TO: Randy Smith, Vice Provost for Academic Programs
Eric Bielefeld, Chair, Council on Academic Affairs
FROM: Shari Speer, Associate Dean for Academic Affairs, Graduate School
DATE: 20 June 2019
RE: Proposal for certificate in Geographic Information Science & Technology, Geography

The Department of Geography is proposing to create a new certificate in *Geographic Information Science and Technology*.

The proposal was received by the Graduate School on September 26th, 2019. It was reviewed by GS/CAA on October 7th, 2019. The proposers were notified of the subcommittee's recommended changes on October 7th, 2019. The revised proposal was received by the Graduate School on October 21st, 2019, and reviewed by GS/CAA on October 24th, 2019. No further revisions were requested, and the proposal was recommended for approval by the Graduate Council. The proposal was approved by the Graduate Council on November 4th, 2019.

THE OHIO STATE UNIVERSITY

Department of Geography
College of Arts and Sciences

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www.geography.osu.edu

October 21, 2019

Prof. Shari R. Speer
GS/CAA Curriculum Subcommittee
The Ohio State University

Dear Prof. Speer and GS/CAA Curriculum Subcommittee,

I have now revised our Proposal for the Graduate Certificate Program of Geographic Information Science and Technology (GIST). Per your request, the revision includes an assessment plan, which can be found in the PDF submitted as the program proposal, on pages 7 and 8. The current version of the PDF now contains the Proposal, Assessment Plan, ASC Certificate Advising Sheet, and ASC Certificate Completion Sheet. In additional, as with the original submission, there is a separate PDF for a market analysis report conducted by the Office of Distance Education and eLearning.

Thank you very much for your consideration. If there are any questions regarding this proposal, please do not hesitate to contact me.

Sincerely,

Ningchuan Xiao
Professor and Chair of Graduate Studies

THE OHIO STATE UNIVERSITY

College of Arts and Sciences

Offices of the Associate
and Assistant Deans

114 University Hall
230 North Oval Mall
Columbus, OH 43210

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asc.osu.edu

October 23, 2019

I am pleased to offer the College of Arts and Sciences' support for the proposed graduate certificate in Geographic Information Science and Technology, to be offered by the Department of Geography, which will be both an embedded and a stand-alone certificate, to be implemented beginning Autumn semester 2020. This is will be a valuable and popular certificate program, filling an established need for both current graduate students in a wide range of other graduate programs across campus as well as for individuals currently employed in government and private agencies. This is a very thorough and well-conceived proposal, which the College endorses whole-heartedly.

Sincerely,

Steve Fink

Associate Executive Dean

THE OHIO STATE UNIVERSITY

School of Communication

3016 Derby Hall
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Columbus, OH 43210

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614-292-2055 Fax

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September 19, 2019

Associate Professor Alison Crocetta
Chair, Arts and Sciences Curriculum Committee

Re: Approval of Graduate Certificate in Geographic Information Science and Technology

Dear Alison,

The Social and Behavioral Science Panel of the ASCC has approved a new Graduate Certificate in Geographic Information Science and Technology. The proposal was originally reviewed on August 30th, 2019, and unanimously approved with two contingencies, which have been resolved.

This graduate certificate program provides students in various disciplines with training in geographic information science and technology (GIST). The proposal effectively documents the increasing demand for employees and researchers with GIST skills. The certificate would provide the opportunity for students to develop their skills by taking 12 credit hours in mapping, spatial analysis, remote sensing, and geospatial data analytics. Students would take a required introductory course in GIS, two elective courses on either spatial analysis, mapping, or remote sensing, and one specialty elective from a range of choices.

The panel agreed that the proposed graduate certificate would be attractive and efficient for many graduate students who want to expand their methodological and technical competencies. Thus we advance the proposed graduate certificate proposal to the Arts and Sciences Curriculum Committee with a motion to approve.

Regards,

Susan L. Kline, PhD
Associate Professor
Director, Undergraduate Communication Program
School of Communication

THE OHIO STATE UNIVERSITY

Department of Geography
College of Arts and Sciences

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September 12, 2019

Vice Provost W. Randy Smith
Council on Academic Affairs
Office of Academic Affairs
203 Bricker Hall
190 North Oval
Columbus, OH 43210

Dear Provost Smith,

The Department of Geography wishes to propose a new graduate certificate program of Geographic Information Science and Technology (GIST). The field of GIST has seen rapid growth in recent years, both nationally and in the state of Ohio. Geography faculty have been regularly contacted by graduate students across campus for advice and assistance with projects which require GIST expertise, or to inquire about what classes they should take to develop their GIST skillset. Many of our own undergraduate students have been actively taking a professional path through graduate certificates in GIST. By creating this new certificate program, we aim to provide comphrensive GIST training for gradaute students on campus (Type 3a, embedded certificate) and beyond (Type 3b, stand-alone certificate).

Attached with this letter please find the Proposal for the new certificate, ASC Certificate Advising Sheet, ASC Certificate Completion Sheet, and a market analysis report conducted by the Office of Distance Education and eLearning. If there are any questions regarding this proposal, please do not hesitate to contact me.

Sincerely,

Ningchuan Xiao
Professor and Chair of Graduate Studies

Cc: Prof. Darla Munroe, Chair, Department of Geography

College of Arts and Sciences Graduate Certificate Proposal

Presented by: Department of Geography
Date: June 10, 2019

Required Information

Name of proposed certificate

Graduate Certificate of Geographic Information Science and Technology

Certificate type

Type 3a; Graduate Academic Certificate; Stand-Alone Certificate
Type 3b; Graduate Academic Certificate; Embedded Certificate

Course delivery

Wholly in-person

Proposed implementation date

Autumn 2020

Academic Unit

Department of Geography

Rationale

Rationale/purpose of certificate

Graduate students across OSU campus have increasingly integrated geographic information science and technology (GIST) into research projects, theses, and dissertations. Faculty and various research centers across campus also need GIST-trained GRAs to assist with research projects. The overall goal of the proposed graduate certificate program is to provide graduate students in various disciplines, and continuing students working in government and private agencies, with professional and technical training in GIST. By completing this program, students will develop their methodological and technical skills in mapping, spatial analysis, remote sensing, and geospatial data analytics that will help them advance their research and career.

The field of GIST has seen rapid growth in recent years. In the attached market analysis conducted by the Office of Distance Education and eLearning (ODEE) using the CIP

(Classification of Instructional Programs) code of Geographic Information Science and Cartography (45.0702), the ratio between unique job postings and hires is 4:1 (page 8), suggesting a strong demand of employees in occupations that require GIST skills and background. The report also shows a strong growth at the rate of 6.8 percent in jobs projected for 2018-2023 (page 7). Another important indication of the growth of the field is the demand for education in GIST. From 2013 to 2017, the number of completions in all GIST programs increased 331.8 percent for distance offered programs and 47.9 percent for non-distance offered programs (page 5). Among all the completions, post-baccalaureate certificates consisted of 28.6 percent (page 5).

It is also noticeable in the report that the only Ohio institute listed is Columbus State Community College, which does not offer graduate level certificates (more on Ohio institutes below in the section of Relationships to Other Programs). Given the strong market demand and on-campus needs, we firmly believe the proposed graduate certificate of GIST is a necessary, if not imperative, addition to our graduate programs.

