



Confirmatory Exam Program Requirements Water Resources Engineering

Water Resources Engineering Technical Exams. You must choose three of your four exams from the Water Resources Engineering Technical Exam list. Two of these exams must be from Group A and one from Group B listed below.

Water Resources Engineering Technical Exams			
Group A		Group B	
07-WRSE-A1	Water Quality & Management	07- WRSE-B1	Geomorphology & Pleistocene Geology (18-Geol-B4)
07- WRSE-A2	Engineering Hydrology (16-Civ-B4)	07- WRSE-B2	Numerical Methods
07- WRSE-A3	Soil Mechanics & Groundwater	07- WRSE-B3	Water Supply and Waste Water Treatment (16-Civ-B5)
07- WRSE-A4	Hydraulics Engineering (16-Civ-A5)	07- WRSE-B4	Open Channel Hydraulics
07- WRSE-A5	Water Resources Planning & Systems	07- WRSE-B5	Limnology
07- WRSE-A6	Municipal and Environmental Engineering (16-Civ-A3)	07- WRSE-B6	Contaminant Transport (18-Env-B3)
07-WRSE-A7	Select <u>ONE</u> from	07- WRSE-B7	Coastal Engineering
	07-WRSE-A7-1 Irrigation, Drainage & Erosion Control (04-Agri-B6)	07- WRSE-B8	River Engineering
	07-WRSE-A7-2 Geomatics (07-Tra-B10)	07- WRSE-B9	Modelling of Surface Water Quality
		07- WRSE-B10	Risk Management in Water Resources
		07- WRSE-B11	Principles of Environmental Engineering (18-Env-A1)
		07- WRSE-B12	Environmental Assessment and Management Systems (18-Env-B1)

Complementary Studies. You must also choose one exam from the Complementary Studies below.

Complementary Studies	
11-CS-1	Engineering Economics
11-CS-2	Engineering in Society – Health & Safety
11-CS-3	Sustainability, Engineering and the Environment
11-CS-4	Engineering Management



PEO'S TECHNICAL EXAMINATION PROGRAMS

WHY A TECHNICAL EXAM PROGRAM?

The academic requirement for licensing as a professional engineer in Ontario is a bachelor's degree in engineering from an accredited program at a Canadian university or its equivalent.

The Canadian Engineering Accreditation Board (CEAB) accredits undergraduate engineering degree programs on behalf of the provincial/territorial engineering associations/order, including PEO.

Applicants who do not hold a bachelor's degree in engineering from a CEAB-accredited program may be required to pursue either PEO's *Confirmatory* or *Specific* exam program to demonstrate that they possess the equivalent academic background for licensing purposes.

PEO's TECHNICAL EXAM PROGRAMS *Confirmatory Exam Program (CEP)*. Applicants whose undergraduate Bachelor's engineering degree was obtained via a program that appears to be similar to the respective CEAB-accredited program are usually assigned a Confirmatory Exam Program, which consists of four exams. The intent is to give the applicant an opportunity to demonstrate that s/he has an academic preparation that is deemed to be equivalent to that of a graduate of a CEAB-accredited program.

***Specific Exam Program (SEP)*.** If PEO's assessment reveals that an applicant's academic qualifications are below the established Canadian standard, s/he will be assigned a Specific Exam Program aimed to remedy identified deficiencies for licensing purposes. A Specific Exam Program may consist of Basic Studies exams, discipline-specific exams, Complementary Studies exams and a thesis.

Basic Studies exams are a prerequisite and must be addressed first; PEO will re-evaluate the applicant's file following the successful completion of all Basic Studies exams and may modify the original exam program, and advise the applicant of the options available to address any outstanding exams.

TIME LIMITS FOR WRITING EXAMS

PEO's technical exams are offered twice annually (in May and December).

Applicants must write at least one exam within two academic years following the date of receipt of their exam program notification. Once the exam program is commenced, the applicant must write at least one exam each academic year or the file will be closed. All exam programs must be successfully completed within eight academic years of the date that the applicant was notified of his/her exam program. ("Academic Year" means the period starting September 1 in a year and ending August 31 in the following year.)

HAVING THE FILE CLOSED

An application file will be closed if any one of the following conditions applies:

- not completing all exam requirements within the specified time limit;
- not writing at least one exam in each academic year after writing the first exam;
- failing the same exam on three attempts;
- failing a total of five exams;
- failing two Basic Studies exams; or
- failing to write a failed exam within one academic year for CEP.

PERFORMANCE STANDARDS

The pass mark for all PEO exams is 50%.

Confirmatory Exam Program. An applicant will be considered to have successfully completed the CEP if the average of the technical exam marks is at least 55% and a pass mark (at least 50%) was received on the Complementary Studies exam.

If an applicant fails two exams or fails the same exam twice in a CEP, s/he may be assigned a Failed-to-Confirm exam program, which may consist of additional exams in the Basic Studies, discipline-specific and Complementary Studies categories.

GOOD-PERFORMANCE REVIEW POLICY

Confirmatory Exam Program. To meet the "good-performance" review criterion, an applicant must have written two technical exams at the first sitting and achieved a minimum average of 65% with no mark below 60%.

After a second exam sitting, if an applicant has passed three technical exams with no mark below 60%, s/he may receive consideration for exemption from writing the Complementary Studies exam. If an applicant attempted two exams in the first sitting but failed one, s/he may still qualify for a "good-performance" review if s/he passes the failed exam with a mark of 70% or higher and achieves 60% or higher on the previously unwritten technical exam attempted at the second sitting.

Important: If an applicant has been assigned a **Directed Confirmatory Exam Program**, the good performance criteria are different; to be eligible, in addition to meeting the above criteria, all the directed exams must be addressed as well. Applicants are advised to contact the Exam Centre to discuss further.

Note:

- Good-Performance reviews are not applicable to Specific Exam Program and Failed-to-Confirm exam program applicants.

WHEN AND WHERE PEO EXAMS ARE OFFERED

PEO technical exams are held in May and December at 14 centres in Ontario. Exams are usually offered over a five-day period.

