Project Management Deficiencies in Constructing the Paul S. Sarbanes Silver Spring Transit Center

2014 Federal Audit Executive Council Annual Conference

September 3, 2014
Report at a Glance

Project Controls Weak or Ineffective
- Design
- Implementation
- Effectiveness

Deficiency with 14 of 22 controls
Alpha Corporation Subject Matter Expert Report

Addition of Water
Test specimens indicate more water at end of pour than beginning

Cold Weather Curing
- Incorrectly implemented
- Protection not maintained
- Temperature maintenance and monitoring
Concrete cured outside acceptable tolerances

Test Specimens Not Representative of In-Situ Concrete
Primary test specimens did not capture impact of water & cold

Concrete Placement
- Thickness not uniform
- Early identification
- Unresolved
Insufficient reinforcement cover evident
November 2010: Pour process never modified

Pour Strip Construction Deficiency
- Drawing submittal process weak
- Professional error
No control to identify expected shop drawings
Drawing omissions not detected by reviewers

Structural Design & Construction Problems Not Effectively Addressed by Project Management
- Repeatedly addressed at stakeholder meetings
- Not addressed effectively

Thermal & Flexural Design Issues Identified Early into Project
- Directed to Structural Engineer of Record to resolve
- Cracking persisted throughout all stages of construction

Contract Requirements Not Met
Deficiencies Not Detected

Despite early detection of cracking, project management did not effect correction
Project management responsibilities distributed among multiple stakeholders

Construction Controls
Structural Strength
Suspected Design Deficiencies
Project Management Deficiencies in Constructing the Paul S. Sarbanes Silver Spring Transit Center

The Paul S. Sarbanes Silver Spring Transit Center (SSTC)

A ground transportation facility located in downtown Silver Spring, Maryland at the intersection of Colesville Road and Wayne Avenue

Constructed by Montgomery County, to be operated by the Washington Metropolitan Area Transit Authority

Bus loops located on ground (Level 305) and second (Level 330) floors

Private vehicles and taxis use the third, smaller floor (Level 350)

Integrated with Metro Red Line and MARC Brunswick Line
Project Management Deficiencies in Constructing the Paul S. Sarbanes Silver Spring Transit Center

**KCE’s post-construction structural evaluation of the superstructure recommended**

Strengthening and repairs required to increase the combined shear and torsional capacity of certain beams and girders

Properly detailed concrete overlay on the top surface for the slabs of Levels 330 and 350 required to provide long-term durability.

Conditions at SSTC were caused in varying degrees by errors and omissions of:
- the designer, Parsons Brinckerhoff (PB)
- the contractor, Foulger-Pratt Contracting, LLC (FP) and its subcontractors, and
- the inspection and materials testing firm and Special Inspections Program Special Inspector, The Robert B. Balter Company (RBB)
Project Management Deficiencies in Constructing the Paul S. Sarbanes Silver Spring Transit Center

Why Montgomery County Office of the Inspector General Did This Inspection

Our objective: Identify and document any project management deficiencies during the construction of the Silver Spring Transit Center.

We attempted to determine:

- which project management controls failed,
- how these controls should have functioned,
- why they failed,
- what the project managers did know, could have know, and should have know, and
- what measures should be taken to ensure controls will be effective in future projects undertaken by Montgomery County.
Construction began in 2009

By June 2010, project already several months behind schedule due to unforeseen contaminated soil and utility relocations

By November 2010, visible evidence of structural issues and concerns about durability had emerged, including:

- Cracks discovered in the concrete slabs, beams and girders;
- Concrete that broke away from the finished drive surface (spalling), revealing post-tensioned tendons and evidencing that an insufficient concrete cover had been placed over the tendons;
- Issues related to post-tensioned tendon elongations and tensioning; and
- Reinforcing bars that were incorrectly installed or partially omitted in a slab pour.
Project Management Deficiencies in Constructing the Paul S. Sarbanes Silver Spring Transit Center

Location in downtown Silver Spring, Maryland
Intersection of Colesville Road and Wayne Avenue
Project Management Deficiencies in Constructing the Paul S. Sarbanes Silver Spring Transit Center

**Timeline:**

October, 1993 – April 2007:

MTA and County agree to MARC station relocation into new transit center. County Executive Douglas M. Duncan says the $20 million transit center will be complete in 1998.
Project Management Deficiencies in Constructing the Paul S. Sarbanes Silver Spring Transit Center

**Timeline:**

- **March, 2003:** Relocated MARC station opens.
- **Apr 1993:** Integrated Transit Center agreement. Cost at $20 mil.
Project Management Deficiencies in Constructing the Paul S. Sarbanes Silver Spring Transit Center

**Timeline:**

- April, 2004: Parsons Brinckerhoff awarded design contract.

