#### **Final Report**

# PATHWAYS FOR CIVIL ENGINEERING AND LAND SURVEYING: WORKFORCE DEVELOPMENT IN WASHINGTON STATE

by

Mehrdad Nasri Research Assistant Muhammad Karim Post-Doc Researcher

Ryan P. Avery Deputy Director Yinhai Wang Director

#### **Washington State Transportation Center (TRAC)**

University of Washington, Box 359446 University Tower, 4333 Brooklyn Ave NE Seattle, Washington 98195-9446

Prepared for
The Washington State Legislature
Joint Transportation Committee
Senator Liias, Co-Chair; Representative Fey, Co-Chair

July 2025

# TECHNICAL REPORT STANDARD TITLE PAGE 2. GOVERNMENT ACCESSION NO.

1. REPORT NO.

3. RECIPIENT'S CATALOG NO.

4. TITLE AND SUBTITLE Pathways for Civil Engineering a Workforce Development in Wash			5. REPORT DATE July 2025	
-			6. PERFORMING ORGANIZA	TION CODE
7. AUTHOR(S) Mehrdad Nasri, Muhammad Kar Wang	im, Ryan P. Avery	y, Yinhai	8. PERFORMING ORGANIZA	TION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS	Cantan		10. WORK UNIT NO.	
Washington State Transportation University of Washington, Box 3 University Tower, 4333 Brooklys Seattle, Washington 98195-9446	59446		11. CONTRACT OR GRANT N	ÑO.
Seattle, Washington 98195-9446  12. SPONSORING AGENCY NAME AND ADDRESS			13. TYPE OF REPORT AND P	
			Research Report	
Washington State Legislature Joi	nt Transportation	Committee	14. SPONSORING AGENCY C	ODE
PO Box 40937	. =			
Olympia, Washington 98501-093	37			
360-786-7313 15. SUPPLEMENTARY NOTES				
This study was conducted in coo	peration with the	University of	Washington.	
16. ABSTRACT Abstract	•	<b>,</b>	<u> </u>	
Washington State's ability to deliver the infrastructure programs is being constrained by a widening shortage of civil engineers and land surveyors. This study quantifies current and future workforce gaps, diagnoses their root causes, and proposes education-centered solutions. A mixed-methods design combined (i) statewide employer and practitioner surveys (47 organizations and 917 professionals, respectively) to capture vacancy durations, retirement horizons, skill shortages and attrition drivers, with (ii) open-ended text-mining that distilled narrative comments into dominant themes, and (iii) an audit of every university, college, apprenticeship and online pathway feeding the talent pipeline. Descriptive statistics revealed vacancy periods exceeding six months for 59 percent of employers and an urgent need to hire additional staff within five years. Nearly one-third of the existing workforce will reach retirement eligibility by 2035, threatening continuity of project delivery. The most acute deficits occur at mid- and senior-career levels, where hybrid competencies in design, project management and regulatory compliance intersect. Topic-modelling of narrative responses pointed to three systemic pressures: the high cost of living and uncompetitive salaries; misalignment between academic preparation and job-ready skills (especially BIM/GIS and field experience); and weak succession planning that fails to transfer institutional knowledge.  The report translates these findings into a three-part action plan: Goal 1: Close immediate skill gaps through short-course upskilling, micro-credentials and expanded continuing-education funding; Goal 2: Expand and modernize degree capacity via targeted state appropriations, faculty hiring and curriculum reform emphasizing digital delivery; and Goal 3: Strengthen pipeline diversity and field readiness by scaling paid internships, apprenticeships and K-12 outreach, with priority on under-represented communities. Together, these pathways offer a pragmatic roadmap for legislator				
Workforce development, civil en surveying, skill gaps, topic mode	· ·	the public th	ns. This documen rough the Nationa Service, Springfic	al Technical
19. SECURITY CLASSIF. (of this report)	20. SECURITY CLASSIF. (of t		21. NO. OF PAGES	22. PRICE
None	Nor			

# **Table of Contents**

List of Initialisms a	and Abbreviations	ix
Executive Summar	y	xi
1.Introduction		1
1.1 Context and	Motivation	1
1.2 Study Object	ctives	2
2.Literature and Inc	lustry Background	4
2.1 National and	d Regional Workforce Trends	4
2.2 Previous Ga	np-Analysis Studies in AEC Professions	5
3. Methodology		7
2.3 Stakeholder	Identification and Sampling Frame	7
2.4 Instrument	Design	7
2.5 Data Collec	tion Procedures	7
2.6 Quantitative	e Analysis	8
2.7 Qualitative	and Text Mining Analysis	8
4. Survey Results (	(Quantitative)	11
4.1 Employer S	urvey Findings	11
4.1.1	Demographics of the Respondents	11
4.1.2	The Identified Challenges	13
4.1.3	Discussion	27
4.2 Practitioner	Survey Findings	28
4.2.1	Demographics of Respondents	28
4.2.2	The Identified Challenges	34
4.2.3	Discussion	38
5.Open-Ended Insig	ghts and Topic Modeling	40
5.1 Challenges	in Workforce Development	40
5.1.1	Attracting and Retaining Experienced Professionals	40
5.1.1	Challenges – Impact of Staff Shortages on the Current Projects	49
5.1.2	Challenges – Pathways into the Field	54
5.1.3	Challenges – Obstacles to Entering the Field	59
5.1.4	Skills Lacking in New Graduates	63
5.1.5	Challenges – Critical Skills Lacking in Experienced Professionals	68
5.1.6	Challenges – Training Resources Most Needed	72

5.1.7	Challenges – Reasons Behind Employees Leaving Their Positions	77
5.2 Solutions to	Address the Current Challenges in Workforce Development	81
5.2.1	Solutions – Suggested Initiatives or Programs for Addressing Workforce Shortages	
5.2.2	Solutions – Improving Education/Training to Address Workforce Needs	86
6. An Overview of	the Current Pathways in Washington State	92
	eering and Land Surveying Programs at the University of Washington coma, Bothell)	92
6.1.1	UW Seattle - Civil and Environmental Engineering Programs	92
6.1.2	UW Tacoma – BS in Civil Engineering	95
6.1.3	UW Bothell	97
6.1.4	Land Surveying Education within UW Programs	97
6.1.5	Enrollment, Graduation and Workforce Outcomes	98
6.1.6	Summary	. 100
	eering and Land Surveying Programs at Washington State University man)	. 101
6.2.1	Program Enrollment and Capacity	. 102
6.2.2	Courses and Curriculum.	. 102
6.2.3	Graduation Rates and Degree Output	. 103
6.2.4	Typical Employment Outcomes for Graduates	. 104
6.2.5	Workforce Development and Educational Enrichment	. 106
6.2.6	Summary	. 108
6.3 Civil Engine	eering and Land Surveying Programs at Seattle University	. 108
6.3.1	Program Enrollment and Graduates	. 109
6.3.2	Curriculum and Course Offerings	110
6.3.3	Employment Outcomes for Graduates	112
6.3.4	Workforce Development and Professional Preparation	114
6.3.5	Summary	117
6.4 Gonzaga Ur	niversity (Spokane, Wash.)	117
6.5 Saint Martir	n's University (Lacey, Wash.)	118
6.6 Walla Walla	University (College Place, Wash.)	119
6.7 Other Unive	ersities	. 120
•	and Technical Colleges (Civil Engineering Technology and Surveying	. 120
6.8.1	Yakima Valley College (Yakima, Wash.) – Civil Engineering and Survey Programs	ing 121

	6.8.2	Clark College (Vancouver, Wash.) – Surveying and Geomatics	123
	6.8.3	Bellingham Technical College (Bellingham, Wash.) – Engineering Technology: Geomatics	125
	6.8.4	Renton Technical College (Renton, Wash.) – Land Surveying Technician	128
	6.8.5	Other Community Colleges and Technical Programs	131
	6.9 Apprenticesl	hip and Workforce Development Programs	132
	6.9.1	Operating Engineers Apprenticeship – Construction Surveyor (Technical Engineer)	
	6.9.2	Other Apprenticeships	134
	6.9.3	Workforce Development Initiatives	135
	6.10  Online Pro	grams Accessible to Washington Residents	136
	6.11  Conclusion	and Key Takeaways	139
	6.11.1	Opportunities for Washington Civil Engineering Education	139
	6.11.2	Summary	142
<u>7</u> S	ummary of Inter	im Findings	143
	7.1 Evidence fro	om Quantitative Analysis	143
	7.1.1	Workforce Structure and Demographics	143
	7.1.2	Pipeline Entry and Early-Career Bottlenecks	143
	7.1.3	Mid-Career and Senior-Level Pressures	144
	7.1.4	Retention Dynamics	144
	7.1.5	Operational Impacts and Quality Risks	144
	7.1.6	Stakeholder-Preferred Solutions	144
	7.1.7	Implications	144
	7.2 Evidence fro	om open-ended responses	145
	7.2.1	Attraction and Retention Challenges	145
	7.2.2	Skill Gaps and Professional Development Needs	145
	7.2.3	Programmatic Solutions and Pathways	146
	7.2.4	Concluding Observations	146
	7.3 Current Path	ways in Washington State for Civil Engineering and Land Surveying	147
	7.3.1	Baccalaureate and Graduate Routes in Civil Engineering	147
	7.3.2	Community-College and Technical-College Pathways	147
	7.3.3	Professional Society and Regulatory Pathways	148
	7.3.4	Transfer and Articulation Mechanisms	148
	7.3.5	Consolidated View	
	7.4 Recommend	ations and Action Plan	149

7.4.1	Strategic Goal 1 – Close Immediate Skill Gaps: Short-Term Training and Continuing Education.	
7.4.2	Strategic Goal 2 – Expand and Modernize Degree Capacity: Targeted Institutional Funding	. 149
7.4.3	Strategic Goal 3 – Strengthen Pipeline Diversity and Field Readiness: Internships, Apprenticeships, and Youth Outreach	. 149
7.5 Conclusion		. 150
References		. 151

# **Figures**

Figure 1. The distribution of respondents in Washington State counties	11
Figure 2. The distribution of respondents based on type of organization	. 12
Figure 3. The distribution of respondents based on the size of organization	. 13
Figure 4. The distribution of employees in the sample based on the profession category	. 14
Figure 5. The situation of retirement in the sample	. 15
Figure 6. The staffing shortage in the sample based on position	. 16
Figure 7. The number of available positions in the sample based on the profession	. 17
Figure 8. The time to fill the vacant positions in the sample based on the profession	. 18
Figure 9. The time to fill the vacant positions in the sample based on the profession	. 19
Figure 10. The primary challenges in recruiting qualified candidates	. 20
Figure 11. The average score of primary challenges in recruiting qualified candidates	. 21
Figure 12. The skills most in demand in the surveyed employers	. 22
Figure 13. The effects of staff shortage on the industry	. 24
Figure 14. The compatibility of educational pathways and industry demands	. 25
Figure 15. The ranking for the proposed solutions	. 26
Figure 16. The average score for the proposed solutions	. 26
Figure 17. The current position of the respondents	. 29
Figure 18. The current position of the respondents	. 30
Figure 19. The geographic distribution of the respondents	. 31
Figure 20. The entry path to the field for the respondents	. 32
Figure 21. The main challenges for entering to the field	. 33
Figure 22. The impacts of staffing issues on the work	. 34
Figure 23. The critical skills lacking in new graduates for entering the field	. 36
Figure 24. The critical skills lacking in experienced engineers in the field	. 37
Figure 25. The main reason for the engineers deciding to leave the field	. 38
Figure 26. Top words frequency graph	. 40
Figure 27. Word cloud from the open-ended responses	. 41
Figure 28. Word Frequency graph	. 49
Figure 29. Word cloud from the responses	. 50
Figure 30. Top word frequency graph	. 55
Figure 31. Word cloud from the responses	. 55
Figure 32. Word frequency graph	. 60
Figure 33. Word cloud from the responses	. 60
Figure 34. Top word frequency graph	. 64
Figure 35. Word cloud from the responses	
Figure 36. Word frequency graph	. 69
Figure 37. Word cloud from the responses	
Figure 38. Top word frequency graph	. 73
Figure 39. Word cloud from the responses	

Figure 40. Top word frequency graph	77
Figure 41. Word cloud from the responses	78
Figure 42. Top word frequency analysis	81
Figure 43. Word cloud from the responses	82
Figure 44. Top word frequency graph	86
Figure 45. Word cloud from the responses	87
Figure 46. Distribution of students in different fields of study in UW Graduate Programs	94
Tables	
Table 1. Approximate Number of University of Washington Graduates per Year (Recent	
Years)	93
Table 2. Annual BSCE Degrees Awarded – Washington State University	103

#### **List of Initialisms and Abbreviations**

AAS Associate of Applied Science

ABET Accreditation Board for Engineering and Technology

ACEC American Council of Engineering Companies
AEC Architecture, engineering, and construction

AGC Associated General Contractors
ASCE American Society of Civil Engineers
BIM Building information modeling

BIMBLS Bureau of Labor Statistics

BRPELS Board of Registration for Professional Engineers and Land Surveyors

BSCE Bachelor of Science in Civil Engineering

BTC Bellingham Technical College

CAD Computer-aided design

CEE Civil and Environmental Engineering

COGO Coordinate geometry

DOT Department of transportation

EIT Engineer-in-Training
ESA Endangered Species Act

FE Fundamentals of Engineering (exam)
FS Fundamentals of Surveying (exam)
GIS Geographic information systems

GPS Global Positioning System

HELM Higher Education and Labor Market

HR Human resources

IIJA Infrastructure Investment and Jobs Act IUOE International Union of Operating Engineers

ITE Institute of Transportation Engineers

LiDA Latent Dirichlet Allocation
LiDAR Light detection and ranging

MSCE Master of Science in Civil Engineering
LSAW Land Surveyors' Association of Washington

LSIT Land Surveyor-in-Training (exam)

MSST Master of Science in Structural Engineering

NCEES National Council of Examiners for Engineering and Surveying

NEPA National Environmental Policy Act

NSPE National Society of Professional Engineers
NSPS National Society of Professional Surveyors

NCHRP National Cooperative Highway Research Program
OERTP Operating Engineers Regional Training Program

OJT On-the-job training

OSHA Occupational Safety and Health

PE Professional Engineer

PLS Professional Land Surveyor

PM Project Management

PMI Project Management Institute

QC Quality control

RCW Revised Code of Washington
RSI Related supplemental instruction

RTC Renton Technical College SCC Spokane Community College

SU Seattle University

SWE Society of Women Engineers
UAA University of Alaska Anchorage

UW University of Washington

WAC Washington Administrative Code

WIOA Workforce Innovation and Opportunity Act
WSDOT Washington State Department of Transportation

WSU Washington State University

YVC Yakima Valley College

# **Executive Summary**

Washington state's ability to deliver necessary infrastructure projects is being constrained by a widening shortage of civil engineers and land surveyors. This report, commissioned by the Washington State Legislature's Joint Transportation Committee and prepared by the Washington State Transportation Center (TRAC) at the University of Washington, provides a comprehensive analysis of workforce gaps, their underlying causes, and actionable solutions to rebuild and future-proof the state's civil engineering and land surveying talent pipeline.

This study quantified current and future workforce gaps and diagnosed their root causes, and the report proposes education-centered solutions. The researchers surveyed employers (47 responses) and practitioners (917 responses) to capture vacancy durations, retirement horizons, skill shortages, and attrition drivers. They analyzed responses by using open-ended text-mining that distilled narrative comments into dominant themes.

#### **Key Findings**

Key findings include the following:

#### Workforce Pressures

- Vacancy and Retirement Risks: Over 59 percent of employers reported vacancies lasting more than six months. Nearly one-third of the current workforce will reach retirement eligibility by 2035, with mid- and senior-level roles most affected.
- Skill Shortages: Employers cited acute deficits in project management and digital design tools such as Building Information Modeling (BIM), geographic information systems (GIS), and hydraulic modeling. Only 18 percent said that they believed graduates were job-ready.
- Attrition Drivers: The high cost of living, uncompetitive salaries, and lack of advancement opportunities are major factors pushing professionals out of the field.
- Succession Planning: Weak planning fails to transfer institutional knowledge.

#### **Educational Misalignment**

- Curriculum Gaps: University programs often lack hands-on field training, advanced digital tools, and interdisciplinary project management content.
- Limited Surveying Pathways: Land surveying faces a steeper demographic cliff, with few academic programs and high licensure barriers contributing to declining interest.

#### Operational Impacts

• Staffing Shortages: Lack of staff leads to increased workloads (68 percent), project delays (52 percent), and quality degradation (44 percent). These issues compound risks during peak infrastructure spending years.

• Increased Costs: Costs increase because of delays as well as lower competition due to constrained staffing.

#### Washington Educational Pipeline

The research team also performed an audit of every university, college, apprenticeship, and online pathway feeding the talent pipeline. Washington offers a wide range of educational programs that lead to the civil engineering and land surveying professions. These include four-year university degrees, two-year community/technical college programs, certificates, apprenticeships, and even online learning options. Educational institutions that offer degrees in engineering or land surveying include the following:

- Universities: The University of Washington (UW, Seattle, Tacoma), Washington State University (WSU, Pullman, Tri-Cities), Seattle University, Gonzaga, Saint Martin's, and Walla Walla University.
- Community and Technical Colleges: Yakima Valley College, Clark College, Bellingham Technical College, Renton Technical College.
- Online Programs: These are offered by the UW, WSU, and out-of-state institutions such as the University of North Dakota (UND), Old Dominion University (ODU), and Arizona State University (ASU). The University of Wyoming offers an online land surveying certificate.

These programs annually produce roughly 300 to 400 civil engineering BS degrees, 100+civil engineering MS degrees, 20 to 30 surveying/geomatics AAS degrees, and a few dozen engineering technology or related AAS degrees.

#### Recommendations

The report translates these findings into recommendations for a three-part action plan:

#### Goal 1: Close Immediate Skill Gaps

- Expand the availability of short-courses that support skill expansion and provide micro-credentials.
- Increase funding for continuing education.
- Promote accelerated licensure/evaluation programs for out-of-state transfers and foreign credentials and competency-based conversion courses for career changers.

#### Goal 2: Expand and Modernize Degree Capacity

- Invest in faculty hiring and curriculum reform.
- Emphasize learning on digital tools (BIM, GIS, LiDAR, etc.).
- Align coursework with industry needs and licensure requirements.

#### Goal 3: Strengthen Pipeline Diversity and Field Readiness

- Scale up paid internships, apprenticeships, and K–12 outreach.
- Prioritize underrepresented communities.

• Support apprenticeship/earn-and-learn models and alternative certification pathways. Together, these pathways offer a pragmatic roadmap for legislators, educators, and industry leaders to retool, diversify, and future-proof Washington's civil engineering and land-surveying workforce through targeted investments in education, training, and workforce development. Without swift and coordinated action, the state risks falling short of its infrastructure goals as a result of talent shortages and institutional knowledge loss.



#### 1. Introduction

#### 1.1|Context and Motivation

Washington state's ability to deliver safe roads, resilient bridges, and climate-ready infrastructure increasingly depends on a talent pipeline that is showing clear signs of strain. Record-level federal and state investment—most visibly the Bipartisan Infrastructure Law, Sound Transit's light-rail expansion, and major Washington State Department of Transportation (WSDOT) corridor projects—has driven demand for civil engineers in the state well beyond the current supply. A 2024 Associated General Contractors (AGC) workforce survey found that 94 percent of construction firms nationwide have craft or professional vacancies and that 54 percent are already experiencing project delays attributable to labor shortages [1]. Closer to home, the Washington Student Achievement Council's 2023 Higher Education and Labor Market (HELM) report listed engineering among the occupational clusters for which annual job openings outstrip post-secondary completions by a wide margin, underscoring a persistent skills gap that state employers rank as their second-largest business challenge [2]. The report stressed that while the need for civil engineers is growing, graduation rates in relevant programs remain flat, creating a persistent skills gap in the state's infrastructure sector.

Evidence from the field confirms how that gap is playing out. An investigative feature in *The Seattle Times* reported that reduced bidder pools and rising cost estimates on large transportation contracts can be traced directly to a "civil-engineering bottleneck," noting that in 2021 only 21,000 people graduated with civil engineering degrees nationwide while vacancy rates at some departments of transportation (DOTs) reached 25 percent [3]. The shortage has already manifested in project delays, higher construction costs, and a shrinking pool of qualified bidders for state contracts. At the same time, Washington's flagship universities have seen flat or declining enrollment in traditional civil engineering programs as students pivot toward trendier technology disciplines. The result is an intensely competitive hiring market in which talented graduates are fielding multiple offers well before commencement.

Land surveying, an occupation without which engineering design and property development cannot proceed, faces an even steeper demographic cliff. Industry analyses show that barely 14 percent of licensed surveyors are under the age of 34, while retirements among practitioners over 60 could erode nearly 40 percent of Washington's in-state surveying capacity within the next decade [4]. Recognizing this risk, the state Board of Registration for Professional Engineers and Land Surveyors (BRPELS) launched its Our Future Workforce initiative in 2024 to "fix gaps in workforce supply and demand" for both professions, but the initiative is still in its formative stages [5]. A near-term industry analysis noted that the land surveying workforce is aging rapidly, with a large portion nearing retirement and few younger professionals entering the field [6]. The profession's visibility, relatively high licensure barriers, and a lack of academic and training pathways have all contributed to declining interest among students and early-career

workers [7]. This impending retirement cliff poses a direct threat to the viability of surveying operations that underpin nearly every construction and infrastructure project.

These converging pressures—historic infrastructure spending, accelerating retirement of baby-boom professionals, and a leaky education-to-employment pipeline—form the backdrop for this report. The pages that follow (1) quantify current and projected workforce shortfalls for civil engineering and land surveying in Washington state, (2) analyze the educational, demographic, and regulatory drivers behind those gaps, and (3) propose evidence-based strategies (from K-12 outreach and apprenticeship pathways to professional licensure reform) that can help the state cultivate, attract, and retain the talent required to sustain its growth and safety goals.

#### 1.2|Study Objectives

This project has been structured around a sequence of practical questions that move from diagnosis to action. The objectives below capture that logic and define the scope of work undertaken.

#### 1. Comprehensively diagnose workforce pressures:

Catalog every factor that may be constraining the civil engineering and land surveying talent pool in Washington—retirement trends, compensation and benefits, workload, licensure hurdles, career-advancement prospects, geographic mobility, workplace culture, and emerging skill requirements.

#### 2. Collect first-hand evidence from the field:

Survey and interview three stakeholder groups—(a) public-sector owners and private-consulting/contracting firms, (b) working engineers and surveyors at all career stages, and (c) university and community college faculty—to capture their distinct experiences with hiring, retention, and professional preparation.

#### 3. Apply rigorous analytical methods:

Use both quantitative techniques (descriptive statistics, cross-tabulation, and gap analysis) and qualitative methods (thematic coding of open-ended responses) to identify systemic patterns and isolate the primary drivers of workforce shortages.

#### 4. Solicit and consolidate stakeholder-generated solutions:

Ask each respondent group to propose strategies they believe would make a tangible difference—ranging from salary adjustments and flexible work policies to streamlined licensure pathways, targeted scholarships, or outreach to K-12 students.

#### 5. Audit Washington's educational infrastructure:

Map the current supply side of talent by reviewing every civil engineering and geomatics/surveying program in the state: enrollment capacity, graduation output, curriculum architecture, faculty resources, transfer pathways, and alignment with licensure requirements.

#### 6. Identify gaps between educational supply and industry demand:

Cross-reference employer-reported skill needs with curriculum content and program capacity to pinpoint mismatches (e.g., digital-delivery tools, data analytics,

sustainable infrastructure design, or drone/light detection and ranging (LiDAR) surveying).

#### 7. Develop actionable pathways for improvement:

Translate the most feasible and high-impact ideas into a coherent set of workforce development pathways. These pathways will specify the following:

- Policy or program owner (agency, professional board, institution, or industry consortium)
- Necessary changes (e.g., curriculum updates, new credentials, incentive structures)
- Expected benefits (greater enrollment, higher retention, faster licensure, reduced project delays).

By pursuing these objectives in sequence—diagnosing challenges, validating them with multi-stakeholder evidence, and crafting education-centric solutions—the study delivers a roadmap that Washington's agencies, academic institutions, and industry partners can use to build, diversify, and future-proof the state's civil engineering and land surveying workforce.

## 2. Literature and Industry Background

#### 2.1|National and Regional Workforce Trends

Federal investment in public infrastructure has accelerated markedly since passage of the Infrastructure Investment and Jobs Act (IIJA) in 2021 and related climate legislation. Because civil engineers design, manage, and deliver the projects funded under these measures, demand for their expertise continues to expand faster than the overall labor market. The U.S. Bureau of Labor Statistics (BLS) has projected that employment of civil engineers will grow 6 percent between 2023 and 2033 (classified as "faster than average") and that approximately 22,900 positions will need to be filled each year, most of them to replace retiring workers rather than to support net new growth [8].

Industry surveys have confirmed that the nation's current supply of professionals is insufficient to meet this rising demand. In the 2024 Workforce Shortage Survey, 94 percent of contractors reported openings for craft labor and 85 percent reported openings for salaried staff. Among firms with vacancies, more than 90 percent stated that the positions were "hard to fill," and over half had already experienced project delays attributable to workforce shortages [9]. These findings underscore concerns expressed by professional societies such as the American Society of Civil Engineers (ASCE), which warn that labor constraints could blunt the effectiveness of unprecedented federal spending on transportation and climate-resilient infrastructure.

The demographic profile of the land surveying profession exposes an even steeper challenge. Trade sources have placed the average age of a licensed Professional Land Surveyor (PLS) at roughly 57 years, signaling an imminent wave of retirements unbuffered by a commensurate flow of new entrants [10]. Although the BLS anticipates a modest 6 percent increase in employment for surveyors through 2033, virtually all projected openings will stem from the need to replace retirees rather than organic industry expansion—making the renewal of the surveying workforce a question of professional survival rather than mere growth.

Regional evidence indicates that Washington state is experiencing the national shortage in amplified form. In the Washington breakout of the 2024 AGC survey, 95 percent of construction firms reported at least one unfilled salaried position, and 84 percent described engineering roles as "difficult to hire." Surveyors ranked among the hardest-to-fill craft positions statewide [9]. On the education side, the Washington Student Achievement Council's HELM report showed that annual openings for engineers (4,651) exceeded in-state completions (2,621) by a ratio of nearly two to one, with civil engineering accounting for more than a quarter of all vacancies [2]. These data reveal a structural gap between workforce demand and the state's current educational output—one that cannot be bridged by incremental recruitment alone.

Taken together, the national indicators of accelerating demand, the aging cohort of licensed professionals, and Washington's documented shortfall in graduate supply provide the empirical backdrop for the present study. They justify an analytical approach that (1) interrogates the full spectrum of workforce pressures—from retirements and compensation levels to licensure

barriers and skill mismatches; (2) gathers first-hand evidence from employers, practitioners, and educators; and (3) develops education-centered pathways capable of expanding, diversifying, and sustaining the state's civil engineering and land surveying talent pipeline.

#### 2.2|Previous Gap-Analysis Studies in AEC Professions

A growing body of scholarship has applied systematic gap-analysis methods to quantify shortfalls between labor market demand and the supply of professionals in the architecture, engineering, and construction (AEC) domain. Collectively, these studies have provided both methodological precedents and empirical baselines for the present investigation of Washington's civil engineering and land surveying pipeline.

Early state DOT research emphasized the demographic cliff facing transportation agencies. National Cooperative Highway Research Program (NCHRP) Synthesis 323 used agency surveys and human resources (HR) data to document high vacancy rates, slow hiring cycles, and impending retirements among professional-series staff; it concluded that traditional recruitment strategies were "insufficient to offset projected losses," calling for targeted retention and succession planning [11]. A decade later, NCHRP Report 693 expanded the scope from state engineers to all system operations and management specialists. Combining supply-and-demand modeling with multi-state case studies, the report identified four critical constraints—accelerating retirements, limited training capacity, rapid technology change, and rigid civil service rules—and packaged its findings as an action-plan workbook for agency HR managers [12].

More recently, NCHRP Research Report 1008 (Workforce 2030) reframed the issue in forward-looking terms: what skills will the transportation workforce need to deliver resilient, multimodal infrastructure by 2030? Through literature synthesis, 85 executive interviews, and focus group analytics, the study isolated ten cross-cutting challenges, ranging from "blue-collar stigma" to the growing expectation of flexible work arrangements [11].

Parallel analyses by industry associations have depicted similar deficits on the private-sector side of the AEC market. The Associated General Contractors (AGC) annual Workforce Survey—based on more than 1,400 contractor responses—showed that 85 percent of firms continue to carry unfilled craft vacancies and 74 percent struggle to hire project engineers; 68 percent of applicants are deemed "not job-ready," signaling a persistent skills gap despite aggressive wage escalation [1]. In the design sector, the American Council of Engineering Companies (ACEC) Research Institute employs economic impact modeling and quarterly CEO sentiment surveys to track labor market tightness. Its 2024 assessment reported 1.5 open positions for every engineering hire and attributed the gap to an aging workforce, uneven regional demand, and accelerating technological change [13]. Management consulting analyses have echoed these findings: a 2023 Boston Consulting Group—SAE International study estimated that one in three U.S. engineering roles could remain unfilled each year through 2030 unless education, industry, and government mount a coordinated upskilling response [14].

Workforce gap studies specific to land surveying are rarer but no less alarming. An Australian longitudinal study commissioned by the Association of Consulting Surveyors

projected a national deficit of 1,500 surveying and geospatial professionals by 2024 (even after accounting for a 22 percent increase in overall employment) owing largely to falling licensure rates and an aging practitioner base [15]. In the United States, the National Society of Professional Surveyors (NSPS) has issued repeated "workforce crisis" alerts, citing similar demographic and educational bottlenecks (although detailed quantitative results remain proprietary).

Taken together, these gap-analysis efforts have established three consistent themes. First, retirement-driven attrition now eclipses organic growth as the dominant source of vacancies. Second, skills misalignment (particularly in digital delivery, data analytics, and emerging technologies) exacerbates hiring difficulties even when headcount is available. Third, both public and private studies have converged on the need for integrated solutions that link employer practice reforms with curricular modernization and alternative credential pathways.

The present study adopts these lessons by employing multi-stakeholder surveys, quantitative supply-demand modeling, and curriculum audits to create Washington-specific workforce pathways grounded in national best practice.

## 3. Methodology

#### 3.1|Stakeholder Identification and Sampling Frame

A multi-frame sampling strategy was adopted to ensure that each of the principal stakeholder groups influencing Washington's civil engineering and land surveying talent pipeline was adequately represented. The target universe comprised (i) licensed civil engineers and professional land surveyors practicing in the state, (ii) engineers-in-training and surveyor interns, (iii) public-sector employers (e.g., WSDOT, county road departments, municipal utilities), (iv) private-sector employers (consulting and construction firms), and (v) academic faculty and researchers in civil engineering and geomatics programs accredited by the Accreditation Board for Engineering and Technology (ABET). Population frames were constructed from different sources, including Washington's BRPELS licensure roster, the Washington Association of Building officials, the National Council of Examiners for Engineering and Surveying (NCEES), ASCE Seattle, Washington Department of Health wastewater management section, Adams County, Benton County, National Society of Professional Engineers (NSPE), the County Road Administration Board, membership lists of professional societies (ASCE and NSPS), institutional directories, and publicly available employer registries.

#### 3.2|Instrument Design

Two separate, web-administered questionnaires were developed: one for employers and one for practitioners/faculty. Item pools were generated from the literature on AEC workforce gaps, national needs assessments, and preliminary key informant interviews. Closed-ended measures included five-point Likert-type agreement scales, importance rankings, and numeric inputs for vacancy counts and time-to-hire. Open and semi-open items captured nuanced views on career exits, perceived skill gaps, and recommended interventions. The adoption of Likert-type response formats followed established practice for attitudinal measurement in organizational research [16].

#### 3.3|Data Collection Procedures

Both questionnaires were built on the basis of the information we needed, and they were distributed by email to addresses obtained from the sampling frames described in Section 3.1. Invitations were sent from a university-hosted account to reinforce legitimacy, and they contained (i) a short project overview and (ii) an embedded URL directing recipients to the appropriate employer or practitioner instrument. Participation was voluntary and anonymous; IP tracking was disabled, and no personally identifying information was collected beyond broad demographic categories needed for representativeness checks.

The survey remained open for four weeks. Automated reminders were issued at the end of week 2 to non-respondents. The final reminder emphasized the survey closing date and again assured confidentiality. To increase reach among practitioners outside formal membership rosters, professional societies posted the survey link in their social-media feeds.

#### 3.4|Quantitative Analysis

The analytical strategy for closed-ended survey items centered on descriptive statistics and priority ranking, consistent with the study's goal of delivering a clear, practitioner-oriented inventory of the most pressing workforce issues and the solutions perceived as most effective.

#### • Computation of central-tendency scores

Each Likert-type item (e.g., perceived severity of problems, importance of specific skill sets, utility of proposed interventions) was transformed to a numerical scale. Mean and standard-deviation values were calculated for every item to gauge both the average level of concern and the degree of consensus among respondents [17].

#### • Priority ranking of issues and solutions

Items were then ordered by descending mean score to create ranked lists of (a) workforce challenges and (b) recommended solutions.

#### • Narrative integration of open-ended responses

Qualitative comments supplied additional explanation for high-priority items. Illustrative quotations were selected to deepen the understanding of why certain issues received elevated scores. This approach aligned with mixed-methods integration guidelines that recommend weaving qualitative insights into quantitative findings to enhance interpretability [18].

All computations were performed in Python using the numpy and pandas libraries. The exclusive focus on descriptive metrics ensured that the resulting priorities are immediately actionable for policymakers and educators without the added complexity of inferential modeling.

#### 3.5|Qualitative and Text Mining Analysis

Open-ended survey responses were analyzed with a two-stage text-mining workflow that combined conventional linguistic pre-processing with Latent Dirichlet Allocation (LDA) topic modeling.

Topic modeling aims to summarize, organize, and understand large corpora of text by identifying groups of words (topics) that frequently co-occur. These topics can give insights into the underlying themes present in the data without any prior labeling or supervision. Documents are viewed as mixtures of topics, and topics themselves are characterized by distributions over words. This means that each document may touch on multiple themes, and each theme is represented by a set of words with varying probabilities.

LDA is a probabilistic model that discovers hidden "topics" in a collection of documents by assuming that each document mixes several latent word distributions and that each topic itself is a distribution over words. LDA is a generative model, meaning it assumes that documents are generated through a random process. Under this process, each document is produced by first sampling a distribution over topics and then, for each word in the document, sampling a topic from this distribution and finally choosing a word from the topic's word distribution.

LDA leverages Dirichlet distributions to manage the uncertainty in topic distributions for documents and word distributions for topics.

- Document-topic distribution: Each document is associated with a multinomial distribution over topics, which is drawn from a Dirichlet distribution (parameterized by α).
- Topic-word distribution: Similarly, each topic is associated with a multinomial distribution over words, drawn from another Dirichlet distribution (parameterized by β).

LDA treats documents as "bags of words," which means it ignores the order of words. While this simplifies the computation, it also means that some contextual information is lost.

LDA posits the following generative process for each document in the corpus:

- 1. Choose a topic distribution for the document: For each document, a topic distribution  $\theta$ \theta is sampled from a Dirichlet distribution with parameter  $\alpha$ .
- 2. Generate words in the document: For each word in the document:
  - o Topic assignment: Select a topic z from the document's topic distribution  $\theta$ .
  - O Word selection: Given the topic z, choose a word w from the topic's word distribution  $\phi$ , which is sampled from a Dirichlet distribution with parameter β.

This process explains how a document can exhibit a blend of topics, each contributing to the overall set of words in the document.

The challenge in using LDA is to reverse-engineer the generative process to infer the latent (hidden) topic structure from observed documents. This involves determining the following:

- The topic distribution  $\theta$  for each document
- The word distribution  $\phi$  for each topic
- The assignment of topics for each word in every document.

Because directly computing the posterior distribution is intractable (it's an NP-hard problem), approximate inference techniques are used, such as the following:

- Gibbs Sampling: A Markov Chain Monte Carlo method that iteratively samples from the conditional distributions
- Variational Inference: An optimization-based approach that approximates the true posterior with a simpler distribution.

These methods allow LDA to "learn" the latent topic structure from the data.

The numbers (e.g., 0.034, 0.017, etc.) represent the weight or importance of each word within that topic. Formally, in LDA, each topic is characterized by a probability distribution over the vocabulary. In simpler terms,

- A higher coefficient means the word is more representative of that topic.
- A lower coefficient means the word is still related, but less central than higher-weighted words.

Because the model is fully unsupervised, it can sift through hundreds of open-ended survey comments and reveal coherent themes without the analyst having to define a coding scheme in advance. In recent workforce-development research, LDA has become a standard tool for distilling large volumes of free-text feedback into a handful of interpretable concepts that can be linked back to quantitative survey results or policy questions.

For pre-processing, all text was lower-cased, tokenized into unigrams, and stripped of punctuation, numerals, e-mail addresses, and URLs. Standard English stop-words were removed, and the remaining tokens were lemmatized to their base forms.

LDA is a generative, hierarchical Bayesian model that represents each document as a mixture of latent topics and each topic as a distribution over words [19]. Interpreting the model involved examining the highest-probability words in each topic and reading exemplary responses that carried a strong proportion of that topic. The researchers independently proposed labels for the topics and reconciled any differences through discussion, ensuring a shared understanding of what each cluster represented. Finally, topic prevalence scores were compared with the descriptive rankings from Section 3.4 to see whether the narrative emphasis echoed the quantitative priorities. Verbatim quotations are woven into the results chapter to give readers a richer picture of the reasoning behind high-priority issues such as licensure reciprocity or digital-delivery training. This integration of numeric and textual evidence strengthens the validity of the study's conclusions and grounds the recommendations in the language of the stakeholders themselves.

### 4. Survey Results (Quantitative)

#### **5.1**|Employer Survey Findings

The employer component of the study received 47 fully completed questionnaires, representing a cross-section of Washington's civil engineering and land surveying labor market that includes state and local public works agencies, consulting firms, design-build contractors, and geospatial services providers. Collectively these organizations manage thousands of lane-miles of roadway, multiple mega-projects currently in design or construction, and the bulk of private-sector surveying work statewide. The analysis that follows examines (1) organizational characteristics such as size, sector, and geographic reach; (2) current staffing levels, vacancy durations, and projected retirements; (3) the severity of skill shortages across technical and managerial domains; (4) perceived impacts of those shortages on project delivery; and (5) employer-generated proposals for alleviating workforce pressures. Descriptive statistics are reported as weighted percentages or means where appropriate, and qualitative excerpts are included to illustrate the reasoning behind high-priority concerns and solutions.

#### **5.1.1** Demographics of the Respondents

The 47 employer respondents were geographically well-distributed, covering at least 17 of Washington's 39 counties and thereby capturing both urban growth centers and rural jurisdictions (Figure 1). The highest concentration of responses originated from Snohomish, Skagit, and Garfield counties, which appear most prominently in the word-cloud graphic. Strong representation was also evident from Franklin, Kitsap, Okanogan, and Stevens counties, followed by contributions from Adams, Benton, Cowlitz, Grays Harbor, Island, Jefferson, Kittitas, Pend Oreille, Skamania, and Whitman counties. This spread—spanning Puget Sound, the I-5 corridor, the Columbia Basin, and the state's northern and inland regions—ensures that the employer findings reflect a broad cross-section of local market conditions, project types, and organizational sizes across Washington state.



Figure 1. The distribution of respondents in Washington State counties

As seen in Figure 2, the sample skewed toward the public sector, with 31 of the 47 respondents (66 percent) representing government entities—principally county public works departments, municipal engineering divisions, and state transportation offices. The remaining 16 respondents (34 percent) were drawn from private consulting, design-build, and surveying firms. This mix was advantageous for two reasons. First, it mirrored Washington's infrastructure delivery landscape, where public agencies remain the dominant owners of civil assets yet rely heavily on private consultants for project execution. Second, the sizeable public-sector share allowed the analysis to surface challenges unique to government hiring—such as civil-service pay bands and protracted procurement cycles—while still capturing market-based pressures identified by private employers, including talent poaching and fluctuating project pipelines.