Registration packages to write are mailed in January for the May sitting and in July for the December sitting.

If the technical exam package is not received by the times indicated above, applicants should call the Exam Centre.

PROCUREMENT OF TEXTS AND OTHER MATERIALS FOR AN EXAM

To help in the procurement of all the suggested technical text books Contact customer service of Login Brothers at orders@lb.ca, through the website www.lb.ca or 1-800-665-1148 to assist you. It is recommended to always purchase the latest edition of any suggested textbook.

If an applicant does not have the current text listing or the text(s) is out of print, the applicant is advised to contact the Exam Centre (see below).

Recent written exams (i.e., reprints) are available on-line at PEO's website at www.peo.on.ca for free download. These past exams are available to provide the applicant with knowledge of the exam format, etc. The answers/solutions of past exams are not available at PEO.



PEO'S TECHNICAL EXAMINATION PROGRAMS

EXAM FEES

All Exam Fees are non-refundable.

First Exam Fee	\$700
Each Subsequent Exam Fee	\$200
Submission of an Engineering Thesis	\$360

COURSES-IN-LIEU

For all course(s)-in-lieu of PEO exam(s), applicants must get prior approval from PEO. A request must be in writing and should include a description of the proposed university calendar course and should be submitted at least two months in advance of the course's registration deadline.

Applicants must arrange for the official grade report(s) to be forwarded to the Licensing and Registration Department upon the completion of the course(s).

NOTE: *Courses-in-lieu are not acceptable for:*

- **Basic Exams,**
- **Confirmatory Exams,**
- **Directed Confirmatory Exams,**
- **Failed exams**

EXAM CENTRES

Exams are offered annually in May and December at the following centres in Ontario:

Belleville	London	Sudbury
Chalk River	Ottawa	Thunder Bay
Hamilton	Peterborough	Toronto
Kingston	Sarnia	Windsor
Kirkland Lake	St. Catharines	

The timetable information and exact location of exams are posted on PEO's website early in April to applicants writing exams in May, and early in November for those writing in December.

Applicants living inside Ontario must write at an Ontario centre. One of the centres listed may be selected. Applicants living outside Ontario may make special arrangements to write outside Ontario or Canada. Call the Exam Centre for further instructions if special arrangements are required.

ADDITIONAL INFORMATION

Order of exams. Basic Studies exams are a prerequisite and must be written first. Following the successful completion of all Basic Studies exams, applicants may write the remaining exams in any order. However, it is recommended that exams in less-advanced subjects be written first. Passing an exam in an advanced subject does not merit credit for a less-advanced subject.

English Language Skills. An acceptable level of English—both written and spoken—is required to practise engineering and to successfully complete PEO exams. If an applicant needs to improve English language skills, s/he should contact one of the many English as a Second Language Programs run by schools and community organizations throughout Ontario.

Penalties. Using notes or other aids in an exam where these are not allowed is strictly forbidden. Applicants caught doing so will have their paper confiscated and risk having their licence application withdrawn.

Exam Results. Exam results are normally mailed within 45 working days following writing of the exam. No results will be given over the telephone or in person at PEO office. Exam papers will not be returned to applicants and answers are not available. Failed exams are automatically re-read. However, applicants may request a formal re-read

of an exam paper. A non-refundable fee of \$330 is charged in the event a formal re-read is requested by an applicant. Requests for a re-read must be received within 30 days after an applicant has been notified of the exam mark.

Reapplying After A File Has Been Closed. If a file has been closed, an applicant may reapply with the understanding that the regulations and policies in effect at the time of the new application will be enforced.

An application for licence fee and all other associated fees will be required.

If a file was closed for poor academic performance, the applicant may be required to show that s/he has taken course(s) in the subject(s) covered by any failed exam(s).

All recorded failed exams from a previous application must be successfully addressed before an applicant will be allowed to pursue the new program.

WORKING IN ENGINEERING BEFORE LICENSURE

Applicants may work in engineering provided a licensed professional engineer takes responsibility for the work. It is illegal to use the title "professional engineer" or any variation thereof (project engineer, systems engineer, etc.) as an occupational or business title that might lead to the belief that a person is a licensed professional engineer.

NEED MORE INFORMATION?

For more information about licensing/registration requirements, please contact:

Licensing and Registration Department
Professional Engineers Ontario
40 Sheppard Avenue West, Suite 101
Toronto, ON M2N 6K9
Tel: (416) 224-1100 / 1-800-339-3716
Fax: (416) 224-8168 / 1-800-268-0496
<http://www.peo.on.ca>

PEO'S CONFIRMATORY EXAMINATION PROGRAM

Confirmatory Exam Program (CEP)

PEO's *Confirmatory Exam Program* (CEP) consists of three technical exams in the applicant's engineering discipline and a *Complementary Studies* exam.

- This program must be completed within eight academic years following the date of receipt of the exam program notification. ("Academic Year" means the period starting September 1 in a year and ending August 31 in the following year.)
- Applicants will have successfully completed the *Confirmatory Exam Program* if the average of their three technical exams is at least 55% with no mark below 50% and they achieve a pass (50%) on the *Complementary Studies* exam.
- To qualify for the good performance review, applicants must address all the directed exams, if the applicant is assigned a *Directed Confirmatory Exam Program*

Good-Performance review for CEP applicants may be warranted as follows:

- Applicants who pass any two technical exams at their first sitting, with a minimum average of 65% and with no mark below 60%, may be exempted from completing the remaining exams in the *Confirmatory Exam Program*.
- Applicants who complete three technical exams in two sittings with no mark below 60% may be exempted from the *Complementary Studies* exam.
- Applicants who fail one technical exam and achieve a mark of 70% or higher on the failed exam on their second attempt, and 60% or higher on a previously unwritten technical exam attempted at the same sitting, may be exempted from completing the remaining exams in their *Confirmatory Exam Program*.