- Mar 2003: Relocated MARC Station Opens
Project Management Deficiencies in Constructing the Paul S. Sarbanes Silver Spring Transit Center

**Timeline:**

- May, 2008: Foulger-Pratt awarded construction contract.
- Apr 1993: Integrated Transit Center agreement. Cost at $20 mil
- Mar 2003: Relocated MARC Station Opens
- Apr 2004: Parsons Brinckerhoff awarded design contract
Project Management Deficiencies in Constructing the Paul S. Sarbanes Silver Spring Transit Center

**Timeline:**

- **September, 2009:** Construction begins on Silver Spring Transit Center.
- **April, 1993:** Integrated Transit Center agreement. Cost at $20 mil
- **March, 2003:** Relocated MARC Station Opens
- **April, 2004:** Parsons Brinckerhoff awarded design contract
- **May, 2004:** Foulger Pratt awarded construction contract
Project Management Deficiencies in Constructing the Paul S. Sarbanes Silver Spring Transit Center

Timeline: April, 2010

Montgomery County Department of Permitting Services inspector raises concerns that post tensioning of the slabs and girders with the built in wall would create a zone of cracking in the slabs along certain points. Project budget increases to $95 million.
Project Management Deficiencies in Constructing the Paul S. Sarbanes Silver Spring Transit Center

**Timeline:**

- **August, 2010:** Concrete pouring begins.
- **Mar 1993:** Integrated Transit Center agreement. Cost at $20 mil.
- **Apr 1993:** Cost at $20 mil.
- **Aug 2010:** Concrete pouring begins.
- **Mar 2003:** Relocated MARC Station Opens.
- **Apr 2004:** Parsons Brinckerhoff awarded design contract.
- **May 2004:** Foulger Pratt awarded construction contract.
- **Apr 2010:** Inspector raises concerns. Cost at $95 mil.
- **Sep 2009:** Construction begins.
- **Apr 2010:** Cost at $95 mil.
Project Management Deficiencies in Constructing the Paul S. Sarbanes Silver Spring Transit Center

**Timeline:**

- September, 2010: Cracking first observed and workers report concrete is too thin in some areas of the center.
- Mar 2003: Relocated MARC Station Opens
- Apr 2003: Integrated Transit Center agreement.
- Apr 2004: Cost at $20 mil.
- Apr 2004: Parsons Brinckerhoff awarded design contract
- May 2004: Foulger Pratt awarded construction contract
- Apr 2009: Construction begins.
- Apr 2010: Inspector raises concerns.
- Cost at $95 mil.
- Aug 2010: Concrete pouring begins.
Project Management Deficiencies in Constructing the Paul S. Sarbanes Silver Spring Transit Center

Timeline:

October, 2010: Cracking observed in concrete slabs in some areas before post-tension commences. Spalling observed.

- Mar 2003: Relocated MARC Station Opens.
- Apr 2004: Parsons Brinckerhoff awarded design contract.
- May 2004: Foulger Pratt awarded construction contract.
- Aug 2010: Concrete pouring begins.
- Sep 2010: 1st cracking, thin Concrete.
Project Management Deficiencies in Constructing the Paul S. Sarbanes Silver Spring Transit Center

**Timeline:**

October, 2011: Project Management Plan maintained by project team indicates Substantial Completion of Project Construction milestone is achieved.
Project Management Deficiencies in Constructing the Paul S. Sarbanes Silver Spring Transit Center

