United States Government Accountability Office

GAO

Report to the Ranking Member, Committee on Veterans' Affairs, House of Representatives

December 2009

# VA CONSTRUCTION

# VA Is Working to Improve Initial Project Cost Estimates, but Should Analyze Cost and Schedule Risks

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# Highlights

Highlights of GAO-10-189, a report to the Ranking Member, Committee on Veterans' Affairs, House of Representatives

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## VA Is Working to Improve Initial Project Cost Estimates, but Should Analyze Cost and Schedule Risks

### Why GAO Did This Study

The Department of Veterans Affairs (VA) operates one of the largest health care systems in the country. As of August 2009, VA's Veterans Health Administration (VHA) had 32 major ongoing construction projects with an estimated total cost of about $6.1 billion and average cost per project of about $191 million. Some of these projects were initiated as part of VA's Capital Asset Realignment for Enhanced Services (CARES) process, which was a comprehensive assessment of VHA's capital asset requirements.

In response to a congressional request, GAO (1) described how costs and schedules of current VHA major construction projects have changed, (2) determined the reasons for changes in costs and schedules, and (3) described the actions VA has taken to address cost increases and schedule delays. To do its work, GAO reviewed construction documents, visited three construction sites, and interviewed VA officials.

### What GAO Recommends

To provide a better estimate of the cost and completion date of a construction project, GAO recommends that the VA Secretary, for all major projects, conduct a cost risk analysis, a schedule risk analysis when appropriate, and require the use of an integrated master schedule. VA concurred with our recommendations.

View GAO-10-189 or key components.
For more information, contact Terrell G. Dorn at (202) 512-6923 or dornt@gao.gov.

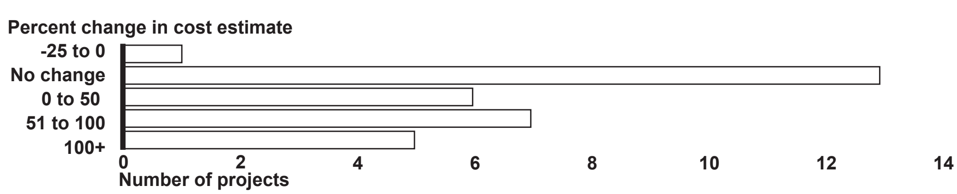
### What GAO Found

While about half of the 32 major ongoing construction projects are within their budget, 18 projects have experienced cost increases and 11 have experienced schedule delays since they were first submitted to Congress. Five projects have experienced a cost increase of over 100 percent. For example, the cost of a new medical center in Las Vegas rose from an initial estimate of $286 million to over $600 million, an increase of about 110 percent. Thirteen projects have experienced cost increases of between 1 and 100 percent. In addition, 11 projects have experienced schedule delays, 4 of which are more than 24 months.

There are several reasons for construction project cost increases and schedule delays, including VA preparing initial cost estimates that were not thorough, significant changes to project scope after the initial estimate was submitted, and unforeseen events such as an increase in the cost of construction materials. According to VA officials, VA prepared numerous estimates during the CARES process, and some of these estimates used rudimentary estimating techniques such as average cost-per-square-foot and were completed by VA staff that did not have cost estimating expertise. The scope of some projects changed after VA submitted an estimate to Congress, which increased the projects' costs. For example, the scope for the original design for a new medical center in Las Vegas did not fully account for the amount of medical services the center would need to provide. As a result, the original estimate of $286 million rose to over $600 million.

VA has taken steps to improve initial construction project cost estimates, but could better assess the risks to costs and schedules. VA plans to prepare more comprehensive estimates after approving projects and before submitting them to Congress. It is not clear how effective this new process will be, but it could improve VA's estimates. While VA contractors follow construction scheduling procedures that generally meet best practices, VA does not conduct cost or schedule risk analyses, which use statistical techniques to predict risks that can lead to cost increases and schedule delays. Thus, VA cannot quantify the largest risks to a project or mitigate those risks. For example, GAO conducted a schedule risk analysis for a medical center in Las Vegas and found that there is a 50 percent chance that the project won't be finished until more than 6 months after its estimated completion date. VA also does not require an integrated master schedule that includes VA and contractor efforts for all project phases, which can be critical to a project's success.

**Range of Cost Changes in Ongoing Projects**




Source: GAO analysis of VA data.

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## Abbreviations

| | |
|---|---|
| A/E | architect/engineering |
| CARES | Capital Asset Realignment for Enhanced Services |
| CFM | Office of Construction and Facilities Management |
| NCA | National Cemetery Administration |
| OMB | Office of Management and Budget |
| PVA | Paralyzed Veterans of America |
| SCI/D | Spinal Cord Injury/Disease |
| SRA | Schedule Risk Analysis |
| VA | The Department of Veterans Affairs |
| VBA | Veterans Benefits Administration |
| VHA | Veterans Health Administration |
| VISN | Veterans' Integrated Service Network |

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**United States Government Accountability Office**
**Washington, DC 20548**

December 14, 2009

The Honorable Steve Buyer
Ranking Member
Committee on Veterans' Affairs
House of Representatives

Dear Mr. Buyer:

The Department of Veterans Affairs (VA) operates one of the largest health care systems in the country. VA, through its Veterans Health Administration (VHA), provided health care to almost 5.5 million veterans in 2008. VA constructs new medical facilities and also maintains and renovates existing medical facilities. Any major medical facility construction project over $10 million must be specifically authorized by law.[1] As part of that approval process, VA sends a prospectus to Congress[2] that contains information about each planned major project. This information includes an initial estimate of the overall cost of the project and, in some cases, a completion date of the project.[3] As of August 2009, VHA had 32 ongoing major construction projects with an estimated total cost of about $6.1 billion and average project cost of about $191 million.

While VA has undertaken a number of major construction projects in recent years, you have expressed concern that some of these projects have increased in cost, are behind schedule, or both. To provide you with information on the costs and schedules of VA's major construction projects, this report (1) describes how costs and schedules of current VHA major construction projects have changed since they were first submitted to Congress, (2) determines the reasons for changes in costs and schedules, and (3) describes the actions VA has taken to address cost

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[1]The term "major medical facility project" means a project for the construction, alteration, or acquisition of a medical facility involving the total expenditure of more than $10 million. See 38 U.S.C. § 8104. For purposes of this report, we are referring to these projects as "major construction projects."

[2]According to 38 U.S.C. §§ 8101 and 8104, the prospectus, or initial estimate, is sent to the House and Senate Committees on Veterans' Affairs. For purposes of this report, we refer to this as sending the prospectus to Congress.

[3]We refer to this prospectus as the "initial estimate" throughout this report because the prospectus contains the first estimate that VA provides to Congress.

increases and schedule delays as well as the challenges VA faces in managing its major construction program.

To do our work, we reviewed VA data on current major construction projects, including the original cost estimates and completion dates submitted to Congress and the project's current status. We reviewed and analyzed construction documents and interviewed VA officials. To obtain detailed information on specific projects, we selected three major construction sites to visit based on their phase of construction and overall estimated cost. We visited construction sites in Cleveland, Ohio, Las Vegas, Nevada, and Syracuse, New York to determine the reasons for changes in costs and schedules. In addition, we researched and reviewed relevant laws relating to the amounts that were authorized and appropriated for these projects. We also performed a risk analysis of the construction schedule for a new medical center in Las Vegas—one of VA's largest ongoing projects—to determine, among other things, the likelihood of its being completed on time. We selected each site based on their relatively high construction costs and the fact that construction was in progress. The information from our site visits is illustrative and cannot be generalized to sites agencywide.

We conducted this performance audit from October 2008 through December 2009 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We determined the data were sufficiently reliable for the purposes of this report. Appendix I contains a detailed description of our scope and methodology.

## Background

Most VA major construction projects are for VHA medical facilities.[4] To determine potential new major construction projects, VHA officials identify gaps in health service during their strategic planning process, and VHA officials in field offices develop capital needs plans to fill these service gaps. These capital plans are then reviewed by a Capital Investment Panel that gives each proposed project a score based on a

[4]While the Veterans Benefits Administration (VBA) and the National Cemetery Administration (NCA) are also authorized to construct major projects, as of August 2009, VBA had no active major construction projects and NCA had 20 projects with a total cost of about $450 million. For the purposes of this report, we focused on VHA projects.

number of factors, including, among other things, the plan's effect on health care, safety, and energy use. The Capital Investment Panel then produces a priority list of projects, and the Secretary of VA determines how many projects to request for funding each year and works with the Office of Management and Budget (OMB) to produce VA's part of the President's budget. Some large projects, such as the construction of a new medical center, can be divided into distinct phases and funded over several years. When the President submits VA's budget to Congress, the budget includes a prospectus for each proposed major construction project. This prospectus includes, among other things, a cost estimate for the project that VA staff has assembled. In addition, some prospectuses include an estimated month and year that the project will be completed, although this is not required by law. This prospectus is the initial estimate that VA sends to Congress. Congress uses this information to authorize and appropriate funds for the project.

In 1999, we reported that with better management of its large, aged capital assets, VA could significantly reduce the funding used to operate and maintain underused, unneeded or inefficient properties.[5] We further noted that the savings could be used to enhance health care services for veterans. Thus, we recommended that VA develop market-based plans for realigning its capital assets. In response, VA initiated a process known as the Capital Asset Realignment for Enhanced Services (CARES)—a comprehensive, long-range assessment of its health care system's capital asset requirements. As a result of CARES, VA requested funding for about 30 new major construction projects in fiscal years 2004 and 2005. While 8 of these projects have been completed, many are among the 32 ongoing projects. This effort required VA to prepare initial estimates for each project over the course of a few months. In the 2 years prior to CARES, VA proposed fewer than five major construction projects each fiscal year. According to VA, the CARES process was a onetime major initiative. However, its lasting result was to provide a set of tools and processes that allow VA to continually determine the future resources needed to provide health care to our nation's veterans.

VA's Office of Construction and Facilities Management (CFM) is responsible for administering major construction projects. Once a project has been authorized by law and Congress appropriates funds for it, CFM

[5]GAO, *VA Health Care: Capital Asset Planning and Budgeting Need Improvement*, GAO/T-HEHS-99-83 (Washington, D.C.: Mar. 10, 1999).

staff contracts with an architect/engineering (A/E) firm to design the project. The A/E firm develops an architectural design for the project and also produces a cost estimate for the entire project. This cost estimate is generally more detailed and accurate than the initial cost estimate. After the project has been designed, CFM then solicits bids for project construction and awards a construction contract. The construction contractor is responsible for developing a detailed construction schedule. CFM reviews the construction schedule and also assigns CFM engineers to work on-site as project managers to monitor the construction process until the facility is ready to be turned over to local VA staff. Once construction begins, the construction company is generally responsible for cost increases and schedule overruns under the terms of the fixed-price contract, unless VA and the contractor agree to a change order to the construction contract to modify scope, account for unforeseen conditions, or remedy a design error.

We have reported that cost estimates that are completed when a project is in the conceptual stage have a high degree of uncertainty.[6] As a project progresses, this degree of uncertainty decreases because risks are mitigated or realized. However, we have also found that cost estimates tend to be lower than the final project costs because program managers and decision-makers do not always consider all of the potential risks to a project and tend to be optimistic when planning a project.

Cost estimating requires both science and judgment. Since answers are seldom—if ever—precise, the goal is to find a reasonable "answer."[7] Cost estimates are based on many assumptions, including the rate of inflation and when construction will begin. Generally, the more information that is known about a project and is used in the development of the estimate, the more accurate the estimate is expected to be.[8] OMB's guidance for preparing budget documents identifies many types and methods of estimating project costs. The expected accuracy of the resulting project cost estimates varies, depending on the estimating method used.

[6] GAO, *GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs*, GAO-09-3SP (Washington, D.C.: March 2009).

[7] GAO-09-3SP.

[8] Office of Management and Budget, *Capital Programming Guide*, Supplement to OMB Circular A-11, Part 7, "Planning, Budgeting, Acquisition, and Management of Capital Assets" (Washington, D.C.: June 2006); and GAO-09-3SP.

## Costs Have Increased for 18 of the 32 Construction Projects and Schedules for 11 Construction Projects Have Been Delayed

While about half of VHA's ongoing major construction projects are within budget, 18 projects have experienced cost increases and 11 have experienced schedule delays. The cost for one project has decreased since the original estimate for it was submitted to Congress.

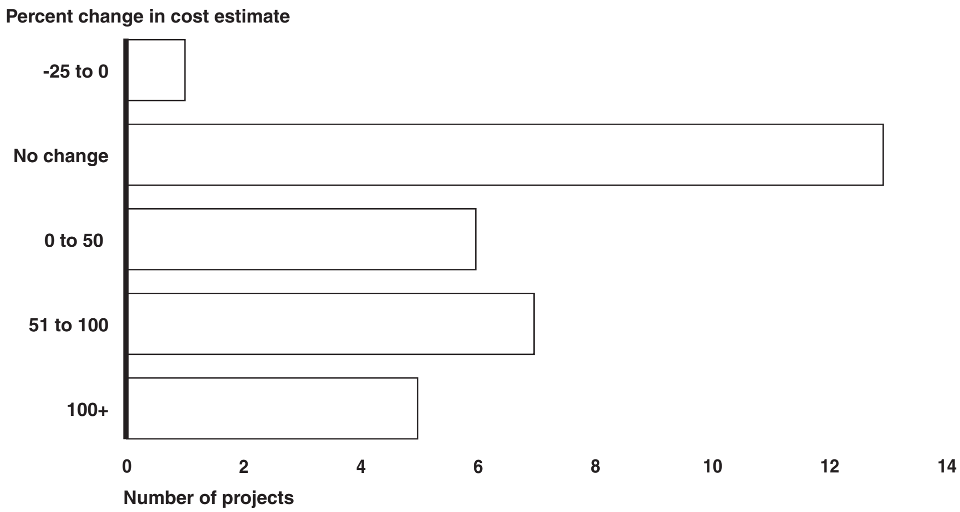
### Several Projects Have Experienced Cost Increases

Eighteen of the 32 ongoing VHA major construction projects have experienced cost increases.[9] When a project's cost increases, VA can receive a new authorization and an additional appropriation from Congress. Without additional funds from Congress, VA must alter the scope of the project to ensure that the project does not exceed the amount Congress has appropriated for the project by more than 10 percent.[10] The cost increases that these 18 projects have experienced since the estimates were initially submitted to Congress range from 2 to 285 percent. In addition to those 18 projects, the costs of 13 projects have not changed, and 1 project has experienced a cost decrease. Figure 1 shows the range of cost changes in ongoing VHA major construction projects.

[9]In this report, we only discuss costs of construction. However, the total cost of a capital asset is its full life cycle cost, including all direct and indirect costs for planning, procurement, operations and maintenance, and disposal in addition to construction. See OMB Circular A-11, *Capital Programming Guide*.

[10]VA must notify the House and Senate Committees on Veterans' Affairs at least 30 days before obligating funds for a major medical construction project that would exceed the amount authorized in law by more than 10 percent and provide the reasons for the amount being exceeded. See 38 U.S.C. § 8104(c).

**Figure 1: Range of Cost Changes in Ongoing Projects**




Source: GAO analysis of VA data.

Five projects have experienced a cost increase of more than 100 percent. These projects include new construction and seismic corrections (which are improvements to a structure to make it less susceptible to earthquakes). For example, in its fiscal year 2006 budget submission, VA submitted a $286 million estimate to Congress for a new medical center in Las Vegas, Nevada. However, VA estimated in 2007 that the project would cost just over $600 million (an increase of 110 percent) and in 2008 the project's authorization was modified and the project received an additional appropriation from Congress. However, VA now estimates that the project will cost about $100 million less than it anticipated.[11] More information about the new medical facility in Las Vegas is in appendix V.

Seven projects experienced a cost increase between 51 and 100 percent and six projects experienced a cost increase between 0 and 50 percent. These projects vary in size and type, from a modernization of patient wards in Georgia that is estimated to cost about $24.5 million to a new

[11] VA officials told us that construction costs have decreased since 2008 largely because of the economic downturn and construction projects that are awarded now and in the near future may be completed at a lower cost than they had estimated. According to VA officials, VA is considering using the remaining unobligated appropriated funds for the project in Las Vegas for additional construction at the medical center site, such as adding administrative offices or a utility tunnel.

medical center in Louisiana that is estimated to cost $925 million. All projects that experienced a cost increase are listed in table 1.

**Table 1: Ongoing Projects That Experienced a Cost Increase as of August 2009**

| Location | Description | Initial estimate | Estimated cost as of August 2009 | Cost increase | Percent increase |
|---|---|---|---|---|---|
| Las Vegas, NV | New medical facility | $286,000,000 | $600,400,000 | $314,400,000 | 110 |
| Orlando, FL | New medical facility | 347,700,000 | 656,800,000 | 309,100,000 | 89 |
| New Orleans, LA | New medical facility | 636,000,000 | 925,000,000 | 289,000,000 | 45 |
| Denver, CO | New medical facility | 621,000,000 | 800,000,000 | 179,000,000 | 29 |
| San Juan, PR | Seismic corrections | 145,200,000 | 299,200,000 | 154,000,000 | 106 |
| St. Louis, MO | Medical facility and cemetery improvement | 69,053,000 | 211,300,000 | 142,247,000 | 206 |
| Biloxi, MS | Hospital restoration/consolidation | 174,600,000 | 310,000,000 | 135,400,000 | 78 |
| Pittsburgh, PA | Medical center consolidation | 185,076,000 | 295,600,000 | 110,524,000 | 60 |
| Bay Pines, FL | New outpatient clinic | 65,100,000 | 131,800,000 | 66,700,000 | 102 |
| Gainesville, FL | Renovate patient rooms | 85,200,000 | 136,700,000 | 51,500,000 | 60 |
| San Juan, PR | Seismic corrections | 50,000,000 | 89,473,968 | 49,473,965 | 79 |
| Palo Alto, CA | Seismic corrections | 14,013,000 | 54,000,000 | 39,987,000 | 285 |
| Fayetteville, AR | Clinical addition | 56,163,000 | 93,000,000 | 36,837,000 | 66 |
| Syracuse, NY | Spinal cord injury/disease center | 53,900,000 | 84,969,000 | 31,069,000 | 58 |
| Tampa, FL | Polytrauma expansion | 223,800,000 | 231,500,000 | 7,700,000 | 3 |
| Long Beach, CA | Seismic corrections | 107,845,000 | 112,845,000 | 5,000,000 | 5 |
| Atlanta, GA | Modernize patient wards | 20,700,000 | 24,534,000 | 3,834,000 | 18 |
| Des Moines, IA | Extended care building | 25,000,000 | 25,550,000 | 550,000 | 2 |
| **Total** | | **$3,166,350,000** | **$5,082,671,968** | **$1,916,321,968** | **61** |

Source: GAO analysis of VA data.

As of August 2009, the costs of 13 projects have not changed from their initial estimated cost. We found that VA reduced the scope of some projects so that the projects would not exceed their budget. For example, one project we visited in Cleveland, Ohio, is designed to consolidate two medical centers and construct a new facility at one of the medical centers. According to VA officials in Cleveland, VA reduced the original scope of the project by excluding room for 30 new patient beds in the new facility so that the project could stay within its budget. However, VA will make space for the 30 beds by expanding part of its existing facility through separate facility funds. VA staff made other changes to the original plan for the new facility, such as deleting balconies from patient's rooms and using more concrete and less steel in the structure, so that the facility could be completed within budget. More information about the medical center consolidation in Cleveland is in appendix III. In addition to those projects that did not experience a cost increase, one project experienced a cost decrease. Specifically, the cost to construct a data center in West Virginia decreased from $35 million to $33.7 million, or about 4 percent.

## Schedule Delays Have Occurred in 11 Projects

Eleven of the 32 ongoing projects are projected to be completed later than originally estimated. Even if the cost of a project has not increased, a schedule delay can lead to an increased cost to VA because CFM project managers must stay on to monitor the project as it is being built. A schedule delay can also affect veterans' access to medical care, since VA constructs facilities where they are needed to serve the local veteran population and a schedule delay results in veterans waiting longer for the services to be available. Of the 11 projects that have experienced a schedule delay, 2 are scheduled to be completed within 2 months of their originally scheduled end date, 5 are scheduled to be completed between 12 and 24 months of their originally scheduled end date, and 4 are scheduled to be completed more than 24 months after their originally scheduled end date. These projects range from an electrical upgrade in Florida that is estimated to end less than a month after its initial estimated completion date to seismic corrections at a facility in Puerto Rico that are estimated to end about 7 years after their initial estimated completion date. The original estimated completion dates, the latest estimated completion dates, and the change in dates for those projects are in table 2. Information on the number of projects that experienced both a schedule delay and a cost increase is in appendix VI.

Table 2: Projects That Have Experienced Schedule Delays

| Location | Description | Initial estimated completion date | Estimated completion date as of August 2009 | Change in months[a] |
|---|---|---|---|---|
| Tampa, FL | Electrical upgrade | 7/2/10 | 7/14/2010 | 0.5 |
| Anchorage, AK | Outpatient clinic | 1/10/2010 | 2/15/2010 | 1 |
| Martinsburg, WV | Capital region data center | 5/30/09 | 7/7/2010 | 13 |
| Milwaukee, WI | Spinal cord injury center | 12/31/2009 | 2/11/2011 | 13.5 |
| American Lake, WA | Seismic corrections | 3/31/2009 | 7/10/2010 | 15.5 |
| Las Vegas, NV | New medical center | 9/6/2009 | 8/22/2011 | 23.5 |
| Columbia, MO | Operating suite replacement | 5/31/2010 | 5/30/2012 | 24 |
| Cleveland, OH | Medical center consolidation | 9/1/2008 | 2/21/2011 | 29.5 |
| Syracuse, NY | Spinal cord injury center | 12/6/2009 | 5/19/2012 | 29.5 |
| Palo Alto, CA | Seismic corrections | 11/30/2006 | 5/27/2011 | 54 |
| San Juan, PR | Seismic corrections | 10/30/2002 | 11/18/2009 | 84.5 |

Source: GAO analysis of VA data.

