 year

32. Worked with computer models (e.g., traffic forecasting, air quality, emissions, cost analysis). Flag VJ
☐ None ☐ Less than 1 year ☐ More than 1 year

33. Developed charts or graphs to depict numerical data. Flag VK
☐ None ☐ Less than 1 year ☐ More than 1 year

34. Used stack sampling equipment. Flag X1
☐ None ☐ Less than 1 year ☐ More than 1 year

35 Performed visual emissions evaluations. Flag X1
☐ None ☐ Less than 1 year ☐ More than 1 year

36. Calculated and explained the conversion of ambient air concentrations from grams per cubic foot to parts per million or other. Flag X3
☐ None ☐ Less than 1 year ☐ More than 1 year

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## WORK EXPERIENCE (Cont.)

37. Diagnosed and/or repaired air monitoring or pollution test/control equipment. Flag X1
☐ None ☐ Less than 1 year ☐ More than 1 year

38. Prepared a project requiring knowledge of pollution transport. Flag U7
☐ None ☐ Less than 1 year ☐ More than 1 year

39. Evaluated the air quality effect(s) of disposal or treatment of hazardous waste, municipal solid waste, or wastewater. Flag X2
☐ None ☐ Less than 1 year ☐ More than 1 year

40. Performed Air Resources Technician II responsibilities at the Air Resources Board. Flag --
☐ None ☐ Less than 1 year ☐ More than 1 year

## STUDENT ASSISTANT/INTERN/VOLUNTEER WORK EXPERIENCE

PLEASE INDICATE YOUR EXPERIENCE AS A:

41. Student Assistant/Intern with the Air Resources Board. Flag --
☐ None ☐ Less than 1 year ☐ More than 1 year

42. Student Assistant/Intern with an air pollution control district or air quality management district. Flag --
☐ None ☐ Less than 1 year ☐ More than 1 year

43. Student Assistant/Intern with other state agencies. Flag --
☐ None ☐ Less than 1 year ☐ More than 1 year

44. Student Assistant/Intern with a city, county or the federal government. Flag --
☐ None ☐ Less than 1 year ☐ More than 1 year

45. Student Assistant/Intern with a non-profit organization. Flag --
☐ None ☐ Less than 1 year ☐ More than 1 year

46. Student Assistant/Intern with industry. Flag --
☐ None ☐ Less than 1 year ☐ More than 1 year

47. Volunteer with the Air Resources Board. Flag --
☐ None ☐ Less than 1 year ☐ More than 1 year

48. Volunteer with an air pollution control district or air quality management district. Flag --
☐ None ☐ Less than 1 year ☐ More than 1 year

## COMPUTER SKILLS

PLEASE INDICATE YOUR EXPERIENCE WITH:

49. A personal computer. Flag --
☐ None ☐ Less than 1 year ☐ More than 1 year

50. Spreadsheet software (Excel®, Lotus®, Quatro Pro® or others). Flag VL
☐ None ☐ Less than 1 year ☐ More than 1 year

51. Database software (dBASE®, FoxPro®, Access®, or others). Flag VJ
☐ None ☐ Less than 1 year ☐ More than 1 year

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## COMPUTER SKILLS (Cont.)

PLEASE INDICATE THE LENGTH OF YOUR EXPERIENCE WITH:

52. Communications software (ProComm® or others). Flag VI
☐ None ☐ Less than 1 year ☐ More than 1 year

53 Word processing software (MS Word®, WordPerfrect®, or others). Flag VM
☐ None ☐ Less than 1 year ☐ More than 1 year

54. Graphics software (Harvard Graphics®, Power Point®, or others). Flag VK
☐ None ☐ Less than 1 year ☐ More than 1 year

55. Project Management Software (MS Project®, PRIMAVERA®, Quicknet®, or others). Flag UT
☐ None ☐ Less than 1 year ☐ More than 1 year

## COMMUNICATION SKILLS

PLEASE INDICATE YOUR EXPERIENCE IN THE FOLLOWING AREAS:

56. Prepared Presentations. Flag U2
☐ None ☐ Less than 1 year ☐ More than 1 year

57. Given a presentation about a project in which you were involved. Flag U2
☐ None ☐ Less than 1 year ☐ More than 1 year