Source of student demand

Students from the following programs are considered to have potential to enroll in the proposed graduate certificate:

Public Health
City and Regional Planning
Earth Sciences
John Glenn College of Public Affairs
Environmental Science Graduate Program
School of Environment and Natural Resources
Food, Agricultural and Biological Engineering
Sociology
Political Science
Education
Human Ecology
Anthropology
Geodetic Science
Civil Engineering

Examples of student demand

Geography faculty are regularly contacted by graduate students across campus for advice and assistance with projects which require GIS/spatial analysis, or to inquire about what classes they should take to develop GIS skills and learn more about spatial statistics. Additionally, faculty from various departments across campus request we distribute job descriptions to geography students for projects which require GIS

expertise; recent examples include faculty from Entomology, Social Work, Public Health, and City and Regional Planning.

Many of our own undergraduate students are actively taking a professional path through graduate certificates. Geography faculty have been writing letters of recommendation for numerous students for their graduate school applications to professional programs.

Learning outcomes

Upon completion of the academic certificate in Geographic Information Science and Technology, learners will be better prepared to:

1. Design and manage processes of acquiring geospatial data and their appropriate metadata for GIS applications
2. Analyze and explain spatial patterns using spatial analytical theory and methods
3. Conduct various GIS related tasks for research and application purposes, including at least one of the following
    a. Design and implement interactive mapping and visualization methods to communicate with users and stakeholders
    b. Automate spatial data handling tasks using programming languages for commercial and open-source platforms
    c. Plan and manage small scale GIS development and application projects
    d. Design and implementation of spatial databases
4. Analyze ethical issues in GIS applications and make ethical decisions based on the analysis

Relationships to Other Programs/Benchmarking

Overlaps with other programs or departments

None

Certificates or similar submitted previously

None

Identify similar programs at other universities and their level of success

The University of South California offers two master's degrees and three graduate certificates in various areas of GIST. These are residential, in-person programs and are highly successful. As far as we know, these are highly successful programs with worldwide reputation.

The Pennsylvania State University has a suite of graduate programs under the umbral of Online Geospatial Education where two master's degrees and five graduate certificates are offered. These are all online programs that mainly target professionals.

In the state of Ohio, Kent State University is currently offering three graduate certificates and a master's degree, but these programs are relatively new. University of Cincinnati also has a graduate certificate in GIS and spatial analysis, but it is not clear how active the program is and their data is not shown in any of the market analysis reports. The lack of graduate level certificates in Ohio is also evident in the attached market analysis where the only Ohio institute listed is Columbus State Community College that only has undergraduate programs.

Student Enrollment

Number of anticipated students

12

Curricular Requirements

ASC Certificate Advising Sheet

Attached

Courses

The following is a list of the courses (along with the credit hours and offering frequency) that are available for students to complete this certificate:

GEOG 5103 Intermediate Spatial Data Analysis (3 Hr, SP)
An intermediate class in spatial data analysis for geography. This course focuses on multivariate model building and evaluation, with a special emphasis on multiple regression models commonly used by geographers: spatial regression, conditional autoregressive, and geographically weighted regression.

GEOG 5200 Cartography and Map Design (3 Hr, AU, SP)
A study of the cartographic techniques of map compilation and design including generalization, symbolization, reproduction, and GIS-based mapping with an emphasis on thematic mapping.

GEOG 5210 Fundamentals of GIS (3 Hr, AU, SP, SU)
Basic principles of geographic and land information systems and their use in spatial analysis and information management.

GEOG 5225 Geographic Applications of Remote Sensing (3 Hr, AU, SP)
Introduction to the fundamental principles, methods, and geographic applications of remote sensing.

GEOG **5201** GeoVisualization (3 Hr, AU, SP)
Examination of issues, techniques and applications of analytic cartography, interactive maps and scientific visualization for exploring geographic data.

GEOG **5212** Spatial Database Design for GIS (3 Hr, AU, SP)
Focuses on designing, implementing, querying and managing spatial databases or persistent data stores where most entities have footprints in geographic space and time. This is critical for designing and implementing GIS for projects and organizations. It is also crucial for moving beyond GIS to the bigger world of geographic information services.

GEOG **5222** GIS Algorithms and Programming (3 Hr, AU, SP)
The theory and algorithms underpinning today's GIS technology and the development of custom GIS applications using the Python programming language.

GEOG **5223** Design and Implementation of GIS (3 Hr, SP)
Practice-oriented development, design, implementation and evaluation of spatial databases, with an emphasis on local problems.

GEOG **5226** Spatial Simulation and Modeling in GIS (3 Hr, AU)
Fundamental modeling and simulation techniques in GIS, including cellular automata, diffusion models, and agent-based models, and their applications in social, environmental, and natural resources research.

All the listed courses are currently offered frequently. To complete this certificate program, students should

- Choose the required course of 5210 (3 credit hours),
- Choose no more than two courses (6 credit hours) from 5103, 5200, and 5225, and
- Choose at least one course (3 credit hours) from **5201**, **5212**, **5222**, **5223**, and **5226**.

Minimum number of credit hours

12

Number of semesters for completion

2

All the courses listed are offered frequently enough (see the frequency in each item in the list) and the department has the capacity to accommodate additional students for the certificate.

Existing facilities, equipment, and off-campus sites; and impact of existing program

N/A

Additional university resources

N/A

ASC Certificate Completion Sheet

Attached

Semester-by-semester sample program

The curriculum is flexible enough for students to complete the program in multiple paths. Students can start the program in any semester. Below are examples of four scenarios.

	Starting Autumn		Starting Spring	
	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Semester 1	5200, 5210	5103, **5226**	5210, 5225	5103, **5226**
Semester 2	5201, **5222**	5200, 5225	5212, **5222**	5200, 5210

Attachments

1. Assessment Plan
2. ASC Certificate Advising Sheet
3. ASC Certificate Completion Sheet
4. Market analysis of programs in the United States (GIS Program_Overview_US.pdf)

Assessment Plan: Graduate Certificate of Geographic Information Science and Technology

October 21, 2019

We plan to use both direct and indirect measures to assess the proposed graduate certificate.

Direct measures will include results from analysis of data that are directly tied to the program learning outcomes. More specifically, we plan to use the following measures to assess how the learning goals are achieved program-wise.

1. Proportion of students exceeding and meeting expectations of the courses. This is a straightforward measure that can be retrieved from the grades of each course.
2. Proportion of students exceeding and meeting program learning outcomes. We plan to use questions given to students at the beginning and end of each semester in selected courses. These questions are specifically designed to reflect the learning outcomes, and therefore the change in student performance before and after each class is a reasonable indicator of how well they achieve the learning outcomes. We as a department have been conducting this type of assessment exercises in recent years for our undergraduate programs, which can be extended for the proposed graduate certificate program.
3. Measure of student performance through course projects related to the program learning outcomes. For example, student performance on mapping projects, database design, data analysis, or applications can be used here. These activities represent a key outcome of our program (Outcome 3) related to student skillset and should be examined separately. Since each course will have a specific requirement in these areas, it is possible and quite straightforward for instructors to provide data for this the assessment purpose.
4. Distribution of cumulative course performance of students. Data for this measure can be easily obtained. We can examine distributions for students of different backgrounds, races, gender, and age, when enough data is accumulated.