**Timeline:**

- **April, 2010:** Inspector raises concerns. Cost at $95 mil.
- **Aug, 2010:** Concrete pouring begins.
- **Sep, 2010:** 1st cracking, thin Concrete.
- **Oct, 2010:** Cracking, spalling.
- **Sep, 2009:** Construction begins.
- **May, 2004:** Foulger Pratt awarded construction contract.
- **Apr, 2004:** Parsons Brinckerhoff awarded design contract.
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Remediation plan incorporating 2 inch Latex Modified Concrete (LMC) overlay is recommended.
Project Management Deficiencies in Constructing the Paul S. Sarbanes Silver Spring Transit Center

Timeline: May, 2012

Montgomery County contracts with KCE Structural Engineers, P.C. (KCE) to conduct a document review and structural evaluation of in-situ conditions at the SSTC.
Project Management Deficiencies in Constructing the Paul S. Sarbanes Silver Spring Transit Center

**Timeline:**

March, 2013: KCE Structural Engineers issues report on the SSTC stating the facility is “severely compromised” and requires extensive remedial strengthening and repair to meet Building Code and WMATA requirements.

- **Apr 1993:** Integrated Transit Center agreement. Cost at $20 mil
- **Mar 2003:** Relocated MARC Station Opens
- **Apr 2004:** Parsons Brinckerhoff awarded design contract
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- **Sep 2009:** Construction begins.
- **Oct 2010:** Inspector raises concerns. Cost at $95 mil.
- **Aug 2010:** Concrete pouring begins.
- **Oct 2010:** 1st cracking, thin Concrete.
- **Jun 2012:** County contracts KCE.
- **Apr 2012:** LMC remediation recommended.
- **Oct 2011:** SUBSTANTIAL COMPLETION.
- **Mar 2013:** Concrete pouring begins.
Project Management Deficiencies in Constructing the Paul S. Sarbanes Silver Spring Transit Center

**Timeline:**

July, 2013

OIG advises Montgomery County Chief Administrative Officer that it will conduct an inspection to identify and document any project management deficiencies during the construction of the Silver Spring Transit Center.
Project Management Deficiencies in Constructing the Paul S. Sarbanes Silver Spring Transit Center

**Timeline:**

- **September, 2013:** Latex Modified Concrete (LMC) overlay remediation approved
- **Aug 2010:** Concrete pouring begins.
- **Sep 2010:** 1st cracking, thin Concrete.
- **Oct 2010:** Cracking, spalling.
- **Jun 2012:** County contracts KCE.
- **Oct 2011:** SUBSTANTIAL COMPLETION.
- **Sep 2009:** Construction begins.
- **Apr 2010:** Inspector raises concerns. Cost at $95 mil.
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- **Oct 2011:** SUBSTANTIAL COMPLETION.
- **Apr 2012:** LMC remediation recommended.
- **Mar 2013:** KCE issues report.
- **Jul 2013:** OIG commences inspection.
- **Jun 2012:** County contracts KCE.
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- **Jul 2013:** OIG commences inspection.
- **Jun 2012:** County contracts KCE.
Project Management Deficiencies in Constructing the Paul S. Sarbanes Silver Spring Transit Center

**Timeline:**

- December, 2013: Remedial work on pour strip reinforcement complete.
- July 2013: OIG commences inspection.
- September 2013: LMC overlay remediation approved.
- June 2012: County contracts KCE.
- October 2011: Substantial Completion.
- April 2012: LMC remediation recommended.
- April 2010: Concrete pouring begins.
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- September 2010: Cracking, spalling.
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Project Management Deficiencies in Constructing the Paul S. Sarbanes Silver Spring Transit Center

Timeline:

April, 2014: OIG provides its report for comment by county. Advisory committee appointed by County Executive recommends addressing safety hazard by strengthening structure and protecting post tensioning and reinforcement. Estimate additional cost of $11M and eight month delay.
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**Timeline:**

Today:

Remediation work to install additional load bearing beams and place 2" LMC overlay continues under direction of KCE. Advisory Group commissioned by County Executive projects completion around April 2015 at a cost of $131 million. KCE’s chief executive officer opines “When I know how long it will take, I can tell them when I’ll be done.”

- **Mar 1993** Integrated Transit Center agreement. Cost at $20 mil
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- **Oct 2010** Cracking, spalling.
- **Sep 2009** Construction begins.
- **Apr 2010** LMC remediation approved.
Portland cement is a fine powder produced by heating materials in a kiln to form what is called cement clinker, which is ground, and to which small amounts of other materials are added.