58. Explained and/or interpreted complex information (e.g., procedures, theories, or policies). Flag U2
☐ None ☐ Less than 1 year ☐ More than 1 year

59. Led and/or facilitated a group/team project. Flag UR
☐ None ☐ Less than 1 year ☐ More than 1 year

60. Prepared written instructions, manuals, and/or complex procedures. Flag VN
☐ None ☐ Less than 1 year ☐ More than 1 year

61. Collected data from a public utility or other public agency in the design of a project. Flag --
☐ None ☐ Less than 1 year ☐ More than 1 year

62. Acted in a customer service capacity where the duties involved responding to various questions and/or providing assistance to others, either in person and/or by telephone. Flag UR
☐ None ☐ Less than 1 year ☐ More than 1 year

63. Proofread and/or edited written reports. Flag U3
☐ None ☐ Less than 1 year ☐ More than 1 year

64. Participated in an organization that promotes speaking skills (e.g., Toastmasters®, etc). Flag U2
☐ None ☐ Less than 1 year ☐ More than 1 year

65. Recognized (by performance evaluation, letter of merit, or other written communication, etc.) for research writing skills and/or other report documents. Flag U3
☐ Yes ☐ No

66. Written and published an article or paper in a peer-reviewed technical or scientific journal. Flag U3
☐ Yes ☐ No

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## PROJECT/LEADERSHIP SKILLS

INDICATE YOUR EXPERIENCE IN THE FOLLOWING AREAS:

67. Called upon to make decisions in supervisor's absence. Flag UR
☐ Yes ☐ No

68. Completed a major long-term project on or ahead of time. Flag UT
☐ Yes ☐ No

69. Completed multiple assignments on time. Flag UT
☐ Yes ☐ No

70. Participated in the planning of a multi-day conference. Flag UT
☐ Yes ☐ No

71. Completed various projects independently. Flag UT
☐ None ☐ Less than 1 year ☐ More than 1 year

72. Devised an alternative plan (due to a setback) by prioritizing current workload in order to complete an assigned project in a timely manner. Flag UT
☐ None ☐ Less than 1 year ☐ More than 1 year

73. Managed a project with a rigid budget. Flag UT
☐ None ☐ Less than 1 year ☐ More than 1 year

74. Dealt with changing or conflicting customer demands. Flag UR
☐ None ☐ Less than 1 year ☐ More than 1 year

75. Responded to public officials requesting specific and/or sensitive confidential information. Flag UR
☐ None ☐ Less than 1 year ☐ More than 1 year

76. Developed written specifications. Flag VN
☐ None ☐ Less than 1 year ☐ More than 1 year

77. Prepared contract documents. Flag VN
☐ None ☐ Less than 1 year ☐ More than 1 year

78. Performed contract administration that involved monitoring contract compliance. Flag UT
☐ None ☐ Less than 1 year ☐ More than 1 year

79. Performed contract administration that involved formulating requests for proposals. Flag UT
☐ None ☐ Less than 1 year ☐ More than 1 year

80. Performed contract administration that involved evaluating contractor performance. Flag UT
☐ None ☐ Less than 1 year ☐ More than 1 year

81. Managed a project where accounting for time was necessary. Flag UT
☐ None ☐ Less than 1 year ☐ More than 1 year

82. Supervised/led the work of others. Flag UR
☐ None ☐ Less than 1 year ☐ More than 1 year

83. Served on a board, commission, or committee that made decisions on behalf of a group, (e.g., homeowners association, student government, social club, etc.). Flag UR
☐ None ☐ Less than 1 year ☐ More than 1 year

84. Planned, prioritized and/or scheduled the work of a group (e.g., volunteer, school group or athletic team). Flag UR
☐ None ☐ Less than 1 year ☐ More than 1 year

85. Primary responsibility for identifying or assessing quality of products or services to meet customer needs. Flag UR
☐ None ☐ Less than 1 year ☐ More than 1 year

## PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY BEFORE YOU PROCEED!

☞ THIS CONCLUDES THE AIR POLLUTION SPECIALIST PORTION OF THE SUPPLEMENTAL APPLICATION EXAMINATION.

