

# 1956 Inventory of State Highway Engineering Manpower

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During the past few years several attempts have been made to obtain a complete and accurate count of state highway department engineering manpower. Previously reported data were in some cases inconsistent due to variations in the classification methods among the states and also due to different interpretations of the several questionnaire forms used. It was apparent that an accurate tabulation of engineering employees was desirable as part of the over-all effort in connection with the present shortage of engineers.

The present study indicates that previous reports have had a reasonably accurate nationwide total for engineers, but the figures reported for individual states vary widely in some instances from those reported in other studies. In addition, the number of engineering aids employed has not been reported previously. As of March 1956, according to the present study, the states employed 20,551 engineers, which total compares favorably with a figure of 21,229 reported by Professor Danner of the University of Illinois as of December 31, 1955. The states also employed 25,911 engineering aids, or a ratio of approximately 1.3 aids per engineer. As of July 1956, the states estimated that they would employ 21,435 engineers and 30,879 aids, the ratio of aids to engineers increasing to more than 1.4. These ratios are somewhat higher than that of one aid employed for each engineer reported in a study of six selected states made in 1955. The regional pattern for the ratio of engineering aids to engineers shows that in general the New England, Mid-Atlantic, East North Central and Pacific regions employ more engineers than aids, whereas in the remaining regions just the reverse is true.

It was also found that of the total engineers employed about 39 percent were neither registered nor graduates, while an additional 17 percent were registered but not graduates. Only one engineer out of five was both a civil engineering graduate and registered.

●THE TITLE of this paper could just as well be "A Further Analysis of State Highway Engineering Manpower," since the information presented supplements that reported by Campbell and Schureman (1) for the year 1954 and by Lewis (2) for the year 1955. The latter article pointed up the need for better information as to the number of engineers and aids employed in each state, and in fact suggested that no one really knows just how many engineers and aids are employed by the several state highway departments. This lack of knowledge is especially critical today in view of the current dearth of engineers in the face of a greatly accelerated highway program.

To meet this deficiency the Highway Research Board prepared and distributed to each state a form for the presentation of uniform information on the several categories of engineers and engineering aids employed by the state highway departments. This form reproduced as Appendix A, requested actual data as of March 1, 1956, and estimated data as of July 1, 1956.

In most cases the states responded with complete information. In several cases, however, it was necessary to make estimates either for the March or the July figures, and in two cases where only totals were given, it was necessary to estimate the number of employees in the several categories which together comprise the totals. That part of the information which is presented state-by-state in the tables shows only those figures reported by each state. Estimates were made for the missing data, but are reflected here only in national totals. The estimates made are based on those figures which were reported by a state as well as the average change indicated by states reporting complete information. In addition, one state did not respond to the question-