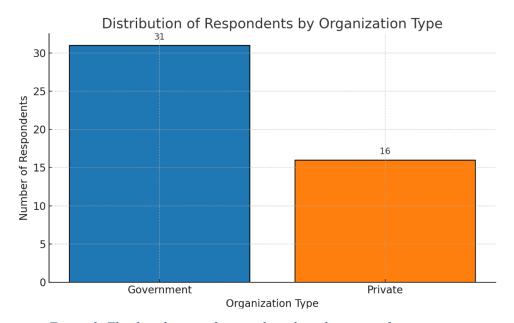


Figure 2. The distribution of respondents based on type of organization

Employer respondents spanned the full spectrum of organizational scale, from very small teams to statewide agencies (see Figure 3). The single largest cohort comprised firms with 11-50 employees (15 respondents,  $\approx 33$  percent), followed by medium-large organizations employing 101-500 staff (12 respondents,  $\approx 26$  percent). Micro-enterprises with fewer than ten employees (nine respondents,  $\approx 20$  percent) and major entities with more than 500 employees (five respondents,  $\approx 11$  percent) were both represented, while upper-mid-size employers in the 51-100 range account for the remaining five responses ( $\approx 11$  percent). This distribution ensured that the analysis captured workforce pressures experienced by lean county road shops and boutique surveying practices as well as the hiring dynamics of large consulting firms and multi-division public agencies. Consequently, subsequent findings on vacancy duration, skill shortages, and suggested remedies could be interpreted with due regard for differences in organizational capacity and staffing flexibility across the employer landscape.

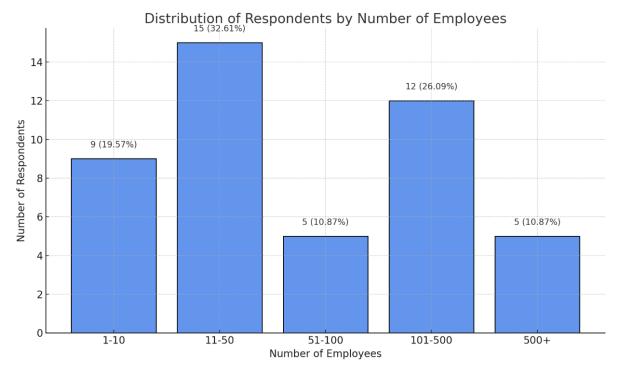


Figure 3. The distribution of respondents based on the size of organization

#### 5.1.2 The Identified Challenges

The combined staffing totals reported by the 47 employers confirmed that civil engineers dominated the workforce mix (762 positions, 63 percent of all personnel reported), while engineering technicians (305 positions, 25 percent) and land surveyors and surveying technicians (193 positions, 12 percent) represented considerably smaller, although still essential, talent pools (see Figure 4). Three inter-locking challenges emerged from this distribution.

First, the sheer scale of civil engineering demand places disproportionate pressure on a pipeline that Washington's higher-education system is already struggling to supply. Even if every in-state civil engineering graduate were to remain in Washington, the numbers would fall short of replacing projected retirements, much less satisfying the growth induced by historic infrastructure spending. Employers therefore confront chronic vacancies in design, construction management, and project delivery roles—vacancies that lengthen procurement schedules and inflate contract bids.

Second, the surveying workforce is numerically smaller but faces the steepest demographic cliff. Employers report barely one surveying professional for every four civil engineers, mirroring statewide licensure data that show an aging cohort of Professional Land Surveyors approaching retirement. Because surveying underpins every stage of infrastructure delivery—from right-of-way definition to as-built verification—the relative scarcity of surveyors can stall projects long before engineering design begins. Compounding the problem, Washington offers limited surveying programs, and students who do enroll often transition into geospatial technology careers in which salaries are higher and licensure hurdles lower.

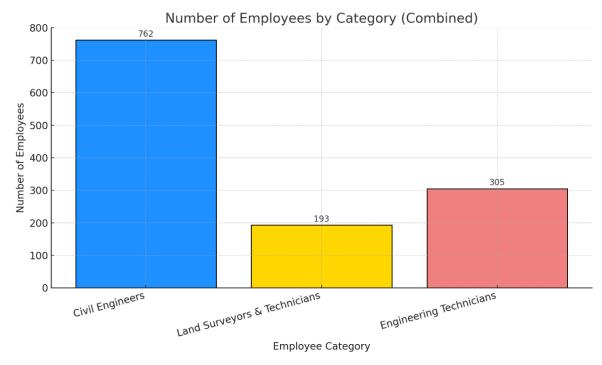


Figure 4. The distribution of employees in the sample based on the profession category

Third, the mid-sized engineering-technician group occupies a pivotal yet unsettled niche. Technicians perform field inspections, materials testing, and computer-aided design (CAD)/building information design (BIM) support—tasks increasingly shaped by digital workflows and sensor-based data acquisition. Employers noted that technicians who master drone photogrammetry, LiDAR processing, and model-based construction often advance rapidly, leaving entry-level gaps behind them. At the same time, community college programs that have historically supplied this workforce report declining enrollments, suggesting that the technician talent pool may tighten just as technology demands intensify.

The retirement profile reported by employers underscored the immediacy of Washington's workforce succession challenge. As seen in Figure 5, on average, almost one-quarter of all civil engineering, surveying, and technician positions (21.8 percent) will reach retirement eligibility within the next five years. Looking a decade ahead, that share will swell to nearly one-third (31.8 percent). Put differently, employers anticipate losing between one in five and one in three experienced staff members over a horizon that is shorter than the typical capital project delivery cycle. This projected "retirement cliff" is broadly consistent with national labor force data showing a bimodal age distribution in the AEC sector, in which large cohorts hired in the infrastructure boom of the 1980s and 1990s are now approaching full-pension status.

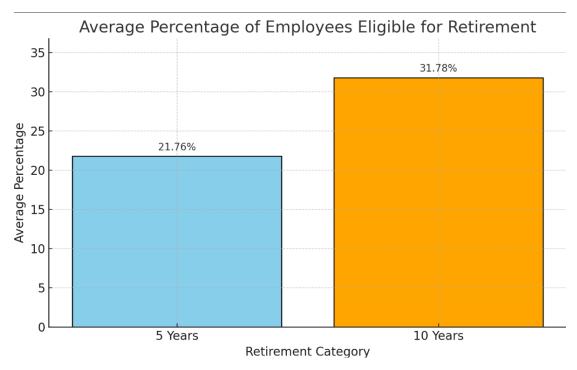


Figure 5. The situation of retirement in the sample

The implications are twofold. First, the impending loss of institutional knowledge—particularly among senior civil engineers and licensed surveyors who carry project management authority or sign-and-seal responsibilities—threatens to elongate design reviews, increase consultant oversight costs, and elevate project risk profiles. Second, the percentage increase between the five-year and ten-year outlook (+10 percentage points) suggests that organizations have only a modest buffer period in which to implement structured succession plans, mentorship programs, and targeted recruitment drives. Smaller county road departments and boutique surveying firms, which already operate with lean staffing, may find it especially difficult to backfill retirements without compromising service levels.

If unaddressed, these retirements will coincide with peak federal funding outlays under the Infrastructure Investment and Jobs Act, magnifying the gap between project demand and available professional capacity. Hence, strategic interventions—ranging from phased retirement options and accelerated licensure pathways for early-career staff to knowledge management systems that capture design standards and lessons learned—will be critical to sustaining project continuity over the next decade.

Employers were asked to indicate the positions for which they were currently experiencing persistent vacancies. As seen in Figure 6, the responses revealed a pronounced "missing middle" in the civil engineering career ladder. Mid-level civil engineers are the single most difficult role to fill, flagged by 34 of the 47 respondents (72 percent). Shortages remain acute at the senior tier as well—27 employers (57 percent) reported unfilled senior-engineer positions—while entry-level civil engineering vacancies affected 25 organizations (53 percent). Taken together, three-quarters of the sample were grappling with vacancies at two

or more career stages simultaneously, a finding that corroborates national studies showing talent leakage at both early-career and leadership nodes. Several factors help explain the spike in mid-career shortages. Public-sector agencies noted that engineers with five to ten years' experience are routinely recruited by private consultancies that can offer faster salary escalation, performance bonuses, and hybrid work arrangements. Conversely, private firms reported losing similar staff to publicly funded mega-projects, where longer delivery schedules and defined-benefit pensions are attractive. The result is a circular poaching cycle that redistributes, rather than grows, the state's engineer stock.

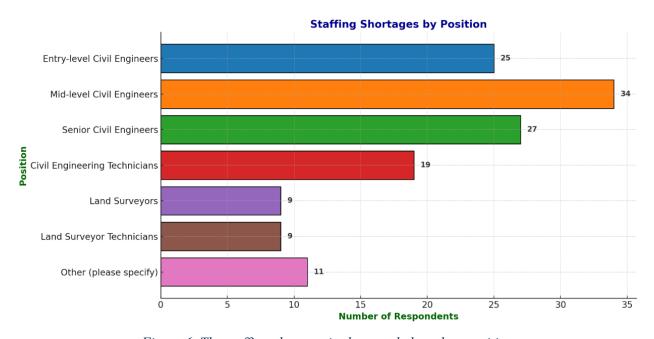


Figure 6. The staffing shortage in the sample based on position

Civil engineering technicians rank next in scarcity, cited by 19 employers (40 percent). Respondents attributed technician gaps to two converging forces: (i) declining community college enrollments in drafting and field inspection programs and (ii) accelerated upskilling of existing technicians into digital design roles, leaving back-of-house inspection slots unfilled.

Land surveying shortages appeared less frequently in absolute terms (nine employers each for surveyors and surveying technicians), yet they are highly consequential. Because only a subset of organizations maintain in-house surveying, those that do confront a tighter labor market, especially for licensed Professional Land Surveyors authorized to sign plats and legal descriptions. Several agencies noted relying on a shrinking pool of on-call contracts, which inflates costs and introduces scheduling risk.

Overall, the distribution of staffing gaps suggests that interventions must be stratified by career stage: incentives to retain and mentor early-career talent; expedited licensure and

leadership development for mid-career staff; and targeted education-industry partnerships to rebuild technician and surveying pipelines.

When the vacancy counts reported by each organization are aggregated, the scope of the shortage becomes even clearer. Across the 47 employers, senior civil engineer positions accounted for 83 of the unfilled posts, the largest single category (see Figure 7). Although fewer employers flagged this role than that of mid-level engineers (see the previous figure), those that did report senior shortages were typically large agencies or firms carrying multiple high-level vacancies at once. Such depth of need at the senior tier is especially problematic because these professionals hold signing authority, lead multidisciplinary design teams, and mentor junior staff; their absence therefore constrains organizational capacity far beyond the raw head-count loss.

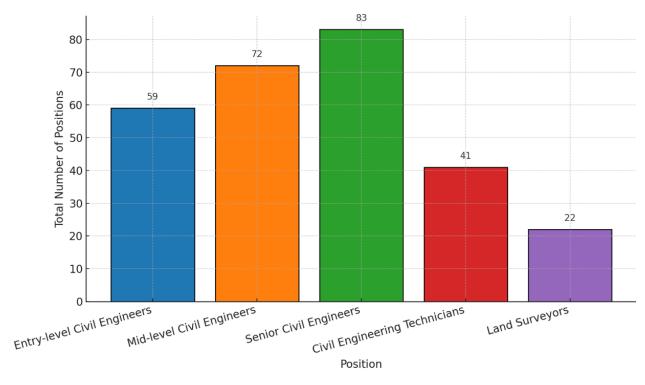


Figure 7. The number of available positions in the sample based on the profession

Mid-level civil engineering vacancies totaled 72 positions, reinforcing the "missing-middle" narrative in Washington's talent pipeline. Because mid-career engineers often serve as task leaders and project managers, their scarcity forces senior staff to absorb day-to-day management and design oversight, thereby magnifying burnout risk and accelerating additional departures.

Entry-level civil engineering roles represented 59 vacancies. Employers noted that many of these positions have remained unfilled for more than six months despite repeated recruitment cycles—a delay that hampers knowledge-transfer programs designed to groom successors for retiring staff.

Civil engineering technicians contributed another 41 unfilled posts, underscoring a gap in the technical workforce needed to support field inspections, materials testing, and BIM model updates. Without sufficient technicians, licensed engineers must divert billable hours to duties below their credential level, raising indirect project costs.

Finally, 22 vacancies pertained to land surveyors, a figure that at first glance appears modest but is significant when set against the small size of the surveying labor pool statewide. Several respondents emphasized that even one unfilled Professional Land Surveyor slot can halt right-of-way determinations or delay construction staking, thereby holding up entire project schedules.

Overall, the cumulative vacancy tally revealed a layered problem: entry-level shortages threaten future growth, mid-level gaps disrupt ongoing project management, and senior-level deficits erode strategic oversight and mentorship capacity. Any effective workforce strategy must therefore operate simultaneously at multiple career stages—expanding educational intake, accelerating early-career licensure, and retaining mid- and late-career talent through flexible work, phased retirement, and leadership development pathways.

The duration required to backfill open positions provides a direct measure of labor-market tightness, and as Figure 8 shows, the results were unambiguous: over half of the employers (27 of 46 usable responses (59 percent)) reported that vacancies persist for more than six months before a suitable candidate is hired. A further 15 organizations (33 percent) need three to six months, while only three employers (7 percent) can fill roles within a single quarter, and a single respondent reported success within one month. Taken together, these figures imply that roughly two-thirds of the engineering and surveying openings in Washington remain vacant for at least one full capital-budget cycle, a delay that compounds staffing shortages already identified in earlier figures.

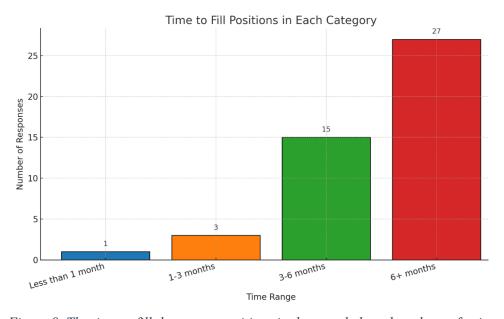


Figure 8. The time to fill the vacant positions in the sample based on the profession

Extended time-to-hire is especially prevalent among rural counties and small consulting firms, which lack the brand recognition and salary flexibility of larger metropolitan agencies. Public-sector respondents added that civil-service classification reviews and background checks can add six to eight weeks to the hiring timeline, further widening the gap between job posting and start date. Private firms, meanwhile, attributed delays to repeated offer rejections as candidates leverage multiple offers in a competitive market—a dynamic consistent with the "poaching cycle" described in national AEC workforce reports.

The operational consequences of protracted vacancies are significant. Project managers must redistribute workload across already burdened staff, increasing overtime costs and burnout risk; procurement schedules slip as design and review milestones go unstaffed; and agencies become more dependent on on-call contracts, raising external-consultant expenditure. These impacts underscore the urgency of the talent pipeline interventions proposed later in the report: without faster, more reliable recruiting channels, even well-funded infrastructure programs will struggle to deliver on schedule and within budget.

Employers were also asked to forecast the head-count they will need to add over three planning horizons. The resulting projections point to a steep and rapidly accelerating demand curve. As shown in Figure 9, across the sample, organizations anticipated hiring 613 additional staff within the next 12 months, rising to 678 hires over the following two- to three-year window and then more than doubling to 1,455 hires in four to five years' time. Cumulatively, that translates to 2,746 new positions—roughly 2.6 times the 1,060 vacancies already identified in the current workforce. Because these figures exclude normal attrition unrelated to retirement, the true hiring requirement is likely to be even higher.

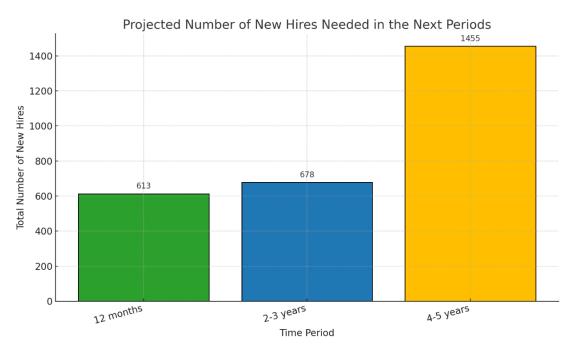


Figure 9. The time to fill the vacant positions in the sample based on the profession

The trajectory aligns with federal funding profiles under the Infrastructure Investment and Jobs Act, which predicts peak construction activity and therefore peak labor demand. If Washington's education and licensure pipelines continue to produce graduates at present rates, the projected shortfall will widen sharply just as the state reaches its most capital-intensive delivery phase. Furthermore, the pronounced jump between the two- to three-year and four- to five-year horizons mirrors the retirement eligibility curve shown earlier. Agencies will be replacing departing senior talent at the same time that they must scale up project execution, creating a "double bind" of growth and replacement demand.

These projections underscore the urgency of pursuing both near-term and long-term interventions. In the short term, accelerated apprenticeship and bridge-to-licensure programs could help agencies fill gaps more quickly than traditional four-year degree pipelines allow. Over the medium term, sustained investments in university enrolment growth, community college technician tracks, and targeted scholarship incentives will be essential to ensuring that the supply of new graduates does not fall even further behind escalating demand.

Figures 10 and 11 synthesizes employers' Likert-scale ratings of four commonly cited recruitment barriers. The stacked bar chart (Figure 10) illustrates the frequency distribution of responses, while the companion plot (Figure 11) translates those ordinal ratings into mean importance scores, allowing a crisp ranking of constraints.

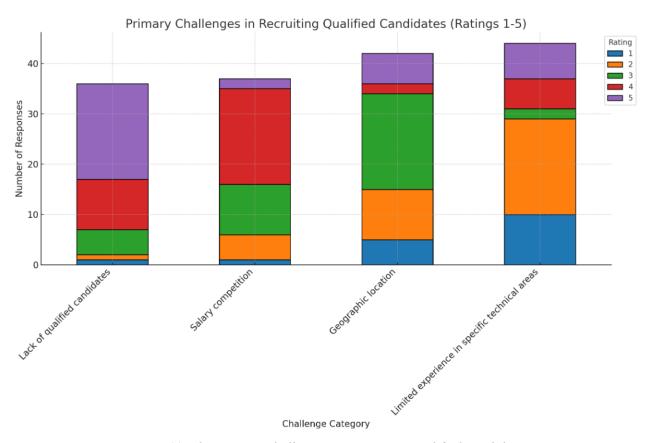


Figure 10. The primary challenges in recruiting qualified candidates

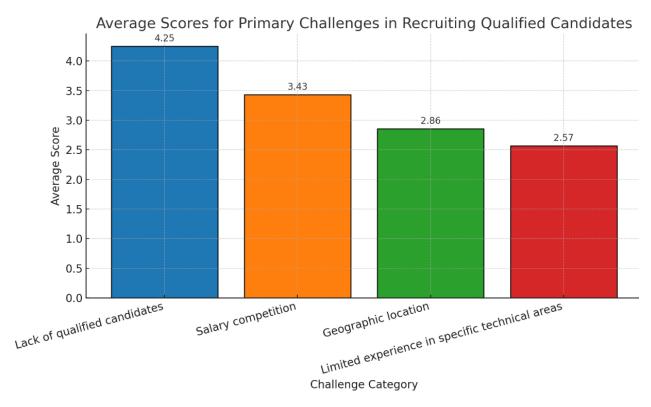


Figure 11. The average score of primary challenges in recruiting qualified candidates

Lack of qualified candidates emerges as the dominant challenge by a wide margin. Fully three-quarters of respondents assigned this item a severity rating of four or five, yielding an average score of 4.25—the only category to break the four-point threshold on the five-point scale. Interview comments suggested that the shortage is felt most acutely in digital delivery skill sets (e.g., BIM, LiDAR processing) and in project management competencies that combine technical acumen with client-facing responsibilities. The finding dovetails with vacancy data reported earlier, in which mid-level and senior civil engineering roles—positions that require precisely these hybrid skills—are in shortest supply.

**Salary competition** ranks second at 3.43. Although fewer employers marked it the top severity level, a substantial cluster of ratings at level four confirmed that Washington's public agencies and smaller consultancies are struggling to keep pace with compensation packages offered by multinational firms and by jurisdictions in the Mountain West that have recently raised pay scales to attract infrastructure talent. Several respondents noted that counter-offers have become routine, lengthening negotiation cycles and sometimes resulting in failed searches after provisional acceptance.

**Geographic location** achieved a mean of 2.86 but exhibited the widest spread in the stacked plot, indicating a bifurcated experience: urban Puget Sound agencies rarely cite location as a constraint, whereas rural counties and Eastern Washington firms frequently rated it a four or five. The disparity underscores the regionally uneven distribution of engineering education

pipelines, as most graduates prefer to remain within commuting distance of metropolitan job centers.

Limited experience in specific technical areas trailed with an average of 2.57. Respondents emphasized that this issue rarely blocks initial hiring but often surfaces during project execution, when engineers are expected to pivot to specialized domains such as hydrologic modeling or traffic signal optimization. Consequently, employers treat it more as an internal upskilling requirement than as an external recruitment obstacle.

Taken together, these results reinforce the quantitative vacancy and time-to-hire findings: the primary bottleneck is not simply persuading candidates to accept offers but locating individuals who already hold—or can rapidly acquire—the blend of licensure, digital fluency, and managerial experience required for modern project delivery. Addressing this hierarchy of challenges will therefore require a dual strategy: expanding the overall talent pool through education and pathway interventions, while simultaneously deploying targeted retention bonuses and flexible work policies to compete in a high-salary bidding environment, particularly for mid-career professionals.

Employers were asked to identify the specialized skill sets they find hardest to source, and the pattern that emerged reinforces the dual pressures of digital delivery and project execution already evident elsewhere in the survey (see Figure 12). Nearly four-fifths of respondents (36 of 46, 78 percent) cited project-management expertise as their most pressing need, signaling that organizations are constrained not only by a lack of technical labor but also by a shortage of professionals capable of coordinating budgets, schedules, risk registers and multidisciplinary teams. Because Washington's infrastructure program is dominated by complex, multi-agency undertakings (light-rail extensions, major Interstate bridges, and dam modernizations), demand for seasoned project managers is rising faster than the state's traditional Professional Engineer (PE) to Project Management (PM) career ladder can supply.

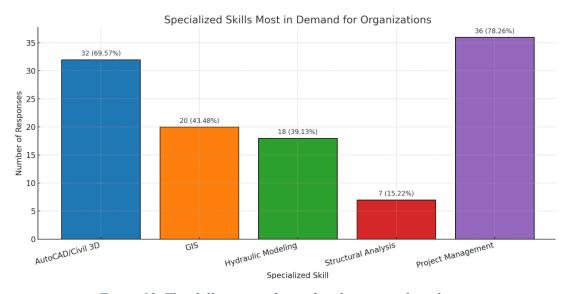


Figure 12. The skills most in demand in the surveyed employers

Digital design capabilities constituted the second major gap. AutoCAD/Civil 3D proficiency is required by 32 employers (≈70 percent), while geographic information systems (GIS) analytics (20 employers, 43 percent) and hydraulic or hydrologic modeling (18 employers, 39 percent) also figured prominently. These tools underpin model-based design reviews, utility-conflict detection, and environmental compliance workflows that are now mandated on most federally funded projects. Respondents emphasized that while recent graduates often have baseline CAD exposure, advanced Civil 3D corridor modeling, parametric subassembly scripting, and geodatabase management remain niche competencies rarely covered in-depth in undergraduate curricula. Likewise, hydraulic modeling software packages such as HEC-RAS or SRH-2D require domain knowledge that blends civil engineering, fluvial geomorphology, and numerical methods—an interdisciplinary mix difficult to cultivate on the job if foundational coursework is absent.

Traditional design domains, by contrast, ranked lower on the scarcity list. Only seven employers ( $\approx$ 15 percent) cited structural analysis expertise as a critical need, a finding that likely reflects the existence of established structural engineering graduate programs in Washington as well as a mature consultant market that can be tapped for bridge design subcontracts. The relative abundance of structural specialists, however, does not mitigate the acute shortages in project management and digital delivery skills that drive delays in early design and permitting phases.

Taken together, these data suggest that incremental increases in general civil engineering enrolment will not by themselves eliminate workforce bottlenecks. Instead, targeted curriculum enhancements (advanced Civil 3D coursework, GIS and data-analytics certificates, and project management modules aligned with Project Management Institute (PMI) or AACE International frameworks) are needed to equip graduates with the competencies most frequently cited by employers. Concurrently, mid-career upskilling programs such as boot camps or micro-credentials could rapidly expand the pool of practitioners capable of stepping into project management roles, thereby easing one of the most significant constraints on Washington's infrastructure delivery pipeline.

The pie chart in Figure 13 summarizes the contextual factors that employers believe will most strongly shape their future staffing needs. Infrastructure projects accounted for one-third of all responses (33 percent), reflecting the unprecedented capital program now under way in Washington—from Sound Transit's light-rail extensions to WSDOT's Interstate bridge replacements. Environmental regulations ranked a close second at 27.5 percent, indicating that compliance with National Environmental Policy Act (NEPA), Endangered Species Act (ESA), and state-level permitting regimes is expected to intensify demand for engineers and surveyors who can navigate environmental review, mitigation design, and habitat restoration requirements. Regional growth patterns comprised a further 25.3 percent, signaling that employers anticipate continued population migration to both Puget Sound and selected inland counties, thereby expanding workloads in land development, roadway capacity improvements, and utility upgrades. The residual 14.3 percent—labelled "other regional considerations"—captures more

localized drivers such as seismic retrofitting mandates on the coast and hydropower relicensing in the Columbia Basin.

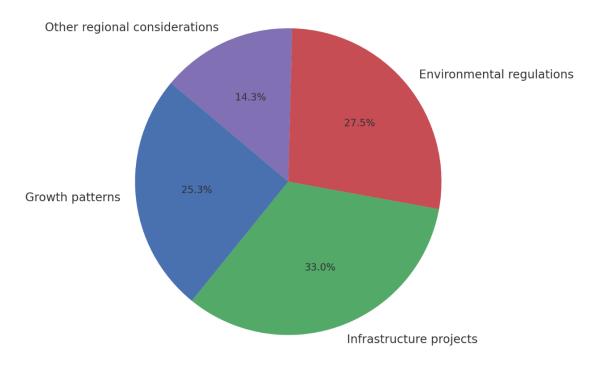


Figure 13. The effects of staff shortage on the industry

Taken together, these proportions suggest that Washington's workforce challenge is driven less by abstract labor-market trends than by concrete project pipelines and regulatory obligations. As infrastructure funding peaks and environmental oversight tightens, employers will need professionals who combine technical design expertise with fluency in permitting and regional planning processes. Education providers and apprenticeship sponsors can therefore maximize impact by aligning curricula with these specific external drivers—integrating modules on sustainable infrastructure, regulatory compliance, and growth management policy alongside traditional engineering fundamentals.

Employers' assessments of local education pathways revealed a significant perception—skills disconnect (see Figure 14). Fewer than one in five respondents believed that Washington's universities and colleges are currently producing graduates who arrive "job-ready." A plurality, 20 organizations (43 percent), answered "No," indicating that graduates lack several core competencies upon entry. Nearly the same share, 18 employers (39 percent), selected "Partially," acknowledging basic technical foundations but pointing to pronounced gaps in advanced digital delivery tools, interdisciplinary project management, and field-ready surveying techniques.

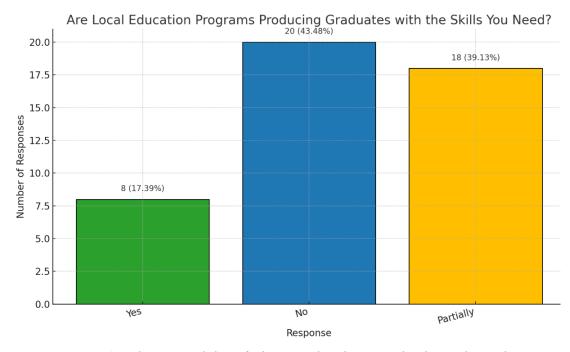


Figure 14. The compatibility of educational pathways and industry demands

These results corroborated earlier findings on specialized skill shortages: employers may find recent graduates familiar with AutoCAD or introductory GIS yet still struggle to recruit staff who can execute corridor modeling, data-driven asset management, or integrated schedule-cost controls without extensive on-the-job training. The perception that local programs under-deliver on practice-oriented skills strengthens the case for curriculum modernization—particularly the infusion of Civil 3D, BIM workflows, advanced hydrologic modeling, and PMI-aligned project management modules into undergraduate and associate degree tracks.

Employers were invited to rate a short-list of potential solutions on a five-point usefulness scale; Figure 15 displays the frequency distribution of ratings, while Figure 16 reports the corresponding weighted-mean scores. Three approaches emerged with nearly identical—and clearly favorable—evaluations, whereas a fourth option was viewed far more skeptically.

Enhanced education programs (defined in the questionnaire as expanding or modernizing university and community college curricula) received the highest weighted average (3.62). More than half of the respondents assigned this option a rating of four or five, signaling broad agreement that deeper digital design content, stronger surveying pathways, and earlier exposure to project management concepts are critical to long-term pipeline health.

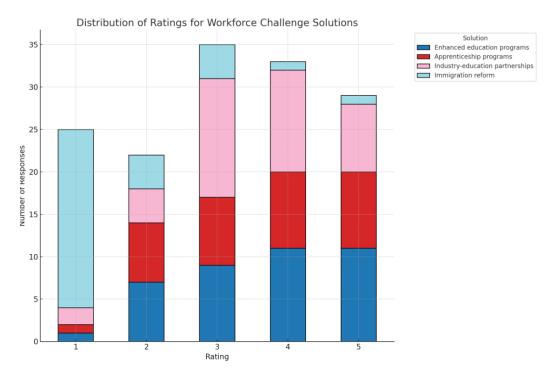


Figure 15. The ranking for the proposed solutions



Figure 16. The average score for the proposed solutions

Close behind were apprenticeship programs (3.53) and industry–education partnerships (3.50). The stacked bars show that both solutions draw most of their support from the upper half of the scale, with relatively few respondents opting for ratings one or two. Qualitative comments suggest that employers value apprenticeships for their "earn-and-learn" model, which can deliver

job-ready technicians within two years, and partnerships for keeping faculty abreast of rapidly evolving software and regulatory standards. The near-parity of the two means indicates that respondents saw them as complementary rather than competing levers.

By contrast, immigration reform registered a markedly lower average of 1.61. Although a handful of respondents rated it highly, the modal response was the minimum value. In follow-up interviews, several county agencies expressed doubt that foreign engineers would relocate to rural jurisdictions, while private firms cited the administrative burden of H-1B sponsorship. The low score does not imply an ideological objection to international recruitment so much as a pragmatic judgment that, given current federal caps and processing times, immigration is an unreliable strategy for meeting near-term labor needs.

Taken together, the ratings suggest a consensus pathway: modernize Washington's education pipeline, scale earn-and-learn models, and institutionalize two-way knowledge flow between classrooms and job sites. Immigration remains on the table but only as a longer-term or supplemental measure rather than a cornerstone of workforce strategy.

# 5.1.3 Discussion

The employer survey paints a convergent picture of Washington's civil engineering and land surveying labor market: acute vacancies, long recruitment cycles, and a looming retirement wave are all sharpening demand for talent faster than the existing education-to-employment pipeline can replenish it. Respondents located the root of the problem not in a single bottleneck but in the interaction of three structural deficits—an undersupply of practice-ready graduates, chronic shortages at the mid-career and senior levels, and persistently weak coverage of niche technical domains such as hydraulic modeling and dam safety.

Yet the same employers offered a remarkably uniform prescription. The three highest-rated interventions (enhanced education programs, apprenticeship pathways, and formal industry—education partnerships) share a common premise: workforce resilience must be built from within the state, through earlier, deeper, and more practice-oriented preparation. That apprenticeships and co-operative education feature so prominently underscores a preference for hands-on learning modalities that shorten the transition from classroom to billable work. It also reflects a desire to smooth the career ladder, giving junior staff clear milestones and route to the mid-level roles that most agencies and firms now find hardest to fill.

The emphasis on curriculum enhancement aligns with the gaps employers observe in recent graduates. Respondents reported that entry-level engineers often possess sound theoretical foundations but lack the interpersonal acumen, critical-thinking habits, and digital-delivery fluency needed for contemporary project environments. Strengthening university and community-college courses in BIM-enabled design, advanced GIS, project management, and interdisciplinary problem solving therefore emerges as an imperative, not merely an incremental upgrade. Continuous feedback loops (formal advisory boards, faculty externships, and co-developed studio projects) are seen as essential for ensuring that curricular updates keep pace with evolving industry standards and regulatory requirements.

Mid-career scarcity demands a complementary strategy. While education improvements will eventually expand the talent pool, employers cannot wait four to six years for supply effects to materialize. Apprenticeships, accelerated licensure tracks, and structured mentoring programs are viewed as near-term levers for retaining early-career staff and propelling them more quickly into supervisory roles. The survey findings also suggest that competitive compensation alone cannot solve senior-level shortages; public agencies and smaller consultancies must craft value propositions that include flexible work arrangements, project leadership opportunities, and phased-retirement options to prolong the tenure of experienced professionals.

Finally, the relatively low confidence in immigration reform highlights a pragmatic constraint rather than an ideological stance. Given federal visa caps and processing delays, employers see international recruitment as an unreliable buffer against the rapid escalation of local demand. Consequently, while immigration may still play a supplementary role, especially for highly specialized skills, it is unlikely to offset the projected hiring surge identified in the five-year outlook.

In sum, the employer data reinforced a central argument of this study: Washington's workforce challenge is best addressed through an integrated, education-centered pathway that combines modernized curricula, immersive work-based learning, and continuous industry engagement. Absent such measures, the state risks entering the peak spending years of the federal infrastructure program with a talent pipeline incapable of delivering projects on time, on budget, and to the standards of safety and resilience that the public expects.

# **5.2**|Practitioner Survey Findings

The practitioner component of the study yielded 917 complete responses, offering an unusually granular view of Washington's civil engineering and land surveying workforce as seen from the front lines. Respondents spanned the full career arc—from recent graduates preparing for the Fundamentals of Engineering (FE) and Land Surveyor-in-Training (LSIT) exams to senior principals with more than three decades of project experience. They also represented every major employment setting, including state and local public agencies, multidisciplinary consulting firms, specialist surveying practices, and construction contractors. This breadth allowed the analysis to probe not only headline indicators such as job satisfaction, intent to stay, and retirement timelines, but also the nuanced ways in which working professionals perceive skill gaps, licensure barriers, compensation structures, workplace culture, and the efficacy of proposed solutions. The sections that follow examine demographic composition, career trajectories, drivers of attrition, self-assessed competency gaps, and practitioner-generated recommendations, thereby complementing the employer perspectives presented in section 4.1 and completing the 360-degree view of Washington's AEC talent pipeline.

### 5.2.1 Demographics of Respondents

The practitioner sample was overwhelmingly composed of credentialed engineers, with 448 respondents (49 percent) self-identifying as civil engineers (see Figure 17). A further 94 individuals (10 percent) reported practicing as licensed land surveyors, while only 16

respondents in total—ten surveying technicians and six civil engineering technicians—occupied technician-level roles. The remaining 359 responses ( $\approx$  39 percent) fell into an "other" category that, based on open-text clarifications, included construction inspectors, utility coordinators, materials testers, GIS analysts, and project management staff who did not fit traditional license classifications.

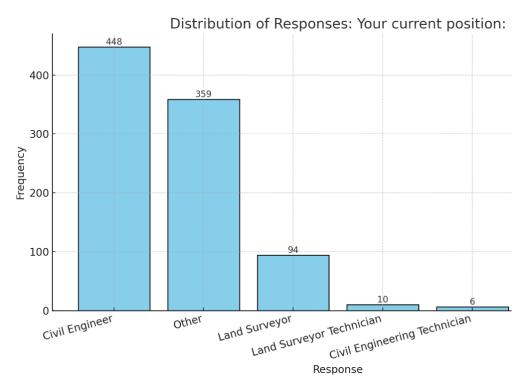


Figure 17. The current position of the respondents

This distribution reinforced two key themes that emerged from the employer survey. First, Washington's workforce pipeline remains heavily tilted toward professionally licensed engineers, even though project delivery increasingly depends on technicians who can operate drones, process LiDAR, and manage BIM models. Second, the comparatively small share of practicing surveyors and the near-absence of surveying technicians mirrored employer concerns about an aging, under-replenished surveying cohort. In short, while the practitioner dataset provided expansive coverage of civil engineering perspectives, it also exposed a structural weakness at the technician tier—precisely the segment that employers identified as their most difficult to staff for inspection, as-built verification, and data collection duties.

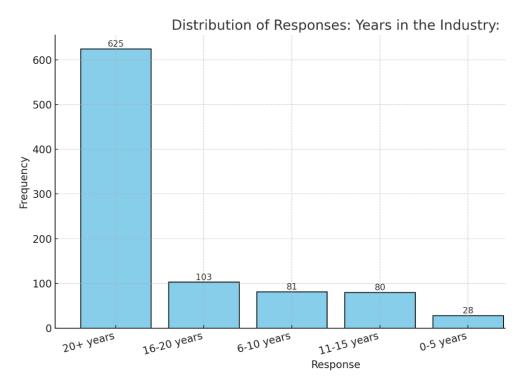


Figure 18. The current position of the respondents

The experience profile of the practitioner sample was heavily skewed toward late-career professionals. Fully 625 respondents (nearly 70 percent of the total) reported more than 20 years in the industry, while an additional 183 individuals (about 20 percent) fell in the 11- to 20-year band. Early-career perspectives were comparatively scarce: only 81 respondents (9 percent) had six to ten years' experience, and a mere 28 practitioners (3 percent) were in their first five years. This distribution mirrored the retirement-eligibility curve reported by employers and confirmed that Washington's AEC workforce is dominated by veterans who entered the profession during the infrastructure expansion cycles of the 1990s and early 2000s. The concentration of seasoned practitioners lends the dataset rich institutional insight into long-term trends, but it also underscores the urgency of replenishing the pipeline: as these individuals approach retirement, the state risks losing both technical expertise and mentorship capacity at a pace that entry-level recruitment alone cannot match.

The geographic footprint of the practitioner sample was strongly centered on Washington's urban corridors yet extended well beyond state lines. The word-cloud in Figure 19 shows Seattle as the dominant locus of activity—unsurprising given the concentration of public-works agencies, design consultancies, and higher-education institutions in King County. Other Puget Sound hubs (Tacoma, Bellevue, Everett, Olympia, Kirkland, Federal Way, and Lynnwood) also register prominently, reflecting the region's dense network of municipal and county engineering offices. Eastern Washington is well represented by Spokane, Richland, and Wenatchee, indicating that the survey captured perspectives from both sides of the Cascades. Border communities such as Vancouver (adjacent to Portland, Oregon) and

Bellingham (near the Canadian border) underscore the cross-jurisdictional nature of the state's infrastructure workforce.



Figure 19. The geographic distribution of the respondents

Smaller but noticeable clusters appear for neighboring states (Portland and Salem, Oregon; Boise, Idaho; and Missoula, Montana) as well as more distant locales, including California, Texas, and Alaska. These out-of-state respondents were largely consultants who served Washington clients remotely or professionals who began their careers in Washington and had since relocated. The presence of the term "Retired" further highlights the aging demographic identified in the experience-level analysis, signaling an emergent cohort of retirees who nonetheless maintain advisory or part-time roles within the industry.

Taken together, the spatial distribution of practitioners confirmed that Washington's civil engineering and land surveying ecosystem is both regionally concentrated and geographically interconnected. The preponderance of Puget Sound responses mirrored the state's population and project density, but the inclusion of voices from rural counties and neighboring states ensured that the forthcoming analyses of skill gaps, career intentions, and solution preferences would be grounded in a truly statewide perspective.

On average, each responding organization carried approximately 65 funded positions. Although that fraction may appear modest in absolute terms, its operational impact is magnified by the mean time-to-hire of nearly five months ( $\approx$  4.7 months). In practice, an agency or firm with four unfilled roles is likely to operate short-staffed for almost half a year, diverting senior personnel to backfill missing capacity and stretching project schedules. When viewed against the backdrop of impending retirements and a projected surge in infrastructure workload, even a mid-single-digit vacancy rate becomes a critical constraint on throughput. These figures

therefore reinforce previous findings that accelerating recruitment pipelines through streamlined HR processes, proactive internship-to-employment pathways, and targeted retention incentives is essential if Washington is to meet its civil engineering and land surveying obligations over the next decade.

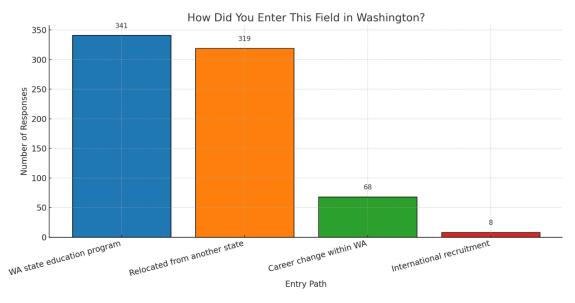


Figure 20. The entry path to the field for the respondents

As seen in Figure 20, responses to the "entry path" question underscored how Washington's AEC labor market relies almost equally on home-grown graduates and interstate in-migrants. Roughly 341 practitioners (37 percent of the sample) entered the profession after completing a Washington-based degree or certificate, confirming the pivotal role of the state's universities and community colleges in supplying first-career talent. Another 319 respondents (35 percent) relocated from other states, signaling that the region's project pipeline and quality-of-life attributes exert a strong pull on mid-career professionals but also making Washington vulnerable to cross-border salary competition and cost-of-living pressures.

