Federal Lands Highway
Phase II Benchmarking Study

November 2000

Federal Highway Administration

PHASE II BENCHMARKING STUDY MEMBERSHIP

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IMPLEMENTATION STATEMENT

The Phase II Benchmarking Study recommendations contained in this report, have been provided to the FLH Leadership Team for their use. The Leadership Team will use this information as a basis for future staffing analysis as the program grows. They will also evaluate the appropriateness of implementing the State DOT's "recommended practices" as identified in this report.

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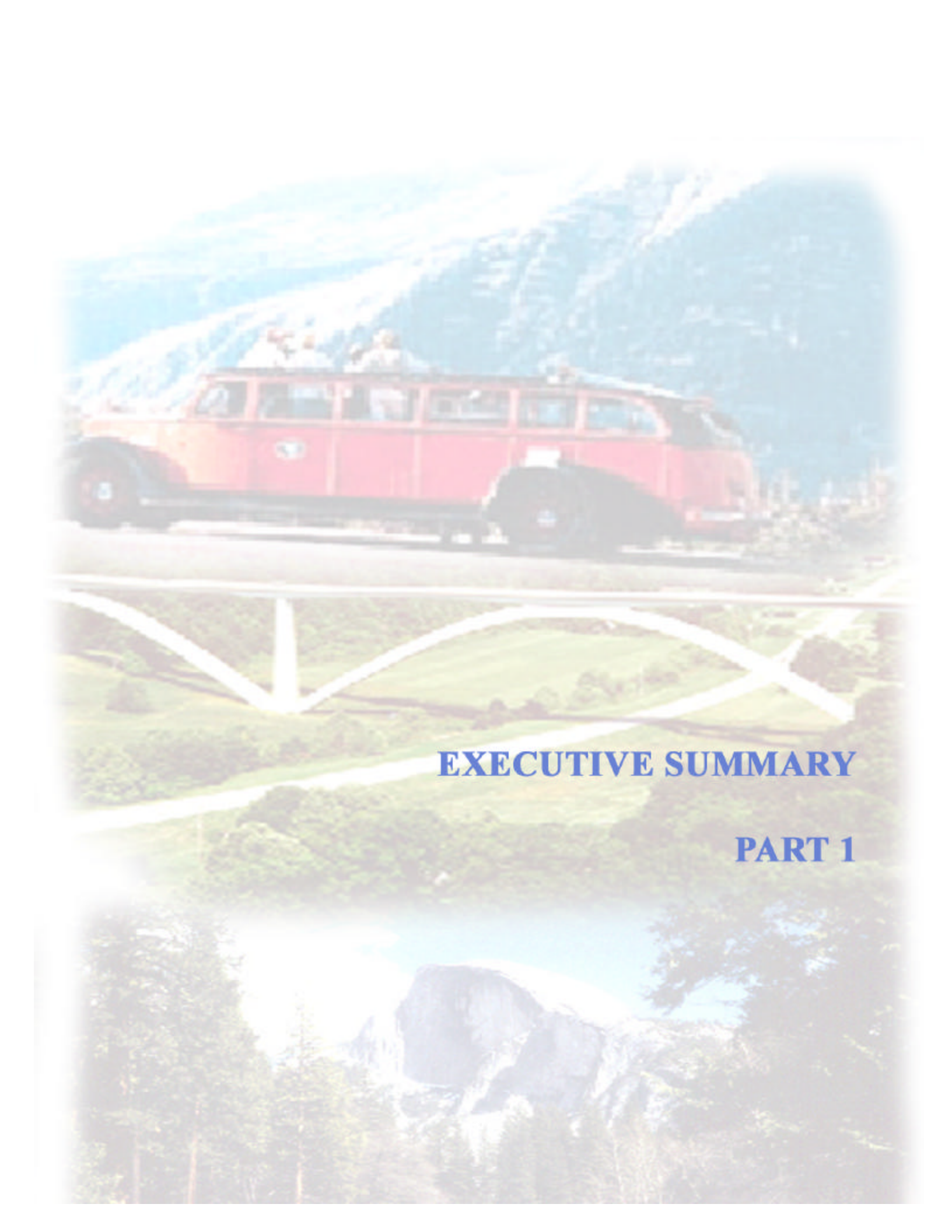


EXECUTIVE SUMMARY

PART 1

EXECUTIVE SUMMARY

Problem Statement

In order to determine the most effective use of existing and future staff, to quantify the appropriate number of engineers and technicians required to deliver the Federal Lands Highway Program and to identify recommended management practices in project delivery (preliminary engineering and construction engineering), the Federal Lands Highway (FLH) funded a study to evaluate and benchmark essential engineering operations of similar State DOT's and industry. This study was divided into three phases. Phase I was essentially a data collection activity. Phase II reviews the information from Phase I, enhances it with some recommended industry practices and recommends a staffing model for project delivery, to optimize the organization's ability to handle future workloads. Phase III of this study will consider implementing the recommendations from the Phase II analysis and will determine the appropriate number of support staff required for an effective, fully staffed FLH division.

Purpose

The purpose of this report is to:

1) Recommend minimum project delivery staffing levels for existing and increased program levels, and

2) Evaluate the information collected in Phase I for staffing recommendations, State DOT's and industry recommended practices.

Problem Approach

Phase I of the study focused mainly on internal and external data collection, establishing an FLH baseline of current staffing levels, the number of projects, employee training and development, consultant levels, and other pertinent information. The Phase I team interviewed eleven State DOT's who indicated that they contract out a substantial portion of their work. In addition to these States, two engineering consulting firms, CH2MHill and Project Time and Cost Consultants, were also interviewed. The study focused primarily on how these entities performed their design and construction management. The final Phase I report was published on September 25, 2000 and forms the basis for the Phase II analysis.

Phase II began by identifying the number and skill level of trained technical and professional employees needed to staff the project delivery portion of a generic FLH division. This core staff of engineers and technicians had to achieve five key objectives. These objectives are:

1) Deliver the FLH project delivery program,

2) Blend the social, environmental, economic and political philosophies of the Federal Land

Management agencies and Tribal governments into their unique highway infrastructures,

3) Maintain the ability to provide state-of-the-art technical assistance to Federal Land Management agencies, Tribal governments, Federal-aid,

4) Provide for training and development of FHWA and Federal Land Management Agencies (FLMA) employees, and

5) Maintain a sustainable and renewable supply of expert transportation engineers who can manage a diverse program of projects.

The information gathered by benchmarking with the State DOT's and consultants provided the Phase II team with information on alternative ways to manage contract services, insight into recruitment objectives, and highlighted some of the pitfalls of outsource contracting. These lessons learned were used to form and modify the basic assumptions used in the staffing models generated in this report.

Phase III of this study calls for the FLH Leadership Team to evaluate the recommendations contained in this report, and Phase I and to add the requirements for support functions, inherent government functions, succession planning and other considerations. The goal will be to define the requirements for a complete FLH organization for the future based on projections of program growth and new business requirements.

Assumptions

Various assumptions were made during the course of the Phase II benchmarking study. The most critical of these include:

<u>The FLH program will continue to increase.</u>
The Transportation Equity Act for the 21st Century (TEA-21) increased the Federal Lands Highway Program nearly 50 percent and there is a need and support for additional increases in the next legislation in the year 2003. In addition, various Tribal governments and several Federal Land Management agencies are using their influence to change existing program management and to add new programs to obtain funding from the Highway Trust Fund, which will increase the demand for FLH services. There is also evidence that many of the Tribal governments would like the FLH to have a more active engineering role in their transportation programs. To account for a range of potential program increases, model calculations were generated for Division construction program levels of $50, $100, $150, $250 and $350 million dollars. With the implementation of TEA-21 and the addition of several special projects, FLH construction awards have averaged nearly $70 million per division over the last two years. Based on current projections, the FY 2001 program is expected to average over $100 million per Division.

<u>Only the engineering activities described as Core Functions are evaluated in the report.</u>
The Core Functions contained are defined as twelve key activities necessary for a project delivery office. These specifically include: Roadway Design, Hydraulics, Project Management, Structural Design, Geotechnical, Environment, Construction Management, Survey & Mapping, Right-of-Way & Utilities, Materials, Safety, and Traffic Engineering. These core functions constitute

approximately **72 percent** of a Division office's staffing requirements. The definitions, staffing size, knowledge level, training, and composition of these core functions are described later in the report.

This report is based on the assumptions that the three field divisions will be maintained.

Reference Documents

Other sources of management, production, organization and staffing examples were used in the development of this report. Major emphasis was placed on tailoring the results to be in compliance with the FLH 2000 Futures Paper and the 1995 FLH Streamlining Task Force Report. Other significant documents include the 2000 Phase I Benchmarking Report, the Louisiana DOT In-House Versus Consultant Design Cost Study, the New Mexico Staffing Plan Survey of State Transportation Agencies, Wilbur Smith Staff /Recruiting/Retainage Study, CH2MHill and Time and Cost consultants interviews, and AOI Consulting experience.

Staffing Model

A cost-based computer model was developed to examine the optimum staffing level for a generic project delivery office. The model was created using the twelve core functions listed previously and is based on maintaining three Division offices. Staffing for the core functions was based on meeting the five key objectives mentioned earlier. Modifications to the staffing levels were made based on attrition rates and skill levels. Three levels of staff competency - Novice, Journey level and Senior Engineers - are described for each of the core functions. To validate assumptions, the model was evaluated against various State, consultant and FLH engineering staffing and production rates.

The following table describes the distribution of the staffing for the program delivery portion of a generic division office:

Table 1
Generic Division – Core Function Staffing Distribution

Program Delivery Core Functions	Novice	Journey level	Sr. Engineers	Total
Roadway Design	8	8	4	20
Hydraulics	1	1	1	3
Project Management	4	4	2	10
Structural Design	6	5	2	13
Geotechnical	4	4	2	10
Environment	4	4	2	10
Construction Management	12	12	6	30
Survey and Mapping	2	8	2	12
Right-of-way and Utilities	1	1	1	3
Materials	4	4	2	10
Safety	1	1	1	3
Traffic Engineering	1	1	1	3
Core Function Total	**48**	**53**	**26**	**127**

The staffing model indicates that 127 engineers and technicians are required to achieve the key objectives of production, providing value added customer support, technical assistance, training, and succession planning. Evaluation of the production output of this model indicates that the assembled team would be able to support an annual $40 million dollar construction award program while concurrently performing needed training and technical assistance functions.

Working from this base of 127 engineers and technicians, additional contract managers would need to be hired to address increased program levels. These contract managers would oversee Architect and Engineering (A&E) consultant contracts necessary to meet our program requirements. The graph on the following page shows the increase in the generic division staff as the program increases. The top line of the graph indicates the number of outsourced A&E contract staff that would be hired to help the core function staff meet the various construction program levels.

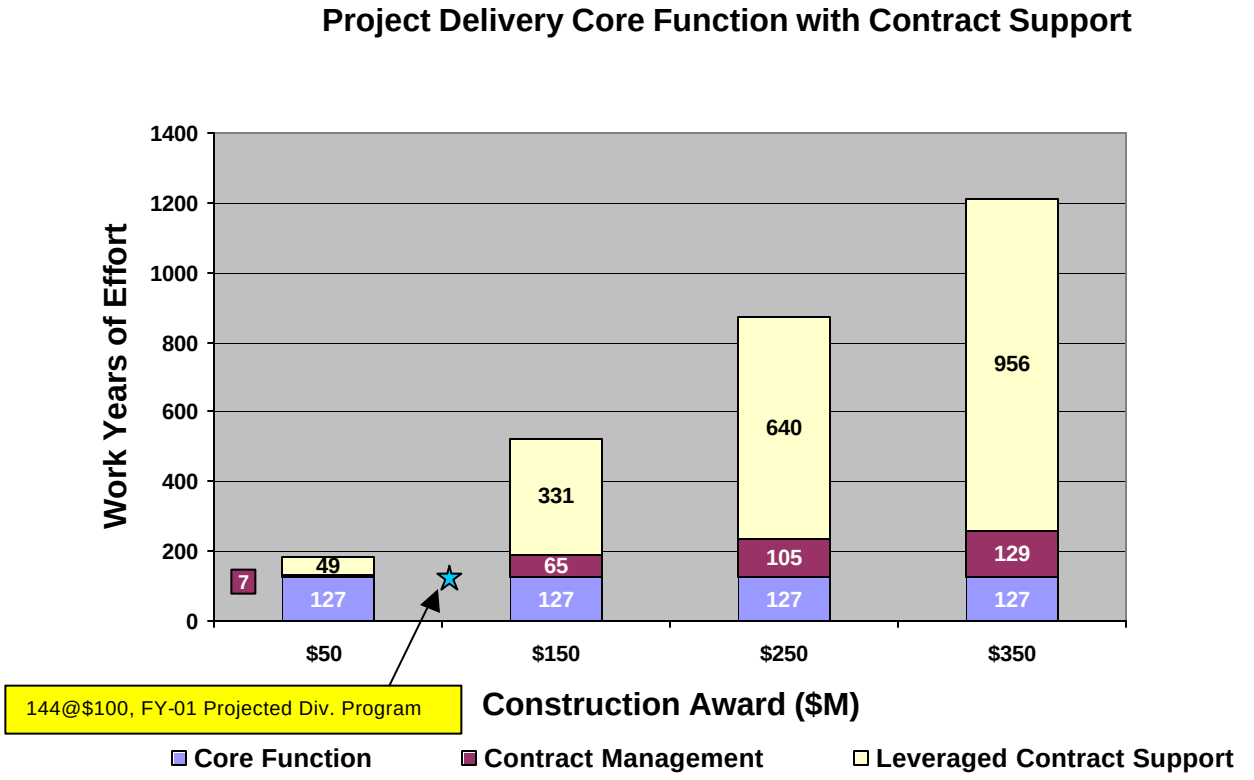


Figure 1 Accounts for only 72% of total Division FTE

For a given program size of $50 million, 183 work years of effort (134 government project delivery employees plus 49 A&E contractor support employees) would be required. The 134 government core function employees would consist of 127 employees dedicated to performing the five key objectives plus 7 contract management employees.

Initially, at the $50 million program level, the 7 contract management employees would add about 15 percent to the total FLH Division preliminary engineering costs for contract management and oversight. This percentage is within the range of oversight management that currently exists in the three division offices. As the program size increases, it is predicted that this percentage would steadily reduce to approximately 9 percent at the $350 million level. These savings would occur as a result of improvements in oversight procedures, experience gained in working repeatedly with specific A&E firms, and bundling of smaller or similar projects for efficiency. Analysis of the information obtained during the Phase I, State DOT's interviews supports this potential for improvement.

The importance of adding additional contract management staff, over and above the core staff, to properly administer outsourcing is one of the most important findings of this Benchmarking study. The following figure shows graphically how the outsource management staff numbers must grow with each increase in the size of the program. This figure also shows that as the program level increases, an outsource management development pool must be established to provide the necessary personnel to assure that the required number of Journey level and Senior engineers will always be available to replace experienced contract managers lost through attrition.

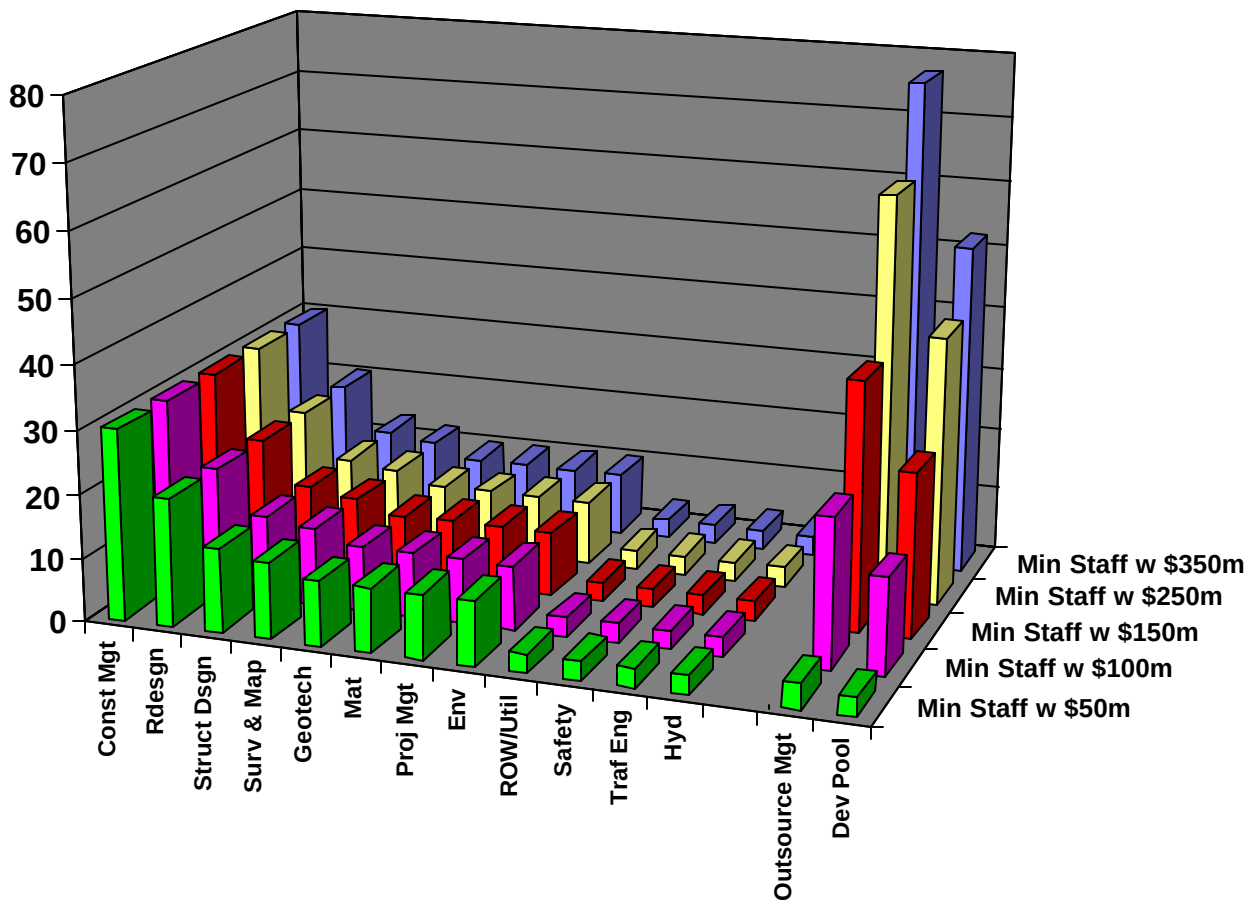


Figure 2

These staffing levels are based on minimum critical mass in each core function plus the minimum internal support to properly manage the outsourced engineering activities.