- ✓ PLEASE RETURN THE COMPLETED SUPPLEMENTAL APPLICATION IN A 9 X 12 ENVELOPE. *(REMEMBER TO PROVIDE ADEQUATE POSTAGE)*
- ✓ RESULTS WILL BE MAILED IN APPROXIMATELY 4-6 WEEKS FROM THE CUT OFF DATE OF THE ADMINSITRATION FOR WHICH YOU SUBMITTED YOUR COMPLETED EXAMINATION MATERIALS.

☞ CANDIDATES ALSO COMPETING IN THE AIR RESOURCES ENGINEER EXAMINATION MUST PROCEED TO PAGE 15

NOTE: REGISTERED ENGINEERS MUST ALSO COMPLETE PAGE 16!!

## FOR AIR RESOURCES ENGINEER COMPETITORS

PLEASE INDICATE THE LENGTH OF YOUR EXPERIENCE I THE FOLLOWING AREAS:

86. Applied automotive engineering principles to test and evaluate the effectiveness of mobile source emissions controls. Flag U8
☐ None ☐ Less than 1 year ☐ More than 1 year

87. Determined the road load horsepower of a vehicle using an established method. Flag U8
☐ None ☐ Less than 1 year ☐ More than 1 year

88. Designed a landfill gas collection system. Flag U8
☐ None ☐ Less than 1 year ☐ More than 1 year

89. Designed a new technology such as electronic continuous emission monitoring system. Flag U8
☐ None ☐ Less than 1 year ☐ More than 1 year

90. Designed a system that monitors and manages vehicle emissions data. Flag U8
☐ None ☐ Less than 1 year ☐ More than 1 year

91. Analyzed and/or proposed solutions to control elevated air pollution levels. Flag U8
☐ None ☐ Less than 1 year ☐ More than 1 year

92. Designed a baghouse to control fine particulates in a gas stream. Flag U8
☐ None ☐ Less than 1 year ☐ More than 1 year

93. Evaluated the results of an emissions test using Federal Test Procedures. Flag U8
☐ None ☐ Less than 1 year ☐ More than 1 year

94. Determined the required dynamometer loading to test a specific vehicle. Flag U8
☐ None ☐ Less than 1 year ☐ More than 1 year

95. Prepared or edited engineering reports. Flag U3
☐ None ☐ Less than 1 year ☐ More than 1 year

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## PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY BEFORE YOU PROCEED!

☞ THIS CONCLUDES THE AIR RESOURCES ENGINEER SUPPLEMENTAL APPLICATION EXAMINATION.

- ✓ RETURN THE COMPETED SUPPLEMENTAL APPLICATION IN A 9 X 12 ENVELOPE. *(REMEMBER TO PROVIDE ADEQUATE POSTAGE)*
- ✓ RESULTS WILL BE MAILED IN APPROXIMATELY 4-6 WEEKS FROM THE CUT OFF DATE OF THE ADMINSITRATION FOR WHICH YOU SUBMITTED YOUR COMPLETED EXAMINATION MATERIALS.

☞ CANDIDATES WHO ARE REGISTERED AS PROFESSIONAL ENGINEERS MUST PROCEED TO PAGE 16.

NCEES
advancing licensure for engineers and surveyors

## Principles and Practice of Engineering
## CIVIL BREADTH and WATER RESOURCES and ENVIRONMENTAL DEPTH
## Exam Specifications

**Effective Beginning with the April 2008 Examinations**

- The civil exam is a breadth and depth examination. This means that examinees work the breadth (AM) exam and one of the five depth (PM) exams.
- The five areas covered in the civil examination are construction, geotechnical, structural, transportation, and water resources and environmental. The breadth exam contains questions from all five areas of civil engineering. The depth exams focus more closely on a single area of practice in civil engineering.
- Examinees work all questions in the morning session and all questions in the afternoon module they have chosen. Depth results are combined with breadth results for final score.
- The exam is an 8-hour open-book exam. It contains 40 multiple-choice questions in the 4-hour AM session, and 40 multiple-choice questions in the 4-hour PM session.
- The exam uses both the International System of Units (SI) and the US Customary System (USCS).
- The exam is developed with questions that will require a variety of approaches and methodologies, including design, analysis, and application. Some problems may require knowledge of engineering economics.
- The knowledge areas specified as examples of kinds of knowledge are not exclusive or exhaustive categories.
- The specifications for the **AM exam** and the **Water Resources and Environmental PM exam** are included here.