The materials in cement clinker are alite, belite, tri-calcium aluminate, and tetra-calcium alumino ferrite.
A composite material in which Portland cement, water, aggregates, and admixtures are bound together through a chemical and physical reaction of cement with water (hydration) in the presence of sufficient water and heat.

Concrete construction requires proper curing to increase concrete strength and durability.
## Construction 101: Recipe for Concrete

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amount (lbs)</th>
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<tbody>
<tr>
<td>stone/gravel</td>
<td>1,850</td>
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<tr>
<td>sand</td>
<td>1,000</td>
</tr>
<tr>
<td>Portland cement</td>
<td>550</td>
</tr>
<tr>
<td>slag</td>
<td>360</td>
</tr>
<tr>
<td>water (36 gal)</td>
<td>297</td>
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<tr>
<td>admixtures to taste to obtain</td>
<td>17</td>
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<tr>
<td>concrete characteristics (dry</td>
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<tr>
<td>time, workability, etc.)</td>
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</table>

Combine ingredients in large drum mounted to back of truck. Rotate drum at least 70 turns to mix. Do not add any additional ingredients after mixing. Serve within 90 minutes. Maintain surface temperature between 55\(^\circ\) F and 75\(^\circ\) F until cured.

Makes 10 cubic yards
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**Construction 101: Terminology - Water to cement ratio (w/c)**

The ability of cement to bind the aggregates together is affected by the ratio of water to cement.

*w/c* is the factor that most influences concrete strength – the higher the ratio of water to cement, the weaker the concrete and vice versa.

Can only be determined:
- By weight measurement at time of batching the concrete
- By petrographic examination of cured concrete specimens
- Can be estimated at time of pour by use of slump testing
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**Construction 101: Terminology - Spalling**

Spalling is the process of surface failure in which flakes of a material (spall) are broken off a larger solid body and shed. Spalling is usually caused by corrosion, weathering, cavitation, or excessive pressure.
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**Construction 101: Terminology - Post-tensioned concrete**

When a spanned concrete surface is presented with a load to bear

- The surface will bow in deference to the load
- However, when post-tension tendons are embedded within the concrete span
- And the tendons are stressed within three days of pouring the concrete
- The surface will convex
- Allowing it to counteract the load
Construction 101: Terminology - Columns, Girders, Beams, and Slabs
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Construction 101: Structural reinforcement assembly

- Stirrups
- Post-tensioning tendons
- Reinforcing Steel “Rebar”
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1. Construct formwork
2. Position Girder reinforcing steel and stirrups
3. Position Beam reinforcing steel and stirrups
4. Position Deck slab reinforcing steel and stirrups
5. Place and secure post-tensioning tendons
6. Pour the concrete
7. and allow the concrete to cure
8. Remove the formwork
9. and stress the tendons
10. and hope the concrete has cured enough to prevent stress cracks
11. Oops!
Project Management Deficiencies in Constructing the Paul S. Sarbanes Silver Spring Transit Center

Report at a Glance

**Compressive Strength**

**Concrete Placement**
- Thickness not uniform
- Early identification
- Unresolved

**Addition of Water**
- Test specimens indicate more water at end of pour than beginning

**Cold Weather Curing**
- Incorrectly implemented
- Protection not maintained
- Temperature maintenance and monitoring
- Concrete cured outside acceptable tolerances

**Test Specimens Not Representative of In-Situ Concrete**
- Primary test specimens did not capture impact of water & cold

**Pour Strip Construction Deficiency**
- Drawing submittal process weak
- Professional error
- No control to identify expected shop drawings
- Drawing omissions not detected by reviewers

**Deficiencies Not Detected**

**Contract Requirements Not Met**
- Insufficient reinforcement cover evident
- November 2010: Pour process never modified

**Structural Strength**
- Concrete cured outside acceptable tolerances

**Suspected Design Deficiencies**

**Construction Controls**

**Thermal & Flexural Design Issues Identified Early into Project**
- Directed to Structural Engineer of Record to resolve
- Cracking persisted throughout all stages of construction

**Structural Design & Construction Problems Not Effectively Addressed by Project Management**
- Repeatedly addressed at stakeholder meetings
- Not addressed effectively