[a]The change in months is rounded to the nearest half month.

## Cost Increases and Schedule Delays Result from a Number of Factors

Cost increases and schedule delays have been caused by factors that have generally occurred before construction of the project begins. These factors include initial estimates that were not thorough because they were completed quickly, scope changes that occurred after the initial estimate, and unforeseen events and market conditions such as a rise in construction costs.

### Some Cost Estimates Were Not Thorough

The CARES process required VA to quickly provide initial cost estimates for about 30 major construction projects. Specifically, in 2004 VA had about 3 months to provide initial cost estimates to Congress so that Congress could consider authorizing these projects and appropriating funds for them in fiscal years 2004 and 2005. According to VA, a number of VA staff worked to produce these initial estimates, including staff that had limited cost estimating expertise. The 30 projects included three new large medical centers in Las Vegas, Nevada; Denver, Colorado; and Orlando, Florida. Estimates prepared for these 30 projects were prepared quickly and sometimes based on rudimentary designs. For example, VHA officials in Syracuse told us that they had about 6 weeks to prepare their initial estimate for a new spinal cord injury center, which they did by using analogous estimating techniques such as the cost-per-square foot of new construction in Syracuse. As a result, the initial estimate was only a rough order-of-magnitude estimate. We have reported that, while it is possible to develop a rough order-of-magnitude estimate in days, a first-time budget-quality estimate would likely require many months.[12] VA officials in Syracuse who worked to prepare this estimate told us that they were surprised when the project was included in VA's fiscal year 2005 budget request because they knew that the estimate was only a rough order-of-magnitude estimate.

## Some Cost Estimates and Schedules Were Affected by Scope Changes

In two of our case studies, the scope of the project changed substantially after VA submitted its estimate to Congress. VA officials also told us that scope changes have occurred in other projects. In Las Vegas, the initial estimate to Congress was based on plans for a large VA clinic. However, VA later determined that a much larger medical center was needed in Las Vegas after it became clear that an inpatient medical facility it shares with the Department of Defense would not be adequate to serve the medical needs of local veterans. This decision greatly increased the cost, delayed the completion date of the project, and required a modified authorization and an additional appropriation from Congress. Since the estimate for the Las Vegas medical center was based on a preliminary design for an expanded clinic, additional functions had to be added to the clinic design to provide the services necessary for the medical center. This expansion of the scope of the project resulted in both a cost increase and schedule delay for the project.

In Syracuse, New York, the original design of a new Spinal Cord Injury/Disease (SCI/D) center that is being built on the campus of the VA medical center did not include money for additional parking. However, after the project had been authorized by Congress and was in design, VA officials in Syracuse commissioned a study to examine future parking needs at the medical center. The study concluded that, based on the new SCI/D center and projected demand from patients and staff, there should be an additional 429 to 528 parking spaces at the medical center. As a result of this study, VA officials in Syracuse decided to add two floors to the existing parking garage at an estimated cost of $10 million. Based on the parking garage addition and other changes to the project, VA received a modified authorization in 2006 and an appropriation of $23.8 million in fiscal year 2008 for the SCI/D center. More information about the new SCI/D center in Syracuse is in appendix IV.

[12] GAO-09-03SP.

Failure to involve stakeholders early in the process can also lead to changes in scope. In Syracuse, the Paralyzed Veterans of America (PVA) objected to some aspects of the design of the SCI/D center. For example, PVA advocated for a dedicated entrance from the parking garage to the SCI/D center, which is being built on the fourth floor of the medical center. This dedicated entrance would allow veterans with spinal cord injuries to enter the center directly from the parking garage, without requiring the veterans to go down to the street from the parking garage, outside to the main entrance of the medical center, then up to the 4th floor of the medical center for treatment. According to VA staff in Syracuse, VA agreed to make changes that would improve access to the facility, and this increased the cost of the project.

## Some Cost Estimates Were Affected by Market Conditions and Some Schedules Were Affected by Unforeseen Events

Changes in construction market conditions can escalate the costs of VA construction projects. The cost of many materials used in construction—from concrete to electrical equipment—increased more than the consumer price index (indicating that construction costs increased more than other costs) from 2003 through 2007. Specifically, the cost of these construction materials increased over 28 percent between 2003 and 2007, whereas the consumer price index increased about 13 percent over the same period.[13] Hurricane Katrina drove up the cost of construction materials nationwide because the high demand for construction in the New Orleans region strained supplies of material and labor. In Las Vegas, several large billion-dollar projects created competition for construction services, and this area experienced an even greater cost increase as the demand for new construction exceeded supply of materials and labor.

The schedule for one of our case studies was delayed by land acquisition issues. In Cleveland, while the project remains within budget, the project schedule was delayed 9 months because a property acquisition took longer than expected. Part of the land that the bed tower is being built on had been donated to the City of Cleveland for use as parkland. The city could not give the land to VA until the city was able to change the designated use of the donated land from parkland to a more general use. More information about the construction project in Cleveland is in appendix III.

[13]We used national data from the Department of Labor, Bureau of Labor Statistics' *Inputs to Construction Industries Producer Price Index* to identify nationwide trends in the costs of many of the materials used in construction.

## VA Is Working to Improve Estimates but Could Better Assess Risks to Costs and Schedules

VA has developed a new process for determining its initial estimates that allows for more time between VA approving a project and submitting a cost and schedule estimate to Congress. However, VA does not analyze cost risks to examine the changing assumptions on the cost estimate. VA also does not have an integrated master schedule, which includes both VA and contractor effort for all phases of the entire project, and does not conduct a schedule risk analysis to help determine when projects will be completed. While VA is not required to develop an integrated master schedule and cost and schedule risk analyses,[14] we have identified these steps as best practices in project scheduling and cost estimating.[15]

### VA Is Working to Improve Initial Estimates, but Needs to Analyze Cost Risks

VA has developed a new process to improve its initial estimates for major construction projects. This new process allows VA to increase the time between VA approving a project and submitting that project, and its initial estimate, to Congress. According to VA officials, with this additional time, VHA will be able to gather more information about a project and begin preliminary design work. These officials noted that VA will ideally have as much as 35 percent of the design work completed before the project's first estimate is submitted to Congress. Cost estimators can then use these designs to develop the initial cost estimate that VA sends to Congress. According to VA officials, the initial estimate should be more precise than estimates provided to Congress in the past because the scope of the project will be more developed.

Until the fiscal year 2010 budget cycle, field staff in VHA produced the first estimate for a project. Beginning with the fiscal year 2010 budget cycle, for any project in the top 10 of the priority list, CFM will work with VHA staff in the field to produce the first estimate of the project's cost. CFM staff includes professionals with estimating and construction engineering skills, whereas VHA staff in the field generally does not possess these skills.

[14] VA stated that it has cost and risk assessment guidance that requires that risk assessments should be performed at the initial concept stage and then monitored and controlled throughout the life cycle of the project, and should include risk information from all stakeholders. However, VA does not conduct cost or schedule risk analyses that would allow it to quantify its level of confidence to finish a project at a specific cost and time.

[15] GAO-09-03SP. While the cost guide was issued in March 2009, the guide identifies best practices that have been widely accepted in the cost estimating field for many years.

These new requirements were not in effect when the projects we studied were developed. Therefore, we were not able to evaluate the process. While it is unclear how much design work will actually occur before VA submits a project and its estimate to Congress, the new process holds promise to improve VA's initial estimates, particularly if the new process requires early stakeholder input on a proposed project so that any resulting changes in the project scope can be incorporated into the estimate before it is submitted to Congress.

After a project has been authorized and funded based on VA's initial estimate, VA hires an architect/engineering firm to design the major construction project. The firm hires a contractor to develop a cost estimate for the project. We visited three major construction sites—Cleveland, Ohio, Las Vegas, Nevada, and Syracuse, New York. At these sites, we found that these cost estimates were generally comprehensive and well documented. Specifically, the estimate included an estimating plan, structure, purpose, and documentation. However, we also found that the cost estimates for projects in Cleveland and Las Vegas were not adequately maintained during construction because they did not include updated information based on actual costs as the project progressed.

We also found that the estimates for projects in Syracuse and Las Vegas did not include a cost risk analysis to examine the effect of changing assumptions on the cost estimate. Conducting a cost risk analysis is particularly important because only by quantifying cost risk can management make informed decisions about risk mitigation strategies. Quantifying cost risk also provides a benchmark for measuring future progress. We identified best practices for estimating and managing program costs in a cost assessment guide we issued in 2009.[16] As we note in our cost assessment guide, agencies should begin to follow these best practices at the earliest stages of the cost estimation process, which includes the preparation of the initial estimate submitted to Congress. Our cost estimating guide has been endorsed by OMB. More information on the cost estimates for these three sites is in appendices III through V.

[16] GAO-09-3SP.

## VA Generally Follows Best Practices for Construction Schedules at the Projects We Visited, but Does Not Conduct a Schedule Risk Analysis

After the design is complete, VA hires a contractor to construct the project by the completion date set in the contract. The contractor then develops a construction schedule that details all of the activities that the contractor plans to finish by the completion date. Generally, the contractor must finish by the completion date or face financial penalties. At the sites we visited, we found that these schedule estimates, which occur after VA has submitted its initial estimate to Congress, generally followed best practices for scheduling. For example, we found that the contractor regularly updated the construction schedule with actual dates as the work progressed. All best practices for schedules, and the extent that they were met at our site visits, are in table 3. More detailed information is included in appendices III through V.

**Table 3: Extent Construction Schedules Met Best Practices**

| Best practice | Cleveland, OH | Las Vegas, NV | Syracuse, NY |
|---|---|---|---|
| Capturing key activities | Met | Substantially met | Met |
| Sequencing key activities | Met | Substantially met | Met |
| Assigning resources to key activities | Met | Substantially met | Met |
| Establishing the duration of key activities | Met | Met | Met |
| Integrating schedule activities horizontally and vertically | Met | Met | Met |
| Establishing the critical path for all activities | Met | Substantially met | Met |
| Identifying the float between activities[a] | Met | Met | Met |
| Conducting a schedule risk analysis | Not met | Not met | Not met |
| Updating the schedule using logic and duration to determine dates | Met | Partially met | Met |

Source: GAO analysis of VA data.

[a]"Float" is the amount of time an activity can slip before delaying the entire project.

Although VA met or partially met nearly all scheduling best practices at the three sites, VA does not conduct a schedule risk analysis of its major construction projects, and therefore cannot predict a project's completion date with confidence. A schedule risk analysis, which is one of our best practices in project scheduling, uses statistical techniques to predict a level of confidence in meeting a project's completion date. The objective of the analysis is to develop a probability distribution of possible completion dates that reflect the project and its quantified risks. This analysis can help project managers both understand the most important risks to the project and to focus on mitigating these risks. We conducted a schedule risk analysis of the construction schedule for the new medical center in Las Vegas, Nevada, that is scheduled to be completed on August 22, 2011. We conducted on-site interviews with staff who are working on the project in Las Vegas and asked them to discuss potential risks to the project, including how the risk would affect the project's timeline and the likelihood of the risk occurring. Using this information, we developed a list of risks to the project (such as the chance that the design is inadequate or that labor is not available) and how each risk would impact the duration of specific activities in the schedule. We then used modeling software to run a Monte Carlo[17] simulation, which consisted of the computer-generated results of 3,000 estimates of the future schedule based on the activities in the schedule, the chance that some activities would be affected by some risks, and the predicted affect of those risks on the duration of each activity. This analysis showed that there is a 50 percent probability that the project will be completed by March 1, 2012 (about 6 months after the current estimated completion date) and an 80 percent probability that the project will be completed by May 17, 2012 (about 9 months after the current estimated completion date). Although we did not conduct a schedule risk analysis for other VA major construction projects, the result of our analysis for the Las Vegas Medical Center project shows the types of risks that major construction projects face and the impact those risks can have on meeting project milestones. More information on our schedule risk analysis can be found in appendix V.

We shared the results of our schedule risk analysis with CFM staff in Las Vegas. Specifically, we noted that we found the two biggest risks to the project are that the design may be inadequate and that the occupancy needs may change. CFM staff in Las Vegas told us that they are working to mitigate the risk of inadequate design and have discovered architectural drawings that do not include utilities. As a result, CFM has directed the architect/engineer firm to revise the drawings to include utilities. CFM staff also stated that they can deny any changes to the project scope and that they can choose not to allow changes that will affect the scheduled completion date.

## VA Does Not Have an Integrated Master Schedule for Major Construction Projects

VA does not require an integrated master schedule for major construction projects that encompasses both VA and contractor effort for all phases of the entire project and shows the relationships between various project phases (such as design, construction, and when the project is "activated" for occupancy and use). However, we have stated that the success of any

[17]A Monte Carlo simulation involves the use of random numbers and probability distributions to examine outcomes.

project depends, in part, on having an integrated and reliable schedule.[18] Without a fully integrated and reliably derived schedule, it is difficult to estimate the overall cost and schedule of a project. In addition, individual phases of a multiphase project can be completed on time, but the project as a whole can be delayed and construction phases that are not part of an integrated master schedule may not be completed in the most efficient manner. For example, a VA nursing home in Las Vegas was completed in 2009 but cannot be put into service until another phase of the construction project—the on-site medical center—is completed and can provide medical care to residents of the nursing home. The medical center is scheduled to be completed in 2011. According to VA officials, VA decided to construct the new nursing home because construction costs in Las Vegas were escalating quickly, and VA officials thought that they could save money by constructing the nursing home as soon as possible. However, construction costs have recently decreased in the Las Vegas area, and VA must pay to maintain the new nursing home from 2009 to 2011 even though the nursing home will not be used for VA patients.

## Conclusions

Estimates for major construction projects, like any estimate of a future activity, can never be exact. Some of VA's past estimates have been off-base, although the reasons for this are sometimes outside of VA's control. These imprecise estimates resulted in Congress authorizing and appropriating millions of dollars for projects based on estimates that proved to be inaccurate. In some of these cases, VA was forced to change the scope of the project in order to stay within the original estimate or the projects' authorizations were modified and Congress has had to appropriate more funds to allow VA to finish some projects.

VA is taking steps to make its initial estimates more accurate in the future. VA is working to complete some preliminary design work on projects and improve initial estimates so that they are more likely to be closer to the actual costs and schedules of a project, but the effect of these changes on VA's initial estimates remains to be seen. While VA is taking steps to improve its initial estimates, it does not always conduct a cost risk analysis, which would allow project managers to better identify issues that could lead to cost escalation and improve managers' ability to make

[18]GAO, *Homeland Security: US-VISIT Exit Initiatives at Varying Stages of Completion but Integrated and Reliable Schedule for Completing Comprehensive Exit Project Needed*, GAO-10-13 (Washington, D.C.: Oct. 28, 2009).

informed decisions on how to minimize cost risks. VA has also not used a schedule risk analysis to determine the likelihood of a major project being completed on time. We recognize that conducting a cost risk and schedule risk analysis takes both financial resources and some time and that it may only be appropriate to conduct these analyses when a project is particularly costly, complex, or has a compressed schedule. However, the overall effect of the analyses is to provide VA, congressional decisionmakers, and other stakeholders with more precise information about when a project will be completed and the main risks to a project being completed on time. With this information, VA could provide more accurate schedule estimates to stakeholders and could also work to mitigate risks to the project and ensure that the project is completed on time. We have identified cost risk and schedule risk analysis as best practices in our cost assessment guide, which has been endorsed by OMB.

While the construction schedules we reviewed generally met best practices, VA's lack of an integrated master schedule—which would integrate VA and contractor effort for all phases of a project, including all design and construction work—hampers VA's ability to provide accurate information on the schedule for a project. Many factors that can delay a project, such as changes in scope and unforeseen site conditions, occur before construction begins. The use of an integrated master schedule could assist VA in monitoring the progress of a major construction project before construction begins and allow VA to increase the accuracy of its schedule estimates.

## Recommendations for Executive Action

To improve estimates of the cost of a major construction project as well as the risks that may influence the cost and how these risks can be mitigated, GAO recommends that the Secretary of Veterans Affairs direct CFM to conduct a cost risk analysis of major construction projects.

To provide a realistic estimate of when a construction project may be completed as well as the risks to the project that could be mitigated, we recommend that the Secretary of Veterans Affairs direct CFM to take the following two actions. First, require the use of an integrated master schedule for all major construction projects. This schedule should integrate all phases of project design and construction. Second, conduct a schedule risk analysis, when appropriate, based on the project's cost, schedule, complexity, or other factors. Such a risk analysis should include a determination of the largest risks to the project, a plan for mitigating those risks, and an estimate of when the project will be finished if the risks are not mitigated.

## Agency Comments and Our Evaluation

We provided a draft of this report to VA for review and comment. VA generally agreed with our conclusions and concurred with our recommendations. In reference to our statement that some cost increases and schedule delays were attributable to scope changes, VA stated that it is important to note that VA followed all applicable laws and congressional notification requirements during the execution of the projects, and maintained the integrity and intent of each project as authorized by Congress. While we did not find any instances where VA did not follow applicable laws or congressional notification requirements, we did not specifically evaluate VA's compliance with such laws and requirements because this was outside the scope of our review. VA's letter is contained in appendix II. In addition, VA made a number of technical corrections, which we incorporated as appropriate.

We are sending copies of this report to the Secretary of Veterans Affairs. Additional copies will be sent to interested congressional committees. The report will also be available at no charge on the GAO Web site at http://www.gao.gov.

If you have any questions about this report, please contact me at (202) 512-2834 or at dornt@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions to this report are listed in appendix VII.

Sincerely yours,

Terrell G. Dorn, PE

Terrell G. Dorn
Director, Physical Infrastructure Issues

# Appendix I: Scope and Methodology

In this report, we examined: (1) how costs and schedules of current Veterans Affairs (VA) major medical construction projects have changed since they were first submitted to Congress,[1] (2) the reasons for cost and schedule changes in VA's major medical construction projects, and (3) the actions VA has taken to address cost increases and schedule delays as well as the challenges VA faces in managing its major medical construction program.

To address these issues, we reviewed pertinent laws relating to construction, authorization and appropriation of VA projects. We also examined the documents VA submitted to Congress, including the Office of Management and Budget's form 300 provided with VA's budget that has been required since 2006 and a project prospectus. We obtained and analyzed data that VA provided on the status of VA's active major medical construction projects, as of August, 2009. We also reviewed VA's management of construction projects at three locations and interviewed VA headquarters' officials from the Veterans Health Administration (VHA) and the Office of Construction and Facilities Management (CFM) as well as project managers at the construction sites we visited.

To determine how costs and schedules of current VA major medical construction projects have changed since they were first submitted to Congress, we reviewed VA data on current major medical construction projects, including the original cost estimates and completion dates submitted to Congress and the projects' current status as of August 2009. We analyzed the current cost and completion dates against the information provided to Congress to determine the increase in costs and the extent to which projects exceeded or were expected to exceed the original time allotted and summarized the results. VA officials confirmed the reliability of the data provided for these projects.

To identify the reasons for cost and schedule changes in VA's construction projects, we interviewed VA headquarters officials regarding the status of all projects and examined project documents and interviewed on-site managers and engineers at three projects we selected. We selected projects based on VA-provided data on all of VA's ongoing major medical construction projects as of March 2009. The data included a short project

[1]The term "major medical facility project" means a project for the construction, alteration, or acquisition of a medical facility involving the total expenditure of more than $10 million. See 38 U.S.C. § 8104. For purposes of this report, we are referring to these projects as "major construction projects."

description, project location, the original and current total cost of the project, the original and current completion date, and the percent of construction completed. VA officials confirmed the reliability of the data provided. We selected projects for site visits based on the following criteria and the results cannot be applied to all of VA's major construction projects:

- Construction projects were between 20 percent and 70 percent completed.
- Projects were estimated to cost $75 million or more.
- Projects were among those experiencing the greatest cost increases or schedule delays relative to other VA major medical construction projects.
- Projects were of different types of major construction projects because there could be factors in cost and scheduling that relate to one project type or factors that are systemic trends that occur across all project types. Project types include new construction, renovation of existing structures, expansion, or a combination of project types.
- Projects were selected from each of VA's three regions to account for differences in management at VA regional offices that could impact cost increases and schedule delays.

Based on our criteria, we selected three major medical construction sites:

- consolidation of the Brecksville Veterans Affairs Medical Center and the Wade Park Veterans Affairs Medical Center and construction of a new 90-bed tower for patient care in Cleveland, Ohio, estimated to cost $102.3 million and to be completed by September 2009 and now scheduled for February 2011;
- construction of Spinal Cord Injury Center, surgical suite renovation, and expansion of the parking garage in Syracuse, New York, originally estimated to cost $53.4 million and be completed by December 2009 and now estimated to cost $84,969,000 and be completed by May 19, 2012; and
- construction of a new, comprehensive Medical Center Complex in Las Vegas, Nevada, that will include a nursing home, ambulatory care center, primary and specialty care, surgery, mental health, rehabilitation, geriatric and extended care. Originally estimated to cost $286 million and be completed by September 2009, it is now expected to open in March 2012 and cost $600.4 million. The Las Vegas project will also include administrative and support functions and Veterans Benefits

Administration offices.

To identify the actions VA has taken to address cost increases and schedule delays as well as the challenges VA faces in managing its major medical construction program we reviewed the procedures that VA's Office of Construction and Facilities Management put in place beginning in 2007. We also reviewed documentation and interviewed VA headquarters officials and project managers for the sites we visited to determine how estimated costs and schedules had been prepared. We then analyzed the cost estimates and schedules prepared for the three projects we visited and interviewed VA project managers and engineers, contractors, and cost estimators and schedulers to ascertain the extent to which their estimates and schedules compared with the best practices identified in previous GAO work.