A **Failed-to-Confirm** Exam Program for CEP applicants, consisting of additional exam(s), will be assigned to applicants who do not confirm their engineering knowledge via their *Confirmatory Exam Program*. At least one of the following will apply:

- Applicants who do not achieve an average mark of at least 55% on the three technical exams will be assigned a *Failed-to-Confirm* Exam Program and one additional technical exam will be assigned.
- Applicants, who failed the same exam twice or failed two different exams will be assigned a *Failed-to-Confirm* Exam Program where an additional exam will be assigned for each exam failure. They must also pass the failed exams.

Please note: For applicants who are assigned a **Failed-to-Confirm** Exam Program, their engineering experience does not begin until after the academic requirements for licencing are met, and they will be required to demonstrate 48 months of engineering experience from that time.

A **file will be closed** under the following circumstances:

- If there is loss of contact (no active mailing address), the applicant's file will be closed.
- Applicants who do not attempt any exams within two academic years after notification of their exam program will have their file closed.
- Once an exam program commences, applicants must write at least one exam each academic year or their file will be closed even if the applicant has successfully passed exams in the past.
- Applicants who fail a technical/Complementary Studies exam on their first sitting must pass the failed exam within one academic year or their file will be closed.

If you have any questions concerning the above listed, please contact the Exam Centre
416-840-1097, 1057, 1096, 1095 or 1(800) 339-3716 1097, 1057, 1096, 1095
e-mail: exams@peo.on.ca

Last Revision: May 2019

WATER RESOURCES ENGINEERING EXAMINATIONS

INTRODUCTION

Each discipline examination syllabus is divided into two examination categories: compulsory and elective. A full set of Water Resources Engineering examinations consists of nineteen, three-hour examination papers and an engineering report. Candidates will be assigned examinations based on an assessment of their academic background. Examinations from discipline syllabi other than those specific to the candidates' discipline may be assigned at the discretion of PEO's Academic Requirement Committee.

Information on examination scheduling, textbooks, materials provided or required, and whether the examinations are open or closed book, will be provided by PEO's examinations Centre.

BASIC STUDIES

04-BS-1 Mathematics

Calculus, Vector, and Linear Algebra: Applications involving matrix algebra, determinants, eigenvalues; first and second order linear ordinary differential equations, Laplace transforms. Vector algebra; vector functions and operations; orthogonal curvilinear coordinates; applications of partial derivatives, Lagrange multipliers, multiple integrals, line and surface integrals; integral theorems (Gauss, Green, Stokes). Power series.

04-BS-2 Probability and Statistics

Concepts of probability, events and populations, probability theorems, concept of a random variable, continuous and discrete random variables, probability distributions, distributions of functions of a random variable, sampling and statistical estimation theory, hypothesis testing, simple regression analysis.

04-BS-3 Statics and Dynamics

Force vectors in two- and three-dimensions, equilibrium of a particle in two- and three-dimensions; moments and couples; equilibrium of rigid bodies in two- and three-dimensions; centroids, centres of gravity; second moment of area, moment of inertia; truss, frame and cable static analysis; friction. Planar kinematics of particles and rigid bodies; planar kinetics of particles and rigid bodies; work and energy, impulse, and momentum of particles and rigid bodies.

04-BS-4 Electric Circuits and Power

Basic laws, current, voltage, power; DC circuits, network theorems, network analysis; simple transients, AC circuits. Impedance concept, resonance; use and application of phasors and complex algebra in steady-state response; simple magnetic circuits; basic concepts and performance characteristics of transformers; an introduction to diodes and transistors; rectification and filtering; simple logic circuits.

04-BS-5 Advanced Mathematics

Series Solutions of Differential Equations: Series solutions of ordinary differential equations, boundary value problems and orthogonal functions, Fourier series. Numerical Methods: Use of computers for numerical solution of engineering problems, including techniques involving library subroutines and spreadsheets. Approximations and errors, interpolation, systems of linear and non-linear algebraic equations, curve fitting, numerical integration and differentiation, and ordinary differential equations.

04-BS-6 Mechanics of Materials

Definitions of normal stress, shearing stress, normal strain, shearing strain; shear force and bending moment diagrams; members subjected to axial loading; members subjected to torsional loading; compound stresses, Mohr's circle; deformation of flexural and torsional members; failure theories; elastic and inelastic strength criteria; columns.

04-BS-7 Mechanics of Fluids

Fluid characteristics, dimensions and units, flow properties, and fluid properties; the fundamentals of fluid statics, engineering applications of fluid statics; the one-dimensional equations of continuity, momentum, and energy; laminar and turbulent flow, flow separation, drag and lift on immersed objects; wall friction and minor losses in closed conduit flow; flow of incompressible and compressible fluids in pipes; dimensional analysis and similitude; flow measurement methods.

04-BS-10 Thermodynamics

Thermodynamic states of simple systems; the laws of thermodynamics; equilibrium, PVT and other thermodynamic diagrams; equation of state; compressibility charts and steam tables; calculation of property changes; enthalpy; applications of thermodynamics, cycles, reversibility; thermodynamics of phase changes, Gibbs phase rule, gas-vapour mixtures.

04-BS-11 Properties of Materials

Properties of materials for mechanical, thermal and electrical applications. Atomic bonding, solid solutions, crystallization. Equilibrium phase diagrams, applications to steel and aluminium alloys, heat treatments. Structure and special properties of polymers and ceramic materials. General characteristics of metallic composites, polymeric composites and concrete. Introduction to materials in hostile environments: corrosion, creep at high temperature, refractory materials, subnormal temperature brittle fracture.

04-BS-12 Organic Chemistry

Principles of organic chemistry developed around the concepts of structure and functional groups. The main classes of organic compounds. Properties of pure substances. Introduction to molecular structure, bond types, properties, synthesis and reactions, reaction mechanisms, as a means of systematizing organic reactions.

04-BS-13 Biology

Cellular reproduction, growth, and differentiation; metabolism and bioenergetics of living cells; cell structure and function related to the material properties of plant and animal tissues; introductory microbiology — characteristics and classification of microorganisms; interactions of microorganisms with man in the natural world; kinetics and mathematical models of microbial growth; engineered biological systems such as bio-reactors, bio-instrumentation, and waste treatment systems.