In addition, we also plan to use indirect measures based on data that indicate (but not directly related) to the learning goals and outcomes. These measures include

1. Number of applications to the program and graduate units participating,
2. Quality of the applicant pool indicated by measures such as GPA
3. Diversity of the application pool
4. Proportion of students admitted and matriculated
5. Student retention rates and graduation rates
6. Cumulative student GPAs
7. Average and range of Time-to-Certificate
8. Relative selection of embedded vs. stand-alone versions

9. Student evaluations of instruction for course satisfaction
10. Surveys of program satisfaction during enrollment and at graduation
11. Alumni surveys (applicable employment, impact of certificate in promotion and other career advancement)

Our graduate coordinator will keep track of each student in the program and maintain a database that can be used to calculate items 1 through 8 of the above measures. We as a department often conduct surveys among our students and alumni about our undergraduate and graduate programs, which makes it possible to include surveys for the proposed program.

The Ohio State University
College of Arts and Sciences

Geographic Information Science and Technology Graduate Certificate Advising Sheet

Ningchuan Xiao, Professor

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154 N Oval Mall
Columbus, OH 43210
Tel: (614) 292-2514
Email: xiao.37@osu.edu
Department website: http://www.geography.osu.edu/

Overview

This graduate certificate program provides students in various disciplines with training in geographic information science and technology (GIS&T). By completing this program, students will develop their methodological and technical skills in mapping, spatial analysis, remote sensing, and geospatial data analytics that will help them advance their research and career.

Certificate Requirements

Required: 12 hours

Introductory Courses

Required course

Course	Hours	Prerequisite
GEOG 5210	3	None

Elective courses: Choose no more than two of the following courses.

Course	Hours	Prerequisite
GEOG 5103	3	GEOG 4103 or program coordinator permission
GEOG 5200	3	None
GEOG 5225	3	None

Specialty Courses

Choose at least one from the following courses.

Course	Hours	Prerequisite
GEOG 5201	3	GEOG 5200
GEOG 5212	3	GEOG 5210 & CSE 1114 or GEOG 5210 & program coordinator permission
GEOG 5222	3	GEOG 5212
GEOG 5223	3	GEOG 5222
GEOG 5226	3	None

GEOG 5103 Intermediate Spatial Data Analysis
GEOG 5200 Cartography and Map Design
GEOG 5201 GeoVisualization
GEOG 5210 Fundamentals of GIS
GEOG 5212 Spatial Database Design for GIS
GEOG 5222 GIS Algorithms and Programming
GEOG 5223 Design and Implementation of GIS
GEOG 5225 Geographic Applications of Remote Sensing
GEOG 5226 Spatial Simulation and Modeling in GIS

"Geographic Information Science and Technology Graduate Certificate" program guidelines

Credit hours required
A minimum of 12 credit hours. Credit hours must be at the 5000-level or above.

X193 credits cannot be applied to the certificate.

All courses applied toward the certificate must be completed at Ohio State.

Overlap with degree program
A maximum of 50% overlap between the certificate and a degree program is permitted.

Grades required
- Minimum C- for a course to be counted on the certificate.
- Minimum 3.00 cumulative point-hour ratio required for the graduate certificate.
- Course work graded Pass/Non-Pass cannot be applied to the certificate.

Certificate approval
The certificate must be approved by the academic unit.

Filing the certificate program form
The certificate program form must be filed at least by the time the graduation application is submitted to a college/school counselor.

Changing the certificate
Once the certificate program is filed in the college office changes must be approved by the academic unit offering the certificate.

COLLEGE OF ARTS AND SCIENCES

GEOGRAPHIC INFORMATION SCIENCE AND TECHNOLOGY
TYPE 3A AND 3B CERTIFICATE (GIST-CRT) – 12 CREDIT HOURS

STUDENT NAME: _____

STUDENT OSU EMAIL: _____

CERTIFICATE ADVISOR NAME: _____

REQUIRED INTRODUCTORY COURSE (1)

Course (Hours)	Course Grade	Term Completed
GEOG 5210 (3)		

ELECTIVE INTRODUCTORY COURSES (NO MORE THAN 2 COURSES FROM LIST OF 3 OPTIONS)

Course (Hours)	Course Grade	Term Completed
1.		
2.		

SPECIALTY COURSES (AT LEAST 1 COURSE FROM LIST OF 5 OPTIONS)

Course (Hours)	Course Grade	Term Completed
1.		
2.		
3.		

SUBSTITUTIONS APPROVED: _____

CERTIFICATE ADVISOR SIGNATURE _____

DATE _____

Program Overview

Geographic Information Science and Cartography

Emsi Q2 2019 Data Set

May 2019

Ohio

Parameters

Programs

Code	Description
45.0702	Geographic Information Science and Cartography

Regions

Code	Description
0	United States

Program Modality

Distance Offered Programs

Education Level

Any

Completions Year

2017

Jobs Timeframe

2018 - 2023

Job Postings Timeframe

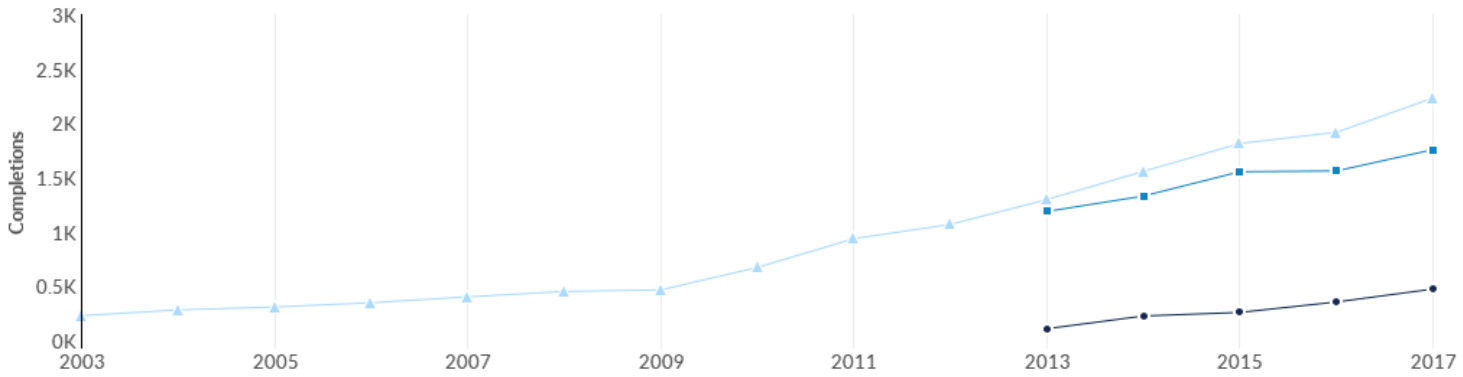
Sep 2016 - Feb 2018

Program Overview

	Completions (2017)	% Completions	Institutions (2017)	% Institutions
All Programs	2,233	100%	208	100%
Distance Offered Programs	475	21%	27	13%
Non-Distance Offered Programs	1,758	79%	155	75%