At present the three FLH Divisions average about 144 government employees delivering approximately $70 million dollars in construction contract awards with their average award in FY 2001 expected to exceed $100 million. At this $100 million program level, the model recommends 165 FTE without an adjustment for construction management as discussed in the report. Analyzing the difference in staffing suggests that several of the key objectives are being neglected. These include:

- Recruitment and training of novices,
- Technical assistance to Federal Land Management Agencies,
- Process improvements and quality control.

These staff shortages also result in overworked and stressed employees.

Out Source Percentages

The cost-based staffing model also determines the percentage of outsourced engineering services that is purchased as the generic division's program increases. The project delivery core function staff, working to accomplish all five key objectives, can deliver a base program level of $40 million dollars. As the program increases, the percentage of work to be outsourced increases dramatically until it approaches the 80 percent level. A division construction program level of $350 million corresponds to a State program of $1 billion. State DOT's with programs of that size that contract out large portions of their program, recommend limiting the amount of outsourced work to the 80 percent level. This recommendation is a caution against losing in-house expertise and the ability to provide quality control reviews of consultant's work.

Figure 3 below indicates the projected percentage of the total construction program engineering that a generic division will contract out in order to maintain core function expertise:

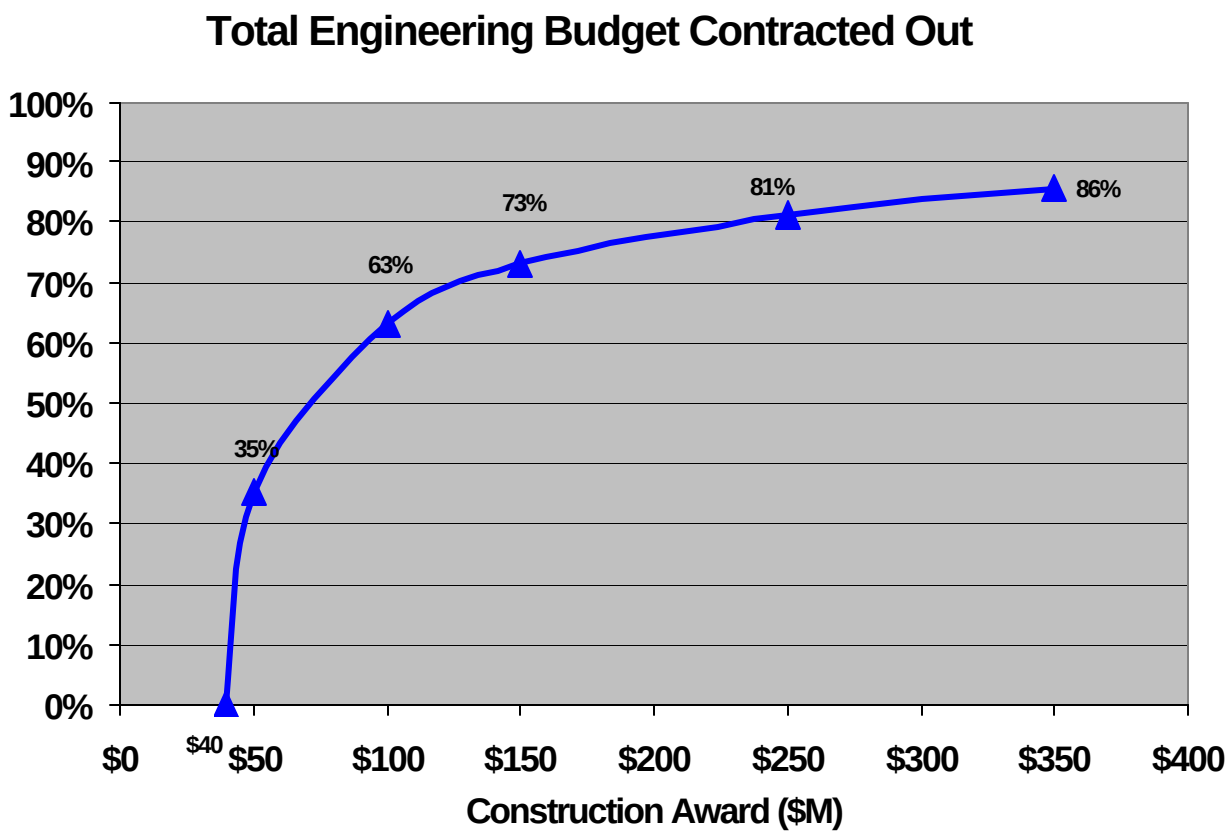


Figure 3

The three FLH field divisions have contracted out various amounts of their preliminary engineering and construction management for the past twenty years. This was done to meet project delivery deadlines and as a means for securing specific engineering specialty services. Since TEA-21 has increased our programs, the percentage of outsourced work has been increasing too. The percentage curve given in Figure 3 is based on the dollar amount of outsourced work divided by the engineering cost to deliver the entire program.

Findings

For a variety of reasons, (workforce shortages, legislative mandates, specialized expertise, program efficiencies, new perspectives), many State DOT's have chosen to contract out portions of their preliminary engineering and construction management. The FLH has benchmarked its production rates and performance practices against these States and against two engineering consulting firms.

While the FLH has been using consulting resources to meet program deadlines, the process has not given due consideration to maintaining a high level of internal technical expertise, maintaining an internal vibrant training program, or focusing on long-range succession planning. By blending the results of this benchmarking information with FLH's Business Plan, Futures Report and a variety of historical and technical reports, the computer model was developed to project the level of staffing,

recruitment and employee development necessary to successfully manage an increased program while also achieving the other key objectives.

The values given on the previous pages are derived and documented within the contents of the report. The report also contains additional recommended management practices extracted from the State DOT interviews and taken from various consulting engineering studies. The report emphasizes the importance of attracting top engineers and technicians and the importance of training, educating, and practicing family friendly policies to retain existing staff. The report offers recommendations on how to staff an office to efficiently handle a significant increase in workload through the proper training and deployment of contract program managers.

Critical Issues

There are three significant points made by the generic division staffing models.

- The first point is the need to increase the staff, even with significant contracting out, to continue to deliver the program and meet the five key objectives.

- The second is the importance of recruiting or attracting new technicians and engineers (novices) into the organization. With the 10 percent attrition rate, and approximately 3 percent more losses to FHWA than gains, the divisions need to focus on replacing 10 to 13 percent of their core work force every year. This number is much higher than FLH is currently attracting.

- The third point is to continue, possibly more aggressively, the technical and contract management training for the program managers who will enable the divisions to successfully deliver the larger programs through the effective use of outsoursing.

Phase III Issues

The FLH Leadership Team should consider the following issues during Phase III of this study:

- Determine the number of FTE and the percent of support services required as core functions to successfully achieve the five key objectives now and in the future.

- Consider Employee Retention, Recruitment and Training as critical in maintaining a quality organization that retains its' skills and expertise.

- Adjust core staffing levels to ensure meeting customer expectations (i.e. – make sure construction projects can be staffed to satisfy customer concerns.).

Subsequent to the Phase III evaluation, the FLH Leadership Team will need to also evaluate the following issues:

- Determine if, and to what extent, FLH should restructure to accomplish project delivery strategies.

- Develop a long term contingencies plan for increasing contracting out as needed to meet future ceiling/workload demands and determine ways to manage this increase and the associated risk.

- Develop a staffing strategy that assures FLH will always attract, internally develop and retain the required core number of quality personnel.

REPORT

PART 2

INTRODUCTION

The use of consulting engineering services for preliminary engineering and construction engineering inspection services has increased within the Federal Lands Highway (FLH) program over the last twenty years. Several organizational studies and program delivery process reviews have been performed over the years to evaluate the best method for balancing internal and out sourced resources. This report examines the results of these past internal studies, analyzes the internal procedures and practices of eleven State Departments of Transportation (DOT's), and examines other related practices of two major consulting firms to create a staffing model for the future FLH organization.

The assumptions used to create and modify the parameters used in the staffing model are based on current production rates and performance levels from the existing three FLH field divisions, the State DOT's and the consultants referenced in the report. The staffing model is for one generic division office with the assumption that there will be three divisions offices required to deliver the National program. Future production rates are modified by the assumption that various recommended practices will be implemented and that process improvements will result.

PURPOSE

In July 2000 the FLH Leadership charged the Phase II team to evaluate the future staffing needs for our organization. Specifically, the Phase II team was to:

- recommend minimum project delivery staffing levels for existing and increased program levels, and

- evaluate the information collected in Phase I for staffing recommendations, State DOT's and industry recommended practices.

This report is meant to focus on the project delivery functions of the Federal Lands Highway program. The activities that comprise project delivery, preliminary engineering and construction engineering, are defined as **core functions** within this report. The specific activities and characteristics of these core functions are explained in detail later in the report. Within these core functions, we need to provide adequate staffing levels to maintain the expertise to add value and provide quality service to our partner agencies. The purpose of this report is not to examine how we should reorganize. It is intended to identify strategies to strengthen our skills and enhance needed expertise. While we recognize that our program level will likely see a substantial increase in the future, the question to be answered is, "What is the right balance between internal capabilities and external outsourcing?" This report examines what similar agencies are doing and how their staffing decisions have impacted their ability to deliver quality programs in an economical manner. The findings of this report can serve as a foundation for staffing, recruitment and training efforts for FLH over the next two decades.

BACKGROUND

The Federal Lands Highway (FLH) organization is one of the Core Business Units within the Federal Highway Administration of the U.S. Department of Transportation. The FLH administers a program of road and related transportation improvements including emergency relief and defense road needs serving federally owned lands. The FLH responsibilities also include actual design and construction supervision of highway projects. The program is administered in accordance with various sections of 23 U.S.C, legislative and executive mandates and interagency agreements for program administration, and for providing transportation planning, engineering, technical and contract services. The FLH program output includes roads, bridges and the administration of programs for the improvement and maintenance of roads providing access to and within Federal and Tribal lands.

The FLH uses quality management principles to guide their organization. The FLH Leadership Team coordinates its program on a national basis. The FLH Leadership Team has developed the following vision, mission and core business statement for the FLH program:

FLH VISION

"Create the best transportation system in balance with the values of Federal and Tribal lands."

FLH MISSION

"We continually improve transportation access to and within Federal and Tribal lands, and provide technical services to the highway community."

FLH CORE BUSINESS STATEMENT

"We are an organization of people dedicated to excellence through:

- Program administration;
- Being the provider of choice in the development and delivery of quality transportation products and services;
- Enhancing transportation expertise through training and technical support;
- Development and dissemination of technology."

The vision, mission and core business statement create a foundation upon which many of the recommendations contained in this study are based.

Phase I of the Benchmarking Study

On March 21, 2000, the FLH Leadership Team established a Benchmarking Team to identify recommended practices for staffing and managing consultants to develop and deliver a highway program. The team consisted of representatives from each of the three field divisions and the FLH headquarters office. Phase I of the study focused mainly on internal and external data collection, establishing an FLH baseline of current staffing levels, numbers of projects, employee training and development programs, consultant levels, and other pertinent information.

To collect information on State/consultant activities, the team with the FLH Leadership Team guidance developed a plan to query 14 State Departments of Transportation. The team developed a list of 16 questions and submitted them to the states for response. Of the 14 States, 12 responses were received. The team then visited 11 of the States to discuss their responses and to establish a rapport for future benchmarking efforts.

It should be noted that the focus of this data collection effort centered around the following factors specifically articulated by the FLH Leadership Team:

- Level of contracting out with an increase in program;
- Identification of a critical mass of internal employees necessary to support the organization's mission;
- The ability to maintain technical expertise;
- A cost effective approach to program delivery;
- The ability to train and develop new and existing employees; and
- Ability to deliver a quality product efficiently to meet Federal Land Management Agency expectations, to be their provider of choice.

In addition to these States, two engineering consulting firms; - CH2MHill and Project Time and Cost Consultants - were also interviewed. The consultant interviews focused primarily on how they performed their planning, preliminary design, construction management and project scheduling.

The final Phase I report was published in September 2000 and forms the primary basis for the Phase II analysis.

Phase II of the Benchmarking Study

In Phase II of the study, a new team was established in July 2000 to evaluate and analyze the information collected from the Phase I study, the 1995 FLH Streamlining Task Force Report, the FLH FY2000 Futures Paper and several other reports and studies. (See the Bibliography in the Appendix for a complete list of references.) This phase also included benchmarking FLH's practices with State DOT's and consultants. Recommended practices are identified related to staffing, maintaining technical expertise, managing consultants, and quality assurance. Phase II will also recommend staffing levels FLH needs to manage various program levels. This report contains the results of the Phase II activities.

The Phase II team began by identifying the number and skill level of trained technical and professional employees needed to staff a generic FLH project delivery division. This core staff of engineers and technicians is to achieve five key objectives :

1) Deliver the FLH construction award program;
2) Blend the social, environmental, economic and political philosophies of the Federal Land Management agencies and tribal governments into their unique highway infrastructures;
3) Maintain the ability to provide state-of-the-art technical assistance to Federal Land Management Agencies, Tribal governments, FHWA Federal-aid division offices and Resource Centers, State DOT's, counties and local governments;
4) Provide for training and development of FHWA employees; and
5) Maintain a sustainable supply of Senior engineers who can manage and deliver a diverse program of projects.

These key objectives are further discussed later in this report.

The information gathered by benchmarking with these State DOT's and consultants provided the Phase II team with information on alternative ways to manage contract services, insight into hiring

objectives, and some of the pitfalls of outsource contracting. These lessons were used to form and modify the basic assumptions used in the staffing models generated in this report.

Phase III of the Benchmarking Study

Phase III of this study calls for the FLH Leadership Team, to evaluate the headquarters management and support services required in a generic division and its headquarters office to follow up on the recommendations contained in this report and to implement those actions that will best position the organization in meeting future objectives.

ASSUMPTIONS

Various assumptions were made during the course of the Phase II benchmarking study. The most critical of these include:

The FLH program will continue to increase.
The Transportation Act of the 21st Century increased the Federal Lands Highway Program nearly 50 percent and there is a need and support for additional increases in the next legislation in the year 2003. In addition, various Tribal governments and several Federal Land Management agencies are using their influence to change existing program management and to add new programs to obtain funding from the Highway Trust Fund which will increase the demand for FLH services. There is also evidence that many of the Tribal governments would like the FLH to have a more active engineering role in their transportation programs. To account for a range of potential program increase, model calculations were generated for Division construction program levels of $50, $100, $150, $250 and $350 million dollars. The current Division construction program levels range from $98m to $127m for FY 2000.

Only the engineering activities described as Core Functions are evaluated in the report.
The basis of the report assumes that there will remain three FLH field divisions. However, for evaluation purposes the report will only look at the project delivery requirements for a single generic division. The Core Functions contained in the report are defined as twelve key activities necessary for a project delivery office. These specifically include: Roadway Design, Hydraulics, Project Management, Structural Design, Geotechnical, Environment, Construction Management, Survey & Mapping, Right-of-Way & Utilities, Materials, Safety, and Traffic Engineering. These core functions constitute approximately **72 percent** of a Division office's staffing requirements. The definitions, staffing size, knowledge level, training, and composition of these core functions are described later in the report.

MAJOR STUDY DRIVERS

There are numerous influences that have driven the assumptions and conclusions contained within this Phase II report. The important aspects of these major program drivers are outlined below:

DOT Strategic Goals

All the agencies within the U.S. Department of Transportation participate in achieving the national strategic goals. Each FLH project has specific elements that focus to some extent on improving and promoting public health and safety; ensuring an accessible, integrated and efficient transportation system; advancing the economic growth and trade through efficient transportation; protecting and

enhancing communities and the natural environment; and advancing the nation's vital security interests.

Add Maximum Value for Customers and Partners

In order to better serve our customers and partners, FLH engineers and technicians must first spend the time and energy to understand a customer's unique requirements. Other federal agencies have specific guidelines and policies on how to manage, preserve and protect the natural and cultural resources within their jurisdiction. However, their transportation infrastructure does not usually receive top priority when policy and funding decisions are being made. The FLH employees must work to understand the local policies and practices of a given park, refuge or forest and must understand how to balance the desires of the agency with sound engineering practices and procedures.

FLH engineers can also add value to their customers by understanding the complexities of financing federal-aid transportation improvements. Many funding options are often available, and the FLH engineers can offer innovative approaches to accessing and managing funds.