By contrast, career changers who re-entered the workforce through Washington programs accounted for just 68 individuals (7 percent), and international recruitment contributed only eight practitioners (about 1 percent). The marginal role of career-transition pathways suggests that industry and licensing boards have yet to capture the untapped pool of professionals from adjacent fields such as construction management, environmental science, or the military who could be reskilled into surveying or technician roles. Likewise, the negligible inflow of foreign-trained engineers corroborated employers' skepticism that immigration reform will meaningfully ease near-term shortages.

Taken together, these findings imply a two-pronged strategy for pipeline resilience. First, strengthening Washington's own education capacity is essential, not merely to expand graduate numbers but also to hedge against the volatility of interstate labor flows. Second, targeted bridge programs such as accelerated licensure for domestic transferees, competency-based conversion

courses for career changers, and streamlined evaluation of foreign credentials could diversify entry routes without waiting for federal immigration policy shifts.

Practitioners were asked to identify the single greatest hurdle they faced when first entering the profession in Washington. As seen in Figure 21, two findings stand out. First, more than two-fifths of respondents (40.7 percent) selected "finding entry-level positions," confirming employers' own admission that vacancies cluster in mid- and senior-career bands while true training roles remain scarce. Interviews suggested that many organizations advertise "junior" openings that nonetheless require previous project experience, effectively excluding recent graduates and reinforcing a self-perpetuating shortage at the zero- to five-year mark.

Main Challenges Entering the Field

# Licensing/certification 19.2% Location/relocation issues 22.1% 40.7% 18.0% Meeting qualification requirements

Figure 21. The main challenges for entering to the field

Second, although access to jobs dominated, a combined 37 percent of respondents cited regulatory and qualification barriers: 19.2 percent struggled with licensure or certification logistics, and 18.0 percent reported difficulty meeting formal qualification requirements such as FE or LSIT passage, accredited program completion, or specific coursework prerequisites. These obstacles are particularly acute for career changers and interstate transferees, who often discover that previous experience does not map neatly onto Washington's licensing framework.

Location or relocation issues accounted for the remaining 22.1 percent. Respondents noted that many entry-level roles are concentrated in high-cost metropolitan areas, creating financial hurdles for graduates burdened by student debt or for mid-career professionals with family ties elsewhere. Conversely, rural agencies reported inability to convince candidates to relocate despite offering competitive salaries, underscoring the geographic asymmetry in Washington's labor market.

Taken together, the data call for a two-tiered intervention. At the organizational level, expanding authentic entry-level roles—internships that convert to permanent positions, structured graduate rotations, and supervised trainee slots—would absorb new graduates and reduce the bottleneck at the bottom of the career ladder. At the policy level, streamlining licensure reciprocity, recognizing relevant non-traditional experience, and subsidizing relocation or housing for early-career hires in high-cost regions could remove barriers that currently deter fresh talent from entering or remaining in the Washington market.

# **5.2.2** The Identified Challenges

Practitioners were asked how chronic understaffing affects their day-to-day work. The responses confirmed that labor shortages are not merely a human resources inconvenience but a direct operational threat (see Figure 22). Increased individual workload is the most pervasive consequence, cited by 625 respondents (68 percent). This intensification manifests as larger project portfolios, compressed design schedules, and diminished time for peer review—conditions associated in the research literature with higher error rates and professional burnout.

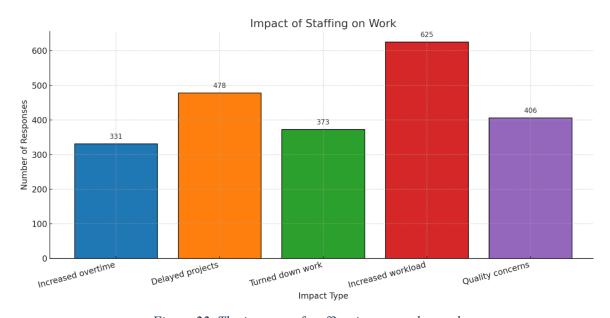


Figure 22. The impacts of staffing issues on the work

The second most frequent impact is project delay, reported by 478 practitioners (52 percent). Delays ripple outward: agency staff described slipping environmental permit deadlines, while consultants noted liquidated-damages clauses that erode profit margins. Closely related was the finding that 373 respondents (41 percent) had turned down work because they could not staff additional assignments without jeopardizing existing commitments. For public owners, this translates into smaller bidder pools and higher construction bids; for private firms, it represents lost revenue and reputational risk.

Quality degradation also looms large. More than 400 practitioners (44 percent) expressed concern that staffing gaps increase the likelihood of design omissions, inadequate field

inspections, or rushed submittal reviews. Such quality deficits can surface years later as premature asset deterioration or safety liabilities, thereby converting short-term labor shortages into long-term maintenance costs and legal exposure.

Finally, 331 respondents (36 percent) reported recurrent overtime as a coping mechanism. While overtime temporarily boosts throughput, it compounds fatigue and accelerates attrition, creating a feedback loop in which understaffing begets the very turnover that deepens the problem. Collectively, these self-reported impacts corroborated employer narratives about rising costs, schedule risk, and institutional knowledge drain, underscoring the urgency of the education, apprenticeship, and partnership interventions recommended in the preceding sections.

Practitioner narratives sharpen the statistical portrait of understaffing by pinpointing where, in the project life-cycle, labor shortages do the most damage. Respondents repeatedly emphasized that a diminished head-count constrains front-end quality assurance such as plan review, peer checking, and site inspection just as workloads are rising under the federal infrastructure program. When experienced reviewers are stretched across multiple submittals, critical design assumptions go unchallenged, and non-conformance items slip through to construction. Equally acute is the deficit in specialized design and construction-oversight talent. Complex tasks such as hydrologic modeling, development phasing, and on-site materials verification demand practitioners who can navigate both technical standards and regulatory requirements; without them, firms defer work, agencies extend review windows, and projects absorb costly schedule float.

The cascading effect surfaces again in permitting and plan-review backlogs. Local governments reported that staffing gaps lengthen turnaround times, frustrating private developers and eroding confidence in statutory deadlines. On the construction side, practitioners warned that insufficient field oversight invites rework: undetected deviations from specifications must be corrected later—often at the owner's expense—while latent defects elevate long-term safety risks. Collectively, these qualitative insights dovetailed with the quantitative findings on increased workload, project delays, and quality concerns, underscoring that workforce shortages are not merely an HR issue but a systemic threat that permeates every stage of Washington's infrastructure delivery pipeline.

Practitioners were unequivocal about the competency gaps they observe in newly minted graduates. Field experience dominated the list, with 624 respondents (more than two-thirds of the sample) identifying it as the most critical shortfall (see Figure 23). The message echoed earlier concerns about project delays and quality lapses: without previous exposure to construction sites, permitting workflows, and inspection protocols, graduates struggle to translate classroom theory into buildable plans and defensible technical memos.

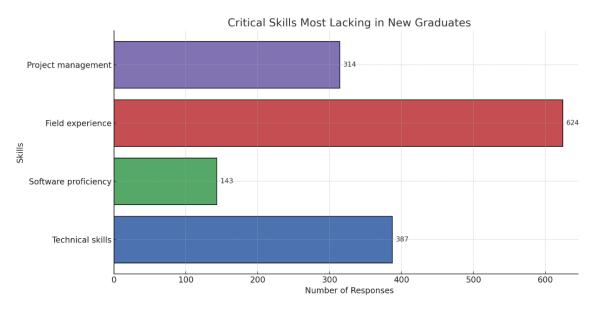


Figure 23. The critical skills lacking in new graduates for entering the field

Core technical skills ranked second (387 responses), suggesting that even foundational knowledge in materials, hydraulics, and geometric design requires further reinforcement once graduates confront real-world tolerances, codes, and interdisciplinary coordination. Closely related is project-management acumen (314 responses). Although few entry-level engineers are expected to manage full project scopes, practitioners emphasize the importance of cost awareness, schedule literacy, and stakeholder communication—competencies that accelerate the path to the mid-career roles now in critically short supply.

Interestingly, software proficiency trailed the other categories (143 responses). This does not mean that digital skills are abundant; rather, basic familiarity with CAD and GIS is becoming universal, while the deeper modeling and data-integration capabilities that employers crave fall under the broader umbrellas of field experience and technical depth. Taken together, the data affirmed that Washington's education pipeline must move beyond credit-hour compliance toward immersive, practice-integrated learning; co-op rotations; capstone projects with genuine client deliverables; and mentorship arrangements that expose students to the messy, multidisciplinary realities of modern infrastructure delivery.

The same pattern of skill gaps that practitioners observed in recent graduates was mirrored—although in a different order of magnitude—among seasoned professionals already established in the field. As shown in Figure 24, when respondents were asked which competencies they most often found missing in experienced engineers, the dominant answer was again on the organizational, rather than purely technical, side of practice. Leadership skills were flagged by 558 practitioners, indicating that even engineers with two or more decades in the profession frequently lack the ability to mentor junior staff, steer multidisciplinary teams, or negotiate scope and risk with owners and contractors. Closely related, project-management capability was cited by 321 respondents, underscoring persistent deficiencies in schedule control,

cost forecasting, and stakeholder coordination—competencies that become critical as engineers transition from task leads to project directors.

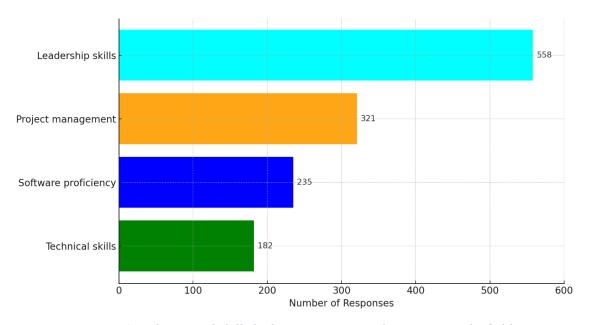


Figure 24. The critical skills lacking in experienced engineers in the field

Digital fluency continued to lag: 235 practitioners pointed to insufficient software proficiency—most often advanced Civil 3D modeling, GIS analytics, or hydraulic-simulation platforms. Another 182 reported gaps in foundational technical knowledge, typically in emerging areas such as low-carbon concrete design or resilience-based bridge analysis. Taken together, the responses revealed that longevity in the profession does not necessarily guarantee mastery of the leadership, managerial, or evolving technical skills demanded by today's infrastructure projects. They reinforce the need for mid-career upskilling programs—leadership academies, PMI-aligned certificates, and software boot camps—that keep veteran engineers current while preparing them to fill the mid- and senior-level vacancies that employers struggle to staff.

The attrition calculus reported by practitioners aligned closely with the demographic and workload trends documented throughout this chapter. Retirement headed the list, cited by 491 respondents (54 percent), reaffirming that the most immediate threat to workforce continuity is not voluntary turnover to competing firms but the large cohort of late-career professionals who will exit permanently within the next decade (see Figure 25). In effect, the retirement cliff is not hypothetical; it is a lived intention among more than half of the survey sample.

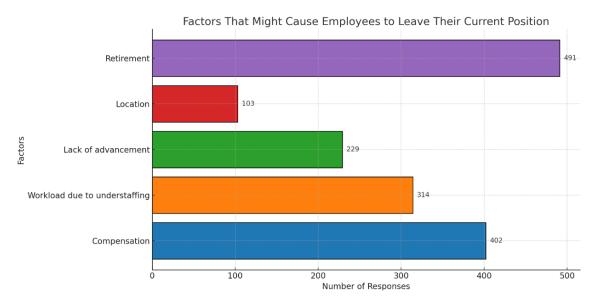


Figure 25. The main reason for the engineers deciding to leave the field

Among non-retirement factors, compensation pressure was the dominant motivator, selected by 402 practitioners (44 percent). This finding underscores employer concerns about salary competition and suggests that Washington's public agencies and smaller consultancies remain vulnerable to poaching by high-margin firms and out-of-state jurisdictions able to offer premium pay. Close behind was the workload induced by understaffing (314 respondents, 34 percent). Heavy overtime and expanded project portfolios are eroding job satisfaction, thereby accelerating departures that further tighten the labor market.

Career development also matters. Lack of advancement opportunities was identified by 229 respondents (25 percent), signaling that flat organizational hierarchies and limited pathways to project management roles can drive mid-career professionals to seek alternative employers or industries. Finally, location considerations (103 respondents, 11 percent) play a comparatively minor role, indicating that for most engineers and surveyors the decision to leave is driven more by conditions intrinsic to the job than by geography alone.

Collectively, these drivers suggest a multifaceted retention strategy: phased retirement or knowledge-transfer programs to capture institutional expertise; market-responsive compensation structures to stem mid-career attrition; workload balancing through targeted hiring and better project-capacity planning; and clearly articulated promotion pathways paired with leadership training to keep early- and mid-career practitioners engaged. Absent such measures, Washington's infrastructure owners and service providers risk a compounded loss: the simultaneous departure of veteran expertise and the voluntary exit of the very professionals needed to replace that expertise in the project delivery pipeline.

### 5.2.3 Discussion

The practitioner survey reinforced and nuanced the labor-market signals recorded by employers. Respondents depicted a workforce strained on three fronts—capacity, capability, and

continuity—and the interplay among those constraints is already eroding Washington's ability to deliver infrastructure projects on time, within budget, and to the desired quality standard.

Capacity. Staffing shortages are pervasive across engineering, surveying, and technician roles, and their operational effects are immediate: inspections are deferred, permit reviews pile up, and construction oversight is stretched so thin that errors and re-work become commonplace. The work therefore shifts onto the shoulders of the staff who remain; nearly one-third of practitioners link their intent to leave directly to the unsustainable workload that results. Because under-staffing triggers overtime fatigue and quality lapses, it sets in motion a self-reinforcing cycle of burnout and further attrition.

Capability. The survey exposed a persistent misalignment between academic preparation and day-one job requirements. Two-thirds of practitioners judged new graduates deficient in field experience, and a substantial share cited gaps in core technical knowledge and rudimentary project management skills. That disconnect slows onboarding, diverts senior engineers into remedial mentoring, and widens the project delivery bottleneck that shortages have already created. Crucially, the capability gap is not confined to early-career hires. Seasoned professionals themselves acknowledge shortcomings in leadership and modern project management practice, suggesting that the industry is promoting technical experts into supervisory posts without equipping them to lead teams, negotiate risk, or integrate the increasingly digital toolsets that projects demand.

**Continuity**. The most frequently cited reason for leaving one's current position is retirement, confirming the demographic cliff first highlighted by employers. More than half of respondents reported planning to exit the labor force in the near term, and their departure will coincide with the very years that federal infrastructure spending is set to peak. Continuity is further threatened by mid-career churn: nearly half of practitioners would consider leaving for higher pay, and a quarter cited insufficient advancement prospects. In short, Washington faces not only a quantitative shortfall in head-count but also a qualitative drain of institutional knowledge and managerial capacity.

Taken together, the practitioner evidence underscores that Washington's workforce challenge cannot be solved by focusing on a single career stage or intervention. Expanding educational enrollment is essential but insufficient if graduates still arrive without field competence; likewise, upskilling incumbent staff is critical but will not avert a talent cliff unless succession pipelines are simultaneously strengthened. An integrated response (modernized, experiential curricula; structured apprenticeships and residencies that accelerate licensure; leadership development academies for mid-career staff; competitive, performance-linked compensation; and phased retirement programs that facilitate knowledge transfer) offers the most plausible route to stabilizing the talent base and safeguarding the state's infrastructure ambitions.

# 6. Open-Ended Insights and Topic Modeling

In the preceding sections of this report, we analyzed responses from practitioners and employers regarding the challenges associated with workforce development. This section focuses on analyzing open-ended responses with topic modeling techniques.

We begin by visualizing the responses through frequency graphs of the top 20 most common words. This is followed by word clouds to illustrate prominent themes. Subsequently, we present the results of topic modeling. Finally, we provide a detailed discussion of the findings and offer interpretations grounded in the results.

# **6.1**|Challenges in Workforce Development

# 6.1.1 Attracting and Retaining Experienced Professionals

The research question asked: "What unique challenges does Washington state or your current state face in attracting new professionals and retaining experienced professionals?"

# Word Frequency Analysis

Figure 26 shows the 20 most common words used in responding to the question. Figure 27 is a word cloud depicting the frequency and importance of words used in the open-ended responses.

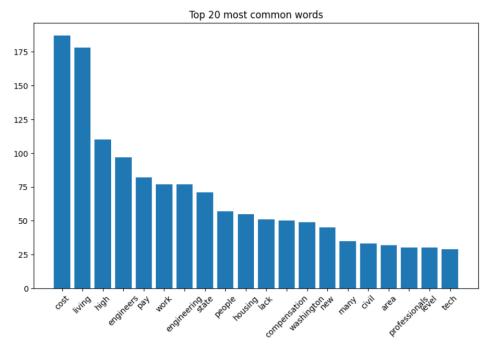


Figure 26. Top words frequency graph



Figure 27. Word cloud from the open-ended responses

### 1. Economic Pressures

"Cost" (187), "living" (178), "high" (110), "housing" (55), "costs" (25) appeared with the highest frequencies.

- The dominance of terms such as "cost" and "living" suggests that economic pressures, particularly the high cost of living, are a major concern.
- This finding directly supports the idea that professionals in Washington state face financial challenges due to expensive housing markets and overall high living expenses.
- High living costs put pressure on employers to offer competitive compensation packages; otherwise, they risk losing or failing to attract talent.

# 2. Compensation and Pay Issues

"Pay" (82), "compensation" (50), "salary" (18), "low" (29), "higher" (22): indicate an ongoing conversation about how professionals are paid.

- The mention of "pay" and "compensation" reflects concerns that the salary levels may not adequately offset the high cost of living.
- Words such as "low" and "higher" suggest a perceived gap or disparity between expected wages and the financial realities of living in a high-cost area such as Washington state (including cities like as Seattle).

# 3. Workforce and Professional Identity

"Engineers" (97), "engineering" (77), "professionals" (30), "professional" (21), "career" (22), "students" (21), "entry" (19) point to issues related to both attracting new talent and retaining existing professionals.

- The frequent appearance of "engineers" and "engineering" confirms the focus on the professional community in this field.
- The inclusion of words such as "*students*," "*entry*," and "*career*" indicates challenges in the pipeline—new professionals may be deterred by the high barriers to entry and the perceived lack of clear career progression.
- "Professionals" and "professional" tie into the overall identity and quality of the workforce, reflecting concerns about both recruitment and retention.

# 4. Geographical and State-Specific References

"Washington" (49), "state" (71), "Seattle" (26), "wa" (23) ground the responses in a specific geographical context.

- They confirm that many of the responses are directly addressing challenges in Washington state.
- The mention of "Seattle" alongside state and "Washington" underscores that urban centers with particularly high living costs and competitive job markets are critical focal points.

# 5. Other Relevant Aspects

"Work" (77), "lack" (51), "industry" (26), "tech" (29) add nuance to the analysis.

- "Work" and "industry" were common, indicating that issues extend to the structure of work itself and the competitive dynamics within the industry.
- The word "*lack*" might relate to a perceived shortage—a lack of either sufficient job opportunities, resources, or support systems.
- "*Tech*" could suggest that there is also competition or influence from the technology sector, which is known for offering attractive compensation and work-life balance options, further challenging traditional engineering roles.

The word frequency analysis reinforces and deepens our understanding of the challenges identified through topic modeling. In Washington state (or your current state),

- High cost of living and expensive housing markets create a financial strain that demands higher salaries; something that traditional engineering roles often struggle to provide.
- Compensation disparities are a significant deterrent, as potential new professionals may not see the financial incentives needed to start a career, while current professionals may leave for better-paying opportunities.
- Pipeline issues and professional identity concerns further compound the problem, as challenges in education, training, and clear career progression discourage fresh talent from entering the field.
- Local economic conditions and competitive pressures from booming industries (like tech) exacerbate these challenges by drawing away talent with more attractive compensation and working conditions.

Together, these factors paint a picture of a state struggling with both attraction and retention of engineering talent. This is a multifaceted challenge that requires coordinated solutions in terms of salary adjustments, educational support, and industry policy reforms.

# Topic Modeling Analysis

# Topic 0

This topic points to concerns about compensation, experience levels, and professional requirements. It could reflect frustration with the pay scale in engineering fields or the notion that professionals might leave for better opportunities.

```
0.034*"level" + 0.034*"pay" + 0.017*"work" + 0.017*"entry" + 0.015*"field" + 0.015*"people" + 0.015*"professional" + 0.014*"better" + 0.014*"requirements" + 0.014*"experience"
```

Original response: Highly paid IT professionals cause many engineers to leave the profession for higher pay.

Original response: experience in broader range

# **Top Terms**

- "Level" and "pay" have the highest coefficients (0.034).
- Other strong words: "entry," "field," "professional," "experience."

These words suggest discussions about job levels, compensation, and professional expectations in an engineering context.

# **Link to Sample Responses**

- "Highly paid IT professionals cause many engineers to leave the profession for higher pay." Matches the emphasis on "pay" and "professional."
- "Experience in broader range." talks about "experience," aligning with the top words.

# Topic 1

This topic revolves around the identity of engineering as a trade or profession, concerns about professional competition, and how external factors such as education or certification play into it.

```
0.058*"engineering" + 0.027*"people" + 0.027*"many" + 0.026*"want" + 0.024*"civil" + 0.023*"engineers" + 0.020*"expensive" + 0.019*"live" + 0.018*"see" + 0.017*"side" Original response: Is it a trade or a profession? When does it change from one to the other? Getting students to FINISH their certification/degree program Original response: Licensed designers do not want to train their competitors Original response: The in-state projects can be limiting based on client size.
```

# **Top Terms**

- "Engineering" (0.058) is very dominant here.
- Other relevant words: "civil," "engineers," "expensive."

• Mentions of "people," "want," and "live" suggest a focus on human/individual aspects of engineering.

# **Link to Sample Responses**

- "Is it a trade or a profession? When does it change from one to the other? Getting students to FINISH their certification/degree program." Reflects the discussion of "engineering" as a profession vs. a trade.
- "Licensed designers do not want to train their competitors." Possibly touches on "people," "engineers," and professional boundaries.

# Topic 2

This topic emphasizes regional (especially Washington state) and economic factors—particularly housing costs, job availability, and the broader economic environment for engineers.

```
0.056*"housing" + 0.036*"work" + 0.030*"washington" + 0.029*"costs" + 0.025*"engineering" + 0.024*"new" + 0.022*"people" + 0.020*"lack" + 0.017*"state" + 0.016*"cost"
```

Original response: This work is technically difficult and there's defined growth potential.

Original response: The biggest challenge is attracting businesses and clients to Washington and Oregon that will require engineering work. The downturn of large manufacturing companies such as Boeing, Intel, and others eliminate engineering positions across the state. Manufacturing drives the basis of the economy which in turn makes infrastructure jobs possible.

Original response: High housing costs and commute time

# **Top Terms**

- "Housing" (0.056) and "Washington" (0.030) stand out.
- "Costs" also appears frequently (0.029), indicating financial considerations.
- The presence of "lack," "new," and "people" suggests regional challenges such as high living expenses.

# **Link to Sample Responses**

- "High housing costs and commute time." Directly references "housing" and "costs."
- "Attracting businesses and clients to Washington... downturn of large manufacturing companies... eliminates engineering positions across the state." Ties in with "Washington," "people," and "lack."

# Topic 3

Topic 3 focuses on compensation issues (pay vs. responsibility), workforce retention, industry cycles, and the challenges faced by licensed engineers in places like Washington.

```
0.076*"engineers" + 0.055*"pay" + 0.019*"industry" + 0.018*"opportunities" + 0.017*"lack" + 0.016*"washington" + 0.016*"licensed" + 0.015*"less" + 0.014*"salary" + 0.014*"state"
```

Original response: Tradesman make more money than engineers with no responsibilities. I can make more money as a driller or truck driver than as a Licensed Professional Engineer in Chicago. Substantially more money. Less headaches less responsibility and less work. The workload expectations, we are expected to handle everything and anything for the same money. Most of the students do not want to be in the field and want to work remotely.

Original response: Inconsistent state funding. Some good years, then hiring freezes and layoffs soon to follow. I have seen the cycle at least three times. We're in the beginning of another now.

Original response: Retaining Experienced Professionals

- 1. Retirement Wave A large portion of Washington's survey workforce is approaching retirement, and knowledge transfer systems are inconsistent across municipalities and companies. Brain Drain As senior surveyors retire, there's a risk of losing institutional knowledge and experience, which can slow projects and decrease efficiency.
- 2. Limited Career Advancement Municipal roles can sometimes lack clear paths for advancement and are often dead ends for upper managers, leading mid-career professionals to pursue opportunities elsewhere. Recognition Gaps Without structured recognition programs, experienced surveyors may feel undervalued, reducing job satisfaction and increasing turnover.
- 3. Technology and Equipment Outdated Tools Some municipalities lack the budget to invest in modern surveying equipment and technology, leading to frustration among professionals who prefer working with the latest tools.
- 4. Workload and Burnout With fewer surveyors available, existing staff often face increased workloads

### Top Terms

- "Engineers" (0.076) has a significantly higher coefficient than "pay" (0.055).
- Words like "industry," "opportunities," "licensed," "salary," "lack" suggest workforce and career advancement issues.

# **Link to Sample Responses**

- "Tradesman make more money than engineers with no responsibilities..." Reflects "pay," "engineers," and "less."
- "Inconsistent state funding... cycle of hiring freezes and layoffs..." Matches words like "state," "opportunities," "lack."
- Longer response about "Retaining Experienced Professionals" with references to retirement waves, knowledge transfer, and job frustration.

### Topic 4

Topic 4 strongly concerns the high cost of living, particularly in places like Seattle, and its impact on compensation and workforce retention. This resonates with broader economic themes regarding housing affordability and salaries.

```
0.173*"cost" + 0.165*"living" + 0.093*"high" + 0.033*"compensation" + 0.025*"state" + 0.020*"area" + 0.015*"work" + 0.013*"wages" + 0.013*"seattle" + 0.012*"applicants"
```

Original response: Competing with startups and software engineering companies that have fully remote work policies makes it difficult to attract new professionals. Retaining experienced professionals is difficult once they earn their PE license due to limited salary increases and sometimes title changes.

Original response: Cost of living

# **Top Terms**

- "Cost" (0.173) and "living" (0.165) dominate this topic.
- "High," "compensation," "wages," "Seattle" reinforce a high cost-of-living theme in specific areas (Seattle).

# **Link to Sample Responses**

- "Competing with startups and software engineering companies... difficult to attract new professionals... limited salary increases..." Ties directly into "cost of living," "compensation," and "wages."
- "Cost of living" repeated. Precisely matches the top terms.

### **Conclusions**

- Topic 0's responses highlight issues around pay and professional stages.
- Topic 1 focuses more on professional identity and education.
- Topic 2 is about economic challenges (housing, business opportunities, state-level factors).
- Topic 3 emphasizes compensation versus responsibility, hiring cycles, and workforce retention.
- Topic 4 zeroes in on cost of living and high expenses in certain areas.

# 1. Economic Pressures and Compensation Challenges

# • High Cost of Living

- o Topic 4 shows dominant weights for "cost" (0.173) and "living" (0.165), with additional emphasis on "high," "compensation," and "Seattle."
- O Interpretation: In Washington state—especially in urban hubs like Seattle—the steep cost of living creates significant pressure on both new and experienced professionals. Companies may struggle to offer salaries that compete with high housing and living expenses, making it difficult to attract new talent. Likewise, experienced professionals might feel that salary increases are inadequate relative to local costs, prompting them to seek opportunities elsewhere.

# Pay Disparities and Workforce Retention

- o Topics 0 and 3 both highlight the importance of "pay," "experience," and "engineers" with relatively high coefficients.
- o Interpretation: Feedback such as "Highly paid IT professionals cause many engineers to leave the profession for higher pay" (Topic 0) and the observation that "Tradesman make more money than engineers..." (Topic 3) suggest that professionals in Washington face stiff competition not only from outside the traditional engineering sector but also within local industries where pay scales do not always align with the cost of living or the level of responsibility. This creates a double-edged problem:
  - Attracting New Talent: Potential entrants may see a career path that does not provide starting salaries that are competitive with those of alternative industries or regions.
  - Retaining Experienced Professionals: Longtime workers may leave if compensation does not improve commensurately with rising living costs and increased job demands.

# 2. Industry Dynamics and Funding Instability

### • Economic Downturns and State Funding Cycles

- Topic 2 incorporates terms such as "housing," "Washington," "costs," and "state," while Topic 3 mentions "industry," "opportunities," "licensed," and "state."
- o Interpretation: Responses point to regional challenges where the downturn of large manufacturing companies (e.g., Boeing, Intel) and inconsistent state funding result in cycles of hiring freezes and layoffs. Such economic instability affects the local engineering ecosystem by
  - Reducing the Number of Positions: A shrinking pool of stable jobs makes the field less attractive to new professionals.
  - Increasing Job Insecurity: Experienced professionals face uncertainty, which can lead to a brain drain as they seek more secure positions elsewhere.
  - Impacting Infrastructure Projects: With fewer companies willing to invest during economic downturns, the pipeline for new projects diminishes, further discouraging both entry and long-term commitment in the field.

# 3. Educational and Professional Identity Concerns

# Certification and Professional Boundaries

- o Topic 1 is weighted heavily on words such as "engineering" (0.058), "civil," and "engineers" along with qualitative terms such as "want" and "expensive."
- o Interpretation: The sample responses raise fundamental questions about the nature of the profession—such as whether engineering is seen as a trade or a full-fledged profession—and highlight the following challenges:

- Completion of Certification/Degree Programs: Struggles in getting students to finish their certification or degree may limit the influx of new talent into the industry.
- Knowledge Transfer Issues: Comments about licensed designers being unwilling to train competitors indicate a potential bottleneck in professional development, which can hinder mentorship and the growth of a robust professional community.
- Perception of the Field: If prospective engineers perceive the career path
  as fraught with issues—from unclear professional boundaries to limited
  advancement opportunities—they may be deterred from entering the
  industry in the first place.

# Merged Insights

By linking the insights from all topics, a coherent picture of the unique challenges in Washington state emerges.

- Economic Pressures: The high cost of living (Topic 4) demands competitive compensation packages. However, local industry responses (Topics 0 and 3) suggest that engineers often receive less pay relative to rising expenses and that other sectors (such as IT or trades) may offer more attractive compensation for similar or even less demanding roles.
- Funding and Industry Cycles: The instability caused by downturns in major manufacturing companies and erratic state funding (Topics 2 and 3) creates a challenging economic environment. These cycles result in fewer opportunities and unstable job security, which in turn makes it hard to build a loyal, long-term workforce.
- Professional Pipeline and Identity Issues: Educational hurdles and the unclear demarcation of what it means to be an engineer (Topic 1) further complicate the landscape. Without a steady stream of well-prepared new entrants or clear professional pathways, the industry struggles to rejuvenate its talent pool.
- Overall Impact: These combined challenges mean that Washington state faces a multifaceted problem:
  - Attraction: New professionals may be discouraged by the perceived lack of competitive starting salaries, high living costs, and an ambiguous professional identity.
  - Retention: Experienced professionals may leave because of insufficient compensation adjustments, job insecurity due to funding cycles, and a lack of clear career advancement paths.

### Summary

The topic modeling results collectively indicate that Washington state's unique challenges in attracting and retaining professionals include the following:

• High living costs that put pressure on salary structures.

- Economic instability due to downturns in key industries and inconsistent state funding.
- Competitive pressures from other sectors (such as IT and trades) offering better compensation and work-life balance.
- Educational and professional identity issues that hinder the development of a robust pipeline of new talent.

Addressing these challenges may require a multifaceted approach, including competitive salary adjustments, strategic investments in education and training, and policies that stabilize funding for key infrastructure projects. This synthesis provides a comprehensive view of why the engineering field in Washington state struggles with both attracting new professionals and retaining experienced ones.

# 5.1.2 Challenges – Impact of Staff Shortages on the Current Projects

### Word Frequency Analysis

Figure 28 shows the 20 most common words used in responding to the question. Figure 29 is a word cloud depicting the frequency and importance of words used in the open-ended responses.

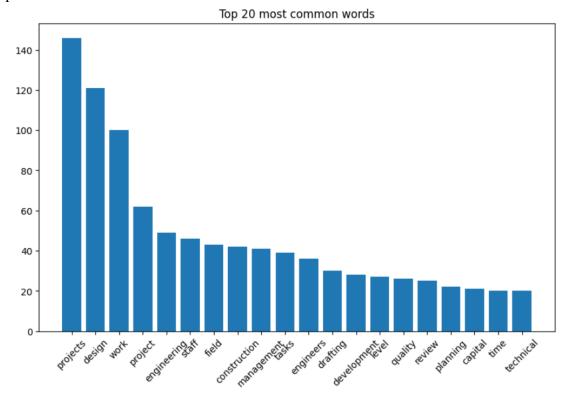


Figure 28. Word Frequency graph



Figure 29. Word cloud from the responses

# Key Themes Emerging from the Frequencies

# 1. High-Frequency Terms

- o "Projects" (146), "design" (121), "work" (100), "project" (62), "engineering" (49) all appear at the top of the list, confirming that respondents frequently mentioned overall project delivery, design tasks, and engineering roles.
- Other notable terms: "Staff" (46), "field" (43), "construction" (42), "management" (41), "tasks" (39), "engineers" (36) highlight a strong emphasis on human resource and management aspects, as well as hands-on technical or site work.

# 2. Project and Task-Oriented Language

- o The words "projects," "work," and "tasks" appear throughout, indicating a broad impact on multiple types of responsibilities—anything from design to construction oversight to quality control.
- o Terms such as "drafting" (30) and "review" (25) imply that detailed, often technical or specialized tasks (e.g., producing construction drawings or conducting peer/design reviews) are particularly affected.

# 3. Themes of Capacity and Expertise

- o Words such as "lack" (17), "training" (16), "experience" (14), and "ability" (13) underscore not just a shortage in headcount but also in skill level or specialized expertise.
- o "Technical" (20) and "quality" (26) suggest that some roles require advanced knowledge or quality checks that are difficult to maintain with limited staff.
- o Mentions of "large" (16) and "complex" (10) projects reflect that bigger or more specialized projects are especially sensitive to staff availability.

# 4. Cross-Functional Impact

o "Maintenance" (12), "inspection" (11), "survey" (11), and "delivery" (11) point to the wide variety of tasks—from field surveys to delivering final products—that are all impacted by staff shortages.

Overall, the frequency analysis revealed a broad-based impact on technical and project management roles, with repeated emphasis on both quantity and quality of staff.

# Topic Modeling Analysis

# Topic 0

```
0.087*"projects" + 0.058*"work" + 0.057*"quality" + 0.037*"maintenance" + 0.035*"ability" + 0.035*"tasks" + 0.035*"office" + 0.034*"land" + 0.031*"impacted" + 0.029*"planning"
```

Original response: Quality control Original response: Everything.

### **Top Terms**

• "Projects," "work," "quality," "maintenance," "ability," "tasks," "office," "land," "impacted," "planning."

### Interpretation

- This topic centers on projects and tasks that require consistent quality control (e.g., "Quality control") and maintenance efforts. The emphasis on "ability," "office," and "planning" suggests that even administrative or office-based planning responsibilities suffer from staff shortages.
- The sample responses confirm that respondents see quality assurance, maintenance, and the overall planning/office tasks as areas heavily impacted by the lack of adequate staffing.

# Topic 1

```
0.127*"project" + 0.086*"management" + 0.062*"engineering" + 0.049*"work" + 0.043*"technical" + 0.042*"design" + 0.041*"analysis" + 0.040*"development" + 0.026*"civil" + 0.024*"bridge"
```

Original response: Slightly longer project lead times.

Original response: Civil site design

Original response: Traffic Engineering Bridge /Structural Development Review (permitting)

# **Top Terms**

• "Project," "management," "engineering," "work," "technical," "design," "analysis," "development," "civil," "bridge."

# Interpretation

• This cluster focuses on engineering and project management aspects—particularly civil/structural (notable mentions: "bridge," "civil"). It points to the technical

complexity of certain projects that are stalled or delayed because of insufficient staff or expertise.

# Topic 2

```
0.141*"construction" + 0.046*"field" + 0.042*"staff" + 0.040*"training" + 0.038*"engineers" + 0.036*"delivery" + 0.032*"experienced" + 0.027*"inspection" + 0.026*"documentation" + 0.025*"water"
```

Original response: Topographic and boundary surveys and support for municipal capital improvement projects, specifically the field mapping and staking and the basemap preparation and processing phases.

Original response: Municipal drinking water and hydroelectric facility capital improvements

Original response: Documentation of Design Process - QC - Training Advanced Skills - Institutional Knowledge

# **Top Terms**

• "Construction," "field," "staff," "training," "engineers," "delivery," "experienced," "inspection," "documentation," "water."

### Interpretation

- This topic revolves around field and construction activities, such as site inspections, field mapping, and ensuring experienced engineers are present to handle complex or specialized tasks (e.g., "water" systems). There is also a notable emphasis on training and documentation—implying that expertise must be developed and maintained, but staff shortages hamper these efforts.
- The sample responses underline the need for experienced field engineers and robust training for staff, especially on critical infrastructure projects in construction and water resources.

### Topic 3

```
0.179*"projects" + 0.084*"work" + 0.044*"drafting" + 0.033*"staff" + 0.028*"field" + 0.026*"large" + 0.026*"capital" + 0.026*"new" + 0.024*"engineers" + 0.023*"shortages"
```

Original response: I work a public utility in wastewater, drainage, and water design. Staff shortages result in projects being delayed or outsourcing design projects to consultants.

Original response: Field work.

### **Top Terms**:

• "Projects," "work," "drafting," "staff," "field," "large," "capital," "new," "engineers," "shortages."

### **Interpretation**

• Similar to Topic 2, there is emphasis on field work and drafting but with specific reference to large or capital projects. Staff shortages lead to either project delays or the necessity to outsource.

• Based on sample responses, large capital projects (e.g., infrastructure, municipal projects) suffer the most.

# Topic 4

```
0.224*"design" + 0.063*"tasks" + 0.053*"level" + 0.051*"review" + 0.040*"engineering" + 0.033*"production" + 0.031*"requiring" + 0.021*"reviews" + 0.021*"lack" + 0.021*"senior"
```

Original response: Quoting, document review.

Original response: Being able to assign staff for peer reviews prior to issuing deliverables.

Original response: Entry level design tasks.

# **Top Terms**

• "Design," "tasks," "level," "review," "engineering," "production," "requiring," "reviews," "lack," "senior."

# Interpretation

- This cluster underscores design and review tasks that require senior-level oversight, or at least specialized engineering knowledge. The mention of "lack" and "senior" highlights that senior engineering roles or technical reviewers might be in particularly short supply, affecting the entire design and QA/QC process.
- The sample responses point to a dual issue: the need for senior experts to conduct reviews and the shortage of entry-level staff who handle foundational design tasks—both ends of the staffing spectrum can be under strain.

### **Conclusions**

# 1. Pervasive Impact Across All Project Phases

 From early-phase planning and design to field work, construction oversight, and final quality control (QC)/reviews, staff shortages impede progress at every stage.
 This underscores the depth and breadth of the shortage problem.

# 2. Particular Vulnerability in Technical and Specialized Roles

Topics and frequencies both point to specialized domains (e.g., civil/structural engineering, water and hydroelectric projects, large capital improvements). These areas require advanced skills or certifications, making it harder to quickly fill staffing gaps.

# 3. Quality Control and Project Management Delays

o Multiple references to "quality," "review," "peer reviews," "analysis," and "management" indicate that the quality and timeliness of deliverables suffer significantly. Longer project lead times and a slower review cycle can hamper an organization's ability to meet deadlines and maintain standards.

# 4. Need for Training and Knowledge Transfer

o Respondents mentioned "training" and "lack of experience," suggesting that a shortage of senior mentors coupled with fewer staff members to train new hires or

document institutional knowledge creates a vicious cycle, exacerbating skill gaps in the workforce.

### 5. Field and Construction Tasks Also Affected

 It's not just office-based roles; field surveys, inspections, and on-site construction oversight also arose frequently. This indicates that shortages are felt both in the office and in the field.