Institution	Distance Offered Completions (2017)	Growth % YOY (2017)	Market Share (2017)
University of Southern California	71	16.4%	14.9%
University of Utah	57	Insf. Data	12.0%
University of Arizona	52	23.8%	10.9%
Oregon State University	50	-15.3%	10.5%
University of Kentucky	37	Insf. Data	7.8%
American Sentinel University	20	-41.2%	4.2%
Northern Arizona University	20	17.6%	4.2%
Eastern Washington University	20	-4.8%	4.2%
University of Denver	18	Insf. Data	3.8%
Northwest Missouri State University	17	-48.5%	3.6%
Itasca Community College	14	0.0%	2.9%
Columbus State Community College	13	Insf. Data	2.7%
University of Central Arkansas	12	300.0%	2.5%
Southeast Community College Area	11	22.2%	2.3%
University of Connecticut	10	100.0%	2.1%
Collin County Community College District	9	-35.7%	1.9%
West Chester University of Pennsylvania	8	700.0%	1.7%
Roane State Community College	6	20.0%	1.3%
Michigan Technological University	6	-14.3%	1.3%
Community College of Philadelphia	5	Insf. Data	1.1%
Tennessee State University	4	300.0%	0.8%
Central Georgia Technical College	4	33.3%	0.8%
Kennesaw State University	4	300.0%	0.8%
Harrisburg Area Community College	3	50.0%	0.6%
Auburn University at Montgomery	2	-66.7%	0.4%
Loma Linda University	1	-50.0%	0.2%
University of Arkansas	1	Insf. Data	0.2%

Regional Trends



	2013 Completions	2017 Completions	% Change
Distance Offered Programs	110	475	+331.8%
Non-Distance Offered Programs	1,189	1,758	+47.9%
All Programs	1,299	2,233	+71.9%

Regional Completions by Award Level

Award Level	Distance Offered Completions (2017)	Percent
Award of less than 1 academic year	74	15.6%
Award of at least 1 but less than 2 academic years	11	2.3%
Associate's Degree	10	2.1%
Bachelor's Degree	42	8.8%
Postbaccalaureate certificate	136	28.6%
Master's Degree	163	34.3%
Post-masters certificate	34	7.2%
Doctor's Degree	5	1.1%
Award of at least 2 but less than 4 academic years	0	0.0%

Similar Programs

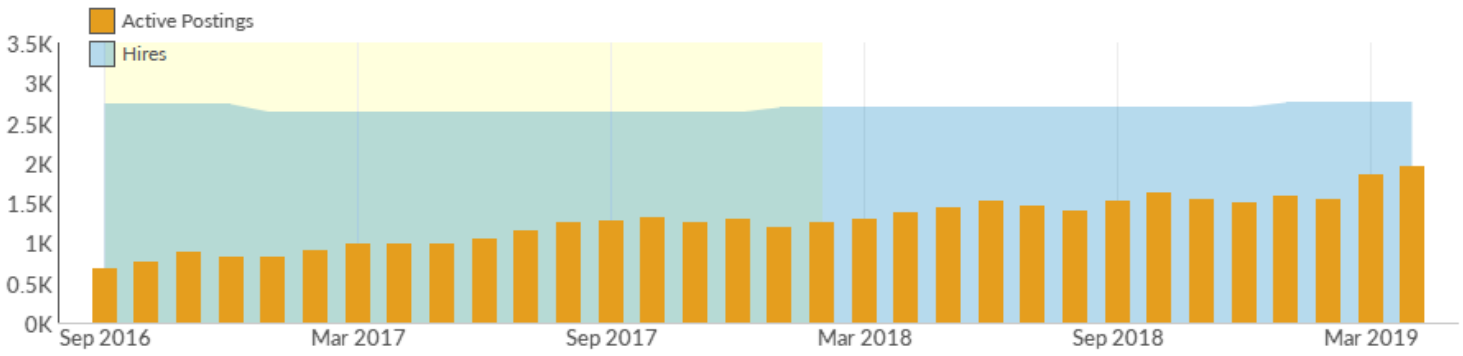
2	306
Programs (2017)	Completions (2017)

CIP Code	Program	Distance Offered Completions (2017)
15.0000	Engineering Technology, General	260
15.1102	Surveying Technology/Surveying	46

Job Postings vs. Hires

1,054	2,666
Avg. Monthly Postings (Sep 2016 - Feb 2018)	Avg. Monthly Hires (Sep 2016 - Feb 2018)

In an average month, there were **1,054** active job postings for *2 Occupations*, and **2,666** actually hired. This means there were approximately 3 hires for *2 Occupations* for every 1 active job posting.



Occupation	Avg Monthly Postings (Sep 2016 - Feb 2018)	Avg Monthly Hires (Sep 2016 - Feb 2018)
Surveying and Mapping Technicians	955	2,150
Cartographers and Photogrammetrists	99	517

Job Postings Summary

7,168	4 : 1	32 days
Unique Postings	**Posting Intensity**	**Median Posting Duration**
27,742 Total Postings	Regional Average: 4 : 1	Regional Average: 31 days

There were **27,742** total job postings for your selection from September 2016 to February 2018, of which **7,168** were unique. These numbers give us a Posting Intensity of **4-to-1**, meaning that for every 4 postings there is 1 unique job posting.

This is close to the Posting Intensity for all other occupations and companies in the region (4-to-1), indicating that they are putting average effort toward hiring for this position.

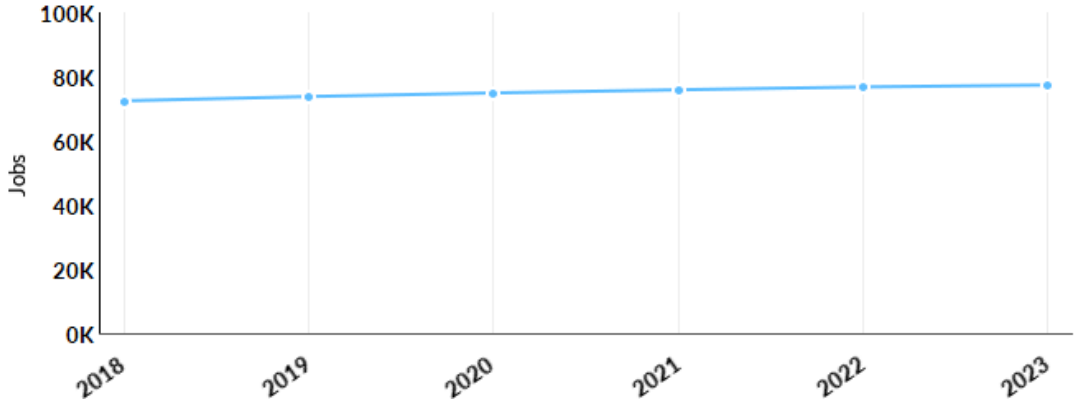
Target Occupations

72,397	+6.8%	$23.16/hr	8,418
Jobs (2018)	**% Change (2018-2023)**	**Median Hourly Earnings**	**Annual Openings**

Occupation	2018 Jobs	Annual Openings	Median Hourly Earnings	Growth (2018 - 2023)
Surveying and Mapping Technicians	58,173	7,106	$21.64/hr	+6.23%
Cartographers and Photogrammetrists	14,224	1,312	$30.56/hr	+9.10%