Streamlining Task Force

In 1995 the FLH undertook an internal organizational and staffing study. The Streamlining Task Force examined several different organizational structures and evaluated them by cost, efficiency, and ability to effectively delivery the program. They also evaluated minimum staffing levels that could be used to deliver the FLH program. Even though the Streamlining Task Force and the Phase II Benchmarking Study used different approaches to determine optimal staffing levels, the results from the two studies are remarkably similar. Many of the recommendations from that Streamlining Task Force were put into practice within FLH and are in existence today. These include the creation of the division Leadership teams, the creation of technical service branches, the introduction of virtual teams, and the consolidation of the bridge design, bridge inspection and road inventory teams.

Futures Paper Challenges

The FLH Leadership Team released its latest Futures Paper in June of 2000. This document examines the current roles and responsibilities of the FLH organization, examines current trends in the transportation industry, predicts some major world occurrences that may have impacts on transportation systems, and challenges FLH employees to creatively consider how we can prepare to proactively meet these opportunities.

Key Core Function Objectives

For the most part, these major program drivers have been used in this study to formulate the five key objectives of the core function areas.

- *Deliver the FL H construction program.* - This activity is the foundation of the FLH organization. Working as partners with the National Park Service, the Forest Service and the

Fish & Wildlife Service, FLH engineers and technicians plan, design and build the roads and infrastructure that provide public access to these National resources.

- *Blend the social, environmental, economic and political philosophies of the Federal Land Management agencies and Tribal governments into their unique highway infrastructures.* - Each of these agencies has their own unique mission. Whether their primary focus is preserving our cultural resources or providing for economic development, FLH listens and blends these concerns into our roadway designs. This forms the essence of the value that FLH adds when asked to deliver a project.

- *Maintain the ability to provide state-of-the-art technical assistance to Federal Land Management agencies, Tribal governments, FHWA Federal-aid division offices and Resource Centers, State DOT's, , counties and local governments* – The FLH fulfills its mission to explore new technologies by investigating and experimenting with new products and processes. By working across State boundaries, it becomes second nature to borrow "best practices" from one State and to lend them to others. FLH is also in the unique position to manage the more complex highway projects; - the Beartooth Highway, the Cumberland Gap Tunnel and the Hoover Dam Bridge - which involve multiple federal and state agency funding and coordination.

- *Provide for training and development of FHWA and FLMA employees.* – Because of its hands on approach to highway engineering, the FLH program provides an excellent training ground for new engineers and technicians. After experiencing varied assignments within one of the three FLH division offices, many of these engineers move into management and leadership positions elsewhere within FHWA. For the same reasons, and its recognition as a leader in Federal transportation FLH Divisions provide both on-the-job and formal training for FLMA. And territorial engineers to help them build expertise through hands-on experience.

- *Maintain a sustainable and renewable supply of transportation engineers who can manage a diverse program of projects.* – To meet the requirements of a transportation program that includes large, small, simple, complex, urban, and rural projects, FLH must develop a variety of engineering skills. These engineers need the flexibility to design complex, multilane interstate highways one day and be able to reengineer a washed out narrow mountain access road the next day. They need the experience to be able to develop projects, manage construction, develop new engineers and to manage multiple outsourced contracts

CORE FUNCTIONS

It is important to keep the total organizational needs in mind when reading the report since it only evaluates about 72 percent of the organization needs. Figure 1, below shows how we are generically organized currently. The numbers in parenthesis in Figure 1 represent a generic division average/median staffing as derived from the Phase I documentation. The data was organized around the core functions contained in this report. Existing Divisions are organized differently with different levels of staffing in the various functions to account for program and customer differences. In Figure

1, the functions are generically shown as reporting to one of the Offices, but organization structure is beyond the scope of this report and will be dealt with by the FLH Leadership and individual divisions subsequent to phase III.

Generic Division Organization Chart

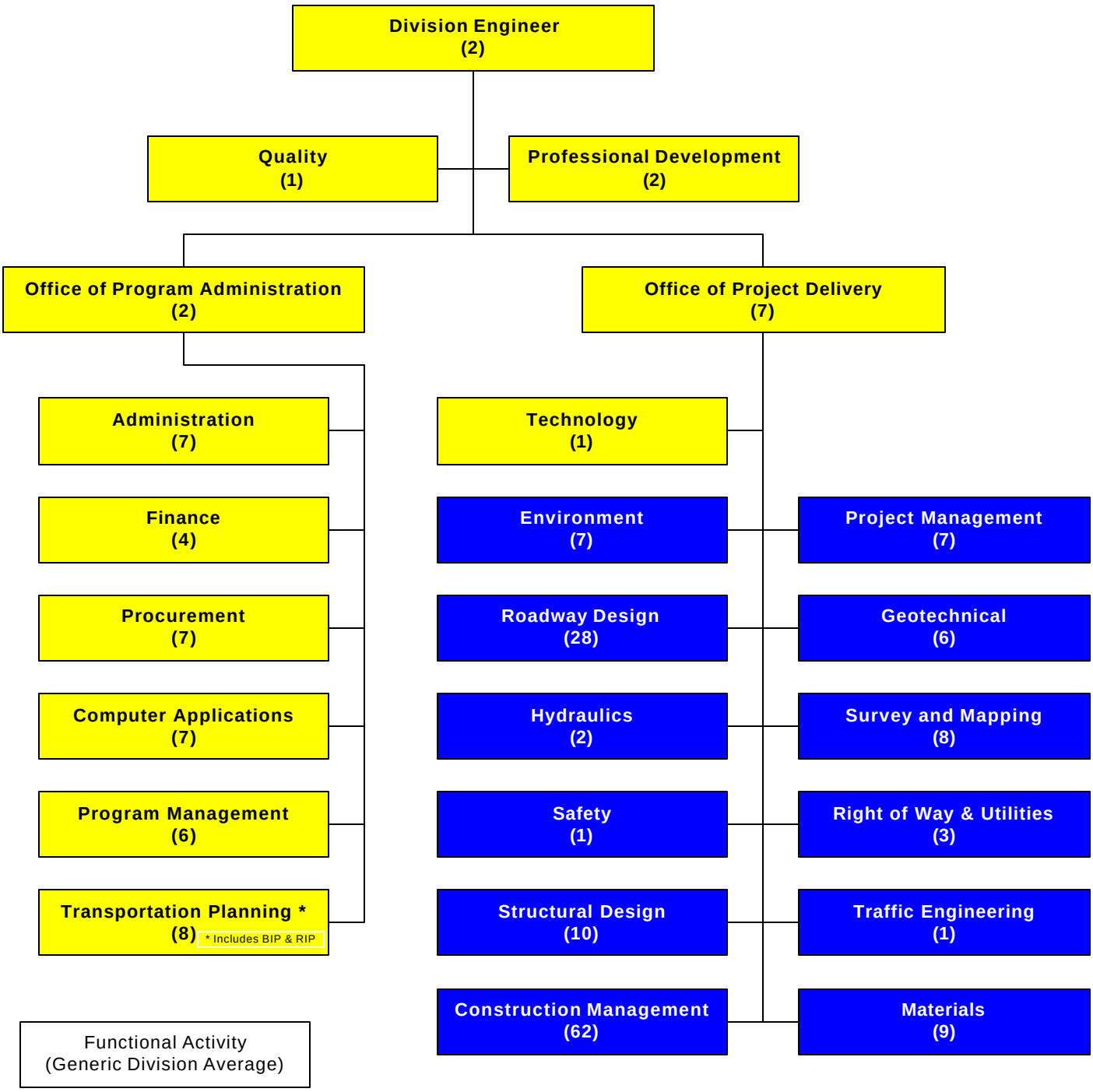


Figure 1

The blue shaded boxes represent the core functions that will be addressed in the balance of this report. It is important when drawing total staffing conclusions from the data presented in this report to add the percentage of the staff shown in yellow to understand total staffing requirements. Defining the need for the functions shown in yellow will be a primary challenge in Phase III of this effort.

The following table shows the split between core functions and support staff within the three divisions.

Table 1
Current Breakdown of Core Functions versus Support Staff

Office	Core	Support	Total	% in Core
Eastern	159	69	228	70%
Central	146	49	195	75%
Western	126	47	173	73%
Summary	431	165	596	72%
Average	**144**	**55**	**199**	**72%**

Based on this analysis, it is recommended that the FLH Leadership Team consider using **72 percent** as the percentage of a generic division represented by the core function staff. The team that performs the Phase III analysis will need to use this value when converting the core function staffing recommendations from this report into the entire FLH program staffing requirements.

It should be noted that the generic division-staffing model assumes a uniform program of projects. Divisional program and the resulting organizational differences will need to be addressed during the Phase III evaluation.

Core function areas and critical skill areas within them have been established as basic building blocks for a successful organization and are the basis for detailed assessments herein. They must be internally staffed by a proper mix of Senior engineers, Journey level and novices to provide adequate resources (numbers and skills) that will produce the best service and overall value to all of FLH's customers.

Support functions listed in Figure 1 make up about 28% of the total and will be addressed in Phase III. Specifically, these support functions include: upper management, secretarial & administrative support, contract administration, procurement, acquisition and purchasing, computer services, finance, human resources, transportation planning, road and bridge inventory, support services, depot and warehouse services, and technology transfer activities.

Core Function Position Qualifications

Based on the requirements to provide the best overall value to their customers, the Following guidelines in Table 2 have been established to define and delineate the differences among Novice, Journey level and Senior engineers. These definitions are based partiallyon personnel definitions, information taken from the State surveys and from the consultant interviews.

Table 2
Core Function Position Desirable Qualifications

	Novice	Journey level	Senior Engineer
Experience	•0-5 years professional experience	•2 - 10 years professional experience •Successful project/task experience	•8+ years professional experience •Successful led major projects •Complete range of functional experience
Typical Grades	GS 5/7/9	GS 11/12	GS 13 +
Education, Training and Certification	•B.S. Degree or equivalent •AD or GED •EIT •Latest computer functional applications •NICET for Technicians	•B.S. Degree or equivalent •P.E. •Project Management •Latest computer applications •NICET for Technicians	•B.S. Degree + advanced degree •P.E. •Successfully led major projects •Latest computer applications
Basic Skills	•Effective communicator •Problem solving •Facilitating •Open rapid learning	•Leadership •Effective communicator •Problem solving •Facilitating •Open rapid learning	•Multi-State perspective •Leadership •Effect. communicator •Problem solving •Facilitating •Open rapid learning
Professionalism	•Desire to be best/customer focused •Seeks out better ways •Readily admits/corrects mistakes	•Desire to be best/customer focused •Seeks out better ways •Readily shares info/knowledge •Readily admits/corrects mistakes •Presents technical papers	•Desire to be best/customer focused •Seeks out better ways •Readily shares info/knowledge •Readily admits/corrects mistakes •FLH recognized Senior level •Active in professional societies •Authors technical papers

Table 2 is based on the FHWA Skills Matrix but does not include positions in the FHWA Technical Career Track (TCT)

BASIC STAFFING MODEL

A cost-based computer model was developed to examine the optimum staffing level for a generic program delivery office. The model was created using the twelve core functions listed above and is based on maintaining the three field Division offices. Staffing for the core functions was based on meeting the five key objectives mentioned above. Modifications to the staffing levels were made based on attrition rates, production rates, and skill levels. Three levels of development; Novice, Journey level and Senior Engineers are described for each of the core functions. To validate our assumptions, the model was evaluated against various State, consultant and FLH engineering staffing and production rates.

The following table describes the distribution of the staffing for the program delivery portion of a generic division office.

Table 3
Generic Division – Core Function Staffing Distribution

Program Delivery Core Functions	Novice	Journey level	Sr. Engineers	Total	Current Avg. Division
Roadway Design	8	8	4	20	28
Hydraulics	1	1	1	3	2
Project Management	4	4	2	10	7
Structural Design	6	5	2	13	10
Geotechnical	4	4	2	10	6
Environment	4	4	2	10	7
Construction Management	12	12	6	30	62
Survey and Mapping	2	8	2	12	8
Right-of-way and Utilities	1	1	1	3	3
Materials	4	4	2	10	9
Safety	1	1	1	3	1
Traffic Engineering	1	1	1	3	1
Total	**48**	**53**	**26**	**127**	**144**

Each core function has unique areas of expertise that require specific critical mass staffing levels. The main consideration is a minimum number of staff required to produce the five key objectives for a given specialty. First, a generic team was developed for the core functions based on the need to maintain senior level engineers to deliver our mission. Using an annual attrition rate of 10 percent, a given time to develop to the next experience level, and approximately 3 percent migration towards management transfer/promotion rate to Federal-Aid a generic team size of four journey level and four novices was derived. The basis and assumptions for these figures are included in the Critical Mass Staffing Model in the Appendix.

The core function areas of Project Management, Geotechnical, Environment and Materials were staffed in the model at the generic team size of 4 novices, 4 Journey level, and 2 Senior level engineers. The structure of the remaining core functions was modified based on discussions with the FLH divisions and the interviewed engineering consultants. The core function areas of Hydraulics, Right-of-Way and Utilities, Safety and Traffic Engineering, were staffed with 1 novice, 1 Journey level, and 1 Senior engineer. These were reduced because at the minimum program level there would not be sufficient work to attract and retain a full staff. These four core functions should be

considered national teams for recruiting and hiring purposes. Because these four core functions will not be fully staffed at each division, the team recommends that special consideration be made to ensure local coverage when a division vacancy occurs. This may involve redistribution of work among divisions and an effort to hire locally at the Journey level or Senior engineer.

The core function area of Roadway Design was doubled for several reasons. The first is to ensure that each design team could supply quality assurance, quality control reviews over the work of the other team. The second is to allow each team to develop a specific area of expertise (urban design versus remote mountainous designs). The Roadway Design unit is also the place where most of the Outsource Managers will receive their training and guidance. The volume of work easily supports at least a double-sized staff.

Similarly, Construction Management will require a larger core staff. One third of this team will consist of construction managers, claims specialists and quality assurance specialists. The remaining two thirds of the core team will be required to manage the large number of field projects.

When comparing the generic division staff needed to maintain capacity in each core function with the staff of the average existing division (see Table 3), the major disparity is in Construction Management. The generic division will provide opportunity to maintain capacity but does not take in to account FLH management drivers to assure customer satisfaction and contract risk as outlined in the FLH Futures Paper. The Futures paper states "The level of staffing required to manage the delivery of contract services will be determined by the complexity, size, and risk of the projects. Accepted staffing models for the management of contracted services range from Government resident engineers overseeing multiple small projects staffed by contract (i.e. no Government employee assigned to each specific worksite), an assigned Government employee as project engineer/manager with performance of engineering functions and analysis staffed through contract services, to a government project with tiered contract services." It goes on to say "It is also recognized that there will be projects completely staffed with FLH and FHWA employee in order to fulfill the mission of developing FHWA employees." Given this desires, Phase III needs to further elaborate on these differences and analyze the need for additional staff based on FLH Leadership Team requirements.

The core function staffing levels of Structural Design and Survey & Mapping were modified based on the anticipated workload and the composition of the team required to accomplish their particular specialties. Both core functions need more Journey level positions to meet project requirements. In the Structural Design core function, a complex training schedule increased the need for novices. In Surveying, the availability of registered land surveyors and the number of available trained technicians reduced the need for novices.

The core staff requirements only relate to the minimum level of staffing required to maintain FLH's quality level and value added capacity for its traditional customers, the Federal Land Management agencies. It is also expected that Phase III will address such things as value added needs, risk managements with respect to contracting certain functions, such as the note for construction above. In addition, where FLH wants to contribute to FHWA initiatives in the technical career tracks and professional development program, etc., additional resources at the journey and senior level should be considered in Phase III>

Attrition Rates

A 10 percent attrition rate used is used within this study. This percentage is based on a multi-year FHWA Human Resource Information and Planning Guide (March 2000). This annual report tracks

the movement of engineers and technicians in and out of FHWA. In addition, losses to other FHWA offices were estimated. Although the actual percentages of transfers between Federal-aid and FLH are not yet available, an estimate of losses in excess of gains from other FHWA offices of 3 percent was used. It also reflects the impacts of various buy-out programs, changes to government retirement systems and various other factors including:

- •Aging workforce;
- •The CSRS system retirement plan, which
  - -creates greater numbers of retirements for Senior personnel > 55 yrs old with 30 years service.
  - - will eventually cause a decrease attrition as all eligible personnel retire;
- •FERS system, makes it easier to go to the private sector without retirement penalty;
- •Dual careers;
- •Difficulty in attracting Senior engineers and Journey level due to competition from industry for;
  - - Salary, Fringe Benefits/Bonuses/Stock Options, and
  - - Ultimate career path potential (i.e. President/CEO type positions).
- •The need to provide a dual career path for technical management and Senior technical positions to retain the necessary Senior personnel and expertise.

While the desire is to hire predominately novices and expose them to several years of Federal Lands' techniques and philosophies, it is recognized that some hiring is beneficial at the Journey level and Senior engineer. It should be recognized that hiring Journey and Senior engineers will possibly require salary considerations.