We used the GAO *Cost Estimating and Assessment Guide*[2] (GAO-09-3SP), as criteria to analyze cost estimates. For this guide, GAO cost experts assessed 12 measures consistently applied by cost-estimating organizations throughout the federal government and industry and considered best practices for developing reliable cost-estimates. We analyzed the cost estimating practices used by VA in developing its cost estimates against these 12 best practices. After reviewing documentation submitted by the VA and information obtained during interviews, we determined the extent that the cost estimates met the characteristics of cost estimating best practices for the three projects we reviewed. For the purpose of this review, we grouped these practices into four characteristics of a high-quality and reliable cost estimate. They are

- **Comprehensive:** The cost estimates should include both government and contractor costs of the project over its full life cycle, from inception of the project through design, development, deployment, and operation and maintenance to retirement of the project. They should also provide a level of detail appropriate to ensure that cost elements are neither omitted nor double counted, and they should document all cost-influencing ground rules and assumptions.

- **Well-documented:** The documentation should address the purpose of the estimate, the project background and system description, its schedule, the

[2]GAO, *GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs*, GAO-09-3SP (Washington, D.C.: March 2009).

scope of the estimate (in terms of time and what is and is not included), the ground rules and assumptions, all data sources, estimating methodology and rationale, the results of the risk analysis, and a conclusion about whether the cost estimate is reasonable. Therefore, a good cost estimate—while taking the form of a single number—is supported by detailed documentation that describes how it was derived and how the expected funding will be spent in order to achieve a given objective. For example, the documentation should capture in writing such things as the source data used and their significance, the calculations performed and their results, and the rationale for choosing a particular estimating method or reference. Moreover, this information should be captured in such a way that the data used to derive the estimate can be traced back to, and verified against their sources. Finally, the cost estimate should be reviewed and accepted by management to ensure that there is a high level of confidence in the estimate and the estimating process.

- **Accurate:** The cost estimates should provide for results that are unbiased, and they should not be overly conservative or optimistic. Estimates are accurate when they are based on an assessment of most likely costs, adjusted properly for inflation, and contain few, if any, minor mistakes. In addition, the estimates should be updated regularly to reflect material changes in the project, such as when schedules or other assumptions change so that the estimate is always reflecting current status. Among other things, the estimate should be grounded in documented assumptions and a historical record of cost estimating and actual experiences on other comparable projects.

- **Credible:** The cost estimates should discuss any limitations of the analysis because of uncertainty or biases surrounding data or assumptions. Major assumptions should be varied, and other outcomes recomputed to determine how sensitive they are to changes in the assumptions. Risk and uncertainty analysis should be performed to determine the level of risk associated with the estimate. Further, the estimate's results should be crosschecked, and an independent cost estimate conducted by a group outside the acquiring organization should be developed to determine whether other estimating results produce similar results.

Our review of project schedules was based on research that identified a range of best practices associated with effective schedule estimating.[3] In addition, we obtained the consulting services of David Hulett, Ph.D., to

[3] GAO-09-3SP.

assist in our risk analysis of the Las Vegas Medical Center project schedule.[4] We analyzed documentation submitted by the VA project office and construction staff for three of VA's major medical construction projects. We also conducted multiple interviews with project managers, contractors, and schedulers to determine the extent that projects' current schedule met the best practice criteria. These practices include

- **Capturing all activities:** The schedule should reflect all activities (steps, events, outcomes, etc.) as defined in the project's work breakdown structure, to include activities to be performed by both the government and its contractors.

- **Sequencing all activities:** The schedule should be planned so that it can meet project critical dates. To meet this objective, activities need to be logically sequenced in the order that they are to be carried out. In particular, activities that must finish prior to the start of other activities (i.e., predecessor activities) as well as activities that cannot begin until other activities are completed (i.e., successor activities) should be identified. Identifying interdependencies among activities that collectively lead to the accomplishment of events or milestones can be used as a basis for guiding work and measuring progress.

- **Assigning resources to all activities:** The schedule should realistically reflect what resources (i.e., labor, material, and overhead) are needed to do the work, whether all required resources will be available when they are needed, and whether any funding or time constraints exist.

- **Establishing the duration of all activities:** The schedule should reflect how long each activity will take to execute. In determining the duration of each activity, the same rationale, data, and assumptions used for cost estimating should be used for preparing the schedule. Further, these durations should be as short as possible and should have specific start and end dates. Excessively long periods needed to execute an activity should prompt further decomposition of the activity so that shorter execution durations will result.
- **Integrating schedule activities horizontally and vertically:** The schedule should be horizontally integrated, meaning that it should link the products and outcomes associated with already sequenced activities (see previous section). These links are commonly referred to as "hand offs" and serve to verify that activities are arranged in the right order to achieve

[4]Hulett & Associates, LLC, Los Angeles, Calif.

aggregated products or outcomes. The schedule should also be vertically integrated, meaning that traceability exists among varying levels of activities and supporting tasks and sub-tasks. Such mapping or alignment among levels can enable different groups to work to the same master schedule.

- **Establishing the critical path for all activities:** Using scheduling software the critical path—the longest duration path through the sequenced list of activities—should be identified. The establishment of a project's critical path is necessary for examining the effects of any activity slipping along this path. Potential problems that may occur on or near the critical path should also be identified and reflected in the scheduling of the time for high-risk activities (see float below).

- **Identifying float between activities:** The schedule should identify float—the time that a predecessor activity can slip before the delay affects successor activities—so that schedule flexibility can be determined. As a general rule, activities along the critical path typically have the least amount of float.

- **Conducting a schedule risk analysis:** A schedule risk analysis uses a good critical path method schedule and data about project schedule risks as well as Monte Carlo simulation techniques to predict the level of confidence in meeting a project's completion date, the amount of time contingency needed for a level of confidence, and the identification of high-priority risks. This analysis should focus not only on critical path activities but also on other schedule paths that may become critical. A schedule/cost risk assessment recognizes the inter-relationship between schedule and cost and captures the risk that schedule durations and cost estimates may vary due to, among other things: limited data, optimistic estimating, technical challenges, lack of qualified personnel, and other external factors. As a result, the baseline schedule should include a buffer or a reserve of extra time. Schedule reserve for contingencies should be calculated by performing a schedule risk analysis. As a general rule, the reserve should be held by the project manager and applied as needed to those activities that take longer than scheduled because of the identified risks. Reserves of time should not be apportioned in advance to any specific activity since the risks that will actually occur and the magnitude of their impact is not known in advance.

- **Updating the schedule using logic and durations to determine the dates:** The schedule should use logic and durations in order to reflect realistic start and completion dates for project activities. The schedule should be continually monitored to determine when forecasted completion dates differ from the planned dates, which can be used to determine whether schedule variances will affect downstream work. Maintaining the integrity of the schedule logic is not only necessary to reflect true status, but is also required before conducting a schedule risk analysis. The schedule should avoid logic overrides and artificial constraint dates that are chosen to create a certain result on paper. Individuals trained in critical path method scheduling should be responsible for updating the schedule.

Based on our work, we determined the extent that estimates and schedules for the three projects we selected met the best practices criteria.

- Not Met—Project officials provided no evidence that satisfies any of the criterion,
- Minimally Met—Project officials provided evidence that satisfies a small portion of the criterion,
- Partially Met—Project officials provided evidence that satisfies about half of the criterion,
- Substantially Met—Project officials provided evidence that satisfies a large portion of the criterion, and
- Met—Project officials provided complete evidence that satisfies the entire criterion.

We conducted this performance audit from October 2008 through December 2009 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained meets these standards.

# Appendix II: Comments from the Department of Veterans Affairs

THE SECRETARY OF VETERANS AFFAIRS
WASHINGTON

December 7, 2009

Mr. Terrell G. Dorn
Director, Physical Infrastructure Issues
U.S. Government Accountability Office
441 G Street, NW
Washington, DC 20548

Dear Mr. Dorn:

The Department of Veterans Affairs (VA) has reviewed the Government Accountability Office's (GAO) draft report, ***VA CONSTRUCTION: VA is Working to Improve Initial Project Cost Estimates, but Should Analyze Cost and Schedule Risks*** (GAO-10-189) and generally agrees with GAO's conclusions and concurs with GAO's recommendations to the Department.

The report states that cost increases and schedule delays for some of the projects are attributable to scope changes. It is important to note that VA followed all applicable laws and congressional notification requirements during the execution of the projects, and maintained the integrity and intent of each project as authorized by Congress. Such projects enable VA facilities to provide a safe and modern environment, which improves health care delivery services for Veterans.

The enclosure specifically addresses GAO's recommendations and provides additional comments to the draft report. VA appreciates the opportunity to comment on your draft report.

Sincerely,

John R. Gingrich
Chief of Staff

Enclosure

Enclosure

Department of Veterans Affairs (VA) Comments to
Government Accountability Office (GAO) Draft Report
***VA CONSTRUCTION: VA is Working to Improve Initial Project Cost Estimates, but Should Analyze Cost and Schedule Risks***
(GAO-10-189)

**GAO Recommendation 1:** To improve estimates of the cost of a major construction project as well as the risks that may influence the cost and how these risks can be mitigated, GAO recommends that the Secretary of Veterans Affairs direct the Office of Construction and Facilities Management (CFM) to conduct a cost risk analysis of major construction projects.

<u>VA comments to the draft report</u>: Concur. While VA assesses risk in both cost and schedule, we do not currently perform the type of risk analysis recommended by GAO. VA will develop a plan and implement GAO's recommendations by the third quarter of Fiscal Year 2010.

The VA's major construction program for health care has grown significantly since 2004 when the initial results of the CARES studies were released. As pointed out in the report, some of the projects were included in budget requests without the benefit of sufficient planning and design information to accurately estimate the cost; and many of these have subsequently experienced cost growth. The Department has already recognized this problem and is taking steps to develop a multi-year construction plan that will enable development of appropriate plans and early designs to ensure that the budget requests to the Congress more accurately predict the cost.

As pointed out in the report, not all of the cost growth can be attributed to the lack of prior planning and design. The projects under review were in design and in some cases in the construction procurement phase during a time when the construction economy in the United States was extremely robust. A large amount of work was available for construction companies in the commercial sector which resulted in a small number of companies competing for VA contracts. In addition, the cost of labor and building materials was rising dramatically. This was exacerbated by the impact on the construction economy of the hurricanes of 2004 and 2005 – most notably Katrina.

**GAO Recommendation 2:** To provide a realistic estimate of when a construction project may be completed as well as the risks to the project that could be mitigated, [GAO] recommends that the Secretary of Veterans Affairs direct CFM to take the following two actions:

- Require the use of an integrated master schedule for all major construction projects. This schedule should integrate all phases of project design and construction, and

Enclosure

Department of Veterans Affairs (VA) Comments to
Government Accountability Office (GAO) Draft Report
***VA CONSTRUCTION: VA is Working to Improve Initial Project Cost Estimates, but Should Analyze Cost and Schedule Risks***
(GAO-10-189)

- Conduct a schedule risk analysis, when appropriate, based on the project's cost, schedule, complexity, or other factors. Such a risk analysis should include a determination of the largest risks to the project, a plan for mitigating those risks, and an estimate of when the project will be finished if the risks are not mitigated.

VA comments to the draft report: Concur. VA is pleased the report highlights that most of the GAO 12 best practices are being met by VA. However, the report recommends that VA implement two of the best practices that VA currently does not include in its process. These are to conduct a cost and schedule risk analysis and maintain an integrated master schedule. The Department accepts GAO's recommendations and the Office of Construction and Facilities Management (CFM) will begin to take steps to implement these process modifications by the third quarter of Fiscal Year 2010.

# Appendix III: Consolidation and Expansion of Medical Centers in Cleveland, Ohio

## Project Overview

The major construction project in Cleveland includes consolidating the Brecksville Veterans Affairs Medical Center and the Wade Park Veterans Affairs Medical Center, which are 26 miles apart. As part of this consolidation, a new bed tower is being built at the Wade Park Medical Center. This bed tower will contain a nursing home and space for psychiatric patients. The project is divided into two phases. Phase I includes the construction of an energy center and phase II includes the construction of a bed tower addition.

## Reasons for the Project

The project was first initiated by the VA under the Capital Asset Realignment for Enhanced Services (CARES) process in 2004 to save money through consolidation and to provide better health care for veterans.[1] According to VA officials, the two medical centers frequently worked together to provide health care for veterans. The Brecksville medical center was primarily a nursing home care unit and psychiatric care facility and the Wade Park medical center was primarily a surgical care facility. According to VA, it was very expensive to operate and maintain the two physical locations. Patients needing immediate care at the Brecksville medical center were sometimes taken to local area hospitals instead of the Wade Park medical center because of the distance between the two medical centers. Maintaining the two medical centers resulted in duplication of services, decreased operational efficiencies, and issues of continuity of care between the two medical centers. Other inefficiencies included ambulance and wheelchair van costs and outdated modes of providing health care.

VA also intended for the project to meet rising demand for services in the Cleveland area and noted that the total number of unique patients at these 2 medical centers had increased. After considering four alternatives, the medical center staff determined that consolidating the two medical centers at Wade Park would lead to better health care for veterans and provide significant cost savings and other efficiencies. Specifically, consolidation would allow VA to avoid approximately $41 million in non-

[1]The Veterans Health Care, Capital Asset, and Business Improvement Act of 2003 authorized the Secretary of VA to carry out major construction projects specified in the final CARES report, which was to be approved by the Secretary of VA. See Pub. L. No. 108-170, § 221, 117 Stat 2042, 2050 (2003). The Secretary's report dated May 20, 2004, listed $15 million for design of phase I of the project, which was authorized under § 221of Pub. L. No. 108-170. Additionally, in 2006 the project's authorization was modified to an amount not to exceed $102,300,000. See Veterans Benefits, Health Care, and Information Technology Act of 2006, Pub. L. No. 109-461, § 802, 120 Stat. 3403, 3443 (2006).

recurring maintenance and infrastructure improvements at the Brecksville medical center and gain approximately $10.6 million in operational savings per year.

## Project Cost

The cost estimate to consolidate the two facilities and construct a new bed tower at Wade Park has remained constant at $102.3 million. According to VA officials, the cost estimate is still reasonable for the project through completion. Of the $102.3 million, $15 million was appropriated in fiscal year 2004 and $87.3 million was appropriated in fiscal year 2008.[2] To keep costs within budget, the VA closely monitored and reduced the scope of the major construction project. Some of the work was also shifted to a minor construction project. The medical center modified the design plans to eliminate 30 beds and one floor from the bed tower. The 30 beds will instead be relocated in the main hospital where space is being renovated to accommodate them. The funding for the 30 beds will not come from the appropriated construction funds. Rather, the 30 beds will be funded out of non-recurring maintenance (NRM) funds, which can be used to renovate spaces and purchase equipment needed as a result of that renovation. Our analysis of how the cost estimate met best practices is in table 4.

**Table 4: Extent That Bed Tower Cost Estimate Met Best Practices**

**Step One: Define the Estimate's Purpose**

The purpose of a cost estimate is determined by its intended use, and its intended use determines its scope and detail. Cost estimates have two general purposes: (1) to help managers evaluate affordability and performance against plans, as well as the selection of alternative systems and solutions, and (2) to support the budget process by providing estimates of the funding required to efficiently execute a program. The scope of the cost estimate will be determined by such issues as the time involved, what elements of work need to be estimated, who will develop the cost estimates, and how much cost estimating detail will be included.

A life cycle cost estimate provides an exhaustive and structured accounting of all resources and associated cost elements required to develop, produce, deploy, and sustain a particular program. As such a life cycle cost estimate encompasses all past (or sunk), present, and future costs for every aspect of a program, regardless of funding source. Life cycle costing enhances decision making, especially in early planning and concept formulation of acquisition. Design trade-off studies conducted in this period can be evaluated on a total cost basis as well as on a performance and technical basis. A life cycle cost estimate can support budgetary decisions, key decision points, milestone reviews, and investment decisions. Because they encompass all possible costs, life cycle cost estimates provide a wealth of information about how much programs are expected to cost over time. Thus, having full life cycle costs is important for successfully planning program resources and making wise decisions.

1. Is the purpose and scope of the cost estimate defined and documented? Have all costs been estimated, including life cycle costs?

[2] Consolidated Appropriations Act for FY 2004, Pub. L. No. 108-199, Div. G, Title I, 118 Stat. 3, 367-368 (2004), and Consolidated Appropriations Act for FY 2008, Pub. L. No. 110-161, Div. I, Title II, 121 Stat., 1844, 2267 (2007).

**Met; the purpose of the cost estimate is documented and defined at a level that would enable VA to submit a quality cost estimate.**

The purpose of the cost estimate is to be the basis of comparison for the bids responding to the CARES tower construction request for proposal (RFP). The scope covers only the construction of the tower; it is not required to include complete life-cycle costs. The scope of the initial estimate is defined through a cost estimate steering committee that included construction cost estimators, architects, and engineers that were familiar with the design and earlier construction phases. Life cycle costs are represented in the OMB Exhibit 300.

The scope of the estimate is defined by VA policy. The Manual for Preparation of Cost Estimates for VA Facilities states that:

1.1.1 - A project estimate shall show the current cost of construction on the date of the estimate. The estimate should reflect current costs on the date the estimate is received and anticipated local escalation to the midpoint of construction, i.e., date of estimate plus half of construction duration.

1.1.2 - The level of detail for this estimate shall be consistent with the degree of completeness of the drawings being submitted. Simply stated, this means that if a construction element is shown, it must be priced; if it is shown in detail, it must be priced in detail. For detailed elements, “lump sum” or “allowance” figures will not be acceptable. Project estimates will include all elements within the contractor’s bid such as insurance, bonds, hazardous abatement and any other such items.

**Step Two: Develop the Estimating Plan**

An analytic approach to cost estimates typically entails a written study plan detailing a master schedule of specific tasks, responsible parties, and due dates. Enough time should be scheduled to collect data, including visits to contractor sites to further understand the strengths and limitations of the data that have been collected. If there is not enough time, then the schedule constraint should be clearly identified in the ground rules and assumptions, so that management understands the effect on the estimate’s quality and confidence.

2. Did the team develop a written study plan?

**Met; the estimating team is from a centralized cost estimating firm that specializes in hospital construction and the estimate follows cost estimate preparation guidance published by the VA.**

CFM publishes guidance on preparing cost estimates that details how construction cost estimates should be created, structured, and presented. The manual also explains roles and responsibilities, units of measure, and guidance on master specifications. The CARES tower cost estimate was created by an independent consultant to the architect as directed by VA contractual requirements. The consulting estimating firm specializes in major construction cost estimates, particularly hospital construction. Officials stated that the cost estimators have extensive experience in the regional marketplace and in creating estimates for high-cost medical centers. Senior cost estimators for the project have 30 years of experience estimating construction costs and are members of a professional cost engineering society.

As outlined in the Manual for Preparation of Cost Estimates for VA Facilities:

1.1.1 - A project estimate shall show the current cost of construction on the date of the estimate. The estimate should reflect current costs on the date the estimate is received and anticipated local escalation to the midpoint of construction, i.e., date of estimate plus ½ of construction duration.

1.1.2 - The level of detail for this estimate shall be consistent with the degree of completeness of the drawings being submitted. Simply stated, this means that if a construction element is shown, it must be priced; if it is shown in detail, it must be priced in detail. For detailed elements, “lump sum” or “allowance” figures will not be acceptable. Project estimates will include all elements within the contractor’s bid such as insurance, bonds, hazardous abatement and any other such items.

**Step Three: Define the Program Characteristics**

Key to developing a credible estimate is having an adequate understanding of the acquisition program—the acquisition strategy, technical definition, characteristics, system design features, and technologies to be included in its design. The cost estimator can use this information to identify the technical and program parameters that will bind the cost estimate. The amount of information gathered directly affects the overall quality and flexibility of the estimate. Less information means more assumptions must be made, increasing the risk associated with the estimate. Therefore, the importance of this step must be emphasized, because the final accuracy of the cost estimate depends on how well the program is defined.

3. Is there a documented technical baseline description?

**Met; the detailed architectural drawings, which served as the technical baseline for the estimate, were continually updated to reflect the latest design changes.**

The master architect plan was used as a technical baseline for the estimate. The master plan was created by consultants to the architect/engineering (A/E) firm. The plan consisted of four volumes of design information that was used as the basis for the cost estimate. The cost estimate was developed as the design was changing. Officials noted that, ideally, architectural changes would be sent to the cost estimator 2 to 3 weeks in advance to give estimators time to update the estimate. However, because VA required the drawings and the estimate due at the same time, estimators only had 9 days to update the estimate for changes. Officials stated the technical baseline went through a fact-check to make sure all changes were incorporated.

Other technical baseline documents to be referenced in the development of a VA cost estimate are defined by VA policy. These documents, listed and defined in The Manual for Preparation of Cost Estimates for VA Facilities, include Practice Design Manuals, Master Specifications, Architect/Engineer Checklists, Design and Quality Alerts, Design Guides, Design and Construction Procedures, Physical Security Design Manuals, and Technical Summaries. The Cost Estimate Manual also includes the cost breakdown categories to be used in the estimate.

**Step Four: Determine the Estimating Structure**

A work breakdown structure (WBS) is the cornerstone of every program because it defines in detail the work necessary to accomplish a program's objectives. A WBS is a valuable communication tool between systems engineering, program management, and other functional organizations because it provides a clear picture of what needs to be accomplished and how the work will be done. Accordingly, it is an essential element for identifying activities in a program's integrated master schedule and it provides a consistent framework for planning and assigning responsibility for the work. Initially set up when the program is established, the WBS becomes successively detailed over time as more information because known about the program.

A WBS deconstructs a program's end product into successive levels with smaller specific elements until the work is subdivided to a level suitable for management control. By breaking the work down into smaller elements, management can more easily plan and schedule the program's activities and assign responsibility for the work. It also facilitates establishing a schedule, cost, and earned value management (EVM) baseline. Establishing a product-oriented WBS is a best practice because it allows a program to track cost and schedule by defined deliverables, such as a hardware or software component. This allows a program manager to more precisely identify which components are causing cost or schedule overruns and to more effectively mitigate the root cause of the overruns.