**Report at a Glance**

**Deficiency with 14 of 22 controls**
- Alpha Corporation Subject Matter Expert Report

**Deficiency with 14 of 22 controls**

Despite early detection of cracking, project management did not effect correction

Project management responsibilities distributed among multiple stakeholders

**Deficiency with 14 of 22 controls**

Project Controls Weak or Ineffective
- Design
- Implementation
- Effectiveness

**Deficiency with 14 of 22 controls**

With 14 of 22 controls

Project management responsibilities distributed among multiple stakeholders
Project Management Deficiencies in Constructing the Paul S. Sarbanes Silver Spring Transit Center

**Weak or ineffective project controls**

- project controls used during the construction of the SSTC evaluated by Subject Matter Expert, Alpha Corporation
- deficiencies identified in KCE and WDP reports related to 14 weak or ineffective controls out of 22
- could and should have directly controlled the construction activities

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**Location of Concrete Specimen Testing**

**Sample Collection**

- Specimen testing samples should have been collected at point of placement
- Consistently weaker than anticipated test results should have led to discovery/correction of concrete mixture issues at early stage
- Weak concrete in structure could have been avoided
- Stronger overall structure
- Would have diminished impact of stress cracks due to tensioning of premature concrete

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![Image 4: Level 330 East Pour Strip Concrete Placement – January 12, 2011](image4.png)

Legend:
1. Concrete Truck
2. Pump Hopper
3. Concrete Pump Truck
4. Pump Discharge Pipe, Hose, & Crane Assembly

Source: Montgomery County Maryland Department of General Services
Project Management Deficiencies in Constructing the Paul S. Sarbanes Silver Spring Transit Center

**Specified Design Strength of In-situ Concrete**

- Strength of in-situ concrete significantly lower than construction specimens even after 1+ year
- Weaker concrete acted to exacerbate other deficiencies
  - slab thickness
  - pour strip reinforcing and tensions
  - design
  - stress cracking due to tendon tensioning

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### Chart 3: Comparison of Same Batch, Inspection Station to Surface Deck Field Cured Strength Results

<table>
<thead>
<tr>
<th>Concrete Batch</th>
<th>Truck #</th>
<th>Ticket #</th>
<th>Location</th>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Sample 1</th>
<th>Sample 2</th>
<th>3-Day Strength</th>
<th>28-Day Strength</th>
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</thead>
<tbody>
<tr>
<td>1-D</td>
<td>67</td>
<td>9101</td>
<td>Inspection Station</td>
<td>6.5</td>
<td>5.1%</td>
<td>20.0</td>
<td>71</td>
<td>0.25</td>
<td>34</td>
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</tbody>
</table>


3-Day Strength results for Pour 1 F were actually tested on Day 4.
Cold Weather Curing

- Concrete test specimens should have been cured on deck under curing blankets.
- 3-day test results would more accurately reflect condition of in-situ concrete.
- Timing of post-tensioning commencement corrected to avoid cracks from premature tensioning.
Project Management Deficiencies in Constructing the Paul S. Sarbanes Silver Spring Transit Center

Data Documenting Deficiencies Existed – Was Not Analyzed

- Routine construction records documented construction & control deficiencies
- Available to all stakeholders
- Evidenced deficiencies that should have been investigated as to cause(s)
- Though not a requirement, available data, if analyzed, would have identified deficiencies
- Known deficiencies were not effectively corrected

“The County will be looking to you as the SER to provide us the guidance in this issue. We all are sensitive to keeping with schedule, but that should not keep us from doing what is right for the long term of the facility.”

Donald Scheuerman, Jr., Chief, Project Management Section, DGS
October 28, 2010
Project Management Deficiencies in Constructing the Paul S. Sarbanes Silver Spring Transit Center

Independent Peer Review

- An independent “peer review” contractor should have been employed
- Work with the Parsons Brinckerhoff-led design team to validate:
  - design engineering and architecture
  - engineering calculations
  - project controls
- Identify design issues that could have been avoided
Independent Construction Manager

- An independent construction manager should have been employed
- Oversee project from planning to completion
- Ensure requisite course corrections are made early upon discovery