Table 4
Minimum Staffing for each Core Function

Novices	Current in position	4.0
	Losses due to attrition	-0.4
	Losses due to promotion to Journey level	-1.0
	New hire requirement	1.4
	Total	4.0
Journey level	Current in position	4.0
	Losses due to attrition	-0.4
	Losses due to promotion to Senior level	-0.5
	Losses due to transfer to Federal-Aid	-0.1
	Gains from Novice level	1.0
	Total	4.0
Senior Engineer	Current in position	2.0
	Losses due to attrition	-0.2
	Losses due to transfers to management	-0.2
	Losses due to transfers to Federal-Aid	-0.1
	Gains From Journey level	0.5
	Total	2.0

The scenario in Table 4 indicates that FLH will need to hire or recruit about 1.4 engineers per 4 novice level required to maintain its core staffing. This would relate to about 18 hires per year at the $50 million level, and up to 35 hires at the $350 million level. It is certainly expected that some of the new hires will be at journey and even senior levels. This will require a concentrated recruitment and training effort.

Project Delivery Percentages

The portion of total engineering effort, including contract oversight, contributed by each of the core technical functions was set based on historical experience of the FLH divisions. The team recognized that each division has different percentages for some areas based on unique circumstances. However, averages were developed that reasonably represent an FLH division and percentages derived from industry. These numbers are the percent of construction contract costs:

Table 5
Project Delivery Percentages

Eng. Services Core Functions	Generic	EFL	CFL	WFL
Roadway Design	6.0%	6.0%	6.0%	9.0%
Hydraulics	0.5%	0.5%	0.5%	0.5%
Project Management	1.5%	1.5%	1.5%	0.0%
Structural Design	2.5%	2.5%	2.5%	2.0%
Geotechnical	1.5%	1.5%	1.5%	2.0%
Environment	2.5%	0.2%	3.0%	2.5%
Construction Management	10.0%	10.0%	10.0%	12.4%
Survey and Mapping	1.7%	2.0%	1.8%	1.5%
Right-of-way and Utilities	0.4%	0.2%	0.4%	0.7%
Materials	1.0%	1.3%	1.3%	0.7%
Safety**	0.2%	0.2%	0.0%	0.0%
Traffic Engineering	0.2%	0.2%	0.0%	0.0%
Total	28.0%***	26.1%	28.5%	31.3%

***** Includes Project Management
****** Roadway Design and Construction Management also have Safety activities
******* Simply stated, Table 5 shows that it would cost $28 million to deliver a $100 million construction program.

The percentages shown in Table 5 are considered reasonable based on limited information collected during the Phase I Benchmarking effort. Environmental work was reported in the 2% to 8% range. Design engineering ranged from 8% to 10% and Construction Management from 8% to 10%.

Salary Level Aspects of the Staffing Model

The FTE staffing is based on fully burdened (Salary plus benefits) costs of; $70,000 per year for a Novice, $90,000 per year for a Journey level, and $110,000 per year for a Senior engineer. These cost figures are based on current FLH pay scale and division office burdened rates.

Table 6
Core Function Burdened Charge Rates

	Novice	Journey level	Sr. Engr.
Core Functions	**$/hr**	**$/hr**	**$/hr**
Roadway Design	32.00	47.40	58.90
Hydraulics	32.00	47.40	58.90
Project Management	47.40	58.90	69.50
Structural Design	32.00	47.40	58.90
Geotechnical	32.00	47.40	58.90
Environment	32.00	47.40	58.90
Construction Management	25.60	37.90	47.10
Survey and Mapping	32.00	47.40	58.90
Right-of-way and Utilities	32.00	47.40	58.90
Materials	32.00	47.40	58.90
Safety	32.00	47.40	58.90
Traffic Engineering	32.00	47.40	58.90

Further refinements have been made to the hourly rates of the Project Managers and the Construction Management core functions. The Project Manager rates were increased one level since the grade structure for this group is typically one grade higher. These individuals are usually the supervisors and team leaders. The Construction Management core function hourly rates were reduced because of the lower grade structure of our field technicians.

A burdened rate of 1.75 is added to preliminary engineering core functions. The rate of 1.75 is an average for the three FLH divisions. For construction engineering, a rate of 1.4 is used. . These burdened rates include an average 65% productivity rate for direct charge employees. The other 35 percent is generated through overhead to pay for non-billable time such as training, leave, meetings, and involvement in national and FLH wide programs and activities. It also covers the salary and benefits of approximately half of the support core functions staff. (The other half of the support core function staff is funded via GOE accounts.) The burdened rate also covers major office equipment, furniture and similar expenditures. Use of burdened rates in this analysis makes these rates comparable to those of outsourced services.

For outside contract work, $140,000 per year average per FTE was used. This is based on current burdened negotiated architectural and engineering service rates. This is confirmed by the Phase I benchmarking information. It takes into consideration contractor profit, overhead, and higher salaries.

Model Operation

The computer staffing models that follow were predicated on total annual construction award levels of $50m, $100m, $150m, $250m and $350 million. This was done in order to show how an increased construction program level will impact staffing.

The outsource requirement for each core function begins by computing the total engineering demand. Next the internal production capacity of each core function is determined. This value is subtracted from the total engineering demand, and the balance of workload is outsourced to consultants.

Table 7 indicates the engineering delivery that the core staff can produce as discussed in the following paragraphs.

Table 7
Base Staffing Model for Generic Division

	Novice	Journ.	Senior Engrs	Total Internal	Total/Yr FTE Based
	FTE	FTE	FTE	FTE	$m
Eng Services Core Functions					
Roadway Design	8	8	4	20	1.8
Hydraulics	1	1	1	3	0.3
Project Management	4	4	2	10	1.2
Structural Design	6	5	2	13	1.1
Geotechnical	4	4	2	10	0.9
Environment	4	4	2	10	0.9
Construction Management	12	12	6	30	2.2
Survey and Mapping	2	8	2	12	1.2
Right-of-way and Utilities	1	1	1	3	0.3
Materials	4	4	2	10	0.9
Safety	1	1	1	3	0.3
Traffic Engineering	1	1	1	3	0.3
	48	**53**	**26**	**127**	**$11.3**
Tot Annual Construction Award ($m)					**40.0**

The first four columns of numbers show the number of core function staff from Table3.. A total of 127 engineers and technicians are required to staff the generic division office within these core areas.

The last column determines the amount of preliminary engineering (in million dollars) that the particular core function is able to produce. For a detailed explanation refer to the example below.

For example, consider Roadway Design. There are 8 novices working for one year (2080 hrs.). They charge the projects an average of $32 per hour (Table 6).

(Taken from Table 7)	Novice	Journ.	Senior Engrs	Total Internal	Total/Yr FTE Based
	FTE	FTE	FTE	FTE	$m
Eng Services Core Functions	A	B	C		D
Roadway Design	8	8	4	20	1.8

(Taken from Table 6)	Novice	Journey level	Sr. Engr.
Charge Rate	$/hr	$/hr	$/hr
Roadway Design	32.00	47.40	58.90
	E	F	G

Multiplied together:

For Novices -- 8*2080*$32.00 = $532,000 of preliminary engineering
A E

For Journey level -- 8*2080*$47.40 = $789,000
B F

For Senior Engrs -- 4*2080*$58.90 = $490,000
C G =1,811,000
D

The total cost of roadway design is approximately $1.8 million. This number is recorded in the last column of Table 8.

The total for the production of the core function (the sum of the sixth column) equals $11.3 million worth of preliminary engineering. Holding preliminary engineer and construction engineering to a maximum of 28% of the total construction award amount indicates that the generic division, staffed as described, without outsourcing, could produce $40 million worth of construction award contracts.

Outsource management resources are based on using a sliding scale of 15 to 9 percent of engineering contract value. This value is based on industry experience for similar applications and on current FLH levels. At present Eastern expends 8 to 20 percent in outsource management oversight. Both Central and Western expend 9 to 20 percent. Within the model, 15% is applied at the $50 million program level. With a concentrated focus on improvement techniques, this rate is expected to reduce to 9% (based on budget – not FTE) at the $350 million program level.

As the construction program level increases, an outsource management development pool was established to provide the necessary personnel to assure the required Journey level and Senior engineers are available. The outsource management is to be performed only by the experienced Journey level and Senior engineers. With the expected 10 percent attrition rates, the number of Journey level is matched by an equal number of novices.

Table 8
Staffing Model for a $50 Million Construction Program

	1	2	3	4	5	6	7	8
	Novice	Journ.	Senior Engrs	Total Internal	Total/Yr FTE Based	Project Delivery	Total/Yr Job Req	Add'l Req.
	FTE	FTE	FTE	FTE	$m	%	$m	Wk Yr.
Eng Services Core Functions								
					A	B	C	D
Roadway Design	8	8	4	20	1.8	6.0%	3.0	14
Hydraulics	1	1	1	3	0.3	0.5%	0.3	0
Project Management	4	4	2	10	1.2	1.5%	0.8	0
Structural Design	6	5	2	13	1.1	2.5%	1.3	1
Geotechnical	4	4	2	10	0.9	1.5%	0.8	0
Environment	4	4	2	10	0.9	2.5%	1.3	4
Construction Management	12	12	6	30	2.2	10.0%	5.0	33
Survey and Mapping	2	8	2	12	1.2	1.7%	0.9	0
Right-of-way and Utilities	1	1	1	3	0.3	0.4%	0.2	0
Materials	4	4	2	10	0.9	1.0%	0.5	0
Safety	1	1	1	3	0.3	0.2%	0.1	0
Traffic Engineering	1	1	1	3	0.3	0.2%	0.1	0
Total	**48**	**53**	**26**	**127**	**$11.3** H	**28.0%**	**$14.0** G	**52** F
Total Construction Award ($m)					**$50.0** E			

	Division						**Consultant**	
Outsourced	L				M			
Outsource Management Dev Pool	3			3	$0.2			
Total FTE with Dev Pool		K	J	**130**	**$11.5**			
Outsource Management @ 15%		3	1	4	$0.4 N			
Total Internal FTE and Cost	**51**	**56**	**27**	**134**	**$11.9** R		P	T
Total Outsource Cost and Wk Yr.				S			**$6.5** I	**49**
Total Project Delivery Cost						**$18.4**		
Add'l PD Cost due to Outsourcing						**$4.4** Q		
% Outsourced							**35.2%** O	

For a $50 million construction award program, the staffing model indicates that 1 additional Senior engineer and 3 additional Journey level are required to manage the additional outsourced work. This staffing number is generated by first determining the total engineering required to deliver a $50 million program. (Column 8) To arrive at this value, the total construction award amount is multiplied by the core function PE percentage (Column 7). For example for Roadway Engineering the value is $50 Million * 0.06 = $3 Million.

E B C

Summed together, $14 million of Preliminary and Construction engineering is required to deliver the $50 million construction program.

The last column of the table is used to determine the amount of consultant work years required to assist the generic division engineering staff. For Roadway Design, the cost produced by the core function team ($1.8 M) is subtracted from the cost of delivering the $50 million program ($3 M).

This leaves $1.2 M of work to be purchased. The average rate is $86,000 per work year for an FLH Project Delivery employee. This equates to 14 work years.

($3,000,000 - $1,800,000) / $86,000 per FLH work year = 14 work years
C A D

For all core functions, the total amount of additional consultant work required to assist the core staff in delivering the $50 million program is approximately 52 work years.
F

From a cost perspective, if the construction program was $50 million and only internal resources were used to deliver this program, the project delivery costs would be $14 million.
G

Using the approximate annual costs for Senior engineers and Journey level, $110,000 and $90,000 respectively and an oversight cost of 15 percent, 1 Senior engineer and 3 Journey level are required to manage 52 weeks of consultant contracts.

((1 * $110,000 * .33) + (3 * $90,000 * .67))/0.15 ≈ $400,000
J K N

Only Senior engineers and Journey level would be allowed to manage these contracts. However, in order to insure an entry level pool of Journey level, a matching number of novices would be hired to help support the outsourcing activities. These novices would be incorporated within the twelve core functional areas. A slight production ($0.2 M) would be generated by these three novices.

3 * $70,000 = $210,000
L M

The total project delivery cost using outsourcing is the sum of the cost of the generic division core function employees plus the cost of the purchased consultant services. A total of 134 government employees are required. The total number of consultant resources required is equal to the additional required work years minus the outsourced management development pool. These two groups have their burdened rates of $86,000 and $140,000 respectively.

(134 * $86,000) + [(52 – 3) = 49] * $140,000 = $18,400,000
S F L = T I

The consultant project delivery cost is $6.5 million.

$18,400,000 - $11,900,000 = $6,500,000
I R P

The additional project delivery cost to the government is the difference between the total outsourced project delivery cost and the cost of doing the work in-house.

$18,400,000 - $14,000,000 = $4,400,000
I G Q

The percentage of outsourced project delivery is equal to the amount of consultant cost divided by the total cost of outsourced project delivery.

$6,500,000 / $18,400,000 = 35.2%

P I O

Models for construction award levels of $100 million, $150 M, $250 M and $350 M follow:

Table 9
Staffing Model for a $100 Million Construction Program

	1	2	3	4	5	6	7	8
	Novice	Journ.	Senior Engrs	Total Internal	Total/Yr FTE Based	Project Delivery	Total/Yr Job Req	Add'l Req.
	FTE	FTE	FTE	FTE	$m	%	$m	Wk Yr.
Eng Services Core Functions								
Roadway Design	8	8	4	20	1.8	6.0%	6.0	49
Hydraulics	1	1	1	3	0.3	0.5%	0.5	2
Project Management	4	4	2	10	1.2	1.5%	1.5	4
Structural Design	6	5	2	13	1.1	2.5%	2.5	16
Geotechnical	4	4	2	10	0.9	1.5%	1.5	7
Environment	4	4	2	10	0.9	2.5%	2.5	19
Construction Management	12	12	6	30	2.2	10.0%	10.0	91
Survey and Mapping	2	8	2	12	1.2	1.7%	1.7	6
Right-of-way and Utilities	1	1	1	3	0.3	0.4%	0.4	1
Materials	4	4	2	10	0.9	1.0%	1.0	1
Safety	1	1	1	3	0.3	0.2%	0.2	0
Traffic Engineering	1	1	1	3	0.3	0.2%	0.2	0
Total	**48**	**53**	**26**	**127**	**$11.3**	**28.0%**	**$28.0**	**196**
Total Construction Award ($m)					**$100.0**			

	Division						Consultant	
Outsourced								
Outsource Management Dev Pool	15			15	$1.1			
Total FTE with Dev Pool				**142**	**$12.4**			
Outsource Management @ 14%		15	8	23	$2.2			
Total Internal FTE and Cost	**63**	**68**	**34**	**165**	**$14.6**			
Total Outsource Cost and Wk Yr.							**$24.9**	**181**
Total Project Delivery Cost						**$39.5**		
Add'l PD Cost due to Outsourcing						**$11.5**		
% Outsourced							**63.1%**	

The $100 million program level closely resembles the program level projected for FY 2001 that the Divisions are trying to deliver currently. At this level, approximately 63 percent of the preliminary and construction engineering work would be contracted out. An additional 38 government employees (15+15+8) are required in addition to the core staff of 127 to deliver the program. These additional 38 employees leverage the work of 181 (196-15) outsourced work years of effort.

Table 10
Staffing Model for a $150 Million Construction Program

	1	2	3	4	5	6	7	8
	Novice	Journ.	Senior Engrs	Total Internal	Total/Yr FTE Based	Project Delivery	Total/Yr Job Req	Add'l Req.
	FTE	FTE	FTE	FTE	$m	%	$m	Wk Yr.
Eng Services Core Functions								
Roadway Design	8	8	4	20	1.8	6.0%	9.0	84
Hydraulics	1	1	1	3	0.3	0.5%	0.8	5
Project Management	4	4	2	10	1.2	1.5%	2.3	13
Structural Design	6	5	2	13	1.1	2.5%	3.8	30
Geotechnical	4	4	2	10	0.9	1.5%	2.3	16
Environment	4	4	2	10	0.9	2.5%	3.8	33
Construction Management	12	12	6	30	2.2	10.0%	15.0	149
Survey and Mapping	2	8	2	12	1.2	1.7%	2.6	16
Right-of-way and Utilities	1	1	1	3	0.3	0.4%	0.6	4
Materials	4	4	2	10	0.9	1.0%	1.5	7
Safety	1	1	1	3	0.3	0.2%	0.3	0
Traffic Engineering	1	1	1	3	0.3	0.2%	0.3	0
Total	**48**	**53**	**26**	**127**	**$11.3**	**28.0%**	**$42.0**	**357**
Total Construction Award ($m)					**$150.0**			

	Division						Consultant	
Outsourced								
Outsource Management Dev Pool	26			26	$1.8			
Total FTE with Dev Pool				**153**	**$13.1**			
Outsource Management @ 13%		26	13	39	$3.8			
Total Internal FTE and Cost	**74**	**79**	**39**	**192**	**$16.9**			
Total Outsource Cost and Wk Yr.							**$45.9**	**331**
Total Project Delivery Cost						**$62.8**		
Add'l PD Cost due to Outsourcing						**$20.8**		
% Outsourced							**73.1%**	

The $150 million program represents a 50 percent increase in the existing FLH program. At this level, approximately 73 percent of the preliminary and construction engineering work would be contracted out. An additional 65 government employees (26+26+13) are required in addition to the core staff of 127 to deliver the program. These additional 65 employees leverage the work of 331 (357-26) outsourced work years of effort.