4. Is there a defined WBS and/or cost element structure?

**Met; the estimate clearly describes how the various sub-elements are summed to produce the amounts for each cost category, thereby ensuring that all pertinent costs are included and no costs are double counted.**

While the WBS is not considered product-oriented by program officials, the breakout of work is based on a required VA element structure. The WBS is based on the standardized WBS on VA form HO-18B/C. Both the architect and cost estimators are required to use this format. The WBS breaks the construction costs into standardized systems such as foundation, substructure, superstructure, and roofing, as well as subsystems such as slab on grade, stair construction, and elevators. These system descriptions are also used in the schedule. The HO-18 WBS elements are defined in the *Manual for Preparation of Cost Estimates for VA Facilities by CFM*.

**Step Five: Identify Ground Rules and Assumptions**

Cost estimates are typically based on limited information and therefore need to be bound by the constraints that make estimating possible. These constraints usually take the form of assumptions that bind the estimate's scope, establishing baseline conditions the estimate will be built from. Ground rules represent a common set of agreed on estimating standards that provide guidance and minimize conflicts in definitions. Without firm ground rules, the analyst is responsible for making assumptions that allow the estimate to proceed. Assumptions represent a set of judgments about past, present, and future conditions postulated as true in the absence of positive proof. The analyst must ensure that assumptions are not arbitrary, that they are founded on expert judgments rendered by experienced program and technical personnel. Many assumptions profoundly influence cost; the subsequent rejection of even a single assumption by management could invalidate many aspects of the estimate. Therefore, it is imperative that cost estimators brief management and document all assumptions well, so that management fully understands the conditions the estimate was structured on. Failing to do so can lead to overly optimistic assumptions that heavily influence the overall cost estimate, to cost overruns, and to inaccurate estimates and budgets.

5. Are there defined ground rules and assumptions that document the rationale and any historical data to back up any claims?

**Met; cost-influencing ground rules and assumptions, such as the programs schedule, labor rates, and inflation rates are documented, and market surveys were conducted to describe variability in material and labor prices.**

Assumptions and ground rules are documented and are included within the cost estimate. The ground rules and assumptions were created by the independent cost estimating firm and vetted with VA engineers and architects at the cost estimate steering committee meetings. Officials stated that the assumptions regarding escalation rates were particularly hard to agree upon between members of the steering committee. At the time, hurricane Katrina had recently struck and material prices were volatile. The final escalation rates were based off independent material price research performed by the cost estimating firm, which were nearly double the original rates proposed by the architect. In addition, the cost estimate includes market survey information to describe the volatility in labor and material prices and the risk of obtaining sufficient labor resources for the project.

**Step Six: Obtain the Data**

Data are the foundation of every cost estimate. How good the data are affects the estimate's overall credibility. Depending on the data quality, an estimate can range anywhere from a mere guess to a highly defensible cost position. Credible cost estimates are rooted in historical data. Rather than starting from scratch, estimators usually develop estimates for new programs by relying on data from programs that already exist and adjusting for any differences. Thus, collecting valid and useful historical data is a key step in developing a sound cost estimate. The challenge in doing this is obtaining the most applicable historical data to ensure that the new estimate is as accurate as possible. One way of ensuring that the data are applicable is to perform checks of reasonableness to see if the results are similar. Different data sets converging toward one value provides a high degree of confidence in the data.

6. Were the data gathered from historical actual cost, schedule, and program and technical sources?

**Met; cost estimators used actual costs from similar programs, incorporated vendor quotes, and conducted market surveys to develop material and labor price estimates.**

Officials stated that historical data were the foundation of the estimate and were based on experience by the cost estimating firm on similar high-profile hospital estimates. The cost estimators leveraged their experience and data from these previous projects to estimate the costs of the VA tower. The initial concept estimates were based primarily on verbal discussions with vendors. As the designs were finalized and the estimate took shape, actual paper quotes for labor and material were submitted by vendors; these were and assessed for appropriateness and realism by the cost estimators. In addition, a market survey was delivered as part of the final cost estimate. The market survey describes the volatility in labor and material prices and the risk of obtaining sufficient labor resources for the project.

**Step Seven: Develop the Point Estimate and Compare It to an Independent Cost Estimate**

Step 7 pulls all the information together to develop the point estimate—the best guess at the cost estimate, given the underlying data. High-quality cost estimates usually fall within a range of possible costs, the point estimate being between the best and worst case extremes. The cost estimator must perform several activities to develop a point estimate: develop the cost model by estimating each WBS element, using the best methodology, from the data collected; include all estimating assumptions in the cost model; express costs in constant-year dollars; time-phase the results by spreading costs in the years they are expected to occur, based on the program schedule; and add the WBS elements to develop the overall point estimate.

Having developed the overall point estimate, the cost estimator must then validate it by thoroughly understanding and investigating how the cost model was constructed. For example, all WBS cost estimates should be checked to verify that calculations are accurate (no double counting) and account for all costs, including indirect costs. Moreover, proper escalation factors should be used to inflate costs so that they are expressed consistently and accurately. Finally, the cost estimator should compare the cost estimate against the independent cost estimate and examine where and why there are differences; perform cross-checks on cost drivers to see if results are similar; and update the model as more data become available or as changes occur and compare the results against previous estimates.

7. Did the cost estimator consider various cost estimating methods like analogy, engineering build up, parametric, extrapolating from actual costs, and expert opinion (if none of the other methods can be used)?

**Met; the cost estimate is based on a detailed engineering buildup methodology using estimated labor and material prices, and crosschecked against an independent unit-cost level assessment. The estimate was vetted through experts to ensure costs were appropriately captured.**

The construction cost estimate is based on engineering buildup of vendor quotes for material and labor dollars. Due to hurricane Katrina, the prices of copper and steel were especially volatile. The cost estimating firm conducted its own market research into material prices to create escalation rates. Moreover, officials stated that contingency factors for the estimate were tailored to the building and the construction situation rather than employing standard rules-of-thumbs. Officials stated that an independent cost estimate was not performed by either the VA or the architect. However, a consultant to the cost estimating firm did perform an assessment, and the two estimates were reconciled. Officials stated that the assessment was performed using a high-level unit cost methodology, which was compared to the original cost estimate's bottom-up engineering methodology.

The draft estimates were created in spreadsheets and reviewed multiple times by senior cost estimators. Officials stated that the cost estimate is reviewed multiple times for errors internally because the estimate must meet requirements imposed by insurance companies (referred to as "professional liability"). Moreover, the estimate was reviewed periodically by the cost estimate steering committee.

Officials noted that the largest pitfall to the VA estimating process is that the budget is already set far in advance of the cost estimate. The cost would be estimated independently, and if the price exceeded the budgeted amount, the cost estimators worked with the engineers and architects to reduce or eliminate costs through the value engineering process.

**Step Eight: Conduct a Sensitivity Analysis**

Sensitivity analysis should be included in all cost estimates because it examines the effects of changing assumptions and ground rules. Since uncertainty cannot be avoided, it is necessary to identify the cost elements that represent the most risk and, if possible, cost estimators should quantify the risk using both a sensitivity and uncertainty (see step 9) analysis. In order for sensitivity analysis to reveal how the cost estimate is affected by a change in a single assumption, the cost estimator must examine the effect of changing one assumption or cost driver at a time while holding all other variables constant. By doing so, it is easier to understand which variable most affects the cost estimate.

8. Did the cost estimate included a sensitivity analysis that identified using a range of possible costs the effects of changing key cost driver assumptions or factors?

**Partially met; while a sensitivity analysis was not conducted by the VA, the estimate identifies volatility in material and labor costs and utilizes conservative escalation rates.**

Program officials stated that a sensitivity analysis was not performed on the estimate. However, they noted that the estimate utilized conservative escalation rates because officials were well aware of the consequences of underestimated material costs. In addition, the cost estimate includes market survey information to describe the volatility in labor and material prices and the risk of obtaining sufficient labor resources for the project. Given the volatility of material prices at the time—officials stated that steel was anywhere from $2,200 to $4,500 a ton—a sensitivity analysis on escalation rates would formally document the sensitivity of the overall estimate to small or large changes in material prices.

**Step Nine: Conduct a Risk and Uncertainty Analysis**

Because cost estimates predict future program costs, uncertainty is always associated with them. Moreover, a cost estimate is usually composed of many lower-level WBS elements, each of which comes with its own source of error. Once these elements are added together, the resulting cost estimate can contain a great deal of uncertainty. Risk and uncertainty refer to the fact that because a cost estimate is a forecast, there is always a chance that the actual cost will differ from the estimate. A lack of knowledge about the future is only one possible reason for the difference. Another equally important reason is the error resulting from historical data inconsistencies, assumptions, cost estimating equations, and factors typically used to develop an estimate. In addition, biases are often found in estimating program costs and developing program schedules. The biases may be cognitive—often based on estimators' inexperience—or motivational, where management intentionally reduces the estimate or shortens the schedule to make the project look good to stakeholders. Recognizing the potential for error and deciding how best to quantify it is the purpose of risk and uncertainty analysis.

Since cost estimates are uncertain, making good predictions about how much funding a program needs to be successful is difficult. In a program's early phases, knowledge about how well technology will perform, whether the estimates are unbiased, and how external events may affect the program is imperfect. For management to make good decisions, the program estimate must reflect the degree of uncertainty, so that a level of confidence can be given about the estimate. Quantitative risk and uncertainty analysis provide a way to assess the variability in the point estimate. Using this type of analysis, a cost estimator can model such effects as schedules slipping, missions changing, and proposed solutions not meeting user needs, allowing for a known range of potential costs. Having a range of costs around a point estimate is more useful to decision makers, because it conveys the level of confidence in achieving the most likely cost and also informs them on cost, schedule, and technical risks.

9. Was a risk and uncertainty analysis conducted that quantified the imperfectly understood risks and identified the effects of changing key cost driver assumptions and factors?

**Not met; a risk and uncertainty analysis was not conducted so that a level of confidence about the estimate could be determined.**

Program officials stated that an uncertainty analysis was not performed on the estimate. Given the volatility of material prices at the time—officials stated that steel was anywhere from $2,200 to $4,500 a ton and copper was falling—an uncertainty analysis on labor and material price estimates would formally document the risks and uncertainty of the overall estimate.

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| **Step Ten: Document the Estimate** |
| Documentation provides total recall of the estimate's detail so that it can be replicated by someone other than those who prepared it. It also serves as a reference to support future estimates. Documenting the cost estimate makes available a written justification showing how it was developed and aiding in updating it as key assumptions change and more information becomes available. Estimates should be documented to show all parameters, assumptions, descriptions, methods, and calculations used to develop a cost estimate. A best practice is to use both a narrative and cost tables to describe the basis for the estimate, with a focus on the methods and calculations used to derive the estimate. With this standard approach, the documentation provides a clear understanding of how the cost estimate was constructed. Moreover, cost estimate documentation should explain why particular methods and data sets were chosen and why these choices are reasonable. It should also reveal the pros and cons of each method selected. Finally, there should be enough detail so that the documentation serves as an audit trail of backup data, methods, and results, allowing for clear tracking of a program's costs as it moves through its various life-cycle phases.<br>10. Did the documentation describe the cost estimating process, data sources, and methods step by step so that a cost analyst unfamiliar with the program could understand what was done and replicate it?<br>**Partially met; while the documentation for the most part provided detailed material and labor build up, we were not able to trace the data back based on the documentation alone.**<br>While officials stated that the estimate was based off data from previous estimates, the cost estimate documentation delivered to VA does not trace estimated values to raw or normalized data. For instance, the delivered cost estimate documentation does not provide a basis or supporting data for included bidding contingency, markup, or escalation rates that would allow an analyst unfamiliar with the project to recreate them. |
| **Step Eleven: Present Estimate to Management for Approval** |
| A cost estimate is not considered valid until management has approved it. Since many cost estimates are developed to support a budget request or make a decision between competing alternatives, it is vital that management is briefed on how the estimate was developed, including risks associated with the underlying data and methods. Therefore, the cost estimator should prepare a briefing for management with enough detail to easily defend the estimate by showing how it is accurate, complete, and high in quality. The briefing should present the documented life-cycle cost estimate with an explanation of the program's technical and program baseline.<br>11. Was there a briefing to management that included a clear explanation of the cost estimate so as to convey its level of competence?<br>**Met; the estimate was approved by internal management and vetted through a cost estimating steering committee consisting of project engineers and architects.**<br>The draft estimates were created in spreadsheets and reviewed multiple times by senior cost estimators. Officials stated that the cost estimate is reviewed multiple times for errors internally because the estimate must meet requirements imposed by insurance companies (referred to as "professional liability"). Moreover, the estimate was periodically vetted through VA engineers and architects familiar with the project at cost estimate steering committee meetings. |

| Step Twelve: Update the Estimate to Reflect Actual Costs and Changes |
| --- |
| The cost estimate should be regularly updated to reflect all changes. Not only is this a sound business practice; it is also a requirement outlined in OMB's Capital Programming Guide.[3] The purpose of updating the cost estimate is to check its accuracy, defend the estimate over time, shorten turnaround time, and archive cost and technical data for use in future estimates. After the internal agency and congressional budgets are prepared and submitted, it is imperative that cost estimators continue to monitor the program to determine whether the preliminary information and assumptions remain relevant and accurate. Keeping the estimate fresh gives decision makers accurate information for assessing alternative decisions. Cost estimates must also be updated whenever requirements change, and the results should be reconciled and recorded against the old estimate baseline. The documented comparison between the current estimate (updated with actual costs) and old estimate allows the cost estimator to determine the level of variance between the two estimates. In other words, it allows estimators to see how well they are estimating and how the program is changing over time. |
| 12. Is there a process for the estimating team to update the estimate with actual costs as it becomes available? |
| **Not met; the VA does not require the cost estimating firm to update the construction cost estimate with actual costs once the project is underway.** |
| Officials from the cost estimating firm stated that while "adds and deducts" were inserted into the estimate as the design changed, the estimate is not updated once construction begins. Officials stated that they are not privy to actual costs incurred by VA general contractors, but that they wish they were in order to check the accuracy of their estimates. Regardless of what type of contract or what organization is managing costs, the purpose of updating the cost estimate is to check its accuracy, defend the estimate over time, shorten turnaround time of future estimates, and archive cost and technical data for use in future estimates. |

Source: GAO analysis of VA information.

## Project Schedule and Changes in Scope

The project was originally a one-phase project and scheduled to be completed in September 2008 but is now a two-phase project and is scheduled to be completed in February 2011. Before construction began, the project was broken into two phases because there was insufficient power capacity to keep the existing hospital functioning while the construction was being completed. As a result, an energy center was added to the design plan and its construction was separated from that of the bed tower. In addition, a property acquisition that took longer than expected delayed the project schedule by nine months. Part of the land that the bed tower is being built on was donated to the City of Cleveland for use as parkland. The acquisition process was prolonged because the City had to change the use of the donated land before the VA could begin construction. Phasing the project and the delayed property acquisition fostered a change in scope of the project and the project's original completion date was moved from September 1, 2008, to November 9, 2010. The projected completion date was again extended to February 1, 2011, due to unforeseen site conditions. Specifically, during the construction of the bed tower, crews discovered and had to move a sewer line before they could continue. According to VA officials, February 1, 2011, is still the

[3]OMB, *Capital Programming Guide: Supplement to Circular A-11, Part 7, Preparation, Submission, and Execution of the Budget.*

projected date for project completion. However, it was not possible for us to determine if the completion date is reasonable because the project's construction schedule has not undergone a schedule risk analysis. We have identified a schedule risk analysis as a best practice in scheduling. As of August 2009, VA has completed the energy center and is constructing the bed tower addition.

The construction schedule for this project generally followed best practices but, as stated, did not include a schedule risk analysis. Specifically, while the schedule met eight of nine scheduling best practices, the schedule did not undergo a risk analysis to determine the major risks to the schedule and the likelihood of the project being completed on time. Our analysis of how the schedule met best practices is in table 5.

**Table 5: Extent That Bed Tower Construction Schedule Met Best Practices**

| Best practice | Explanation | Met? | GAO analysis |
|---|---|---|---|
| Capturing activities | The schedule should reflect all activities as defined in the project's work breakdown structure, which defines in detail the work necessary to accomplish a project's objectives, including activities to be performed by both the owner and contractors. | Met | The schedule is required by contract to include approximately 2,500 activities in order to sufficiently detail the level of work required (the actual schedule has 2,725, approximately 75 detail activities per milestone). Each activity is mapped to an activity ID number, building area, and work trade, which allows the scheduler to quickly filter the schedule by type of work or subcontractor. The schedule is reviewed by the VA CFM for completeness to ensure all necessary activities and milestones are included. |

| Best practice | Explanation | Met? | GAO analysis |
|---|---|---|---|
| Sequencing activities | The schedule should be planned so that critical project dates can be met. To meet this objective, activities need to be logically sequenced—that is, listed in the order in which they are to be carried out. In particular, activities that must be completed before other activities can begin (predecessor activities), as well as activities that cannot begin until other activities are completed (successor activities), should be identified. This helps ensure that interdependencies among activities that collectively lead to the accomplishment of events or milestones can be established and used as a basis for guiding work and measuring progress. | Met | All detail activities and milestones are properly sequenced. Out of 2,378 remaining detail activities, we found only 2 activities that were not properly driving the start date of a predecessor activity. There are no lags, hard constraints, or soft constraints in the schedule, as required by contract specifications. Officials stated that, if the project runs late, the VA requires the baseline schedule to show the slip in the finish milestone (as opposed to constraining the finish milestone and simply reporting negative float). The VA also requires a diagram of the schedule network, similar to a PERT diagram, that clearly displays the relationships between tasks. |
| Assigning resources to activities | The schedule should reflect what resources (e.g., labor, materials, and overhead) are needed to do the work, whether all required resources will be available when needed, and whether any funding or time constraints exist. | Met | The VA requires schedules to be cost loaded with prorated overhead and profit, and the total price loaded into the schedule must equal the total contract price. Each detail activity has an associated manpower requirement. |
| Establishing the duration of activities | The schedule should realistically reflect how long each activity will take to execute. In determining the duration of each activity, the same rationale, historical data, and assumptions used for cost estimating should be used. Durations should be as short as possible and have specific start and end dates. The schedule should be continually monitored to determine when forecasted completion dates differ from planned dates; this information can be used to determine whether schedule variances will affect subsequent work. | Met | As required by VA schedule contract specifications, activity durations are 20 days or less, except for procurement activities. Our analysis shows the median task duration is 10 days. Less than 1% of the remaining activities are 1 day in duration. Activity durations are estimated using input from subcontractors who will be performing the work. All activities are based on a standard 5-day workweek with holidays. |

| Best practice | Explanation | Met? | GAO analysis |
| --- | --- | --- | --- |
| Integrating activities horizontally and vertically | The schedule should be horizontally integrated, meaning that it should link products and outcomes associated with other sequenced activities. These links are commonly referred to as “handoffs” and serve to verify that activities are arranged in the right order to achieve aggregated products or outcomes. The schedule should also be vertically integrated, meaning that the dates for starting and completing activities in the integrated master schedule should be aligned with the dates for supporting tasks and subtasks. Such mapping or alignment among levels enables different groups to work to the same master schedule. | Met | Our analysis shows the schedule to be horizontally integrated due to the high number of straightforward finish-start links, realistic float, and valid critical path. The schedule is vertically integrated, with all activities subsumed under organized higher levels. Each activity is mapped to an area and trade, clearly indicating which subcontractor is responsible for what work in each area at any time. |
| Establishing the critical path for activities | Scheduling software should be used to identify the critical path, which represents the chain of dependent activities with the longest total duration. Establishing a project’s critical path is necessary to examine the effects of any activity slipping along this path. Potential problems along or near the critical path should also be identified and reflected in scheduling the duration of high-risk activities. | Met | Officials stated the critical path is calculated by the scheduling software and is a crucial tool for managing the construction project. The critical path and activities near the critical path (the “hot list”) are reviewed in management meetings on a monthly basis. Our analysis shows the critical path to be structurally sound, running the length of the schedule and encompassing several major milestones. |
| Identifying the float between activities | The schedule should identify the float—the amount of time by which a predecessor activity can slip before the delay affects successor activities—so that a schedule’s flexibility can be determined. As a general rule, activities along the critical path have the least float. Total float is the total amount of time by which an activity can be delayed without delaying the project’s completion (if everything else goes according to plan). | Met | Total float represents the amount of time an activity can slip before it affects the project finish date. It is therefore a crucial tool for resource allocation and risk mitigation. There appear to be excessive values of total float in the schedule, but officials stated that they were not concerned with these float values. Officials told us that in a construction project, many tasks can be performed in any order, and the only float values of real concern for management was float on or near the critical path. |

| Best practice | Explanation | Met? | GAO analysis |
|---|---|---|---|
| Conducting a schedule risk analysis | A schedule risk analysis should be performed using statistical techniques to predict the level of confidence in meeting a project's completion date. This analysis focuses not only on critical path activities but also on activities near the critical path, since they can affect the project's status. | Not met | The program has not performed a schedule risk analysis (SRA). Officials stated that they see value in an SRA particularly if it is performed very early in the program, for example, during the OMB 300 budget request procedure. However, best practices suggest that even at the construction bid phase, an SRA can be used to determine a level of confidence in meeting the completion date or whether proper reserves have been incorporated into the schedule. An SRA will calculate schedule reserve, which can be set aside for those activities identified as high-risk. Without this reserve, the program faces the risk of delays to the scheduled completion date if any delays were to occur on critical path activities. |
| Updating the schedule using logic and durations to determine dates | | Met | The schedule is reviewed and updated formally in monthly management meetings. During these meetings, officials update and examine actual start and finish dates and remaining durations of activities. The schedule is manually updated through "progress reporting." During progress reporting, the general contractor physically walks through the job site and updates the remaining durations on each ongoing activity. Our analysis found no date anomalies in the schedule. Date anomalies are errors such as actual finish dates in the future, outdated tasks that have no actual start date, and completed tasks in the past with no actual finish date. |

Source: GAO analysis of VA information.

# Appendix IV: Construction of Spinal Cord Injury/Disease Center in Syracuse, New York

## Project Overview

This project includes the construction of a 30-bed center for treating spinal cord injuries to be attached to the current VA medical center in Syracuse, New York. The project also includes adding two levels to the current parking garage. The project is divided into two phases. Phase I includes the addition on the parking garage and Phase II includes the construction of the Spinal Cord Injury/Disease (SCI/D) center.