### CIVIL BREADTH Exam Specifications

| | | Approximate Percentage of AM Exam |
|---|---|---|
| I. | **Construction** | **20%** |

A. Earthwork Construction and Layout
   1. Excavation and embankment (cut and fill)
   2. Borrow pit volumes
   3. Site layout and control

B. Estimating Quantities and Costs
   1. Quantity take-off methods
   2. Cost estimating

C. Scheduling
   1. Construction sequencing
   2. Resource scheduling
   3. Time-cost trade-off

D. Material Quality Control and Production
   1. Material testing (e.g., concrete, soil, asphalt)

E. Temporary Structures
   1. Construction loads

## II. Geotechnical 20%

A. Subsurface Exploration and Sampling
   1. Soil classification
   2. Boring log interpretation (e.g., soil profile)

B. Engineering Properties of Soils and Materials
   1. Permeability
   2. Pavement design criteria

C. Soil Mechanics Analysis
   1. Pressure distribution
   2. Lateral earth pressure
   3. Consolidation
   4. Compaction
   5. Effective and total stresses

D. Earth Structures
   1. Slope stability
   2. Slabs-on-grade

E. Shallow Foundations
   1. Bearing capacity
   2. Settlement

F. Earth Retaining Structures
   1. Gravity walls
   2. Cantilever walls
   3. Stability analysis
   4. Braced and anchored excavations

## III. Structural 20%

A. Loadings
   1. Dead loads
   2. Live loads
   3. Construction loads

B. Analysis
   1. Determinate analysis

C. Mechanics of Materials
   1. Shear diagrams
   2. Moment diagrams
   3. Flexure
   4. Shear
   5. Tension
   6. Compression
   7. Combined stresses
   8. Deflection

D. Materials
   1. Concrete (plain, reinforced)
   2. Structural steel (structural, light gage, reinforcing)

E. Member Design
   1. Beams
   2. Slabs
   3. Footings

## IV. Transportation 20%

A. Geometric Design
   1. Horizontal curves
   2. Vertical curves
   3. Sight distance
   4. Superelevation
   5. Vertical and/or horizontal clearances
   6. Acceleration and deceleration

## V. Water Resources and Environmental 20%

A. Hydraulics – Closed Conduit
   1. Energy and/or continuity equation (e.g., Bernoulli)
   2. Pressure conduit (e.g., single pipe, force mains)
   3. Closed pipe flow equations including Hazen-Williams, Darcy-Weisbach Equation
   4. Friction and/or minor losses
   5. Pipe network analysis (e.g., pipeline design, branch networks, loop networks)
   6. Pump application and analysis

B. Hydraulics – Open Channel
   1. Open-channel flow (e.g., Manning's equation)
   2. Culvert design
   3. Spillway capacity
   4. Energy dissipation (e.g., hydraulic jump, velocity control)
   5. Stormwater collection (e.g., stormwater inlets, gutter flow, street flow, storm sewer pipes)
   6. Flood plains/floodways
   7. Flow measurement – open channel

C. Hydrology
   1. Storm characterization (e.g., rainfall measurement and distribution)
   2. Storm frequency
   3. Hydrographs application
   4. Rainfall intensity, duration, and frequency (IDF) curves
   5. Time of concentration
   6. Runoff analysis including Rational and SCS methods
   7. Erosion
   8. Detention/retention ponds