# 6. Outsourcing and Delays

 Several references to outsourcing tasks or delaying projects illustrate a direct operational impact. Where staff are unavailable, projects are either postponed or handed off to external consultants, sometimes at higher cost or with lower overall control.

From high-level project management and technical design/engineering activities to field surveys, construction oversight, and quality control tasks, staff shortages were reported to have a widespread, adverse effect. The frequency data highlights recurring challenges with "design," "project," and "engineering," while the topic modeling clusters confirm that both specialized and generalized roles are struggling to cope.

Most critically, respondents pointed to the following:

- Delays and extended project timelines (due to fewer technical staff and managers).
- Reduced quality and consistency (fewer experienced reviewers and mentors).
- Heightened reliance on outsourcing (to compensate for in-house staff gaps).
- Gaps in training (limiting the ability to grow the next generation of skilled employees).

In short, the ability to deliver infrastructure, civil, and engineering projects effectively (whether large capital projects or smaller maintenance tasks) depends heavily on having sufficient, well-trained staff. Where those shortages exist, organizations face delayed schedules, increased costs, and potential declines in the quality of outcomes.

# 5.1.3 Challenges – Pathways into the Field

# Word Frequency Analysis

Figure 30 shows the 20 most common words used in responding to the question. Figure 31 is a word cloud depicting the frequency and importance of words used in the open-ended responses.

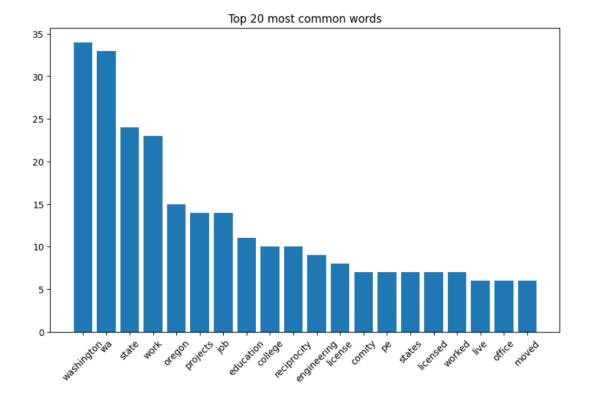


Figure 30. Top word frequency graph



Figure 31. Word cloud from the responses

# 1. Geographical and Location-Based References

o High-frequency words include "Washington" (34), "WA" (33), "state" (24), "work" (23), and "Oregon" (15). These terms indicate that location is a major

factor in the responses. Many respondents referenced Washington explicitly, with several also mentioning Oregon, which hints at regional mobility or cross-border professional practice.

# 2. Pathways via Education and Professional Credentials

- Words such as "education" (11), "college" (10), "license" (8), "comity" (7), "PE"
   (7), "licensed" (7), "degree" (6), and "got" (5) underscore that formal education and the process of obtaining a professional engineering (PE) license (often through reciprocity or comity) are significant entry points.
- o The presence of terms such as "*reciprocity*" and "*comity*" is particularly telling, suggesting that many professionals entered the Washington market by transferring credentials from another state.

# 3. Career Movements and Job-Related Terminology

- Words such as "job" (14), "worked" (7), "moved" (6), "company" (6), and "office"
   (6) suggest that respondents often discuss relocation or employment changes as part of their entry into the field.
- The emphasis on these terms hints at a pattern in which moving to Washington or transitioning from other regions (e.g., Oregon) plays a role in how professionals begin working in the state.

# Topic Modeling Analysis

# Topic 0

```
0.267*"wa" + 0.143*"job" + 0.142*"projects" + 0.089*"live" + 0.083*"washington" + 0.071*"company" + 0.038*"license" + 0.032*"licensed" + 0.024*"oregon" + 0.017*"got"

Original response: Not in WA

Original response: Left wa
```

### Top Terms

• "Wa," "job," "projects," "live," "Washington," "company," "license," "licensed," "Oregon," "got."

# Interpretation

• This cluster appears to capture responses in which the respondent either did not practice in Washington or had left the state. The sample responses such as "Not in WA" and "Left WA" indicate that not all answers fit the primary focus of entering the field in Washington.

### Topic 1

```
0.264*"washington" + 0.151*"oregon" + 0.146*"college" + 0.111*"comity" + 0.079*"degree" + 0.069*"office" + 0.034*"worked" + 0.034*"licensed" + 0.021*"education" + 0.019*"got"
```

Original response: Currently own a business in Oregon and get requests to do projects in Washington

Original response: Relocated to Washington then left Washington

# **Top Terms**

• "Washington" "Oregon" "college" "comity" "degree" "office" "worked" "licensed" "education" "got"

# Interpretation

Here, the emphasis is on educational backgrounds and relocation. Respondents
mentioned college education and degrees alongside phrases like "Relocated to
Washington then left Washington." In some cases, professionals indicated that they
were based in Oregon but worked on projects in Washington, suggesting a mix of
physical relocation and cross-state business practices.

# Topic 2

```
0.317*"state" + 0.118*"education" + 0.106*"engineering" + 0.081*"states" + 0.080*"wa" + 0.058*"job" + 0.046*"school" + 0.034*"moved" + 0.029*"licensed" + 0.028*"got"
```

Original response: Reciprocal license from another state

Original response: Odd question with odd answers. I studied Civil Engineering in college, then got a job in engineering with a local municipality

# **Top Terms**

• "State," "education," "engineering," "states," "WA," "job," "school," "moved," "licensed," "got."

# Interpretation

• This cluster focuses on the traditional educational and employment pathway. One respondent described studying civil engineering in college and subsequently getting a job with a local municipality. Another mentioned obtaining a reciprocal license—a process through which professionals transfer their credentials from another state. This highlights both formal education and the licensing process as common routes.

### Topic 3

```
0.242*"reciprocity" + 0.170*"pe" + 0.137*"license" + 0.117*"washington" + 0.111*"clients" + 0.051*"work" + 0.038*"moved" + 0.031*"engineering" + 0.009*"oregon" + 0.007*"college"
```

Original response: Comity process to receive my WA PE license which was needed for a project.

Original response: I do not work in Washington, I am PE by commity from Oregon.

# **Top Terms**

• "Reciprocity," "PE," "license," "Washington," "clients," "work," "moved," "engineering," "Oregon," "college."

# Interpretation

• The dominant theme here is licensure via reciprocity (or comity). Respondents noted that obtaining their WA PE license through the comity process was essential for their

work in Washington. Sample responses include explicit references to "*License reciprocity*" and the need to meet licensing requirements to secure projects, underscoring the regulatory pathway as a key entry method.

# Topic 4

```
0.272*"work" + 0.124*"wa" + 0.097*"washington" + 0.072*"based" + 0.071*"worked" + 0.058*"projects" + 0.055*"oregon" + 0.045*"surveying" + 0.033*"moved" + 0.027*"office"
```

Original response: Moved to Washington to work after graduating from college Original response: Washington resident, OR college, returned to WA for work.

# **Top Terms**:

• "Work," "WA," "Washington," "based," "worked," "projects," "Oregon," "surveying," "moved," "office."

# **Interpretation**:

• This topic revolves around relocation and job-based entry. Responses such as "Moved to Washington to work after graduating from college" illustrate that some professionals physically relocated to Washington for work opportunities. It also hints at cross-border practices in which some respondents are based in one state (such as Oregon) while actively engaging in projects in Washington.

### **Conclusions**

# Merged Insights and Main Findings

# 1. Educational Routes

A significant number of responses underscore the importance of formal education with several mentioning college degrees, engineering studies, and related academic backgrounds. This suggests that higher education is a common and expected foundation for entering the field.

# 2. Licensure Processes

A strong theme across topics is the role of licensure. Multiple clusters (especially Topics 2 and 3) highlight that obtaining a Washington PE license is a pivotal step. This implies that regulatory hurdles and credential transfer are major factors in professional entry.

# 3. Relocation and Geographic Mobility

Many respondents described moving to Washington or engaging in projects across state lines (notably between Washington and Oregon). This geographic fluidity indicates that location plays a crucial role, with many professionals either relocating or balancing multi-state work arrangements.

# 4. Outliers and Alternative Cases

Topic 0 reveals that not every respondent was currently active in Washington, as some indicated that they were "not in WA" or have "left WA." This highlights that while the

primary focus is on entering the field in Washington, there is some variability in respondents' current practice locations.

#### Overall Trends

# • Integration of Education and Regulatory Requirements

The responses reflect a blend of educational qualifications and the necessity of meeting state-specific licensing requirements. The frequent mention of reciprocity and comity underscores that the regulatory environment is a defining characteristic of entering the field.

# • Inter-State Dynamics

The interplay between Washington and Oregon appears frequently. Respondents often referenced their education or practice in one state while engaging in work or licensure processes in the other, which suggests a regional professional network that transcends state borders.

# • Career Development and Transition

Whether through relocating after college or navigating licensing transfers, the responses indicate that career development in this field is multi-faceted. There is a clear pattern of professionals leveraging both academic credentials and licensure pathways to secure positions in Washington.

The analysis of the survey responses reveals that entering the field in Washington is characterized by a combination of formal education, licensure processes, and geographic mobility. Key findings include the following:

- Educational background and college degrees are foundational, as many respondents mentioned completing their studies before moving or transferring credentials.
- Licensure through reciprocity/comity plays a critical role in establishing professional credentials in Washington.
- Relocation or cross-state work is common, with several responses indicating movement between Oregon and Washington.
- A minority of responses indicate alternative scenarios, such as not currently working in Washington, which reflects the diversity of professional pathways.

In sum, the data suggest that the most common entry routes into the field in Washington involve a blend of academic preparation, regulatory compliance via licensure, and strategic relocation. Each of these is essential for overcoming the barriers to entering the professional market in the state.

# 5.1.4 Challenges – Obstacles to Entering the Field

# Word Frequency Analysis

Figure 32 shows the 20 most common words used in responding to the question. Figure 33 is a word cloud depicting the frequency and importance of words used in the open-ended responses.

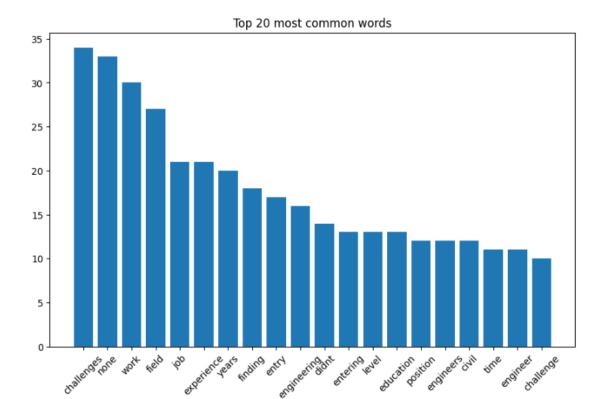


Figure 32. Word frequency graph



Figure 33. Word cloud from the responses

The most frequently mentioned words highlight common barriers to entering the engineering field:

- 1. "Challenges (34)," "work (30)," "field (27)," "job (21)," "experience (21)," "entry (17)," "level (13)," "position (12)," "hiring (9)," "opportunities (7)."
  - o Finding an entry-level position was one of the biggest challenges for respondents.

- o Lack of experience for entry-level roles was frequently cited as a barrier.
- 2. "Years (20)," "education (13)," "degree (10)," "training (6)," "college (7)," "school (7)."
  - Graduates felt unprepared by their education and often needed additional training to meet job expectations.
- 3. "Didn't (14)," "didn't have challenges (33)."
  - A significant number of respondents indicated that they did not face major challenges, particularly those who entered the field many years ago.
- 4. "Companies (8)," "hiring (9)," "cost (8)," "pay (8)," "Washington (9)," "WA (6)."
  - Some respondents struggled with the job market, hiring practices, and regional workforce conditions in Washington state.

# Topic Modeling Analysis

# Topic 0

```
0.342*"none" + 0.081*"work" + 0.065*"lots" + 0.056*"jobs" + 0.055*"hired" + 0.054*"time" + 0.054*"salary" + 0.049*"hiring" + 0.039*"due" + 0.034*"wanted"

Original response: If your response is 'Other', please specify:

Original response: School/work balance

Original response: re-entering the work force after time off for raising my kids
```

# Topic 1

```
0.115*"experience" + 0.101*"years" + 0.087*"job" + 0.051*"hire" + 0.040*"college" + 0.038*"civil" + 0.037*"worked" + 0.034*"training" + 0.033*"ago" + 0.033*"degree"
```

Original response: After hire, travel and workload made the licensing a challenge. That is filter for those committed to the profession and I wouldn't change it. Firms should try to support their employees pursuing a PE, but that can be hard for smaller companies.

Original response: not a challenge, worked for designer for years prior to getting my license.

Original response: I have worked multiple fields in my career. In the current world, companies would rather hire a "fully qualified" engineer from India, rather than hire a local who would need as little as two week's training to be proficient. Companies do not want to provide ANY training. I currently work as a Federal pipeline inspector. PHMSA is a great agency to work for. My agency tends to hire engineers with over 10 years experience who want less stress and better job security. One entry path is to take a job through an engineering consulting company or through a temp firm. Job security is zero but employers are not as picky regarding qualifications; they can lay you off at a moment's notice without any pain. I have worked for some companies whose corporate policy was to hire all technical staff as a temp for 6 months before considering them for a direct position. I used to snub temp jobs until I found that they were an entry path.

### Topic 2

```
0.209*"challenges" + 0.093*"work" + 0.077*"didnt" + 0.066*"field" + 0.051*"find" + 0.051*"entering" + 0.038*"wa" + 0.038*"washington" + 0.036*"job" + 0.031*"really"

Original response: Not applicable. I was able to find a job before I graduated.

Original response: There were no challenges for me to enter my field in WA.
```

# Topic 3

```
0.107*"education" + 0.106*"finding" + 0.062*"cost" + 0.059*"opportunities" + 0.053*"engineering" + 0.044*"want" + 0.043*"people" + 0.043*"would" + 0.043*"need" + 0.039*"work"
```

Original response: I graduated with a BSEE, out of state, and was recruited by a Seattle based company. I later moved from Seattle to St. Louis. The structure of your questions isn't a direct match for me. However, the issues are common to my current location and appear systemic throughout the country.

Original response: Finding mid-level engineering professionals.

Original response: Automated filtering by HR - Engineers know what they need in a candidate, candidates know what they have to offer, HR fails to understand the hiring needs and candidate capabilities.

#### Topic 4

```
0.109*"field" + 0.087*"entry" + 0.071*"level" + 0.066*"issues" + 0.051*"entered" + 0.049*"position" + 0.047*"positions" + 0.046*"challenge" + 0.045*"engineers" + 0.040*"pay"
```

Original response: Finding the right position.

Original response: Finding the right entry level position with the right firms.

#### Summary

Each topic highlights different types of challenges:

# • Topic 0: Work-Life Balance and Returning to the Workforce

- o Some respondents mentioned balancing school and work as a challenge.
- o Re-entering the workforce after a career break (e.g., raising kids) is difficult.

### • Topic 1: Job Market and Licensing Barriers

- o Travel and workload make obtaining a professional license (PE) challenging.
- Some respondents noted that companies prefer hiring fully qualified engineers rather than training new graduates.

# • Topic 2: No Significant Challenges for Some Respondents

 A subset of respondents reported finding jobs easily and not experiencing difficulties.

#### • Topic 3: Hiring Process and Filtering Issues

 HR filtering systems (e.g., automated resume screening) make it difficult to get noticed by employers.  Companies struggle to find mid-level professionals, but entry-level jobs are still competitive.

# • Topic 4: Finding the Right Position

- Entry-level engineers have difficulty finding a job that matches their skills and interests.
- Some struggle to find a good fit with companies

#### **Conclusions**

The responses indicate that entry-level experience requirements, hiring practices, and lack of job-ready skills are the biggest challenges for new engineers. To address these issues, employers should offer internships, rethink hiring filters, and support licensing efforts. Additionally, universities should focus on practical, industry-relevant education to better prepare graduates for the workforce. Key takeaways from these responses include the following:

# 1. Entry-Level Experience Requirements Create Barriers

- o Lack of experience for entry-level jobs was a common issue.
- Employers should consider apprenticeship and internship programs to bridge this gap.

# 2. HR Screening Processes May Exclude Qualified Candidates

- o Automated filtering in hiring systems prevents engineers from getting interviews.
- Companies should improve their hiring processes to ensure qualified candidates aren't overlooked.

# 3. Workforce Development and Training Are Needed

- Many new engineers felt unprepared by their education and needed more handson training.
- o Universities and employers should collaborate to offer job-ready skills training.

### 4. Balancing Work and Licensing Is a Challenge

- Workload and travel demands make it difficult for engineers to obtain a PE license.
- Employers should provide better support for licensing efforts, such as flexible schedules or study time.

### 5. Some Respondents Did Not Face Challenges, but Conditions Have Changed

- o Many older professionals did not experience difficulty entering the field.
- The job market has shifted, making it harder for new graduates to enter the profession today.

### 5.1.5 Skills Lacking in New Graduates

#### Word Frequency Analysis

Figure 34 shows the 20 most common words used in responding to the question. Figure 35 is a word cloud depicting the frequency and importance of words used in the open-ended responses.

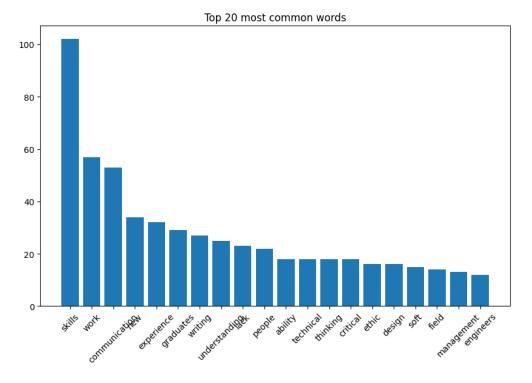


Figure 34. Top word frequency graph



Figure 35. Word cloud from the responses

Key observations from the word frequency analysis include the following:

- 1. Dominance of "skills"
  - With 102 occurrences, "skills" stands out as the most cited term, reflecting respondents' focus on identifying specific skill gaps in new graduates.
- 2. High Prevalence of "work," "communication," and "experience"

- "Work" (57) and "communication" (53) are the next most frequent words, suggesting that many respondents emphasized not only the environment or type of work but especially communication as an essential skill set.
- "Experience" (32) also appears prominently, indicating that practical or real-world experience is lacking.

# 3. Specific Skill Gaps

- "Communication" (53), "writing" (27), "critical thinking" (18), "technical skills" (18), "soft skills" (15), and "management" (13) point to a combination of technical and non-technical (soft) skills deficits.
- "Work ethic" (16), "time" (10), "ownership" (7) also suggest issues with self-motivation, responsibility, and time management.

#### 4. Contextual Clues

• Frequent mentions of "lack" (23), "lacking" (8), "don't" (11), "willingness" (9), and "expectations" (8) indicate that respondents perceive an overall deficit in both skill levels and professional attitudes.

Overall, the word frequency analysis points to soft skills (communication, writing), critical thinking, practical experience, time management, and work ethic as major concerns.

### Topic Modeling Analysis

The topic modeling has divided responses into five key topics. Each topic lists keywords along with their relative weights. Below is a summary of each topic, its main keywords, and representative responses.

# Topic 0

```
0.152*"new" + 0.127*"graduates" + 0.073*"design" + 0.050*"experience" + 0.042*"job" + 0.039*"learn" + 0.037*"years" + 0.032*"project" + 0.031*"training" + 0.028*"field"
```

Original response: Awareness of detailing connections

Original response: New grads, especially the ones with advanced degrees, think they are exempt from being outside. We had geotechnical engineers that don't want to touch soils because they have a masters degree.

### Interpretation

• Focuses on new graduates, their design-related knowledge, and practical job training. Mentions of "*learn*," "*project*," and "*training*" suggest the importance of hands-on experience and structured onboarding for newer professionals.

### **Representative Responses**

- "Awareness of detailing connections" highlights a specific technical/design detail often overlooked by new graduates.
- "New grads ...think they are exempt from being outside ... We had geotechnical engineers that don't want to touch soils." indicates a mismatch between academic background and the realities of fieldwork.

### Topic 1

```
0.102*"writing" + 0.082*"thinking" + 0.077*"critical" + 0.069*"ability" + 0.052*"technical" + 0.046*"knowledge" + 0.042*"real" + 0.038*"experience" + 0.037*"take" + 0.037*"work"
```

Original response: Knowledge and appreciation of our niche industry.

Original response: Technical writing.

Original response: Knowledge of Licensure Process.

# Interpretation

• Emphasizes critical thinking and writing skills alongside the need to apply technical knowledge in real-world scenarios.

## **Representative Responses**

- "Knowledge and appreciation of our niche industry." underscores missing industry-specific knowledge.
- "Technical writing" highlights writing as a crucial technical skill.
- "Knowledge of Licensure Process" suggests awareness of professional requirements is also lacking.

## Topic 2:

```
0.296*"skills" + 0.161*"communication" + 0.058*"experience" + 0.055*"soft" + 0.049*"understanding" + 0.033*"field" + 0.031*"interpersonal" + 0.031*"technical" + 0.030*"practical" + 0.024*"lack"
```

Original response: Basic computer skills

Original response: Communication skills

Original response: Soft skills and field experience.

### **Interpretation**:

• Heavy emphasis on "*skills*," particularly communication and interpersonal (soft) skills, combined with a need for practical or field-related experience.

#### Topic 3

```
0.144*"work" + 0.092*"skills" + 0.085*"people" + 0.065*"lack" + 0.062*"ethic" + 0.039*"understanding" + 0.032*"willingness" + 0.029*"communication" + 0.028*"computer" + 0.023*"written"
```

Original response: Work ethic and ability to focus

Original response: I have noticed that interns and new graduates lack a sense of pride and ownership in their work. I have spoken with my colleagues in the public sector as well as consulting firms, and we all noticed that entry level engineers are not completing internal checks prior to submitting their work. There is a large effort in coaching to ensure that new graduates understand internal quality control checks on their work. We have also noticed a lack of attention to detail, which again, reflects in work quality.

Original response: People skills.

#### Interpretation

 Highlights work ethic, people/communication skills, and willingness to tackle different tasks. Also mentions a lack of computer skills and proper written communication.

# Topic 4

```
0.086*"sense" + 0.086*"time" + 0.078*"common" + 0.069*"expectations" + 0.067*"know" + 0.058*"management" + 0.051*"attention" + 0.051*"detail" + 0.045*"don't" + 0.034*"work"
```

Original response: Responsibility and time management

Original response: A grasp of the breadth of the profession, when they become proficient in one area, they want to be promoted but they don't know what they don't know.

Original response: Communication, time management, investment and ownership of own career growth.

# Interpretation

• Points to issues with time management, a sense of professional expectations, and attention to detail. Also suggests new graduates may not fully know what they don't know ("common sense" and "don't" appear frequently).

#### Summary

Based on our analysis, the following insights can be drawn from the responses:

#### 1. Soft Skills and Communication

- Both the top words and Topics 2 and 3 consistently emphasize communication, both written and interpersonal, as a critical gap.
- Alongside communication, work ethic and time management (Topic 4) are frequently cited.

### 2. Critical Thinking and Technical Proficiency

- Topic 1 underscores the need for critical thinking, technical knowledge, and writing. Word frequency also highlights "thinking," "technical," and "critical" frequently.
- Writing appears in both the frequency list and Topic 1, signaling a strong emphasis on the need for clearer, more professional technical writing skills.

# 3. Practical/Hands-On Experience

- Multiple topics (especially Topics 0, 2) mention field experience, real-world application, or practical training. This ties into the general feeling that many new graduates are not fully prepared for the actual demands of a project or site work.
- The word frequency list includes "practical," "real," "experience," and "field," reinforcing that lack of hands-on learning is a critical shortcoming.

# 4. Ownership, Responsibility, and Professional Attitude

• Phrases like "lack of pride," "ownership," and "attention to detail" appear in the topics and the representative quotes (Topic 3 in particular).

• New graduates might also have unrealistic "expectations" (Topic 4) regarding their roles and responsibilities early in their careers.

#### **Conclusions**

Considering both the word frequency and the topic modeling results, several core skill deficits emerge for new graduates:

# 1. Communication (Especially Written)

• The most consistent theme: new graduates need stronger communication skills, including technical writing and the ability to convey ideas clearly.

#### 2. Soft Skills and Work Ethic

 Professionalism, ownership of tasks, willingness to learn, and attention to detail repeatedly surface as lacking. Employers see a need for greater accountability and initiative.

# 3. Critical Thinking and Technical Application

• While academic knowledge may be solid, graduates often struggle with applying it to real-world problems and demonstrating robust critical thinking on the job.

### 4. Practical, Hands-On Experience

• There is a clear gap in practical field or project-based experience. Even with strong theoretical backgrounds, new graduates might not be prepared for day-to-day realities, from site work to detailed design tasks.

# 5. Time Management and Understanding of Professional Expectations

• Several respondents noted issues with managing deadlines, setting realistic expectations, and recognizing the breadth of the profession. This extends to broader organizational and business contexts, not just engineering tasks.

Overall, employers and experienced professionals signal that while technical knowledge is important, the ability to communicate effectively, manage time, take ownership, and apply critical thinking in a practical context is just as vital. Bridging these gaps through internships, mentoring, project-based learning, and early-career professional development would significantly improve graduates' readiness for the workforce.

### 5.1.6 Challenges – Critical Skills Lacking in Experienced Professionals

#### Word Frequency Analysis

Figure 36 shows the 20 most common words used in responding to the question. Figure 37 is a word cloud depicting the frequency and importance of words used in the open-ended responses.

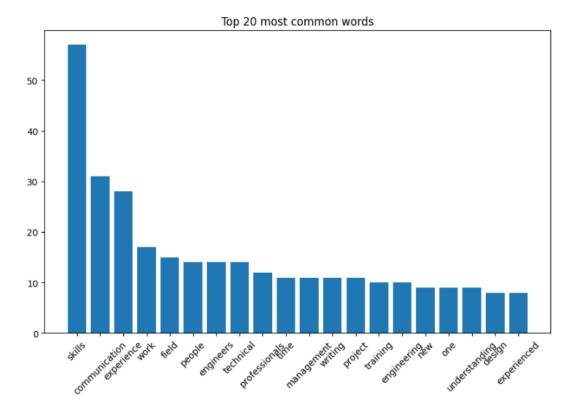


Figure 36. Word frequency graph



Figure 37. Word cloud from the responses

The most frequently mentioned words highlight key skill gaps among experienced professionals:

- 1. "Skills" (57), "communication" (31), "writing" (11), "interpersonal" (5), "soft" (6).
  - Communication and soft skills are the most commonly cited gaps.

- Many experienced professionals struggle with clear communication, teamwork, and effective writing.
- 2. "Experience" (28), "field" (15), "engineering" (10), "design" (8), "technical" (14), "project" (11).
  - Despite their years in the field, some professionals lack hands-on technical skills or struggle to keep up with new industry advancements.
- 3. "Management" (11), "leadership" (8), "time" (11), "professionals" (12), "working" (6), "keeping" (6).
  - Leadership and management skills are often weak, particularly in terms of mentoring younger engineers and managing workloads efficiently.
- 4. "Training" (10), "understanding" (9), "need" (5), "judgment" (4).
  - A lack of structured training and continuous learning leads to gaps in industry knowledge and innovation.

# Topic Modeling Analysis

## Topic 0

```
0.244*"experience" + 0.132*"ability" + 0.114*"engineers" + 0.099*"one" + 0.095*"people" + 0.086*"technical" + 0.058*"dont" + 0.040*"lack" + 0.029*"project" + 0.020*"new"
```

Original response: Willingness to fully investigate a problem/issue and review all pertinent details.

Original response: Ethics.

#### Topic 1

```
0.184*"work" + 0.131*"professionals" + 0.095*"time" + 0.092*"management" + 0.088*"experienced" + 0.066*"leadership" + 0.045*"need" + 0.043*"jobs" + 0.042*"many" + 0.041*"lack"
```

Original response: The willingness to sometime do lower level work when it needs to be done.

Original response: Unless they are a SME, experienced professionals can get rusty in these areas as they move into management or to another industry.

# Topic 2

```
0.223*"training" + 0.157*"new" + 0.146*"technical" + 0.132*"working" + 0.084*"writing" + 0.048*"engineers" + 0.045*"time" + 0.037*"project" + 0.026*"lack" + 0.005*"skills"
```

Original response: Patience and time when training new engineers. We're overworked as it is. Training is simply an additional task imposed upon us.

Original response: Developing professional/working relationships with new employees.

*Original response: Ingenuity (recognition of new technology and its application).* 

# Topic 3

```
0.165*"field" + 0.146*"experience" + 0.090*"engineering" + 0.087*"design" + 0.073*"project" + 0.073*"understanding" + 0.069*"keeping" + 0.045*"engineers" + 0.036*"one" + 0.031*"management"
```

Original response: Hands-on field skills.

Original response: Judgment in determining efficient design.

Original response: Leadership skills are typically not taught in engineering schools. My experience as a Mech and Elect PE is that college only teaches one 1/3 of what is needed on the job; typically the 1/3 that can't be self taught or taught by an employer. If you really want to know skill gaps, contact engineering temp placement firms. To gain experience, new engineers should consider US government jobs. There are many openings for two reasons; the pay is extremely low and the hiring process is long and tortuous. An applicant package goes through 6 human resource hands before being given to the supervisor who is hiring; any one of these six will cancel the application if a T is not crossed or an I is not dotted.

# Topic 4

```
0.446* "skills" + 0.248* "communication" + 0.069* "people" + 0.060* "writing" + 0.046* "soft" + 0.041* "interpersonal" + 0.014* "project" + 0.014* "professional" + 0.011* "lack" + 0.004* "field"
```

Original response: soft skills, communication skills, people skills.

Original response: Communication skills.

#### Summary

Each topic highlights different skill deficiencies:

# • Topic 0: Investigative and Ethical Decision-Making

- Some professionals fail to fully investigate problems, leading to poor decisionmaking.
- o Ethics and responsibility are also mentioned as concerns.

### • Topic 1: Willingness to Adapt and Engage in Different Tasks

- Some experienced professionals become resistant to performing hands-on work as they move into leadership.
- Lack of technological proficiency is also an issue, especially when transitioning into management.

### Topic 2: Training and Mentoring Skills

- Experienced engineers struggle with mentoring and training younger professionals.
- Heavy workloads prevent them from dedicating time to knowledge transfer.

#### • Topic 3: Technical Proficiency and Hands-on Skills

- o Many professionals lack modern field skills and technical judgment.
- o Leadership and decision-making are not well developed in engineering education.

### • Topic 4: Communication and Soft Skills

- o The most critical skill gap is communication.
- Respondents repeatedly emphasize the need for better writing, interpersonal, and leadership communication skills.

#### **Conclusions**

The responses indicate that communication, leadership, and mentorship skills are the most critical gaps for experienced professionals. Many struggle with training younger engineers, keeping up with technology, and making sound management decisions. Addressing these skill shortages through soft skills training, leadership development, and structured mentorship programs will improve workforce effectiveness. Key takeaways from these responses are as follows:

# 1. Improve Communication and Soft Skills Training

- Organizations should offer workshops on technical writing, presentation skills, and interpersonal communication.
- Mentorship programs can help experienced professionals develop their ability to train younger engineers.

# 2. Enhance Leadership and Management Training

- Many experienced professionals struggle with leadership responsibilities.
- Engineering organizations should provide structured leadership training for midcareer professionals.

## 3. Ensure Continuous Technical Learning

- Many engineers lose technical proficiency when transitioning to leadership roles.
- Companies should encourage regular hands-on field training and exposure to new technologies.

### 4. Address Resistance to Training and Mentorship

- Workloads often prevent experienced professionals from mentoring and developing the next generation.
- Employers should offer incentives and structured time for senior engineers to train new hires.

# 5. Reinforce Ethical Decision-Making and Critical Thinking

- Some engineers lack investigative skills when assessing problems.
- Training programs should emphasize analytical thinking, ethics, and problem-solving.

### 5.1.7 Challenges – Training Resources Most Needed

#### Word Frequency Analysis

Figure 38 shows the 20 most common words used in responding to the question. Figure 39 is a word cloud depicting the frequency and importance of words used in the open-ended responses.

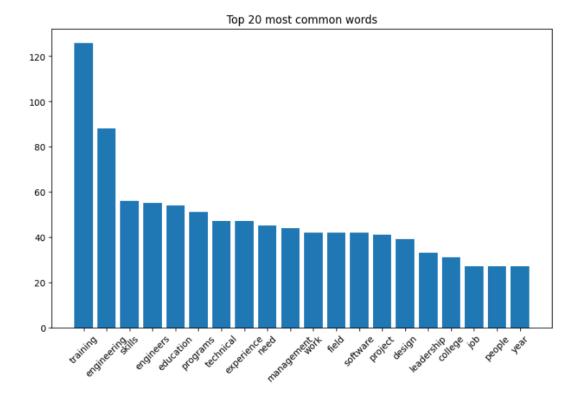


Figure 38. Top word frequency graph

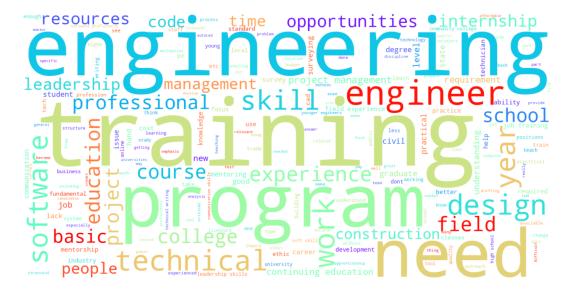


Figure 39. Word cloud from the responses

The most frequently mentioned words highlight key training needs were as follows:

1. "Training" (126), "engineering" (88), "skills" (56), "technical" (47), "experience" (47), "management" (44), "project" (41).

- o There is a strong demand for technical and project management training in the engineering workforce.
- 2. "Programs" (51), "education" (54), "college" (31), "school" (18), "courses" (25), "resources" (25), "continuing" (25).
  - o Many respondents emphasized the need for formal training programs, continuing education, and accessible courses.
- 3. "Software" (42), "surveying" (21), "design" (39), "communication" (18), "writing" (15)
  - Training in industry-specific software, modern surveying techniques, and communication skills is needed.
- 4. "Internships" (20), "opportunities" (26), "understanding" "practical" (22), "mentoring" (14), "apprenticeship" (mentioned in responses).
  - Respondents indicated a need for more hands-on, mentorship-based training opportunities.

# Topic Modeling Analysis

## Topic 0

```
0.050*"training" + 0.049*"software" + 0.035*"engineering" + 0.032*"design" + 0.027*"surveying" + 0.021*"people" + 0.020*"programs" + 0.020*"field" + 0.018*"civil" + 0.018*"need"
```

Original response: Training resources exist; I think most professionals are so overloaded that they don't have time to access existing training resources.

Original response: In Washington, the most needed training resources for land surveyors and related professionals include:

- 1. Mentorship and Apprenticeship Programs With increasing retirements, there's a critical need for structured programs that transfer knowledge from experienced surveyors to new entrants.
- 2. Licensure Preparation Courses More accessible courses that help candidates prepare for the Fundamentals of Surveying (FS) and Principles and Practice of Surveying (PS) exams. Online and hybrid options would help broaden access.
- 3. Technological Proficiency Training in cutting-edge survey technology such as drones, LiDAR, GIS, and advanced CAD software. This ensures professionals stay competitive and efficient.
- 4. Continuing Education Regular, affordable workshops that cover changes in state surveying laws, boundary law, and best practices. This is vital for maintaining licensure and staying current.
- 5. Leadership and Management Skills Mid-career professionals could benefit from courses on project management, leadership, and team building to prepare for supervisory roles as senior surveyors retire.

- 6. Outreach and Recruitment Programs Initiatives aimed at high schools, community colleges, and universities to increase awareness and interest in surveying careers.
- 7. Soft Skills Development Communication, negotiation, and conflict resolution training can help surveyors interact more effectively with clients, the public, and other professionals.

# Topic 1

```
0.059*"education" + 0.054*"experience" + 0.035*"continuing" + 0.032*"need" + 0.027*"field" + 0.024*"internships" + 0.022*"construction" + 0.022*"work" + 0.018*"understanding" + 0.018*"requirements"
```

Original response: How to run a business and an understanding of how to do work more efficiently to make money.

Original response: Universities need to shift and provide useful knowledge. Not everyone will be a researcher or a professor. Students need to understand that the diploma is not everything and getting their license is important as well as being in the field.

# Topic 2

```
0.077*"management" + 0.073*"project" + 0.053*"technical" + 0.029*"hands" + 0.027*"communication" + 0.027*"skills" + 0.025*"back" + 0.024*"engineers" + 0.022*"college" + 0.022*"experience"
```

Original response: None. Technical and management training opportunities are plentiful.

*Original response: Technical webinars updating state of the practice issues.* 

# Topic 3

```
0.137*"training" + 0.098*"engineering" + 0.050*"job" + 0.030*"opportunities" + 0.025*"development" + 0.022*"professional" + 0.021*"school" + 0.021*"level" + 0.021*"state" + 0.019*"classes"
```

*Original response: How to appropriately/effectively utilize AI tools on the job.* 

Original response: Craftsman and Operator training.

Original response: Traffic Engineering Structural engineering Process improvement Project management.

# Topic 4

```
0.057* "skills" + 0.052* "leadership" + 0.048* "programs" + 0.039* "work" + 0.037* "engineers" + 0.034* "training" + 0.031* "technical" + 0.025* "management" + 0.023* "year" + 0.021* "new"
```

Original response: Tech school programs for good technician level positions with potential for advancement.

Original response: Septic that are affordable and local.

Original response: More opportunities for mentoring.

#### Summary

Each topic highlights different areas of training needs:

# • Topic 0: Technical and Software Training

- Engineers need more training in software tools, surveying technology, and CAD programs.
- There is a demand for field-based training in civil engineering and design software.

# • Topic 1: Practical Industry Knowledge and Business Skills

- o Universities should provide real-world engineering knowledge rather than purely academic research skills.
- Respondents want training on how to run a business, improve efficiency, and understand financial aspects of engineering work.

# • Topic 2: Project and Management Training

- Project management and leadership training is necessary, especially for midcareer professionals.
- Engineers seek courses on handling budgets, leading teams, and improving efficiency in engineering projects.

# • Topic 3: AI, Advanced Engineering Topics, and Emerging Technologies

- o AI, structural engineering, process improvement, and traffic engineering training are requested.
- o Engineers want technical webinars on state-of-the-art engineering topics.

# • Topic 4: Mentorship and Technician-Level Training

- More mentorship and apprenticeship programs are needed to train new engineers and technicians.
- Respondents suggest on-the-job training (OJT) and structured mentorship programs to support career development.

#### **Conclusions**

The responses indicate that Washington state engineers need more practical, software-based, and management-focused training resources. Expanding technical skills training, AI education, mentorship programs, and leadership development initiatives can help bridge workforce gaps and improve career advancement opportunities. Key takeaways from the responses we analyzed include the following:

#### 1. Expand Technical and Software Training

- Engineers need training in modern software, CAD tools, GIS, LiDAR, and AI applications in engineering.
- Companies and universities should offer more online, hybrid, and hands-on technical training.

### 2. Increase Access to Business and Practical Engineering Education

• Universities should integrate business and financial management courses into engineering programs.

• Engineers need training in budgeting, consulting, and managing projects efficiently.

# 3. Enhance Project Management and Leadership Training

- Organizations should provide leadership development programs for mid-career professionals.
- Training in team leadership, communication, and decision-making will help address workforce retention issues.

# 4. Introduce More Industry-Driven Training in AI and Emerging Technologies

- AI, process automation, and emerging engineering fields should be included in professional development programs.
- Technical webinars and continuing education on state-of-the-art industry practices should be widely available.

# 5. Develop Stronger Mentorship and Apprenticeship Programs

- On-the-job training, apprenticeships, and structured mentorship programs can help new professionals transition into the workforce.
- There is a need for state-funded, technician-level programs and hands-on learning opportunities.

# 5.1.8 Challenges – Reasons Behind Employees Leaving Their Positions

# Word Frequency Analysis

Figure 40 shows the 20 most common words used in responding to the question. Figure 41 is a word cloud depicting the frequency and importance of words used in the open-ended responses.