Table 1 -- State highway department engineering employees 1/

As of March 1, 1956

State	Classified as engineers								Total engineers	Classified as engineering aids					Total state engineer- ing employees	Equivalent consultant engineers employed 2/	Total engineering personnel equivalent
	Civil engineers				Other engineers					Classified as engineering aids							
	Both a graduate and registered	Graduate only	Registered only	Total	Both a graduate and registered (Other than civil)	Graduate only (Other than civil)	Neither graduate nor registered (In any branch)	Total other		Both a graduate and registered civil engineer	Graduate civil engineer only	Regis- tered engineer only	Neither graduate nor registered	Total engineer- ing aids			
Alabama	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Arizona	30	-	23	53	3	-	-	3	56	-	10	1	493	504	560	560	
Arkansas	42	10	36	88	4	3	42	49	137	4	3	5	375	387	524	524	
California	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Colorado	20	18	120	158	18	19	134	171	329	-	-	-	438	438	767	768	
Connecticut	41	75	40	156	2	11	544	557	713	-	-	-	235	435	948	2,298	
Delaware	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Florida	57	57	35	149	3	2	198	203	352	-	-	-	1,183	1,183	1,535	1,535	
Georgia	58	35	92	185	8	13	375	396	581	1	4	2	1,230	1,237	1,818	1,818	
Idaho	33	35	36	104	3	3	29	35	139	-	-	-	453	453	592	592	
Illinois	306	333	203	842	-	111	101	212	1,054	-	-	-	151	151	1,205	1,205	
Indiana	270	80	-	350	-	10	-	-	360	-	-	-	169	169	529	529	
Iowa	112	18	92	222	-	-	-	-	222	-	-	-	745	745	967	967	
Kansas	129	23	114	266	11	21	12	44	310	-	-	5	557	562	872	895	
Kentucky	62	35	148	245	5	9	318	332	577	-	-	-	584	584	1,161	1,211	
Louisiana	80	-	225	305	-	-	-	-	305	-	-	14	910	924	1,229	1,204	
Maine	63	33	30	126	10	13	21	44	170	-	-	-	57	57	227	229	
Maryland	7	36	36	79	1	2	308	311	390	-	-	-	372	373	763	776	
Massachusetts	-	-	-	-	-	-	-	-	(400)	-	-	-	(1,054)	(1,054)	(1,664)	(450)	
Michigan	107	156	31	294	7	17	181	205	492	-	-	-	800	800	1,239	1,239	
Minnesota	196	37	146	379	3	6	217	226	605	-	-	-	635	635	1,240	1,240	
Mississippi	60	6	21	87	18	-	1	19	106	11	9	4	566	590	696	696	
Missouri	127	116	137	380	-	-	263	263	643	-	-	-	725	725	1,368	1,368	
Montana	16	13	64	93	-	11	100	111	204	-	2	-	281	283	487	487	
Nebraska	27	28	70	125	-	11	105	116	221	-	1	2	222	225	466	466	
Nevada	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
New Hampshire	43	52	22	117	-	5	93	98	215	-	-	22	98	120	335	360	
New Jersey	-	-	-	-	-	-	-	-	(425)	-	-	-	-	(77)	(502)	(502)	
New Mexico	26	-	22	48	-	-	-	-	48	-	30	-	490	520	568	568	
New York	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
North Carolina	17	124	20	161	-	10	277	287	448	-	-	-	608	608	1,056	1,056	
North Dakota	28	11	24	63	4	6	46	56	119	-	-	-	45	45	164	166	
Ohio	336	54	261	651	-	-	-	-	651	-	-	-	1,306	1,306	1,957	1,957	
Oklahoma	39	10	38	87	5	14	34	53	140	1	2	-	565	568	708	748	
Oregon	56	57	48	161	-	55	293	348	509	-	-	-	278	278	787	787	
Pennsylvania	24	31	21	106	3	16	401	420	526	2	4	2	1,047	1,055	1,581	1,581	
Rhode Island	12	6	16	34	1	10	40	51	85	-	-	-	109	109	194	194	
South Carolina	23	92	2	117	-	11	136	147	284	-	1	-	445	445	709	709	
South Dakota	14	29	6	49	-	3	32	35	84	-	-	-	363	363	447	447	
Tennessee	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Texas	522	176	213	913	-	-	-	-	913	-	-	-	2,755	2,755	3,668	3,668	
Utah	-	-	-	-	-	-	-	-	(55)	-	-	-	-	(99)	(154)	(154)	
Vermont	27	37	17	81	4	12	62	78	159	-	-	-	46	46	205	213	
Virginia	25	47	62	134	-	-	213	213	347	-	2	-	763	765	1,112	1,157	
Washington	57	123	50	230	5	42	336	383	613	-	4	-	364	368	981	981	
West Virginia	32	-	49	81	-	-	-	-	81	-	-	-	191	191	272	284	
Wisconsin	70	142	50	262	16	27	88	131	393	-	-	-	349	349	742	742	
Wyoming	35	3	45	83	-	-	10	10	93	-	10	4	151	165	258	258	
District of Columbia	6	26	4	36	-	3	42	45	81	-	-	-	77	77	158	158	
Totals for States fully classified	3,235	2,164	2,701	8,100	144	466	5,052	5,662	13,762	19	83	61	21,230	21,393	35,155	37,179	
Estimated grand totals	4,287	3,655	3,477	11,419	182	945	8,005	9,132	20,551	19	107	63	25,722	25,911	46,462	48,938	

1/ Detail figures reported by the several State highway departments. Items shown in parentheses are not included in fully classified totals since a complete classification was not given by the State.

2/ Includes engineering aids in Kansas and Missouri.

3/ Idaho, Indiana, Ohio and Pennsylvania gave the number of firms employed rather than the equivalent engineering personnel. No estimate has been made for these States.