Table 11
Staffing Model for a $250 Million Construction Program

	1	2	3	4	5	6	7	8
	Novice	Journ.	Senior Engrs	Total Internal	Total/Yr FTE Based	Project Delivery	Total/Yr Job Req	Add'l Req.
	FTE	FTE	FTE	FTE	$m	%	$m	Wk Yr.
Eng Services Core Functions								
Roadway Design	8	8	4	20	1.8	6.0%	15.0	153
Hydraulics	1	1	1	3	0.3	0.5%	1.3	11
Project Management	4	4	2	10	1.2	1.5%	3.8	30
Structural Design	6	5	2	13	1.1	2.5%	6.3	59
Geotechnical	4	4	2	10	0.9	1.5%	3.8	33
Environment	4	4	2	10	0.9	2.5%	6.3	62
Construction Management	12	12	6	30	2.2	10.0%	25.0	265
Survey and Mapping	2	8	2	12	1.2	1.7%	4.3	36
Right-of-way and Utilities	1	1	1	3	0.3	0.4%	1.0	8
Materials	4	4	2	10	0.9	1.0%	2.5	19
Safety	1	1	1	3	0.3	0.2%	0.5	2
Traffic Engineering	1	1	1	3	0.3	0.2%	0.5	2
Total	**48**	**53**	**26**	**127**	**$11.3**	**28.0%**	**$70.0**	**682**
Total Construction Award ($m)					**$250.0**			

	Division						Consultant	
Outsourced								
Outsource Management Dev Pool	42			42	$2.9			
Total FTE with Dev Pool				**169**	**$14.3**			
Outsource Management @ 11%		42	21	63	$6.1			
Total Internal FTE and Cost	**90**	**95**	**47**	**232**	**$20.4**			
Total Outsource Cost and Wk Yr.							**$89.2**	**640**
Total Project Delivery Cost						**$109.6**		
Add'l PD Cost due to Outsourcing						**$39.6**		
% Outsourced							**81.4%**	

The $250 million program represents over a two fold increase in the existing FLH program. At this level, approximately 81 percent of the preliminary and construction engineering work would be contracted out. An additional 105 government employees (42+42+21) are required in addition to the core staff of 127 to deliver the program. These additional 105 employees leverage the work of 640 (682-42) outsourced work years of effort.

At this level of outsourcing, several State DOT's were concerned about losing their expertise and their ability to effectively manage their A&E programs.

Table 12
Staffing Model for a $350 Million Construction Program

	1	2	3	4	5	6	7	8
	Novice	Journ.	Senior Engrs	Total Internal	Total/Yr FTE Based	Project Delivery	Total/Yr Job Req	Add'l Req.
	FTE	FTE	FTE	FTE	$m	%	$m	Wk Yr.
Eng Services Core Functions								
Roadway Design	8	8	4	20	1.8	6.0%	21.0	223
Hydraulics	1	1	1	3	0.3	0.5%	1.8	17
Project Management	4	4	2	10	1.2	1.5%	5.3	47
Structural Design	6	5	2	13	1.1	2.5%	8.8	89
Geotechnical	4	4	2	10	0.9	1.5%	5.3	51
Environment	4	4	2	10	0.9	2.5%	8.8	91
Construction Management	12	12	6	30	2.2	10.0%	35.0	382
Survey and Mapping	2	8	2	12	1.2	1.7%	6.0	56
Right-of-way and Utilities	1	1	1	3	0.3	0.4%	1.4	13
Materials	4	4	2	10	0.9	1.0%	3.5	30
Safety	1	1	1	3	0.3	0.2%	0.7	5
Traffic Engineering	1	1	1	3	0.3	0.2%	0.7	5
Total	**48**	**53**	**26**	**127**	**$11.3**	**28.0%**	**$98.0**	**1008**
Total Construction Award ($m)					**$350.0**			

	Division						Consultant	
Outsourced								
Outsource Management Dev Pool	52			52	$3.6			
Total FTE with Dev Pool				**179**	**$15.0**			
Outsource Management @ 9%		51	26	77	$7.5			
Total Internal FTE and Cost	**100**	**104**	**52**	**256**	**$22.4**			
Total Outsource Cost and Wk Yr.							**$133.4**	**956**
Total Project Delivery Cost						**$155.9**		
Add'l PD Cost due to Outsourcing						**$57.9**		
% Outsourced							**85.6%**	

The $350 million program represents a billion dollar FLH program nationwide. At this level, approximately 86 percent of the preliminary and construction engineering work would be contracted out. An additional 129 government employees (52+51+26) are required in addition to the core staff of 127 to deliver the program. These additional 129 employees leverage the work of 956 (1008-52) outsourced work years of effort.

A summary of these tables is contained in the next two figures. The first shows the growth of both internal and outsourced work years as the program increases. The second figure shows the percentage of work outsourced to consultants versus the growth in program

Figure 2 Accounts for only 72% of total Division FTE

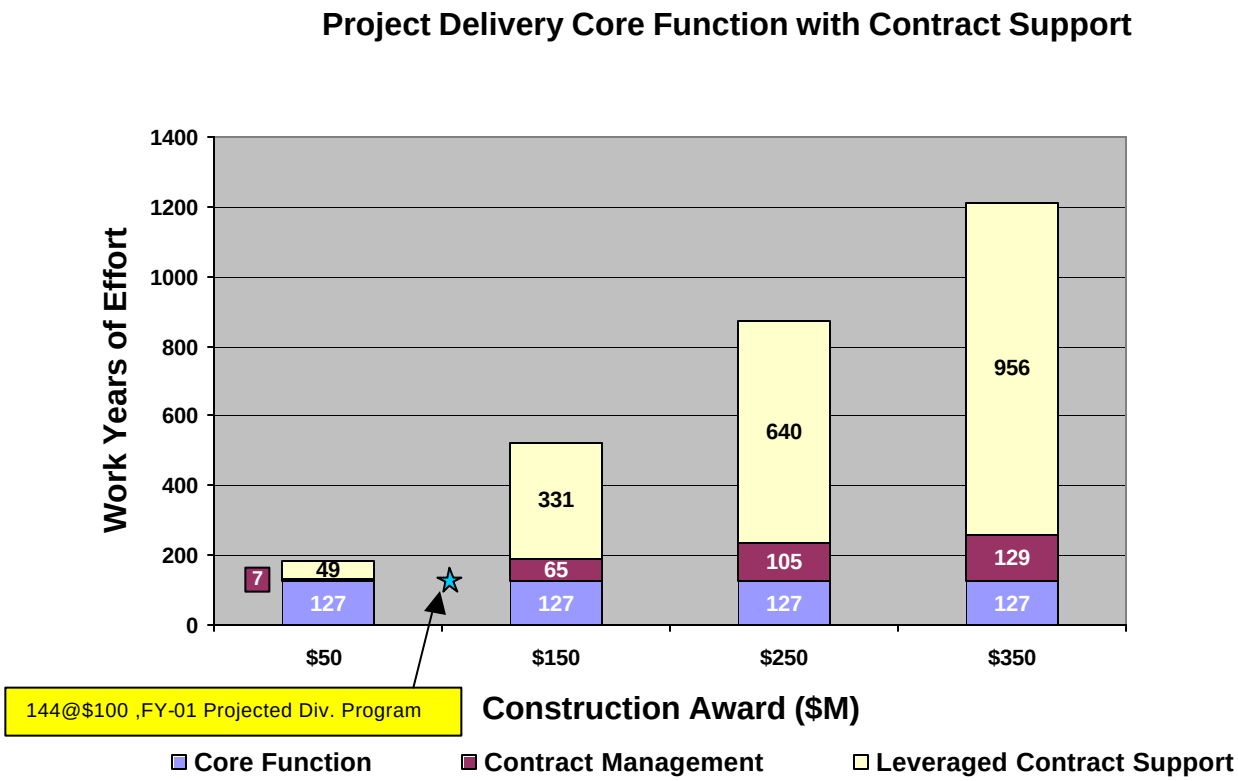


Figure 2 indicates that as our program size grows a small increase in FTE will be essential to manage additional outsource work. It also indicates that there will be an increased leveraging of outsourced support at higher levels. Although, some adjustments may be required to meet value added management needs, a generic division can increase its contract delivery seven fold with only a two fold increase in core staff by increasing contracting out from 35% to 86%.

The ☆ indicates that at the $100 million level, FLH divisions are slightly understaffed. The FLH current core function is 144 FTE as compared to the 165 FTE recommended by the model for our FY 2001 workload. At present the division staffing includes considerable more construction management staff than the base model recommends and we were able to continue to deliver the project development portion of the program because of the experience level of the staff we have in Project Development. More construction staff than the model recommends is needed to satisfy the value added requirements and risk associated with construction. (see Futures Paper which is consistent with State Highway Departments concerns). For FLH this is compounded by the scattered and remote locations of our construction projects that makes multi-project management difficult. Therefore, more than just the basic number of staff to maintain expertise is needed to fulfill our vision and mission requirements.

Overall this indicates a shortfall in staffing at the $100 million level of about 21 FTE per division plus additional construction staffing requirements. We are able to continue to deliver the program because of the experience of our current staff but are generating considerable risk in quality and long term capacity. The five key objectives of the core functions are not totally being addressed. Problem areas include:

- Sufficient entry level engineers are not being hired to assure long term maintenance of capacity.
- Training is not being performed to a level to assure quality products delivery and professional development.
- Technical assistance to outside organizations is reactive rather than proactive.
- Contract oversight is being managed without a plan (inefficiently).

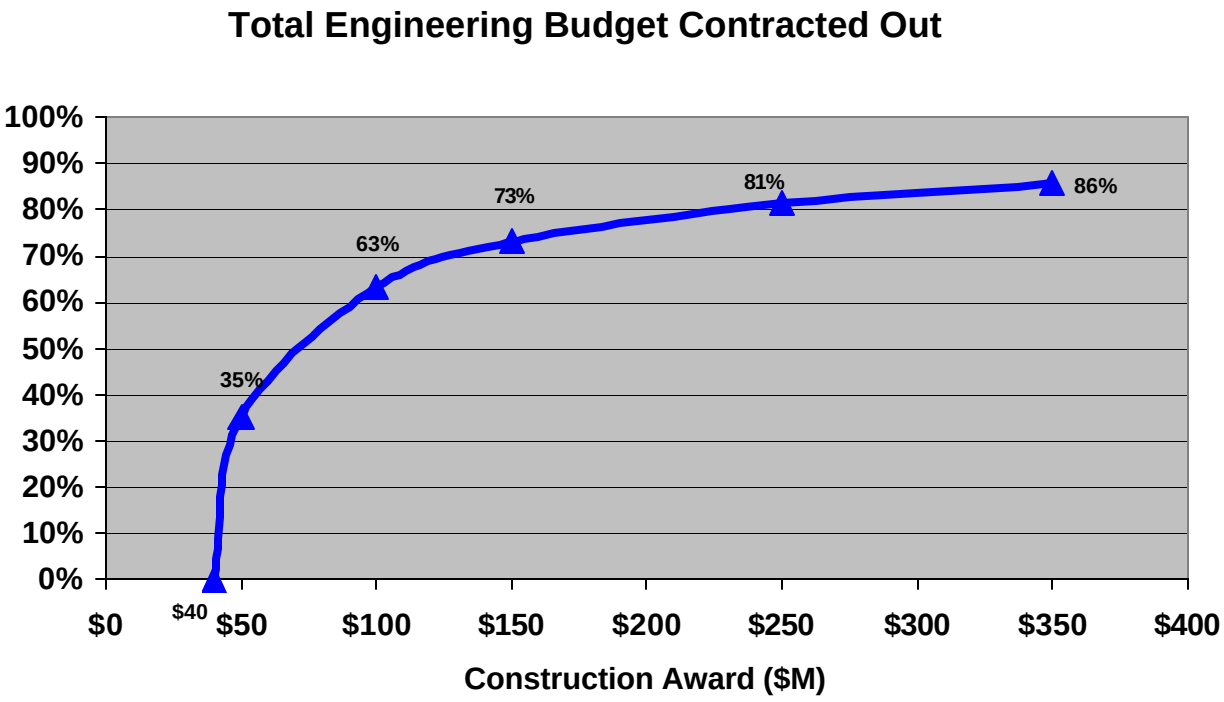


Figure 3

One of the findings from the Phase 1 benchmarking efforts is that 4 States cautioned that 80 percent outsourcing is a limit that should not be exceeded. Above 80 percent, these States felt that they lost control of the process and that their quality suffered.

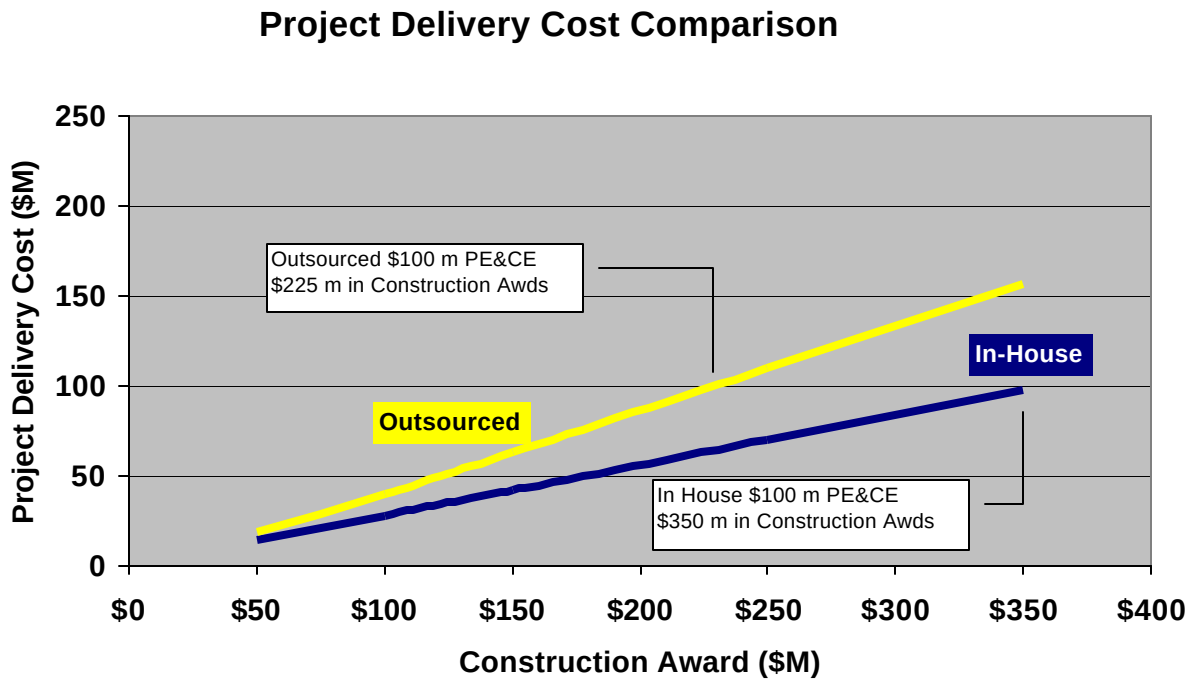


Figure 4

Figure 4 indicates that as the amount of outsourcing goes up the cost of program delivery will go up. This translates into less construction for the program dollar. The example labeled on the figure indicates that with all in house staff a $350 million program can be delivered for $100 million in engineering cost while only $225 million worth of construction will be delivered with significant outsourcing. Referring to tables 9 through 12, the extra cost of delivery grows from $4.4 million at $50 million construction program with 35 percent outsourced to $57.9 million extra for a $350 million construction program with 86 percent outsourced.

PHASE I RESULTS

Introduction

This section provides a summary of the information obtained from the Phase I benchmarking study with 11 state departments of transportation. The focus of the effort was to identify recommended practices relative to staffing and managing consultants in the delivery of highway projects. This data has been analyzed and reduced to eight focus areas that are critical in the consideration of maintaining a competitive, quality organization. While the sample of recommended practices come from specific State DOT's, the same idea or practice may have been used in other states.

The Phase I effort indicated that many State DOT's are struggling with the same issue that FLH is. Lack of resources, how to manage outsourced work, turnover of staff, growing programs, etc. They are also struggling with good data systems to quantify the impact of these issues either independently or collectively. Therefore, the results of Phase I are in many cases based on anecdotal information from the interviews of Phase I team. With this, there were several focus areas that were identified , as follows:

Focus Areas

Employee Retention

People, their capabilities, knowledge and skills are at the heart of the knowledge driven economy and are the key to achieving organizational objectives.

Innovative Human Resource practices are needed in the engineering industry (I.e. pay banding to expand salary ranges) to attract and retain quality employees.

To attract and retain quality employees, organizations must be sensitive to the development of their employees and to their personal needs.

Recruitment

Total salary and benefit packages are becoming more competitive in the engineering industry. In today's competitive market, industry is seeking out the most qualified personnel. Public sector organizations must keep up to attract employees.

A/E + Outside Resource Management

Outsourcing requires new skills in contract management as well as having a technical background. Project execution costs and timely delivery are dependent on quality statements of work and sound management of contracts.

Cost

Basic project execution costs are higher with outside contractors due to profit, oversight, pay scale difference, and potentially higher operating costs. When trained internal oversight and management personnel are not available, project design costs may increase and project execution problems may occur.

Internal technical and management expertise and sound processes are critical to maintain control over project execution costs.

Workload Distribution

Policy decisions for significant outsourcing can create situations where the necessary critical mass of expertise and job challenge to attract and retain necessary personnel is jeopardized.

Effective operational planning systems are critical with significant outsourcing to minimize inefficiencies and properly manage internal resources.

Quality and Customer Satisfaction

Skilled personnel and effective processes are required to maintain a seamless product to the customer regardless of whether it is internally produced or outsourced.

Innovative Contracting

Larger programs and more outsourcing is driving industry to employ more streamlined operating processes, effective measurements and simple/innovative contracting methods to effectively deliver products and services that meet customer needs.