## Reasons for the Project

VA initiated this project under the Capital Asset Realignment for Enhanced Services (CARES) process in February 2004 because the Veterans' Integrated Service Network (VISN) did not have the ability to treat acute spinal cord injuries. Syracuse had the only in-patient rehabilitation unit and SCI/D expertise within the VISN; so, VA decided to put the new SCI/D center in Syracuse.

## Project Cost

The project cost has increased from the original estimate submitted to Congress of $53.9 million to $84,969,000 (an increase of 58 percent). According to VA officials in Syracuse, this estimate was developed in about 6 weeks and was based on the total square footage required multiplied by the cost per square foot of new construction. Congress authorized $53.9 million for the project in 2004[1] and appropriated about $53.4 million in funds in the Consolidated Appropriations Act for FY 2005.[2]

According to VA officials in Syracuse, the main reason for the cost increase is that the initial estimate did not fully consider several factors. The original design of a new SCI/D center did not include money for additional parking. However, when the project had been approved by Congress and was in design, VA officials in Syracuse commissioned a study to examine future parking needs at the Syracuse medical center. The study concluded that, based on the new SCI/D center and projected demand from patients and staff, there should be an additional 429 to 528

[1]The Veterans Health Care, Capital Asset, and Business Improvement Act of 2003 authorized the Secretary of VA to carry out major construction projects specified in the final CARES report, which was to be approved by the Secretary of VA. See Pub. L. No. 108-170, § 221, 117 Stat 2042, 2050 (2003). The Secretary's report dated May 20, 2004, listed $53.9 million for construction of a spinal cord injury center, which was authorized under § 221 of Pub. L. No. 108-170. The project's authorization was modified in 2006 to an amount not to exceed $77,700,000. See Pub. L. No. 109-461 § 802.

[2]Consolidated Appropriations Act for FY 2005, Pub. L. No. 108-447, Div. I, Title I, 118 Stat. 2809, 3289-3290 (2004).

parking spaces at the medical center. As a result of this study, VA officials in Syracuse decided to add two floors onto the existing parking garage at an estimated cost of $10 million.

In addition to parking, stakeholders identified needed scope changes in the project. Specifically, the Paralyzed Veterans of America (PVA) insisted that there be a dedicated entrance from the parking garage to the SCI/D center, which is being built on the 4th floor of the medical center. This dedicated entrance would allow veterans with spinal cord injuries to enter the center directly from the parking garage, without requiring the veterans to go down to the street from the parking garage, outside to the main entrance of the medical center, then up to the 4th floor of the medical center for treatment. According to VA staff in Syracuse, VA agreed to make changes that would improve access to the facility, and this increased the cost of the project and delayed the project's schedule. As a result of these changes to the project's scope, VA received an additional $23.8 million from Congress in fiscal year 2008.[3] Our analysis of how the cost estimate for the SCI/D center met best practices is in table 6.

**Table 6: Extent That SCI/D Center Cost Estimate Met Best Practices**

| **Step One: Define the Estimate's Purpose** |
|---|
| The purpose of a cost estimate is determined by its intended use, and its intended use determines its scope and detail. Cost estimates have two general purposes: (1) to help managers evaluate affordability and performance against plans, as well as the selection of alternative systems and solutions, and (2) to support the budget process by providing estimates of the funding required to efficiently execute a program. The scope of the cost estimate will be determined by such issues as the time involved, what elements of work need to be estimated, who will develop the cost estimates, and how much cost estimating detail will be included. |
| A life-cycle cost estimate provides an exhaustive and structured accounting of all resources and associated cost elements required to develop, produce, deploy, and sustain a particular program. As such a life cycle cost estimate encompasses all past (or sunk), present, and future costs for every aspect of a program, regardless of funding source. Life-cycle costing enhances decision making, especially in early planning and concept formulation of acquisition. Design trade-off studies conducted in this period can be evaluated on a total cost basis as well as on a performance and technical basis. A life-cycle cost estimate can support budgetary decisions, key decision points, milestone reviews, and investment decisions. Because they encompass all possible costs, life cycle cost estimates provide a wealth of information about how much programs are expected to cost over time. Thus, having full life cycle costs is important for successfully planning program resources and making wise decisions. |
| 1. Is the purpose and scope of the cost estimate defined and documented? Have all costs been estimated, including life cycle costs? |

[3] Pub. L. No. 110-161, 121 Stat. 1844, 2267 (2007).

**Substantially Met; the purpose of the cost estimate is documented and clearly defined at a level that would enable VA Syracuse to submit a quality cost estimate: however, the cost estimate does not cover the full life cycle and therefore does not account for all costs.**

The purpose of the VA cost estimate is to support the basis for the budget request for the Syracuse Spinal Cord Injury/Disease (SCI/D) center. As they work through the process they further refined the estimate. VA Syracuse did not do a life-cycle cost estimate (LCCE), they only addressed design and construction in their estimate. In the OMB Exhibit 300, VA only showed costs for the acquisition base year and 3 additional years. No costs were reported for maintenance.

The scope of the estimate is defined by VA policy. In the Manual for Preparation of Cost Estimates for VA Facilities (00CFM1B) June 2007, page 1, sections 1.1.1 – 1.1.2 says:

1.1.1 - A project estimate shall show the current cost of construction on the date of the estimate. The estimate should reflect current costs on the date the estimate is received and anticipated local escalation to the midpoint of construction, i.e., date of estimate plus ½ of construction duration.

1.1.2 - The level of detail for this estimate shall be consistent with the degree of completeness of the drawings being submitted. Simply stated, this means that if a construction element is shown, it must be priced; if it is shown in detail, it must be priced in detail. For detailed elements, “lump sum” or “allowance” figures will not be acceptable. Project estimates will include all elements within the contractor’s bid such as insurance, bonds, hazardous abatement, and any other such items.

**Step Two: Develop the Estimating Plan**

An analytic approach to cost estimates typically entails a written study plan detailing a master schedule of specific tasks, responsible parties, and due dates. Enough time should be scheduled to collect data, including visits to contractor sites to further understand the strengths and limitations of the data that have been collected. If there is not enough time, then the schedule constraint should be clearly identified in the ground rules and assumptions so that management understands the effect on the estimate’s quality and confidence.

2. Did the team develop a written study plan?

**Met; the cost estimator followed the process for developing the estimate as outlined in the Manual for Preparation of Cost Estimates for VA Facilities (00CFM1B) June 2007.**

The Phoenix Engineering staff who worked on the estimate is very experienced. The cost estimator has worked in the construction industry for 30 years and has been doing cost estimates for the past 7 years. The senior electrical estimator has 40 years of experience in construction. Most of the cost estimators’ team came from the construction industry.

The team follows a systematic approached outlined in the Manual for Preparation of Cost Estimates for VA Facilities (00CFM1B) June 2007, page 1, sections 1.1.1 – 1.1.2, which says:

1.1.1 - A project estimate shall show the current cost of construction on the date of the estimate. The estimate should reflect current costs on the date the estimate is received and anticipated local escalation to the midpoint of construction, i.e., date of estimate plus half of construction duration.

1.1.2 - The level of detail for this estimate shall be consistent with the degree of completeness of the drawings being submitted. Simply stated, this means that if a construction element is shown, it must be priced; if it is shown in detail, it must be priced in detail. For detailed elements, “lump sum” or “allowance” figures will not be acceptable. Project estimates will include all elements within the contractor’s bid such as insurance, bonds, hazardous abatement, and any other such items. Submission requirements are indicated in the VA Cost Estimating Guide.

**Step Three: Define the Program Characteristics**

Key to developing a credible estimate is having an adequate understanding of the acquisition program—the acquisition strategy, technical definition, characteristics, system design features, and technologies to be included in its design. The cost estimator can use this information to identify the technical and program parameters that will bind the cost estimate. The amount of information gathered directly affects the overall quality and flexibility of the estimate. Less information means more assumptions must be made, increasing the risk associated with the estimate. Therefore, the importance of this step must be emphasized, because the final accuracy of the cost estimate depends on how well the program is defined.

3. Is there a documented technical baseline description?

**Met; a technical baseline has been documented that includes requirements, purpose, and system design features.**

Phoenix engineering, the cost estimating firm, worked with QPK, the architectural and engineering firm, to obtain design specifications and clarifications when needed for the estimates. QPK provided draft copies of each of the submissions to the VA 2 weeks before the schematic design and design development milestones were reached. Both the medical center staff and central office staff commented on the design before it was released. For example, there were questions about the specifications for the depth of the caissons in the amount of concrete needed. The caissons are the underground supports for the columns in the garage. They are large diameter holes in the ground filled with concrete and rebar that in some cases, go as deep as 30 feet. QPK reviewed the estimate before it was released to the VA. This is an iterative process that is defined by the VA Project Guide.

The Manual for Preparation of Cost Estimates for VA Facilities (00CFM1B) June 2007, sections 1.4 – 1.4.2.3 outlines the technical resources and their descriptions.

In addition, the VA has set of master specifications based on the in Construction Specification Institute format. Midstream during the estimating process the VA switched to the newer CSI format which has 50 divisions versus the previous 16 divisions. The most recent cost estimate is based on the VA Manual, which discusses foundation, frame, floor structure, etc., which is standard in the construction industry

**Step Four: Determine the Estimating Structure**

A work breakdown structure (WBS) is the cornerstone of every program because it defines in detail the work necessary to accomplish a program's objectives. A WBS is a valuable communication tool between systems engineering, program management, and other functional organizations because it provides a clear picture of what needs to be accomplished and how the work will be done. Accordingly, it is an essential element for identifying activities in a program's integrated master schedule and it provides a consistent framework for planning and assigning responsibility for the work. Initially set up when the program is established, the WBS becomes successively detailed over time as more information because known about the program.

A WBS deconstructs a program's end product into successive levels with smaller specific elements until the work is subdivided to a level suitable for management control. By breaking the work down into smaller elements, management can more easily plan and schedule the program's activities and assign responsibility for the work. It also facilitates establishing a schedule, cost, and earned value management (EVM) baseline. Establishing a product-oriented WBS is a best practice because it allows a program to track cost and schedule by defined deliverables, such as a hardware or software component. This allows a program manager to more precisely identify which components are causing cost or schedule overruns and to more effectively mitigate the root cause of the overruns.

4. Is there a defined WBS and/or cost element structure?

**Met; the estimate describes how the various sub-elements are summed to produce the amounts for each cost category, thereby ensuring that all pertinent costs are included and no costs are double counted.**

The backbone of the VA work breakdown structure is based on the Construction Specifications Institute (CSI). The VA has a master specification based on 16 divisions of costs from CSI. Midstream during the estimating process the VA switched to the newer CSI format, which has 50 divisions versus the previous 16 divisions. The latest estimate that Phoenix engineering prepared was made against the VA manual specifications. This is different from what the construction industry has. It is VA's attempt to track costs for the future. The VA guide discusses foundations, frames, floor structure etc.

The cost estimate WBS is product oriented to the extent possible and it is at a level of detail to ensure that costs are neither omitted nor double counted. The WBS is in a standard format and is consistently used. The WBS is also used by the contractor for cost estimates and scheduling. A view of the work breakdown structure down to at least level 3 is shown below:

Base Building—Spinal Cord Injury Center

A. Foundation

B. Sub-structure—includes the cost of slab on grade and basement walls.

C. Super structure—includes the cost of floor and roof construction, interstitial and stair construction as well as structural steel.

D. Exterior structure—includes the cost of exterior walls, doors and windows

E. Roofing

F. Interior construction—includes the cost of partitions and interior finishes.

G. Conveying systems—includes the cost of elevators, moving stairs and walkways, dumbwaiters, pneumatic tubing and conveying systems.

H. Mechanical systems—includes the cost of plumbing, HVAC, fire protection, medical gas system, sewage treatment and solar mechanical system.

I. Electrical systems—includes the cost of base materials, lighting, electrical systems, communication systems as well as heating systems.

J. General conditions

K. Equipment—includes the cost of equipment, special construction and furnishings.

L. Sitework—includes the cost of site preparation, site improvements, site utilities, and other specified off-site work.

**Step Five: Identify Ground Rules and Assumptions**

Cost estimates are typically based on limited information and therefore need to be bound by the constraints that make estimating possible. These constraints usually take the form of assumptions that bind the estimate's scope, establishing baseline conditions the estimate will be built from. Ground rules represent a common set of agreed on estimating standards that provide guidance and minimize conflicts in definitions. Without firm ground rules, the analyst is responsible for making assumptions that allow the estimate to proceed. Assumptions represent a set of judgments about past, present, and future conditions postulated as true in the absence of positive proof. The analyst must ensure that assumptions are not arbitrary, that they are founded on expert judgments rendered by experienced program and technical personnel. Many assumptions profoundly influence cost; the subsequent rejection of even a single assumption by management could invalidate many aspects of the estimate. Therefore, it is imperative that cost estimators brief management and document all assumptions well, so that management fully understands the conditions the estimate was structured on. Failing to do so can lead to overly optimistic assumptions that heavily influence the overall cost estimate, to cost overruns, and to inaccurate estimates and budgets.

5. Are there defined ground rules and assumptions that document the rationale and any historical data to back up any claims?

**Met; the estimator identified ground rules and assumptions as well its escalation rates.**

In preparing the estimates Phoenix engineering made some assumptions regarding costs. They supported their assumptions with information from the designers and discussions with the VA. For example, for this estimate they assumed that inflation would be tied to the Boechk index. The escalation worksheets that the cost estimator provided show what assumptions were made.

Phoenix engineering also reviewed the schedule assumptions for the cost estimate and had concerns about whether the 1,000 day schedule was realistic. For example, there will be three major phases to the project which the firm believed would take about 4 years to complete: Phase 1 involves removal/site prep/foundation/underground utilities (1 year due to life safety & infection control); Phase 2 will be for construction (2 years due to weather related issues); and Phase 3 will be for the renovation of the 4th floor (1 year to complete).

The cost estimate was prepared using current prices as if bids were received on the date of the estimate. The cost estimate was then escalated to the planned construction contract award date using rates established by OMB. The cost estimator demonstrated in their escalation paper the gap between OMB mandated escalation rates and actual market conditions reflected by the Boechk Index.[4]

**Step Six: Obtain the Data**

Data are the foundation of every cost estimate. How good the data are affects the estimate's overall credibility. Depending on the data quality, an estimate can range anywhere from a mere guess to a highly defensible cost position. Credible cost estimates are rooted in historical data. Rather than starting from scratch, estimators usually develop estimates for new programs by relying on data from programs that already exist and adjusting for any differences. Thus, collecting valid and useful historical data is a key step in developing a sound cost estimate. The challenge in doing this is obtaining the most applicable historical data to ensure that the new estimate is as accurate as possible. One way of ensuring that the data are applicable is to perform checks of reasonableness to see if the results are similar. Different data sets converging toward one value provides a high degree of confidence in the data.

6. Was the data gathered from historical actual cost, schedule, and program and technical sources?

[4]The BOECKH Index is a measurement of construction cost inflation published by American Appraisal Associates Inc. The rate of inflation is based on actual reported construction costs. Other published construction cost indexes indicate national average construction cost inflation in the range of 17.6 percent to 29.6 percent from January 2004 to October 2006. The BOECKH Index is at the lower end compared to other indexes.

**Met; program office took well-documented steps to obtain data.**

For all four iterations of the cost estimate, with the first being done in 2005 and the last in spring 2009, Phoenix engineering used the PROEST construction software package. PROEST updates the software with the updates from the RS Means which is an industry-standard estimating database. They validate and supplement the RS Means data with internal cost information that they have obtained from quotes from vendors on other jobs that they have been involved in or data from research on other projects. The only drawback to the software is that they had to convert the cost estimate to Excel in order to manipulate it. Phoenix engineering also updated PROEST data with changes in material costs. PROEST data was also used for estimating recurring costs. For example, data from PROEST was used to estimate the cost of slabs used for elevator shafts by multiplying the costs by the number of floors. The cost of fuel also had an impact on project costs so they added a surcharge for fuel that would reflect the expected inflation rate for fuel. The cost of fuel also affected the costs for concrete and steel. Because quotes from vendors were not local, the data was normalized by using a location factor that adjusted prices for Syracuse.

Phoenix engineering used several resources to look at square footage costs and historical data that they have in-house for recent construction. They also used construction industry data from sources such as RS Means or Dodge Design Cost Data. Phoenix engineering worked with QPK to get design specifications and clarifications when needed for the estimates. QPK provided draft copies of each of the submissions to the VA 2 weeks before the schematic design and design development milestones were reached. Both the medical center staff and central office staff commented on the design before it was released. For example, there were questions about the specifications for the depth of the caissons in the amount of concrete needed. The caissons are the underground supports for the columns in the garage. They are large diameter holes in the ground filled with concrete and rebar that in some cases go as deep as 30 feet.

**Step Seven: Develop the Point Estimate and Compare It to an Independent Cost Estimate**

Step 7 pulls all the information together to develop the point estimate—the best guess at the cost estimate, given the underlying data. High-quality cost estimates usually fall within a range of possible costs, the point estimate being between the best and worst case extremes. The cost estimator must perform several activities to develop a point estimate: develop the cost model by estimating each WBS element, using the best methodology, from the data collected; include all estimating assumptions in the cost model; express costs in constant-year dollars; time-phase the results by spreading costs in the years they are expected to occur, based on the program schedule; and add the WBS elements to develop the overall point estimate.

Having developed the overall point estimate, the cost estimator must then validate it by thoroughly understanding and investigating how the cost model was constructed. For example, all WBS cost estimates should be checked to verify that calculations are accurate (no double counting) and account for all costs, including indirect costs. Moreover, proper escalation factors should be used to inflate costs so that they are expressed consistently and accurately. Finally, the cost estimator should compare the cost estimate against the independent cost estimate and examine where and why there are differences; perform cross-checks on cost drivers to see if results are similar; and update the model as more data become available or as changes occur and compare the results against previous estimates.

7. Did the cost estimator consider various cost estimating methods like analogy, engineering build up, parametric, extrapolating from actual costs, and expert opinion (if none of the other methods can be used)?

**Met; the cost estimate is based on an engineering buildup.**

The initial estimate for the SCI/D was $56 million. This initial estimate was a gross level (rough order of magnitude) based on the aggregate square footage and historical costs per square foot. This estimate was developed in a rough manner using the square footage multiplied by the per square foot cost of market-based construction. In addition, the estimate included contingencies and overhead. Contingencies and overhead came to about $2.1 million and the construction cost was estimated at $53.9 million. The life cycle costs included in the OMB 300 were developed by medical center staff and were done in a hurry.

In 2006 it became clear that the original estimate would be too little too complete the spinal cord injury center. The Construction and Facilities Management Office came up with the revised estimate. The new estimate was for approximately $78 million or $24 million more than the original estimate, and medical center staff were not informed of how this cost estimate was developed. The medical center received $23.8 million in 2007 supplemental appropriations bill.

In the summer of 2008, Phoenix Engineering estimated the costs would be much higher because the cost estimate was updated to reflect a more detailed design and reflected delays in the project. As a result, when the project went out for bid, the medical center found it would have to break the project up into smaller increments because there was not enough budget to do it all at once. These increments would be listed in the bid package as bid alternates (i.e., additional projects) that potential contractors would also provide bids for along with the base bid.

In developing their estimate, Phoenix Engineering used an engineering build up method based on square feet times the labor rate plus analogous material costs. Phoenix engineering used square feet data from QPK and converted it to a cost by multiplying the square feet by the labor rate using data from RS Means. They also checked the labor rates against union labor agreements and the Davis Bacon Act, which mandates minimum labor rates to check their estimate for consistency.

The $77.7 million appropriated for the construction includes the cost of the garage. The garage contract is for almost $10.6 million, which leaves only $66.1 million for the SCI/D.

There were several internal reviews of the cost estimate that were done to scrub the numbers. First, QPK reviewed the estimate, then VA reviewed it, and finally Alpha performed a peer review of the cost estimate. There was no independent cost estimate, but the Alpha peer-review served that purpose. Phoenix made some changes that had a major impact on the estimate. For example, Phoenix changed the estimate to reflect a lower inflation rate and less design contingency. Phoenix felt that the decrease was acceptable because the recession has caused the cost of materials to decrease and contractors were lowering their labor rates and fees in this competitive environment. Phoenix engineering initially delivered a conservative estimate so there was room to lower the cost estimate. In addition, there were no engineering change orders because the VA would not accept any changes. Only one state, New York, will budget a contingency for change orders for construction.

As a crosscheck, Phoenix engineering had someone gather labor rates that were applicable to Syracuse. Their estimate was based on a composite rate for the crew that would do the work.

**Step Eight: Conduct a Sensitivity Analysis**

Sensitivity analysis should be included in all cost estimates because it examines the effects of changing assumptions and ground rules. Since uncertainty cannot be avoided, it is necessary to identify the cost elements that represent the most risk and, if possible, cost estimators should quantify the risk using both a sensitivity and uncertainty (see step 9) analysis. In order for sensitivity analysis to reveal how the cost estimate is affected by a change in a single assumption, the cost estimator must examine the effect of changing one assumption or cost driver at a time while holding all other variables constant. By doing so, it is easier to understand which variable most affects the cost estimate.

8. Did the cost estimate included a sensitivity analysis that identified using a range of possible costs the effects of changing key cost driver assumptions or factors?

**Not met; while a sensitivity analysis was not conducted in their risk analysis, VA Syracuse did identify major cost drivers.**

There was no sensitivity analysis done. Square footage was dictated by VA. The only changes were scope changes. Similarly, there was no sensitivity analysis of the inflation index. The fuel surcharge that was included in the estimate, which had been volatile, was taken out because fuel prices had leveled off. They did not vary the composite labor rate.

While the VA Syracuse project followed most of the best practice steps, they do not perform a full sensitivity analysis. However, the estimating team did develop a risk analyses that identified major cost drivers that could adversely affect the project.