D. Wastewater Treatment
   1. Collection systems (e.g., lift stations, sewer networks, infiltration, inflow)

E. Water Treatment
   1. Hydraulic loading
   2. Distribution systems

## CIVIL–WATER RESOURCES and ENVIRONMENTAL Depth Exam Specifications

| | | Approximate Percentage of PM Exam |
|---|---|---|
| I. | **Hydraulics – Closed Conduit** | **15%** |
| | A. Energy and/or continuity equation (e.g., Bernoulli) | |
| | B. Pressure conduit (e.g., single pipe, force mains) | |
| | C. Closed pipe flow equations including Hazen-Williams, Darcy-Weisbach Equation | |
| | D. Friction and/or minor losses | |
| | E. Pipe network analysis (e.g., pipeline design, branch networks, loop networks) | |
| | F. Pump application and analysis | |
| | G. Cavitation | |
| | H. Transient analysis (e.g., water hammer) | |
| | I. Flow measurement – closed conduits | |
| | J. Momentum equation (e.g., thrust blocks, pipeline restraints) | |
| II. | **Hydraulics – Open Channel** | **15%** |
| | A. Open-channel flow (e.g., Manning's equation) | |
| | B. Culvert design | |
| | C. Spillway capacity | |
| | D. Energy dissipation (e.g., hydraulic jump, velocity control) | |
| | E. Stormwater collection including stormwater inlets, gutter flow, street flow, storm sewer pipes | |
| | F. Flood plain/floodway | |
| | G. Subcritical and supercritical flow | |
| | H. Flow measurement – open channel | |
| | I. Gradually varied flow | |
| III. | **Hydrology** | **15%** |
| | A. Storm characterization including rainfall measurement and distribution | |
| | B. Storm frequency | |
| | C. Hydrographs application | |
| | D. Hydrograph development and synthetic hydrographs | |
| | E. Rainfall intensity, duration, and frequency (IDF) curves | |
| | F. Time of concentration | |
| | G. Runoff analysis including Rational and SCS methods | |
| | H. Gauging stations including runoff frequency analysis and flow calculations | |
| | I. Depletions (e.g., transpiration, evaporation, infiltration) | |
| | J. Sedimentation | |
| | K. Erosion | |
| | L. Detention/retention ponds | |

## IV. Groundwater and Well Fields — 7.5%

A. Aquifers (e.g., characterization)
B. Groundwater flow including Darcy's Law and seepage analysis
C. Well analysis (steady flow only)
D. Groundwater control including drainage, construction dewatering
E. Water quality analysis
F. Groundwater contamination

## V. Wastewater Treatment — 15%

A. Wastewater flow rates (e.g., municipal, industrial, commercial)
B. Unit operations and processes
C. Primary treatment (e.g., bar screens, clarification)
D. Secondary clarification
E. Chemical treatment
F. Collection systems (e.g., lift stations, sewer network, infiltration, inflow)
G. National Pollutant Discharge Elimination System (NPDES) permitting
H. Effluent limits
I. Biological treatment
J. Physical treatment
K. Solids handling (e.g., thickening, drying processes)
L. Digesters
M. Disinfection
N. Nitrification and/or denitrification
O. Operations (e.g., odor control, corrosion control, compliance)
P. Advanced treatment (e.g., nutrient removal, filtration, wetlands)
Q. Beneficial reuse (e.g., liquids, biosolids, gas)

## VI. Water Quality — 15%

A. Stream degradation (e.g., thermal, base flow, TDS, TSS, BOD, COD)
B. Oxygen dynamics (e.g., oxygenation, deoxygenation, oxygen sag curve)
C. Risk assessment and management
D. Toxicity
E. Biological contaminants (e.g., algae, mussels)
F. Chemical contaminants (e.g., organics, heavy metals)
G. Bioaccumulation
H. Eutrophication
I. Indicator organisms and testing
J. Sampling and monitoring (e.g., QA/QC, laboratory procedures)

## VII. Water Treatment — 15%

A. Demands
B. Hydraulic loading
C. Storage (raw and treated water)
D. Sedimentation
E. Taste and odor control
F. Rapid mixing
G. Coagulation and flocculation

H. Filtration
I. Disinfection
J. Softening
K. Advanced treatment (e.g., membranes, activated carbon, desalination)
L. Distribution systems

**VIII. Engineering Economics** **2.5%**

A. Life-cycle modeling
B. Value engineering and costing