04-BS-14 Geology

The structure of the earth, plate tectonics, earthquakes and igneous activity. Minerals and rocks including their formation, identification, basic properties, and classification. Processes of weathering, erosion, transport, and deposition of geological materials and their results of significance to engineering. Occurrence, flow, and quality of groundwater. Introductory aspects of structural geology including faulting, folding, and the overall formation of discontinuities and their effect on the engineering properties of rock masses. Aerial photography and geological maps.

04-BS-15 Engineering Graphics and Design Process

Engineering drawing: Orthographic sketching. Standard orthographic projection. Principal views, selection and positioning of views. Visualization. Conventions and practices. First and second auxiliary views. Basic descriptive geometry. Section views, types, hatching conventions. Basic dimensioning requirements. Tolerance for fits and geometry control. Detail drawings and assembly drawings, other drawings and documents used in an engineering organization. Bill of materials. Fasteners and welds. Design process and methods. Project management & teamwork. Requirements and function analysis in design. Conceptual design and testing. Concept evaluation design factors such as: cost, quality, manufacturability, safety, etc. Systems modelling & design detail.

GROUP A

07-WRSE- A1 Water Quality & Management

Standard methods of water quality analysis for physical, chemical and biological characteristics of water; significance and interpretation of analytical results; modelling of water quality in natural systems; and introduction to engineered water and wastewater treatment systems; management of water supply, irrigation, flood control, drainage and water pollution control; economic and social aspects of water management decisions.

07-WRSE- A2 Engineering Hydrology (16-Civ-B4)

Hydrologic processes: precipitation and snow melt, infiltration, evaporation and evapotranspiration, ground-water flow, runoff. Point and area estimates of precipitation. Stream flow measurement. Runoff hydrographs, unit hydrographs, conceptual models of runoff, and basics of hydrologic modelling. Channel system: reservoir and lake routing, channel routing and flood wave behavior Statistical methods: frequency and probability with application to precipitation, floods, and droughts.

Urban and highway drainage structure design.

07-WRSE- A3 Soil Mechanics & Groundwater

Soil composition, properties, identification and classification. Particle size distribution. Seepage and permeability. Concepts of pore water pressure and effective stress. Compressibility. Capillary pressure and hydraulic head. Principles of effective stress, stress-deformation and strength characteristics of soils, consolidation, compaction, slope stability, infiltration, stress distribution with soils and settlements. Fundamental physics and properties of groundwater flow in porous geologic material; anisotropy, heterogeneity. Introduction to the theory of groundwater flow; groundwater flow equations and patterns, recharge and discharge, flow nets, aquifer pumping, two-phase flow, well hydraulics and non-aqueous phase liquids. Numerical modeling concepts. Aquifer development and management. Wellhead protection.

07-WRSE- A4 Hydraulics Engineering (16-Civ-A5)

Dimensional analysis and hydraulic models. Application of continuity, momentum and energy principles. Steady, closed conduit flow in single pipes and pipe networks. Steady, open-channel flow under uniform and gradually varied conditions, control sections, hydraulic jumps, and energy dissipaters. Hydraulic transients; surges and water hammer in closed conduits, surface waves in open channels. Concepts and principles of turbo machinery, especially centrifugal pumps; similarity relations and cavitation; operation of pump-and-pipe systems.

Introductory concepts of hydraulic structures, including environmental aspects of hydraulic works and water quality management.

Hydraulic aspects of the theory and design of hydraulic structures. Storage dams, spillways, outlet works, diversion works, drop structures, stone structures, conveyance and control structures, flow measurement and culverts.

07-WRSE- A5 Water Resources Planning & Systems

Application of engineering economics, microeconomic theory, and mathematical simulation and optimization models to the planning and management of water systems; major topics include systems analysis, flood control, hydroelectric power, water supply, multi-objective planning, and urban water resource management.

07-WRSE- A6 Municipal and Environmental Engineering (16-Civ-A3)

Municipal infrastructure including, water supply, wastewater disposal, roads and land development; population forecasting; demand analysis. Water supply; source development, transmission, storage, pumping, distribution networks. Sewerage and drainage; sewer and culvert hydraulics; collection networks; stormwater management. Maintenance and rehabilitation of water and wastewater systems; buried pipe design; optimization of network design.

Select ONE from: 07-WRSE-A7-1 or 07-WRSE-A7-2

07-WRSE- A7-1 Irrigation, Drainage & Erosion Control: (04-Agri-B6)

Irrigation: Land classification, development, and preparation. Consumptive use of water, estimation of crop water requirements. Design of distribution systems, canals and structures, design of sprinkler and surface systems. Selection of nozzles, pipes, pump, and power units. Analysis of rate of advance and recession curves. Irrigation efficiencies. Design of low earth dams.

Drainage: Design, layout and installation of subsurface and surface systems. Spacing formulae for steady-state and transient conditions. Outlet ditch design. Flow through bridges and culverts. Drainage pumps, secondary drainage practices, surface drainage, grading, land levelling, water table control. Use of drainage systems to control water pollution. Implications of draining wetlands.

Erosion Control: Basic principles of wind and water erosion. Soil loss prediction methods and sustainability. Methods of soil erosion and sediment control including contouring, terracing, grass waterways, silt fences, channel stabilization, and land management practices. Agroforestry and cropping systems.

07-WRSE- A7-2 Geomatics: (07-Tra-B10)

Satellite-based positioning systems (GPS); observations and development of mathematical models used for absolute and differential static and kinematic positioning; error analysis; quantitative remote sensing methods using optical, infrared and microwave radiation; physical principles, including governing equations; imaging system geometries; space and airborne sensor systems; radiometric corrections, including calibration and atmospheric correction; geometric corrections; geographic Information Systems (GIS); characteristics of GIS data structures and database management systems; applications to map projections; geodetic datums; coordinate systems; georeferencing; spatial modelling and analysis.