Table 2. -- State highway department engineering employees 1/

As of July 1, 1956

State	Classified as engineers									Classified as engineering aids					Total State engineering employees
	Civil engineers				Other engineers				Total engineers						
	Both a graduate and registered	Graduate only	Registered only	Total	Both a graduate and registered (Other than civil)	Graduate only (Other than civil)	Neither graduate nor registered (In any branch)	Total other		Both a graduate and registered civil engineer	Graduate civil engineer only	Registered engineer only	Neither graduate nor registered	Total engineering aids	
Alabama	32	16	11	59	-	-	485	485	544	-	-	-	957	957	1,501
Arizona	33	-	27	60	-	-	-	-	60	-	15	1	663	679	739
Arkansas	50	15	40	105	1	5	50	56	161	10	5	15	375	405	566
California	488	1,001	330	1,819	13	331	1,554	1,898	3,717	-	-	-	1,672	1,672	5,389
Colorado	20	18	120	158	18	19	134	171	329	-	-	-	488	488	817
Connecticut	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Delaware	15	15	6	36	-	-	9	9	45	-	-	-	183	183	228
Florida	-	-	-	-	-	-	-	-	-	-	-	-	(1,283)	(1,283)	-
Georgia	(65)	(25)	(97)	(208)	-	-	-	(418)	(625)	(1)	(4)	(2)	(1,546)	(1,553)	(2,179)
Idaho	(33)	(48)	(36)	(117)	-	-	-	(35)	(152)	-	-	-	(500)	(500)	(652)
Illinois	(306)	(350)	(203)	(859)	-	-	-	-	(1,075)	-	-	-	(251)	(251)	(1,326)
Indiana	273	94	-	367	10	-	-	10	377	-	-	-	235	235	612
Iowa	112	18	92	222	-	-	-	-	222	-	-	-	745	745	967
Kansas	(136)	(33)	(114)	(283)	-	-	-	(44)	(327)	-	-	(5)	(745)	(750)	(1,077)
Kentucky	(55)	(34)	(148)	(237)	-	-	-	-	(340)	-	-	-	(746)	(746)	(1,323)
Louisiana	90	-	225	315	-	-	-	-	312	-	-	14	950	964	1,279
Maine	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Maryland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Massachusetts	-	-	-	-	-	-	-	-	(610)	-	(20)	-	(1,180)	(1,200)	(1,810)
Michigan	(107)	(166)	(31)	(304)	-	-	-	(194)	(498)	-	-	-	(1,000)	(1,000)	(1,498)
Minnesota	(193)	(40)	(146)	(379)	-	-	-	(226)	(605)	-	-	-	(650)	(650)	(1,255)
Mississippi	60	13	21	94	19	-	1	20	114	11	9	4	566	590	704
Missouri	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Montana	(21)	(17)	-	-	-	-	-	-	(216)	-	(8)	-	(405)	(413)	(659)
Nebraska	-	-	-	-	-	-	-	-	(255)	-	-	-	-	(300)	(555)
Nevada	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
New Hampshire	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
New Jersey	(55)	(70)	(26)	(151)	-	-	-	-	(144)	-	-	(28)	(144)	(172)	(467)
New Mexico	-	-	-	-	-	-	-	-	(425)	-	-	-	-	(77)	(502)
New York	29	-	25	54	-	-	-	-	54	-	35	-	500	535	589
North Carolina	208	170	141	519	21	77	711	809	1,328	-	18	3	854	875	2,203
North Dakota	(17)	(128)	(20)	(165)	-	-	-	(293)	(458)	-	-	-	-	(683)	(1,141)
Ohio	(28)	(16)	(24)	(68)	-	-	-	(25)	(124)	-	-	-	(200)	(200)	(324)
Oklahoma	336	54	261	651	-	-	-	-	651	-	-	-	1,579	1,579	2,230
Oregon	(43)	(12)	(40)	(95)	-	-	-	-	(60)	(155)	(2)	(5)	(600)	(607)	(762)
Pennsylvania	(72)	(72)	(58)	(202)	-	-	-	-	(383)	(585)	-	-	(333)	(333)	(918)
Rhode Island	-	-	-	-	-	-	-	-	(566)	(3)	(4)	(3)	(1,066)	(1,066)	(1,532)
South Carolina	(12)	(6)	(16)	(34)	-	-	-	(51)	(85)	-	-	-	(111)	(111)	(196)
South Dakota	(23)	(98)	(2)	(123)	-	-	-	(149)	(272)	-	(1)	-	(469)	(470)	(742)
Tennessee	(14)	(33)	(5)	(53)	-	-	-	(35)	(88)	-	-	-	(327)	(327)	(615)
Texas	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Utah	522	196	215	933	-	-	-	-	933	-	-	-	3,255	3,255	4,188
Vermont	-	-	-	-	-	-	-	-	(58)	-	-	-	(120)	(120)	(178)
Virginia	(26)	(37)	(17)	(80)	-	-	-	(98)	(178)	-	-	-	(91)	(91)	(269)
Washington	26	49	62	137	-	-	213	213	350	-	2	-	877	879	1,229
West Virginia	(58)	(124)	(50)	(232)	-	-	-	(386)	(618)	-	(6)	-	(257)	(263)	(1,081)
Wisconsin	32	-	49	81	-	-	-	-	81	-	-	-	220	220	301
Wyoming	(75)	(150)	(55)	(280)	-	-	10	(131)	(411)	-	-	16	(675)	(675)	(1,086)
District of Columbia	38	3	47	88	-	-	-	-	98	-	-	4	165	185	283
District of Columbia	(6)	(26)	(4)	(36)	-	-	(45)	(81)	-	-	-	-	(77)	(77)	(158)
Totals for States fully classified	2,364	1,662	1,672	5,698	82	432	3,167	3,681	9,379	21	100	41	14,284	14,446	21,825
Estimated grand totals	4,418	3,908	3,574	11,900	180	983	8,372	9,535	21,435	27	150	82	30,620	30,879	52,314

1/ Detail figures reported by the several State highway departments. Items shown in parentheses are not included in fully classified totals since a complete classification was not given by the State.

naire at all and one other state could not supply any data, so that it was necessary to make complete estimates for these states. In spite of these and perhaps other shortcomings it is believed that the present inventory of state highway engineering manpower is about as accurate as can be obtained.

### NUMBER OF ENGINEERING EMPLOYEES

Tables 1 and 2 present the results of the 1956 study of state highway department engineering manpower in summary form. As shown in Table 1, the estimated total number of engineering employees as of March 1, 1956, was 46,462, consisting of 20,551 employees classified as engineers and 25,911 employees classified as engineering aids. The ratio of aids to engineers was therefore 1.26.

According to Table 2, the corresponding estimated total number of engineering employees as of July 1, 1956, was 52,314, consisting of 21,435 engineers and 30,879 aids. The increase in total engineering employees, then, was 12.6 percent; engineers and aids increased 4.3 and 19.2 percent, respectively. The ratio of aids to engineers increased to 1.44.