Growth

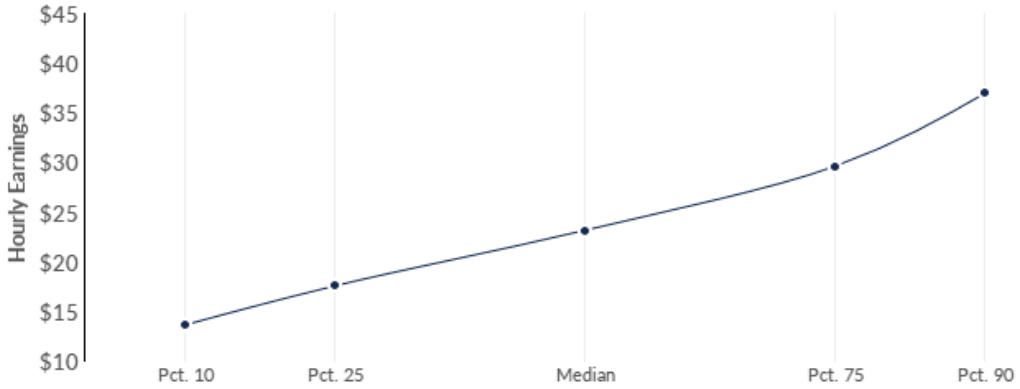
72,397	77,314	4,917	6.8%
2018 Jobs	2023 Jobs	Change (2018-2023)	% Change (2018-2023)



Occupation	2018 Jobs	2023 Jobs	Change	% Change
Cartographers and Photogrammetrists (17-1021)	14,224	15,518	1,294	9%
Surveying and Mapping Technicians (17-3031)	58,173	61,797	3,624	6%

Percentile Earnings

$17.56/hr	$23.16/hr	$29.61/hr
25th Percentile Earnings	Median Earnings	75th Percentile Earnings



Occupation	25th Percentile Earnings	Median Earnings	75th Percentile Earnings
Cartographers and Photogrammetrists (17-1021)	$24.24	$30.56	$38.90
Surveying and Mapping Technicians (17-3031)	$16.50	$21.64	$27.43

Top Companies Posting

Company	Total/Unique (Sep 2016 - Feb 2018)	Posting Intensity	Median Posting Duration
Aerotek, Inc.	1,697 / 279	6 : 1	15 days
Dewberry Consultants LLC	549 / 158	3 : 1	59 days
CARDNO LIMITED	664 / 111	6 : 1	65 days
BAE SYSTEMS PLC	568 / 98	6 : 1	66 days
Surveying and Mapping, Inc.	657 / 93	7 : 1	38 days
Stantec Inc.	324 / 88	4 : 1	46 days
Hatch Mott Macdonald, LLC	453 / 82	6 : 1	36 days
David Evans and Associates, Inc.	171 / 79	2 : 1	55 days
Bowman Consulting Group, Ltd.	184 / 76	2 : 1	45 days
McKim & Creed, Inc.	121 / 72	2 : 1	32 days
Timmons Group, Inc	180 / 65	3 : 1	41 days
Booz Allen Hamilton Holding Corporation	447 / 55	8 : 1	30 days
AMEC CONSTRUCTION LTD	263 / 53	5 : 1	39 days
Aecom	433 / 52	8 : 1	38 days
Arcadis U.S., Inc.	171 / 52	3 : 1	59 days
Pacific Gas and Electric Company	181 / 51	4 : 1	19 days
United States Department of the Army	142 / 49	3 : 1	14 days
Vanasse Hangen Brustlin Inc.	146 / 47	3 : 1	47 days
The Interior Company Inc	60 / 45	1 : 1	88 days
WS ATKINS PLC	85 / 44	2 : 1	75 days
Jacobs Engineering Group Inc.	181 / 41	4 : 1	56 days
Maser Consulting P.A.	127 / 41	3 : 1	53 days
Summit Design and Engineering Services, Pllc	252 / 40	6 : 1	48 days
Halff Associates, Inc.	130 / 39	3 : 1	49 days
Pennoni Associates Inc.	261 / 37	7 : 1	61 days
Psomas	184 / 37	5 : 1	50 days

TRC Companies, Inc.	139 / 37	4 : 1	45 days
Woolpert, Inc.	142 / 37	4 : 1	17 days
Huitt - Zollars, Inc.	205 / 36	6 : 1	41 days
Macdonald Mott Inc	140 / 36	4 : 1	38 days
Merrick & Company	93 / 35	3 : 1	33 days
Westwood Professional Services, Inc.	73 / 32	2 : 1	31 days
Langan Engineering and Environmental Services, Inc.	478 / 31	15 : 1	42 days
Sam	371 / 30	12 : 1	65 days
Larson Design Group, Inc.	153 / 29	5 : 1	50 days
Synerfac, Inc.	68 / 29	2 : 1	63 days
Michael Baker Corporation	77 / 28	3 : 1	49 days
Nana Regional Corporation, Inc.	113 / 28	4 : 1	59 days
Leidos Holdings, Inc.	215 / 27	8 : 1	56 days
Blackmon-Mooring Company	46 / 26	2 : 1	32 days
Federal Government	123 / 26	5 : 1	4 days
First American Financial Corporation	118 / 26	5 : 1	61 days
Pape-Dawson Engineers, Inc.	99 / 26	4 : 1	34 days
Parsons Brinckerhoff Group LLC	74 / 26	3 : 1	46 days
Pike Corporation	92 / 24	4 : 1	40 days
Surveying Co., Inc	130 / 24	5 : 1	20 days
Hunt, Guillot & Associates, L.L.C.	213 / 23	9 : 1	15 days
Kiewit Corporation	83 / 23	4 : 1	55 days
Nesco Resource	88 / 23	4 : 1	21 days
USDA Forest Service	42 / 23	2 : 1	9 days

Top Posted Job Titles

Job Title	Total/Unique (Sep 2016 - Feb 2018)	Posting Intensity	Median Posting Duration
Field Technicians (Architecture and Engineering)	8,071 / 2,057	4 : 1	33 days
Survey Party Chiefs	4,407 / 1,241	4 : 1	34 days
CAD Technicians	3,879 / 690	6 : 1	32 days
Surveyors	1,617 / 456	4 : 1	31 days
Instrumentation Technicians (Architecture and Engineering)	831 / 246	3 : 1	35 days
Cartographers	838 / 237	4 : 1	33 days
Civil Engineers	397 / 147	3 : 1	30 days
Instrument Designers	439 / 133	3 : 1	29 days
Entry Level Electrical Engineers	279 / 80	3 : 1	49 days
Quality Assurance Engineers (Architecture and Engineering)	362 / 64	6 : 1	29 days
Field Engineers (Architecture and Engineering)	208 / 61	3 : 1	54 days
Field Technicians (Life, Physical, and Social Science)	235 / 55	4 : 1	29 days
Geospatial Analysts	352 / 55	6 : 1	66 days
Interviewers	164 / 55	3 : 1	21 days
Engineering Technicians (Architecture and Engineering)	166 / 53	3 : 1	31 days
Operations Technicians (Architecture and Engineering)	152 / 50	3 : 1	44 days
Drafters	165 / 39	4 : 1	34 days
Construction Technicians (Architecture and Engineering)	107 / 36	3 : 1	23 days
Office Technicians	123 / 33	4 : 1	17 days
Environmental Services Technicians (Architecture and Engineering)	113 / 29	4 : 1	25 days
Technician Assistants	40 / 29	1 : 1	88 days
Geographic Information Systems (GIS) Analysts	282 / 28	10 : 1	58 days
Carpet Cleaning Technicians	47 / 27	2 : 1	3 days