**Step Nine: Conduct a Risk and Uncertainty Analysis**

Because cost estimates predict future program costs, uncertainty is always associated with them. Moreover, a cost estimate is usually composed of many lower-level WBS elements, each of which comes with its own source of error. Once these elements are added together, the resulting cost estimate can contain a great deal of uncertainty. Risk and uncertainty refer to the fact that because a cost estimate is a forecast, there is always a chance that the actual cost will differ from the estimate. A lack of knowledge about the future is only one possible reason for the difference. Another equally important reason is the error resulting from historical data inconsistencies, assumptions, cost estimating equations, and factors typically used to develop an estimate. In addition, biases are often found in estimating program costs and developing program schedules. The biases may be cognitive—often based on estimators' inexperience—or motivational, where management intentionally reduces the estimate or shortens the schedule to make the project look good to stakeholders. Recognizing the potential for error and deciding how best to quantify it is the purpose of risk and uncertainty analysis.

Since cost estimates are uncertain, making good predictions about how much funding a program needs to be successful is difficult. In a program's early phases, knowledge about how well technology will perform, whether the estimates are unbiased, and how external events may affect the program is imperfect. For management to make good decisions, the program estimate must reflect the degree of uncertainty, so that a level of confidence can be given about the estimate. Quantitative risk and uncertainty analysis provide a way to assess the variability in the point estimate. Using this type of analysis, a cost estimator can model such effects as schedules slipping, missions changing, and proposed solutions not meeting user needs, allowing for a known range of potential costs. Having a range of costs around a point estimate is more useful to decision makers, because it conveys the level of confidence in achieving the most likely cost and also informs them on cost, schedule, and technical risks.

9. Was a risk and uncertainty analysis conducted that quantified the imperfectly understood risks and identified the effects of changing key cost driver assumptions and factors?

**Partially met; while VA Syracuse followed most of the best practice steps, they do not perform an uncertainty analysis: however, they did perform risk analyses for the various alternatives.**

Phoenix Engineering collected risks in excel spreadsheets and identified the likelihood of the risks occurring as well as the impact of the risks. In addition, the VA Cares Risk Analysis included a Risk Control Plan which identified the risks, probability of occurring, and the internal mitigation resources as well as the responsible parties. In the list of risks identified by VA Cares Syracuse, the majority of the issues focused on the construction of the new operating room (OR) while the current ORs still need to be in operation while the project is under construction.

See list of risks identified below.

Risk Categories:

i. Schedule – Operating Room construction may fall behind schedule

ii. Initial Costs – Costs associated with Operating Room construction may be higher than expected

iii. Life Cycle Costs – Expenses to run the Operating Room may be greater than predicted

iv. Technical Obsolescence – New Operating Room equipment could become available soon after project completion

v. Feasibility – Issues In operating room design, execution, or functioning could result in financial feasibility problems.

vi. Reliability of Systems – Equipment fails to perform as designed

vii. Dependencies & Interoperabilities – Facility is incapable of supporting operating room equipment

viii. Surety (Asset Protection) – Risk of vandalism (intentional damage)

ix. Risk of Creating a Monopoly – Dependence on operating room vendors for upgrades/repairs

x. Capability of Agency to Manage the Project – Expertise unavailable or has many competing projects in addition to operating room project

**Step Ten: Document the Estimate**

Documentation provides total recall of the estimate's detail so that it can be replicated by someone other than those who prepared it. It also serves as a reference to support future estimates. Documenting the cost estimate makes available a written justification showing how it was developed and aiding in updating it as key assumptions change and more information becomes available. Estimates should be documented to show all parameters, assumptions, descriptions, methods, and calculations used to develop a cost estimate. A best practice is to use both a narrative and cost tables to describe the basis for the estimate, with a focus on the methods and calculations used to derive the estimate. With this standard approach, the documentation provides a clear understanding of how the cost estimate was constructed. Moreover, cost estimate documentation should explain why particular methods and data sets were chosen and why these choices are reasonable. It should also reveal the pros and cons of each method selected. Finally, there should be enough detail so that the documentation serves as an audit trail of backup data, methods, and results, allowing for clear tracking of a program's costs as it moves through its various life cycle phases.

10. Did the documentation describe the cost estimating process, data sources, and methods step by step so that a cost analyst unfamiliar with the program could understand what was done and replicate it?

**Partially met; while the VA Syracuse office provided some documentation, the cost estimator only provided the cost estimate and without any supporting backup documentation.**

Design drawings were logged in with the dates they were prepared. Phoenix Engineering also discussed the format of the software that was used to document where the labor rates came from and they provided 3 to 5 pages of explanation along with the document log sheet.

In the estimate documentation we found that Phoenix Engineering compared the last estimate to the current estimate and the reasons for any differences. Between design and construction drawings, there were some changes in the way the estimate was organized, but the cost difference was minimal. There were, however, changes in the alternate designs.

The VA Syracuse team provided electronic files for the estimate summary and detailed estimate, which included the WBS based on a required VA element structure. In both the summary and detail estimate documentation, the WBS broke down the construction costs into standardized systems such as foundations, substructure, superstructure, exterior closure and roofing as well as interior construction, conveying systems, mechanical & electrical systems, equipment, and site work.

**Step Eleven: Present Estimate to Management for Approval**

A cost estimate is not considered valid until management has approved it. Since many cost estimates are developed to support a budget request or make a decision between competing alternatives, it is vital that management is briefed on how the estimate was developed, including risks associated with the underlying data and methods. Therefore, the cost estimator should prepare a briefing for management with enough detail to easily defend the estimate by showing how it is accurate, complete, and high in quality. The briefing should present the documented life cycle cost estimate with an explanation of the program's technical and program baseline.

11. Was there a briefing to management that included a clear explanation of the cost estimate so as to convey its level of competence?

**Met; VA Syracuse reviewed the cost estimate many times before it became final.**

The estimate was presented via written documentation and Excel spreadsheet. Phoenix engineering made changes based on comments received from QPK and VA (including comments from Alpha Engineering, who conducted a peer review of the estimate). The reviewers provided written comments to Phoenix via the 'doctor checks' system. This system provided a centralized place to record comments. Comments were sent electronically to Washington, D.C., so that others could review them.

**Step Twelve: Update the Estimate to Reflect Actual Costs and Changes**

The cost estimate should be regularly updated to reflect all changes. Not only is this a sound business practice; it is also a requirement outlined in OMB's Capital Programming Guide.[5] The purpose of updating the cost estimate is to check its accuracy, defend the estimate over time, shorten turnaround time, and archive cost and technical data for use in future estimates. After the internal agency and congressional budgets are prepared and submitted, it is imperative that cost estimators continue to monitor the program to determine whether the preliminary information and assumptions remain relevant and accurate. Keeping the estimate fresh gives decision makers accurate information for assessing alternative decisions. Cost estimates must also be updated whenever requirements change, and the results should be reconciled and recorded against the old estimate baseline. The documented comparison between the current estimate (updated with actual costs) and old estimate allows the cost estimator to determine the level of variance between the two estimates. In other words, it allows estimators to see how well they are estimating and how the program is changing over time.

12. Is there a process for the estimating team to update the estimate with actual costs as it becomes available?

**Partially met; the program's cost estimate is not updated with actual costs once the project is underway; however, that is not the contractor's fault because once the contract is awarded the contractor is no longer apart of the process.**

Thus far, the estimate has been a living document. For example, the cost estimator has been working on the document since 2005, making revisions and updates as warranted. However, once the contract is awarded, Phoenix Engineering's services will no longer be employed; therefore, they cannot update the estimate with actual costs.

Source: GAO analysis of VA information.

## Project Schedule

VA initially estimated that the project would be completed by December 6, 2009. VA awarded the contract to construct the SCI/D center on August 12, 2009, and estimates that the SCI/D center will be completed in May 2012, or 29 months after the first estimated completion date.

The schedule delays and cost increases occurred before construction began, and once construction commenced we found that the construction schedule for this project generally followed best practices. Specifically, the schedule met eight of nine scheduling best practices but did not include a schedule risk analysis. The schedule did not undergo a risk analysis to determine the major risks to the schedule and the likelihood of the project being completed on time. Our analysis of how the schedule met best practices is in table 7.

[5]OMB, *Capital Programming Guide: Supplement to Circular A-11, Part 7, Preparation, Submission, and Execution of the Budget.*

**Table 7: Extent That Parking Garage Schedule Met Best Practices**

| Best practice | Explanation | Met? | GAO analysis |
|---|---|---|---|
| Capturing activities | The schedule should reflect all activities as defined in the project's work breakdown structure, which defines in detail the work necessary to accomplish a project's objectives, including activities to be performed by both the owner and contractors. | Met | The parking garage schedule follows a specific work breakdown schedule that includes bonds, insurance, mobilization, demolition, earthwork, sidewalks, chainlink fence, pavement markings, concrete, cast-in-place, precast pre-stressed, architectural precast, masonry, structural steel, waterproofing, roofing, doors/frames/hardware, painting, interior signage, dry stand pipe, elevators, plumbing/mechanical, and electrical. This level of breakdown ensures that all of the work has been identified. Moreover, the schedule is fully resource-loaded and all the resources in the schedule add up to the cost estimate providing the scheduler with confidence that it includes all of the work.<br>In developing the schedule, the scheduler used activity codes to develop the work and also used a description of each trade, so that it is possible to sort on an activity, by person responsible, and check the progress against what the contractor has been paid. The activity codes confirm with account numbers. In addition, the VA follows a disciplined process for incorporating changes to ensure that new activities are described and the cost for the change are identified so that changes can be incorporated quickly into the schedule. |
| Sequencing activities | The schedule should be planned so that critical project dates can be met. To meet this objective, activities need to be logically sequenced—that is, listed in the order in which they are to be carried out. In particular, activities that must be completed before other activities can begin (predecessor activities), as well as activities that cannot begin until other activities are completed (successor activities), should be identified. This helps ensure that interdependencies among activities that collectively lead to the accomplishment of events or milestones can be established and used as a basis for guiding work and measuring progress. | Met | The schedule includes the sequencing of activities. The program's schedule includes both the predecessor and successor activities to ensure that the interdependencies among activities are used as a basis for guiding work and measuring progress. For example, VA provided us with a detailed network diagram of the schedule that depicts all of the work that the contractor needs to complete to finish the garage.<br>The driving logic for Syracuse is the weather which dictates what work can start and when. In evaluating the schedule, while we found a few activities that were missing logic links, the scheduler was able to demonstrate why this was the case and the answers were reasonable. All of the activities in the schedule have a finish to start relationship that is a VA specification that is in line with best practices. |

| Best practice | Explanation | Met? | GAO analysis |
|---|---|---|---|
| Assigning resources to activities | The schedule should reflect what resources (e.g., labor, materials, and overhead) are needed to do the work, whether all required resources will be available when needed, and whether any funding or time constraints exist. | Met | The schedule allocates resources, such as labor costs and materials, to all activities. For example, the schedule includes specific activity codes that correspond to a description of each trade making it possible to sort by activity or person responsible. By having this capability, the contractor can easily check progress and determine if resources are in short supply or overallocated. Moreover, since the schedule is fully resource loaded it can also be used to track costs. |
| Establishing the duration of activities | The schedule should realistically reflect how long each activity will take to execute. In determining the duration of each activity, the same rationale, historical data, and assumptions used for cost estimating should be used. Durations should be as short as possible and have specific start and end dates. The schedule should be continually monitored to determine when forecasted completion dates differ from planned dates; this information can be used to determine whether schedule variances will affect subsequent work. | Met | The schedule establishes the durations of activities based on contractor expert opinion and historical data. The schedule activity durations were determined by identifying the various crews and methods necessary for getting specific work done. Using this information, the scheduler relied on historical data from RS Means to identify the number of days necessary for each task. Developing the duration estimates was a complex effort for the garage because weather was always an issue—-the garage is open to the elements and limited crew space creates inefficiencies that needed to be considered. Finally, most of the activities were of short duration (i.e., less than 21 days) in keeping with best practices. There was one long duration activity (i.e., 125 days), but it was not driving the critical path. This activity was in the schedule to remind the contractor to turn over the drawings to the VA when the garage was complete. |
| Integrating activities horizontally and vertically | The schedule should be horizontally integrated, meaning that it should link products and outcomes associated with other sequenced activities. These links are commonly referred to as “handoffs” and serve to verify that activities are arranged in the right order to achieve aggregated products or outcomes. The schedule should also be vertically integrated, meaning that the dates for starting and completing activities in the integrated master schedule should be aligned with the dates for supporting tasks and subtasks. Such mapping or alignment among levels enables different groups to work to the same master schedule. | Met | The schedule is horizontally integrated, meaning that the activities across the multiple teams are arranged in the right order to achieve aggregated products or outcomes. We tested horizontal integration by extending a non-critical activity 200 additional days to see if it showed up on the project’s critical path. The activity became critical and as a result the completion date for the project was pushed out to July 2010 providing us with confidence that the schedule was horizontally dynamic. The schedule was also vertically integrated in that traceability existed among varying levels of the activities allowing multiple trades to work to the same master schedule. |

| Best practice | Explanation | Met? | GAO analysis |
|---|---|---|---|
| Establishing the critical path for activities | Scheduling software should be used to identify the critical path, which represents the chain of dependent activities with the longest total duration. Establishing a project's critical path is necessary to examine the effects of any activity slipping along this path. Potential problems along or near the critical path should also be identified and reflected in scheduling the duration of high-risk activities. | Met | The project's critical path has been defined using scheduling software and includes, among other things, installing steel and pre-cast concrete planks, pouring cement, and installing a snow melt system. Program officials demonstrated the critical path using their scheduling tool. Specifically, they showed us which remaining activities fell on the critical path. For example, elevator extension work, refurbishment of cab controls, testing elevators, form tower columns, reinforcing steel columns, rebar and place concrete columns to roof, and install masonry shell and enclosure were all critical path activities. |
| Identifying the float between activities | The schedule should identify the float—the amount of time by which a predecessor activity can slip before the delay affects successor activities—so that a schedule's flexibility can be determined. As a general rule, activities along the critical path have the least float. Total float is the total amount of time by which an activity can be delayed without delaying the project's completion (if everything else goes according to plan). | Met | The contractor's overall schedule process enabled good visibility into the float between activities and demonstrated that float is actively managed. While we found some instances of high float, the contractor had valid reasons for it. For example, we found one activity that had 154 days of float but the contractor explained to us that this activity was for a change order that was overcome by a supplemental agreement. According to the contractor, supplemental agreements cancel out change orders; however, they like to keep change orders in the schedule for tracking purposes. Similarly, there was also high float for activities associated with the guardrails and sidewalks, but these activities do not drive any critical work and just need to be done by the end of the project so the high float was justified. For the remaining tasks, we found that most had less than 40 days float and we found no instances of negative float. |

| Best practice | Explanation | Met? | GAO analysis |
|---|---|---|---|
| Conducting a schedule risk analysis | A schedule risk analysis should be performed using statistical techniques to predict the level of confidence in meeting a project's completion date. This analysis focuses not only on critical path activities but also on activities near the critical path, since they can affect the project's status. | Not met | The project did not perform a schedule risk analysis that would determine the level of confidence in meeting the program's completion date, even though the project's Exhibit 300 identified the probability of falling behind schedule as a medium risk. As a result, the project did not identify any schedule reserve which should be calculated by performing a schedule risk analysis, and set aside for those activities identified as high-risk. Without this reserve, if any delays were to occur on any activities on the critical path, the program faces the risk of further delays to the scheduled completion date.<br><br>There have been schedule slips in the parking garage construction project. Most notably, the Request for Proposal assumed that the contract would be awarded on May 23, 2008, with a Notice to Proceed occurring about 2 weeks later. Relying on these assumptions, the contractor estimated that construction would be complete by July 19, 2009. However, these assumptions did not hold true. For example, while the contract was awarded in the middle of June 2008, the Notice to Proceed did not occur until the end of July 2008—a delay of almost 46 days. This slip had major ramifications on the schedule as the contractor had planned to pour concrete in the fall so that structural steel could be laid by the time winter set in. Instead, the contractor had to pour concrete during the winter, which was problematic as the extreme cold not only affected worker productivity but also the time it took for the concrete to cure. Thus, the almost 2-month slip caused an approximate 4-month delay due to productivity being hampered by the cold weather. Due to these problems and other change orders, the completion date has been extended to November 2009. The delay in completing the project also has been increasing costs to the medical center because they have to pay for remote parking and a shuttle bus for employees who are unable to park in the parking garage. |

| Best practice | Explanation | Met? | GAO analysis |
|---|---|---|---|
| Updating the schedule using logic and durations to determine dates | | Met | The schedule is updated on a monthly basis using logic and durations to determine the dates. As a result, the schedule is a good tool to identify the critical path so that VA can use it for making management decisions. VA is briefed monthly on the schedule via contractor progress reports that discuss major variances, percent complete, duration changes, change orders and how they affect logic and durations, supplemental agreements, and time extensions that must be incorporated into the schedule network. The monthly report also identifies what activities are driving the critical path so that management can focus its attention on them. Using this approach, the VA ensures that the schedule is accurate and current to the contractor's plan of construction.<br><br>There are two construction reasons for the extended contract completion delay to November 2009. First, during construction the contractor found a buried cable conduit and it took some time to figure out what it was, who it belonged to, and where to move it. This effort took about 42 days to complete. Second, while the construction crew was renovating the walls around the elevators on all floors of the garage, they found blue flexible pipe that was once used in construction but is no longer up to code. As a result, they had to replace and reroute the tubing in the garage, causing a slip of 17 days. |

Source: GAO analysis of VA information.

# Appendix V: Construction of New Medical Center Complex in Las Vegas, Nevada

## Project Overview

This project involves construction of a comprehensive Medical Center Complex in Las Vegas, Nevada. The complex will consist of up to 90 inpatient beds, a 120-bed Nursing Home Care Unit, Ambulatory Care Center, primary and specialty care, surgery, mental health, rehabilitation, geriatrics and extended care, as well as administrative and support functions. VA also plans to include Veterans Benefits Administration offices attached to the medical center. The project is divided into four phases. Phase I includes the construction of a new utility building and related infrastructure such as streets, sewers, and connections to electric and water utilities that are miles away from the construction site. Phase II includes the construction of the foundation of the new medical center. Phase III includes the construction of the Nursing Home Care Unit and Phase IV includes the construction of the medical center and the Veterans Benefits Office.

## Reasons for the Project

VA initiated the medical center project under the Capital Asset Realignment for Enhanced Services (CARES) process between 2003 and 2004 because, according to VA officials, the increase in the number of Iraq war veterans needing medical care combined with the growth in the Las Vegas area supported building a large medical center.[1] Out-patient medical care for veterans in the area was provided at 15 leased primary care clinics located throughout the Las Vegas area. In-patient services were provided under a joint venture with the Air Force's Mike O'Callaghan Federal Hospital located at Nellis Air Force Base. However, some VA patients had to be sent to other VA hospitals for care that could not be provided at the Mike O'Callaghan hospital such as spinal cord injuries. VA officials said they initially sought to expand its medical services and construct a nursing home at Nellis Air Force Base in 2004, but the Air Force would not agree to such an expansion and advised VA that the number of veterans' in-patient beds would likely have to be reduced in the future. As a result, VA

[1]The Veterans Health Care, Capital Asset, and Business Improvement Act of 2003 authorized the Secretary of VA to carry out major construction projects specified in the final CARES report, which was to be approved by the Secretary of VA. See Pub. L. No. 108-170, § 221, 117 Stat. 2042, 2050 (2003). The Secretary's report dated May 20, 2004, listed $60 million for construction of a new medical facility, design and land purchase, which was authorized under § 221 of Pub. L. No. 108-170. Additionally, in 2006 the project's authorization was modified to an amount not to exceed $406,000,000. See Pub. L. No. 109-461 § 802. The project's authorization was modified again in 2008 to an amount not to exceed $600,400,000. See The Veterans' Mental Health and Other Care Improvements Act of 2008, Pub. L. No. 110-387, § 702, 122 Stat. 4110, 4137 (2008).

decided to construct a new comprehensive medical complex, including a nursing home care unit.

## Project Cost

The cost of the medical center has increased from an initial estimate of $286 million in 2004 to a current estimate of $600.4 million (an increase of 110 percent). In accordance with these increased cost estimates, Congress has appropriated $600.4 million for the medical center, providing $60 million for fiscal year 2004,[2] an additional $199 million for fiscal year 2006,[3] and $341.4 million for fiscal year 2008.[4] The original estimate to Congress was based on plans for a large VA clinic. However, VA later determined that a much larger medical center was needed in Las Vegas after it became clear that an inpatient medical facility it shares with DOD would not be adequate to serve the medical needs of local veterans. Since the estimate for the Las Vegas medical center was based on a preliminary design for an expanded clinic, additional functions had to be added to the clinic design to provide the services necessary for the medical center. This expansion of the scope of the project resulted in both a cost increase and schedule delay for the project. According to VA officials, a lack of planning and the omission of key facilities contributed to the cost increases. Specifically, VA officials stated that the original cost estimate did not correctly anticipate the amount of preparation that the site needed. For example, the original estimate did not include funding for the roads and street lights required for the facility. In addition, the medical center could not anticipate that the Department of Homeland Security would institute new requirements for federal facilities as part of its continuing response to the events of September 11, 2001, which resulted in further cost increases. VA officials also explained that the nationwide increase in construction, the rebuilding in the New Orleans area since hurricane Katrina, and the local building boom in Las Vegas have driven up the cost of material and labor. The Las Vegas area had several multi-billion dollar projects underway. Locally, construction costs increased over 20 percent in 2006 and 2007 while the standard that VA uses for contingencies is 5 percent. To illustrate, VA staff told us that Las Vegas builders had tied up almost 80 percent of the nation's large cranes used to build tall buildings.

[2] Pub. L. No. 108-199, 118 Stat. 3, 367-368 (2004).

[3] Military Quality of Life and Veterans Affairs Appropriations Act for FY 2006, Pub. L. No. 109-114, Title II, 119 Stat. 2372, 2386-2387 (2005).

[4] Pub. L. No. 110-161, 121 Stat. 1844, 2267 (2007).