Table 3 presents summary information on engineers and aids employed. Although the July figures show substantial increases over those of March, it must be remembered that these can be attributed in large part to temporary employees hired for the summer construction season only. Also, some of the increases estimated by the states may reflect some wishful thinking. Several states did not estimate increases, and one showed an estimated decrease, for the period indicated.

It is obvious that additional technical talent should be obtained to modernize our highway plant, but finding and keeping such talent is another matter indeed. Several states mentioned during the course of the study that they are losing engineers faster than they are recruiting them. Maine, for example, lost 24 members of its engineering staff between January and October; three of these retired, but the rest went to private industry. To replace them the state has been able to recruit only one engineering aid (a college graduate just returned from service) and three high school graduates. Similarly, New Hampshire lost more than 15 engineering employees during the early part of 1956.

Table 4 shows the number of engineering employees assigned to maintenance work. Some states did not complete this part of the form, but estimates have been made for the missing information. The total of 1,298 engineers as of March 1, 1956 is approximately 13 percent greater than the 1,151 reported by Campbell and Schureman for 1954. Total engineering employees assigned to maintenance as of March 1, 1956 was 2,082 as compared with 2,164 for July 1, 1956.

The information pertaining to consultants shown in Table 1 (similar information is not included in Table 2 because only one figure was requested for consultants) is also open to some question. Some of the states reported the number of consulting firms retained rather than the equivalent engineering employees, and some did not report this item at all. Accordingly, the engineering effort expended through consultants is undoubtedly greater than that indicated.

The data reported as to the number of engineers and aids employed by the state highway departments, however, is probably as good as can be obtained in view of the widely varying employee classification plans of the several states. The total number of engineering aids has not been reported in recent years, so far as is known, and the total number of engineers is believed to be a better figure than has been available previously.

For purposes of comparison, and to emphasize the uncertainty which has existed with respect to the number of engineers employed by state highway departments, Table 5 shows the number of engineers reported as employed by the state highway departments in a number of previous studies. It should be noted that Danner's data as of December 31, 1955, compare favorably with the March 1, 1956, figures of this study in total, although wide variations exist in individual states. New Mexico and Utah are two cases in point; in each case the figures reported to Danner are approximately three times as large as those reported to the Highway Research Board only two months later.

Table 3.--State highway department engineering personnel

State	March 1, 1956			July 1, 1956		
	Engineers	Aids	Total	Engineers	Aids	Total
Alabama	-	-	-	544	957	1,501
Arizona	56	504	560	60	679	739
Arkansas	137	387	524	161	405	566
California	-	-	-	3,717	1,672	5,389
Colorado	329	438	767	329	488	817
Connecticut	713	235	948	-	-	-
Delaware	-	-	-	45	183	228
Florida	352	1,183	1,535	-	-	-
Georgia	581	1,237	1,818	626	1,553	2,179
Idaho	139	453	592	152	500	652
Illinois	1,054	151	1,205	1,075	251	1,326
Indiana	360	169	529	377	235	612
Iowa	222	745	967	222	745	967
Kansas	310	562	872	327	750	1,077
Kentucky	577	584	1,161	577	746	1,323
Louisiana	305	924	1,229	315	964	1,279
Maine	170	57	227	-	-	-
Maryland	390	373	763	-	-	-
Massachusetts	600	1,064	1,664	610	1,200	1,810
Michigan	499	800	1,299	498	1,000	1,498
Minnesota	605	635	1,240	605	650	1,255
Mississippi	106	590	696	114	590	704
Missouri	643	725	1,368	-	-	-
Montana	204	283	487	246	413	659
Nebraska	241	225	466	255	300	555
Nevada	-	-	-	-	-	-
New Hampshire	215	120	335	295	172	467
New Jersey	425	77	502	425	77	502
New Mexico	48	520	568	54	535	589
New York	-	-	-	1,328	875	2,203
North Carolina	448	608	1,056	458	683	1,141
North Dakota	119	45	164	124	200	324
Ohio	651	1,306	1,957	651	1,579	2,230
Oklahoma	140	568	708	155	607	762
Oregon	509	278	787	585	333	918
Pennsylvania	526	1,055	1,581	566	1,066	1,632
Rhode Island	85	109	194	85	111	196
South Carolina	264	445	709	272	470	742
South Dakota	84	363	447	88	527	615
Tennessee	-	-	-	-	-	-
Texas	913	2,755	3,668	933	3,255	4,188
Utah	55	99	154	58	120	178
Vermont	159	46	205	178	91	269
Virginia	347	765	1,112	350	879	1,229
Washington	613	368	981	618	463	1,081
West Virginia	81	191	272	81	220	301
Wisconsin	393	349	742	411	675	1,086
Wyoming	93	165	258	98	185	283
District of Columbia	81	77	158	81	77	158
Totals for States reporting	14,842	22,633	37,475	18,749	27,481	46,230
Estimated grand totals	20,551	25,911	46,462	21,435	30,879	52,314