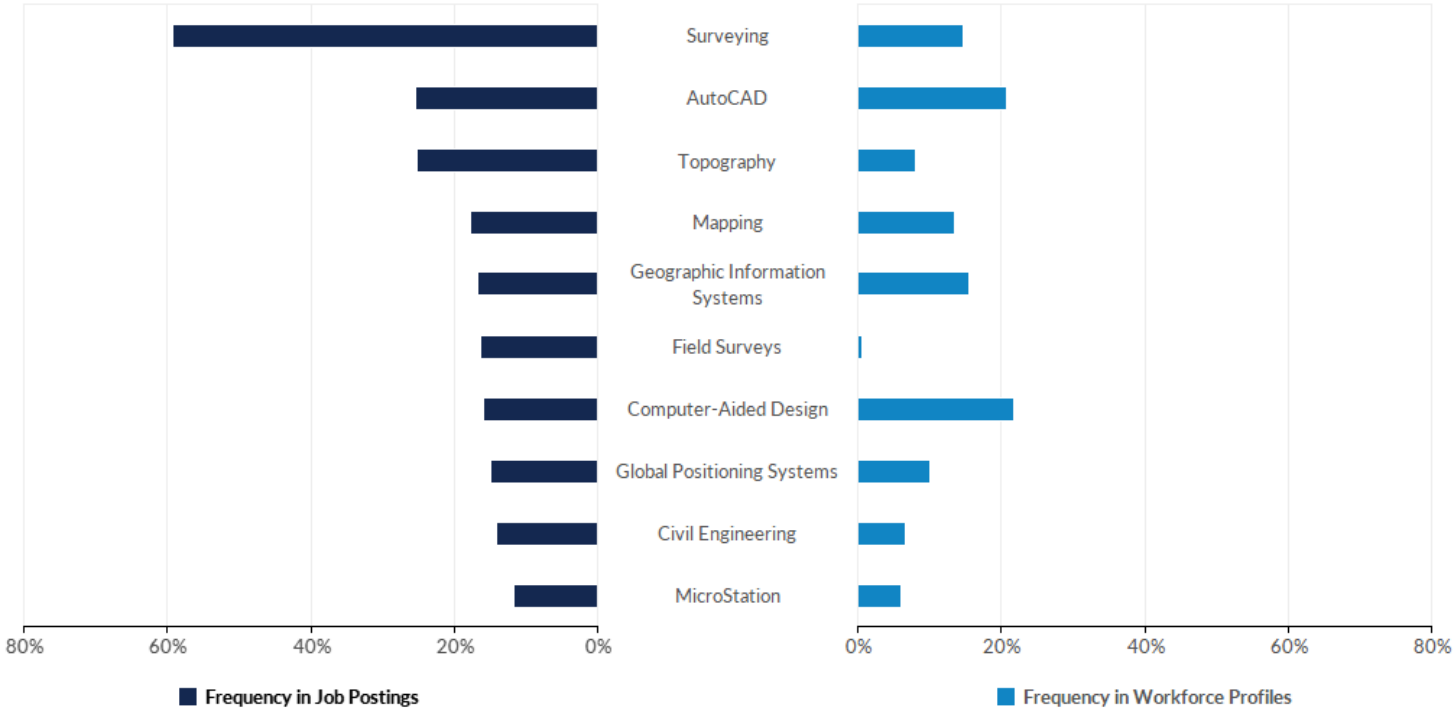
Engineering Interns	73 / 23	3 : 1	33 days
Quality Control Leads	92 / 23	4 : 1	22 days
Counterintelligence Officers (Protective Service)	49 / 21	2 : 1	6 days
Data Center Technicians	49 / 21	2 : 1	15 days
Geotechnical Engineers	146 / 21	7 : 1	58 days
Office Clerks	64 / 21	3 : 1	43 days
Digital Technicians	48 / 20	2 : 1	21 days
Pharmacy Technicians	110 / 20	6 : 1	34 days
Crew Leads	39 / 18	2 : 1	31 days
Data Entry Clerks	77 / 17	5 : 1	27 days
Project Administrative Staff	59 / 17	3 : 1	23 days
Research Analysts (Life, Physical, and Social Science)	65 / 17	4 : 1	29 days
Distribution Supervisors (Production)	38 / 16	2 : 1	63 days
Design Engineers (Architecture and Engineering)	62 / 15	4 : 1	19 days
Imagery Analysts	44 / 15	3 : 1	17 days
Maintenance Technicians (Architecture and Engineering)	62 / 14	4 : 1	18 days
Project Engineers (Architecture and Engineering)	27 / 14	2 : 1	86 days
Project Managers (Computer and Mathematical)	77 / 14	6 : 1	45 days
Computer Aided Design (CAD) Technicians	33 / 13	3 : 1	26 days
Electronics Technicians	37 / 13	3 : 1	44 days
Clinical Documentation Specialists	39 / 12	3 : 1	12 days
Crew Chiefs (Installation, Maintenance, and Repair)	41 / 12	3 : 1	15 days
Environmental Engineers	60 / 12	5 : 1	17 days
GIS Analysts	49 / 12	4 : 1	39 days
Human Resources Assistants	69 / 12	6 : 1	13 days
Statisticians	23 / 12	2 : 1	32 days

Equipment Technicians (Installation, Maintenance, and Repair)	21 / 11	2 : 1 	24 days

The following provides insight into the supply and demand of relevant skills by comparing the frequency of skills present in job postings against skills present in today's workforce. Along with Emsi's job posting analytics, this comparison leverages Emsi's dataset of more than 100M online resumés and profiles. All resumés and profiles used in these comparisons have been updated within the last three years.