GROUP B

07-WRSE- B1 Geomorphology & Pleistocene Geology: (18-Geol-B4)

Objectives and basic principles of physical oceanography and hydrography surveying; tides, water levels and vertical reference surfaces. Hydrography positioning including mathematical models, optical and radio techniques, radio propagation, satellite, acoustic and self-contained techniques. Depth determination including underwater acoustics, single and multi-beam systems, sea water properties, acoustic and non-acoustic techniques, sea tides, sea surface topography and sea bed properties. Data visualization and standards for safety of navigation.

07-WRSE- B2 Numerical Methods

Introduction to numerical techniques for water resources systems, focusing on the understanding of fundamental principles and an appreciation of the role of models. Finite difference, finite element, and particle tracing methods are studied and applied to the solution of problems.

07-WRSE- B3 Water Supply and Waste Water Treatment: (16-Civ- B5)

Physical, chemical, and microbiological characteristics of water and wastewater. Regulation of water quality for supply and discharge, elements of receiving water characterization and specification of effluent limits. Elements of water and wastewater treatment including, coagulation, flocculation, filtration, settling, softening, disinfection, fluoridation, taste and odour control and biological processes. Sludge disposal.

07-WRSE- B4 Open Channel Hydraulics:

Analysis and characteristics of flow in open channels (natural and artificial); channel design considerations including uniform flow (rivers, sewers), flow measuring devices (weirs, flumes), gradually varied flow (backwater and other flow profiles, flood routing), rapidly varied flow (hydraulic jump, spillways), and channel design problems (geometric considerations, scour, channel stabilization, sediment transport).

07-WRSE- B5 Limnology:

Physical processes that affect the behaviour of lakes, including reservoirs, water filled mine pits, mine tailings, pond and other standing water bodies. Impacts of these processes on water quality and methods used in the rehabilitation of lakes.

07-WRSE- B6 Contaminant Transport: (18-ENV-B3)

Major types of contaminants in air, surface water and ground water. Physical phenomena governing the transport of contaminants in different environments: advection, dispersion, diffusion, sorption, ion exchange, precipitation, dissolution, volatilization, equilibrium partitioning of contaminants amongst air, water, soil, sediments and biota. Development of governing transport equations, initial and boundary conditions, completely mixed and plug flow systems. Analytical and numerical solutions, model development, calibration, verification, sensitivity analysis, prediction and post audit.

07-WRSE- B7 Coastal Engineering

This course covers basic wave theory, wave measurement, wave statistics, wave record analysis, wave transformation, tides, water levels and storm surges. It introduces design of breakwaters and ocean structures, and uses hydraulic and numerical coastal models. The final projects consist of the design of a breakwater, design of a hydraulic model of the breakwater and testing with the hydraulic model to determine breakwater stability. Environmental considerations, coastal zone management, coastal sediment transport and design in the coastal zone are also treated

07-WRSE- B8 River Engineering

Prediction and consequences of sediment transport, aggradation and erosion, meandering and braiding, design of river engineering structures, water quality modelling, hydraulic modelling of fluvial processes and control structures, numerical modelling of dispersion and environmental impact of river engineering projects

07-WRSE- B9 Modelling of Surface Water Quality

Development and application of water quality models for lakes, rivers, estuaries, and reservoirs. Derivation of differential equations of pollutant transport; kinetic relationships for physical and chemical transformation of substances; numerical and analytical solutions to transport equations; and calibration and verification of models.

07-WRSE- B10 Risk Management in Water Resources

Risk Terminology and quantified risk analysis (QRA) techniques, Safety analysis studies. Decision-making methods in environmental engineering including matrix methods, linear programming, network models, Lagrange multipliers and dynamic programming. The concept of risk, risk probability, dose response models, decision analysis and risk-cost-benefit analysis. Evaluating environmental systems: probability and predicting failure.

07-WRSE- B11 Principles of Environmental Engineering (18-ENV-A1)

Population, economic growth, industrialization, urbanization and energy-use, as causes of environmental pollution. Mass and energy balance for environmental engineering systems under steady state and unsteady state conditions. Physical and transport properties of homogeneous and heterogeneous mixtures. Contaminant partitioning and transport in air, water and solids. Characteristics of particles, chemistry of solutions and gases, material balances, reaction kinetics, microbiology and ecology, as related to the environment. Application of environmental principles (technical and non-technical) to: water resource management, water and wastewater treatment, air pollution control, solid waste management, environmental impact assessment, and environmental ethics. Thermal pollution, noise pollution, greenhouse effect, acid precipitation, ozone depletion, air toxics, and ground-level ozone and fine particulates (photochemical smog). Sustainable development, life cycle analysis, and principles of environmental quality objectives, standards and guidelines.

**07-WRSE- B12 Environmental Assessment and Management Systems
(18-ENV-B1)**

Applicable federal and provincial environmental regulations. Analysis of environmental impact using technical and non-technical parameters. Environmental impact assessment legislation and regulatory framework. Environmental impact assessment applied to solid and liquid waste management, effluent control, air pollution control, urban development, and transportation systems. Environmental audits. Introduction to geographical information systems (GIS). Environmental management systems (EMS) ISO 14000/14001 standards, and applications. Principles of sustainable development and implications of finite biosphere and complexities for engineering design and decision-making. Design of controlled environments to enhance health and protection of natural resources for sustainable development. Resource problems and design with ecological, economic, demographic and social dimensions. Techniques to integrate knowledge and define policy. Risk analysis. Life cycle analysis. Risk management.

COMPLEMENTARY STUDIES

11-CS-1 Engineering Economics

Basic concepts of engineering economics through understanding of the theoretical and conceptual financial project analysis. Types and applications of engineering economic decisions. Capital, cash flow, and the time value of money concepts. Nominal and effective interest rates when considering loans, mortgages, and bonds. The application of present worth analysis, annual equivalent analysis and rate of return analysis in evaluating independent projects, comparing mutually exclusive projects, analyzing lease vs. buy alternatives and making decisions. After-tax financial analysis requiring an understanding of capital cost allowance (depreciation) and corporate income tax. Understanding methods of financing and capital budgeting. Break-even, sensitivity and risk analyses.