Table 4.--State highway department engineering employees assigned to maintenance

State	March 1, 1956			July 1, 1956		
	Engineers	Aids	Total	Engineers	Aids	Total
Alabama	-	-	-	-	-	-
Arizona	-	-	-	-	-	-
Arkansas	28	-	28	37	-	37
California	-	-	-	71	-	71
Colorado	-	-	-	-	-	-
Connecticut	-	-	-	-	-	-
Delaware	-	-	-	5	7	12
Florida	33	-	33	-	-	-
Georgia	27	5	32	27	5	32
Idaho	42	-	42	42	-	42
Illinois	85	1	86	85	10	95
Indiana	21	16	37	21	25	46
Iowa	36	-	36	36	-	36
Kansas	11	-	11	11	-	11
Kentucky	30	-	30	30	-	30
Louisiana	46	-	46	46	-	46
Maine	2	-	2	-	-	-
Maryland	26	-	26	-	-	-
Massachusetts	53	37	90	53	37	90
Michigan	17	-	17	17	-	17
Minnesota	20	-	20	20	-	20
Mississippi	10	41	51	10	41	51
Missouri	36	-	36	-	-	-
Montana	11	-	11	12	-	12
Nebraska	-	-	-	-	-	-
Nevada	-	-	-	-	-	-
New Hampshire	12	-	12	18	-	18
New Jersey	6	-	6	6	-	6
New Mexico	11	10	21	11	10	21
New York	-	-	-	131	20	151
North Carolina	36	48	84	36	48	84
North Dakota	6	-	6	6	-	6
Ohio	35	26	61	35	26	61
Oklahoma	11	-	11	11	-	11
Oregon	27	2	29	27	2	29
Pennsylvania	28	-	28	30	-	30
Rhode Island	4	-	4	4	-	4
South Carolina	54	-	54	54	-	54
South Dakota	1	-	1	1	-	1
Tennessee	-	-	-	-	-	-
Texas	17	300	317	17	300	317
Utah	7	6	13	7	6	13
Vermont	23	1	24	25	1	26
Virginia	-	-	-	-	-	-
Washington	9	-	9	9	-	9
West Virginia	15	90	105	15	90	105
Wisconsin	21	33	54	21	50	71
Wyoming	5	-	5	5	-	5
District of Columbia	2	-	2	2	-	2
Totals for States reporting	864	616	1,480	994	678	1,672
Estimated grand totals	1,298	784	2,082	1,336	828	2,164

Table 5.--Comparison of number of engineers reported employed  
by State highway departments in recent years

State	Highway Research Board March 1, 1956		Prof. Danner Dec. 31, 1955	Campbell- Schureman 1954 1/	Information from State highway departments 1950
	Civil graduate and/or registered	Total engineers			
Alabama	-	-	403	403	665
Arizona	53	56	53	59	504
Arkansas	88	137	120	69	233
California	-	-	3,451	3,388	2,462
Colorado	158	329	328	147	248
Connecticut	156	713	402	163	526
Delaware	-	-	70	67	52
Florida	149	352	693	137	540
Georgia	185	581	524	329	993
Idaho	104	139	130	63	75
Illinois	842	1,054	1,002	1,131	857
Indiana	350	360	368	316	312
Iowa	222	222	336	360	212
Kansas	266	310	317	338	364
Kentucky	245	577	617	252	1,047
Louisiana	305	305	309	276	284
Maine	126	170	174	68	125
Maryland	79	390	350	165	397
Massachusetts	-	2/ (600)	702	742	877
Michigan	294	499	601	407	572
Minnesota	379	605	530	247	466
Mississippi	87	106	111	111	259
Missouri	380	643	702	470	491
Montana	93	204	214	85	145
Nebraska	125	241	239	245	230
Nevada	-	-	89	76	65
New Hampshire	117	215	237	200	103
New Jersey	-	2/ (425)	420	479	551
New Mexico	48	48	124	73	132
New York	-	-	1,377	1,839	1,856
North Carolina	161	448	437	284	2,726
North Dakota	63	119	63	61	61
Ohio	651	651	636	654	537
Oklahoma	87	140	115	115	222
Oregon	161	509	495	452	656
Pennsylvania	106	526	480	300	235
Rhode Island	34	85	73	43	198
South Carolina	117	264	241	230	200
South Dakota	49	84	91	79	87
Tennessee	-	-	216	560	366
Texas	913	913	922	875	1,904
Utah	-	2/ (55)	175	78	176
Vermont	81	159	158	153	50
Virginia	134	347	360	376	500
Washington	230	613	966	206	256
West Virginia	81	81	226	76	399
Wisconsin	262	393	398	422	328
Wyoming	83	93	92	74	204
District of Columbia	36	81	92	48	114
Totals for States reporting to Highway Research Board	8,100	13,762	-	-	-
Totals including estimates	11,419	20,551	21,229	17,791	24,862

1/ Registered professional engineers or those qualified to register.

2/ Not included in totals for States reporting since information as  
to graduates or registered was not reported.