Liability

Greater use of outsourcing creates a more diverse delivery team. Ownership of product quality and risks become more complex.

Given these focus areas, Phase I information was categorized in the following table to highlight some of the best "practices" that were found through the benchmarking effort. Even though, sometimes only one State DOT was listed in implementing a specific practice, the practice is believed to be an opportunity for improvement of our delivery process. Several of these practices are already in place in FLH and for those that are not, a level of difficulty to implement is shown. Table 13 shows the results of this evaluation.

Table 13

Recommended Practices from State DOT's	Number of State DOTs	Does FLH currently do this?	Degree of Difficulty in Implementing
Retain Complex, interesting projects in-house	7	Yes	
Develop Scholarship programs to attract prospective recruits	2	No	Difficult
Pay banding, recruitment, retention bonuses, and alternative pay schedules for EIT and PE licenses	6	No	Difficult
Develop a design matrix to determine which projects go to A/E	1	No	Moderate
Require A/E design firms to use same software packages and in-house	1	Yes	
Establish post contract reviews to learn what went well and what did not	2	Some	Easy
Working repeatedly with specific A/E firms	9	Yes	Moderate /Difficult
Bundling small or similar projects into more manageable an economic sizes	2	Yes	
Limiting the outsource work to no more than 80%	4	No	Moderate
Design team on board through construction	9	No	Easy
Lump Sum design for more efficient and timely deliveries	2	No	Moderate
Combine training for Project Management, construction & other in-house and consultants personnel	8	Some	Moderate
Partnering during contract work and continuous periodic partnering with contractor industry, prior to contract work. (NOTE: the four states listed all do partnering outside contract work)	4	Yes – Construction contract Limited Design contract. No pre-contract partnering	Moderate
Competes for work against consultants	2	No	Easy
Sensitive to where people want to work, employee flexibility, family friendly policies	3	Some	Easy
Include construction contingency pay items in	3	No	Moderate

PS&E			/Difficult
Construction Inspector Training and certification required	5	Encouraged	Easy
Hold frequent status meetings and employ good scheduling methods	8	Yes	
Review consultant designs for scope and guidelines, not for technical accuracy	3	No	Moderate (we have to assure customer satisfaction so it is difficult to turn it over but we agree, it needs to be pushed to the limit)
Standard clause for consultant liability in all contracts	1	Yes (FAR 52.236-23)	Easy
Give employees projects with increasing difficulty	1	Some	Easy
Holds contract retainage for task order work	8	Available	Easy
Consultant prepares SOW for task order work at no charge to State DOT	1	Some	Easy
Constructability reviews or VE studies during project development	3	Some (partly)	Easy
Prequalification process once/year for A/E's	1	No	Moderate /Difficult
Consultant evaluation process	5	Yes	
A + B bidding to reduce contract time and oversight time	1	Yes	
Preliminary design & environmental scoping before contract task order work. The whole cross-functional team participates	4	Some	Easy
Consultants live in and pay taxes in State	1	No	Difficult
Checklist review for consultant designs	2	No	Easy
School outreach programs	2	Some	Moderate
All design employees attend context sensitive design training	1	No	Easy
Limits overtime and comp-time to retain employee quality of life	1	No	Easy

Graduate Engineer training program	2	Yes	
Technical career track positions	1	Yes	
Consultant overhead and salary caps	2	No	Difficult
Categorize contract change orders to identify trends	1	Some	Easy
Cross-functional team develops project delivery schedule and includes construction liaison	2	Yes	
Include disincentive clause on A/E contracts for contracts not completed on time	1	No	Moderate
Assist employees to become PE's	1	Yes	Moderate
Improved Performance recognition system	1	Some	Moderate

NOTE: These recommended practices were compiled from the Phase 1 Benchmarking Report. Specific questions regarding these practices were not posed to every state DOT consequently, there may be more states using these practices than indicated.

RECOMMENDATIONS

Based on the findings of this effort, there are two basic recommendations.

- Seek staffing levels as indicated by the generic division models.
- Implement the recommended practices as noted in Table 13.

Given the continuing increase in program levels, it is essential that some flexibility in staffing and improvement in processes be implemented. The FLH will define its minimum staffing levels for the entire organization in Phase III, but the backbone of delivering the five "key objectives" set out for this report will depend on the project delivery functions to develop employees, and provide technical assistance to assure that the federal transportation system of the future is efficient, safe and meets the needs of Federal users.

Phase III Issues

The FLH Leadership Team should consider the following issues during Phase III of this study:

- Determine the number of FTE and the percent of support services required as core functions to successfully achieve the five key objectives now and in the future.

- Consider Employee Retention, Recruitment and Training as critical in maintaining a quality organization that retains its' skills and expertise.

- Adjust core staffing levels to ensure meeting customer expectations (i.e. – make sure construction projects can be staffed to satisfy customer concerns.).

Subsequent to the Phase III evaluation, the FLH Leadership Team will need to also evaluate the following issues:

- Determine if, and to what extent, FLH should restructure to accomplish project delivery strategies.

- Develop a long term contingencies plan for increasing contracting out as needed to meet future ceiling/workload demands and determine ways to manage this increase and the associated risk.

- Develop a staffing strategy that assures FLH will always attract, internally develop and retain the required core number and quality personnel.

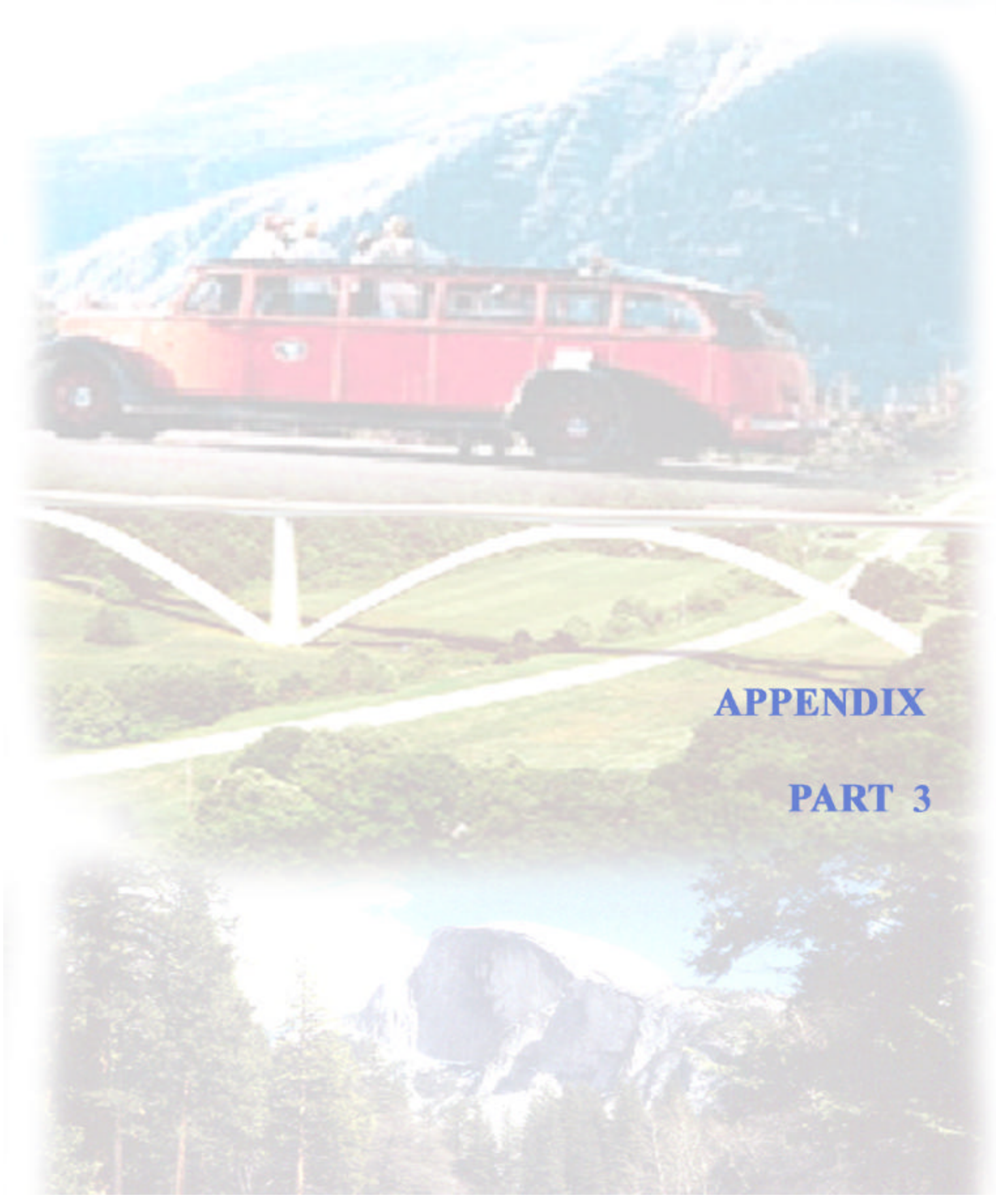
Conclusion

Building a foundation from the FLH Vision to "Create the best transportation system in balance with the values of Federal and Tribal lands" and the Mission to "Continually improve transportation access" and to "provide technical services to the highway community", the team has created a staffing model that will meet future program requirements and ensure engineering sustainability. The knowledge and lessons obtained from the Phase I data gathering from the State DOT's was used to calibrate and test the model.

Directions from the FLH Leadership Team have been used to establish the boundaries that the team used to focus their investigations. The twelve core functions listed previously cover the main portion of each Divisions engineering and technical functions. Extrapolations of the staffing model to a national program, one that includes FLH transportation planners, administrative and support staff, and the headquarters program managers, will be made during the Phase III portion of the study.

The future program values were selected to bracket the minimum program level that a core staff can adequately deliver up to a maximum $1 billion National construction program that could quite possibly occur. This range takes into consideration the most recent efforts of Tribal governments to work directly with FLH and it assumes some success by the Forest service to become a Highway Trust funded public road agency. Either of these two occurrences could feasibly double the existing program workload.

The internal and external drivers mentioned in the report; FLH Strategic Goals, Customer Value added, Building on Successes, Requirements for Future Successes, the Benchmarking Information, the Streamlining Task Force Report and the Futures Paper, have all influenced the discussions, debates and creation of the data assumptions that were used in the staffing model.



APPENDIX

PART 3

APPENDIX

Item 1

Core Function Definitions and Descriptions

ROADWAY DESIGN

Senior Engineer:

Highway Design Manager GS-810-13
Responsible for supervising a highway design staff in Project Development and managing highway design services to the Division's Project Managers. Manage the scheduling of all design activities (resources and durations) and the preparation of design. Provides expertise on Highway Design, Safety, and Quality Assurance. (Central Division Only). Eastern and Western Divisions have no Managers in this capacity. (Central and Western Divisions combined Safety with GS-2102-13 position).

Journey Level:

Highway Design (Quality Assurance) GS-810-12
Responsible for supervising a highway design staff in Project Development and managing highway design services to the Division's Project Managers. Manage the scheduling of all design activities (resources and durations) and the preparation of design budgets for all projects. Oversees the PS & E design process improvements.

Highway Engineer (CADD Coordinator) GS-810-11/12
Serves as the CADD Coordinator whose typical assignments pertain to the development of the application of computer software, support of all CADD users' hardware and software, and overall coordination of the computer environment for the Project Development Branch. Recognized as the technical expert for the implementation and support of the CADD tool throughout the Division.

Design Team Leader GS-802/810-11/12
Responsible for the conceptual, preliminary, and final design functions. This includes preparation of plans, specifications, and estimates (PS & E) packages for the construction of highways under a wide variety of terrain conditions. Assists and cooperates with the Lead Project Manager in the day-to-day operation and general supervision of the Design Staff. Performs coordination with Customer Agencies on Project Specific Issues. GS-11 is assigned less complex work.

Novice:

Designer Engineer GS-802/810-5/7/9
Performs assignments in accordance with prescribed procedures. Typical assignments pertain to the development of certain phases of a project. This includes development of technical design details, supporting documents, cost estimates, special contract requirements, and contract drawings for highway projects. Works under the guidance of the Design Team Leader.

HYDRAULICS

Senior Engineer:

Hydraulic Engineer GS-810-13
Responsible for sizing bridge waterway openings and computing scour, determining and designing mitigation for floodplain impacts, designing storm water management facilities, large culverts, storm sewer systems, energy dissipaters, channel relocations, and developing and administering water quality monitoring contracts. Also responsible for review of hydraulic design and erosion control on projects. Recognized as the National Expert on Hydraulic and Hydrology matters.

Journey Level:
Hydraulic Engineer GS-810-11/12
Serves as the specialist with expertise in the fields of hydrology and hydraulics as related to the location, design, and construction of culverts for roads and bridges. Recognized as the local expert on Hydraulic and Hydrology issues.
Novice:

Hydraulic Engineer GS-810-5/7/9 Serves under the guidance of the Team Leader. Provides assistance and continues to learn on developmental assignments.

PROJECT MANAGEMENT
Senior Engineer:

Lead Project Manager GS-810-13
Responsible for managing the development of highway design projects through either cross functional Division team members or private A/E contractors. Functions as the manager of cross functional teams responsible for the direction of professional and technical positions engaged in civil engineering work. Serves as a member of the Project Development Management Team to help manage the Project Development Branch, including business planning and management support. (GS-14 Special Major Projects Manager in Central Division; Combined function with Design Operating Engineer (DOE) in the Western Division).
Journey Level:

Highway Engineer (Project Manager) GS-810-11/12
Responsible for managing the development of selective highway design projects through either cross functional Division team members or private A/E contractors. The highway designs are primarily identified as being of less complexity and scope than those assigned to higher graded project managers.
Novice:
No "Novice Project Managers" on Staff. Entry level Engineers working in other core functions develop expertise to manage projects.

STRUCTURAL DESIGN

Senior Engineer:

Structural Engineer GS-810-13

Serves as the team leader on the Structures Staff for Federal Lands. Responsible for the planning, designing, directing, coordinating of the structural design, and the PS&E plan preparation functions. Expertise covers a wide range of structural engineering design, rehabilitation concepts or procedures, and construction of structural elements for complex and multi-faceted projects. (Two positions in the Western Division are not in a supervisory capacity).

Journey Level

Structural Design Engineer GS-810-11/12
Participates in the planning, designing, directing, and coordination of the structural design and the PS&E plan preparation for Federal Lands. Expertise covers a wide range of structural engineering design, rehabilitation concepts or procedures, and construction of structural elements for specific projects, many of which are typical from the viewpoint of construction and/or engineering.
Novice:

Structural Design Engineer GS-810-5/7/9
Serves under the direction of the Team Leader. Performs work on developmental assignments.

GEOTECHNICAL

Senior Engineer:

Lead Geotechnical Engineer GS-810-13
Serves as the Division's Geotechnical engineering specialist and team leader with responsibility for soil mechanics, foundation engineering, slope stability analysis, landslide engineering, pavement design, Geotechnical laboratory testing, field exploration, and Geotechnical computer programs. Leads and directs professional technical personnel on the Division's Geotechnical team. Provides technical review and oversight of Geotechnical consultant services.

Journey Level:

Geotechnical Engineer GS-810-11/12
Serves as a Geotechnical engineer in the areas of soil mechanics, foundation engineering, slope stability analysis, laboratory testing, and pavement design. Prepares task orders, negotiates scope of work, and monitors progress of A/E consultants doing Geotechnical work.

Novice:

Geotechnical Engineer GS-810-5/7/9
Serves as a Geotechnical engineer in the area of soil mechanics, foundation engineering, slope stability analysis, laboratory testing and pavement design. Analyzes field data and test reports and summarizes findings and recommendations in pavement evaluation and Geotechnical reports. Works on developmental assignments under the direction of the Team Leader.

ENVIRONMENTAL

Senior Engineer:

Environmental Engineer GS-810-13 or Environmental Specialist GS-0028-13
Principal advisor to the Division on the environmental impact of Federal Lands projects. Interprets policy and provides guidance, direction, and coordination in all matters with respect to all environmental legislation and executive orders. Serves as the Environmental team leader.

Journey Level:

Environmental Engineer GS-810-11/12 or Environmental Specialist GS-0028-11/12
Provides support to the Environmental Section of the Project Development Branch (Central and Western divisions only), as well as, technical assistance to other sections within the Division. Performs public and interagency relations, research, analysis, and environmental document preparation. Coordinates and serves as the Division co chair on the Social, Economic, and Environmental (SEE) Study Team and prepares SEE Study team Reports.

Novice:

Environmental Specialist GS-0028-5/7/9
Primary functions include assessment and evaluation of social, economic, and environmental impacts of transportation projects; writing environmental documents; public involvement coordination; and

oversight of contractors performing Division environmental work for complete environmental projects and/or studies.

CONSTRUCTION MANAGEMENT

Senior Engineer:

Construction Operations Engineer (COE) GS-810-13 – *Contract Engineering*
Expert in construction and is responsible to the Division's Construction Engineer for all construction operations on assigned projects. Provides professional engineering expertise and consulting services in solving engineering problems and controversial issues.-(Technical Expert).

Construction Management Engineer GS-810-13 – *Contract Administration*
Responsible for the development, organization, and overall supervision and management of the contract administration functions for the Federal Lands Highway construction program. Also, may serve as the Construction Operations Engineer (COE) on a limited number of projects as Division needs and workload may dictate.