11-CS-2 Engineering in Society – Health and Safety

The duties and legal responsibilities for which engineers are accountable; safety laws and regulations; and a basic knowledge of potential hazards and their control: biological hazards – bacteria, viruses; chemical hazards – gases, liquids and dusts; fire and explosion hazards; physical hazards – noise, radiation, temperature extremes; safety hazards – equipment operation; workplace conditions – equity standards, human behaviour, capabilities, and limitations; managing safety and health through risk management, safety analyses, and safety plans and programs; practices and procedures to improve safety. The roles and social responsibilities of an engineer from a professional ethics point of view, as applied in the context of Canadian values. The integration of ethics into engineering practice, and its effect on public safety and trust.

11-CS-3 Sustainability, Engineering and the Environment

Basic knowledge of soil, water and air quality engineering: soil and water interaction, water supply issues, human activities and their interaction on soil, air and water resources. Fundamentals of: soil erosion, water quality, atmospheric pollution (carbon

and nitrogen cycle), climate change, risk assessment. Basic knowledge of renewable energy sources: solar, photovoltaic, wireless electricity, thermal, wind, geothermal, and biofuels. **Introduction to renewable materials engineering**; nano materials, new material cycles. Eco-product development, and product life cycle assessment; recycling technologies; reuse of products; design for disassembly, recycling, e-waste, and reverse manufacturing. Consumption patterns; transportation; environmental communication; consumer awareness. Optimized energy and resources management. Sustainable methods: sustainability indicators; life cycle assessment; regulatory aspects of environmental management, ecological planning.

11-CS-4 Engineering Management

Introduction to management principles and their impact upon social and economic aspects of engineering practice. Engineering management knowledge topics including: market research, assessment and forecasting; strategic planning; risk and change management; product, service and process development; engineering projects and process management; financial resource management; marketing, sales and communications management; leadership and organizational management; professional responsibility. New paradigms and innovative business models, including: sustainable production, products, service systems and consumption; best practices and practical examples of successful implementations of sustainable scientific and engineering solutions.

3.2 ENGINEERING REPORT

Upon passing the examination(s) assigned by PEO's Academic Requirements Committee, a candidate may be required to write an Engineering Report. The report must demonstrate the candidate's ability to present an engineering problem, observation, or idea, and to analyze it logically and accurately using engineering principles, and to draw conclusions or make recommendations. The work must include acceptable technical content involving engineering analysis, design, development, or research. The report must also demonstrate a satisfactory level of writing and graphical skills, thus the quality of the presentation will be a factor in determining the acceptability of the report.

The report itself need not prove originality of ideas, but the candidate should demonstrate his/her ability to appreciate, present, differentiate between and draw conclusions from observations and ideas. The definition of a "report" is flexible and could also include discussion and judgement of opposed theories or methods, or a description of a novel technique or process and a discussion of the practicality of its application. The key consideration is that the report address a new issue, and not repeat the coverage of the particular subject available in textbooks. It is the current state of the art, the novel or the contentious that is expected to be explored in the report.

While no rigid rules of format are specified, it is recommended that the report be suitably subdivided and include:

- a) A title page and date
- b) A signed declaration of authorship
- c) A table of contents
- d) A summary of the report and its conclusions
- e) Technical content including analysis, design, development or research

- f) Conclusions and/or recommendations
- g) A list of the technical literature cited
- h) A list of acknowledgements, contributors, reviewers and sources of information

The report should be about 5,000 words long, not including tables and graphs. Diagrams, illustrations, etc. should be clearly and properly identified. It is preferable to locate graphs, diagrams, etc. necessary for the understanding of the text at the place where reference to them is made.

07-WRSE-A1, Water Quality & Management

George Tchobanoglous and E.D. Schroeder, Water Quality, Addison Wesley, 0-201-05433-7.

07-WRSE-A2, Engineering Hydrology

Viessman, Knapp, Lewis & Harbaugh, Introduction to Hydrology, 2nd Edition, Harper Row (ISBN # 0-7002-24971)

Ven Te Chow, David R. Maidment & Larry W. Mays, Applied Hydrology, McGraw-Hill, 1988, ISBN # 0-07-010810-2

Ray K. Linsley & Joseph B. Franzini, Water Resources Engineering, 3rd Edition, McGraw-Hill, 1979, ISBN # 0-07-037965-3

07-WRSE-A3, Soil Mechanics and Groundwater

Das, Braja M., Principles of Geotechnical Engineering, 5th edition; ISBN 0-534-38742-X

07-WRSE-A4, Hydraulics & Hydraulics Structures

R.L. Daugherty, J.B. Franzini and E.J. Finnermore, Fluid Mechanics with Engineering Applications, 8th Edition, McGraw-Hill, 1985 (omit chapters 5, 9, 16, and 17)

A suitable alternate text is:

V.L. Streeter, E.B. Wylie, Fluid Mechanics, SI Edition, McGraw-Hill, 1981 (omit chapter 6 on compressible flow) Note there may be a more recent version of this text if there is please use the latest edition.

07-WRSE-A5, Water Resources Planning & Systems

Water-Resources Engineering, 3rd edition, by David A. Chin; ISBN-13: 9780132833219

Civil and Environmental Systems Engineering, 2nd edition, by Charles S. Revelle, E. Earle Whitlatch, and Jeff R. Wright; ISBN-13: 9780130478221

The first text covers the water resources aspect (including economic considerations) of your course description, while the second text provides the systems analysis/multi-objective planning components of the course description.

07-WRSE-A6, Municipal Engineering

Viessman and Hammar, Water Supply and Pollution Control, 6th Edition, Harper Collins College Publishers ISBN # 0-321-01460-X, 1988

Brière, François G. (1999) Drinking-Water Distribution, Sewage, and Rainfall Collection, Presses internationale Polytechnique, École Polytechnique de Montréal. ISBN number: 2-55300-796-5

McGhee, T.J., Water Supply and Sewerage, 6th Edition, McGraw-Hill Publishing Co. ISBN # 0-07-060938-1, 1991

Metcalf & Eddy Inc., Wastewater Engineering: Collection and Pumping of Wastewater, McGraw-Hill Publishing Co. ISBN # 0-07-041680-X, 1981

07-WRSE-A7-1, Irrigation, Drainage, and Erosion Control

Schwab, G.O., D.D. Fangmeier, W.J. Elliot, and R.C. Fravert, Soil and Water Conservation Engineering, 4th Edition. J. Wiley & Sons, 1993.