## GRADUATE AND REGISTERED ENGINEERS

Referring again to Tables 1 and 2, of the 20,551 engineers employed as of March 1, 1956, approximately 21 percent were both civil engineering graduates and registered civil engineers. An additional 17 percent were registered civil engineers but were not civil engineering graduates, and another 18 percent were civil engineering graduates but not registered civil engineers. Still another 5 percent were graduates of or registered in branches of engineering other than civil, so that approximately 39 percent of all employees classified as engineers were neither registered engineers nor engineering graduates. A similar situation exists with respect to engineers employed as of July 1, 1956, but since the July figures are based on estimates, they are probably of less interest than the March figures.

Including those classified as engineers and also those classified as aids, 9,195 engineering graduates were employed by the 48 state highway departments and the District of Columbia as of March 1, 1956. Of this total, 8,068 were civil engineering graduates and 1,127 were engineering graduates in branches other than civil. In the past it was the practice in many states to employ young graduate engineers as engineering aids during their initial assignments, and apparently about one-third of the states still follow this procedure to some degree, as 126 of the engineering graduates employed were classified as aids.

Table 6 shows for each state the percentage of graduate and registered civil engineers included in the total number of classified engineers employed. Only 38.6 percent of the total classified engineers employed by all states are graduate civil engineers, and only 37.8 percent are registered civil engineers; the percentages for individual states vary from 10.5 to 97.2 in the case of graduate engineers and from 8.3 to 100 percent in the case of registered engineers. The columns of Table 6 are non-additive, because some engineers are both graduates and registered, but from Table 1 it can be seen that only 55.6 percent of all classified engineers employed are civil engineering graduates and/or registered civil engineers; probably this is one of the most significant findings of the present study.

There seems to be little relation between the percentage of civil engineering graduates and either the amount of capital outlay or the geographical location of a particular state. Texas, for example, has one of the highest percentages of graduate civil engineers, 76.5, whereas Pennsylvania has one of the lowest, 10.5; Ohio, adjacent to Pennsylvania, shows a percentage of 59.9. Of the states with low capital outlays, Maine, for example, has 56.5 percent graduate civil engineers, but Montana has only 14.2 percent. Similarly, there appears to be little relation between the percentage of registered civil engineers and either the amount of capital outlay or geographical location.

It is interesting to note that in three states (Louisiana, New Mexico, and West Virginia) 100 percent of the employees classified as engineers are registered civil engineers. In these same states the percentages of graduate civil engineers are 26.2, 54.2, and 39.5, respectively. Several other states show more than 90 percent of their engineer employees as registered, and probably require registration as a prerequisite to classification as an engineer, except in the case of young graduate engineers without the experience necessary for registration.

## RATIO OF AIDS TO ENGINEERS

As stated previously, the ratio of aids to engineers for state highway department engineering employees was 1.26 in March 1956 and 1.44 in July. There were wide variations among the states, as shown in Table 7. In March the variation was from 10.83 in New Mexico to 0.14 in Illinois, and in July it was from 11.32 in Arizona to 0.18 in New Jersey. Unfortunately there is no obvious explanation for these wide variations.

A regional pattern is apparent, however, as indicated by Tables 8 and 9. In March the New England, Middle Atlantic, East North Central and Pacific regions each employed more engineers than aids, whereas in each of the other regions the reverse was true. In July the same situation prevailed, except in the case of the East North Central region, which then employed more aids than engineers although the ratio of aids to



Table 6.--Percentages of graduate and registered civil engineers  
among total classified engineers employed

As of March 1, 1956

State	Graduate civil engineers		Registered civil engineers	
	Number <u>1/</u>	Percentage	Number <u>1/</u>	Percentage
Alabama	-	-	-	-
Arizona	30	54.6	53	94.6
Arkansas	52	38.0	78	56.9
California	-	-	-	-
Colorado	38	11.6	140	42.6
Connecticut	116	16.3	81	11.4
Delaware	-	-	-	-
Florida	114	32.4	92	26.1
Georgia	93	16.0	150	25.8
Idaho	68	48.9	69	49.6
Illinois	639	60.6	509	48.3
Indiana	350	97.2	270	75.0
Iowa	130	58.6	204	91.9
Kansas	152	49.0	243	78.4
Kentucky	97	16.8	210	36.4
Louisiana	80	26.2	305	100.0
Maine	96	56.5	93	54.7
Maryland	43	11.0	43	11.0
Massachusetts	-	-	-	-
Michigan	263	52.7	138	27.7
Minnesota	233	38.5	342	56.5
Mississippi	66	62.3	81	76.4
Missouri	243	37.8	264	41.1
Montana	29	14.2	80	39.2
Nebraska	55	22.8	97	40.2
Nevada	-	-	-	-
New Hampshire	95	44.2	65	30.2
New Jersey	-	-	-	-
New Mexico	26	54.2	48	100.0
New York	-	-	-	-
North Carolina	141	31.5	37	8.3
North Dakota	39	32.8	52	43.7
Ohio	390	59.9	597	91.7
Oklahoma	49	35.0	77	55.0
Oregon	113	22.2	104	20.4
Pennsylvania	55	10.5	75	14.3
Rhode Island	18	21.2	28	32.9
South Carolina	115	43.6	25	9.5
South Dakota	43	51.2	20	23.8
Tennessee	-	-	-	-
Texas	698	76.5	737	80.7
Utah	-	-	-	-
Vermont	64	40.3	44	27.7
Virginia	72	20.7	87	25.1
Washington	180	29.4	107	17.5
West Virginia	32	39.5	81	100.0
Wisconsin	212	53.9	120	30.5
Wyoming	38	40.9	80	86.0
District of Columbia	32	39.5	10	12.3
Totals for States reporting	5,399	39.2	5,936	43.1
Estimated grand totals	7,942	38.6	7,764	37.8

1/ Columns one and three are not additive since 4,287 engineers are both graduates and registered.