**The skills associated with workforce profiles represent workers of all education and experience levels.*

Top Hard Skills



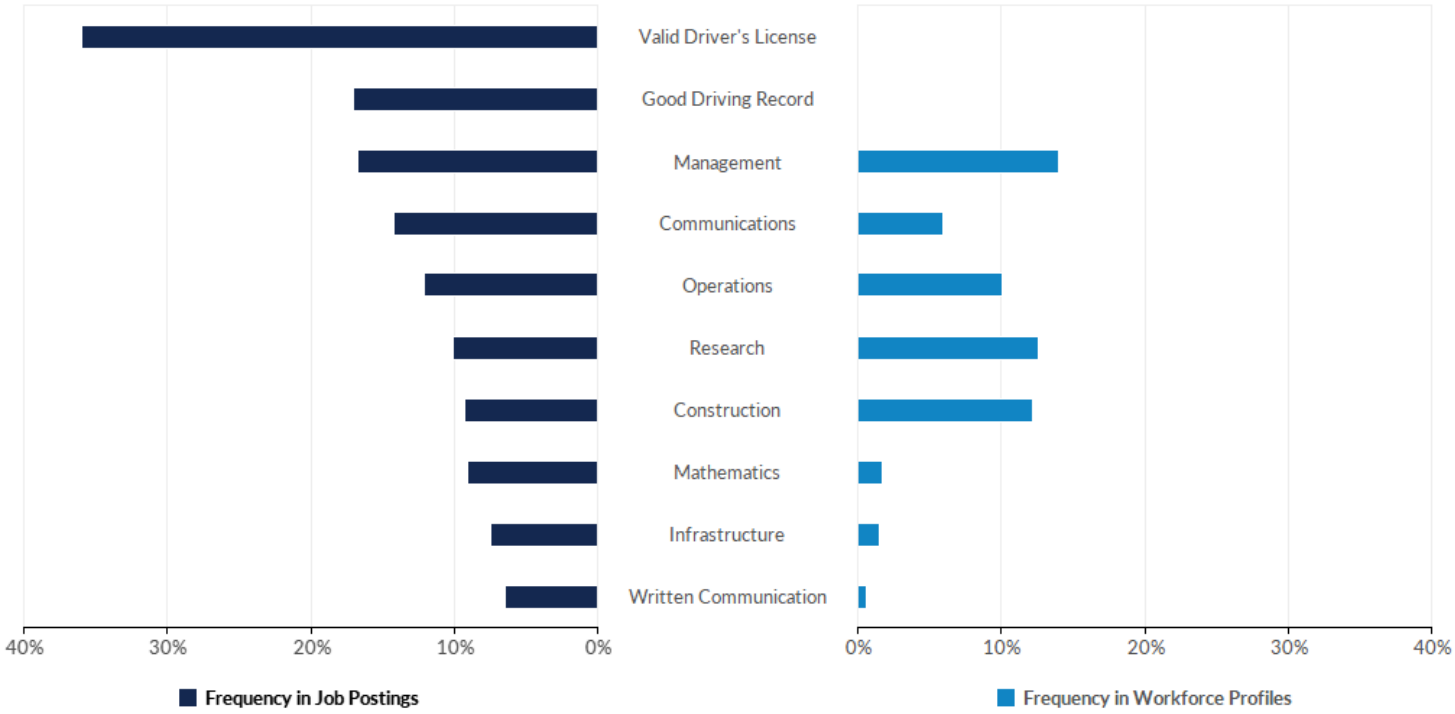
Top Hard Skills

Skill	Frequency in Postings	Postings with Skill / Total Postings (Sep 2016 - Feb 2018)	Frequency in Profiles	Profiles with Skill / Total Profiles (2017 - 2019)
Surveying	59%	4,249 / 7,168	15%	480 / 3,253
AutoCAD	25%	1,816 / 7,168	21%	678 / 3,253
Topography	25%	1,808 / 7,168	8%	265 / 3,253
Mapping	18%	1,272 / 7,168	13%	439 / 3,253
Geographic Information Systems	17%	1,195 / 7,168	15%	502 / 3,253
Field Surveys	16%	1,168 / 7,168	1%	20 / 3,253
Computer-Aided Design	16%	1,144 / 7,168	22%	707 / 3,253
Global Positioning Systems	15%	1,074 / 7,168	10%	329 / 3,253

Civil Engineering	14%	1,014 / 7,168	7%	216 / 3,253
MicroStation	12%	833 / 7,168	6%	198 / 3,253
Total Station	11%	824 / 7,168	3%	113 / 3,253
Elevation	9%	654 / 7,168	4%	124 / 3,253
ArcGIS (GIS Software)	7%	516 / 7,168	11%	351 / 3,253
Trigonometry	7%	514 / 7,168	0%	12 / 3,253
Geometry	7%	502 / 7,168	0%	10 / 3,253
Land Development	7%	472 / 7,168	4%	135 / 3,253
Data Collection	7%	468 / 7,168	3%	98 / 3,253
Laser Scanning	6%	436 / 7,168	1%	18 / 3,253
Professional Services	6%	414 / 7,168	0%	9 / 3,253
Cartography	5%	386 / 7,168	9%	285 / 3,253
Land Surveyor In Training	4%	305 / 7,168	0%	0 / 3,253
Algebra	4%	275 / 7,168	0%	13 / 3,253
Lidar	4%	270 / 7,168	3%	87 / 3,253
Construction Management	4%	251 / 7,168	3%	99 / 3,253
Product Quality Assurance	3%	238 / 7,168	2%	76 / 3,253
Hydrographic Survey	3%	235 / 7,168	0%	15 / 3,253
Landscape Architecture	3%	231 / 7,168	0%	4 / 3,253
Profit Sharing	3%	225 / 7,168	0%	0 / 3,253
Remote Sensing	3%	209 / 7,168	3%	103 / 3,253
GPS Navigation Devices	3%	205 / 7,168	0%	6 / 3,253
Surveys	3%	203 / 7,168	6%	188 / 3,253
Data Processing	3%	201 / 7,168	0%	11 / 3,253
Survey Methodologies	3%	197 / 7,168	2%	73 / 3,253
Calculations	3%	187 / 7,168	1%	22 / 3,253
Disability Insurance	3%	184 / 7,168	0%	0 / 3,253
Engineering Design Process	2%	178 / 7,168	1%	43 / 3,253

Personal Protective Equipment	2%	177 / 7,168	0%	13 / 3,253
Subsurface Utility Engineering	2%	177 / 7,168	0%	0 / 3,253
Microsoft Access	2%	171 / 7,168	5%	165 / 3,253
Oil And Gas	2%	168 / 7,168	2%	49 / 3,253
Information Systems	2%	164 / 7,168	0%	13 / 3,253
Stereophonic Sound System	2%	161 / 7,168	0%	0 / 3,253
Photogrammetry	2%	160 / 7,168	1%	45 / 3,253
Digital Data	2%	159 / 7,168	0%	0 / 3,253
Strategic Partnership	2%	153 / 7,168	0%	0 / 3,253
Digital Mapping	2%	152 / 7,168	1%	23 / 3,253
Geospatial Analysis	2%	147 / 7,168	0%	15 / 3,253
Geography	2%	145 / 7,168	3%	89 / 3,253
Coordinate Geometry	2%	142 / 7,168	0%	0 / 3,253
Aerial Photography	2%	141 / 7,168	1%	39 / 3,253

Top Common Skills



Top Common Skills

Skill	Frequency in Postings	Postings with Skill / Total Postings (Sep 2016 - Feb 2018)	Frequency in Profiles	Profiles with Skill / Total Profiles (2017 - 2019)
Valid Driver's License	36%	2,576 / 7,168	0%	0 / 3,253
Good Driving Record	17%	1,217 / 7,168	0%	0 / 3,253
Management	17%	1,201 / 7,168	14%	455 / 3,253
Communications	14%	1,019 / 7,168	6%	195 / 3,253
Operations	12%	868 / 7,168	10%	327 / 3,253
Research	10%	724 / 7,168	13%	411 / 3,253
Construction	9%	664 / 7,168	12%	398 / 3,253
Mathematics	9%	653 / 7,168	2%	55 / 3,253
Infrastructure	7%	536 / 7,168	2%	50 / 3,253
Written Communication	6%	462 / 7,168	1%	21 / 3,253
Detail Oriented	6%	460 / 7,168	0%	0 / 3,253
Innovation	5%	387 / 7,168	1%	27 / 3,253