According to VA officials, in response to the increasing costs, the VA and the architectural/engineering firm preparing the medical center design reduced the scope of work for the final phase of the project. Gross square footage was reduced from about 900,000 square feet to 785,000 square feet and they eliminated extra space between floors for mechanical and electrical cables that would have made maintenance easier. They also reduced warehouse space and space for administrative offices because estimators were concerned that the project could not be completed with the funds available. The medical center warehouse, which is used to store maintenance and medical supplies, was reduced to one-third of its originally proposed size. As, a result, the hospital will need to acquire warehouse storage and procure warehouse management services from contractors outside of the VA facility.

The economic recession that began in 2008 led several companies to suspend their construction projects in Las Vegas, and there was greater competition among construction firms to construct the hospital. This change in the construction market led to a significantly lower cost of construction than VA staff had anticipated, and VA now estimates that the total project will cost about $100 million less than estimated. As a result, VA officials explained they are taking steps to add these features back into the medical center prior to completion. For example, a utility tunnel running from the utility building to the medical center was added back to the project once the construction contract was awarded and VA saw they had funds available. Adding this tunnel will reduce operating and maintenance costs for the medical center. VA officials are also reviewing their options for adding back features that had been eliminated such as administrative offices. This would save operating costs by eliminating the need to lease office space. Our analysis of VA's current cost estimate for the construction of the medical center is in table 8.

**Table 8: Extent That Cost Estimate for Las Vegas Medical Center Met Best Practices**

**Step One: Define the Estimate's Purpose**

The purpose of a cost estimate is determined by its intended use, and its intended use determines its scope and detail. Cost estimates have two general purposes: (1) to help managers evaluate affordability and performance against plans, as well as the selection of alternative systems and solutions, and (2) to support the budget process by providing estimates of the funding required to efficiently execute a program. The scope of the cost estimate will be determined by such issues as the time involved, what elements of work need to be estimated, who will develop the cost estimates, and how much cost estimating detail will be included.

A life-cycle cost estimate provides an exhaustive and structured accounting of all resources and associated cost elements required to develop, produce, deploy, and sustain a particular program. As such a life-cycle cost estimate encompasses all past (or sunk), present, and future costs for every aspect of a program, regardless of funding source. Life-cycle costing enhances decision making, especially in early planning and concept formulation of acquisition. Design trade-off studies conducted in this period can be evaluated on a total cost basis as well as on a performance and technical basis. A life-cycle cost estimate can support budgetary decisions, key decision points, milestone reviews, and investment decisions. Because they encompass all possible costs, life-cycle cost estimates provide a wealth of information about how much programs are expected to cost over time. Thus, having full life-cycle costs is important for successfully planning program resources and making wise decisions.

1. Is the purpose and scope of the cost estimate defined and documented? Have all costs been estimated, including life-cycle costs?

**Met; the purpose of the cost estimate is documented and clearly defined at a level that would enable VA Las Vegas to submit a quality cost estimate.**

The cost estimate is an estimate of probable cost, developed by an independent consultant to the architect for the purposes of comparing incoming bid proposals. The estimate covers the construction of Phase IV at an estimated construction cost of $365 million. The estimate was not required to include complete lifecycle costs estimate; it includes the construction of Phase IV up to the hand-over of the keys to the building. Life cycle costs are included in the OMB Exhibit 300.

The scope of the estimate is defined by VA policy. The Manual for Preparation of Cost Estimates for VA Facilities states that:

1.1.1 - A project estimate shall show the current cost of construction on the date of the estimate. The estimate should reflect current costs on the date the estimate is received and anticipated local escalation to the midpoint of construction, i.e., date of estimate plus half of construction duration.

1.1.2 - The level of detail for this estimate shall be consistent with the degree of completeness of the drawings being submitted. Simply stated, this means that if a construction element is shown, it must be priced; if it is shown in detail, it must be priced in detail. For detailed elements, “lump sum” or “allowance” figures will not be acceptable. Project estimates will include all elements within the contractor's bid such as insurance, bonds, hazardous abatement, and any other such items. Submission requirements are indicated in VA Cost Estimating Guide.

**Step Two: Develop the Estimating Plan**

An analytic approach to cost estimates typically entails a written study plan detailing a master schedule of specific tasks, responsible parties, and due dates. Enough time should be scheduled to collect data, including visits to contractor sites to further understand the strengths and limitations of the data that have been collected. If there is not enough time, then the schedule constraint should be clearly identified in the ground rules and assumptions, so that management understands the effect on the estimate's quality and confidence.

2. Did the team develop a written study plan?

**Met; the estimating team is from a centralized cost estimating firm that specializes in construction and the estimate follows cost estimate preparation guidance published by the VA.**

Officials stated that the estimate includes the full cost of construction regardless of funding source. The VA Office of Construction and Facilities Management (CFM) publishes guidance on preparing cost estimates that details how construction cost estimates should be created, structured, and presented. The manual also explains roles and responsibilities, units of measure, and guidance on master specifications.

The cost estimate documentation includes introductory notes that explain the overall cost estimating approach. Officials stated that the process for developing estimates begins with the contract documents, then the pricing of materials and overhead, collection of historical data, gathering of current market pricing, and conducting market studies.

As consultants to the architect, the independent cost estimating firm has a staff of 25 cost estimators dedicated to developing construction cost estimates. The 25 estimators have extensive backgrounds ranging from new hires to individuals with 40+ years of experience in the cost estimating discipline.

The basic approach of the estimate is defined by VA policy. The Manual for Preparation of Cost Estimates for VA Facilities states that:

1.1.1 - A project estimate shall show the current cost of construction on the date of the estimate. The estimate should reflect current costs on the date the estimate is received and anticipated local escalation to the midpoint of construction, i.e., date of estimate plus ½ of construction duration.

1.1.2 - The level of detail for this estimate shall be consistent with the degree of completeness of the drawings being submitted. Simply stated, this means that if a construction element is shown, it must be priced; if it is shown in detail, it must be priced in detail. For detailed elements, “lump sum” or “allowance” figures will not be acceptable. Project estimates will include all elements within the contractor’s bid such as insurance, bonds, hazardous abatement and any other such items. Submission requirements are indicated in VA Cost Estimating Guide.

**Step Three: Define the Program Characteristics**

Key to developing a credible estimate is having an adequate understanding of the acquisition program—the acquisition strategy, technical definition, characteristics, system design features, and technologies to be included in its design. The cost estimator can use this information to identify the technical and program parameters that will bind the cost estimate. The amount of information gathered directly affects the overall quality and flexibility of the estimate. Less information means more assumptions must be made, increasing the risk associated with the estimate. Therefore, the importance of this step must be emphasized, because the final accuracy of the cost estimate depends on how well the program is defined.

3. Is there a documented technical baseline description?

**Met; a technical baseline has been documented that includes requirements, purpose, and system design features.**

The Technical Baseline is based on the construction drawings and specifications used by the architect to design the hospital. These construction documents were approved by the architect, and officials stated that the VA provided written approval to the architect regarding the technical baseline.

Other technical baseline documents to be referenced in the development of a VA cost estimate are defined by VA policy. These documents, listed and defined in The Manual for Preparation of Cost Estimates for VA Facilities, include Practice Design Manuals, Master Specifications, Architect/Engineer Checklists, Design and Quality Alerts, Design Guides, Design and Construction Procedures, Physical Security Design Manuals, and Technical Summaries. The Cost Estimate Manual also includes the cost breakdown categories to be used in the estimate.

**Step Four: Determine the Estimating Structure**

A work breakdown structure (WBS) is the cornerstone of every program because it defines in detail the work necessary to accomplish a program's objectives. A WBS is a valuable communication tool between systems engineering, program management, and other functional organizations because it provides a clear picture of what needs to be accomplished and how the work will be done. Accordingly, it is an essential element for identifying activities in a program's integrated master schedule and it provides a consistent framework for planning and assigning responsibility for the work. Initially set up when the program is established, the WBS becomes successively detailed over time as more information because known about the program.

A WBS deconstructs a program's end product into successive levels with smaller specific elements until the work is subdivided to a level suitable for management control. By breaking the work down into smaller elements, management can more easily plan and schedule the program's activities and assign responsibility for the work. It also facilitates establishing a schedule, cost, and earned value management (EVM) baseline. Establishing a product-oriented WBS is a best practice because it allows a program to track cost and schedule by defined deliverables, such as a hardware or software component. This allows a program manager to more precisely identify which components are causing cost or schedule overruns and to more effectively mitigate the root cause of the overruns.

4. Is there a defined WBS and/or cost element structure?

**Met; the estimate clearly describes how the various sub-elements are summed to produce the amounts for each cost category, thereby ensuring that all pertinent costs are included and no costs are double counted.**

The cost estimate categorizes construction costs into a required VA element structure that breaks the building down into systems and subsystems. The WBS is based on the standardized WBS on VA form HO-18B/C. The WBS breaks the construction costs into standardized systems such as foundation, substructure, superstructure, and roofing, as well as subsystems such as slab on grade, stair construction, and elevators. These system descriptions are also used in the schedule. The HO-18 WBS elements are defined in the Manual for Preparation of Cost Estimates for VA Facilities.

**Step Five: Identify Ground Rules and Assumptions**

Cost estimates are typically based on limited information and therefore need to be bound by the constraints that make estimating possible. These constraints usually take the form of assumptions that bind the estimate's scope, establishing baseline conditions the estimate will be built from. Ground rules represent a common set of agreed on estimating standards that provide guidance and minimize conflicts in definitions. Without firm ground rules, the analyst is responsible for making assumptions that allow the estimate to proceed. Assumptions represent a set of judgments about past, present, and future conditions postulated as true in the absence of positive proof. The analyst must ensure that assumptions are not arbitrary, that they are founded on expert judgments rendered by experienced program and technical personnel. Many assumptions profoundly influence cost; the subsequent rejection of even a single assumption by management could invalidate many aspects of the estimate. Therefore, it is imperative that cost estimators brief management and document all assumptions well, so that management fully understands the conditions the estimate was structured on. Failing to do so can lead to overly optimistic assumptions that heavily influence the overall cost estimate, to cost overruns, and to inaccurate estimates and budgets.

5. Are there defined ground rules and assumptions that document the rationale and any historical data to back up any claims?

**Met; cost-influencing ground rules and assumptions, such as the programs schedule, labor rates, and inflation rates are documented**.

The cost estimate documentation provides an overview of basic assumptions underlying the estimate. For example, the documentation notes which construction drawings were the basis of the estimate as well as the number of assumed bids. The cost estimate also notes the areas in which contingency was removed and the reasons for its removal. Officials stated that the cost estimate is based on prevailing labor wage rates as well as local pricing of material. In addition, the cost estimate outlines the specific items that are not included in the estimate.

The Manual for Preparation of Cost Estimates for VA Facilities specifically notes what costs should be included for each system and subsystem category.

**Step Six: Obtain the Data**

Data are the foundation of every cost estimate. How good the data are affects the estimate's overall credibility. Depending on the data quality, an estimate can range anywhere from a mere guess to a highly defensible cost position. Credible cost estimates are rooted in historical data. Rather than starting from scratch, estimators usually develop estimates for new programs by relying on data from programs that already exist and adjusting for any differences. Thus, collecting valid and useful historical data is a key step in developing a sound cost estimate. The challenge in doing this is obtaining the most applicable historical data to ensure that the new estimate is as accurate as possible. One way of ensuring that the data are applicable is to perform checks of reasonableness to see if the results are similar. Different data sets converging toward one value provides a high degree of confidence in the data.

6. Was the data gathered from historical actual cost, schedule, and program and technical sources?

**Met; cost estimators used local pricing of labor and material as well as local escalation rates. Historical data were used when applicable, but the Las Vegas area has not had major hospital construction in recent years.**

Officials stated the cost estimate is based on local pricing of labor and material. They stated that although the cost estimating firm has data collected over 20 years, the hospital estimate is not entirely based on historical data. Officials told us this is because there have been no large-scale hospitals built in Las Vegas in recent years; and the last major VA hospital was constructed over 20 years ago. Due to project uniqueness, pricing was based primarily on quotes and estimates. The estimate used local escalation rates instead of OMB rates because of the high real estate costs in the Las Vegas area at the time of the estimate construction. Officials stated that the estimates include pricing for labor and detailed materials, such as linear feet of wire, light fixtures, cubit years of concrete, and pounds of steel and rebar. In addition, officials stated that material estimates went through peer reviews.

**Step Seven: Develop the Point Estimate and Compare it to an independent cost estimate**

Step 7 pulls all the information together to develop the point estimate—the best guess at the cost estimate, given the underlying data. High-quality cost estimates usually fall within a range of possible costs, the point estimate being between the best and worst case extremes. The cost estimator must perform several activities to develop a point estimate: develop the cost model by estimating each WBS element, using the best methodology, from the data collected; include all estimating assumptions in the cost model; express costs in constant-year dollars; time-phase the results by spreading costs in the years they are expected to occur, based on the program schedule; and add the WBS elements to develop the overall point estimate.

Having developed the overall point estimate, the cost estimator must then validate it by thoroughly understanding and investigating how the cost model was constructed. For example, all WBS cost estimates should be checked to verify that calculations are accurate (no double counting) and account for all costs, including indirect costs. Moreover, proper escalation factors should be used to inflate costs so that they are expressed consistently and accurately. Finally, the cost estimator should compare the cost estimate against the independent cost estimate and examine where and why there are differences; perform cross-checks on cost drivers to see if results are similar; and update the model as more data become available or as changes occur and compare the results against previous estimates.

7. Did the cost estimator consider various cost estimating methods like analogy, engineering build up, parametric, extrapolating from actual costs, and expert opinion (if none of the other methods can be used)?

**Met; the cost estimate is based on a detailed engineering buildup methodology using estimated labor and material prices, and crosschecked against independent cost assessments. The estimate was vetted through experts to ensure costs were appropriately captured.**

The cost estimate is based on a detailed engineering buildup methodology using estimated labor and material prices. Officials stated that parametric methodologies were used to conduct crosschecks during early design, when details were not that well defined. At the request of the VA, two additional cost estimates were performed and compared against the original estimate. These independent third-party estimates were performed using price databases and parametric techniques. The crosscheck estimates were provided to the VA in February and April of 2008, several weeks before the final detailed estimate was delivered in May 2008.

The detailed estimate is vetted through layers of experts, including the architect, outside peer reviews by third-party consultants, and VA resident engineers. In addition, officials stated that the required breakout by the VA ensures transparency and documents that all costs are properly captured.

**Step Eight: Conduct a Sensitivity Analysis**

Sensitivity analysis should be included in all cost estimates because it examines the effects of changing assumptions and ground rules. Since uncertainty cannot be avoided, it is necessary to identify the cost elements that represent the most risk and, if possible, cost estimators should quantify the risk using both a sensitivity and uncertainty (see step 9) analysis. In order for sensitivity analysis to reveal how the cost estimate is affected by a change in a single assumption, the cost estimator must examine the effect of changing one assumption or cost driver at a time while holding all other variables constant. By doing so, it is easier to understand which variable most affects the cost estimate.

8. Did the cost estimate included a sensitivity analysis that identified using a range of possible costs the effects of changing key cost driver assumptions or factors?

**Not met; a sensitivity analysis was not performed.**

While officials noted that market surveys were conducted for the cost estimate and contingency was included, a formal sensitivity analysis was not performed because it was not requested by the VA. The cost estimating firm performs market surveys at each stage of design, evaluating local capital and the availability of trade skills in the local market. However, officials stated that the final product to VA is a point estimate because they are not they are not afforded the luxury of providing ranges of costs.

**Step Nine: Conduct a Risk and Uncertainty Analysis**

Because cost estimates predict future program costs, uncertainty is always associated with them. Moreover, a cost estimate is usually composed of many lower-level WBS elements, each of which comes with its own source of error. Once these elements are added together, the resulting cost estimate can contain a great deal of uncertainty. Risk and uncertainty refer to the fact that because a cost estimate is a forecast, there is always a chance that the actual cost will differ from the estimate. A lack of knowledge about the future is only one possible reason for the difference. Another equally important reason is the error resulting from historical data inconsistencies, assumptions, cost estimating equations, and factors typically used to develop an estimate. In addition, biases are often found in estimating program costs and developing program schedules. The biases may be cognitive—often based on estimators' inexperience—or motivational, where management intentionally reduces the estimate or shortens the schedule to make the project look good to stakeholders. Recognizing the potential for error and deciding how best to quantify it is the purpose of risk and uncertainty analysis.

Since cost estimates are uncertain, making good predictions about how much funding a program needs to be successful is difficult. In a program's early phases, knowledge about how well technology will perform, whether the estimates are unbiased, and how external events may affect the program is imperfect. For management to make good decisions, the program estimate must reflect the degree of uncertainty, so that a level of confidence can be given about the estimate. Quantitative risk and uncertainty analysis provide a way to assess the variability in the point estimate. Using this type of analysis, a cost estimator can model such effects as schedules slipping, missions changing, and proposed solutions not meeting user needs, allowing for a known range of potential costs. Having a range of costs around a point estimate is more useful to decision makers, because it conveys the level of confidence in achieving the most likely cost and also informs them on cost, schedule, and technical risks.

9. Was a risk and uncertainty analysis conducted that quantified the imperfectly understood risks and identified the effects of changing key cost driver assumptions and factors?

**Partially met; while cost estimators did not perform a formal uncertainty analysis, risk assessments were developed on the availability of trades.**

Officials stated that while VA does not require a formal uncertainty analysis, cost estimators did perform an internal risk analysis evaluating at-risk trades. From that risk analysis, estimators stated they had a low level of confidence in the availability of mechanical, plumbing and electrical trades. Officials stated that part of the risk was based on how competitive the market was in Las Vegas at the time they prepared the estimate. Officials told us that the VA does not require an uncertainty analysis and the analysis is, generally speaking, not a construction industry best practice.

**Step Ten: Document the Estimate**

Documentation provides total recall of the estimate's detail so that it can be replicated by someone other than those who prepared it. It also serves as a reference to support future estimates. Documenting the cost estimate makes available a written justification showing how it was developed and aiding in updating it as key assumptions change and more information becomes available. Estimates should be documented to show all parameters, assumptions, descriptions, methods, and calculations used to develop a cost estimate. A best practice is to use both a narrative and cost tables to describe the basis for the estimate, with a focus on the methods and calculations used to derive the estimate. With this standard approach, the documentation provides a clear understanding of how the cost estimate was constructed. Moreover, cost estimate documentation should explain why particular methods and data sets were chosen and why these choices are reasonable. It should also reveal the pros and cons of each method selected. Finally, there should be enough detail so that the documentation serves as an audit trail of backup data, methods, and results, allowing for clear tracking of a program's costs as it moves through its various life-cycle phases.

10. Did the documentation describe the cost estimating process, data sources, and methods step by step so that a cost analyst unfamiliar with the program could understand what was done and replicate it?

**Partially met; while the documentation for the most part provided detailed material and labor build up, we were not able to trace the data back based on the documentation alone.**

While officials stated that the estimate was in part based off data from previous estimates and market surveys, the cost estimate documentation delivered to VA does not trace estimated values to raw or normalized data. For instance, the delivered cost estimate documentation does not provide a basis or supporting data for included labor dollars or general conditions markup that would allow an analyst unfamiliar with the project to recreate them.

**Step Eleven: Present Estimate to Management for Approval**

A cost estimate is not considered valid until management has approved it. Since many cost estimates are developed to support a budget request or make a decision between competing alternatives, it is vital that management is briefed on how the estimate was developed, including risks associated with the underlying data and methods. Therefore, the cost estimator should prepare a briefing for management with enough detail to easily defend the estimate by showing how it is accurate, complete, and high in quality. The briefing should present the documented life cycle cost estimate with an explanation of the program's technical and program baseline.

11. Was there a briefing to management that included a clear explanation of the cost estimate so as to convey its level of competence?

**Met; the estimate is vetted through layers of experts, including the architect, outside peer reviews by third-party consultants, and VA resident engineers.**

Officials stated that the cost estimate was first reviewed by the architect responsible for the detailed design of the hospital. After this initial review, the estimate is then presented to the VA. The cost estimate is part of the milestone submittal outlined in the contractual requirements between the architectural firm and the VA. Officials stated that the cost estimate review is a month-long process.

The detailed estimate is vetted through layers of experts, including the architect, outside peer reviews by third-party consultants, and VA resident engineers. These reviews helped refine the estimate and its underlying assumptions. For example, officials stated that one third-party reviewer took issue with the assumed price of steel in the estimate. VA officials stated that they use information from the peer reviews prior to giving the estimate their approval.

At the request of the VA, two additional cost estimates were performed and compared against the original estimate. These independent third-party estimates were performed at a unit-level using pricing databases. The crosscheck estimates were provided to the VA in February and April of 2008, several weeks before the final detailed estimate was delivered in May 2008.

**Step Twelve: Update the Estimate to Reflect Actual Costs and Changes**

The cost estimate should be regularly updated to reflect all changes. Not only is this a sound business practice, it is also a requirement outlined in OMB's Capital Programming Guide.[5] The purpose of updating the cost estimate is to check its accuracy, defend the estimate over time, shorten turnaround time, and archive cost and technical data for use in future estimates. After the internal agency and congressional budgets are prepared and submitted, it is imperative that cost estimators continue to monitor the program to determine whether the preliminary information and assumptions remain relevant and accurate. Keeping the estimate fresh gives decision makers accurate information for assessing alternative decisions. Cost estimates must also be updated whenever requirements change, and the results should be reconciled and recorded against the old estimate baseline. The documented comparison between the current estimate (updated with actual costs) and old estimate allows the cost estimator to determine the level of variance between the two estimates. In other words, it allows estimators to see how well they are estimating and how the program is changing over time.