Table 7.--Ratio of aids to engineers among State highway department employees

State	March 1, 1956	July 1, 1956
Alabama	-	1.76
Arizona	9.00	11.32
Arkansas	2.82	2.52
California	-	0.45
Colorado	1.33	1.48
Connecticut	0.33	-
Delaware	-	4.07
Florida	3.36	-
Georgia	2.13	2.48
Idaho	3.26	3.29
Illinois	0.14	0.23
Indiana	0.47	0.62
Iowa	3.36	3.36
Kansas	1.81	2.29
Kentucky	1.01	1.29
Louisiana	3.03	3.06
Maine	0.34	-
Maryland	0.96	-
Massachusetts	1.77	1.97
Michigan	1.60	2.01
Minnesota	1.05	1.07
Mississippi	5.57	5.18
Missouri	11.13	-
Montana	1.39	1.68
Nebraska	0.93	1.18
Nevada	-	-
New Hampshire	0.56	0.58
New Jersey	0.18	0.18
New Mexico	10.83	9.91
New York	-	0.66
North Carolina	1.36	1.49
North Dakota	0.38	1.61
Ohio	2.01	2.43
Oklahoma	4.06	3.92
Oregon	0.55	0.57
Pennsylvania	2.01	1.88
Rhode Island	1.28	1.31
South Carolina	1.69	1.73
South Dakota	4.32	5.99
Tennessee	-	-
Texas	3.02	3.49
Utah	1.80	2.07
Vermont	0.29	0.51
Virginia	2.20	2.51
Washington	0.60	0.75
West Virginia	2.36	2.72
Wisconsin	0.89	1.64
Wyoming	1.77	1.89
District of Columbia	0.95	0.95
Totals	1/ 1.26	1/ 1.44

1/ Includes estimates for States not reporting information.

ratio was 0.38 in March and 1.61 in July, but South Dakota's was 4.32 in March and 5.99 in July. In general, the highly populated regions employed more engineers than aids, although some of the highly populated states within these regions employed more aids than engineers.

It might be noted that the July ratios of aids to engineers showed slight decreases over the March ratios in five states (Arkansas, Mississippi, New Mexico, Oklahoma, and Pennsylvania). In Illinois, Vermont, and Wisconsin, however, the July ratios were almost double those for March, and in North Dakota the July ratio was more than four times that for March.

Table 8.-- Ratio of aids to engineers among State highway department engineering employees by region

As of March 1, 1956

Region	Number of engineers	Number of aids	Ratio of aids to engineers
New England	1,942	1,631	0.84
Middle Atlantic	2,224	1,819	0.82
East North Central	2,957	2,775	0.94
West North Central	2,224	3,300	1.48
South Atlantic	2,587	5,023	1.94
East South Central	1,429	2,209	1.55
West South Central	1,495	4,634	3.10
Mountain	1,009	2,562	2.54
Pacific	4,684	1,958	0.42
Total	20,551	25,911	1.26

Table 9.-- Ratio of aids to engineers among State highway department engineering employees by region

As of July 1, 1956

Region	Number of engineers	Number of aids	Ratio of aids to engineers
New England	2,088	1,929	0.92
Middle Atlantic	2,319	2,018	0.87
East North Central	3,012	3,740	1.24
West North Central	2,291	4,053	1.77
South Atlantic	2,686	5,801	2.16
East South Central	1,469	2,597	1.77
West South Central	1,564	5,231	3.34
Mountain	1,086	3,042	2.80
Pacific	4,920	2,468	0.50
Total	21,435	30,879	1.44

engineers in this region was still below the national average. The variations among regions are not nearly so extreme as those among states.

In the individual regions there were some states which did not fall into the pattern of their regions. In the West North Central region, for example, which in March employed 1.48 aids per engineer and in July 1.77, North Dakota's

## CONCLUSION

This 1956 inventory of engineering manpower was undertaken primarily to obtain an accurate tabulation of the engineers and aids employed by the several state highway departments. In view of uncertainties which existed in connection with previous studies,

ERRATUM

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Manpower Potentials in Highway Engineering

\* \* \* \*

In the paper "1956 Inventory of State Highway Engineering Manpower," by James A. Montgomery, Table 7, page 10, the March 1, 1956, value for Missouri should be 1.13 instead of 11.13 as shown. This change does not affect the column total.

it was felt that such a summary was necessary as a basis for further studies of manpower requirements in connection with the ever-expanding highway program.

It is believed that the data presented satisfy these requirements. As already noted, a few states did not furnish complete information, so that some estimates had to be made. Also, there may be certain inconsistencies or inaccuracies inherent in the data because of the different classification plans in use by the several states, the lack of standard definitions for engineers and aids, and the complexities of the professional engineering registration laws in the different states. Nevertheless, the picture portrayed is probably as good a one as can be obtained in view of the existing difficulties.