Journey Level:

Highway Engineer GS-810-12 – *Contract Engineering*
Serves as the Project Engineer on projects, which are highly complex in nature. Responsible for the physical construction and contract management of highway projects under the jurisdiction of the Division. Serves as the Contracting Officer's Representative. Projects are major in size, complex, and difficult of contract management, and are often isolated from shipping points and population centers.

Contract Administration Technician GS-802-11 – *Contract Administration*
Responsible for the contract administration functions for the Federal Land Highways construction program. Works independently and serves under the direction of the Construction Management Engineer for Contract Administration.
Novice:

Highway Engineer GS-810-5/7/9– *Construction Engineering*
Serves as the project engineer on projects, which are simple in nature. May serve as Assistant project engineer on more complex projects requiring the direction of a Senior Project Engineer. Projects are generally environmentally sensitive, fall into the multi-million dollar cost range, and frequently encompassing several construction seasons.
Civil Engineering Technician GS-802-10 – *Construction Engineering*
Serves as project engineer on projects of moderate complexity. Performs assignments, which involve an understanding of standards for construction of roads and bridges on Federal Highway projects and the ability to read and interpret plans and other special provisions for such construction.

Assistant Construction Management Engineer GS-810-5/7/9 – *Contract Admin*
Serves under the guidance of the Construction Management Engineer for Contract Administration. Provides contract management support and continues in career growth while working on developmental assignments.

SURVEY & MAPPING

Senior Engineer:

Survey and Mapping Project Manager GS-810-13
Responsible for the survey, mapping, and right of way and utilities support functions for the Federal Highway functions within the Division. Paramount knowledge and skills necessary in this position are obtained from credentials obtained from either the professional engineering or professional land surveying series. Supervises and directs a subordinate office and field staff comprised of professional and technical personnel.

Journey Level:

Cartography Team Leader GS-1371-12 – *Mapping*
Responsible for directing all cartographic team activities. Has a full technical knowledge of a wide range of cartographic tasks and processes in the development, planning and implementation of various photogrammetric and digital mapping functions.

Survey Team Leader GS-1373-12 – *Survey*
Responsible for directing all Survey Team activities including technical personnel engaged in field and office survey positions. Reports to and receives guidance from the Survey and Mapping Project Manager. Recognized as the local expert on all survey matters.

Novice:

Survey Crew GS-1373-5/7/9 – *Survey*
Developmental position as a member of the Survey Team. Works under the direct guidance of the Survey Team Leader and performs a variety of survey office and field activities.

Cartographer GS-1371-5/7/9 – *Mapping*
Participates as a member of the Mapping Team. Receives developmental assignments from the Team Leader.

RIGHT OF WAY

Journey Level:

Team Leader Right of Way GS-1373-12
Serves as the local expert on major right-of-way issues.
Civil Engineering Technician (Right of Way Specialist) GS-802-11
Responsible for administering and performing surveying activities, mapping development processes, and right-of-way activities. Serves as the Right-Of-Way specialist concerned with various types of surveys and right-of-way plan preparations. Assists the Right-Of-Way Team Leader in the day-to-day operations of the Right-Of-Way Section.

Novice:

Right of Way Technician GS-802-5/7/9
Works on developmental assignments under the direction of the team leader.

MATERIALS

Senior Engineer:

Materials Engineer GS-810-13 – *Testing and Analysis*
Responsible for supervising a materials engineering staff while serving as a materials specialist in the fields of soils, aggregates, concrete, bitumen, asphalt, and quality assurance. Serves as a source of specialized expertise for training, research, experimental and demonstration projects in the areas of materials engineering.

Journey Level:

Materials Engineering Technician GS-810/802-12 – *Testing*
Specialist in subsurface exploration techniques for materials and Geotechnical engineering activities including the operation, use and interpretation of data obtained from the following:
Auger, rotary and core drilling equipment, geophysical exploration instruments, undisturbed sampling tools, insitu testing devices, and non-destructive pavement deflection and smoothness testing equipment. Specialists in determining which tests to run on samples received in the laboratory, on all laboratory testing procedures, and in the analysis of the results from these tests.

Highway Engineer GS-802-11 – *Analysis*
Performs duties in quality assurance, equipment calibration, equipment adjustment and repair, training, project materials sampling and testing, and hazardous materials handling. Provides engineering assistance mainly to the Materials Technical Support Engineer, and more limited, to the Materials Engineer.

Novice:

Materials Engineering Technician GS-802-5/7/9 – *Testing*
Works on developmental assignments under the guidance of the Materials Engineering Technician for Testing.

Materials Engineering Technician GS-802-5/7/9 – Analysis
Performs developmental work in the areas of material analysis. Serves under the guidance of the Highway Engineer for Analysis.

SAFETY

Senior Engineer:

Highway Safety Engineer GS-810-13

Serves as the Division technical expert on highway safety matters. Advances state-of-the-art technology, procedures, and programs to improve highway safety and provides technical assistance in safety issues to our partner agencies.

Journey Level:

Highway Safety Engineer GS-810-11/12
Serves as an assistant to the Division Highway Safety Engineer on issues related to highway safety. Assist with the implementation of policy, procedures, and programs to improve highway safety. Performs.

Novice:

Highway Safety Engineer GS-810-5/7/9
Serves under the guidance of the National Safety expert. Works on developmental assignments related to highway safety technical, policy, and procedural matters.

TRAFFIC ENGINEERING
Senior Engineer:

Traffic Operations Engineer GS-810-13
Serves as the FLH's national authority for promoting, coordinating, and implementing the various highway traffic operations, safety programs, and Intelligent Transportation Systems (ITS). Promotes the development and implementation of innovative and state-of-the-art technologies, practices, and products to meet the Divisions transportation related needs.

Journey Level:

Traffic Operations Engineer GS-810-12
Serves as the local expert on Division's transportation related needs. Works closely with the National Traffic Operations expert in implementing the various highway operations.

Novice:

Traffic Operations Engineer GS-810-5/7/9
Serves under the guidance of the Traffic Operations Engineer. Performs developmental assignments in the various areas of highway traffic operations.

Item 2

Estimated Range of Typical Project Development Costs

Activity	Percentage of Construction Costs
$ Preliminary and Final Design (Contract Documents, PS&E)	.8% to 10%
$ Environmental Process	
Environmental Assessment/FONSI	4% to 6%
Environmental Impact Statement (Following Completion of EA)	.2% to 3%
Environmental Impact Statement (EIS from the start)	6% to 8%
$ Construction Management	
DOT	8% to 10%
Municipal	4% to 6%
$ Right-Of-Way Plans and Legal Descriptions	.$2,000 to $2,500 per Parcel

Note:
The percentages shown represent typical consultant costs only; other project costs such as Agency staff time and expenses are not included.

Source: HNTB Consultants, 1997

Item 3

Recommended Practice's from State DOT's	**States using these Practices (CO25 = Colorado, page 25 in Phase 1 Benchmarking Study report)**
Retain Complex, interesting projects in-house	CO25,FL37,IN41,KS52,MD66,NV74,NM85
Develop Scholarship programs to attract prospective recruits	KY58,IN47
Pay banding, recruitment, retention bonuses, and alternative pay schedules for EIT and PE licenses	IN47,KS53,KY61,MD66,NM88,OR95
Develop a design matrix to determine which projects go to A/E	OR95
Require A/E design firms to use same software packages and in-house	AZ17
Establish post contract reviews to learn what went well and what did not	KS51,KY58
Working repeatedly with specific A/E firms	AZ15,CN31,FL36,IN46,KS53,KY59,MD69,NV76,OR94
Bundling small or similar projects into more manageable an economic sizes	AZ10,FL36,TN105
Limiting the outsource work to no more than 80%	AZ14,CN30,KS52,KY57
Design team on board through construction	CN29,FL36,IN48,KY58,NV74,NM89,OR95,TN105
Lump Sum design for more efficient and timely deliveries	AZ10,FL36
Combined Training for Project Management, construction & other in-house and consultants personnel	AZ10,FL37,IN44,MD66,NV74,NM85,OR94,TN105
Partnering during combat work and continuous periodic partnering with contractor, industry prior to contract work	AZ11,IN45,KS50,KY58
Competes for work against consultants	AZ10,IN41
Sensitive to where people want to work, employee flexibility, family friendly policies	AZ11,KS50,MD66
Include construction contingency items in PS&E	AZ11,FL36,NV74
Construction Inspector Training and certification required	AZ13,FL36,KS51,NV74,NM85
Hold frequent status meetings and employ good scheduling methods	AZ17,KS54,IN49,KY58,MD66,NV76,NM85,OR94
Review consultant designs for scope and guidelines, not for technical accuracy	AZ17,MD66,IN48

Standard clause for consultant liability in all contracts	AZ18
Give employees projects with increasing difficulty	CO24
Holds contract retainage for task order work	CN29,IN4,NV80,NM85,TN106,IL42,KS56
Consultant prepares SOW for task order work at no charge to State DOT	CN29
Constructability reviews or VE studies during project development	CN32,FL38,KS51,NV74
Prequalification process once/year for A/E's	CN32
Consultant evaluation process	FL36,IN45,OR94,TN105
A + B bidding to reduce contract time and oversight time	FL38
Preliminary design & environmental scoping before contract task order work. The whole cross-sectional team partcipates	FL38,IN45,KS53,KY58
Consultants live in and pay taxes in State	IN44
Checklist review for consultant designs	IN44,NM90
School outreach programs	KY58,MD66
All design employees attend context sensitive design training	KY58
Limits overtime and comp-time to retain employee quality of life	MD66
Graduate Engineer training program	MD66,NM85
Technical career track positions	MD66
Consultant overhead and salary caps	MD66,NV76
Categorize contract change orders to identify trends	MD66
Cross-functional team develops project delivery schedule and includes construction liaison	NM85,TN104
Include disincentive clause on A/E contracts for contracts not completed on time	NM85
Assist employees to become PE's	OR95
Improved Performance recognition system	TN106

These recommended practices are compiled from the Phase 1 Benchmarking Report. Specific questions regarding these practices were not posed to every state DOT consequently, there may be more states using these practices than indicated.

Item 4

BASIC CORE STAFFING MODEL FOR CRITICAL MASS

Year from Base		1	2	3	4	5	6	7	8	9	10
Novice	Current	4	4	4	4	4	4	4	4	4	4
	Losses/Attrition	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4
	Losses/Journeyman	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
	New Hires	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
	Total	4	4	4	4	4	4	4	4	4	4
Journey	Current	4	4	4	4	4	4	4	4	4	4
	Losses/Attrition	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4
	Losses/Senior	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
	Losses/FHWA	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
	Gains From Novices	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
	Total	4	4	4	4	4	4	4	4	4	4
Senior	Current	2	2	2	2	2	2	2	2	2	2
	Losses/Attrition	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
	Losses/Management	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
	Losses/FHWA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Gains From Journeyman	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	Total	2	2	2	2	2	2	2	2	2	2

Year from Base		11	12	13	14	15	16	17	18	19	20
Novice	Current	4	4	4	4	4	4	4	4	4	4
	Losses/Attrition	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4
	Losses/Journeyman	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
	New Hires	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
	Total	4	4	4	4	4	4	4	4	4	4
Journey	Current	4	4	4	4	4	4	4	4	4	4
	Losses/Attrition	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4
	Losses/Senior	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
	Losses/FHWA	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
	Gains From Novices	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
	Total	4	4	4	4	4	4	4	4	4	4
Senior	Current	2	2	2	2	2	2	2	2	2	2
	Losses/Attrition	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
	Losses/Management	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
	Losses/FHWA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Gains From Journeyman	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	Total	2	2	2	2	2	2	2	2	2	2

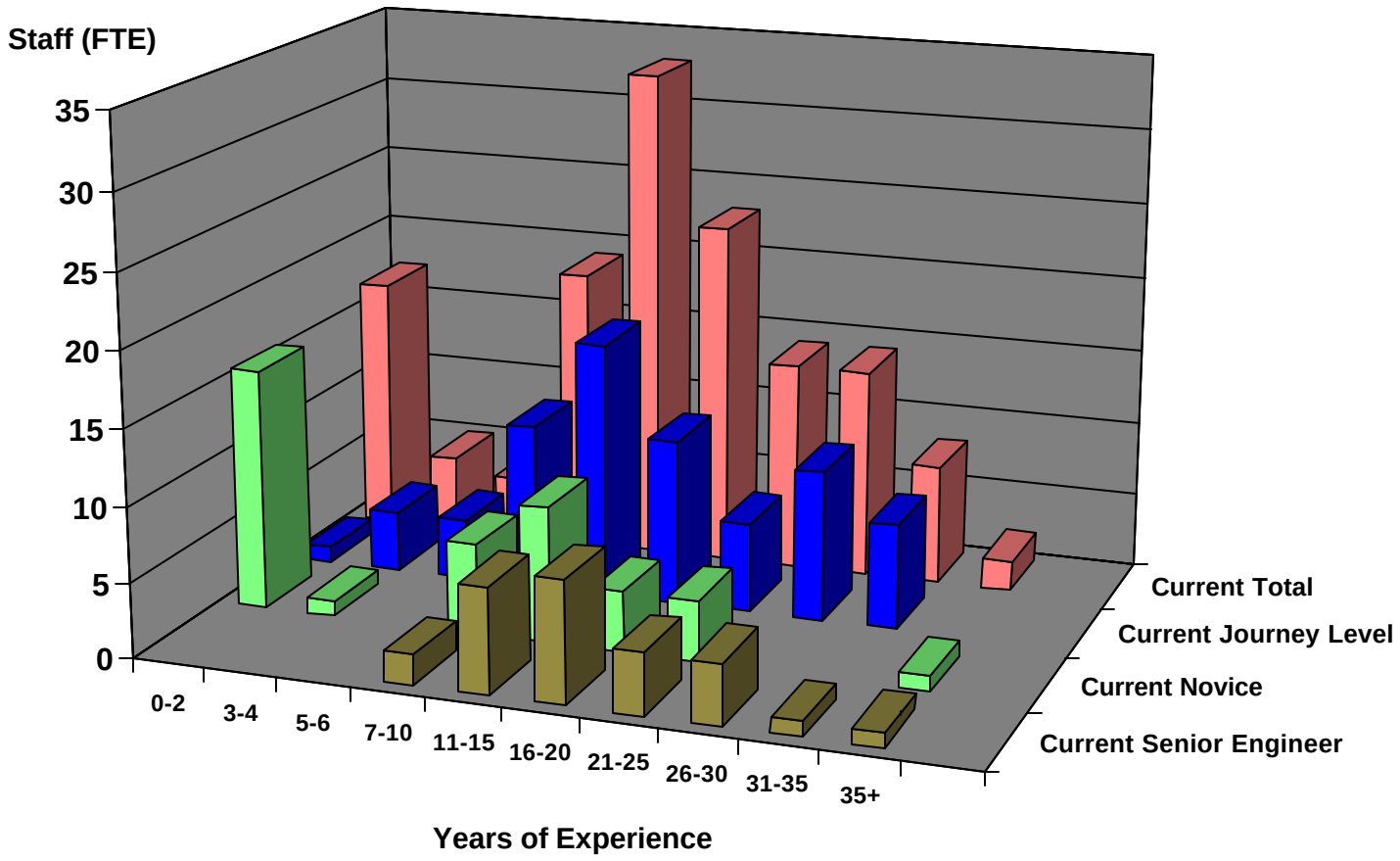
Assumptions

Attrition rate (10%) is equally spread out over all 3 experience level groups
Additional loss rate to other FHWA over gains from Federal-aid offices is 2% per year for Journey and Senior levels
Assume no Novice loses to FHWA

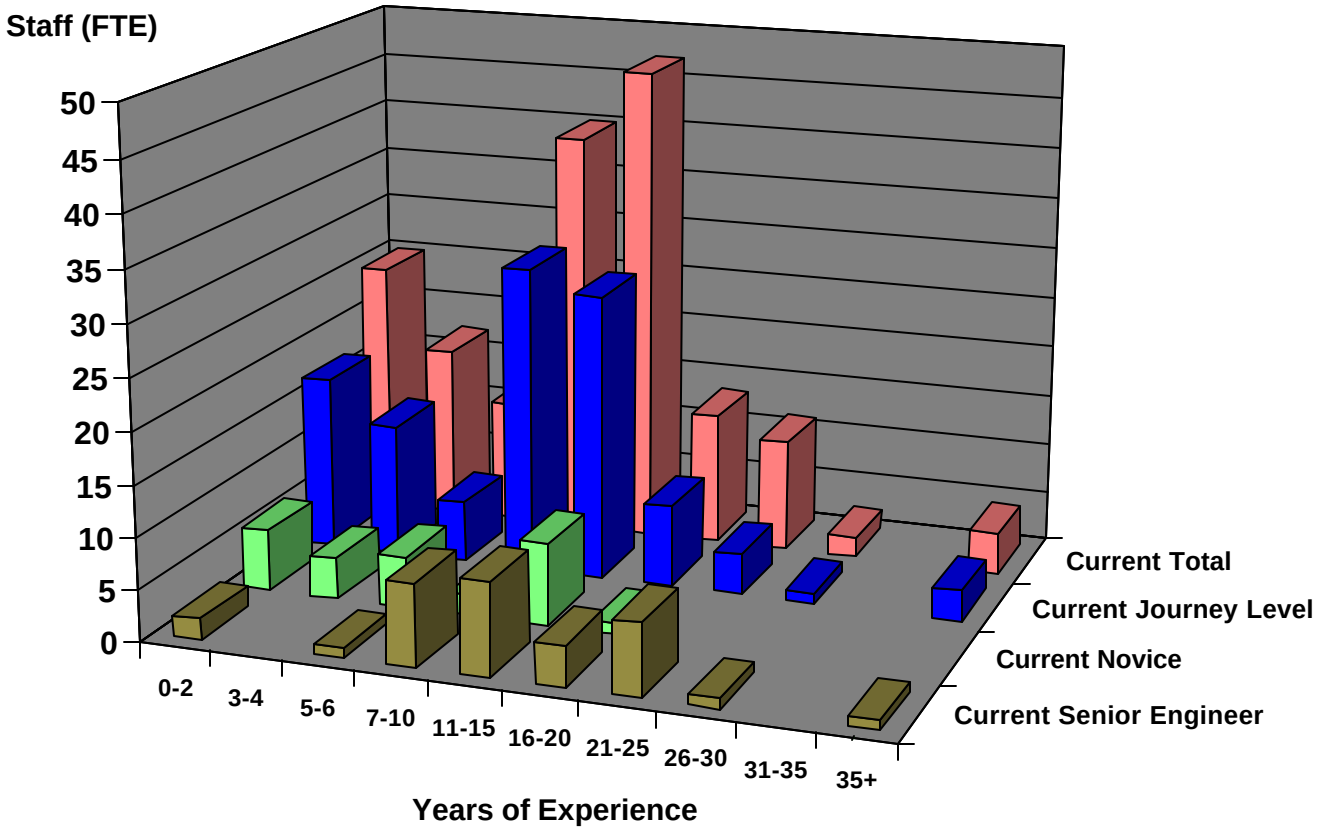
	Average Years	Attrition Rate/Yr	Losses to FHWA	
Average Time in Novice Position	4	0.1	0	(GS 5-9) - 0 to 5 years professional experience
Average Time in Journey Position	8	0.1	0.02	(GS 11-12) - 2 to 10 years professional experience
Average Time in Senior Position	10	0.1	0.02	(GS 13) - 8+ years professional experience