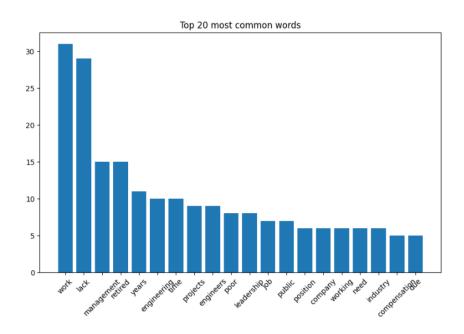


Figure 40. Top word frequency graph

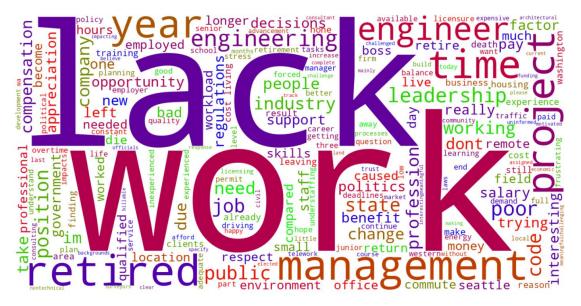


Figure 41. Word cloud from the responses

The most frequently mentioned words highlight key concerns that lead to engineers leaving their jobs:

- "Work" (31), "lack" (29), "projects" (9), "opportunity" (4), "interesting" (4), "challenging" (3).
  - Lack of engaging, meaningful work and limited career growth opportunities contribute to dissatisfaction.
- "Management" (15), "poor" (8), "leadership" (8), "decisions" (4), "support" (4), "respect" (3).
  - Management issues are a major source of frustration, including lack of engineering representation in leadership roles.
- "Compensation" (5), "pay" (4), "salary" (4), "cost" (5).
  - o Low pay and inadequate compensation remain recurring reasons for leaving a job.
- "Retired" (15), "years" (11), "career" (3), "professional" (3), "industry" (6).
  - o Retirement and career transitions naturally lead some professionals to leave.
- "Politics" (4), "public" (7), "regulations" (4).
  - Political interference and policy decisions impact engineering work, leading to frustration.

# Topic Modeling Analysis

### Topic 0

```
0.426*"lack" + 0.150*"leadership" + 0.118*"job" + 0.080*"im" + 0.075*"engineers" + 0.044*"poor" + 0.042*"years" + 0.007*"management" + 0.006*"retired" + 0.004*"public"
```

Original response: Having to track billable hours as consultant.

Original response: Elected officials making uninformed policy decisions.

# Topic 1

```
0.229*"time" + 0.201*"engineering" + 0.154*"public" + 0.105*"don't" + 0.077*"position" + 0.060*"retired" + 0.034*"working" + 0.030*"im" + 0.030*"job" + 0.009*"compensation"
```

Original response: Politics impacting decisions more than engineering and economic factors.

Original response: I hope I can continue to provide engineering services to the public until the day before I die.

Original response: Retirement and manager pressure to do things against good engineering judgment.

## Topic 2

```
0.446*"work" + 0.200*"retired" + 0.093*"years" + 0.077*"company" + 0.063*"compensation" + 0.043*"engineers" + 0.020*"position" + 0.007*"industry" + 0.007*"leadership" + 0.004*"lack"
```

Original response: Lack of opportunity for interesting/meaningful work.

Original response: lack of meaningful/challenging work.

*Original response:* Conflicts with personnel / uncollaborative work environment.

# Topic 3

```
0.201*"projects" + 0.134*"need" + 0.128*"industry" + 0.112*"state" + 0.110*"working" + 0.060*"engineers" + 0.051*"years" + 0.049*"position" + 0.028*"work" + 0.027*"public"
```

Original response: I am motivated by learning new skills and being challenged. In my current position, I do not believe I will be assigned to projects that will challenge me.

Original response: Does not apply since I am a principal of my company. However prior when I worked for the state, it was workload due to understaffing.

Original response: Need for money and the possibility of a suitable engineeringrelated position.

#### Topic 4

```
0.387*"management" + 0.178*"lack" + 0.131*"poor" + 0.060*"engineering" + 0.039*"work" + 0.035*"time" + 0.033*"years" + 0.033*"company" + 0.031*"compensation" + 0.007*"state"
```

Original response: Lack of engineers in management. It can be frustrating to work as an engineer under management who are mainly from a planning, architectural, or non-technical backgrounds.

Original response: Poor management, lack of funding to actually do much engineering.

Original response: Bad management.

#### **Summary**

Each topic highlights a different set of concerns:

# • Topic 0: Leadership and Workplace Culture Issues

- Lack of leadership, poor management, and unqualified decision-makers create frustration.
- Engineers prefer to work under technical leadership rather than non-engineering managers.

# Topic 1: Political and Ethical Conflicts in Engineering

- Political interference and non-engineering factors affecting decisions push professionals to leave.
- Some respondents mentioned being forced to compromise engineering integrity because of external pressures.

# • Topic 2: Compensation and Lack of Career Progression

- o Inadequate salaries, lack of promotion opportunities, and stagnant career growth push engineers away.
- Some mentioned leaving because of conflicts in workplace culture or lack of collaboration.

# • Topic 3: Lack of Meaningful or Challenging Work

- Engineers want work that is engaging, technically stimulating, and allows skill growth.
- o Understaffing and excessive workloads are also concerns in some roles.

# • Topic 4: Poor Management and Organizational Challenges

- Engineers feel that management lacks technical expertise, leading to poor decision-making and inefficient workflows.
- Underfunding and lack of resources prevent professionals from doing impactful work.

#### **Conclusions**

We can summarize the main reasons that lead to current practitioners leave their position in the field of civil engineering and land surveying as follows:

### 1. Poor Management and Lack of Engineering Leadership

- Engineers prefer to work under technical leaders who understand engineering challenges.
- Organizations should promote experienced engineers into leadership roles instead of relying on non-technical managers.

# 2. Lack of Meaningful, Challenging Work

- Engineers are highly motivated by complex, impactful projects.
- Organizations should offer career development opportunities and innovative projects to keep professionals engaged.

# 3. Political and Bureaucratic Interference in Engineering Decisions

- Many respondents mention frustration with politically driven decisions that override technical expertise.
- Organizations should ensure engineering decisions are guided by data, safety, and best practices rather than external pressures.

# 4. Compensation and Career Growth Concerns

- Low pay and lack of salary progression drive professionals to leave.
- Employers should offer competitive salaries, structured promotion pathways, and performance-based incentives.

# 5. Toxic Work Culture and Lack of Support

- Engineers value collaborative work environments and professional respect.
- Employers should foster supportive teams, mentorship programs, and transparent management practices.

# 5.2|Solutions to Address the Current Challenges in Workforce Development

# 5.2.1 Solutions – Suggested Initiatives or Programs for Addressing Workforce Shortages Word Frequency Analysis

Figure 42 shows the 20 most common words used in responding to the question. Figure 43 is a word cloud depicting the frequency and importance of words used in the open-ended responses.

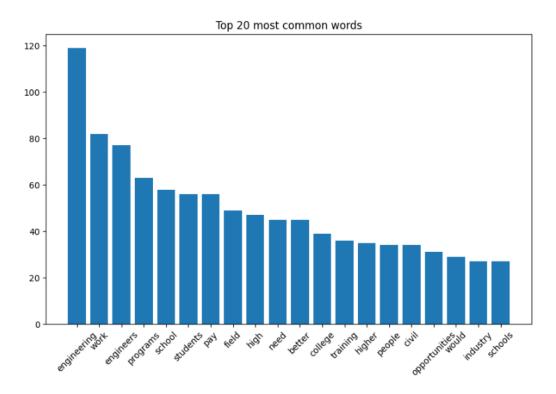


Figure 42. Top word frequency analysis

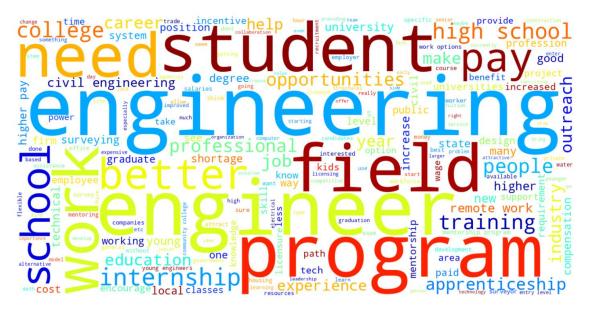


Figure 43. Word cloud from the responses

The most common words provide insights into key workforce challenges and possible solutions:

- 1. "Engineering" (119), "engineers" (77), "field" (49), "industry" (27), "civil" (34).
  - Respondents focused on shortages within engineering fields, particularly civil engineering.
- 2. "Work" (82), "programs" (63), "school" (58), "students" (56), "college" (39), "education' (25).
  - Workforce shortages may be linked to gaps in educational preparation, suggesting a need for improved training programs.
- 3. "Internships" (27), "opportunities" (31), "training" (36), "apprenticeship" (20), "experience" (20), "remote" (25).
  - Respondents highlighted the need for hands-on experience, paid apprenticeships, and flexible work arrangements.
- 4. 'Pay" (56), "compensation" (21), "higher' (35), "better" (45), "increased" (17).
  - Compensation is a major concern, indicating that low wages may deter new engineers from entering or staying in the field.
- 5. "Outreach" (25), "mentorship" (22), "career" (24), "technical" (18).
  - Outreach, mentorship, and career support programs could help attract and retain workers.

# Topic Modeling Analysis

# Topic 0

```
0.059*"internships" + 0.046*"industry" + 0.036*"work" + 0.028*"would" + 0.025*"compensation" + 0.021*"system" + 0.021*"sure" + 0.018*"know" + 0.017*"many" + 0.017*"shortages"
```

Original response: heavy industrial.

Original response: Bring in more working professionals to talk with high school and college-level students and other areas to provide real-world perspectives of technical vocations. Students have no idea what it's really like in industry, and any glimpse would help.

# Topic 1

```
0.089*"work" + 0.052*"engineers" + 0.047*"training" + 0.038*"remote" + 0.030*"field" + 0.027*"time" + 0.020*"professionals" + 0.020*"options" + 0.020*"young" + 0.019*"experience"
```

Original response: Remote work options are extremely attractive to younger workers.

Original response: Reduce politics and let the engineers do their job.

## Topic 2

```
0.085*"engineering" + 0.054*"school" + 0.046*"high" + 0.035*"students" + 0.032*"civil" + 0.030*"college" + 0.026*"programs" + 0.020*"schools" + 0.020*"mentorship" + 0.018*"engineers"
```

Original response: Opportunities for Solutions • Outreach and Recruitment Programs – Partner with community colleges and universities to establish survey-specific programs. Increase awareness in high schools through hands-on workshops and internships. • Retention Through Recognition – Develop formal recognition programs to celebrate achievements and create pathways for leadership roles. • Mentorship and Knowledge Transfer – Encourage experienced surveyors to mentor new hires, preserving institutional knowledge. • Competitive Benefits and Flexibility – Offer flexible work options, competitive salaries, and technology investments to make public sector roles more attractive.

Original response: It's mostly about compensation relative to other engineering fields and computer programming. To a degree, civil engineers also need to work harder to convince freshman/sophomore college students to pursue CE vs other engineering branches and related fields (CM and architecture for instance).

Original response: More incentives for college students to enter the engineering field and more outreach to high school students about engineering in general.

# Topic 3

```
0.073*"pay" + 0.048*"better" + 0.047*"higher" + 0.040*"engineering" + 0.037*"programs" + 0.035*"engineers" + 0.032*"students" + 0.020*"program" + 0.018*"see" + 0.018*"opportunities"
```

Original response: Uncertain - I don't see a short-term solution to this. Perhaps improve access to recent state university graduates for employers. How about a state-sponsored job site where employers can post engineering positions for free - Only state university engineering graduates can access and apply.

Original response: More outreach by companies in the classroom to guide students on the appropriate academic program based on their job interests instead of just through recruiting at career fairs.

#### Topic 4

```
0.044*"need" + 0.035*"increased" + 0.030*"design" + 0.027*"employees" + 0.026*"programs" + 0.025*"new" + 0.022*"licensure" + 0.022*"incentives" + 0.021*"technical" + 0.021*"industry"
```

Original response: Students need more field experience.

Original response: I think you've covered it above.

Original response: Assistance in transitioning from labor and technical positions through certification outside of a classroom setting.

#### **Summary**

Each topic reveals different perspectives on workforce shortages and potential solutions:

#### • Topic 0: Industry Engagement and Internships

- Respondents stressed the importance of bringing industry professionals into schools and colleges.
- Exposure to real-world engineering careers could help students make informed career choices.

### • Topic 1: Apprenticeship, Remote Work, and Work Culture

- Apprenticeship programs could help address skill gaps and provide alternative pathways into engineering careers.
- Younger workers are attracted to remote work options, which may help with retention.

### • Topic 2: Outreach and Mentorship Initiatives

- Expanding outreach efforts in high schools and colleges could increase awareness of engineering careers.
- o Mentorship and structured career development programs could improve retention.
- o Competitive salaries and better benefits are necessary to attract and retain talent.

### • Topic 3: Compensation, Job Access, and Industry Collaboration

 Some respondents believed compensation gaps between engineering and other fields (e.g., computer science) contribute to shortages.  Employers need better access to recent engineering graduates through targeted job placement initiatives.

# • Topic 4: Hands-on Experience and Non-traditional Pathways

- o Engineering students need more field experience to prepare for real-world work.
- Certification and alternative training options could allow workers from other industries to transition into engineering roles.

#### **Conclusions**

The responses indicate that workforce shortages in engineering are driven by low compensation, lack of practical experience, and limited awareness among young students. Solutions include expanding internships, improving mentorship programs, offering better pay, and increasing outreach efforts. Additionally, providing remote work options, alternative certification pathways, and employer-sponsored job placement programs could help bridge the workforce gap. Based on the responses from the survey participants, we can summarize the key solutions as follows:

### 1. Expand Industry Collaboration and Hands-on Training

- Companies should partner with universities and technical schools to provide realworld exposure to engineering careers.
- Internship and co-op programs should be expanded to give students early hands-on experience.
- Apprenticeship programs could provide alternative entry points for individuals without traditional engineering degrees.

# 2. Improve Compensation and Retention Strategies

- Many respondents see low pay as a key factor in workforce shortages.
- Employers should reassess salary structures to remain competitive with other industries such as technology.
- Incentives such as student loan repayment, bonuses, and flexible work options could help retain talent.

### 3. Increase Outreach and Awareness in High Schools

- Engineering careers are often misunderstood or overlooked by high school students.
- Schools should offer hands-on STEM programs, workshops, and industry presentations to increase interest.
- Scholarships and tuition support for engineering students could attract more talent.

#### 4. Leverage Remote Work and Alternative Pathways

- Many younger engineers value remote work flexibility.
- Offering hybrid or remote work options could help recruit and retain a diverse workforce.

• Fast-track certification programs could help transition workers from related fields into engineering roles.

# 5.2.2 | Solutions – Improving Education/Training to Address Workforce Needs

# Word Frequency Analysis

Figure 44 shows the 20 most common words used in responding to the question. Figure 45 is a word cloud depicting the frequency and importance of words used in the open-ended responses.

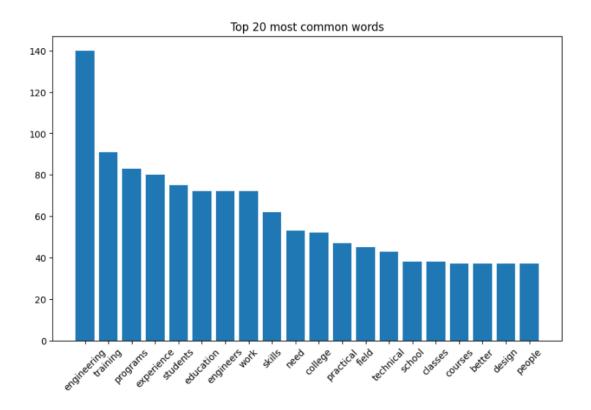


Figure 44. Top word frequency graph



Figure 45. Word cloud from the responses

The most common words in the responses suggest key themes in workforce challenges and potential educational improvements:

- 1. "Engineering" (140), "training" (91), "programs" (83), "experience" (80), "education" (72), "students" (75)
  - o These words indicate a strong focus on the structure and content of engineering education, with an emphasis on practical training and hands-on experience.
- 2. "Skills" (62), "practical" (47), "technical" (43), "writing" (24), "communication" (28).
  - There is a demand for technical, practical, and communication skills development to better prepare students for real-world engineering work.
- 3. "College" (52), "school" (38), "classes" (38), "courses" (37), "degree" (34).
  - The discussion includes concerns about the structure of college curricula and whether they effectively prepare students.
- **4.** "Internships" (29), "industry" (28), "real-world" (28), "hands-on" (24), "opportunities" (24).
  - o Respondents highlighted the need for more practical, hands-on training, internships, and industry collaboration.
- 5. "Management" (27), "project" (31), "surveying" (23), "math" (23).
  - Project management and surveying are seen as areas that could be better addressed in engineering education.

# Topic Modeling Analysis

# Topic 0

```
0.047*"engineering" + 0.033*"students" + 0.022*"work" + 0.021*"need" + 0.019*"practical" + 0.018*"focus" + 0.017*"classes" + 0.017*"education" + 0.015*"people" + 0.015*"would"
```

Original response: Need to start at the primary/secondary education level and produce students that have interest and aptitude for STEM. Colleges/universities need to provide an engineering education that provides necessary technical skills. I have interviewed many recent college grads in the past several years and it's obvious most don't have the technical skills that fresh grads had ~15-20 years ago.

Original response: Show the students the reality of engineering. Give them a hammer and a shovel.

# Topic 1

```
0.080*"engineering" + 0.054*"programs" + 0.032*"students" + 0.028*"schools" + 0.024*"make" + 0.023*"high" + 0.022*"surveying" + 0.018*"emphasis" + 0.016*"thinking" + 0.015*"understand"
```

Original response: Class size at the university level could probably be increased without compromising the quality of the graduates they produce.

Original response: Need to focus on engineering principles including system behavior and material properties.

Original response: Encouraging students to get into engineering.

## Topic 2

```
0.057*"experience" + 0.041*"field" + 0.039*"work" + 0.037*"education" + 0.028*"real" + 0.026*"world" + 0.026*"internships" + 0.026*"training" + 0.023*"engineers" + 0.021*"engineering"
```

Original response: Increased co-op type opportunities for students prior to making course selections for their final semester or quarter.

*Original response: My experience informs the following:* 

- More offerings of Online and Hybrid Programs Provide flexible learning options for working professionals or those in rural areas who cannot easily commute to campus. Promotion of Surveying as a STEM Career requiring little to no "college" classes, which are often expensive:
- Expanding High School Outreach Launch programs that introduce surveying in high schools through career fairs, presentations, and field demonstrations. Early exposure can spark interest in the profession.
- STEM Integration Incorporate surveying concepts into STEM curricula, blending math, geography, and technology courses with real-world applications. Apprenticeship and Internship Programs

- Earn-While-You-Learn Models Develop apprenticeship programs that allow individuals to gain hands-on experience while working toward licensure. This helps fill workforce gaps and accelerates professional development.
- Partner with Municipalities and Firms Collaborate with public and private sectors to provide internships that offer field experience and mentorship opportunities. Accelerated and Stackable Credentials
- Certificate Programs Create short-term certificate programs in specific areas (e.g., drone surveying, GIS, CAD) that can lead to larger degrees over time. This enables professionals to build skills progressively.
- Bridge Programs Develop bridge courses that allow professionals from related fields (e.g., civil engineering, forestry, geography) to transition into surveying roles. Support for Licensure and Continuing Education
- Exam Preparation Resources Provide more affordable and accessible FS (Fundamentals of Surveying) and PS (Principles and Practice of Surveying) exam prep courses.
- Continuing Education Credits Encourage lifelong learning by offering CEUs (Continuing Education Units) through local workshops, online courses, and professional conferences.

Original response: I went to UOP Process Division when I graduated. They took my attaché case and gave lunch bucket, coveralls and put me on rotating shift in the pilot plants. What learned in that two years I carried with me through my entire career. I also had a 6-week hands-on unit operations summer course at the Colorado School of Mines.

# Topic 3

```
0.035*"college" + 0.028*"engineers" + 0.027*"year" + 0.024*"degree" + 0.023*"programs" + 0.020*"program" + 0.020*"see" + 0.019*"job" + 0.016*"profession" + 0.015*"needs"
```

Original response: Community outreach to developers about fair pay. Original response: A closer collaboration with industry.

# Topic 4

```
0.075*"skills" + 0.060*"training" + 0.047*"technical" + 0.042*"project" + 0.039*"management" + 0.032*"school" + 0.028*"communication" + 0.026*"writing" + 0.021*"better" + 0.016*"opportunities"
```

Original response: Emphasis on soft skills and planning/budgeting/project management.

Original response: Higher education should also train more on project management, project budgeting, time management and project prioritization skills.

Original response: Early education (like middle school) of what the engineering fields are and the jobs that are available.

#### **Summary**

Each topic reveals different aspects of the workforce education challenge:

# • Topic 0: Practical Engineering Education and Technical Focus

- Emphasizes the need for practical, real-world experience and skill-focused engineering programs.
- Calls for hands-on learning, better technical preparation, and problem-solving focus.

## • Topic 1: Structural Changes in Education Programs

- Suggests changes to high school and college programs to make engineering more accessible.
- o Includes a focus on increasing class sizes, improving educational outreach, and emphasizing foundational engineering principles.

# • Topic 2: Real-World Experience and Internships

- o Stresses the need for more internship and co-op opportunities.
- Discusses alternative educational paths, such as apprenticeships, industry partnerships, and flexible online learning.

# • Topic 3: Industry Collaboration and Professional Development

- o Highlights the importance of direct engagement with industry.
- o Calls for better alignment between university programs and industry needs.

# • Topic 4: Soft Skills and Management Training

- Respondents emphasized the need for project management, budgeting, time management, and communication training.
- o Suggests earlier exposure to engineering concepts in middle and high school.

#### **Conclusions**

The responses indicate that engineering education must evolve to meet workforce challenges. There is a disconnect between academic training and industry needs, and respondents call for more hands-on experience, industry collaboration, technical skills development, and soft skills training. Implementing internships, alternative education paths, and better skill integration will help produce engineers who are more prepared for real-world challenges. Key takeaways include the following:

# 1. Stronger Emphasis on Practical Training and Industry Collaboration

- There is a clear demand for more real-world experience, including internships, coop programs, and apprenticeships.
- Universities could increase partnerships with industry to offer hands-on experience before graduation.
- Programs should integrate fieldwork, lab-based courses, and applied engineering projects earlier in the curriculum.

#### 2. Curriculum Enhancements: More Technical and Soft Skill Training

• Traditional engineering education often lacks emphasis on project management, budgeting, and leadership skills.

- Courses should include communication training to prepare engineers for teamwork and client interactions.
- More programs should introduce multidisciplinary coursework that blends engineering principles with business and management.

# 3. Alternative Pathways: Expanding Education Beyond Traditional Degrees

- Many respondents see value in certificate programs, stackable credentials, and online/hybrid learning models.
- Surveying and technical roles could benefit from shorter, more focused training rather than full college degrees.
- Offering early exposure in high school STEM programs could attract more students into engineering careers.

# 4. Bridging the Skills Gap

- Employers report that recent graduates lack technical skills in comparison to engineers of 15–20 years ago.
- This suggests universities need to reassess their approach to skill-building by integrating modern tools, simulations, and field-based training.

## 5. Addressing Workforce Needs More Holistically

- Beyond technical skills, the industry requires engineers to be critical thinkers, problem-solvers, and effective communicators.
- Colleges should integrate case studies, industry-sponsored projects, and real-world problem-solving exercises into coursework.

# 6. An Overview of the Current Pathways in Washington State

Washington offers a wide range of educational programs leading into the civil engineering and land surveying professions. These include four-year university degrees, two-year community/technical college programs, certificates, apprenticeships, and even online learning options. Below, the opportunities are organized by institution and program type, with details on curriculum, capacity, industry connections, and how each prepares students for the workforce.

# 6.1 Civil Engineering and Land Surveying Programs at the University of Washington (Seattle, Tacoma, Bothell)

The University of Washington (UW) hosts civil engineering programs across its campuses, with a long-established department in Seattle and a newly launched program in Tacoma (UW Bothell currently does not offer a civil engineering degree) [20,21,22]. These programs prepare students at the undergraduate and graduate levels to design, build, and maintain infrastructure, addressing critical needs in safe structures, transportation, water systems, and sustainable development. Civil engineering education at UW is broad-based, covering subdisciplines such as structural, geotechnical, transportation, hydrology, environmental, and construction engineering. While land surveying is not offered as a stand-alone degree, the essential principles of surveying and geomatics are integrated into the civil engineering curricula (e.g., through courses in surveying engineering and GIS) to ensure that graduates acquire fundamental mapping and measurement skills [20]. The following sections provides a detailed review of these programs, including enrollment and capacity, curricula, graduation trends, employment outcomes, and how UW prepares students for careers in civil engineering and surveying-related fields at the UW campuses.

### 6.1.1 UW Seattle – Civil and Environmental Engineering Programs

#### Undergraduate Program

The Seattle campus offers a Bachelor of Science in Civil Engineering (BSCE) through the Department of Civil and Environmental Engineering (CEE), an ABET-accredited program dating back many decades. This BSCE program provides a comprehensive foundation across six major emphasis areas:

- construction engineering,
- transportation engineering,
- structural engineering,
- geotechnical engineering,
- hydrology/hydraulics engineering,
- and environmental engineering.

Students complete fundamental science and math prerequisites in the first two years, followed by core civil engineering courses in their junior and senior years. The curriculum includes courses such as structural analysis and design, soil mechanics and foundation

engineering, transportation engineering, fluid mechanics and hydrology, environmental engineering (water and air quality), construction materials and project management, and a senior capstone design project. Notably, geomatics and surveying are incorporated via coursework in surveying engineering and GIS for civil engineers, ensuring that students gain skills in land surveying techniques and spatial data analysis. The program requires 180 quarter credits and emphasizes hands-on labs in areas such as construction materials, geotechnical engineering, hydraulics, and environmental processes, giving students practical experience with modern instrumentation and methods.

Program capacity and enrollment in Seattle are substantial: as of Autumn 2023 the department enrolled 313 undergraduate students (across civil and its allied environmental engineering major). The BSCE program typically admits on the order of 120–130 juniors each year through a competitive process (which includes direct admits from freshman engineering and transfer/upper-division applications) [20]. Retention in the program is high (around 90 percent from junior to senior year), reflecting strong student support and success. Table 1 summarizes recent graduation numbers. Approximately 100–120 students graduate with a UW Seattle civil engineering bachelor's degree each year (e.g., 119 BSCE degrees awarded in 2022–2023). An additional smaller cohort (15 students in 2023) complete the BS in Environmental Engineering, a separate undergraduate track within the department. Over the past five years, the annual number of BSCE graduates has remained in the low hundreds, meeting steady demand for new engineers in the region.

Program	Annual Graduates (approx.)
UW Seattle – BS Civil Engineering	100–120 per year (119 in 2022–23)
UW Seattle – BS Environmental Eng.	10–20 per year (15 in 2022–23)
UW Seattle – MS and PhD	150 per year (152 in 2022–23)
UW Tacoma – BS Civil Engineering	First cohort graduated 2024 (7 graduates in 2023–24)
UW Bothell – Civil/Surveying	N/A – no program offered at Bothell

Table 1. Approximate Number of Graduates per Year (Recent Years)

### **Graduate Programs**

UW Seattle also hosts robust graduate offerings in civil engineering. The department confers Master of Science in Civil Engineering (MSCE) degrees in several specialty areas (such as structural engineering, transportation, geotechnical, construction, water resources, and environmental engineering), including both thesis-based and coursework-based professional master's options. Additionally, two online master's programs are available in specialized fields (Construction Engineering and Supply Chain Transportation and Logistics) to serve working professionals. Figure 46 shows the distribution of graduate students in different engineering fields of study at the UW.

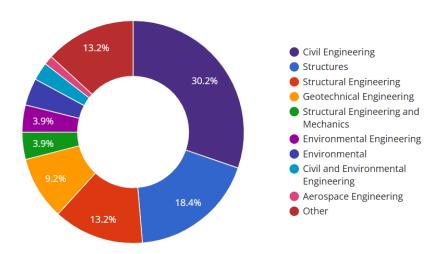


Figure 46. Distribution of students in different fields of study in UW Graduate Programs

A PhD program prepares students for advanced research and academic or industry leadership roles. Graduate enrollment in Seattle was 335 students in Autumn 2023, and the program awarded approximately 152 graduate degrees in 2022–2023 (133 master's degrees and 19 doctorates). Graduate students engage in cutting-edge research through numerous research centers and laboratories, often in collaboration with industry and government (areas of research range from earthquake engineering and smart transportation systems to water treatment and sustainable infrastructure). The graduate curriculum is structured to deepen technical expertise in a chosen sub-discipline; for example, an MS student might take advanced courses in finite element structural analysis, bridge design, or traffic flow theory alongside research or capstone projects. These offerings have earned UW Seattle a high reputation – *U.S. News* ranks UW's civil engineering graduate program #12 nationally. Graduates of the MS and PhD programs proceed to careers in industry (as specialized engineers or project managers), public agencies, or academia, contributing expert leadership in their fields.

# **Educational Approach and Preparation**

The UW civil engineering program places strong emphasis on real-world preparation and hands-on learning. More than 80 percent of CEE undergraduates have had an engineering internship by the time they graduate [20]; many students secure paid summer internships as early as their junior year, gaining experience on construction sites, in design offices, and for research projects. In fact, 81 percent of students have internships lined up by junior year, a reflection of the department's encouragement and industry connections. The curriculum incorporates practical laboratory courses (for instance, students mix and test concrete in the materials lab, and perform surveying exercises and geotechnical soil testing in field labs), as well as field trips to see infrastructure in action (visiting glaciers, construction sites, dams and other projects is part of the learning experience). A hallmark of the senior year is the capstone design project, for which students work in teams to solve an open-ended engineering problem often drawn from local industry or community needs (e.g., designing a bridge, a water supply system, or a transportation

plan), integrating skills from various sub-disciplines. This mirrors professional practice and frequently involves mentorship or sponsorship from practicing engineers.

This program also invests in professional development. The department hosts an annual CEE Career Fair that connects students with over 80 employers in the industry (engineering firms, construction companies, public agencies). Career seminars, mentorship by an Industry Advisory Board, and alumni networking events further prepare students for the workforce. Thanks to these efforts, the job market outcomes for graduates are excellent: approximately 74 percent of UW civil engineering seniors have job offers by the time of graduation. Seattle's strong civil engineering industry helps; the Seattle metro area is ranked among the top regions for civil engineers to start their careers (taking into account job availability, salary, and cost of living).

Students are encouraged to take the Fundamentals of Engineering (FE) exam during their senior year or soon after graduation, which is the first step toward PE licensure. The BSCE curriculum is aligned with ABET standards and covers the knowledge areas tested on the FE exam; in addition, ethics and professionalism are stressed. Within a few years of graduation, alumni are expected to progress toward professional certification; indeed, program objectives include that graduates will make progress toward becoming licensed engineers. Overall, UW Seattle produces broadly trained civil engineers who are technically proficient and ready to address societal challenges, consistent with the department's mission of preparing engineers to solve complex, multi-faceted problem

# 6.1.2 UW Tacoma – BS in Civil Engineering

UW Tacoma launched its Bachelor of Science in Civil Engineering (BSCE) program very recently to expand engineering education in the South Puget Sound region. Housed in the School of Engineering and Technology, the Tacoma BSCE admitted its first cohort in 2022 and will seek ABET accreditation after graduating its initial class (the first seven students graduated in Spring 2024). This program was established to meet local workforce demand and improve access to civil engineering training in the Tacoma area, backed by state initiatives to increase engineering enrollments.

Although new, the Tacoma curriculum closely mirrors the core content of a traditional civil engineering degree, ensuring that graduates attain the same competencies. Students must complete foundational math and science courses (calculus through differential equations, calculus-based physics series, general chemistry) and basic engineering mechanics (statics, mechanics of materials, dynamics) before entering the junior-year curriculum. The BSCE major requirements at Tacoma comprise 180 credits and include a robust set of required civil engineering courses: for example, CAD for civil engineers, construction engineering, GIS for civil engineers, transportation engineering, construction materials (with lab), fluid mechanics, environmental engineering, geotechnical engineering (with lab), structural analysis, project management, hydraulics and hydrology (with lab), and a two-quarter senior capstone project sequence. Technical elective courses allow seniors to delve into at least two specialization areas (options include foundation design, steel or reinforced concrete design, traffic engineering, urban

transportation planning, air and water quality engineering). This curriculum design ensures that Tacoma graduates are well-versed in all fundamental areas of civil engineering practice. The program's mission emphasizes designing safe, resilient, and sustainable infrastructure to improve quality of life for all, with attention to equity and global societal needs

As a new program, UW Tacoma's civil engineering cohort sizes are modest but growing each year. In the 2022–2023 academic year, the program enrolled 7 students (juniors) as it launched; by 2023–2024 enrollment had grown to 19 students, and in 2024–2025 it reached 38 students (as the first cohort moved into senior year and a new cohort of juniors was added) [21]. These numbers indicate an annual intake of around 20+ students in the early years. The program has a planned capacity. The application is competitive and may close after the priority deadline once the cohort is full, likely on the order of a few dozen new students per year during this rampup phase. The faculty has been expanding accordingly, with new professors hired to build the program and modern laboratory facilities being developed to support coursework and student research.

UW Tacoma aims to achieve ABET accreditation in the 2024–25 cycle (after the first graduates), which will certify that the BSCE meets the same high standards as the Seattle program. Plans for the future may include growing the program size and possibly adding graduate or other specialized programs, but at present the BSCE is the primary offering in civil engineering at Tacoma (no separate land surveying degree or graduate degree is offered on this campus as of 2025).

The Tacoma civil engineering program places emphasis on practical, career-oriented training and industry connections. The curriculum features a GIS course and integrates surveying and data collection skills, reflecting the importance of geospatial competency in civil projects. Small class sizes allow for individualized mentorship, and the faculty are implementing a "Research for All" initiative to involve undergraduates in hands-on engineering research as part of their coursework. This approach gives students lab and field research experience (for example, studying local infrastructure challenges or materials testing), which can be a distinct advantage in both job and graduate school applications. An External Advisory Board of civil engineering professionals from the South Puget Sound region provides guidance to ensure that the program aligns with industry needs. Local engineering firms and public agencies are engaged through this board and through internship opportunities for students.

Tacoma civil engineering students have access to the career services and job fairs of UW Tacoma and can also tap into UW Seattle's engineering career resources; given the program's location, many students secure internships or jobs with employers in the Seattle–Tacoma metro area, which is among the nation's top regions for civil engineering employment.

Washington state has a high demand for civil engineers (the Bureau of Labor Statistics projects ~7 percent growth nationally in the coming decade) and one of the highest state average salaries for the field (around \$98,800 mean annual wage in Washington). This context has informed the program's development: UW Tacoma trains graduates for roles such as civil engineer, construction engineer, environmental engineer, geotechnical engineer, structural

engineer, transportation engineer, and water resources engineer, as highlighted in its promotional materials. As with Seattle, ethical practice and licensure are encouraged; within a few years of graduation, Tacoma alumni are expected to be pursuing Engineer-in-Training (EIT) certification and on the path to PE licensure.

In summary, though still growing, UW Tacoma's civil engineering program offers a high-quality, ABET-aligned education that leverages UW's academic rigor with a focus on regional infrastructure needs and workforce development in civil and surveying-related fields.

## **6.1.3 UW Bothell**

Unlike Seattle and Tacoma, UW Bothell does not currently offer a degree in civil engineering or land surveying. UW Bothell's School of Science, Technology, Engineering and Mathematics has concentrated on other disciplines (such as computer science, mechanical engineering, and electrical engineering). As shown in UW Bothell's degree listings, no undergraduate or graduate program in civil or environmental engineering is available on that campus. Students in the Bothell region who are interested in civil engineering typically enroll at the Seattle or Tacoma campuses or elsewhere. Bothell also does not host a dedicated land surveying program. However, some related coursework can be found in Bothell's offerings (for instance, GIS and environmental science courses or interdisciplinary programs that touch on urban infrastructure), but these are not comprehensive surveying or civil engineering degrees.

Bothell's focus remains on other STEM fields, so this campus is not a direct contributor of civil engineering graduates. Nonetheless, Bothell's growth in engineering (e.g., new mechanical and electrical engineering BS programs) demonstrates UW's overall expansion in engineering education, which could potentially include civil engineering in the future if demand and resources allow. For now, UW Seattle and UW Tacoma are the primary UW campuses serving students in civil engineering and surveying education.

# 6.1.4 Land Surveying Education within UW Programs

Although the University of Washington does *not* offer an independent Bachelor's in Land Surveying or a geomatics degree, surveying principles are incorporated into the civil engineering curriculum at UW Seattle and Tacoma. In the Seattle BSCE program, students typically take a course on Surveying Engineering (CEE 316), which covers measurement theory, leveling, distance and angle measurement, traverse computations, and other fundamental land surveying techniques.

Additionally, a course in GIS for Civil Engineers (CEE 424) is offered, introducing computational mapping and spatial data analysis in civil/environmental engineering contexts. These courses ensure that civil engineering students gain the ability to interpret maps, conduct basic field surveys, and use surveying instruments – skills that are crucial for site development, route location, construction layout, and other civil projects.

At UW Tacoma, surveying content is weaved into the GIS and remote sensing coursework (TCE 309) and other design classes; students learn to work with survey data and mapping software as part of their training. The Tacoma program's inclusion of a GIS course

indicates recognition of the importance of geospatial competencies for modern civil engineers, even if a dedicated surveying course is not explicitly listed.

For those specifically interested in the surveying profession (e.g., becoming a licensed Professional Land Surveyor, PLS), UW's civil engineering degrees provide a solid foundation (particularly in understanding of geodesy, mapping, and land development), but additional specialized coursework or on-the-job training may be pursued outside UW. In Washington state, licensure as a surveyor generally requires passing the Fundamentals of Surveying (FS) exam and acquiring specific surveying experience or coursework.

UW students sometimes take advantage of continuing education programs or community college courses in advanced surveying to supplement their UW degree if they aim for dual licensure (PE and PLS). It is worth noting that UW's Urban Studies program at Tacoma offers a GIS Certificate that can complement a civil engineer's education in the geospatial aspects of land analysis. Moreover, the Land Surveyors' Association of Washington (LSAW) provides student resources and may have connections with UW students interested in surveying.

In summary, while UW does not produce "surveying" graduates, it integrates key surveying knowledge into its civil engineering programs, ensuring that graduates are conversant in land surveying basics and prepared to collaborate with surveying professionals. This integration reflects industry reality, as many civil engineers work closely with surveyors or even perform limited surveying tasks in their projects.

#### 6.1.5 Enrollment, Graduation and Workforce Outcomes

#### Enrollment and Graduation

Both the Seattle and Tacoma civil engineering programs are geared toward supplying a well-trained workforce to meet industry and public sector needs. To highlight trends: UW Seattle's civil engineering undergraduate program consistently produces roughly 100+ new civil engineers each year, and this output has been steady or growing slightly with the addition of the environmental engineering major. The Tacoma program, having just begun graduating students, adds a small but growing number (seven in 2024, expected to increase in subsequent years as enrollment rises). Combined, the UW system's civil engineering degrees awarded over the past five years would number in the hundreds, contributing significantly to the regional talent pipeline. On the graduate side, Seattle's ~150 annual MS and PhD graduates provide advanced expertise, some of whom remain in academia or research while many join industry roles that require higher-level specialization.

## **Employment Outcomes**

Typical employment outcomes for UW civil engineering graduates are strong in terms of both placement rate and the diversity of sectors and roles. According to departmental surveys and employer data, UW CEE graduates secure positions across all major sectors of civil engineering:

- Consulting engineering firms (design and analysis roles),
- Construction and contracting companies (field engineering, project management roles),

- Public agencies and government (transportation departments, utilities, regulatory agencies),
- Technology or industry groups that require analytical skills (some civil graduates go into data analytics, tech companies working on smart city or mapping projects, etc.).

A breakdown from UW Seattle shows alumni working in areas that include the following:

- Infrastructure design and construction: e.g., structural engineers designing buildings and bridges, geotechnical engineers working on foundations and tunnels, transportation engineers planning highways and transit, and construction engineers managing project sites.
- Water and environment: e.g., water resources engineers and environmental engineers focusing on water supply, wastewater treatment, environmental remediation, and sustainability projects.
- Public sector and utilities: many graduates work as civil engineers in government (city/county engineers, DOT engineers, public utilities) maintaining infrastructure and ensuring public safety.
- Private consulting and industry: graduates join large engineering consulting firms and smaller specialty firms, taking roles such as design engineer, project engineer, or consultant in areas such as structural design, transportation planning, or environmental consulting. Others enter construction companies as field engineers or project managers. A few leverage their quantitative skills in fields such as data science, tech, or finance (for instance, working on infrastructure-related software or analytics)[20].