Smedema & Rycroft, Land Drainage. Cornell U. Press, 1993.

James, L.G., Principles of Farm Irrigation System Design. Krieger Publishing Company, 1993.

07-WRSE-A7-2, Geomatics

Bossler J.D. (Editor), J.R. Jensen, R.B. McMaster, C. Rizos (Associate Editors) (2002). Manual of geospatial science and technology, Taylor & Francis, ISBN: 0748409246.

1- For the GPS part:

Hofmann-Wellenhof B., H. Lichtenegger, J. Collins (2001). GPS: theory and practice, 5th revised edition, Springer-Verlag, ISBN: 3211828397.

2- For the Remote Sensing part:

Jensen J.R. (2007). Remote sensing of the environment: an earth resource perspective, 2nd Edition, Pearson Prentice Hall, ISBN-10: 0131889508; ISBN-13: 978-0131889507

3- For the GIS part:

Bernhardsen T. (2002). Geographic Information Systems: an introduction, 3rd edition, John Wiley & Sons, New York, ISBN: 0471419680.

07-WRSE-B1, Geomorphology & Pleistocene Geology

Prime Text:

Ingham, A.E. Hydrography for the Surveyor and Engineer. 3rd edition. Wiley, 1994. ISBN 0632029439.

Supplementary Texts:

Bowditch, N., American Practical Navigator, Volumes I and II. Topographic Centre, United States Defence Mapping Agency, 1976. ISBN 0403089948.

de Jong, C.D., G. Lachapelle, S. Skone, and I. Elema, Hydrography. Delft University Press, 2002.

Appleyard, S.F. et al., Marine Electronic Navigation, 2nd edition. Routledge & Kegan Paul, 1988.

Forrester, W. D., Canadian Tidal Manual. Department of Fisheries and Oceans, Canadian Hydrographic Service, 1983. ISBN 0660113414.

07-WRSE-B3, Water Supply and Wastewater Treatment

Viessman and Hammar, Water Supply and Pollution Control, 6th Edition, Harper Collins College Publishers ISBN # 0-321-01460-X, 1988

R.L. Droste, Theory and Practice of Water and Wastewater Treatment, J. Wiley and Sons Inc. New York, N.Y., 1997

07-WRSE-B4, Open Channel Hydraulics

Chow, Ven Te (1959) Open-Channel Hydraulics. New York, McGraw-Hill, 1959. ISBN 00701077693

07-WRSE-B5, Limnology

- Wetzel, Robert G.,
 - Limnology, W. W. Saunders Company, 1975, ISBN 0-7216-9240-0.
 - Limnology, Saunders, 1983, ISBN - 10:0030579139; ISBN - 13:9780030579134
 - Limnology: Lake and River Ecosystems, 3rd Edition, Academic Press, ISBN - 10:0127447601; ISBN - 13:9780127447605
 - Please consider only chapters in either of these editions concerning:
 - Heat and Energy (Chapter 6 in 1st edition), and
 - Hydrodynamics (Chapter 7 in 1st Edition).
- Castendyk, D.N. and Eary, L.E., 2009. Mine Pit Lakes, characteristics, Predictive Modeling, and Sustainability; Management Technologies for Metal Mining Influenced Water, Volume 3; Society for Mining, Metallurgy and Exploration. "Mine Pit Lakes" for title page.
 - Please consider only the following chapters:
 - 4, Hydrologic Characteristics and Classifications of Pit Lakes

- 5, Stratification and Circulation of Pit Lakes
- 17, Flooding Pit Lakes with surface Water
- 21, Induced Meromixis.
- Jorgensen, S.E., 1980. Lake Management, Pergamon Press. ISBN0-08-022432-6.
 - Please consider only Chapter 4 in this book. “Lake Management” for title page and a copy of Chapter 4.

07-WRSE-B6, Contaminant Transport

Fetter, C.W., Contaminant Hydrogeology. 2nd Ed., Prentice Hall, 1998.

Schnoor, J.L., Environmental Modeling: Fate of Chemicals in Water, Air and Soil. John Wiley & Sons, New York, 1996

Wark, K., C.F. Warner and W.T. Davis, Air Pollution: Its Origin and Control. Addison and Wesley, 1998.

Zheng, C. and G. D. Bennett, Applied Contaminant Transport Modeling, Theory and Practice. Van Nostrand Reinhold, New York, 1995.

07-WRSE-B11, Principles of Environmental Engineering

David A. Cornwell, Mackenzie L. Davis, Introduction to Environmental Engineering.

McGraw-Hill Companies, October 2006 ISBN-13: 9780072424119, Edition Number: 4

Mackenzie Davis and Susan Masten, Principles of Environmental Engineering and Science, Product Dimensions, ISBN-13: 978-0073122359 ISBN-10: 0073122351, Publisher: McGraw-Hill

Kiely, G., Environmental Engineering. McGraw Hill, 1996. ISBN: 007091272

07-WRSE-B12, Environmental Assessment and Management Systems

Canter, L., Environmental Impact Assessment. McGraw Hill, 1996. ISBN: 0070097674

Bartell, S., Kolluru, R., Pitblado, R., and Stricoff, S., Risk Assessment and Management Handbook: For Environmental, Health and Safety Professionals. McGraw Hill, 1996. ISBN: 0070359873

Lerch, I. And Paleologos, E., Environmental Risk Analysis. McGraw Hill, 2001. ISBN: 0071372660

McGraw, D., Environmental Auditing and Compliance Manual. Wiley Interscience, 1993. ISBN: 0471285854

Woodside, G. Yturri, J. and Aurricio, P., ISO 14001 Implementation Manual. McGraw Hill, 1998. ISBN: 0070718520

Curran, M., Environmental Life-Cycle Assessment. McGraw Hill, 1996. ISBN: 007015063X

Dorf, R.C., Technology, Humans and Society: Toward a Sustainable World. Academic Press, 2001. ISBN: 0122210905

Pearce, D. and Barbier, E., Blueprint for a Sustainable Economy. Earthscan Publications, 2000. ISBN: 1853835153

Updated: January 2014

11-CS-1 Engineering Economics**Primary Text**

Fraser, Niall; Jewkes, Elizabeth; Bernhardt, Irwin and Tajima, May. Global Engineering Economics: Financial Decision Making for Engineers. Fourth edition, Pearson Education Canada, 2008. ISBN: 978-0132071611.