<table>
<thead>
<tr>
<th>SSTC “Construction Management” Responsibilities as Performed</th>
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<tbody>
<tr>
<td>Construction Management Element</td>
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<tr>
<td>Conduct &amp; Document Periodic Progress Meetings</td>
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<tr>
<td>Document Control</td>
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<tr>
<td>Cost Tracking &amp; Management</td>
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<tr>
<td>Evaluation of Payment Requests</td>
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<tr>
<td>Change Order Management</td>
</tr>
<tr>
<td>Quality Management</td>
</tr>
<tr>
<td>Review Daily Quality Control (QC) reports</td>
</tr>
<tr>
<td>Complete Daily CM Log</td>
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<tr>
<td>Schedule Control</td>
</tr>
<tr>
<td>Review and verify contractor’s project record drawings are updated</td>
</tr>
<tr>
<td>Monitoring Contractor Safety</td>
</tr>
<tr>
<td>Conduct inspections</td>
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<tr>
<td>Issue inspection deficiency letter to the contractor</td>
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</tbody>
</table>

Source: OIG Staff Analysis
Project Management Deficiencies in Constructing the Paul S. Sarbanes Silver Spring Transit Center

“When I know how long it will take, I can tell them when I’ll be done.”

Allyn Kilsheimer
CEO, KCE Structural Engineers
Washington Post Interview, August 17, 2014
Project Management Deficiencies in Constructing the Paul S. Sarbanes Silver Spring Transit Center
Project Management Deficiencies in Constructing the Paul S. Sarbanes Silver Spring Transit Center

Timeline:

October 1993 - April 1997:
- MTA and County agree to MARC station relocation into new transit center. County Executive Douglas M. Duncan says the $20 million transit center will be complete in 1998.
- $20m Federal funding. Cost up to $40m.

1998:
- Design submission. 2002 completion.
- 2 phase development. 2003 completion. Cost up to $57.2m.

2000:
- Project completion expected 2007.

2001:
- WMATA selects Foulger-Pratt as co-development partner.

2002:
- Project completion expected 2007.

2003:
- Relocated MARC station opens.

2005:
- Project cost up to $75m.

2006:
- Road work, bus stop relocations begin.
- Foulger-Pratt awarded construction contract.

2008:
- Contaminated soil first encountered.

2009:
- Construction begins on SSTC.
- Foundations work begins. Inspector questions design. Cost up to $95m.

2010:
- Substantial completion.
- Project cost up to $99m.

2011:
- OIG report. Advisory group report – additional $11m.
- Pour strip remediation completed.

2012:
- Remedial work spring 2013.

2013:
- OIG report. County Council approves project. Cost up to $119.5m.
Project Management Deficiencies in Constructing the Paul S. Sarbanes Silver Spring Transit Center
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Project Management Deficiencies in Constructing the Paul S. Sarbanes Silver Spring Transit Center
Project Management Deficiencies in Constructing the Paul S. Sarbanes Silver Spring Transit Center

**Timeline:**

- **April, 2010:** Montgomery County Department of Permitting Services inspector raises concerns that post tensioning of the slabs and girders with the built in wall would create a zone of cracking in the slabs along certain points. Project budget increases to $95 million.

- **Mar 2003:** Relocated MARC Station Opens
- **Apr 2004:** Parsons Brinckerhoff awarded design contract
- **May 2004:** Foulger Pratt awarded construction contract
- **Oct 2011:** Substantial completion.
- **Apr 2012:** LMC remediation recommended.
- **Jun 2012:** County contracts KCE.
- **Mar 2013:** KCE issues report.
- **Jul 2013:** OIG commences inspection.
- **Dec 2013:** Pour strip remediation completed.
- **Sep 2014:** LMC overlay remediation approved.
- **Apr 2015:** Advisory Group issues recommendations. Cost at $131 m. Est. completion Apr 2015.
- **Aug 2010:** Concrete pouring begins.
- **Sep 2010:** 1st cracking, thin Concrete.
- **Oct 2010:** Cracking, spalling.
- **Nov 2010:** Concrete pouring begins.
- **Dec 2010:** Pour strip remediation completed.
- **Jan 2011:** LMC overlay remediation approved.
- **Feb 2011:** Substantial completion.
- **Mar 2011:** County contracts KCE.
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