Geographically, a significant portion of UW's civil engineering graduates remain in the Puget Sound region (Seattle-Tacoma), which "overwhelmingly counts on our graduates" to fill engineering positions for local infrastructure needs. Washington state employs thousands of civil engineers (over 20 percent of them in the Seattle metro area alone), and UW alumni have a strong reputation with local employers. Many grads work in Seattle, Tacoma, Bellevue, and surrounding areas, contributing to projects such as light rail expansion, highway improvements, waterfront developments, and environmental restoration in the Pacific Northwest. However, UW engineers are not limited to the local area, and alumni can be found across the country and internationally.

# Top Employers

UW CEE maintains statistics on companies that frequently hire its graduates. In 2017–2020, for example, over half of CEE graduates who gained employment went to just 56 companies, indicating strong pipelines to those employers. The top ten employers (by number of hires of UW civil graduates) during that period included major public agencies and leading engineering firms:

• WSDOT was the single largest hirer, reflecting the draw of public infrastructure jobs.

- Prominent consulting/design firms such as KPFF Consulting Engineers and Jacobs Engineering, and large construction companies such as Kiewit and Clark Construction, were also top destinations.
- Other notable employers of UW civil engineers include the Seattle Department of Transportation, regional consulting firms (e.g., Perteet, Parametrix, Mott MacDonald), and contractors (Skanska, Walsh Group, Turner Construction, etc.).
- A number of graduates also join private sector technology or aerospace companies in infrastructure-related roles (for instance, Boeing and Amazon have hired UW civil engineers—Boeing for structural analysis of aircraft and facilities, Amazon for its transportation or warehouse infrastructure teams), and even SpaceX appears on the list of employers (likely for roles in facilities or construction project management).
- Consulting firms across disciplines including structural design (e.g., DCI Engineers, Coughlin Porter Lundeen), transportation planning (Transpo Group, HNTB), and water/environment (BHC Consultants, Aspect Consulting) employ UW alumni as well.

This spread of employers showcases that UW civil engineering graduates are highly sought after in both the public and private sectors, and across sub-fields from traditional civil engineering companies to innovative tech-driven organizations. Graduates who pursue the PE license often advance into roles of greater responsibility within a few years, such as project managers or lead design engineers, and UW's strong reputation and alumni network help in career advancement.

In terms of salaries and career satisfaction, the outlook is positive. The median starting salary for UW CEE bachelor's graduates is around \$78,000 per year [20], which is notably high for entry-level positions and reflects the strong tech and construction economy in the Seattle area (this starting median saw an 8 percent rise from the previous year). Nationally, civil engineers have a median wage in the upper \$80,000s across all experience levels, and environmental engineers around \$96,000, according to the U.S. Bureau of Labor Statistics, indicating room for growth as young engineers gain experience.

## **6.1.6**| **Summary**

In summary, the civil engineering programs at UW Seattle and Tacoma are thriving contributors to workforce development, producing graduates who fill essential roles in building and maintaining infrastructure. With strong enrollment, rigorous coursework, and close industry ties, these programs ensure students gain the knowledge, practical experience, and professional readiness to excel as engineers. Land surveying, while not a standalone program, is an integral supporting component, equipping civil engineering students with critical spatial and measurement skills for their careers. The combination of academic excellence and experiential learning from labs and capstones to internships and career fairs has yielded graduates who are in high demand by employers and who help drive the economic and physical development of Washington State and beyond. The University of Washington's commitment to engineering

education thus plays a key role in addressing the growing needs for civil engineers and surveyors, preparing graduates to design resilient infrastructure and sustainable solutions for our communities

# 6.2 Civil Engineering and Land Surveying Programs at Washington State University (WSU, Pullman)

Washington State University (WSU) offers accredited programs in Civil Engineering through its Voiland College of Engineering and Architecture. The Bachelor of Science in Civil Engineering (BSCE) is offered at the main Pullman campus and at WSU Tri-Cities (in Richland). The Pullman program is administered by the Department of Civil and Environmental Engineering, while the Tri-Cities program is delivered through the School of Engineering and Applied Sciences. WSU's Vancouver campus does not currently host a stand-alone civil engineering undergraduate program; Vancouver students interested in civil engineering typically transfer to Pullman or Tri-Cities, although WSU Vancouver's 2025 commencement did include a small number of civil engineering bachelor's degrees conferred, reflecting recent cross-campus offerings. [23]

At the undergraduate level, WSU's civil engineering curriculum covers the major sub-disciplines, including structural, geotechnical, transportation, water resources, and environmental engineering, and it includes an introduction to land surveying. For example, WSU's BSCE requires a two-credit course in surveying (CE 302 Introduction to Surveying) as part of the junior-year core. Beyond the BSCE, WSU also offers a separate Bachelor of Science in Construction Engineering (BSConE) at Pullman (a related field focusing on construction management and engineering).

Graduate programs at WSU include the Master of Science (MS) and Doctor of Philosophy (PhD) in Civil Engineering, primarily based in Pullman. WSU's MS program offers both thesis and non-thesis options (including a professional Master of Engineering track), allowing specialization in areas such as structural, environmental, water resources, geotechnical, and transportation engineering. WSU's civil engineering graduate research is supported by various laboratories and research centers, and the Pullman campus hosts the majority of faculty and facilities for advanced study. (WSU Tri-Cities does not currently offer a full standalone MS in Civil Engineering, although some graduate-level civil/environmental engineering courses and research opportunities are available in the Tri-Cities focusing on environmental and infrastructure topics, given the region's industry presence.)

WSU does *not* offer a dedicated degree in land surveying or geomatics; however, surveying content is incorporated within the civil engineering program. All BSCE students take foundational surveying coursework (e.g., CE 302 Intro to Surveying – covering plane surveying techniques, use of GPS and total stations, and basic geomatics). Students interested in professional land surveying licensure often supplement their civil engineering degree with additional geomatics electives or pursue surveying certificates at technical colleges (since Washington's licensure path for surveyors allows an engineering degree plus experience or a

surveying-specific degree). In summary, WSU addresses land surveying through the civil engineering curriculum rather than a separate program.

## 6.2.1 Program Enrollment and Capacity

WSU's civil engineering program is one of the larger engineering programs at the university. At the Pullman campus, undergraduate enrollment in civil engineering was 307 students in Fall 2023 [23]. Enrollment has fluctuated in recent years – for example, Pullman civil engineering enrollment was 424 in Fall 2020 and has since declined to around 300 as of 2023. The Tri-Cities civil engineering cohort is smaller, with a few dozen students (e.g., ~50 students in Fall 2021) as the program there has grown since its establishment. Combined across campuses, WSU's total BSCE enrollment has been roughly in the mid-300s to low-400s in recent years. This indicates a program capacity capable of accommodating around 80–100 incoming civil engineering majors per year system-wide. WSU Vancouver currently has no separate cohort (aside from a handful of students taking preliminary engineering courses), so virtually all WSU civil engineering undergraduates are at Pullman or Tri-Cities.

In Pullman's civil engineering graduate programs, there are typically on the order of 40–60 graduate students in total, including both MS and PhD students, depending on research funding and yearly admissions. Recent data show about 16–24 MS graduates and around five to ten PhD graduates per year, implying a steady-state enrollment of perhaps ~50+ MS students and ~20 doctoral students at any time (precise current enrollment figures were not published in the sources).

## 6.2.2 Courses and Curriculum

WSU's civil engineering curriculum is structured to provide a broad foundation in engineering science and design, while also allowing some technical electives for specialization. The undergraduate course sequence includes fundamental math and science in the first year (calculus, physics, chemistry), engineering mechanics (statics, dynamics, mechanics of materials), and civil engineering core subjects typically in the second and third years. Notable required courses include the following:

- CE 211 and 215 Engineering Statics and Mechanics of Materials (sophomore year).
- CE 302 Introduction to Surveying (two credits, typically junior year) covering surveying methods, use of instruments, and basic mapping.
- CE 315 Fluid Mechanics; CE 317 Geotechnical Engineering; CE 341 Environmental Engineering (junior year core courses).
- CE 320/321/322 Structural analysis and design courses (steel, concrete design, etc.) in the junior/senior year.
- CE 351 Introduction to Transportation Engineering (traffic engineering, highway design principles).
- CE 465 Senior Capstone Design (a four-credit capstone project course taken in the final semester). In this capstone, students work in teams on a comprehensive civil

engineering design project, often incorporating multiple sub-disciplinary aspects (structures, transportation, water, etc.) and mirroring a real-world project scenario.

In addition to the core, students must take technical electives (18 credits) in at least two different civil engineering sub-areas. WSU offers electives in structural engineering (e.g., advanced steel or concrete design), geotechnical (foundation engineering, soil improvement), water resources (hydrology, open channel flow), environmental engineering (water/wastewater treatment, hazardous waste), transportation/pavements, and sustainability. Some of these electives include design-focused courses to satisfy the degree's design requirements (e.g., bridge design, hydraulic design, pavement design).

WSU integrates surveying into the BSCE via the required CE 302 course. This gives students hands-on field experience with surveying equipment and methods. Further geomatics or GIS training is available as electives, though not mandatory. For instance, students can choose to take courses in GIS or remote sensing through related departments (such as Earth Sciences or Geography) if they desire additional GIS proficiency. The civil engineering department itself emphasizes use of modern tools such as Global Positioning System (GPS)-based surveying and CAD in design projects, but a dedicated GIS course is not listed as a core requirement in the civil curriculum. Students interested in geomatics beyond the introductory level often pursue those skills via technical electives or as part of research projects.

At the graduate level, WSU's course offerings span advanced topics such as finite element analysis, earthquake engineering, advanced hydrologic modeling, traffic systems design, and environmental remediation. Graduate students can specialize through their coursework and thesis work. For example, a graduate student in water resources might take advanced hydrology and GIS-based watershed modeling courses, while a structural emphasis student might take prestressed concrete and structural dynamics. The MS curriculum is flexible to support these specializations, and PhD students focus on research under faculty supervision.

#### 6.2.3 Graduation Rates and Degree Output

WSU produces a significant number of civil engineering graduates annually, although the numbers have varied. Table 2 summarizes the number of BS Civil Engineering degrees awarded by WSU in recent years:

Academic Year (July–June)	BS Civil Eng Degrees Awarded (WSU)
2019–2020	97 students
2020–2021	130 students
2021–2022	101 students
2022–2023	88 students
2023–2024	~72 students

Table 2: Annual BSCE Degrees Awarded – Washington State University

As shown, WSU saw a peak of around 130 civil engineering BS graduates in 2020–21, while more recent years have been closer to 80–100 graduates per year. Over a five-year span, WSU has averaged roughly 100 BS civil engineers graduated per year. The variation can be attributed to enrollment trends and perhaps pandemic-related timing (the Class of 2021 was large, followed by a dip). If data prior to 2019–20 were considered, the annual output was on the order of 90–100 graduates as well (e.g., the academic year 2018–2019 produced a similar magnitude of graduates, although exact figures were not published in our sources).

For graduate degrees, WSU awarded around 14–21 MS degrees in Civil Engineering per year in recent times (e.g., 21 MS degrees in fiscal year 2022), and typically five to ten PhD degrees in civil engineering each year (five PhDs in fiscal year 2022). These numbers indicate a moderate-sized graduate program, with WSU contributing a steady pipeline of advanced civil engineers (many of whom enter consulting or industry with an MS, or academia/advanced research and development with a PhD).

By comparison, no stand-alone land surveying degrees are granted by WSU. (The university's contribution to the surveying workforce is via civil engineering graduates who have taken the surveying course or via graduate research in geospatial topics.) Those seeking surveying credentials in Washington often attend community/technical colleges (for Associate of Applied Science (AAS) programs in surveying) or specialized geomatics programs at other institutions.

## **6.2.4** Typical Employment Outcomes for Graduates

WSU civil engineering graduates have strong placement in industry and government, benefiting from the program's long-standing reputation and ties to employers in the Pacific Northwest. Within a few months of graduation, a majority of graduates secure employment or pursue further education. According to university-wide surveys, about 71 percent of WSU engineering graduates (class of 2021) were employed within three months of graduation, and over 90 percent typically find jobs or graduate school placements within six months. Civil engineering majors specifically follow a similar or slightly higher placement trend because of consistent demand in the civil/infrastructure sector.

## Geographic Placement

Many WSU civil engineering alumni remain in Washington or the broader Pacific Northwest. A large portion take jobs in the Puget Sound region (Seattle metropolitan area), which has a high demand for civil engineers, or in Eastern Washington cities (Spokane, Tri-Cities) where infrastructure and energy projects are ongoing. Some graduates relocate elsewhere in the western U.S. or beyond, but WSU's network is strongest regionally. The Tri-Cities campus graduates often have ties to local employers in the Mid-Columbia region (e.g., engineering contractors at the Hanford nuclear site, regional consulting firms, and public utilities in the Columbia Basin), so many Tri-Cities students take jobs in or around the Tri-Cities, Spokane, or

Portland/Vancouver after graduation. Vancouver-area students (those who transferred to complete the BSCE) tend to work in the Portland, Oregon–Vancouver, Washington, metro area.

## **Primary Employment Sectors**

The primary employment sectors for WSU civil engineering graduates include the following:

- Engineering design and consulting firms (private sector): A significant number join engineering consultancies from large global firms (e.g., Jacobs, HDR, WSP, AECOM) to regional companies (e.g., KPFF, Parametrix, DCI Engineers). They work as design engineers or project engineers in disciplines such as structural design (buildings and bridges), transportation/highway design, water resources and stormwater management, geotechnical engineering, and environmental consulting. Graduates often start in Engineer-in-Training (EIT) roles, working under licensed Professional Engineers on project teams.
- Construction and infrastructure contractors: Some graduates work for construction companies or design-build firms in roles such as field engineer, project engineer, or construction management trainee. Given WSU's construction engineering focus (with some students earning the construction engineering degree or taking construction management electives), graduates are sought by major contractors (e.g., Kiewit, Granite, Skanska) for infrastructure projects and by local construction firms building civil works.
- Public sector agencies: Many WSU alumni enter government roles. Common employers include state and local government agencies. For example, WSDOT hires WSU civil grads as transportation engineers and project managers; city and county public works departments (City of Seattle DOT, Spokane Public Works, various counties) hire them as design engineers, utility engineers, or field engineers for public infrastructure. Federal agencies such as the U.S. Army Corps of Engineers and Bureau of Reclamation (which have a strong presence in the Pacific Northwest) also employ WSU civil engineers for water resources, hydropower dam projects, and military infrastructure roles.
- Utilities and industry: Some graduates work for utility companies (power, water, telecom) in roles involving civil infrastructure (e.g., structural support for facilities, transmission structures, dams). Others may join industries such as oil and gas or manufacturing in plant engineering roles, although this is a smaller fraction relative to the traditional civil roles.
- Advanced education: A portion of WSU BSCE grads (roughly 10–20 percent) opt to
  attend graduate school either immediately or after a year or two of work. They pursue
  MS or PhD degrees in specialized fields (structural, transportation, etc.) at WSU or
  other universities. Some also pursue a Master of Business Administration or related
  management degrees later in their careers, especially those moving into project
  management tracks.

## Top Employers

Based on regional hiring patterns, notable employers of WSU civil engineering graduates include WSDOT (with multiple regional offices that consistently recruit), large Seattle-area engineering firms (such as Jacobs, HDR, and Parametrix which frequently attend WSU career fairs), and municipal entities such as the City of Spokane, City of Kennewick/Pasco (near Tri-Cities), and Seattle Public Utilities. The U.S. Army Corps of Engineers (particularly the Walla Walla District and Seattle District) is also a significant employer, given the number of dams and waterways in the region. On the private side, structural engineering consultancies in Seattle (e.g., Magnusson Klemencic Associates, KPFF) have hired WSU graduates for building design, while geotechnical firms (e.g., Shannon and Wilson, GeoEngineers) recruit those with geotech interest. In construction, companies such as Kiewit and Bechtel (the latter operating in Richland for Department of Energy projects) have been frequent destinations. Overall, WSU's civil engineers find roles across the spectrum of consulting engineer, design engineer, field engineer, project manager, or analyst in their early careers, and many advance to become licensed PEs after four to five years of experience and passing the PE exam.

## 6.2.5 Workforce Development and Educational Enrichment

WSU emphasizes practical experience and professional preparation throughout its civil engineering program. Key workforce development strategies include the following:

- Experiential learning requirement: Uniquely, WSU's BSCE has a formal requirement that each student complete an experiential learning component before graduation. Students can fulfill this by doing an industry internship (eight+ weeks) for academic credit (CE 495), participating in faculty-supervised research (CE 499), studying abroad, serving in ROTC or military, or holding a significant leadership/service position. This requirement ensures that every student has practical experience or global exposure. Internships are the most common choice; many students intern with engineering firms or agencies typically in the summer of junior year, applying their coursework to real projects.
- Capstone design projects: The senior capstone course (CE 465) is a comprehensive design project often done in teams with industry-sponsored project topics. Students are mentored by faculty and sometimes by professional engineers from industry partners. This culminates in a final report and presentation, simulating an engineering consulting project from conception to design. WSU touts that students "gain direct engineering experience through a senior capstone design course" and graduate "ready to obtain a Professional Engineering license." Many capstone projects at WSU have real-world clients (e.g., designing a real bridge or infrastructure improvement for a community), which helps students build a portfolio and network with potential employers.
- Laboratories and field work: The curriculum includes lab courses (e.g., materials lab, soils lab, hydraulics lab) and field exercises. In the surveying class (CE 302), for example, students go outside to practice land surveying techniques on campus. In

- geotechnical engineering, students conduct soil tests in the lab. WSU's facilities such as the hydraulics lab, structures lab, and the SIMIAN construction materials laboratory (at Tri-Cities) allow students to work with modern equipment and instruments. This hands-on training makes graduates more workforce-ready by familiarizing them with tools and protocols they will encounter on job sites and in quality control labs.
- FE exam preparation: While WSU does not require passing the Fundamentals of Engineering (FE) exam for graduation, the program strongly encourages students to take the FE (which is the first step toward PE licensure) in their senior year. Coursework is aligned with FE topics, and often review sessions are organized. (Seattle University, by contrast, actually requires the FE exam, but WSU makes it voluntary albeit common.) The emphasis on licensure is part of the professional orientation of the program; indeed, WSU advertises that graduates are "ready to obtain a Professional Engineering license," reflecting that many do pursue EIT status upon graduating.
- Industry partnerships and advisory boards: WSU's Civil and Environmental Engineering department maintains an Industry Advisory Board composed of practicing engineers from leading firms and public agencies. This board provides input on curriculum and often facilitates internship and job opportunities. Both the Pullman and Tri-Cities programs engage local industry; for example, Tri-Cities faculty work closely with engineering employers at the Hanford site and local municipalities, and those partners may sponsor senior design projects or offer internships. WSU also hosts guest lectures by industry professionals in classes and has "experienced industry partners" engaging with students.
- Student professional organizations: There are active student chapters of professional societies, notably the American Society of Civil Engineers (ASCE) at WSU. The ASCE student chapter at Pullman participates in annual competitions such as the Concrete Canoe and Steel Bridge contests. These extracurricular projects are significant team endeavors in which students design and build a concrete canoe or a steel bridge under ASCE competition rules, providing experience in project management, design, fabrication, and teamwork. Such activities hone leadership and practical skills (and WSU teams have historically performed well regionally). There are also chapters for Institute of Transportation Engineers (ITE), Society of Women Engineers (SWE), Engineers Without Borders, and other relevant groups. These organizations host technical talks, run community service projects, and often connect students to employers (for instance, ASCE meetings may include presentations by engineering companies). According to WSU, the college supports over 40 engineering student organizations that offer professional development, and many civil engineering students take on club leadership or competition teams.

- Career fairs and recruiting events: WSU's central Career Center and the Voiland College organize career fairs each semester that attract numerous engineering employers. The WSU Engineering Career Expo is a major fall event in which civil engineering seniors and juniors meet dozens of employers hiring for entry-level jobs and internships. Employers from across Washington and the Pacific Northwest attend, including consulting firms, construction companies, and government agencies. Tri-Cities campus also hosts a smaller annual career fair focusing on regional industries (with companies such as Bechtel, Pacific Northwest National Lab, local public works). These fairs, along with on-campus interviews, result in many students securing job offers before graduation. Additionally, the department often publicizes job openings and brings in alumni for "industry panels" to give job search advice.
- Curriculum integration of professional skills: The WSU civil program integrates
  communication and teamwork skills through project-based assignments. For example,
  the required Engineering Communications courses and writing-intensive courses
  ensure students practice writing reports and giving presentations (the senior capstone
  includes a formal report and oral presentation to an audience). There is also an
  emphasis on ethics and professional responsibility in the curriculum (through
  seminars or a dedicated engineering ethics module), preparing students for the
  professional practice portion of their careers.

## **6.2.6** | **Summary**

Overall, WSU's civil engineering programs (Pullman and Tri-Cities) are designed with a strong practical slant – combining rigorous academics with hands-on experiences (labs, fieldwork), required internships/research, a capstone with real clients, and active engagement with industry. These elements align with workforce development goals, producing graduates who are not only technically competent but also familiar with the engineering workplace. It is reflected in outcomes: a high proportion of WSU civil engineering students pass the FE exam and eventually become licensed, and employers often note WSU graduates' readiness to contribute in entry-level roles.

## 6.3 Civil Engineering and Land Surveying Programs at Seattle University

Seattle University (SU) offers civil engineering programs through its College of Science and Engineering, with a focus on small-class, practice-oriented education in an urban setting. The primary offering is the Bachelor of Science in Civil Engineering (BSCE), which is accredited by ABET and features both a general civil engineering curriculum and an Environmental Specialization track within the BSCE [24]. The BSCE program at Seattle U is somewhat unique in that it combines civil and environmental engineering content; students can choose the general civil path or elect the environmental specialization, which adds courses in environmental science, water supply, and hazardous waste in addition to the standard civil engineering core [24]. All students graduate with a BS in Civil Engineering, and those who complete the environmental track have that noted as a specialization.

Seattle U's Department of Civil and Environmental Engineering is a teaching-focused program known for its low student-to-faculty ratio and close mentorship. Classes are taught by faculty, and the program emphasizes fundamental engineering science as well as humanities and social responsibility consistent with the university's Jesuit educational mission. The BSCE curriculum provides a "strong foundation in mathematics, engineering sciences and the humanities," and it integrates sustainability and equity considerations into engineering problem-solving.

In terms of program capacity, Seattle U's civil engineering is relatively small and selective. Annual freshman cohorts are on the order of 15–25 students, keeping total enrollment around 70–80 undergraduates at any given time. Indeed, in Fall 2023 the civil engineering program enrolled 79 undergraduate students in total, a testament to the small, close-knit nature of the program. This small size is intentional to maintain quality and intensive mentoring. The program places heavy emphasis on design projects, liberal arts integration, and ethical formation of engineers.

For graduate education, Seattle U offers a Master of Science in Structural Engineering (MSST). This is a professionally focused graduate degree tailored to working professionals in the Seattle area who want advanced coursework in structural analysis and design. The MSST (sometimes just referred to as an MS in Civil Engineering with a structural focus) typically covers advanced topics such as seismic design, advanced concrete and steel design, and structural dynamics. Seattle U's MS program is smaller than the undergraduate program; it graduates on the order of five to ten master's students per year (for example, eight master's degrees in civil/structural were awarded in 2020–2021 [24]). There is no PhD program at Seattle U in engineering; the focus is on undergraduate and master's education.

Seattle U does not offer a separate land surveying degree. Instead, surveying and geomatics are integrated into the civil engineering curriculum. As described below, SU has a dedicated surveying course and uses modern surveying/GIS tools in coursework, but students who wish to become licensed surveyors would typically pursue additional specialized training or work experience beyond the BSCE.

## 6.3.1 Program Enrollment and Graduates

Seattle U's civil engineering program is deliberately kept small. Current undergraduate enrollment is about 70–80 students (79 in Fall 2023), spanning freshman through senior years. This suggests that each class year has on the order of 20 students or fewer. The program's capacity is largely determined by this cohort size and the desire to maintain an average class size of about 18 and a student-faculty ratio of approximately11:1.

In terms of annual graduates, Seattle University's BSCE program produces a few dozen new civil engineers each year. Over the past five years, the number of BSCE graduates per year has typically been in the range of 15 to 25. In the most recent year reported, the program awarded 19 bachelor's degrees in civil engineering in the 2022–2023 academic year. This is fairly consistent with prior years (for example, if we extrapolate, one might expect around 20 graduates in 2021–22, etc., given steady enrollment). The small graduating class size is a

hallmark of Seattle U, as each senior class often works together closely (especially through the year-long capstone project sequence).

For the master's program (MS in Structural Engineering), the output is even smaller: typically around five to ten graduates per year. In 2020–21, SU awarded eight master's degrees in civil/structural engineering. Many MS students are part-time (working engineers returning for an advanced degree), so the enrollment in any given term is modest (perhaps 20–25 total MS students across cohorts).

The land surveying content at Seattle U is contained within the BSCE program and thus no separate enrollment or graduation data apply. All civil engineering students receive training in surveying as part of their degree.

## 6.3.2 Curriculum and Course Offerings

Seattle University's civil engineering curriculum is known for its practical, hands-on approach and integration of design across all four years. It requires a total of 180 quarter credits, which includes both technical courses and the university's Core Curriculum in liberal arts. Some distinctive features of SU's curriculum include the following:

- Math and science foundation: Students complete a typical suite of math (calculus I—III, differential equations, linear algebra, probability and statistics) and science (calculus-based physics I—III with labs, general chemistry) in the first two years.
   These fundamentals underpin the engineering courses. Class sizes in these courses are small at SU and often taught with an eye towards engineering applications.
- Engineering fundamentals: Early engineering courses include ENGR 1050
   Engineering Graphics and Communication (introducing CAD drafting and graphical
   communication) and CEEGR 1000 Intro to Civil and Environmental Engineering in
   the freshman year. Statics and mechanics of materials are taken in the sophomore year
   (MEGR 2100 Statics and CEEGR 2210/2211 Mechanics of Materials I with lab),
   followed by CEEGR 3230 Mechanics of Materials II in the junior year. The
   curriculum stresses understanding of engineering mechanics as a basis for all civil
   sub-disciplines.
- Civil engineering core subjects: During the junior year, students take core courses covering each major sub-field of civil engineering:
  - o CEEGR 3310 and 3370 Fluid Mechanics and Lab (fundamentals of fluid flow)
  - o CEEGR 3510 Engineering Geology (soil/rock geology for engineers)
  - o CEEGR 3530 Soil Mechanics (geotechnical engineering with lab)
  - o CEEGR 3420 Environmental Engineering Chemistry (water quality and treatment fundamentals)
  - o CEEGR 3710 Water Resources Engineering I (hydrology, open channel flow)
  - o CEEGR 3350 Applied Hydraulics (water resources II)
  - CEEGR 3260 Transportation Engineering (an elective option focusing on transportation planning and traffic engineering).

Notably, surveying and geomatics is a significant part of the core: CEEGR 3110 – Surveying and Geomatics (five credits) is taken in spring of the junior year. In this course, students learn land surveying principles, field measurement techniques, use of levels and theodolites/total stations, GPS surveying, and mapping. They also likely get introduced to GIS as part of "Geomatics." By dedicating a full five-credit course, Seattle U ensures its graduates have a solid grasp of surveying, a reflection of the importance of land measurements in civil projects. The program description highlights that courses cover "transportation and surveying" among other subdisciplines.

- Design integration and specialization: In the senior year, students take advanced design courses. All students must complete two sequences:
  - A structural design sequence or an environmental engineering sequence, depending on interest. For example, one option is CEEGR 4470 Structural Design I (steel design) and CEEGR 4490 Structural Design II (reinforced concrete design) in the senior year. The alternative is CEEGR 4740 Water/Wastewater Engineering and CEEGR 4750 Hazardous Waste Engineering for those leaning toward environmental engineering. This choice effectively implements the general vs environmental specialization: general-track students do structural design, whereas environmental-track students do the environmental engineering courses. Both tracks ensure depth in a particular area while all still meet core civil outcomes.
  - CEEGR 4450 Structural Mechanics (senior fall, an advanced mechanics course focusing on structural analysis, likely including matrix methods or indeterminate structures).
- Capstone project (Senior Design): Seattle U has a year-long senior design sequence: CEEGR 4870 (Engineering Design I) in fall, CEEGR 4880 (Engineering Design II) in winter, and CEEGR 4890 (Engineering Design III) in spring of the senior year. Over these three quarters, students work in teams on a comprehensive civil engineering project sponsored by an external client (often an engineering firm, nonprofit, or government agency). This capstone is a signature element of Seattle U's program. The projects are industry-sponsored and interdisciplinary, requiring students to apply their accumulated knowledge to solve real problems. The teams are mentored by faculty and licensed professional engineers from industry, which has resulted in Seattle University achieving remarkable recognition: the program has won 21 NCEES Engineering Education Awards since 2009 – "more than any other program in the US." These NCEES awards specifically honor engineering programs that foster collaboration between students and professional engineers on real projects. SU's dominance in these awards underscores how integrated its capstone projects are with the needs of industry and how effectively students engage with professional practice during their education.

- Core curriculum and ethics: Being a Jesuit institution, Seattle U requires students to complete a series of core liberal arts courses (philosophy, theology, ethics, humanities, social sciences) alongside engineering. These are spread out (UCOR courses in the curriculum plan). In particular, an ethics course (Engineering Ethics or general Ethical Reasoning) is mandatory, and themes of social justice, sustainability, and serving society are woven into many civil engineering classes. This produces graduates attuned not only to technical aspects but also to ethical and societal implications of engineering an outcome in line with program objectives.
- Use of modern tools: The curriculum places importance on students gaining proficiency in modern engineering tools and software. From early on, students learn engineering graphics (likely using AutoCAD or similar in CEEGR 1050). Through various courses, they encounter structural analysis software, hydraulic modeling software, GIS and surveying equipment, and more. The department notes use of "cutting-edge surveying and mapping tools such as drones and Geographic Information Systems (GIS), GPS-enabled surveying equipment, modern computer-aided design and analysis software, and air and water quality sensors" in coursework and projects. By graduation, Seattle U students are comfortable with industry-standard tools, giving them practical skills for the workplace.
- FE exam requirement: A distinctive feature is that Seattle U requires all civil engineering undergraduates to take the FE exam as a graduation requirement. Students usually sit for the FE (Civil Engineering discipline exam) in their senior year. This not only encourages near-100 percent participation in the FE, but also reflects that SU is confident in its preparation of students across all fundamental topics. The FE exam requirement underscores the program's commitment to licensure-track education. (It's worth noting that the FE pass rate for Seattle U students is reportedly high, thanks to the small class sizes and thorough preparation.)

In summary, Seattle U's curriculum is rigorous and well-rounded: students get in-depth technical knowledge in core civil engineering fields, significant hands-on design experience, training in surveying/geomatics and modern computational tools, and a broad education in ethics and social context. The result is graduates who are technically competent, prepared for the FE/PE licensure path, and conscious of the role of engineering in society.

## 6.3.3 Employment Outcomes for Graduates

Seattle University's civil engineering graduates enjoy excellent employment outcomes, facilitated by the program's location in the heart of Seattle and the strong reputation of SU engineers. Placement rates are very high: over 92 percent of civil and environmental engineering graduates from SU are employed or enrolled in graduate school within six months of graduation. In fact, many secure positions even before graduating, through internships or the extensive professional connections the department fosters. The combination of ABET-accredited engineering skills and the soft skills honed via SU's core curriculum makes these graduates attractive to employers.

The majority of Seattle U civil engineering grads stay in the Puget Sound region (Seattle and surrounding cities) for work, as that's where they have built networks and where the construction and engineering market is robust. Seattle's booming infrastructure and tech-driven development mean many opportunities in structural design, transportation planning (with major transit expansions ongoing), and environmental services. A portion of graduates also work elsewhere on the West Coast (Portland, Bay Area) or further afield, but SU's ties are strongest locally.

Common sectors and roles include the following:

- Structural engineering firms: Given Seattle U's urban focus and the availability of the MS in Structural Engineering, a significant portion of graduates go into structural design of buildings and bridges. They join structural consulting firms (from large ones like Magnusson Klemencic Associates (MKA) or DLR Group, to smaller specialty firms) as design engineers. They work on high-rise buildings, commercial developments, and seismic retrofits. Seattle's seismic design requirements and rapid development provide a fertile ground for structural engineers.
- General civil and multidisciplinary engineering firms: Many SU grads work at consulting firms offering civil, transportation, and environmental engineering services. For example, companies like Jacobs, WSP, HDR, Stantec, and Parametrix hire SU alumni. They may start as civil analysts or staff engineers working on roadway designs, site development (grading, drainage), utility design, or transit projects. The broad training at SU means they can fit into various civil roles.
- Construction and project management: Some graduates, especially those interested in field work, go to work for construction companies (e.g., Sellen Construction, Hensel Phelps, Kiewit in the Seattle area) in roles such as project engineer or field engineer.
   A notable number of SU civil grads have the skills to coordinate between design and construction teams, and their strong communication training is an asset here.
- Transportation and public sector: Graduates also find roles with public agencies. The City of Seattle (Seattle Department of Transportation, Seattle Public Utilities) is a key employer, as are neighboring cities (Bellevue, Redmond, Tacoma) and King County. They might work as entry-level civil engineers focusing on municipal infrastructure, or capital project management. Washington State DOT and county road departments also hire SU grads, although these agencies also have many WSU/UW grads; SU's smaller program means fewer absolute numbers going that route, but those who do are well regarded. Environmental agencies (such as the Washington Department of Ecology or environmental consulting firms) attract those from the environmental specialization track, who may work on water quality, environmental remediation, or sustainability projects.
- Specialized fields and further education: A portion of SU grads opt for further specialization. Some pursue graduate degrees at other institutions (for instance, a few might go to University of Washington for an MS or PhD in a specific sub-field,

leveraging UW's research focus in areas such as hydrology or structural engineering). SU's own MS in Structural Engineering keeps some talent in-house for another year or two. Additionally, because of SU's emphasis on holistic education, a few graduates have been known to branch out.

Seattle University's career services and department connections frequently link students to local employers. Some top employers that consistently recruit SU civil engineers include the following:

- City of Seattle and King County: SU alumni work as civil engineers in departments managing transportation infrastructure and utilities for the region.
- Puget Sound-area engineering consultancies: firms such as Coughlin Porter Lundeen (structural/civil), KPFF, and smaller structural outfits have hired SU grads, often because faculty or alumni at those firms recommend them. SU's alumni network in Seattle's engineering community is strong.
- Contractors in Seattle: e.g., Sellen Construction (a large local building contractor) has taken SU grads for project engineer roles (one alumni example was highlighted by SU, indicating the education prepared him well for structural engineering in practice).
- Environmental firms and nonprofits: some grads with the environmental focus join environmental consulting companies or non-governmental organizations focusing on sustainability, water resources, and habitat restoration.

In surveys, 95 percent of SU civil engineering seniors report high satisfaction with their preparation for careers, and within six months most are in roles that utilize their engineering skills. The typical entry-level titles are "Civil Engineer I," "Staff Engineer," "Design Engineer," "Project Engineer," or "Engineer in Training (EIT)", depending on the employer's convention. SU grads rapidly accumulate experience toward professional licensure; the program's insistence on the FE exam means that graduates leave with EIT status already in hand, and many are on track to take the PE exam after four years of work.

Employers often note SU graduates' strengths in communication, teamwork, and project leadership, attributes developed in the small-class environment. Furthermore, SU's focus on ethics and social impact means that its graduates are often leaders in community and professional organizations, advocating for sustainable and equitable engineering solutions as they progress in their careers.

## 6.3.4 Workforce Development and Professional Preparation

Seattle University's approach to civil engineering education is inherently workforce-focused, given its emphasis on practical skills, real-world projects, and professional formation. Key strategies and features that support workforce development include the following:

• Industry-sponsored capstone projects: The hallmark of SU's program is the year-long senior design project done in partnership with industry. Every senior team works on a project provided by an external client, often a local engineering firm, government agency, or community organization. Each team is co-mentored by a professional engineer from the client or from SU's industry advisory board. This collaboration

gives students invaluable exposure to how projects unfold in practice: scoping problems with a client, considering real constraints (budgets, permitting, community impact), and incorporating feedback from seasoned engineers. As mentioned, the success of this model is reflected in 21 NCEES awards for SU's projects. For example, SU teams have worked on designs such as pedestrian bridge concepts for the city, sustainable stormwater facilities for nonprofits, or retrofit designs for aging infrastructure. Students often present their final designs to both faculty and the client's engineering staff, mirroring an industry design review. These capstones frequently lead directly to job offers or at least to strong recommendations; they effectively serve as a year-long "internship" in design experience.

- Internships and undergraduate research: Seattle U encourages every civil engineering student to have an internship or research experience before graduating. Despite not being explicitly required (except indirectly through the hands-on curriculum), this is strongly facilitated: the department reports that over 70 percent of CEE students complete an internship or undergraduate research during their studies. The program's connections to industry help many students find paid summer internships with local engineering companies, often through faculty referrals or the college's career events. SU's location in downtown Seattle means students can intern part-time during the academic year as well. These internships provide practical workplace experience, from construction site exposure to assisting in design calculations, which complements academic learning. For those inclined toward academia or technical depth, undergraduate research with faculty is an option; students might work on projects such as seismic analysis of novel materials or water treatment studies, gaining lab and analytical skills.
- Professional exam and licensure emphasis: Requiring the FE exam ensures that students revise and solidify their fundamental knowledge, making them job-ready and on a fast track to become licensed Professional Engineers. Faculty often help organize FE review sessions or provide guidance on problem areas. Having the FE passed is a strong signal to employers that SU grads are serious about licensure (many employers, especially public agencies, value EIT certification for entry hires). This accelerates the graduates' career development and aligns with workforce needs for licensed engineers.
- Close faculty mentorship and advising: Because of the small program size, each student receives extensive advising. Faculty advisors guide course selections, encourage particular internships or extracurriculars based on the student's interests, and often connect students with their industry contacts. This mentorship means that students get personalized professional development plans. For instance, a student interested in transportation engineering might be advised to take an extra GIS course or join the local ITE chapter events; a structurally inclined student might get matched with a seismic design competition. Faculty also instill professional ethics and

- leadership, as the professors often have extensive industry experience and model professional behavior.
- Student professional societies and competitions: Seattle University has an active ASCE Student Chapter and other clubs. Given the program size, nearly all students participate in at least one club or competition team. SU's ASCE chapter competes in the Concrete Canoe and Steel Bridge competitions (often in collaboration with University of Washington or by leveraging shared resources, since SU is smaller, they have at times formed joint teams or focused on specific competitions). These competitions offer design/build experience outside of class. SU has also been involved in Engineers Without Borders projects, in which students design water supply or civil projects for communities abroad, aligning with the university's mission of service. Furthermore, SU's location allows students to attend the Seattle ASCE professional chapter meetings and networking events; the department often funds students to go to engineering luncheons or regional conferences. All these activities help students build professional networks and soft skills. By graduation, an SU student likely has interacted with numerous professionals and perhaps even presented at a professional forum (for example, some senior design teams have presented their project at ASCE Seattle Section meetings).
- Career services and fairs: Seattle University's Career Engagement Office works closely with the College of Science and Engineering. It hosts an engineering-specific career fair annually, which, while smaller than a large state school's fair, attracts many local employers who know SU's reputation for quality graduates. Students also benefit from Seattle's thriving tech and engineering scene, as many companies routinely offer info sessions on SU's campus or invite SU students to office visits. Resumé workshops, mock interviews (often with industry volunteers, including SU alumni), and networking socials are organized to prepare students. The outcomes, a high employment rate and high student satisfaction, indicate that the career preparation is effective.
- Focus on communication and teamwork: Throughout SU's curriculum, there is heavy emphasis on developing "soft skills" that are crucial in the workforce. Students do numerous presentations, write technical reports each year, and work on team projects in many courses (not just the capstone). The small class size means that every student must actively participate, and this builds confidence in communication. Employers often remark that SU grads have excellent communication and collaboration skills for entry-level engineers. Teamwork is explicitly taught; for example, in the capstone and other group projects, students are coached on project management, conflict resolution, leadership, and client communication. These abilities give SU graduates a quick ramp-up in their jobs, often allowing them to take on leadership on projects sooner than peers who may not have had as much team-based training.

• Ethical and societal perspective: In line with its mission, Seattle U ingrains a sense of responsibility and ethics. Students engage in discussions about public welfare, sustainability, and equity in infrastructure (Seattle's program highlights solving problems such as making buildings safe in earthquakes, designing flood management that improves ecosystems, etc., in its overview). This mindset prepares students to be conscientious engineers who consider safety and public health as paramount. The curriculum's philosophy component and the example of faculty (many of whom volunteer in professional societies or community boards) produce graduates who often become thought leaders in their workplaces on issues such as sustainability and inclusive design.