The analysis of the ratio of aids to engineers is in a sense beyond the scope of an inventory. It was undertaken in an effort to increase the value of the basic information. The wide variations which exist among the states cannot be explained at this time, but do suggest the need for additional detailed studies, perhaps in the individual states. They also furnish the states with information which should be useful for comparative purposes.

It has been pointed out that a regional pattern exists with respect to the ratio of aids to engineers, and the tentative conclusion of an earlier study that a combination of aids and engineers is the best indication of engineering effort has been confirmed. Both of these are significant findings. With the continuing cooperation of the states, they can be further explored to a point where it can be determined whether or not a particular state is making the best possible use of its engineering manpower.

#### REFERENCES

1. Campbell, M. Earl and Schureman, L. R. , "Engineering Personnel Needs for Highway Departments." Highway Research Board Bulletin 106 (1955).
2. Lewis, R. S. , "A Six-State Classification Study of Engineering Personnel." Public Roads, Vol. 29, No. 2 (June 1956).

## Appendix A

Highway Research Board  
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Washington 25, D. C.

### SUMMARY OF ENGINEERING EMPLOYEES

Please read accompanying instructions carefully before completing form.

**A. Employees Classified as Engineers:**

	3/1/56 (Actual)*1 Total: Mtnce : Only	7/1/56 (Estimated)*2 Total: Mtnce : Only
1. Both a civil engineering graduate and registered as a civil engineer	: ( )	: ( )
2. Civil engineering graduate only, but not registered	: ( )	: ( )
3. Registered only, (as a civil engineer)	: ( )	: ( )
4. Neither a civil engineering graduate nor registered as a civil engineer. (These may be registered in other branches.)	: ( )	: ( )
5. .... Grand totals	: ( )	: ( )
6. Of the employees classified as engineers (in item 4 above)		
a. How many are graduates from other branches of engineering, or other sciences ( ), and how many of these are registered ( )		
b. How many are doing design or other work requiring the exercise of independent engineering judgment, i.e., are in "responsible charge", as opposed to high-grade inspecting, surveying, and similar work? ( )		

**B. Employees Classified as Engineering Aids or Equivalent:**

	3/1/56 (Actual)	7/1/56 (Estimated)
1. Both a civil engineering graduate and registered	: ( )	: ( )
2. Civil engineering graduate only	: ( )	: ( )
3. Registered only	: ( )	: ( )
4. Neither a civil engineering graduate nor registered	: ( )	: ( )
5. .... Grand totals	: ( )	: ( )

**C. Remarks:**

**D. Number of equivalent consulting engineers employed** : ( )

\*1. See instructions.

\*2. Show breakdown if available - otherwise total only.

**INSTRUCTIONS FOR SUMMARY OF ENGINEERING EMPLOYEES**  
(Include both permanent and temporary employees)

Recent studies of state highway department employees have, because of non-uniformity in the method of reporting used, made it difficult to determine the number of employees in each of the various classes. It is the purpose of the attached form to obtain information based on a uniform system of classification for the different categories of engineers and for sub-professional people as well. Actual data as of March 1, 1956 and estimated data as of July 1, 1956 are requested.

Most States have graded classification plans for engineering employees, i.e., Engineer I, II, III, IV, V, etc., or Junior Engineer, Assistant Engineer, etc., and should report under the first major heading of the form all employees classified as engineers by such plans. In those States which do not have a graded classification plan, job titles may be related to specific duties, i.e. junior engineer of final plans, senior instrumentman, junior designer, senior designer, etc., and the job titles which are included in the engineering category will be a matter of judgment.

States with graded classification plans usually classify their sub-professional employees as Engineering Aid I, II, III, etc., or A, B, C, etc., and these should be reported under the second major heading of the form, "Employees classified as engineering aids or equivalent." For States without a graded classification plan, such titles as rodman, chainman, instrumentman, laboratory assistant, inspector, computer, draftsman, etc. should be included here. In any event, all technical employees should be included under one of the two major headings.

Under each heading, provision is made for indicating the professional qualifications of the employees included in the March 1 tabulation. The first line will include those employees who are both civil engineering graduates and also registered professional engineers, the second line those who are civil engineering graduates but not registered engineers, the third line those who are registered engineers but not civil engineering graduates, and the fourth line those who are neither. It is realized that there will be very few civil engineering graduates or registered engineers among the engineering aids, but in some States the item may be significant.

Also, since in relating the number of engineering employees to program or capital-outlay amounts it is desirable to exclude those employees assigned to maintenance, provision has been made for showing such employees separately in each case. Thus, if there are 653 employees in a particular category, and 87 of these are assigned to maintenance, the entry would be 653 (87).

Any necessary or desirable explanations of the data submitted can be made under the "Remarks" heading, and continued on the back of the form. The completed form should be forwarded to the Highway Research Board as soon after March 1 as is feasible.

**Purpose of Inventory:** (1) Determination of engineering requirements for construction and for maintenance; (2) To relate the requirements to an expanded construction and maintenance program; (3) To determine the number of aides required in terms of those classified as engineers; (4) To determine the best utilization of engineers.