Additional Resources

Sonyi, Andrew; Fenton, Robert and White, John. Principles of Engineering Economics Analysis. Canadian edition, Wall & Emerson Inc., 2000. ISBN: 978-0921332497.

Web Resources

Key words: engineering economics, cost engineering, financial analysis

Organizations: International Cost Engineering Council, Association of Cost Engineers, Association for the Advancement of Cost Engineering

11-CS-2 Engineering in Society – Health & Safety**Primary Text**

Brauer, Roger L. Safety and Health for Engineers. Second edition, John Wiley & Sons Inc., 2006. ISBN: 978-0471286325.

Web Resources

Key words: health and safety, public safety, engineering ethics

Organizations: Canadian Society of Safety Engineering (CSSE), Canadian Centre for Occupational Health and Safety (CCOHS), Health Canada, National Academy of Engineering Center for Engineering, Ethics and Society

11-CS-3 Sustainability, Engineering and the Environment

Mihelcic, J.R. and Zimmerman, J.B. (2014) *Environmental Engineering: Fundamentals, Sustainability, Design*, 2nd edition. John Wiley & Sons, Hoboken, NJ.

Berg, L., Hager, M.C., Goodman, L. and Baydack, R. (2010) *Visualizing the Environment* (Canadian Edition). John Wiley & Sons, Hoboken, NJ. (Chapters 10, 11)

Wimmer, W. and Kauffman, Joanne. Handbook of Sustainable Engineering. First edition, Springer Publishing, 2011. ISBN: 978-1-4020-8939-8.

Additional Resources

The Report of the Brundtland Commission ("Our Common Future")
1972 Stockholm Report of the United Nations Conference on the Human Environment
1992 United Nations international Earth Summit in Rio de Janeiro

Web Resources

Key words: Sustainability; Sustainable engineering; Energy, Engineering and the Environment

Organizations: Environment Canada, Natural Resources Canada, Organisation for Economic Co-operation and Development (OECD) sustainable development

11-CS-4 Engineering Management**Primary Text**

American Society for Mechanical Engineers. Guide to the Engineering Management Body of Knowledge. American Society for Mechanical Engineers, 2010. ISBN: 978-0791802991

Additional Resources

Gray, Clifford F. and Larson, Erik W. Project Management: The Managerial Process. Canadian 5th edition. Irwin/McGraw-Hill, 2011. ISBN: 978-0073403342

aussi disponible en français :

Gray, Clifford F. et Larson, Erik W. Management du projet. Chenelière McGraw-Hill, 2006. ISBN: 978-2765104537

Web Resources

Key words: engineering management, financial management, strategic management, resource management, operations management

Organizations: American Society for Mechanical Engineers (ASME), Canadian Society for Engineering Management, Project Management Institute, American Society for Engineering Management

Updated: October 2014

TOTAL EXAMINATION PROGRAM
PEO Syllabus of Examinations, 2011 Edition

WATER RESOURCES ENGINEERING

INTRODUCTION

A full set of Water Resources Engineering examinations consists of the following, three-hour examination papers and an engineering report. Candidates will be assigned examinations based on an assessment of their academic background. Examinations from discipline syllabi other than those specific to the candidates' discipline may be assigned at the discretion of PEO's Academic Requirement Committee.

BASIC STUDIES EXAMINATIONS

04-BS-1	Mathematics
04-BS-2	Probability and Statistics
04-BS-3	Statics and Dynamics
04-BS-4	Electric Circuits and Power
04-BS-5	Advanced Mathematics
04-BS-6	Mechanics of Materials
04-BS-7	Mechanics of Fluids
04-BS-8	Digital Logic Circuits
04-BS-9	Basic Electromagnetics
04-BS-10	Thermodynamics
04-BS-11	Properties of Materials
04-BS-12	Organic Chemistry
04-BS-13	Biology
04-BS-14	Geology
04-BS-15	Engineering Graphics and Design Process
04-BS-16	Discrete Mathematics

PROFESSIONAL EXAMS – SPECIFIC TO WATER RESOURCES ENGINEERING

GROUP A

07-WRSE-A1	Water Quality & Management
07-WRSE-A2	Engineering Hydrology
07-WRSE-A3	Soil Mechanics & Groundwater
07-WRSE-A4	Hydraulics Engineering
07-WRSE-A5	Water Resources Planning & Systems
07-WRSE-A6	Municipal and Environmental Engineering
07-WRSE-A7	Select <u>ONE</u> from
	07-WRSE-A7-1 – Irrigation, Drainage & Erosion Control
	07-WRSE-A7-2 – Geomatics

GROUP B

07-WRSE-B1	Geomorphology & Pleistocene Geology
07-WRSE-B2	Numerical Methods
07-WRSE-B3	Water Supply and Waste Water Treatment
07-WRSE-B4	Open Channel Hydraulics
07-WRSE-B5	Limnology
07-WRSE-B6	Contaminant Transport
07-WRSE-B7	Coastal Engineering
07-WRSE-B8	River Engineering
07-WRSE-B9	Modelling of Surface Water Quality
07-WRSE-B10	Risk Management in Water Resources
07-WRSE-B11	Principles of Environmental Engineering
07-WRSE-B12	Environmental Assessment and Management Systems

COMPLEMENTARY STUDIES

11-CS-1	Engineering Economics
11-CS-2	Engineering in Society – Health & Safety
11-CS-3	Sustainability, Engineering and the Environment
11-CS-4	Engineering Management

3.2	Engineering Report
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