Microsoft Office	5%	379 / 7,168	18%	585 / 3,253
Verbal Communication Skills	4%	300 / 7,168	0%	9 / 3,253
Computer Literacy	4%	298 / 7,168	2%	63 / 3,253
Interpersonal Skills	4%	290 / 7,168	1%	30 / 3,253
Problem Solving	4%	279 / 7,168	5%	153 / 3,253
Microsoft Excel	4%	264 / 7,168	18%	582 / 3,253
Writing	3%	230 / 7,168	3%	86 / 3,253
Office Suite	3%	215 / 7,168	0%	6 / 3,253
Program Management	3%	204 / 7,168	1%	44 / 3,253
Investigation	3%	193 / 7,168	1%	18 / 3,253
Microsoft Outlook	2%	176 / 7,168	5%	155 / 3,253
Information Technology	2%	172 / 7,168	2%	81 / 3,253
Leadership	2%	164 / 7,168	13%	427 / 3,253
Fine Motor Skills	2%	160 / 7,168	0%	1 / 3,253
Spreadsheets	2%	147 / 7,168	1%	33 / 3,253
Word Processor	2%	136 / 7,168	0%	12 / 3,253
Coordinating	2%	134 / 7,168	3%	94 / 3,253
Customer Service	2%	119 / 7,168	14%	462 / 3,253
Career Development	2%	117 / 7,168	0%	7 / 3,253
Time Management	2%	117 / 7,168	4%	135 / 3,253
Spanish Language	2%	113 / 7,168	2%	59 / 3,253
English Language	2%	109 / 7,168	3%	95 / 3,253
Punctuality	1%	105 / 7,168	0%	2 / 3,253
Real Estates	1%	103 / 7,168	1%	27 / 3,253
Mentorship	1%	98 / 7,168	1%	40 / 3,253
Training And Development	1%	97 / 7,168	1%	34 / 3,253
Physics	1%	97 / 7,168	1%	26 / 3,253
Presentations	1%	92 / 7,168	3%	91 / 3,253

Creativity	1%	89 / 7,168	0%	0 / 3,253
Microsoft PowerPoint	1%	86 / 7,168	11%	354 / 3,253
Reliability	1%	85 / 7,168	0%	4 / 3,253
Chinese Language	1%	80 / 7,168	0%	6 / 3,253
Microsoft Windows	1%	76 / 7,168	4%	120 / 3,253
Map Reading	1%	73 / 7,168	0%	0 / 3,253
Decision Making	1%	70 / 7,168	1%	36 / 3,253
Microsoft Word	1%	65 / 7,168	12%	384 / 3,253
Quality Assurance	1%	65 / 7,168	2%	67 / 3,253
Microsoft Internet Explorer	1%	64 / 7,168	0%	1 / 3,253

Top Qualifications

Qualification	Postings with Qualification
Certified Survey Technician	84
Certified Benefits Professional	33
Certified First Responder	31
Professional Engineer	19
Transportation Worker Identification Credential (TWIC) Card	19
Drone Pilot Certificate	13
Licensed Professional Engineer	13
Certified Photogrammetrist	11
CompTIA Security+	8
Certified Nurse Practitioner	8
Licensed Vocational Nurses	7
Commercial Driver's License (CDL)	7
Certified Internal Auditor	5
Certified Safety Professional	4
CompTIA A+	4
Advanced Life Support	3
Certified Mapping Scientist	3
Certified Instrumentation Specialist	3
Certified Application Counselor	3
Certified Medication Technician	3
Cisco Certified Design Associate	2
CompTIA Network+	2
Certified Veterinary Technician	2
LEED Accredited Professional (AP)	1
Certified Information Systems Security Professional	1
Certified Lodging Security Supervisor	1
Certified Novell Engineer	1

Certified Nursing Assistant	1
Certified Public Accountant	1
Chartered Financial Analyst	1
Certified Financial Risk Management	1
Microsoft Certified Professional	1
Nurse Practitioner	1
Project Management Professional Certification	1
Professional Wetland Scientist	1
System Operator Certification	1
Certified Residential Specialist	1

Appendix A - Data Sources and Calculations

Institution Data

The institution data in this report is taken directly from the national IPEDS database published by the U.S. Department of Education's National Center for Education Statistics.

Emsi Job Postings

Job postings are collected from various sources and processed/enriched to provide information such as standardized company name, occupation, skills, and geography.

Occupation Data

Emsi occupation employment data are based on final Emsi industry data and final Emsi staffing patterns. Wage estimates are based on Occupational Employment Statistics (QCEW and Non-QCEW Employees classes of worker) and the American Community Survey (Self-Employed and Extended Proprietors). Occupational wage estimates also affected by county-level Emsi earnings by industry.

Location Quotient

Location quotient (LQ) is a way of quantifying how concentrated a particular industry, cluster, occupation, or demographic group is in a region as compared to the nation. It can reveal what makes a particular region unique in comparison to the national average.

State Data Sources

This report uses state data from the following agencies: Alabama Department of Industrial Relations; Alaska Department of Labor and Workforce Development; Arizona Department of Administration, Office of Employment and Population Statistics; Arkansas Department of Workforce Services; California Labor Market Information Department; Colorado Department of Labor and Employment; Connecticut did not provide us with a data source; Delaware Office of Occupational and Labor Market Information, Delaware Wages 2004; District of Columbia Department of Employment Services; Florida Department of Economic Opportunity; Georgia Department of Labor, Workforce Information and Analysis, Occupational Information Services Unit; Hawaii Department of Labor and Industrial Relations, Research and Statistics Office; Idaho Department of Labor; Illinois Department of Employment Security, Employment Projections; Indiana Department of Workforce Development; Iowa Workforce Development; Kansas Department of Labor, Labor Market Information Services, Kansas Wage Survey; Kentucky Office of Employment and Training; Louisiana Department of Labor; Maine did not provide us with a data source; Maryland Department of Labor, Licensing and Regulation, Office of Labor Market Analysis and Information; Massachusetts Executive Office of Labor and Workforce Development; Michigan Department of Labor and Economic Growth, Bureau of Labor Market Information and Strategic Initiatives; Minnesota Department of Employment and Economic Development; Mississippi Department of Employment Security; Missouri Department of Economic Development; Montana Department of Labor and Industry, Research and Analysis Bureau; Nebraska Workforce Development; Nevada Department of Employment, Training and Rehabilitation, Information Development and Processing Division, Research and Analysis Bureau; New Hampshire Department of Employment Security; New Jersey Department of Labor and Workforce Development; New Mexico Department of Labor, Bureau of Economic Research and Analysis; New York Department of Labor, Division of Research and Statistics; North Carolina Department of Commerce, Labor and Economic Analysis Division; North Dakota Job Service, Labor Market Information Center; Ohio Department of Job and Family Services, Labor Market Information Division; Oklahoma Employment Security Commission; Oregon Employment Department, Oregon Labor Market Information System; Pennsylvania Department of Labor and Industry, Center for Workforce Information and Analysis; Rhode Island did not provide us with a data source; South Carolina Employment Security Commission, Labor Market Information Department; South Dakota Department of Labor, Labor Market Information Division; Tennessee Department of Labor and Workforce Development, Research and Statistics Division; Texas Workforce Commission; Utah Department of Workforce Services; Vermont did not provide us with a data source; Virginia Employment Commission, Economic Information Services; Washington State Employment Security Department, Labor Market and Economic Analysis Branch; West Virginia Bureau of Employment Programs, Research Information & Analysis Division; Wisconsin Department of Workforce Development, Bureau of Workforce Information; Wyoming Department of Employment, Research and Planning