## **6.3.5** | **Summary**

In conclusion, Seattle University's civil engineering program excels in producing well-rounded, practically trained, and highly employable engineers. With strong industry integration (through capstones and internships), enforced academic rigor (FE exam, comprehensive curriculum), and a commitment to personal development (ethics, leadership, communication), SU ensures that its civil engineering graduates are workforce-ready and frequently in leadership positions early in their careers. The combination of technical prowess and soft skills meets the needs of employers in the Seattle region and beyond, as evidenced by the near-total employment rate and the high regard in which local engineering firms hold Seattle U alumni

## 6.4|Gonzaga University (Spokane, Wash.)

Gonzaga University, as a private Catholic university in Spokane that offers programs including Bachelor of Science in Civil Engineering (BSCE) with optional concentrations in environmental and structural engineering, and a minor in entrepreneurial leadership is also available (for project management skills). A five-year combined BS/MS in Civil Engineering is under development (as of mid-2020s), which will allow students to earn a master's degree with one extra year.

Gonzaga's civil engineering program focuses on a balance of theory and application with a liberal arts core. Students begin with common engineering fundamentals and a strong emphasis on math and science, then specialize in civil topics. The program includes a required surveying course and lab early in the curriculum, where students learn to operate levels, total stations, and GPS units for land measurements, which is crucial for site development and construction layout. Core courses cover structural analysis and design, concrete and steel design, soil mechanics and foundation engineering, transportation engineering (with highway design), fluid mechanics and hydrology.

In line with Gonzaga's mission, there's attention to sustainability and ethics throughout the coursework. For instance, assignments might examine the environmental impact of infrastructure or the ethics of land development. A two-semester Senior Design Project caps the degree: student teams work on real civil engineering projects (often provided by Spokane-area

engineering firms or agencies). Projects have included bridge designs, subdivision plans (requiring surveying of a site and designing roads/utilities), and riverbank stabilization designs.

Gonzaga typically graduates about 30–45 civil engineers per year. Class sizes are small (typically 20–30 students in upper-level classes), fostering interaction with professors. The civil engineering faculty at Gonzaga includes licensed professionals who have industry experience, and they leverage their contacts to place students in internships (common placements are the City of Spokane engineering department, local consulting firms, and construction companies in the Inland Northwest). An Industrial Advisory Council reviews the program and ensures that graduates have skills employers seek (such as proficiency in AutoCAD Civil 3D for plan drafting and GIS basics for mapping).

Students often join the Engineers Without Borders chapter or service projects, applying civil engineering to community needs, experience valued by employers. Because Spokane's construction and engineering industry is growing, Gonzaga civil grads are readily employed. Many take jobs in Spokane or Seattle, and a significant number pursue their PE license (Gonzaga's curriculum is aligned with FE exam topics, aiding a high pass rate).

The university's Center for Engineering Design and Entrepreneurship also provides project management experience and sometimes pairs civil students with business students to simulate real-world project teams. Overall, Gonzaga's civil engineering program produces broadly educated engineers with solid technical skills and a service-oriented mindset, well-prepared for both immediate engineering roles and long-term leadership.

## 6.5|Saint Martin's University (Lacey, Wash.)

Saint Martin's University offers civil engineering programs that include the following:

- Bachelor of Science in Civil Engineering (BSCE), and,
- Master of Civil Engineering (MCE) with specializations possible in structural or geotechnical engineering [25].

The engineering school at Saint Martin's is relatively small but ABET-accredited and known for close student-faculty collaboration. The BSCE program covers the full spectrum of civil engineering fundamentals. It combines theoretical coursework with practical projects and labs in materials, soils, fluid mechanics, and surveying.

Notably, civil engineering students at Saint Martin's take a construction surveying course and a separate GIS mapping course, ensuring competence in land measurement and spatial data. This is important because of the school's long-standing relationship with WSDOT, which is headquartered nearby.

Enrollment is modest; around 20 civil engineering bachelor's degrees are awarded per year, which means students get individualized attention and ample access to lab equipment. Saint Martin's has built strong industry partnerships, partly because of its location in the state capital region. The university has a history of collaboration on transportation research with WSDOT, and many students intern at WSDOT's Materials Lab or local consulting firms in Olympia/Tacoma. The engineering department hosts an annual "Engineering Career Fair" that attracts regional employers (including civil firms, construction companies, and government

agencies). The curriculum requires a capstone design project (often WSDOT or local civil engineers serve as clients for these capstones, giving students direct exposure to real projects; e.g., designing a highway interchange improvement or a stormwater facility for a local municipality).

To prepare for the workforce, Saint Martin's emphasizes professional development: students get training in technical writing, project management, and are encouraged to take the FE exam before graduation. The pass rate for Saint Martin's civil grads on the FE is consistently high, indicating a solid preparation across subjects. Graduates often go on to work in both private industry (design engineer roles) and public sector (city/county engineering positions) [25].

The optional master's program allows further specialization; for example, some BSCE graduates stay an extra year to earn an MCE focusing on structural design – a path that can accelerate progress toward professional licensure or more advanced roles. Saint Martin's civil alumni network in the Pacific Northwest helps new graduates find mentors and job leads.

#### 6.6 Walla Walla University (College Place, Wash.)

Walla Walla University offers a Bachelor of Science in Engineering (BSE) with a civil engineering concentration and other BSE concentrations in mechanical, electrical, and other engineering fields. It also offers a Master of Engineering (MEng), which can be pursued after the BSE [26].

Students in the BSE program take a common engineering core in the first two years, then select the civil engineering concentration for specialized upper-division courses. The civil concentration requires ~83 credits of civil-specific courses. This includes ENGR 346: Surveying (four credits), where students learn land survey theory and practice using surveying instruments (total stations, levels) and learn to measure distances, angles, and elevations accurately. Other required civil courses listed in the catalog include Civil Engineering Analysis, Contracts and Specifications, Structural Analysis, and design courses in steel, concrete, and others.

Because Walla Walla's program grants a general engineering degree, civil students also get exposure to electrical and mechanical basics, which can be valuable in multidisciplinary projects. However, the civil concentration ensures depth in traditional civil topics (structures, construction, geotechnical, etc.). Students complete a senior project – often this is a design project in their concentration. Past civil projects at Walla Walla have included designs of small bridges, hydraulic ram pumps for developing communities, and campus infrastructure improvements.

The civil engineering concentration is fairly small. Recently, Walla Walla University has been graduating around five to seven civil engineering concentrators per year [26]. The small size means that students get lots of faculty interaction and often work as research or teaching assistants in labs. Despite its size, the program is robust – Walla Walla civil students have access to well-equipped labs (the School of Engineering has materials testing equipment, a fluid hydraulics lab, and survey equipment for student use). Many students participate in ASCE Concrete Canoe and Steel Bridge competitions, giving practical fabrication and teamwork experience.

Walla Walla University's engineering graduates (including civil concentrators) are known to be well prepared for entry-level roles. The curriculum's mix of theory and hands-on opportunities (including a required internship for credit) means that students often have some real project exposure before graduating. Internship placements for Walla Walla civil students have included the U.S. Army Corps of Engineers at the Walla Walla District (which manages local dams and levees) and private engineering firms in the Pacific Northwest. The university's strong emphasis on problem-solving and ethics in a Christian context means that graduates are often noted for integrity and community-mindedness. Many grads go on to become licensed engineers; the program's ABET accreditation and comprehensive coursework qualify graduates to take the FE exam and pursue licensure. For students wishing to advance, the one-year M.Eng. program allows further study (some use it to deepen knowledge in structural engineering or engineering management). Walla Walla's civil alumni often work across the West Coast, and the school's reputation in engineering has grown due to its graduates' success in industry and graduate studies.

## **6.7**|Other Universities

Other four-year institutions in Washington without standalone civil engineering programs often provide pre-engineering pathways. For example, Western Washington University and Eastern Washington University do not offer accredited civil engineering degrees, but they do offer transfer programs or related fields (Eastern has minors such as geotechnical engineering and a construction management technology BS, while Western offers industrial design and plastics engineering, which are different fields). Students from those schools typically transfer to one of the universities listed above for the civil engineering major. Additionally, some out-of-state universities offer fully online accredited civil engineering degrees in which Washington residents can enroll. For instance, University of North Dakota offers an ABET-accredited online BSCE program that combines online lectures with brief on-campus labs, providing another pathway for place-bound students to enter the field. However, Washington's in-state options (such as UW's and WSU's online master's programs or UW Tacoma's BSCE) usually serve most needs for online/local flexibility.

# 6.8 Community and Technical Colleges (Civil Engineering Technology and Surveying Programs)

Washington's community and technical colleges play a key role in training civil engineering technicians, surveying technicians, and providing transfer pathways. These programs often lead to Associate of Applied Science (AAS) degrees or shorter certificates. They tend to emphasize practical skills in surveying, drafting (CAD), basic design, and GIS which produce graduates ready to support licensed engineers and surveyors. Many also have options to transfer into four-year engineering programs. In the following sections we introduce the notable programs.

# 6.8.1| Yakima Valley College (Yakima, Wash.) – Civil Engineering and Surveying Programs

Yakima Valley College (YVC) offers the following degrees/certificates:

- AAS in Civil Engineering Technology two-year associate degree.
- AAS in Land Survey and Construction Design Technology two-year associate degree.
- Land Surveying Certificate short-term certificate in surveying and mapping technology.
- AS-Track 2 Engineering (Pre-Engineering transfer) two-year Associate of Science for engineering transfer. [27]

#### **Overview**

Yakima Valley College (YVC) offers a comprehensive suite of programs to enter the civil and surveying fields. The Civil Engineering Technology AAS prepares students to become engineering technicians, focusing on skills such as drafting, basic design, and materials testing. The Land Survey and Construction Design AAS is geared toward aspiring surveying technicians and design drafters, and it provides a "broad base of engineering services" training, including elements of structural design, construction plan reading, and surveying practices (combining civil engineering fundamentals with surveying). In these AAS programs, students take courses such as plane surveying, construction materials, CAD (computer-aided design), and possibly introductory structures or hydrology, giving them a well-rounded skillset for infrastructure projects. The Land Survey Certificate is a shorter program (less than one year) that concentrates on surveying and mapping fundamentals, teaching students to use modern surveying equipment, interpret legal land descriptions, and perform basic field and office survey tasks [27]. It's intended for quick workforce entry or for those already working in related jobs who need formal surveying education. YVC also provides a pre-engineering AS degree for students aiming to transfer to a university engineering program (including civil engineering). This transfer track covers calculus, physics, chemistry, and introductory engineering, aligning with freshman/sophomore requirements at universities.

#### **Enrollment and Graduates**

As a newer program (the AAS in surveying started in 2019), class sizes are relatively small. YVC became the fourth college in Washington to offer a two-year surveying degree when it launched the program. Early indications (and industry interest) suggest a cohort of around 10–15 students per year in the survey AAS, with annual graduates in the single digits initially as the program grows. The presence of the certificate means some students opt for the short credential. YVC's civil tech AAS similarly graduates a small number each year, feeding local employer needs. Despite the small size, the demand in the Yakima region is high, and local surveying firms and public agencies are eager to hire these graduates.

#### **Curriculum and Courses**

YVC's curriculum is hands-on. Surveying students spend significant time in outdoor labs learning to measure distances, angles, and elevations, and to operate instruments such as total stations and GPS receivers. They also learn office skills: reducing field data, using coordinate geometry software, and drafting site maps in CAD. Coursework in the Land Survey AAS likely includes boundary law (understanding property boundaries and legal descriptions), construction design (perhaps basic road or site design principles), and GIS basics for mapmaking. YVC's civil engineering tech courses cover topics such as statics and strength of materials (to understand forces in structures), construction materials testing (e.g., concrete and soil labs), and possibly estimating and project management fundamentals. Both AAS programs emphasize GIS and computer-aided design; students learn to create and interpret engineering drawings and topographic maps using software. For example, a student might complete a capstone project in which they survey a piece of land, produce a contour map, and create a basic site development plan.

## Workforce Preparation and Partnerships

YVC's programs were designed in response to local industry needs. The Land Survey program was developed with input from the Land Surveyors' Association of Washington (LSAW) and local surveyors. In fact, one of YVC's instructors is the local LSAW chapter president. This ensures that the curriculum aligns with state licensing expectations (e.g., covering knowledge needed for the LSIT exam).

The college reports that survey technicians are in high demand in the Yakima area, so it works closely with employers: YVC hosts networking events and invites industry speakers (from surveying firms, the Yakima County Public Works, WSDOT, and even the Yakama Nation) to meet students. Many students secure internships or part-time jobs while in school; the program schedules allow some flexibility for working students. For example, students might intern with a county surveyor's office while finishing their certificate. YVC highlights that a land survey technician can enter the workforce much faster (about two years) than the six or more years it might take to become a licensed PLS. The programs also articulate with further education; graduates of the civil tech AAS or surveying AAS can continue to a bachelor's degree if they choose. (YVC's engineering transfer track provides the academic groundwork if they decide to pursue a BSCE or a BS in Geomatics at a later date.)

Graduates of YVC's AAS programs typically find jobs with surveying firms, engineering design companies, construction contractors, or government agencies. They are prepared for roles such as surveying technician, CAD technician, materials testing technician, or engineering aide. The curriculum's inclusion of an internship or capstone ensures that students have real project experience. Local employers have been supportive. For example, WSDOT's South Central Region (based in Yakima) often hires YVC-trained technicians; one report noted that the local DOT office employs seven surveyors year-round and adds more seasonally [27]. This indicates a healthy job market for the program's graduates. Overall, YVC's civil and survey programs

provide a crucial workforce pipeline in central Washington, delivering immediately applicable skills and a pathway toward licensure.

## 6.8.2 Clark College (Vancouver, Wash.) – Surveying and Geomatics

Programs offered by Clark College include the following:

- AAS in Surveying and Geomatics: Two-year Associate of Applied Science degree.
- Certificate of Proficiency (Surveying and Geomatics Technician (Boundary)): A oneyear certificate focusing on boundary surveying.
- Certificate of Proficiency (Surveying and Geomatics Technician (GIS)): One-year certificate focusing on GIS applications in surveying.
- Additionally, Clark offers an AS-T transfer degree for engineering, but its signature offering in this field is the Surveying/Geomatics program.

#### **Overview**

Clark College's Surveying and Geomatics program is a well-established and highly regarded training pathway for land surveyors. Established in 2007, it was one of the first programs of its kind in Washington and was built in collaboration with local surveying firms to address a shortage of survey technicians [28]. The AAS degree prepares students for entry-level work in both field and office surveying roles. The program is designed for flexibility, classes are held in evenings and on some weekends, allowing working adults or those with daytime obligations to attend.

#### Curriculum and Courses

Clark's curriculum places heavy emphasis on real-world practice, as students spend ample time using professional-grade equipment and software. The program explicitly notes that it uses "state-of-the-art land surveying equipment and techniques" to train students, and indeed the college has an inventory of modern Leica and Trimble total stations, digital levels, GNSS (GPS) receivers, and software such as AutoCAD Civil 3D.

Over the two-year AAS program, students progress from fundamentals to advanced topics. Early courses cover basic surveying theory and field methods. Students learn manual drafting and CAD, taking a course like ENGR 140 (Basic AutoCAD) to gain drawing skills. The curriculum includes SURV 104: Survey Computation (covering survey math such as traverse adjustments) and SURV 121: Field Survey I, in which students practice topographic surveys and construction layout. As they advance, students take courses in boundary surveying (boundary law and property surveying), likely SURV 202: Boundary Surveys, which teaches how to interpret legal descriptions and retrace property lines. GIS is another key component; Clark offers a GIS technician certificate, and AAS students often take GIS coursework to learn how to collect, analyze, and visualize spatial data.

The Surveying and Geomatics Technician – GIS certificate focuses specifically on skills such as using ESRI ArcGIS software for mapping and spatial analysis, which complements traditional surveying. The boundary certificate option includes the legal and field components needed for roles such as boundary/land title survey technician. Additionally, Clark's program

teaches GPS surveying techniques, digital mapping, and surveying adjustments. In the second year, students usually undertake a capstone project or an independent project. Clark has a course that prepares students for the Level I Certified Survey Technician (CST) exam sponsored by NSPS/LSAW, ensuring that they meet industry competency standards. Graduates are proficient in using Civil 3D software for drafting survey plats and in reading engineering plans.

## **Enrollment and Graduates**

Clark's program typically enrolls a few dozen students across the two-year span. According to a recent program report, annual student headcount is around 40–42, with about eight to nine students completing the AAS each year [28]. These modest numbers actually meet local industry capacity, as Clark notes that the program isn't aiming for huge growth but rather to produce a steady pipeline of qualified technicians to support the region. Many students are already working (or find work) as survey crew assistants or drafters while finishing their degree, so not all who enroll full-time finish in exactly two years. Some take a bit longer because of work, which the evening/weekend schedule accommodates.

The one-year certificates (Boundary or GIS) may have slightly smaller intakes – often these are pursued by those who already have some experience or another degree and want specialized knowledge. For instance, working engineering techs might take the Boundary certificate courses to bolster their surveying credentials. Clark has robust retention and completion support, including faculty advisors and cohort-based learning that help students through challenging topics such as advanced math or complex legal concepts.

## Industry Partnerships and Workforce Integration

Clark College's Surveying and Geomatics program is deeply integrated with industry. It maintains an Advisory Committee of local employers and licensed surveyors who review curriculum and provide guidance. This close relationship translates into tangible support: local surveying and engineering firms donate equipment, offer internships, and even provide funding. In fact, the program has a Career Launch endorsement by the state – a recognition that it integrates classroom learning with meaningful work experience.

As part of a Career Launch partnership, the prominent Vancouver-based firm MacKay Sposito (and others such as Olson Engineering) actively support the program, collectively contributing funding each year to sustain program operations. MacKay Sposito also typically hosts one paid intern at a time from the program, giving students on-the-job training while in school. The goal is to increase the number of employers offering such internships, and indeed in the coming years more surveying companies are expected to participate in co-op/work-based learning with Clark students. The curriculum itself encourages real work exposure; there's a required Cooperative Work Experience course (SURV 290) in which students earn credit for time spent working under a surveyor's supervision. Many students do this co-op with their current employer or through summer internships arranged via the program's connections.

Clark's program explicitly prepares graduates to take on roles such as instrument operator, survey party chief (with experience), GIS technician, or surveying CAD drafter. The training aligns with the NSPS Certified Survey Technician exams, and Clark students are known

to sit for the Level I and II CST exams. In fact, the program outcomes include that "Graduates will prepare for the Level I Survey Technical Exam given by the Career Development Committee of LSAW (Land Surveyors' Association of Washington)." This gives students a portable certification to show employers. Clark students have excelled in co-curricular competitions as well. A team of Clark surveying students won 1st place in the 2025 NSPS national student competition, outperforming teams from universities across the country. This achievement highlights the quality of training; students demonstrated skills in monument recovery, field measurements (even doing old-school chain and compass traverses), and high-tech GPS work.

Clark graduates are highly sought by employers in the Portland–Vancouver metro area. Many receive job offers even before graduating. Typical employers include land surveying firms, engineering consultancies, construction contractors (who often have their own surveying crews), utilities (for GIS and mapping roles), and public agencies such as city/county survey departments. The program boasts strong placement of graduates into full-time careers regionally.

Some graduates also choose to continue education, as Clark has an articulation program that allows transfer to a four-year Geomatics bachelor's program at Oregon Institute of Technology (OIT). Students can thus use Clark's AAS as a stepping stone to a BS in Geomatics (Surveying) at OIT (in Klamath Falls, Oregon), which is ABET-accredited and can lead directly to Professional Land Surveyor licensure in many states. This partnership is valuable because Washington itself does not have a four-year surveying degree program in-state. Overall, Clark College's Surveying and Geomatics program is a flagship workforce program producing well-rounded surveying professionals, supported strongly by the surveying community, and known for producing graduates ready to "hit the ground running."

# 6.8.3 Bellingham Technical College (Bellingham, Wash.) – Engineering Technology: Geomatics

Bellingham Technical College (BTC) offers one program: AAS in Engineering Technology – Geomatics Specialization (two-year). BTC often refers to this as a Geomatics or Surveying and Mapping Technology degree [29].

#### **Overview**

This program prepares students for careers as surveying and mapping technicians, blending surveying with GIS and CAD training. BTC has the state's northernmost surveying degree program, serving the northwest Washington region. Graduates earn an AAS degree and are job-ready for roles in land surveying, construction surveying, or GIS data collection. BTC's geomatics program is ABET-aligned through its engineering technology accreditation and emphasizes competency in modern geospatial techniques.

## Curriculum and Courses

The BTC Geomatics curriculum is comprehensive and geared toward current industry practices. Key components include the following:

- Surveying fundamentals: Students learn land surveying theory and practice in a sequence of courses. For example, an introductory course covers chaining, leveling, angle measurement, traverses, and coordinate calculations. A later course such as Survey of Public Lands (CET 205) teaches the Public Land Survey System (PLSS) and how original government surveys are used to establish boundaries today. Another course, Boundary Law and Land Description (CET 210), delves into the legal principles of surveying how to interpret deeds, plats, and apply state/federal laws regarding boundaries [29].
- Geomatics technology: GIS courses (CET 141 and CET 142, likely) cover geographic information systems; students use ArcGIS software extensively, learning to create maps, edit spatial data, and perform spatial analysis. They focus on real-world GIS tasks such as symbolizing and overlaying data to extract information. BTC also includes a dedicated GPS Systems course (CET 220) in which students learn to collect and post-process GPS data using professional survey-grade receivers and software. They practice techniques such as static GPS surveying and using the National Geodetic Survey's online services to improve accuracy.
- Computer-aided design: The program requires proficiency in CAD. AutoCAD Civil 3D I (CET 251) is a course focusing on the civil/survey specific functions of Civil 3D. Students learn to generate site plans, contours, and alignments, essentially translating field data into professional drawings.
- Advanced topics and integration: In their final quarters, students take Advanced Survey Seminar (CET 225). This course simulates real job scenarios and higher-level problem solving, covering advanced GPS, GIS, data collection, and surveying software in a self-directed project format. It helps transition students from the school environment to the workplace by emphasizing self-motivation and independent research. Additionally, Environmental Mapping (CET 215) teaches how surveying and mapping intersect with environmental fieldwork, e.g., wetlands mapping and habitat restoration surveys— an important niche in Washington with its environmental regulations.
- General education and science: Because it's an AAS, the program includes applied general education. Students likely take technical math (trigonometry and algebra are essential for surveying computations), maybe physics basics, and some communications coursework. The program outline suggests options for electives such as general biology if relevant, but core focus remains technical.

Collectively, BTC ensures that graduates "demonstrate competency in basic GIS and surveying and mapping skills," "entry-level competency in CAD," "working knowledge of GPS," and familiarity with Washington state surveying laws and standards. In fact, one stated outcome is that graduates will be prepared to take the Level I Survey Technician certification exam from LSAW/NSPS, reinforcing that the curriculum aligns with industry certification standards.

#### **Enrollment and Capacity**

BTC is relatively small. The Geomatics AAS might admit on the order of 15–20 students per year, although exact numbers fluctuate. The program's capacity is often around that range to ensure ample equipment for each student. In recent data, BTC was seeing growth in technical program enrollment, which likely benefited Geomatics as well. The college has a history of strong retention in this program because of active support and the high job placement rate. BTC graduates on average perhaps eight to twelve students each year from Geomatics. For example, in the class of 2022, it's known that seven students graduated with the civil (geomatics) focus (some sources indicate around seven degrees conferred, up from the previous year). This small but steady output meets local demand. The program keeps its cohort intimate, enabling one-on-one instruction, especially during field labs.

## **Industry Connections and Pathways**

BTC's geomatics program works closely with the surveying community in northwest Washington. The program advisory committee includes local surveyors from Whatcom and Skagit counties, and the college partners with the LSAW's Northwest Chapter for events and scholarships. Employers often hire students for part-time work or summer internships; being in Bellingham, some students even go across the border for opportunities in British Columbia or find work with federal agencies (the area has national parks and forests requiring survey work).

A noteworthy partnership is that BTC has an articulation agreement with the University of Alaska Anchorage (UAA). Since 2022, graduates of BTC's Geomatics AAS can transfer into UAA's ABET-accredited Bachelor of Science in Geomatics program as juniors. This agreement allows a seamless transition to earn a four-year degree in geomatics (with concentrations in surveying, GIS, etc.) after completing the AAS. UAA's geomatics BS covers advanced surveying, remote sensing, and spatial data science, and BTC graduates get credit for their two years of coursework. This is a significant opportunity, given that Washington state itself does not offer a four-year geomatics degree. BTC grads can go to UAA (with distance learning options available for some courses) and attain a bachelor's that makes them eligible for PLS licensure in any state. As UAA noted, "graduates from the program are highly sought after in Alaska and across the nation," and this likely applies to BTC's graduates continuing on as well.

In terms of direct workforce entry, BTC geomatics graduates find work throughout the Puget Sound and beyond. Common job titles after graduation include Survey Technician, CAD Technician, GIS Mapping Technician, or Engineering Technician. The program specifically trains students in skills such as survey crew procedures, GIS data collection, construction layout, and land development surveying. For example, students practice drone (unmanned aerial vehicles) surveying and processing of aerial photogrammetry as part of keeping up with industry trends (BTC's marketing mentions aerial surveying with drones and GPS as part of the well-rounded education). Many graduates join local surveying firms, some work for county or city public works, and others go into construction companies (which need surveyors for site layout). The program's focus on practical competency means that graduates often hit the ground with

minimal additional training needed. Moreover, BTC's career services and faculty often assist students in connecting with the LSAW job board and other networks to land positions quickly.

The geomatics AAS at Bellingham Technical College ensures that by graduation, students can perform as entry-level surveyors with tasks such as operating equipment, running traverses, preparing maps, and also handling GIS tasks and advanced technology (such as GPS and drone data) that are increasingly part of the surveying profession. The inclusion of Washington-specific surveying law means graduates understand things such as land subdivision law, boundary resolution in Washington, and ethical requirements. BTC's combination of surveying and GIS is especially valuable, as the line between those skill sets is blurring in industry. With its strong curriculum and direct ties to both workforce and continuing education pathways, BTC's Geomatics program plays a crucial role in supplying qualified personnel for Washington's spatial and civil infrastructure industries.

# 6.8.4 Renton Technical College (Renton, Wash.) – Land Surveying Technician

Renton Technical College (RTC) offers programs including the following:

- AAS in Land Surveying Technician Geospatial Science (two-year Associate of Applied Science).
- Certificate of Completion Field Surveying Technician (short program, approx. one year or less).
- Certificate of Completion Land Surveying Technician (advanced one-year program, primarily online) [30].

RTC offers a laddered approach to surveying education. Students typically start with the Field Surveying Technician certificate, which covers fundamental surveying field skills. After completing this, they can continue with the Land Surveying Technician certificate, which is a more advanced curriculum focusing on professional survey practices and office skills. Together, the credits from these certificates can fulfill requirements for the AAS degree in Land Surveying Technician (Geospatial Science). Essentially, the AAS encompasses both first-year field training and second-year advanced training, producing a well-rounded graduate.

One distinctive aspect is that the Land Surveying Technician program is offered largely online. In fact, Renton advertises it as "a one-year online curriculum designed to prepare you for professional licensing," combining cutting-edge software training with traditional field methods. This online program "follows the Field Surveying Technician certificate program," indicating that after students learn hands-on fieldwork (often on-campus or in-person) in the first stage, then move to an online format for advanced courses [30]. This hybrid model allows flexibility; students can be employed in the industry while completing their second year studies online, which is quite advantageous. The online courses are adaptive, meaning there may be opportunities for on-campus labs or meetups, but much of the theory and computer-based work can be done remotely (important for a working professional or someone outside the Seattle area).

#### Curriculum and Content

In the Field Surveying Tech certificate, students learn core field skills: how to set up and use surveying instruments (levels, total stations), basic surveying math (traverse calculations, leveling calculations), note-keeping, and safety. They likely engage in projects such as a small topographic survey or a construction layout of a building corner, under instructor guidance. This program aims to prepare students to start as a survey crew member or instrument operator, working under a licensed surveyor. It's relatively short (could be a few quarters long; one source suggests about 12 weeks to less than one year, which implies maybe a three-quarter sequence). By the end of the field certification, students should be able to perform tasks of a rod-person or instrument tech (e.g., staking points, running a level circuit, operating a total station with guidance).

The Land Surveying Technician certificate is more advanced, focusing on the office and theoretical side that leads toward licensure. This program is described as a "three-quarter program" emphasizing professional land surveying practices. Key topics include the following:

- Survey data processing and software: Students train on industry-standard software for survey data reduction, coordinate geometry (COGO), and drafting. For example, they might use software such as Trimble Business Center or Civil 3D to download raw field data, adjust and compute coordinates, and produce plats. Learning COGO computations (such as intersection calculations, curves, area calculations) is crucial for higher-level technicians.
- Boundary law and legal principles: Because this program gears students toward the PLS track, the emphasis is on understanding land ownership, writing survey descriptions, and reading/retracing legal records. Washington state-specific surveying law is likely taught (Revised Code of Washington (RCW) and Washington Administrative Code (WAC) relevant to surveying).
- Geodesy and geodetic surveying: Because it's a "geospatial science" AAS, students probably learn about map projections, state plane coordinates, GPS networks, and maybe an introduction to photogrammetry or remote sensing.
- Professional practice: Topics such as survey project management, ethics, and perhaps business aspects (many Professional Land Surveyors run their own firms) are included. The description explicitly says it prepares graduates to "continue their careers toward their Professional Land Surveyor licenses [30]. So, it covers material tested in the NCEES Fundamentals of Surveying (FS) exam, which is the first step to LSIT certification.

The online format for the advanced certificate suggests that students might do field exercises on their own or via occasional meetups. However, because most advanced topics are calculation and computer-heavy, online delivery works well. Renton likely provides students with access to software remotely and uses tools such as virtual lab environments. The first-year field certificate is presumably hands-on (in-person) to ensure that students develop practical skills before moving online.

#### Enrollment

Renton Tech's surveying program serves the greater Seattle/King County region, a populous area with significant demand. The program's flexible online nature also attracts students from all over Washington (and possibly beyond) who want to become surveyors but need to keep working. Typically, a cohort for the Field certificate might be 10–15 students (small enough for field labs). The online second-year might have similar numbers, although potentially more if some students join in after doing field training elsewhere or returning to school. Renton's program being unique (online) means that it can accommodate more students in lectures than a strictly in-person program might. The college being a state technical college also often draws mid-career adults (some students are in their 30s or older, possibly construction workers or military veterans retraining for surveying).

Graduation numbers are not published, but anecdotal evidence suggests on the order of six to ten graduates each year earning the AAS. Because some may only do the certificate portions (for instance, a person might do the Field Survey Tech cert and go straight to work without immediately doing the second year), the college likely has more certificate completers than full AAS graduates. Nonetheless, the AAS is there for those who complete both stages.

## **Industry Connections**

RTC works closely with the surveying industry and unions in the Seattle area. The program's advisory committee includes local surveying company representatives. Additionally, Renton Tech's program has synergy with the union apprenticeship (Operating Engineers, see below). Some apprentices might take classes at Renton to satisfy related supplemental instruction requirements. Renton advertises on platforms such as "Apprenticeships Rock," highlighting its Field Surveying program alongside trades such as carpentry and welding, which suggests integration with broader workforce initiatives. The program is Workforce Innovation and Opportunity Act (WIOA) eligible, meaning that unemployed workers can get funding to enroll, which ties into state workforce development goals.

## Workforce Preparation

The Field Survey certification gets students ready for immediate field jobs (chainperson, instrument operator). By learning with modern equipment and practicing as a crew, graduates can step onto a survey crew with familiarity of procedures. The advanced certificate/AAS then propels them toward higher responsibility. Renton Tech explicitly states that the one-year advanced program "prepares graduates for their Professional Land Surveyor licenses." While an AAS alone does not make one a licensed surveyor, the intent is to give them the knowledge to pass the LSIT (Fundamentals of Surveying exam) and eventually, with experience, the PLS exams.

Employers in the Puget Sound region, which has many engineering and surveying firms, eagerly recruit from Renton Tech. Graduates often find positions with civil engineering companies, surveying firms, or construction outfits (major contractors in Seattle often have surveying crews for building high-rises or roads). Some may work with public agencies such as King County or the City of Seattle survey department. Because the program instills strong

software skills (such as proficiency with Civil 3D and coordinate geometry software), graduates are not only useful in the field but can also take on office duties (processing survey data, drafting plats). This dual capability is valuable in smaller firms where one might do both field and office work.

Moreover, Renton's program has a history of being taught by licensed professionals (often working surveyors teaching part-time). This mentorship connects students to the professional network – often instructors help students line up jobs. The program's flexible structure also means that many students are already working in surveying while studying. For instance, someone might be working as a rod-person and taking the online classes at night to become a crew chief. The program explicitly mentions career progression: "starting with technician and advancing to crew chief." So, the curriculum likely covers what a crew chief needs: how to run a crew, check work, and communicate with project managers, which is taught in the second-year courses.

# Summary

In summary, Renton Technical College's surveying program is a modern, flexible training pathway that aligns with licensure and industry needs. By offering a combination of in-person field training and online advanced coursework, it removes barriers for non-traditional students and addresses the severe surveyor shortage. Graduates are well prepared for the Seattle-area market, entering with both practical skills and knowledge of advanced surveying methods. They can rapidly progress from entry-level to higher roles; indeed, many eventually pursue becoming licensed Professional Land Surveyors, fulfilling the program's ultimate goal of supporting the profession's talent pipeline.

#### 6.8.5 Other Community Colleges and Technical Programs

Outside the above primary programs, several other Washington colleges contribute to civil engineering and surveying career pathways:

• Spokane Community College (Spokane, Wash.): While Spokane Community College (SCC) does not have a standalone civil engineering or surveying degree, it incorporates surveying and GIS into its Natural Resource Management AAS. In this two-year program, students learn to "run a surveying total station, navigate with a map and compass" and perform basic survey measurements in the context of forestry and environmental fieldwork. SCC also has a Certificate in Natural Resources Technology – GIS that teaches GIS mapping skills for environmental and land management careers. Thus, students interested in land surveying can gain foundational skills at SCC (for example, a course such as NATRS 205: Surveying teaches elementary surveying with forest survey applications). These skills can transfer to surveying jobs (especially in rural or resource areas) or prepare a student to enter a dedicated surveying program later. Additionally, SCC's program requires a 400-hour internship, which some students complete with agencies such as the US Forest Service or Department of Natural Resources, often doing surveying/GIS tasks.

- The Land Surveyors' Association of Washington recognizes SCC as a college offering surveying courses (although not a full degree).
- Yakima Valley College (mentioned above in detail): YVC not only provides degrees but also short-term CAD and Engineering Technology certificates that can funnel into entry-level civil/survey drafting positions. For example, a CAD Certificate from YVC covers AutoCAD skills in one year, useful for working in engineering offices.
- Other pre-engineering programs: Virtually all community colleges in Washington (such as Bellevue College, Tacoma Community College, Olympic College, Pierce College, etc.) offer an Associate of Science Transfer (Track 2), which is a pathway into civil engineering bachelor's programs. Students spend two years completing calculus, physics, chemistry, and often an introductory engineering course (such as statics or an intro to design), then transfer to a university to finish a BSCE. These programs usually have "Engineering" or "Pre-Engineering" advisement tracks. For instance, Bellevue College has an engineering program that explicitly lists equivalencies for transferring to universities in civil, mechanical, and other fields. While these transfer degrees don't by themselves credential someone for a surveying or civil tech job, they are a critical pathway into the profession for many students who start at a community college and then move on to UW, WSU, or other engineering schools. They ensure broad access to engineering education across the state.
- Construction management and technology programs: A few colleges (such as Central Washington University and Eastern Washington University in the university system, or some technical colleges) offer Construction Management or Civil Engineering Technology programs that, while not pure surveying or engineering, overlap with civil engineering careers. For example, Centralia College and South Puget Sound Community College have Civil Engineering Technology courses or construction project management programs that teach plan reading, basic surveying, and CAD. These can lead to technician roles in construction companies or public works departments. As an example, Central Washington University's Construction Management BS has a heavy civil construction focus that is unique in the state. Graduates often work for heavy civil contractors (bridges, roads) and need to understand surveying layout, though they aren't licensed surveyors or engineers.

In summary, Washington's network of two-year colleges offers multiple on-ramps to civil and surveying careers: from direct-to-workforce AAS degrees in surveying and civil tech (as detailed for Yakima, Clark, Bellingham, Renton) to transfer degrees for budding engineers, to certificates that upgrade specific skills (such as CAD or GIS). Many of these programs maintain partnerships with employers and professional organizations, ensuring that curriculum stays relevant and students transition smoothly into jobs or further education.

# 6.9 Apprenticeship and Workforce Development Programs

Beyond formal college degrees, Washington also provides apprenticeship and workforce training pathways into civil engineering and surveying fields. These programs combine on-the-

job training with classroom instruction and are often sponsored by employers, labor unions, or government agencies. They offer another route to a career, typically allowing individuals to "earn while they learn" and achieve journey-level status or certifications.

# 6.9.1 Operating Engineers Apprenticeship – Construction Surveyor (Technical Engineer)

Washington state's Operating Engineers Regional Training Program (OERTP) Joint Apprenticeship and Training Committee offers a registered apprenticeship for the occupation of Construction Site Surveyor / Technical Engineer. This apprenticeship is affiliated with the International Union of Operating Engineers (IUOE), which represents many surveyors and technical engineers in the heavy construction industry.

- Apprenticeship structure: The program is a 6,000-hour apprenticeship (approximately three years of full-time work) toward the Construction Site Surveyor/Technical Engineer. During this period, apprentices receive on-the-job training (OJT) under the guidance of experienced journey-level surveyors and engineers on construction sites. They also complete related supplemental instruction (RSI), which are classroom or lab courses that typically occur in the evenings or in short blocks throughout the year. The curriculum for the RSI covers subjects such as construction math, blueprint reading, site layout, survey equipment use, and safety. For example, apprentices learn how to read site/plot drawings, perform layout calculations, and use laser levels and GPS on site skills also highlighted in pre-apprenticeship programs. The term of 6,000 hours implies a structured progression; apprentices might start with basic tasks (holding the rod, running level loops) and gradually take on more complex duties (operating a total station, computing coordinates, leading a two-person crew) as they advance through defined stages (or "periods") of apprenticeship.
- Role and work environment: A Construction Site Surveyor/Technical Engineer apprentice works primarily on construction projects, such as building highways, bridges, large buildings, or utilities. They perform construction layout, transferring design plans to physical points on the ground. This can include staking out foundations, column lines, road centerlines, grading elevations, etc. The apprenticeship trains them in using construction surveying tools (total stations, GPS rovers, construction lasers) and in understanding construction plans and specifications. They are often employed by large construction contractors or engineering companies that do construction staking. The term "Technical Engineer" in union parlance can also involve related work such as quantity tracking (calculating volumes of earth moved) or checking as-built conditions. The apprenticeship expects apprentices to become proficient in construction math and in maintaining accurate field notes/data crucial for quality control on job sites.
- Classroom training and certification: Apprentices in this program likely attend classes at the union's training center (for IUOE Local 302 in Washington, a major training facility is near Ellensburg, Wash.). Topics include survey computations, highway surveying, earthwork and paving layout, and even some basic civil engineering

concepts to understand what they are building. Safety training (Occupational Safety and Health certifications, etc.) is also provided. The standards mention that apprenticeship uses a combination of time-based and competency-based approach, meaning an apprentice must both complete the hours and demonstrate certain competencies. Apprentices might earn interim certifications or cards (for example, flagger certification, first aid, and possibly a certificate for completing a surveying module). By the end of the program, apprentices can handle tasks equivalent to a survey party chief on a construction project.

- Outcomes: After completing the 6,000 hours and all coursework, apprentices achieve journey-level status as Construction Site Surveyors/Technical Engineers. They can command high wages (the apprenticeship documentation notes they are paid on a scale relative to union journey worker rates). As journey workers, they are qualified to work unsupervised and even lead survey crews on construction projects. Many choose to pursue the PLS license as well, although additional experience (and passing the LSIT/LS exams) is required outside the apprenticeship. The apprenticeship provides an excellent foundation for that, since it covers so much practical and theoretical knowledge.
- Integration with colleges: Some apprentices use the apprenticeship's related training as credit toward college programs. For instance, there might be agreements in which completing the apprenticeship can count for some credits in Renton Technical College's program or vice versa. However, primarily this is a distinct pathway from college one enters by applying to the union program (which often requires a high school diploma and passing an entrance exam in math). Once accepted, apprentices rotate through various contractors for their OJT. The union and employers jointly sponsor the training costs, so apprentices usually pay little or no tuition and earn wages from day one.