Item 5

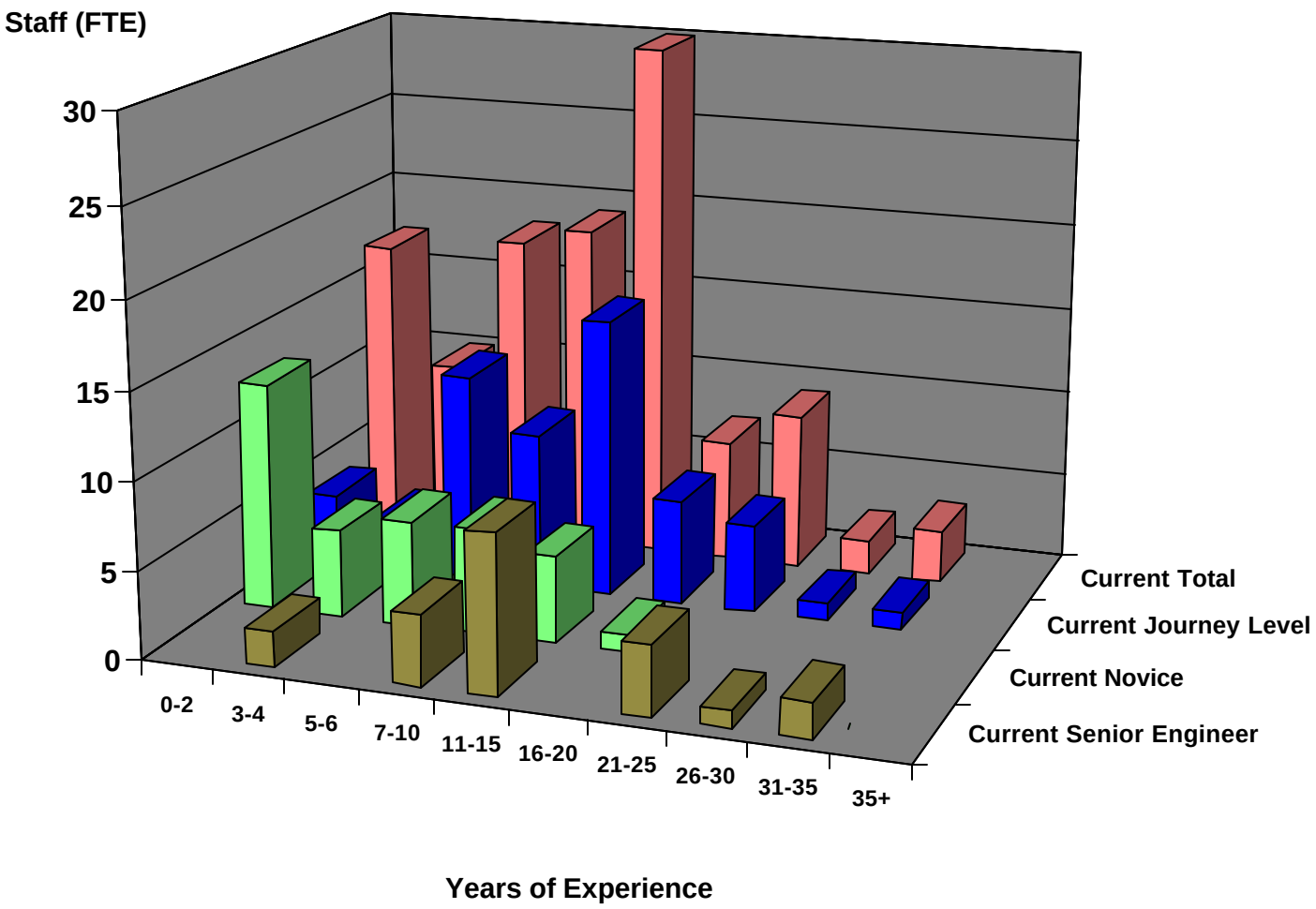
Existing FLH Division Staffing Profile – Central Federal Lands



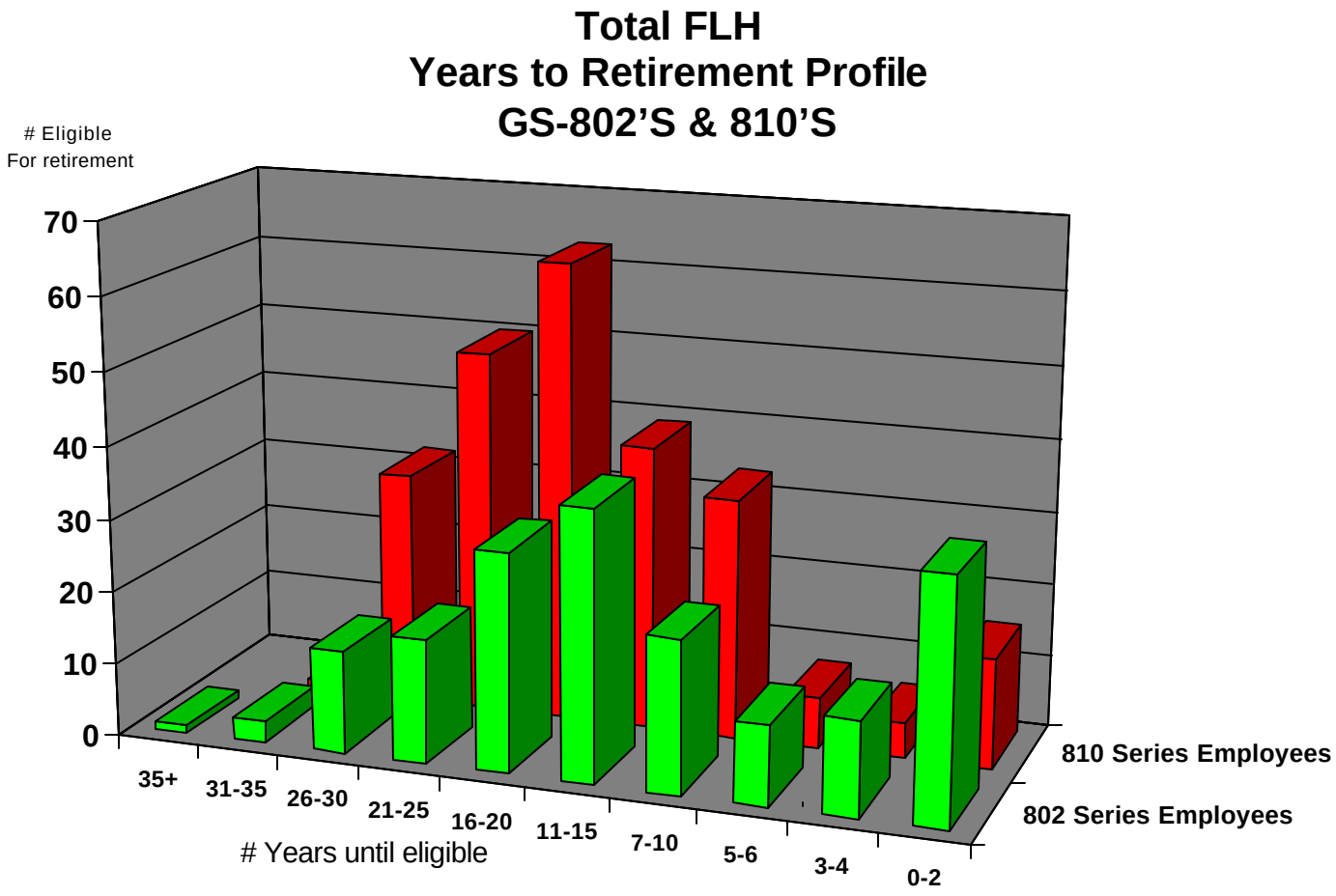
Existing FLH Division Staffing Profile – Eastern Federal Lands



Existing FLH Division Staffing Profile – Western Federal Lands

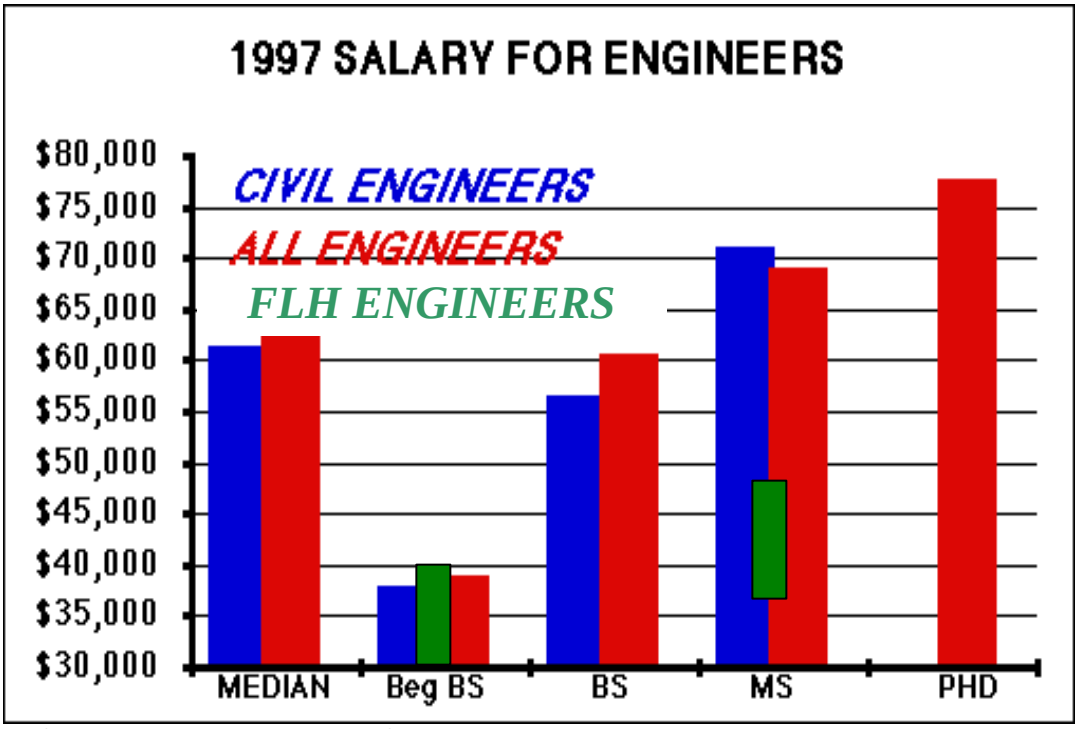


Item 6



Indicates 20% of the core staff will be eligible for retirement in five to six years.

Item 7



The figure is based on data taken from Engineers' Salaries: Special Industries Report 1996, Engineering Workforce Commission of the AAES, 1996, p. 17-22, 205-209.

1997 engineers salary at GS-7 level was $30,848 step 1. It was $40,093 at step 10.

1997 engineers salary at GS-9 level was $37,727 step 1. It was $49,045 at step 10.

Item 8

CONSULTANTS INTERVIEW SUMMARIES

CH2M Hill Interview Summary (Lakewood, Co - July 26, 2000)

Summary of Key Points from Interview:

- Focus Good Project Managers - Project Managers must have technical experience or strong lead engineer skills.

- Have 4-5 levels of Project Managers (salary $50-120k + bonus and stock options).

- Core staff includes Roadway Designers, Technicians, Traffic Engineers, Project Managers, Junior Designers, Bridge Engineers, Geotechnical, and Environmental.

- Smaller offices must have Project Managers, lead engineer, Technicians and junior staff as a minimum.

- Pay based on years of experience.

- 4 regions, 12 offices, 3 business groups – only some offices have core competencies.

- Expect 75% billable on a 40 hour basis.

- 4-8% turnover

- No outsourcing of key staff, some contract drafting.

- Strategy is to do core work with own people.

- Workload balancing meeting, every two weeks.

- QA/QC may be 10% of an 100 hour job.

- Select offices based on customer locations.

- Best DOT models in their opinion – Colorado, Wisconsin, Oregon.

Project Time and Cost Consultants Interview Summary (6-14-99),
(Notes by Rick West)

Interviewed with: Mike Deters, CCE, Executive Vice President
Gary Haddle, CCE, Vice President

- They use $1000/ year per person for a training budget

- Try to keep good people by using psychological factors:
  People in the organization are the key to its success
  Once/month, employees do a presentation of his/her work - (In- house training that rotates monthly)
  Keep people challenged and they remain happy
  Management communication is very important - What's happening in the company?
  Keep work diverse

- Hire people with 2-4 years experience (Found that they are the best employees and that they can keep them.

- They do not recruit from colleges.

- Provide 1 week Primavera Scheduling (P3) classes to their PM's for construction activities.

- Weekly meeting to dole out work. They do not use P3 to do this.

- Use 4-8 hours to plan projects that have durations of 1 to 2 months. ($120,000)

- Use 4-8 hours to plan projects that have longer durations and are $150,000+. They require external quality control and independent review by management in-house for these type projects.

- Use 1 hour planning time for projects that take 1 week.

- Pay non-billable employees on Overhead for 60-90 days. Selective lay-offs occur after that.

Item 9

Existing Core Function Staffing Levels by Division

Generic Division – Core Function Staffing Distribution

Project Delivery Core Functions	Generic Base	Current Avg. Division	CFL	EFL	WFL
Roadway Design	20	28	30	28	25
Hydraulics	3	2	3	2	2
Project Management	10	7	8	5	5
Structural Design	10	10	0	28	4
Geotechnical	10	6	5	8	8
Environment	10	7	8	2	8
Construction Management	30	62	63	74	51
Survey and Mapping	12	8	15	4	15
Right-of-way and Utilities	3	3			
Materials	10	9	13	6	9
Safety	3	1	1	0	0
Traffic Engineering	3	1	0	1	0
Total	**127**	**144**	**146**	**158**	**127**

Item 10

Recruitment of Engineers Supporting Data

BUSINESS PRACTICES FOR SUCCESSFUL FIRMS CASE SURVEY OF TRAINING AND CONTINUING EDUCATION PRACTICES - (Data Provided by AOI Consulting)

TRAINING NEW ENGINEERS

92% of the respondents said that they lost money on newly graduated engineers for an average of 9.7 months. For this reason the training program to bring new engineers up to speed is particularly important. Most training is "on the job" consisting of close coordination between the new engineer and his or her supervisor or mentor.

Trying to compare the varied training programs of the firms is difficult but a few trends are apparent.

- 83% of firms spend an average of 1.2 days familiarizing the new engineer with general office procedures.

- 78% spend an average of 1.5 days acquainting the new engineer with general engineering procedures, available computer programs and design aids etc.

- 22% train the engineer by having them gain 1 to 6 weeks of CAD experience.

- 39% have the new engineer spend two or more weeks reviewing the calculations of other engineers.

- 78% report that after the above training, they start the new engineer on simple projects.

- 87% have the engineer's direct supervisor serve as a mentor, 36% of firms assign a mentor in addition to the direct supervisor and 13% have someone other than the direct supervisor serve as mentor.

- 26% will have the new engineer work with a senior detailer who plans and coordinates the projects, while the new engineer only designs the various structural members.

- 26% have new engineers charge time spent becoming familiar with a design procedure for a project, to an overhead project number rather than charging this time to the project.

BIBLIOGRAPHY

FLH Futures Paper – FLH 2000: Embracing the Future As We Honor the Past, June 2000

FLH Streamlining Task Force, Final Report, August.1995

FLH Phase I Benchmarking Report, September 2000

Louisiana Department of Transportation and Development, In-House Versus Consultant Design Cost Study, October 1998

New Mexico Staffing Plan Survey of State Transportation Agencies

Wilbur Smith Staff /Recruiting/Retainage Study

CH2MHill and Time and Cost consultants interviews