12. Is there a process for the estimating team to update the estimate with actual costs as it becomes available?

**Not met; the VA does not require the cost estimating firm to update the construction cost estimate with actual costs once the project is underway.**

The estimate is not updated once construction begins. Officials from the cost estimating firm stated that they attempt to collect past bid results when possible; however, the tracking and reporting of actual costs by the estimator is not part of the contractual requirements between the VA and the A/E firm. VA officials stated that because this is a fixed price contract, the contractor is responsible for managing the costs. However, regardless of what type of contract or what organization is managing costs, the purpose of updating the cost estimate is to check its accuracy, defend the estimate over time, shorten turnaround time of future estimates, and archive cost and technical data for use in future estimates.

Source: GAO analysis of VA information.

## Project Schedule

The first two phases of the project have been completed and, according to VA officials, Phase III will be completed in February 2010. However, the nursing home completed in Phase III of the project will not be open for patient care until the medical center becomes operational in 2012, as the nursing home relies upon the hospital for patient medical care and food service. Since the nursing home will be vacant for about 2 years before the medical center opens, VA may use part of the nursing home for administrative offices.

The final phase of the project, the construction of the new medical center, is underway with completion scheduled for August 2011. According to VA officials, the medical center is scheduled to become operational in the spring of 2012, depending upon how quickly the equipment for the hospital can be purchased and the additional personnel can be hired. Our analysis of the construction schedule of the medical center is in table 9.

[5]OMB, *Capital Programming Guide: Supplement to Circular A-11, Part 7, Preparation, Submission, and Execution of the Budget.*

**Table 9: Extent That Construction Schedule for Las Vegas Hospital Met Best Practices**

| Best practice | Explanation | Met? | GAO analysis |
|---|---|---|---|
| Capturing activities | The schedule should reflect all activities as defined in the project's work breakdown structure, which defines in detail the work necessary to accomplish a project's objectives, including activities to be performed by both the owner and contractors. | Substantially met | The schedule is required by contract to include approximately 2,500 to 3,000 activities in order to sufficiently detail the level of work required (the actual schedule has 6,089 activities, approximately 16 detail activities per milestone). Each activity is mapped to an activity ID number, building area, and work trade, which allows the scheduler to quickly filter the schedule by type of work or subcontractor. The schedule is reviewed by the VA CFM for completeness to ensure all necessary activities and milestones are included. Construction drawings and specifications are used to create the schedule, which officials stated helps to ensure the entire scope is included. However, we found several key activities were missing from the approved baseline schedule, including redesign for ductwork; submit, approve, fabrication, and delivery of electrical equipment; contractor approval time for changes above $100,000; government furnished equipment delivery milestones; systemwide testing; and effort related to telecommunications. |

| Best practice | Explanation | Met? | GAO analysis |
|---|---|---|---|
| Sequencing activities | The schedule should be planned so that critical project dates can be met. To meet this objective, activities need to be logically sequenced—that is, listed in the order in which they are to be carried out. In particular, activities that must be completed before other activities can begin (predecessor activities), as well as activities that cannot begin until other activities are completed (successor activities), should be identified. This helps ensure that interdependencies among activities that collectively lead to the accomplishment of events or milestones can be established and used as a basis for guiding work and measuring progress. | Substantially met | All detail activities and milestones in the baseline schedule are properly sequenced. Each activity—except the start and finish milestones—has at least one predecessor or successor. Out of 5,701 detail activities, we found less than 1 percent that were not properly driving the start date of a predecessor activity start date. There are no lags in the schedule, as required by contract specifications. There is one hard Finish No Later Than constraint on the finish milestone, which the VA CFM recommended be removed. Program management officials stated that the constraint is used solely to calculate negative float. The VA requires a diagram of the schedule network, similar to a PERT diagram, which clearly displays the relationships between tasks. However, because the schedule is missing several key activities, it is uncertain whether or not all activities are scheduled in the correct order. |
| Assigning resources to activities | The schedule should reflect what resources (e.g., labor, materials, and overhead) are needed to do the work, whether all required resources will be available when needed, and whether any funding or time constraints exist. | Substantially met | The VA requires schedules to be cost loaded with prorated overhead and profit, and the total price loaded into the schedule must equal the total contract price. Officials stated that the term “resources” is defined as manpower by the VA schedule specifications. Accordingly, each detail activity has an associated manpower requirement. However, because the baseline schedule is missing key contractor activities such as ductwork redesign, systemwide testing, and telecommunications effort, it is uncertain how or whether resources are properly allocated. |
| Establishing the duration of activities | The schedule should realistically reflect how long each activity will take to execute. In determining the duration of each activity, the same rationale, historical data, and assumptions used for cost estimating should be used. Durations should be as short as possible and have specific start and end dates. The schedule should be continually monitored to determine when forecasted completion dates differ from planned dates; this information can be used to determine whether schedule variances will affect subsequent work. | Met | As required by VA schedule contract specifications, activity durations are 20 days or less, except for procurement activities. Our analysis shows the median task duration is 5 days. Approximately 8 percent of the remaining activities are 1 day in duration. All activities are based on a standard 5-day workweek with holidays. |

| Best practice | Explanation | Met? | GAO analysis |
|---|---|---|---|
| Integrating activities horizontally and vertically | The schedule should be horizontally integrated, meaning that it should link products and outcomes associated with other sequenced activities. These links are commonly referred to as "handoffs" and serve to verify that activities are arranged in the right order to achieve aggregated products or outcomes. The schedule should also be vertically integrated, meaning that the dates for starting and completing activities in the integrated master schedule should be aligned with the dates for supporting tasks and subtasks. Such mapping or alignment among levels enables different groups to work to the same master schedule. | Met | The schedule is vertically integrated, with all activities subsumed under organized higher levels. Each activity is mapped to an area and trade, clearly indicating which subcontractor is responsible for what work in each area at any time. Our analysis shows the schedule to be, in general, horizontally integrated due to the high number of straightforward finish-start links and continuous critical path. |
| Establishing the critical path for activities | Scheduling software should be used to identify the critical path, which represents the chain of dependent activities with the longest total duration. Establishing a project's critical path is necessary to examine the effects of any activity slipping along this path. Potential problems along or near the critical path should also be identified and reflected in scheduling the duration of high-risk activities. | Substantially met | Officials stated the critical path is calculated by the scheduling software and will become a crucial tool for managing the construction project once the project is fully underway. Our analysis shows the existing critical path to be structurally sound, running the length of the schedule and encompassing several major milestones. However, because the schedule is missing key activities, we cannot be certain the activities are sequenced logically. It is uncertain whether or not missing activities would appear on the critical path once inserted into the network. |
| Identifying the float between activities | The schedule should identify the float—the amount of time by which a predecessor activity can slip before the delay affects successor activities—so that a schedule's flexibility can be determined. As a general rule, activities along the critical path have the least float. Total float is the total amount of time by which an activity can be delayed without delaying the project's completion (if everything else goes according to plan). | Met | Total float represents the amount of time an activity can slip before it affects the project finish date. It is therefore a crucial tool for resource allocation and risk mitigation. There appear to be excessive values of total float in the schedule. But officials stated that the project schedule will have excessive float in some areas. For instance, mobilization tasks in the beginning of the project will have high float. Furthermore, officials stated that this construction project is unique because the hospital's foundation and control plant were constructed in prior phases. Therefore, upfront Phase IV tasks related to work performed in earlier phases may appear to have excessive float. |

| Best practice | Explanation | Met? | GAO analysis |
|---|---|---|---|
| Conducting a schedule risk analysis | A schedule risk analysis should be performed using statistical techniques to predict the level of confidence in meeting a project's completion date. This analysis focuses not only on critical path activities but also on activities near the critical path, since they can affect the project's status. | Not met | The program has not performed a schedule risk analysis (SRA) and officials stated that SRAs are not typically done in the construction industry. However, best practices suggest that even at the construction bid phase, an SRA can be used to determine a level of confidence in meeting the completion date or whether proper reserves have been incorporated into the schedule. An SRA will calculate schedule reserve, which can be set aside for those activities identified as high risk. Without this reserve, the program faces the risk of delays to the scheduled completion date if any delays were to occur on critical path activities. |
| Updating the schedule using logic and durations to determine dates | | Partially met | At the time of the analysis the baseline schedule had not been fully statused. Notice to Proceed (NTP) was given to the general contractor on October 22, 2008, and work began in October. The contract requires the general contractor to submit a network schedule to the VA within 60 days of the NTP; yet, the schedule was not received until April 21, 2009—181 days after the NTP. Moreover, the schedule was received 50 days after the project executive notified the contractor on March 2, 2009, that the schedule was over 60 days late. The VA CFM recommended the first submitted schedule be rejected by the local resident engineer's office. A second schedule was submitted on June 15, 2009, and the VA CFM recommended the schedule for approval on June 29, 2009. General contractor officials stated that they have been tracking progress on an internal schedule since October 2008. The VA is requiring the general contractor to retro-actively status the approved schedule for the previous months. By September 2009, contractor officials had retroactively statused the schedule up to August 2009. |

Source: GAO analysis of VA information.

## Schedule Risk Analysis

The sole best practice that the schedule did not meet is conducting a schedule risk analysis (SRA), which is not required by the VA schedule specifications. VA officials told us that they do not conduct SRAs and that a risk analysis is typically not performed in the construction industry. In August and September 2009, we performed our own schedule risk analysis on the construction schedule. Specifically, we analyzed the *C07P* schedule, which was the latest statused version available to us at the time of the analysis.

A schedule risk analysis uses statistical techniques to predict a level of confidence in meeting a program's completion date. This analysis focuses on critical path activities and on near-critical and other activities, since any activity may potentially affect the program's completion date. The objective of the simulation is to develop a probability distribution of possible completion dates that reflect the program and its quantified risks. From the cumulative probability distribution, the organization can match a date to its degree of risk tolerance. For instance, an organization might want to adopt a program completion date that provides a 70 percent probability that it will finish on or before that date, leaving a 30 percent probability that it will overrun, given the schedule and the risks. The organization can thus adopt a plan consistent with its desired level of confidence in the overall integrated schedule. This analysis can give valuable insight into what-if drills and quantify the impact of program changes.

In developing a schedule risk analysis, probability distributions for each activity's duration have to be established. Further, risk in all activities must be evaluated and included in the analysis. Some people focus only on the critical path, but because we cannot know the durations of the activities with certainty, we cannot know the true critical path. Consequently, it would be a mistake to focus only on the deterministic critical path when some off-critical path activity might become critical if a risk were to occur. Typically, three-point estimates—that is, best, most likely, and worst case estimates—are used to develop the probability distributions for the duration of workflow activities.

Once the distributions have been established, a Monte Carlo simulation uses random numbers to select specific durations from each activity probability distribution and calculates a new critical path and dates, including major milestone and program completion. The Monte Carlo simulation continues this random selection thousands of times, creating a new program duration estimate and critical path each time. The resulting frequency distribution displays the range of program completion dates along with the probabilities that these dates will occur. Table 10 provides a range of dates and the probability of the project completing on those dates or earlier, based on our 3,000-iteration Monte Carlo simulation. For example, according to our SRA, there is a 5 percent chance that the project will finish on or before December 1, 2011. Likewise, there is an 80 percent chance that the project will finish on or before May 17, 2012.

Because completion on any date is uncertain, it is more realistic to show a range of possible completion dates than to focus on a single date. In deciding which percentile to use for prudent scheduling, there is no international best practice standard. The chosen percentile depends on the riskiness and maturity of the project. For some projects we emphasize the 80th percentile as a conservative promise date. While the 80th percentile may appear overly conservative, it is a useful promise date if a number of new but presently unknown risks (i.e., "unknown unknowns") are anticipated. The 50th percentile date may expose the project to overruns.

**Table 10: Probability of Project Completion**

| | As scheduled[a] | 5th percentile | 50th percentile | 80th percentile | 95th percentile |
|---|---|---|---|---|---|
| Finish date | **Oct. 20, 2011** | **Dec. 1, 2011** | **Mar. 1, 2012** | **May 17, 2012** | **Aug. 23, 2012** |
| Months beyond scheduled finish date | - | 1.4 | 4.4 | 6.9 | 10.1 |

Source: GAO analysis of VA data.

[a]The actual "as scheduled" finish date in the schedule is August 29, 2011. However, this finish date does not include the 21 working days of negative float that were in the schedule at the time of our analysis. Moreover, an additional 22 working days (1 month) were added to allow time for overall system commissioning. VA officials told us that the system commissioning would take at least 1 month to complete beyond the scheduled finish date.

In the case of the medical center construction schedule, our analysis concludes that VA should realistically expect turnover from the general contractor between March 1, 2012, and May 17, 2012, the 50th and 80th percentiles, respectively. The must finish date of August 29, 2011, is very unlikely.[6] Our analysis shows the probability of completing medical center turnover by October 20, 2011, is less than 1 percent with the current schedule without risk mitigation.

## Identified risks

The project executive identified 22 different risks as a preliminary exercise to our SRA. Using these risks as a basis for discussion, we interviewed 14 experts familiar with the project, including VA resident engineers, general contractor officials, and A/E consultants. Each interviewee was asked four general questions:

[6]At the time of our analysis, the projected finish of August 29, 2011, did not include 21 days of negative float or a month of required system commissioning. Moreover, VA officials told us in September, after the SRA was completed, that delays in steel procurement had already pushed the scheduled completion date to October 2011.

1. *To provide an estimate of the probability an identified risk will occur on the project in such a way that some activity durations are affected.* The estimated probability is translated into the percentage of the iterations that are chosen at random during the simulation. For example, if the expert believed weather has a 10 percent chance of affecting some activities, then, on average, weather risk will occur in 10 percent of the Monte Carlo iterations.

2. *If the interviewee believed the risk could occur, the interviewee was asked to identify which activities' durations would be affected.* For example, activities related to steel erection or concrete pouring may be affected if the weather risk occurs.

3. *Upon identifying affected activities, interviewees were then asked to provide a 3-point estimate for the impact on duration.* These are low, most likely, and high impact estimates. Estimates were provided as percentages, which were applied to the activity durations in the Monte Carlo simulation if the risk occurred. For example, if the weather risk occurs, a 10-day steel erection activity may be affected a minimum of 110 percent, a most likely of 150 percent, or a maximum of 200 percent (i.e., the 3-point estimates for steel erection if weather risk occurs are 11 days minimum, 15 days most likely, and 20 days maximum). If the risk does not occur, there is no change to the original estimated duration.

4. *Finally, interviewees were asked to identify any risks they believe we did not account for.*

We began the interviews with 22 risks and through the interview process identified 11 more risks. During data analysis, some risks were consolidated with others or eliminated due to a low amount of data. In all, 20 risks were identified and incorporated into the Monte Carlo simulation. These include 18 risk drivers, 1 schedule duration risk,[7] and 1 overall system commissioning activity that was not included in the baseline schedule. The final risk drivers used in the SRA are:

- Occupancy needs may change.
- Design may be inadequate.
- Steel design may be inadequate.

[7]The schedule duration risk is applied to each activity duration to represent the inherent inaccuracy of scheduling.

- Medical technology may change.
- Work may be misfabricated.
- Equipment may not meet design requirements.
- Subcontractors may fail.
- Suppliers may not deliver equipment on time.
- Resident Engineer (RE) staffing may be inadequate.
- Contractor field office staffing may be inadequate.
- Architect/Engineer (A/E) staffing may be inadequate.
- Labor may not be available.
- Contractor coordination problems may exist.
- Communication between RE, contractor, and A/E may be ineffective.
- May experience problems testing systems.
- Construction disciplines may not be coordinated.
- Vendor drawings may not be submitted on time.
- Change orders under $100,000 may affect schedule.

Most risks received multiple responses during the interviews. During data analysis, we combined and analyzed data from the interviews to create ranges and probabilities for each of the 18 risk drivers.

Because risks are multiplicative, several risks occurring on the same activity may overestimate the true risk. That is, in the Monte Carlo simulation, risks occur in a series, one after another, so that an activity that has several risks may be unrealistically extended if all risks occur. For example, drawing approval activities may possibly be affected by RE, contractor field office, or A/E staffing being inadequate, as well as the schedule duration risk. If all risks occurred, drawing approval activities will most likely be overestimated. In reality, an activity may successfully recover from two or more risks simultaneously, so that the actual risk is not multiplicative. Therefore, to avoid overestimation of risk, the impact ranges of risks that occur together are reduced. That is, the 3-point duration estimates for risks that occur together frequently were reduced; in this particular analysis, we decreased the estimated duration impact ranges by a factor of 0.3. This adjustment helps temper any over-estimated risk caused by a multiplication of risk factors.

Of the 6,098 activities in the schedule, 3,193 had risk drivers assigned to them. Some activities had one or two risks assigned, but some had as many as seven assigned.

## Prioritizing risks and risk mitigation

Risks can impact the schedule in several ways: they can have a high probability of occurring, have a large percentage impact on the durations of the activities they affect, and/or they can apply to risk-critical paths, which may differ from the baseline deterministic critical path. Beyond applying 20 risks to the schedule, we are interested in identifying the marginal impact of each risk. That is, we are interested in identifying which risks have the largest impact on the schedule, because these are the risks that should be targeted first for mitigation.

To find the marginal impact of a risk on the total project risk at a certain percentile, the Monte Carlo simulation is performed with the risk removed. The difference between the finish dates of the simulation with all the risks and the simulation with the missing risk yields the marginal impact of the risk. Table 11 gives the priority of risks at the 80th percentile and the marginal impact of each risk.

**Table 11: Risks at the 80th Percentile**

| Risk | Marginal impact in calendar days |
|---|---:|
| Design may be inadequate | 59 |
| Occupancy needs may change | 48 |
| Change orders under $100,000 may affect schedule | 21 |
| Schedule duration estimates may be inaccurate | 18 |
| Construction disciplines may not be coordinated | 16 |
| System commissioning may take longer than a month | 15 |
| Work may be misfabricated | 8 |
| Labor may not be available | 5 |
| Suppliers may not deliver equipment on time | 6 |
| Steel design may be inadequate | 9 |
| Remaining risks | 5 |
| **Total** | **210** |

Source: GAO analysis of VA information.

The marginal impact directly translates to potential calendar days saved if the risk is mitigated. Once risks are prioritized at the percentile desired by management, a risk mitigation workshop can be implemented to deal with the high-priority risks in order. The prioritized list of risks will form the basis of the workshop, and risk mitigation plans can be analyzed using the risk model to determine how much time might be saved. Project managers cannot expect to completely mitigate any one risk nor is it reasonable to expect to mitigate all risks. In addition, risk mitigation will add to the project budget. However, some opportunities may be available to partially mitigate risks.

## Schedule issues

During our interviews with the local VA office in North Las Vegas, we identified several missing activities:

- Redesign for ductwork.
- Submittal, approval, fabrication, and delivery of all Division 16 (electrical equipment).
- Effort related to building the tunnel from the central plant to the hospital basement.
- VA-furnished equipment delivery to the general contractor.
- Systemwide testing.
- Effort related to telecommunications.

Missing activities will lead to an underestimation of schedule risk because these activities may become critical either in the baseline schedule or the SRA. In particular, the missing fabrication and delivery of electrical equipment assumes that the equipment will be at the construction site when needed. Since the schedule does not contain activities for the delivery of this equipment, risks leading to delays in delivery of electrical equipment are not reflected in the SRA results.

Additionally, during our analysis, we identified 58 remaining activities with finish dates that did not drive successor activities. That is, the activities are open ended. This is a potential problem because the open-ended activity can have an extended duration and not drive any successor in the SRA simulation. However, officials stated that they were aware of these open ends and they did not believe them to be an issue.

# Appendix VI: Cost Increases and Schedule Delays

We found some projects that experienced both cost increases and schedule delays, while other projects experienced only a cost increase and still others experienced only a schedule delay. All projects, and whether they experienced a cost increase, a schedule delay, or both, are in table 12.

**Table 12: Projects That Experienced a Cost Increase and/or a Schedule Delay**

| Location | Description | Cost increase | Schedule delay |
|---|---|---|---|
| American Lake, WA | Seismic corrections | | X |
| Anchorage, AK | Outpatient clinic | | X |
| Atlanta, GA | Modernize patient wards | X | |
| Bay Pines, FL | Outpatient clinic | X | |
| Biloxi, MS | Hospital restoration/consolidation | X | |
| Gulfport, MS | Environmental cleanup | | |
| Syracuse, NY | Spinal cord injury/disease center | X | X |
| Fayetteville, AR | Clinical addition | X | |
| Cleveland, OH | Brecksville consolidation | | X |
| Denver, CO | New medical facility | X | |
| Gainesville, FL | Renovate patient rooms | X | |
| Indianapolis, IN | Ward modernization | | |
| Columbia, MO | Operating suite replacement | | X |
| Las Vegas, NV | New medical facility | X | X |
| Long Beach, CA | Seismic corrections | X | |
| Martinsburg, WV | Capital region data center | | X |
| New Orleans, LA | New medical facility | X | |
| Des Moines, IA | Extended care building | X | |
| Palo Alto, CA | Seismic corrections building 2 | X | X |
| Palo Alto, CA | Centers for ambulatory care and polytrauma rehabilitation | | |
| Pittsburgh, PA | Medical center consolidation | X | |
| St. Louis, MO | Medical facility improvement and cemetery expansion | X | |
| San Antonio, TX | Ward upgrades and expansion | | |
| San Antonio, TX | Polytrauma center and renovation of building 1 | | |
| San Juan, PR | Seismic corrections | X | X |
| San Juan, PR | Seismic corrections | X | |
| Tampa, FL | Upgrade electrical system | | |
| Tampa, FL | Polytrauma expansion | X | X |
| Orlando, FL | New medical facility | X | |
| Temple, TX | IT building | | |
| Walla Walla, WA | Multi specialty care | | |

| Location | Description | Cost increase | Schedule delay |
|---|---|---|---|
| Milwaukee, WI | SCI Center | | X |
| **Total** | **32** | **18** | **11** |

Source: GAO analysis of VA data.

# Appendix VII: GAO Contact and Staff Acknowledgments

## GAO Contact

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## Staff Acknowledgments

In addition to the contact person named above, Tisha Derricotte, Colin Fallon, Hazel S. Gumbs, Ed Laughlin, Jason T. Lee, Susan Michal-Smith, Karen Richey, John W. Shumann, and Frank Taliaferro also made key contributions to this report.

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