#### 6.9.2 Other Apprenticeships

While the Operating Engineers apprenticeship is the main formal apprenticeship in surveying, there are related apprenticeships and pre-apprenticeships:

- Ironworkers and carpenters unions: These unions sometimes train on construction layout for their trades (e.g., an Ironworker apprentice learns to do simple site measurements for placing anchor bolts, a carpenter may learn to read levels for formwork). But those are incidental and not full surveying careers.
- Engineering technician apprenticeships: A few public agencies and companies have started apprenticeships for engineering technicians (which could include civil drafting or inspection). For example, Seattle City Light has an apprenticeship for Design and Civil Engineering Specialist in training, and WSDOT has in the past explored an apprenticeship model for Transportation Technicians (who do materials testing and surveying tasks). These are not widespread, but as the workforce ages, more agencies may implement apprenticeship programs for civil tech roles.

• Pre-apprenticeships: Programs such as Regional Apprenticeship Pathways (RAP) in Clark County (a high school pre-apprenticeship) expose students to construction trades including surveying basics [32]. In the RAP curriculum, students practice the layout responsibilities of surveyors and field engineers, learning to interpret site drawings and use basic surveying tools as part of a multi-craft introduction [32]. Such programs prepare youth to enter directly into apprenticeships such as for Operating Engineers or to go to a technical college.

#### **6.9.3** Workforce Development Initiatives

Washington's workforce development system supports civil and surveying career pathways through several initiatives:

- Career Launch and Career Connect Washington: These state programs endorse educational pathways that include significant work-based learning. For example, as noted earlier, Clark College's surveying program is a Career Launch program. This means that the program meets high standards for combining classroom learning with paid work experience (internships). Through Career Launch, the state facilitates partnerships between colleges and employers, sometimes providing funding or coordination so that more students can intern in their field. For students, this means that while studying they might work part-time for an employer such as a surveying firm, get paid, and have that count for credit. Employers get to train and vet potential future hires. Other colleges (such as Renton with its connections to union contractors, or Yakima with its local industry ties) also effectively function this way, even if not formally labeled Career Launch.
- WorkSource and WIOA funding: Washington residents looking to retrain for new careers can access funding for high-demand fields. Programs such as surveying and civil engineering tech are often classified as high demand (because of infrastructure spending and retiring workforce). The state's Eligible Training Provider List (ETPL) includes many of the programs that have been discussed. For example, Renton Technical College's Field Surveying Tech certificate is WIOA-approved, meaning that dislocated workers or others eligible under the Workforce Innovation and Opportunity Act can get tuition assistance to attend. Similarly, Yakima's and Clark's programs likely appear on this list (as indicated by the SkillPointe and CareerOneStop entries). This financial support is part of workforce development, ensuring that cost is not a barrier for entering these fields.
- Short-term continuing education: Some workforce development efforts focus on quick upskilling. For instance, fundamentals of surveying review courses have been offered by colleges or LSAW chapters to help working technicians pass the LSIT exam. These are non-credit courses but important for career advancement. Additionally, safety and certification courses (such as OSHA's 30-hour flagging or construction surveillance technician prep) are offered through community/technical

- colleges' continuing education departments or union training centers, complementing formal education.
- Employer partnerships and scholarships: Many employers in civil engineering and surveying sponsor scholarships or loaned employee programs. For example, some public works departments will hire a student full-time in summers and pay for their schooling in exchange for a work commitment after graduation. The LSAW Education Foundation provides scholarships to surveying students at the aforementioned colleges. These reduce the financial burden and encourage more entrants to the field, a priority for workforce planners given the shortage of surveyors.
- Licensing agency collaboration: The Washington State Board of Registration for Professional Engineers and Land Surveyors (BRPELS) engages with educational programs to ensure that the pipeline to licensure is clear. They offer LSIT certification for those who pass the FS exam and meet education/experience requirements. Notably, in Washington a two-year surveying degree can count toward part of the experience required for PLS licensure. Specifically, per WAC 196-21, a two-year approved surveying program may count as two years of experience toward the four-year experience requirement for the PLS (if the person also has their LSIT). This essentially fast-tracks graduates of programs such as Renton, Clark, BTC, and Yakima by crediting their education as if it were work experience. It's a major incentive and validation of those programs as workforce development. (On the engineering side, an ABET-accredited BS is required for PE in Washington, so the two-year tech degrees lead to supportive roles rather than licensure, but those techs often work under PEs, filling crucial workforce needs).

In summary, Washington state's apprenticeship and workforce programs provide alternative and complementary routes into civil engineering and surveying careers. The IUOE apprenticeship produces surveying professionals tailored for the construction industry through extensive hands-on experience. Meanwhile, workforce development funding and initiatives reinforce the college programs, enabling students to participate in internships and afford their training. Together with the formal education system, these efforts help address the skilled labor shortage in surveying and civil engineering fields, creating multiple entry points whether one prefers a college classroom, an on-the-job training approach, or a hybrid of both. All pathways ultimately contribute to a pipeline of qualified technicians, technologists, and future licensed professionals who will build and maintain Washington's infrastructure.

#### 6.10 Online Programs Accessible to Washington Residents

With the growing demand for flexibility, several online program options allow Washingtonians to prepare for civil engineering and surveying careers remotely. Some have already been touched on (such as UW's online graduate programs and Renton Technical College's hybrid surveying program). Here we summarize notable online opportunities:

• University of Washington Online Masters: UW's Department of Civil and Environmental Engineering offers online master's degrees in specialized areas of civil

engineering. For instance, the online master's degree in Construction Engineering (a professional master's program) is designed for working professionals to enhance skills in construction project management, heavy construction methods, and business aspects. Similarly, UW has an online master's degree in Sustainable Transportation and an online master's degree in Supply Chain Transportation and Logistics, which are interdisciplinary programs combining civil engineering transportation planning with logistics (beneficial for those interested in transportation engineering careers). These programs typically can be completed in two to three years part-time and involve live or prerecorded lectures, online discussions, and project work. They are accessible statewide, meaning a civil engineer in, say, Spokane or Vancouver can earn an advanced degree without relocating. While these are graduate-level (requiring a bachelor's in a related field), they directly contribute to higher-level expertise and leadership roles in the civil engineering workforce.

- UW Continuum College Certificates: The University of Washington's Continuum College (Professional and Continuing Education) has certificate programs in GIS and related fields. The Certificate in Geographic Information Systems is a sequence of evening/online courses (often over nine months) teaching practical GIS skills, from spatial data collection to analysis and cartography. This is open to anyone (one does not need to be a UW degree student) and is popular among environmental professionals, planners, and also surveyors who want to add GIS to their toolkit. There are also certificates in areas such as data science for the built environment or construction management that overlap with civil engineering skills. These certificates allow someone working full-time in Washington to upskill part-time.
- Washington State University Global Campus: WSU's Global Campus offers fully online degrees, but engineering offerings are limited at the undergraduate level (because of the lab components). WSU Global Campus does have an online Bachelor of Science in Data Analytics and in Cybersecurity, but not yet a BS in Civil Engineering. However, for related fields, it offers an online Professional Science master's degree in Electric Power Engineering and has discussed online engineering technology degrees. For civil-specific content, WSU's Global Campus does provide some online courses that on-campus students use (for example, some engineering management or technical writing courses). It's worth noting that WSU's Engineering Management master's degree can be completed via distance, which could be useful for civil engineers moving into management.
- Out-of-state online engineering degrees: A few ABET-accredited online undergraduate programs are open to Washington residents:
  - University of North Dakota (UND): Offers an online BS in Civil Engineering that is ABET-accredited. Students watch lectures online and come to campus for short lab residencies (typically a week) a few times. Washington students who cannot

- attend a local university sometimes use this option. It covers the same curriculum as on-campus and prepares graduates for the FE/PE exams.
- Old Dominion University (ODU): Has an online Civil Engineering Technology bachelor's (a degree-completion program), which can suit someone who already has an AAS in civil/surveying technology (such as from a Washington college) and wants to get a bachelor's degree. While a "technology" degree, it can open opportunities, and some states allow "civil engineering technology" grads to pursue licensure with additional experience.
- Arizona State University (ASU) Online: ASU offers a variety of online engineering degrees. As of recent info, a BS in Engineering with an emphasis in engineering management or electrical engineering is available; a fully online BS in Civil Engineering is under development. Even if not ABET accredited, ASU Online has a Master of Engineering in Civil Engineering that's fully online, focusing on areas such as sustainable engineering and urban systems.
- Southern Utah University recently launched an online AAS in Surveying (and BS in Surveying in-person). Also, Eastern Oregon University offers an online minor in GIS that could complement a Washington two-year degree.

It's recommended that Washington residents verify state licensure requirements when considering out-of-state online programs. For example, if the goal is PLS licensure, one should ensure that the program meets the state's educational criteria (most states accept ABET-accredited degrees or a combination of education and experience as per Washington's rules). Many Washingtonians use online programs for convenience and then go through the same LSIT/FE and licensure process as traditional students.

- Online Surveying Certificate (University of Wyoming): Worth mentioning is that the University of Wyoming offers a distance-learning Land Surveying Certificate (focused on cadastral surveying) that has won awards [33]. It's designed for those who already have a technical background to meet additional coursework needed for licensure. A Washington resident who has, say, a civil engineering degree but needs specific surveying courses for PLS exam eligibility might take such a program remotely. This shows the range of online options to satisfy niche needs.
- Professional Development Online: Organizations such as ASCE and NSPS offer
  online courses/webinars that Washington professionals use for continuing education
  or skill development. While not full programs, these can lead to micro-credentials or
  simply keep skills sharp. For example, ASCE has an online certificate in
  Fundamentals of Civil 3D or roadway design, which a technician in Washington
  could take to improve job performance.

In conclusion, online programs provide flexibility for Washington residents to enter or advance in civil and surveying careers, especially for those who cannot attend campus because of location or work. The combination of Washington-based online offerings (such as the UW's certificates and Renton's hybrid program) and accredited out-of-state online degrees ensures that

even those living far from the major campuses or balancing a job can obtain relevant education. These online avenues, when paired with Washington's robust local industry for internships and practical experience, create even more pathways into the profession. Students, however, must be self-motivated and disciplined to succeed in these remote formats. They should seek out opportunities to get hands-on experience (through local labs, summer workshops, or field jobs) to complement the online theory, as civil engineering and surveying remain very tactile, field-oriented fields at their core.

#### 6.11 Conclusion and Key Takeaways

#### 6.11.1| Opportunities for Washington Civil Engineering Education

Washington State's educational landscape for civil engineering and land surveying is rich and diverse.

- Major research universities (UW, WSU) produce hundreds of civil engineering
  graduates each year, armed with broad engineering expertise and often moving
  toward professional engineer licensure. These universities maintain strong industry
  partnerships and provide opportunities such as internships, capstones, and career fairs
  that pipeline students directly into engineering roles.
- Smaller private and regional universities (Seattle U, Gonzaga, Saint Martin's, Walla Walla) contribute dozens more civil engineers annually, often with specialized training (e.g., structural focus, or heavy civil construction focus) and close mentoring. Their graduates are well prepared for entry-level positions, and many gain recognition in competitions and projects (Seattle U and Gonzaga teams frequently excel in ASCE competitions, and Saint Martin's proximity to WSDOT gives students unique design experiences).
- Community and technical colleges fill a crucial gap by training civil engineering technicians and surveying technicians. Programs at Yakima Valley College, Clark College, Bellingham Technical College, and Renton Technical College offer AAS degrees and certificates that blend classroom learning with extensive practical training. They cover surveying fundamentals, CAD, GIS, and materials testing, producing graduates who can step immediately into supporting roles at engineering firms, survey companies, or public works departments. Many of these programs report small class sizes (often <20) and graduate five to ten students per year, which is enough to feed local demand, given the niche but critical nature of these jobs. They also often align with certifications (such as the Certified Survey Technician exam or FE exam for civil techs) and have transfer pathways for those who choose to continue to a BS degree.
- Apprenticeships and workforce programs provide alternative routes. The IUOE's
  Construction Surveyor apprenticeship allows one to become a journey-level surveyor
  through a combination of work and study, particularly servicing the construction
  industry. Meanwhile, the state's Career Launch initiatives and WIOA funding

- integrate with college programs to ensure that students get work experience (internships) and financial support. Pre-apprenticeships such as high school programs introduce young people to surveying and civil trades early. All of these contribute to a more robust workforce pipeline.
- Online and flexible programs make training accessible statewide. UW's online certificates and master's degrees, Renton Tech's online surveying curriculum, and out-of-state online degrees provide options for those needing to study remotely. This flexibility is increasingly important in a large state like Washington, enabling those in rural areas or working full-time to gain credentials.

# Courses and Content Emphasis

Across these programs, there is a clear emphasis on practical skills:

- Surveying and geomatics: Virtually all relevant programs (from university civil degrees to community college AAS) include training in surveying, whether through a dedicated course or integrated in projects. Students learn to use levels, total stations, GPS, and GIS, reflecting industry's reliance on geospatial data.
- Civil engineering fundamentals: Topics such as statics, materials, fluid mechanics, and design principles are taught at appropriate depth for the program level. University students go deep into theory and design codes; college tech students focus on application and supporting calculations.
- GIS and CAD: Mastery of computer tools is universal. Programs highlight teaching AutoCAD/Civil 3D drafting, and GIS software (ArcGIS) is taught not only in surveying-centric programs but also in natural resource and university settings for environmental and transportation applications.
- Soft skills and professional prep: Many programs incorporate teamwork (group
  projects, competitions) and communication (technical report writing, presentations) to
  prepare students for the collaborative nature of work in these fields. Internship or
  capstone experiences are common, ensuring that graduates have something tangible
  on their resume.

#### Enrollment and Graduate Output

In summary, Washington's annual output in these fields can be roughly estimated as follows:

- Civil engineering BS degrees: On the order of 300–400 per year (UW ~120, WSU Pullman ~80, WSU Tri-Cities ~10–20, Seattle U ~30, Gonzaga ~40, Saint Martin's ~20, Walla Walla ~seven, plus a few from other smaller pipelines).
- Civil engineering MS degrees: 100+ per year (mostly UW and WSU, many part-time professionals).
- Surveying/geomatics AAS degrees: Perhaps 20–30 per year statewide (Clark ~eight, Renton ~eight, Bellingham ~seven, Yakima a few just starting out).
- Engineering tch and related AAS (civil tech, construction management tech): a few dozen per year across various colleges.

• Apprenticeship completers in surveying: A handful per year (the IUOE program might graduate a few each year, as apprentices complete in a rolling fashion).

While the numbers are not huge in surveying, they are vital because the surveying profession has more retiring personnel than entering – these grads and apprentices help fill the void. Civil engineering grads are more plentiful, yet with infrastructure funding increasing, even they are in high demand.

# **Employment Outcomes**

Graduates of all these programs generally have strong job prospects.

- Bachelor's-level civil engineers often join engineering design firms, construction companies (as project engineers), or public sector agencies (as design engineers or project managers in training). Many pursue EIT certification right after graduation and plan for PE licensure.
- Associate-level techs and certificate holders secure roles as surveying technicians,
  drafters, engineering aides, construction inspectors, or materials lab technicians. For
  example, a Clark College grad might become a Survey Crew Instrument Operator at a
  surveying firm, while a Yakima civil tech grad could work as an engineering
  technician at a county road department, assisting engineers with CAD drawings and
  field measurements. These roles often serve as stepping stones. Some technicians go
  on to become licensed surveyors or even pursue an engineering degree while
  working.
- Apprentices typically continue with their employer as journey-level workers, earning union scale. A journey Construction Surveyor can work on major projects statewide and even move into management roles (such as Chief of Party or Survey Manager on big jobs). They also have the union as a career support network.
- Online learners who augment their skills often leverage those for promotions. For example, a working civil engineer getting an online MS might move up to a senior engineer position or specialize in a niche such as traffic engineering, and a survey tech taking an online certificate might qualify to sit for the LSIT exam, putting them on track for licensure (and higher responsibility).

#### **Partnerships**

Many programs feature partnerships worth noting:

- Employer sponsorships: Clark College's program receiving annual donations from MacKay Sposito and Olson Engineering is a model of industry supporting education. Likewise, LSAW chapters giving scholarships and equipment is common.
- Union and college synergy: Renton Tech and the Operating Engineers apprenticeship complement each other – and some students do both, enhancing their credentials.
   Also, WSDOT frequently collaborates (WSDOT sits on advisory boards, offers internships, hires many graduates, and sometimes provides guest lectures or materials).

• Inter-state articulations: Examples include BTC with UAA (Alaska), and Clark/Yakima sending students to Oregon Tech. These show regional cooperation to ensure that students can progress to higher degrees even if they are not available instate.

#### **6.11.2**| **Summary**

Ultimately, Washington's approach is holistic. It provides academic routes, hands-on technical routes, and work-based routes to enter civil engineering and surveying. Students can choose a path based on their circumstances – whether it's a four-year university right out of high school, a two-year technical degree with immediate job entry, or joining a crew and learning through apprenticeship. All paths can lead to rewarding careers building and mapping the world around us. And with strong demand projections (civil engineering jobs are expected to grow ~5 percent in the next decade, and surveying technicians likewise will be in demand as a result of infrastructure projects and an aging workforce), the investment in these education and training programs is critical. Washington appears committed to maintaining and expanding these pathways, evidenced by program updates (new BS at UW Tacoma, new AAS at Yakima), funding initiatives, and industry engagement to ensure that graduates remain at the cutting edge of civil and geomatics technology.

# 7. Summary of Interim Findings

This study conducted an extensive literature review with primary data from a multi-stakeholder survey program to diagnose Washington's civil engineering and land surveying workforce challenges and to identify evidence-based solutions for improvement. Two complementary questionnaires were deployed: an employer survey (47 valid responses spanning state and local agencies, private consultants, contractors, and specialist surveying firms), and a practitioner survey (917 responses covering every career stage and region of the state). The instruments mixed closed-ended scales with open-response items; quantitative data were prioritized by weighted means, while text was mined with Latent Dirichlet Allocation to surface latent themes. The analyses integrated employer and practitioner results, situating them within the demographic and policy context established in the literature review.

#### 7.1|Evidence from Quantitative Analysis

#### 7.1.1| Workforce Structure and Demographics

Employer perspective: Responding organizations collectively employed about 1,260 civil engineers, 305 engineering technicians, and 193 surveyors or surveying technicians. Mid-level and senior civil engineering roles accounted for the largest absolute vacancy counts (72 and 83 openings, respectively), while Professional Land Surveyors remained numerically scarce. Average time-to-hire exceeded 4.5 months for many positions.

Practitioner perspective: Of the respondents, 68 percent had 20 or more years' experience, and another 20 percent were between 11 and 20 years. Early-career voices (< 10 years) constituted 12 percent of the sample, corroborating state licensure data that show a declining influx of newly credentialed engineers and surveyors. Geographically, responses concentrated in the Puget Sound area yet included every region of the state as well as a few out-of-state professionals who served Washington clients.

# 7.1.2 Pipeline Entry and Early-Career Bottlenecks

Two equally important pipelines feed Washington's workforce: Washington state graduates (37 percent) and interstate in-migrants (35 percent). Career changers (7 percent) and internationally trained professionals (1 percent) make only marginal contributions. Among those who had recently entered the field, the top barriers were securing an authentic entry-level role (41 percent) and surmounting licensure or formal-qualification hurdles (37 percent combined). These findings echo employer complaints that "junior" postings often demand previous experience, creating a catch-22 for new graduates.

Field experience (68 percent), technical knowledge (42 percent), and project-management skills (34 percent) were the competencies most frequently judged missing in new hires. The pattern signals a persistent gap between academic curricula and industry demands; particularly in design, inspection, permitting, and construction-phase coordination.

#### 7.1.3 Mid-Career and Senior-Level Pressures

Employers reported the greatest hiring difficulty in the five- to 15-year experience band, while practitioners cited leadership (61 percent) and project-management (35 percent) as the skills most lacking among experienced colleagues. The data converged on a structural weakness: technical specialists are advancing into supervisory roles without the managerial and interpersonal training required to lead complex, multi-agency projects now common under the Infrastructure Investment and Jobs Act.

#### 7.1.4 Retention Dynamics

Retirement was reported to be the single largest attrition driver (54 percent of practitioners), followed by compensation (43 percent) and workload due to understaffing (34 percent). Employers confirmed a retirement eligibility curve that rises from 22 percent of current staff within five years to 32 percent within ten. Practitioners added nuance: overtime fatigue, limited promotion pathways, and salary compression, especially in public agencies, accelerate mid-career exits, compounding the retirement cliff.

#### 7.1.5 Operational Impacts and Quality Risks

Practitioners associated understaffing with increased workload (68 percent), delayed projects (52 percent), refused work (41 percent), and overt quality concerns (44 percent). Narrative responses highlighted thinner plan reviews, reduced inspection frequency, and higher re-work rates, each of which magnifies cost overruns and schedule slip on state and local capital programs.

#### 7.1.6 Stakeholder-Preferred Solutions

Across both surveys, three interventions dominated:

- Enhanced education programs—modernized curricula that embed emerged technologies, advanced GIS, sustainability analytics, and practicum-style field experience.
- Apprenticeship/earn-and-learn pathways to accelerate early-career licensure and absorb students into paid roles before graduation.
- Formal industry-education partnerships to sustain curricular relevance and faculty upskilling.

#### 7.1.7 Implications

Capacity can no longer be expanded solely through traditional four-year graduation flows; Washington must diversify entry routes (career changers, interstate reciprocity, accelerated apprenticeships) while protecting its share of national engineering graduates.

Capability deficits: field readiness in graduates and leadership gaps in mid-career staff necessitate curricular overhaul and intensive mid-career training.

Continuity demands phased-retirement options and knowledge-transfer systems to capture the expertise of the imminent retiree cohort.

The evidence to date indicates that labor shortages are already constraining project throughput and quality. Without coordinated action—including combining educational reform, structured work-based learning, compensation realignment, and robust succession planning—Washington risks missing the delivery window of the current infrastructure-investment cycle. Subsequent phases of this study will integrate academic-faculty data, cost-benefit modeling of proposed interventions, and pilot-project case studies to refine the implementation roadmap.

#### 7.2 Evidence from open-ended responses

#### 7.2.1 Attraction and Retention Challenges

**Economic pressures dominate the recruitment narrative.** Topics anchored by the word clusters "pay / compensation / cost / housing" revealed that high living costs—especially in the Seattle–Bellevue corridor—undermine the state's ability to attract early-career talent and to retain mid-career, newly licensed PEs who are aggressively courted by remote-work technology firms. Practitioners repeatedly contrasted "IT salaries" with civil engineering pay scales, echoing employers' quantitative ranking of salary competition as a top-three recruitment barrier.

**Perceptions of career mobility shape retention.** Leadership-oriented terms ("promotion, recognition, advancement") co-occurred with negative qualifiers ("lack, limited"). The pattern dovetailed with the 25 percent of practitioners who cited "lack of advancement" as a potential exit trigger; LDA revealed that the complaint was less about formal titles than about access to project-management responsibility and mentoring support.

Retirement remains the single largest attrition driver. Topic clusters surrounding "retired, years, leaving" accounted for more than half of all departure comments, mirroring the 54 percent quantitative figure. However, text mining revealed a corollary risk: senior staff feel over-utilized in quality control and client defense roles because shortages have emptied the mid-career bench, accelerating their decision to retire "early and completely" rather than phase down.

#### 7.2.2 Skill Gaps and Professional Development Needs

Graduates: field readiness eclipses classroom prowess. Across multiple questions, the highest-probability words were "field, practical, real, hands-on." Fully 68 percent of respondents said that new graduates lack field exposure; LDA-generated exemplars highlighted an inability to interpret survey cuts, flag construction non-conformance, or translate hydraulic calculations into drain-age-plan annotations. Traditional technical deficits (materials, statics) appeared, but with lower weights, suggesting that employers would tolerate modest theoretical gaps if practical judgment were stronger.

**Experienced professionals: leadership over lagging software.** Contrary to anecdotal belief, veteran engineers do not primarily lack digital proficiency; rather, "leadership, mentoring, management" dominated the high-weight word lists. Practitioners lamented senior colleagues who "never learned to delegate" and "cannot translate risk into dollars for clients." Software

gaps (advanced Civil 3D scripting, GIS geodatabase design) were recognized but viewed as teachable; leadership capability was seen as harder to retrofit.

Training resources suffer a utilization, not merely a supply, deficit. A substantial topic centered on "training exists but we lack time to use it." Respondents linked heavy overtime loads to the inability to attend webinars or pursue CPD credits, turning an apparent surplus of online courses into a practical shortfall.

#### 7.2.3 Programmatic Solutions and Pathways

Internships and apprenticeships dominate solution talk. The most coherent solution topic combined "internships / co-op / apprenticeships / earn-and-learn." Practitioners and employers alike called for structured, paid placements embedded within academic calendars and leading directly to licensure hours. Several comment clusters advocated reviving community-college technician tracks with clear articulation agreements into four-year programs.

Curricular modernization centers on integration, not accumulation. High-weight verbs included "embed, integrate, weave," signaling a desire to insert new content (BIM, AI-assisted design, project finance) into existing courses rather than layering on elective credits that lengthen degree time. Respondents applauded capstone studios tied to real public-sector requests for proposals, arguing that such models compress learning curves and tighten feedback loops between faculty and practitioners.

Leadership academies emerge as the preferred mid-career fix. The phrase "leadership academy" appeared in multiple LDA topics, packaged with "mentorship, rotation, soft skills." Suggested formats ranged from week-long boot camps at WSDOT to joint ACEC/UW certificate programs indexed to PE renewal cycles. Crucially, practitioners stressed that leadership content must be coupled with workload relief; otherwise, attendance will remain aspirational.

#### 7.2.4 Concluding Observations

Qualitative analysis confirmed that Washington's workforce constraints are systemic, spanning the attraction of new entrants, the up-skilling of incumbents, and the retention of senior expertise. Economic competitiveness, experiential learning, and leadership capacity form an interconnected triad; failure in any one node reverberates across project schedules, quality assurance, and long-term institutional memory. The proposed interventions include modernized curricula, robust earn-and-learn pathways, and structured leadership development to address each leg of that triad, but their success will hinge on coordinated implementation and sustained funding. Subsequent research phases will pair these qualitative insights with cost-benefit modeling and academic-faculty survey results to refine a statewide action plan.

# 7.3 Current Pathways in Washington State for Civil Engineering and Land Surveying

# 7.3.1 Baccalaureate and Graduate Routes in Civil Engineering

#### *University of Washington – Seattle (UW-Seattle)*

UW-Seattle offers a tiered suite of credentials, beginning with the BS in Civil Engineering (BSCE) and the BS in Environmental Engineering (BSENVE). Graduate students may pursue MS or PhD concentrations in Construction, Energy and Sustainable Infrastructure (CESI); Environmental Engineering and Hydrology/Hydrodynamics (CEWA); Structural and Geotechnical Engineering and Mechanics (CESG); Supply-Chain Transportation and Logistics (SCTL); and Transportation Engineering (CET). Common post-graduation job titles include civil and environmental engineer, project engineer, and transportation analyst, while top employers range from WSDOT, KPFF, and Kiewit to Kimley-Horn, HNTB, and Jacobs. Internship participation exceeds 80 percent, and graduates disperse across research, consulting, and public-sector roles.

#### Washington State University – Pullman (WSU)

WSU confers the BS in Civil Engineering, BS in Construction Engineering, two distinct MS degrees (Civil and Environmental Engineering), and the PhD in Civil Engineering.

# Seattle University (SU)

SU's portfolio includes the BS.in Civil Engineering and BS in Environmental Science; a Master of Science in Structural Engineering; an Environmental Engineering minor; and an undergraduate certificate in GIS and Geospatial Technology. Recent cohorts are majority-female (51 percent) and majority students of color (62 percent), and over 90 percent secure employment or graduate-school placement within six months of graduation.

#### University of Washington – Tacoma (UW-Tacoma)

UW-Tacoma's BSCE resides in the School of Engineering and Technology. Enrollment climbed from seven students in 2022-2023 to 19 in 2023-2024, with seven degrees awarded in that period. Top career trajectories have been civil, construction, environmental, geotechnical, structural, transportation, and water-resources engineer.

#### 7.3.2 Community-College and Technical-College Pathways

#### Renton Technical College (RTC)

RTC delivers a fully online Land Surveying Technician certificate (one year) aimed at LSIT preparation, plus a three-quarter Field Surveying Technician Certificate and a subsequent AAS in Land Surveying-Geospatial Science. Coursework spans survey adjustments, CAD for surveying, GNSS, geodetic methods, and technical writing.

#### Clark College

Clark awards an AAS in Surveying and Geomatics (six quarters) with transfer potential to the Oregon Institute of Technology. Certificates include Boundary Technician and GIS Technician, and the curriculum emphasizes electronic instrument use, survey computation, boundary law, and GIS fundamentals.

# Bellingham Technical College (BTC)

BTC offers an AAS in Engineering Technology – Geomatics Specialization. A formal partnership allows graduates to articulate into the University of Alaska Anchorage's BS in Geomatics. Core courses cover construction and highway surveys, GIS and GPS, and AutoCAD.

#### Yakima Valley College (YVC)

YVC's menu comprises an AAS in Land Survey and Construction Design Technology, an AAS in Civil Engineering Technology, and stackable certificates in CAD and Land Surveying. Detail on specific course outcomes is limited, but the pathway clearly supports technician-level entry.

#### Additional Providers

Other two-year institutions with surveying-related offerings include Cascadia College, Spokane Community College, South Puget Sound, Olympic College, Lake Washington Institute of Technology, Pierce College, Clover Park Technical College, Everett, Centralia College, Tacoma, and Walla Walla. Programs range from drafting and engineering technology to discrete geomatics courses.

# 7.3.3 Professional Society and Regulatory Pathways

Professional development continues outside formal academia. The Land Surveyors' Association of Washington (LSAW) and the National Society of Professional Surveyors (NSPS) deliver continuing education workshops, exam-prep seminars, and webinars. The Washington State Board of Registration for Professional Engineers and Land Surveyors provides licensure guidance and hosts practice-oriented sessions, while the State Board for Community and Technical Colleges coordinates program standards across its member schools.

#### 7.3.4 Transfer and Articulation Mechanisms

There are several vertical pathways: Clark College to Oregon Tech in Geomatics; BTC to UAA's BS in Geomatics; and Bellevue's AS-Track II feeding directly into Washington's four-year civil engineering programs. These linkages allow certificate and AAS holders to step into upper-division curricula without loss of credit, enlarging the pipeline from technician to licensed professional.

#### 7.3.5 | Consolidated View

The identified pathways show a multi-tiered ecosystem: flagship universities anchor advanced civil engineering education; regional universities and private institutions extend access; community and technical colleges supply technician and survey-entry training; and professional societies maintain licensure-aligned continuing education. Transfer agreements and certificate-to-degree bridges knit these layers together, allowing students to progress from foundational certificates all the way to doctoral research in specialized sub-fields. While

enrollment and outcome data are spotty outside UW and Seattle University, the breadth of offerings—from online surveying certificates to PhD specializations—provides a scaffold on which to build expanded, practice-ready pathways for Washington's civil engineering and land surveying workforce.

#### 7.4| Recommendations and Action Plan

The solutions presented below flow directly from the evidence gathered in the literature review, the employer and practitioner surveys, and the current-pathway inventory.

# 7.4.1 Strategic Goal 1 – Close Immediate Skill Gaps: Short-Term Training and Continuing Education

Washington's infrastructure owners cannot wait for four-year degree cycles to relieve today's vacancy pressure. The PacTrans Workforce Development Institute can be tasked through a dedicated WSDOT contract with producing modular, competency-based courses in the four shortage areas that employers ranked highest: project management, AutoCAD/Civil 3D corridor modeling, GIS analytics, and hydraulic modeling. Each micro-course would award continuing education units and count toward PE or PLS renewal, thereby attracting both early-career staff who need licensure hours and mid-career professionals who must upskill for promotion. Parallel funding should maintain and expand the successful Roads Scholar Program, which already provides inspection and materials-testing credentials to county and city staff.

# 7.4.2 Strategic Goal 2 – Expand and Modernize Degree Capacity: Targeted Institutional Funding

Eight universities and 14 community or technical colleges already offer civil- and surveying pathways. To raise throughput without diluting quality, the state should consider the following:

- Allocate budget in competitive grants for curriculum modernization; priority given to courses that embed BIM, Global Navigation Satellite Systems/LiDAR, sustainability analytics, and real-client capstones.
- Continue the WSDOT Fellows program, raising the cohort from five to seven funded master's students per year. Fellows must complete a thesis tied to agency project needs and commit to two years of post-graduation service.
- Ensure that AAS holders in surveying or civil technology can enter university programs with junior standing statewide.

# 7.4.3| Strategic Goal 3 – Strengthen Pipeline Diversity and Field Readiness: Internships, Apprenticeships, and Youth Outreach

Of Seattle University graduates, 90+ percent report that internships accelerated placement; employers meanwhile rate field experience as the single largest graduate deficit. To scale experiential learning, the following are needed:

- Create a statewide Infrastructure Internship Clearinghouse hosted by PacTrans, matching sophomores and juniors with WSDOT, county road shops, and private consultants.
- Expand WSDOT's summer camp for high school students and seed analogous programs at Eastern Washington University and Yakima Valley College to attract rural and under-represented youth.
- Incentivize employers to adopt registered apprenticeships in surveying and civil design tech.

#### 7.5 | Conclusion

The action plan recognizes that no single lever, whether higher salaries, more graduates, or better software training, can by itself stabilize Washington's civil engineering and land surveying workforce. Instead, a portfolio of interventions, sequenced across time horizons and coordinated among education, industry, and government partners, is required. Implemented together, the recommended measures are projected to shrink vacancy duration, add new survey tech and civil tech graduates annually, and retain at-risk retirees long enough to mentor their replacements. These gains would place the state on a sustainable footing to deliver its historic infrastructure program while safeguarding public safety, fiscal stewardship, and project quality.

# References

- 1. Associated General Contractors of America, and Arcoro. (2024, August 28). 2024 workforce survey analysis: National results (PDF). Associated General Contractors of America. <a href="https://www.agc.org/sites/default/files/Files/Communications/2024\_Workforce\_Survey\_Analysis.pdf">https://www.agc.org/sites/default/files/Files/Communications/2024\_Workforce\_Survey\_Analysis.pdf</a>
- 2. Washington Student Achievement Council. (2023). *Higher education and labor market (HELM) report* (PDF). https://wsac.wa.gov/sites/default/files/2023.WSAC\_HELM\_Report.pdf
- 3. The Seattle Times. (2023, October 25). *Lack of civil engineers a bottleneck for WA's large transportation projects*. <a href="https://www.seattletimes.com/seattle-news/transportation/lack-of-civil-engineers-a-bottleneck-for-was-large-transportation-projects">https://www.seattletimes.com/seattle-news/transportation/lack-of-civil-engineers-a-bottleneck-for-was-large-transportation-projects</a>
- 4. Electronics Reference. (2023, October 25). *Civil engineer shortage in U.S. threatens infrastructure projects*. <a href="https://electronicsreference.com/civil-engineer-shortage-in-u-sthreatens-infrastructure-projects/">https://electronicsreference.com/civil-engineer-shortage-in-u-sthreatens-infrastructure-projects/</a>
- 5. McSteen Land Surveyors. (n.d.). Why is there a shortage of land surveyors? ... and what can we do about it? Retrieved May 12, 2025, from <a href="https://mcsteen.com/shortage-of-land-surveyors/">https://mcsteen.com/shortage-of-land-surveyors/</a>
- 6. Board of Registration for Professional Engineers and Land Surveyors. (2024, December 10). *Our future workforce* [Web page]. <a href="https://brpels.wa.gov/news/2024/our-future-workforce">https://brpels.wa.gov/news/2024/our-future-workforce</a>
- 7. Nearterm. (2020, November 2). *Is there a shortage of land surveyors?* Nearterm Blog. <a href="https://nearterm.com/is-there-a-shortage-of-land-surveyors/">https://nearterm.com/is-there-a-shortage-of-land-surveyors/</a>
- 8. Bureau of Labor Statistics. (2024, August 29). *Employment projections 2023–2033* (USDOL-24-1776).
- 9. Associated General Contractors of America, and Arcoro. (2024). 2024 workforce survey analysis: National results.
- 10. Ayres Associates. (2022, August 16). Does it matter if your surveyor is licensed?
- 11. National Academies of Sciences, Engineering, and Medicine. (2022). Attracting, retaining, and developing the 2030 transportation workforce: Design, construction, and maintenance (NCHRP Research Report 1008). The National Academies Press. <a href="https://doi.org/10.17226/26768">https://doi.org/10.17226/26768</a>
- 12. National Cooperative Highway Research Program. (2012). *Attracting, recruiting, and retaining skilled staff for transportation system operations and management* (NCHRP Report 693). Transportation Research Board. <a href="https://www.trb.org/Publications/Blurbs/166342.aspx">https://www.trb.org/Publications/Blurbs/166342.aspx</a>

- 13. ACEC Research Institute. (2024). *Economic assessment of the engineering and design services industry*. American Council of Engineering Companies. <a href="https://www.acec.org/wp-content/uploads/2024/10/ACEC-Research-Institute-2024-Economic-Assessment-Forecast-Final-1.pdf">https://www.acec.org/wp-content/uploads/2024/10/ACEC-Research-Institute-2024-Economic-Assessment-Forecast-Final-1.pdf</a>
- 14. Boston Consulting Group, and SAE International. (2023, December 6). *The US needs more engineers: What's the solution?* Boston Consulting Group. <a href="https://www.bcg.com/publications/2023/addressing-the-engineering-talent-shortage">https://www.bcg.com/publications/2023/addressing-the-engineering-talent-shortage</a>
- 15. Blicavs, M. (2023, March 20–22). *Determining the future demand, supply and skills gap for surveying and geospatial professionals: 2022–2032*. Paper presented at the 26th Association of Public Authority Surveyors Conference (APAS 2023), Coffs Harbour, NSW, Australia. Association of Consulting Surveyors National. <a href="https://www.apas.org.au/files/conferences/2023/Determining-the-Future-Demand-Supply-and-Skills-Gap-for-Surveying-and-Geospatial-Professionals-2022-2032.pdf">https://www.apas.org.au/files/conferences/2023/Determining-the-Future-Demand-Supply-and-Skills-Gap-for-Surveying-and-Geospatial-Professionals-2022-2032.pdf</a>
- 16. Likert, R. (1932). A technique for the measurement of attitudes. *Archives of Psychology*, 22(140), 1-55.
- 17. Fowler, F. J. (2014). Survey research methods (5th ed.). SAGE Publications.
- 18. Creswell, J. W., and Plano-Clark, V. L. (2018). *Designing and conducting mixed methods research* (3rd ed.). SAGE Publications
- 19. Blei, D. M., Ng, A. Y., and Jordan, M. I. (2003). Latent Dirichlet allocation. *Journal of Machine Learning Research*, *3*, 993–1022.
- 20. University of Washington Dept. of Civil and Environmental Engineering official website and fact sheets (https://www.ce.washington.edu/)
- 21. University of Washington Tacoma School of Engineering and Technology BSCE program page and FAQs (https://www.tacoma.uw.edu/)
- 22. UW Bothell degree programs catalog (confirmation of no civil engineering program at Bothell (<u>uwb.edu</u>)
- 23. Washington State University Civil and Environmental Engineering Department: Program descriptions, degree requirements and enrollment/graduation data (<a href="https://wsu.edu/">https://wsu.edu/</a>)
- 24. Seattle U Department of Civil and Environmental Engineering curriculum plan and program details (https://www.seattleu.edu/)
- 25. Saint Martin's University civil engineering graduates per year (collegefactual.com)
- 26. Walla Walla University School of Engineering (wallawalla.smartcatalogiq.com)
- 27. Yakima Valley College Academics (<u>vvcc.edu</u>)

- 28. Clark College Surveying and Geomatics (clark.edu)
- 29. Bellingham Technical College Geomatics program outcomes (skills and exam prep(<u>btc.edu</u>)
- 30. Renton Technical College program description snippets (<u>rtc.edu</u>)
- 31. LSAW (Land Surveyors' Assoc. of WA) list of colleges with surveying programs (<u>lsaw.org</u>)
- 32. Washington State Department of Labor & Industries (<a href="mailto:lni.wa.gov">lni.wa.gov</a>)
- 33. University of Wyoming. *Civil and Architectural Engineering and Construction Management*. (uwyo.edu)